Impact of Automation on Sesame Seed Production in Nigeria

BY:

NATHANIEL IDOKO SALEH

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SUPERVISOR:

DR. MICHELLE KELLY

STUDENT ID:

X19121881

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Abstract

The agriculture sector in Nigeria is continuously being improved because it serves as the major source of livelihood for the majority of the population. Sesame seed is the extensively cultivated seed of Nigeria yet its productivity, as well as its profitability, is not as per the expectations. For many years the agriculture system and production system of sesame seeds in Nigeria remained manual and technologically out-dated, resulting in the low return and high seasonal labour force fluctuations. There is a need to utilise technology efficiently in producing a significant output of sesame seed for export. This study aimed to evaluate the role of modern technology and automation in improving the efficiency of production of sesame seed in Nigeria.

The primary data was collected by interviewing six farmers and farm owners in Nigeria working in sesame seed production. The study revealed a number of challenges inherent in sesame seed production. However, the skilled and talented farmers are ready to adapt the change of technology in this sector which they believe can enhance sesame seed production.

Keywords: *Agriculture, Automation, Sesame seed*

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Student Number: X19121881

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Dedication

This dissertation is dedicated to my brother **Oyihoma Saleh** who taught me to be the hardest worker in the room and always believe I am deserving of every opportunity I get.

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Chapter 1 Introduction

Introduction

This chapter provides an overview of the selected topic that is the impact of automation on Sesame seed production in Nigeria. The first chapter aims to provide some background information on the sesame seed production and agriculture industry in Nigeria while discussing the significance of automation in this area. In addition to these research aims, questions, problem state and significance are also discussed in this chapter.

Background

Agriculture in Nigeria

The agriculture sector in Nigeria is continuously being improved because it serves as the major source of livelihood for the majority of the population (Tambo and Abdoulaye, 2012). The last year saw growth of 3.17% which is the highest rate recorded by the Bureau in the agriculture sector of Nigeria. This was an increase of 2.4% on the previous quarter (Adesoji, 2019). Farmers and agriculturists are focusing more on the application of automation and machine working to yield more and more crops within a specific period. Farm automation is associated with the use of technology which automates the livestock production cycle, making the farminf of seeds and crops more efficient (Ku, 2020). The current statistics reveal that agriculture is one of the most vital sectors in the Nigerian economy. In 2018 it was recorded that the agricultural sector contributed 21.2% to Nigeria's GDP (Statista, 2019). This study is focused on improving Sesame seed production by evaluating the impact of automation on its production cycle.

The key growth drivers contributing to the practices of agriculture in Nigeria include the production of crops, fishing, forestry and livestock. However, the most contributing factor and major key growth driver is crop production accounting for almost 85% of the most total GDP from the agriculture sector (Adesoji, 2019). Every year more than 25 million hectares of land are cultivated in Nigeria for the production of crops and thus agricultural growth is recognised as the central sustainable pillar for economic development. For many years the agriculture system and production system of sesame seeds in Nigeria remained manual and technologically outdated resulting in low return and high seasonal labour force fluctuations (Imaenyin, 2015). Therefore, farmers have faced challenges and struggled because of the outdated technology for Sesame seed production and cultivation

Sesame Production

Sesame seed is a flowering plant which belongs to the genera *sesamum indicum* that is widely found in the tropical regions of the world. It was first domesticated 3000 years ago and consumed as a food item (Haruna et al., 2011). The quality of the seed is that it is highly tolerant to drought conditions and therefore can easily grow when other crops fail. Consequently, the drought-resistance ability of sesame seed makes it an increasingly popular choice for growth in Northern Nigeria (Haruna, 2011). The production and growth are widely observed in the north of Cross river states and in Ebonyi, however, its growth in the Delta region did not produce much quantity of seeds (Agronigeria, 2016). Currently, approximately 300,000 tonnes of Sesame seed are produced by Nigeria states, including Taraba, Benue, Jigawa and Nassarawa. Presently, there are 26 states across the world that grow sesame and it is expected that its production will increase resulting in high prices (Agronigeria, 2016). This means as the demand for sesame rises across the world; Nigeria can easily set desired prices in the global market for its export.

According to El Khier, Ishag and Yagoub (2008), the majority of the sesame seeds are utilised for the purpose of extracting oil and the rest of the production is used as edible items. Being tolerant and resistant to high temperatures, it is considered useful seed and its production is considered vital for both financial and nutritional needs (Akinoso, Igbeka and Olayanju, 2006). Therefore, production requires more attention and focus towards its efficiency through the use of upgraded technology and automation (Imaenyin, 2015).

Importance of Automation

The turning point in the development of the agriculture sector is the conversion of manual techniques into automation by using machines and updated technology. Automation provides an opportunity for farmers to be able to generate more food with sustainable large-scale production in less time. In Nigeria, the advent of technology provides a wider range of advancement in sesame seed production through self-driving machinery. Considering the estimated global population of approximately 9.7 billion by 2050, experts believe that there is a need to increase production levels by at least 70% from the current level in order to meet the nutritional needs of people (Ranganathan et al., 2016). Therefore, currently, farmers are under pressure to generate more crops that are essential from a nutritional standpoint and create a healthy impact on the planet and its population. The current examples of the advancement of technology in the agriculture sector ranges from automation machines to robotics and the latest are drones along with computer monitoring systems (Mekonnen et al., 2020). Automation has

thus completely transformed the agriculture sector and farmers can now meet the ever-increasing demands of the population.

Research Problem

According to Tunde-Akintunde, Oke and Akintunde (2012) sesame seed is considered an important component of agricultural export in Nigeria. Currently, the sesame seed is ranked second after cocoa in terms of export volume and is increasingly becoming a prominent item in the category of non-oil exports (Abu, Abah and Okpachu, 2011). It is because sesame seed is Nigerian's cash crop that yields foreign exchange. Thus, the increasing demand for sesame seed is a great opportunity for the Nigerian economy to progress, address its needs of crop production and meet the international demand for commodities. The export market for Nigerian's sesame includes India, Korea, