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TECHNOLOGY AUDIT OF THE NIGERIAN AGRICULTURAL SECTOR: TOWARDS FOOD SECURITY

Technology-driven innovation has been generally believed to play a key role in the building of a sustainable economy. The object of the research is the audit of agricultural technology for businesses in Nigeria. This research aimed to audit the existing technologies for agricultural businesses in Nigeria, in a bid to determine the technological strengths, weaknesses, opportunities and needs that are required to transform the sector to an enviable status.

The methodology involved the use of a well-structured questionnaire for data collection from 133 randomly selected agriculture-based firms, spread across the country. The instrument inquired about the technology use, needs, and prospective technological potentials. Issues relating to effective utilization, technology diffusion, and factors affecting the firms were also assessed.

The results of the technology audit of the Nigerian agriculture sector revealed the prevalence of medium and low-classed technologies among the surveyed firms, while a majority desired the technologies in the medium-to-high category. Firms scarcely (4.4 %) deploy high technologies, and effective diffusion of available technologies is due largely to human/technical factors. A good percentage of respondents affirmed competency and continuous training as critical factors for the effective utilization of technologies. Finances are critical not only to acquire, but also to run, maintain, hire experts, and perform other necessary activities that would enhance effective use of technologies.

The present results revealed that most firms do not opt for high technologies mainly because of a huge capital base, and unavailability of basic infrastructures such as power, and space which many of the surveyed firms considered unsurmountable. Thus, a lot is required technology-wise for Nigeria to achieve sustainable and innovative agricultural growth.

Keywords: *technology audit, agriculture sector, economic development, sustainable agriculture, innovative agricultural growth.*

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1. Introduction

Past administrations at various levels in Nigeria have made frantic efforts towards rebounding the lost glory of the nation's agriculture sector, back to its state before crude oil discovery. In the 50s, agriculture contributed as much as 63.49 percent to the Gross Domestic product (GDP) of the country's economy [1], this was lost to the discovery and then overreliance on crude oil to the detriment of other sectors, and the economy at large. During the years of the oil boom, the export revenue generated from crude oil accounted for over 85 % of government revenue in 2015 [2]. However, with the collapse of oil price in the international market, the Nigerian economy has experienced inflation, unemployment, security challenges, poor value addition to products, high incidence of poverty and depreciation of the national currency [3]. Worse still, between 2016 and 2017, the Nigerian economy plunged into recession, with grievous consequential impacts on diverse areas of the nation's economy. This gave rise to the economy diversification agenda of governments at all levels in the country.

Following the recession that hit the Nigerian economy in 2016, the administration led by President Muhammad Buhari launched the Economic Recovery and Growth Plan (ERGP). The ERGP was a policy document principally designed to enhance the diversification of the economy and provide support to ensure sustained technological growth pathways. In resonance with global best practices, the ERGP emphasizes the significance of a knowledge-based economy, driven by Science, Technology, and Innovation (STI). The plan equally prioritized agriculture as one of the productive sectors that must be driven by STI for increased productivity. In agreement with the plan, [4] in «the role of Science, technology, and Innovation in ensuring food security by 2030» emphasized the significance of deploying new and emerging technologies to food security and agricultural development. Other authors also specified that technology adoption is a key driver of agricultural sustainability, profitability, efficiency, safety, and environmental friendliness [5–7].

It is therefore pertinent that the country exploits technological opportunities in actualizing the much-desired innovation in the agricultural sector. Thus, underscoring the significance of auditing available technology in the sector.

Auditing technologies in a sector is a critical strategy for the identification of existing technologies, recognizing technology needs, exploring technology trends, and establishing a detailed course of action toward effective technology use [8]. In addition, a technology audit (TA) report furnishes policymakers and other stakeholders with significant information on technological requirements in a sector, as well as what opportunities are available for competitive advantage.

Sustainable and innovative agricultural growth is a goal of several governments in Nigeria. In achieving this feat, technological innovations offer the benefits of sustainability, profitability, efficiency, and environmental friendliness in the last decades; and have been an instrument to transform agriculture sectors in many developed countries. However, in Nigeria, there is a paucity of data to ascertain technological innovation potentials and competitiveness in the agricultural sector. These indices are mainly evaluated through a technology audit (TA) exercise. Among other benefits, TA gives information as to the type and state of technologies deployed by firms or industries, the qualities of the available workforce, and what technologies are required for optimum business performance. Thus, *the aim of current study* is to conduct a technology audit of the Nigerian agricultural sector in a bid to assess the technological strengths, weaknesses, opportunities and needs that are required to transform the sector to an enviable status. To do this, it is necessary to complete the following tasks:

1. Identify and categorize existing technologies used by agricultural firms in Nigeria.

2. Determine firms' technology acquisition plans and factors affecting the same.

3. Evaluate the extent of utilization and diffusion of technologies in the sector.

4. Investigate the extent of local manufacture of technologies.

2. Materials and Methods

2.1. Contextual discourse – agriculture in Nigeria. Agriculture has been described as the most important economic sector, with a high socioeconomic importance for many countries [4]. This is the case in the pre-independence era in Nigeria, where agriculture had consistent and significant contributions to the economy, and contributed as much as 63.5 % to the Gross Domestic Product (GDP), and employed about 70 % of the total workforce [1, 9]. However, the rhetoric changed upon large discovery and overreliance on crude oil, which plunged the economy into a mono sector, leading to a neglect of other productive sectors, including agriculture. The percentage of the working population in the sector decreased over time as a result of the sector's long-term neglect and the resulting decline in its economic contribution [10]. Only 38 per cent of the working population was employed by the sector in 2015 [11].

Moreover, several factors further hindered the growth and development of agriculture in the country, one of which is subsistence-level farming, which is small-scale and operated with much tedium. Studies such as [12, 13] revealed that more than 80 percent of farming activities in Nigeria are undertaken at the subsistence level. Another major challenge to the advancement of the agricultural sector is insufficient capital investment and the prevalent use of primitive technology [14, 15]. The last two factors impede technological knowledge that provides a reliable critical and potential pathway to the expansion and development of the sector.

Furthermore, the United Nations projects Nigeria's population to be about 389 million by the year 2050. This signifies a great challenge to the Nation's agriculture, in terms of food and nutrition security. Feeding this huge population requires a paradigm change to the current practices, driven largely by the adoption of new, improved, and existing agricultural technologies. Improved and cutting-edge agricultural technologies are necessary to increase agricultural productivity, according to [5, 7]. Technology deployment remains a major force behind agricultural sustainability, profitability, efficiency, safety, and environmental friendliness in the last centuries. To achieve the sector's rapid growth, it is crucial to prioritize the use of technological innovations for agricultural development.

2.2. Potentials of agriculture to the Nigerian economy. Agriculture has played a significant role in the building and supporting of sustainable economies in societies since times immemorial. It is a critical tool for the socioeconomic development of many countries through the supply of food, employment, income, nutrition, rural development, social fabric, etc. [4]. Because of this tremendous benefit, achieving agricultural growth is focal to the development policies of many nations. However, for agriculture to excel maximally, in ensuring food security, poverty reduction, and fostering sustainable economic growth, paradigm changes to agricultural systems are required [6]. The deployment of new and existing applications of science, technology, and innovation across the food system, has been emphasized. The use of appropriate technologies for all aspects of agricultural practices should be part of all transformation agendas to replace the traditional and archaic techniques that are still widely used in many developing nations, including Nigeria. Several authors have stressed the significance of the adoption of new, improved, eco- and user-friendly technologies in any sustainable agricultural program [16–18].

2.3. Science and technology for agricultural development. Technology-driven innovation has been generally believed to play a key role in the building of a sustainable economy. Technology is pivotal to growth and competitiveness in business. This is logical because high-tech-intensive firms tend to innovate more, win new markets, use available resources more productively, and generally offer better pay to their employees [19]. Although the potential of agriculture as an engine of economic growth has been well argued, its contribution remains insignificant in many climes due to several factors including the use of traditional techniques.

Agricultural businesses and food systems have witnessed a paradigm change over the last 60 years, especially in developed countries with the introduction of agriculture technology. The strength of science and technology can and in fact, have been wielded to boost agricultural productivity at every point along the agricultural value chain from farm-market-fork. The green revolution in the 1960s was borne out of the massive deployment of agricultural technology to boost production in Asian countries. Benefits obtainable from the adoption of tech include cost reduction,

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reduction in seed and pesticide use, improved crop handling process, reduction in insect and pest infestation, increased yield, reduction in grain, and better-quality product.

The deployment of modern high-yielding varieties of rice and improved ground-water-based, small-scale shallow tube well-based irrigation systems resulted in profound success in cereal and rice production in Bangladesh. As a result of which, the country attained self-sufficiency in rice food production [18, 20]. Similarly, Nepal's adoption of mechanized farming in rice resulted in a lowering of the production cost by up to 27 % [21]. In [22] it was reported that the use of integrated pest management, row seeding, and harvesting by machine and rice dryers proved to increase paddy yields.

2.4. Categorization of industrial technologies. In literature, technologies are often classified contextually, including new/trending and emerging technologies. Industrial technologies are also categorized, based on sizes, products, and sectors. The OECD Secretariat has taken the lead in paving the path to classify industries by levels of technology. Two major approaches adopted involved classification based on products and sectors, none without its limitations. The classification by product utilizes the level of complexity of industry outputs to classify into high-, medium- and low-tech products. The fact that intercountry comparison is difficult is a major limitation of this approach.

Meanwhile, sectoral classification is mainly based on the technology intensity of a firm or industry, and uses both direct (production of technology) and indirect (use of technology) R&D intensity to classify into any of the four categories:

1) high-technology;
2) medium-high-technology;
3) medium-low technology;
4) low-technology [19, 23].

Some authors [24, 25] classified industrial technologies into high, medium, and low, each with defining characteristics:

1. *Low technology*: Mainly refers to technologies that are used widely by society, due to the simplicity of their operation. Such technologies require people with relatively low levels of education or skill, and low levels of research expenditure, and are often manually operated.

2. *Medium technology*: this category falls between high and low technologies. They are more mature than those in the low category and are more amenable than others to technology transfer.

3. *High technology* is a necessity for technological innovation; and requires high technical know-how to operate. It also involves a high level of research and development expenditure.

2.5. Classification of agricultural technology based on type and use. Modern technologies for sustainable agriculture differ in size, sophistication, functions, and cover the whole spectrum of farming systems. Several technologies have been developed to mitigate some challenging aspects of agricultural value. Some of these include:

– amelioration of biotic and abiotic stresses;
– improve crop production (row seeding, planters, harvesters' machine, pest-resistant crops, pest-resistant eggplant, rust-resistant varieties, tilling machines, spatial repellent for on-farm pests);
– improved water storage and irrigation system;
– environmental protection;
– improve soil fertility;
– precision technologies;
– power and control-intensive operations;
– improved agronomic practices;
– post-harvest management (dryers, improved crop storage technologies, preservation, cold chain technologies);
– integrated pest management;
– climate-adjusted seeds;
– modern management practices;
– conservation of resources using scale-appropriate new agricultural machinery, agro-processing technologies, etc. [4, 18, 22].

A classification of technology based on sector and product sophistication was discussed in [19].

2.6. Audit and development. An audit is a systematic exercise undertaken to identify, measure, and verify the status of a subject or an organization in any particular area [26, 27]. Auditing is an important growth strategy, as it enables an organization to identify opportunities and limitations, and create channels to overcome deficiencies, thereby placing it in a competitive vantage position. An accurate audit provides unbiased evidence about the subject of the examination. Different aspects of an organization can be audited, however, common areas reported in scholarly literature include information, financial, project, innovation, process, clinical, and technology audit [8, 26, 28, 29].

Technology audit (TA) as an important knowledge map strategy, has been described as a form of innovation audit, as it aids in the identification of an organization's technological capacity, procedures, and needs. Its prominence emanated from a diverse model in the European environment in the 90s and mainly applied to small and medium-sized enterprises (SMEs) [24, 30]. Among other benefits, a successful TA is an instrument for the optimal exploitation of technologies and sheds light on factors that can positively or negatively affect the technological advancement of the organization [8, 24]. It is critical to the identification and classification of technological assets of SMEs. This enables the organizations to explore trends in technology and establish a detailed course of action toward tech-wise development. The TA process reveals the strengths and weaknesses of a firm's technology process while keeping the organization coherent with the latest technology trends [28]. [8] reported a strong relationship between the TA exercise and the creation, acquisition, and exploitation of technology in Pakistani training institutes.

2.7. Technology audit measurement. Tech audit has been conducted on high-innovative potential sectors including manufacturing, service, education, etc. and is very applicable to SMEs that are willing to create new products, incorporate new processes, diversify their activities and with growth potential. In [30] alluded to the fact that there exists no 'universal' standards method for conducting a technology audit, certain results are expected from a well-conducted technology audit exercise. It highlights a firm's technology portfolio; its requirements for its sustainable growth, the firm's innovation propensity, and the identification of technological trends and markets. The methodology adopted is dependent on the sector, firm, and institution of interest. TA has been done in the education sector in many nations [31, 32]. In [8] investigated the impact of tech audits on tech capabilities in Pakistani training institutes. Major variables of interest in TA measurements include the tech environment, tech capabilities, tech categorization, tech acquisition and exploitation [8, 33].

2.8. Methodology

2.8.1. Data, sample, and research design. A stratified sample technique was employed to select firms in two different stages. Based on the classification of the 36 states of the country into six (6) geo-political zones, 6 sampling strata were identified. Thereafter, 190 agriculture firms were randomly selected using the registered archive of agri-firms across states. Selected firms were visited between July and December 2019 with a copy of the survey instrument. The latter is a well-structured questionnaire used to obtain information on various technologies employed in the firm's day-to-day activities. One questionnaire is administered per firm and was completed by a senior staff, including a chief executive officer, senior manager, or any designated officer. The questionnaire included both close-ended and Likert scale questions.

Firm-level information obtained includes basic information about the firms, the current portfolio of state-of-the-art technologies and future technology needs to enhance their productivity; technology sourcing, future technology acquisition plans, utilization, and diffusion of technologies. The diverse technologies in use by firms were collated and classified into low, medium, and high technology as previously described [24, 25] to capture the agriculture context.

A total of 133 firms responded to the instrument, which implies a 70 % response rate. Data obtained through the questionnaire were analyzed using descriptive analysis.

2.8.2. Key assumption. The current study conducted an audit of machinery and equipment. Other technologies such as intellectual assets as licensing, and trademarks were not captured.

3. Results and Discussions

3.1. Contextual information of the surveyed firms. The agricultural activities undertaken by surveyed firms are divided into four main areas. Fig. 1 shows that the majority of them are involved in crop and livestock production.

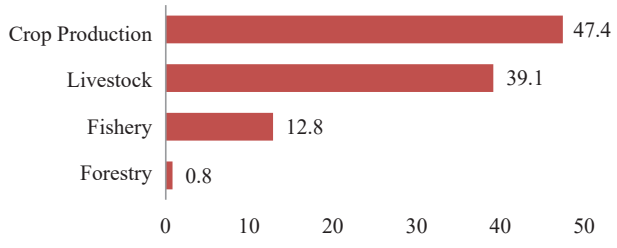

Fig. 1. Distribution of firms by sub-sector

Following categorization of firms by size [34], a good percentage of the firms are SMEs (Fig. 2).

The next information reveals that 93 (72.7 %) of the firms were between their first and tenth year of existence, and only two firms (1.6 %) have been in business for more than 30 years (Fig. 3).

3.2. Technology audit of firms. The systematic audit and classification of available technologies for agri-businesses in the surveyed firms are presented in Table 1. Only 24 of the 513 technologies declared by firms were at best classified as high technology, while more than half (55.8 %) fall under the medium-to-high technology category. A majority of the needed technologies (73.2 %) fall within the medium-to-high category (Table 1).

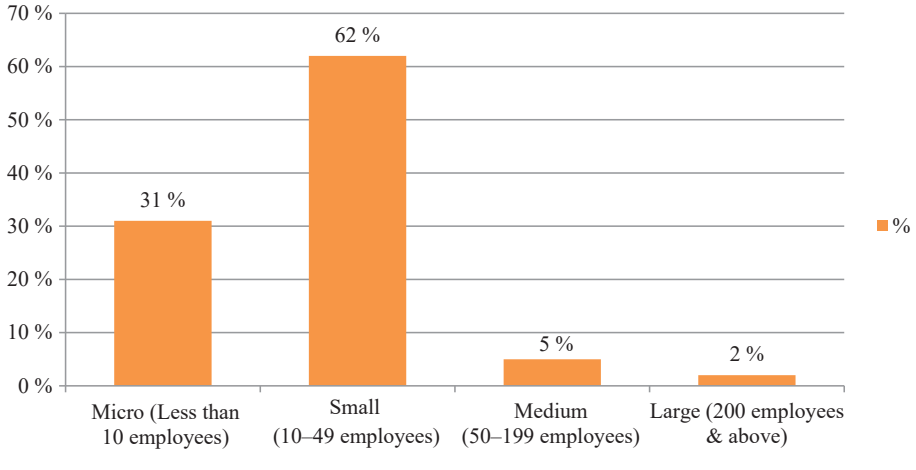

Fig. 2. Classification of Firms by Size

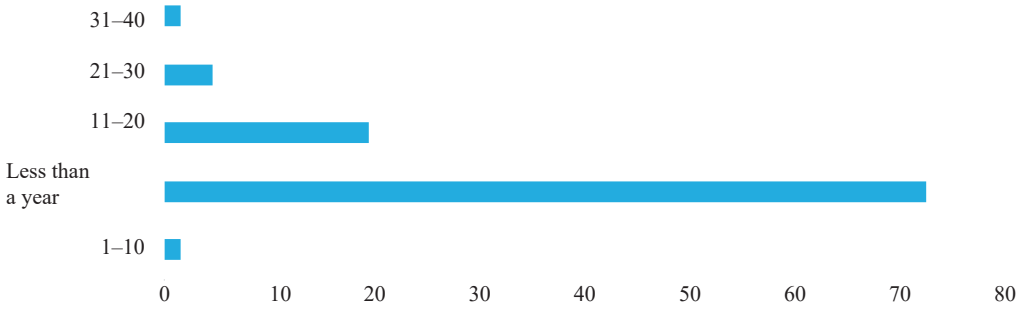

Fig. 3. Classification of Firms by Age

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Additionally, respondents to the survey mentioned technologies that they believed were most important to core agricultural activities; when these were categorized, two-thirds of the sixty-three technologies falls under the low-tech category. This is closely followed by the medium-high category, which accounts for about one-third of the total (Table 1).

Table 1

Technologies available for performance of firms' core activities

Type of Technologies Deployed	Frequency	%
High technology	24	4.4
Medium-high technology	307	55.8
Medium technology	3	0.5
Low technology	216	39.5
Total	550	100.0
State-of-the-art technologies needed to enhance firms' productivity	–	–
High technology	6	2.6
Medium-high technology	167	73.2
Medium technology	1	4
Medium-low technology	3	1.3
Low technology	51	22.4
Total	228	100.0
Most important technologies used for firms' operations	–	–
Medium-high technology	24	38.1
Medium-low technology	1	1.6
Low technology	38	60.3
Total	63	100.0

Note: field survey

Furthermore, the survey sourced information on the local availability and affordability of the firms' most important technologies (Table 2). Although about half of the respondents opined that their most important technologies are scarce, about two-thirds agreed that these technologies are available in the country. In relation to affordability, 4 out of every 5 respondents (82.9 %) agreed that their most important technologies are expensive to acquire, but can be locally fabricated (Table 3).

Table 2

Perception of respondents on availability of the most important technologies to firms

Perception	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Available in Nigeria	2.0	8.1	25.3	33.3	31.3
Scarce to come by in Nigeria	13.1	35.4	16.2	21.2	14.1
Expensive to acquire	3.0	9.1	5.1	27.3	55.6
Available in your firm	8.2	13.4	16.5	39.2	22.7

Table 3

Possibility of local manufacture of technologies

Technologies can be manufactured locally	Frequency	%
No	29	25.0
Yes	87	75.0
Total	116	100.0
Types of Technologies that can be manufactured locally	–	–
High	1	3.2
Medium-to-high	15	48.4
Low	15	48.4
Total	31	100.0

3.3. Technology acquisition plans. To unravel critical challenges besetting firms' investment in new technologies, respondents were asked to indicate how certain factors influence the same using five choice levels. The responses are categorized into organizational, finance, infrastructure, human capital, technological, and governmental factors, and hereafter discussed sequentially.

First is the organizational factor where the majority of the respondents claimed that insecurity (80.6 %), lack of awareness (59.0 %), and fear of uncertainty (55.8 %) are all likely to prevent them from investing in new technologies (Fig. 4).

Next, is the finance factor, over half of the respondents attested to all itemized finance-related elements as likely factors preventing investment in new technologies (Fig. 5). Moreover, lack of electricity (87.5 %) and poor infrastructure (68.3 %) are two infrastructure facilities that respondents perceived as negatively influencing investment in new technologies (Fig. 6)

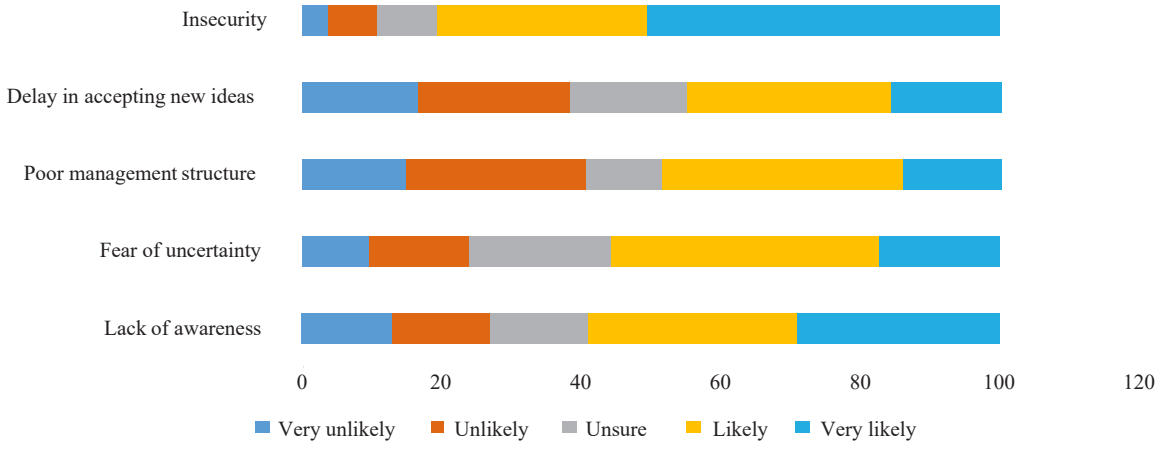

Fig. 4. Perception of organizational factors that prevent investment in new technologies

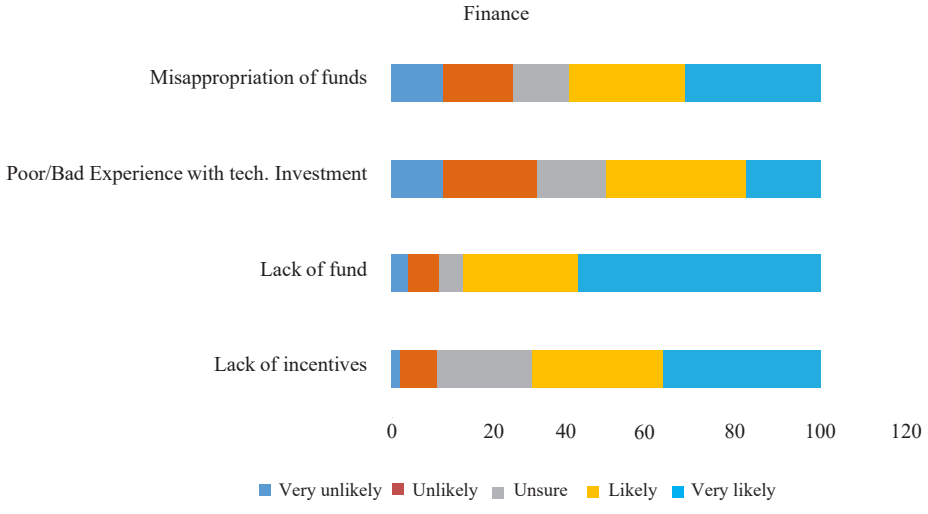

Fig. 5. Perceptions on financial factors that prevent investing in new technologies

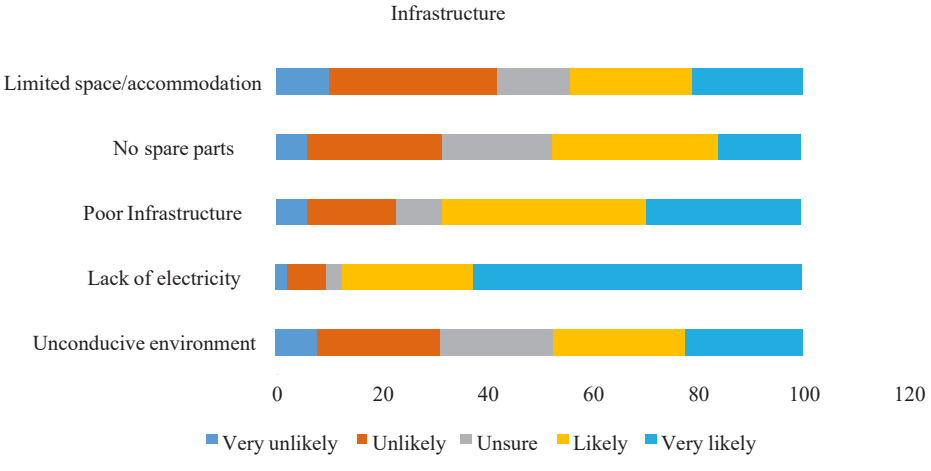

Fig. 6. Perception of infrastructural related factors that prevent investment in new technologies

Additionally, respondents highlighted government-related factors that can prevent investments in new technologies (Fig. 7). Most respondents believed that all three 'government' related factors prevent investment in new technologies. Likewise, inaccessibility to necessary technologies and early obsolescence were pinpointed by 68.4 % and 37.7 % of respondents respectively to likely prevent investment in new technologies (Fig. 8).

Finally, regarding human capital-related factors, more than half of respondents believed that a lack of innovators and insufficient manpower will hinder technological investments (Fig. 9). A lack of technical know-how was also mentioned.

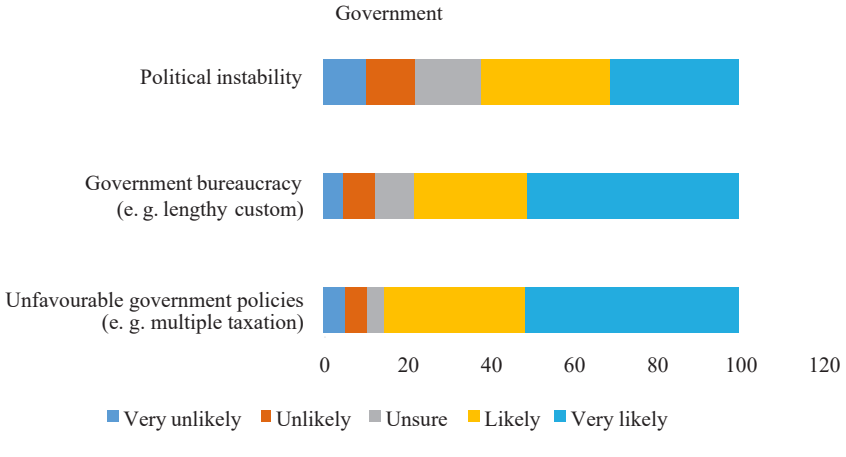

Fig. 7. Perception of respondents on government-related factors that prevent firms from investing in new technologies

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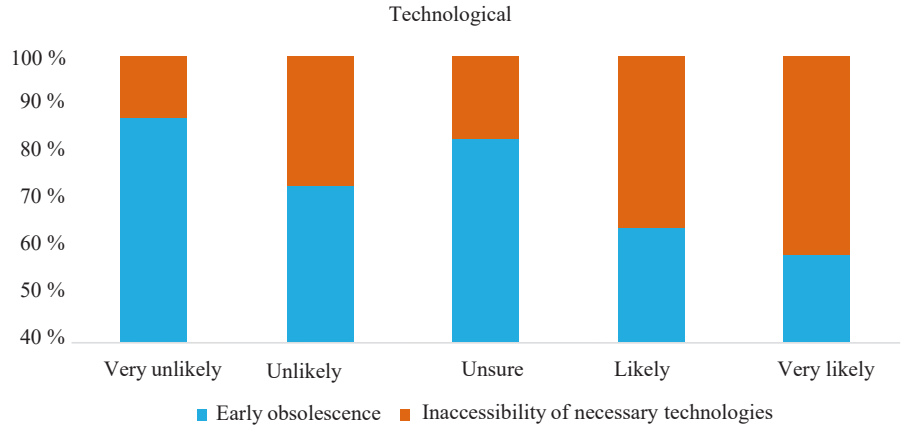

Fig. 8. Perception of respondents technological related factors that prevent firms from investing in new technologies

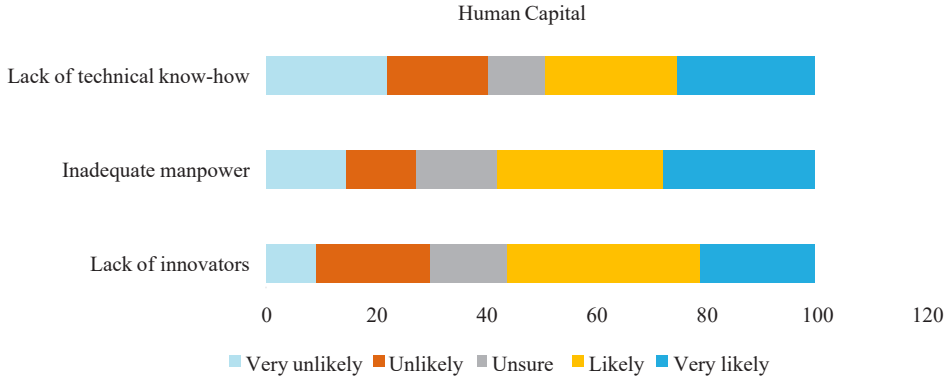

Fig. 9. Perception of respondents on human-related factors that prevent firms from investing in new technologies

3.4. Utilization and diffusion of technologies. Most respondents affirmed the effective use of available technologies in their firms (Table 4). Moreover, respondents mentioned certain factors as being responsible for the effective use of the technologies, including competency (34.6 %) and continuous training (27.6 %). However, 17 of the 123 firms that responded to the question about technology utilization stated that available technologies in their firms are not being used effectively. Chief among the reasons is unstable power.

Regarding the status of technology diffusion in the sector, a majority responded in the affirmative, this was attributed primarily to human/technical as well as organizational factors (Fig. 10). However, about 40 percent of the respondents disagreed that there is no effective diffusion of available technology (Fig. 11). This was attributed to financial concerns, such as the cost of acquiring and operating the technologies (Fig. 12). Regarding measures to overcome the challenges related to the diffusion of available technologies, 45.7 % of the respondents suggested financial interventions (Fig. 13).

Table 4

Use of available technologies

The firm made effective use of available technologies	Frequency	%
No	17	13.2
Yes	112	86.8
Total	127	100.0
Factors that influence the effective utilization of available technologies	–	–
Competency	88	34.6
Educational level	58	22.8
Continuous training	70	27.6
Adequacy of infrastructure	38	15.0
Total	254	100.0
Factors hindering the effective deployment of available technologies	–	–
Lack of manpower with necessary skill/manpower	3	11.1
Poor power supply	8	29.6
Poor maintenance culture in the firm	3	11.1
Redundant technology	1	3.7
Financial constraints	8	29.6
It feels like extra work	0	0.0
Insufficient access to the hardware required	3	11.1
Insufficient access to the software required	1	3.7
Total	27	100.0

Note: field survey

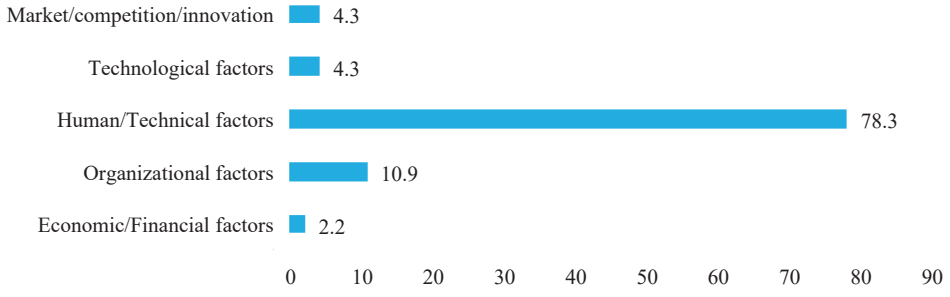

Fig. 10. Factors responsible for effective diffusion of technologies in Nigeria

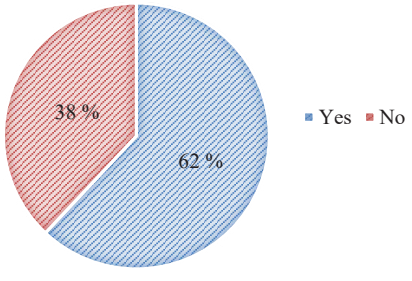

Fig. 11. Effective diffusion of available technologies in Nigeria

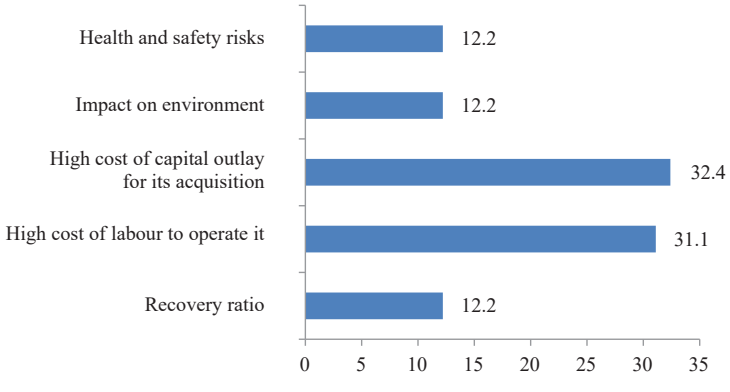

Fig. 12. Barriers to effective diffusion of available technologies in Nigeria

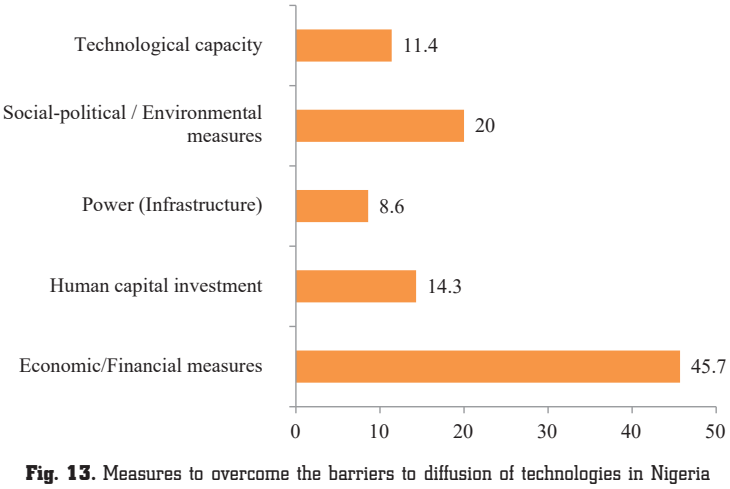

Fig. 13. Measures to overcome the barriers to diffusion of technologies in Nigeria

3.5. Discussion. Nonetheless, the sampling method adopted in this study, it is unsurprising that small-scaled, crop and livestock production farmers make up a good percentage of respondents (Fig. 1). It is previously [35] reported that Nigeria's private sector is primarily comprised of small and medium-sized businesses (SMEs), and small-scale farmers are also known to predominate in Nigeria's agricultural sector. Further demographic information reveals a good number of the sampled firms were in their first to tenth year of establishment (Fig. 3), suggesting a need for strategic and coordinated technological policy efforts to keep and sustain the firms in business. The number of years in business is expected to influence not only adoption but also the quest for new technologies, as experienced farmers are more likely than new ones to acquire advanced technologies [36].

The technology audit exercise found the prevalence of medium and low-classed technologies among the surveyed firms (Table 1). Although this is arguably related to the size and year of establishment of the firms, it is also a reflection of the state of their business activities. A further categorization of responses on the specific technologies needs for operations in their firms, revealed that the majority of firms desired medium-to-high category. High technologies are known to require high technical know-how, a huge capital base, as well as available infrastructures such as power, and space which many of the surveyed firms may consider unsurmountable, as was later confirmed in their responses. Furthermore, an insight into the list of most important techs mentioned by the surveyed firms is implicative of the prevalence of rudimentary or low-level technologies, and/or an apathy for high technologies, due to a lack of knowledge and/or unavailability. Further information revealed that the technologies needed by the firms are available in the country, but are expensive to acquire (Table 2). This may explain the prevalence of low-tech among respondents.

This survey further unraveled factors affecting firms' investment in new technology; critical among others are unstable power and finance (Fig. 5, 6). Several authors have reported on factors hampering industrial activity, and by extension economic growth and development in Nigeria. Chief among these is unstable power, in agreement with the current study. Energy has long recognized as an important factor in all sectors of the economy, and its role in the growth and development of any economy cannot be undermined [37–39]. As a result of the unstable and 'epileptic' power supply in the country, most firms now make use of power-generating sets with the resultant effect of increased production cost.

Moreover, access to finance has been reported to be a significant constraint for small businesses in Nigeria [39]. Investment in new technologies is known to be a costly and risky undertaking, therefore small businesses may generally find it difficult to undertake. In addition, lack of adequate collateral, as well as difficult bureaucratic application procedures

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have been reported as major constraints for small-medium enterprises to access bank loans in Nigeria. The reluctant attitude of some Nigerian banks in giving loans to SMEs has also been reported [39, 40]. These issues compounded access to loans from banks to invest in technologies in Nigeria.

Another element of utmost importance, attested to by the majority of respondents in this study is insecurity (Fig. 4). The continual upsurge of violence and insurgency in Nigeria deters investment in new technologies. Certainly, economic activities thrive more in a peaceful environment, where investors can acquire maximum returns from their investments. Investors tend to withdraw where this is not guaranteed. Consequently, ongoing religious, tribal, ethnic, and economic conflicts in different parts of Nigeria, all have their share in preventing potential investors from the country. Another important factor of interest is unfavourable government policies, bureaucracy, and political instability.

The importance of effective agricultural technology use, diffusion, and maintenance cannot be overstated as a fundamental requirement for sustainable agricultural development. Expectedly, most of the firms surveyed are effectively using the technologies at their disposal (Table 4), perhaps because they are mainly in the low-to-medium category. The results also suggest that worker training leads to competence development (Fig. 10), which is critical to optimal technology use in agricultural firms. On the contrary, some firms opined that their available tech is ineffective, primarily due to unstable power, financial constraints, and a lack of skilled labor (Fig. 12).

Finally, financial constraints and the absence of skillful manpower deter effective diffusion of technology among respondents to this study. According to the current findings, the major barrier to technology diffusion in the Nigerian agricultural sector was economic/financial measures. In support of this observation, other authors posited that farmers' adoption of new technology is subject to affordability and accessibility [41–44].

Policy Recommendations:

1. The dominance of low-medium-high technologies is a pointer to the despondence of technological innovation in the sector, pragmatic action is required to change the rhetoric, not only in Nigeria.

2. Financial interventions and adequate infrastructure are required at every stage of technological interventions.

3. There is a need to mobilize, organize, and empower agriculture technology fabricators for optimal performance since a majority of needed technologies can be locally manufactured.

Study limitations: The scope of this study was limited by funds, as a result of which one state was selected from each geopolitical zone in the country for data collection. Furthermore, technology audit studies that focus on each agricultural subsector (e. g. crop, livestock production) are strongly recommended for more implicit insight into the technological needs' assessment.

4. Conclusions

Agribusinesses in Nigeria mainly deploy a blend of both low and medium technologies for their core operations; for optimal performance, many desires to acquire those in the higher categories but have cost constraints. Finances are required not only to acquire, but also to run, maintain, hire experts, and perform other necessary activities that would improve the effective use of technologies. Additionally, a lack of stable electricity in the country prevents investment in new technology and the use of existing ones. These findings call for critical intervention from stakeholders in the public and private space to ensure the availability of critical infrastructure as well as subsidization of the cost of agricultural technologies.

Conflict of interest

The author declares that she has no conflict of interest about this research, whether financial, personal, authorship or otherwise, that could affect the research and the results presented in this paper.

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Data availability

The manuscript has no associated data.

Use of artificial intelligence

The author confirms that she did not use artificial intelligence technologies when creating the current work.

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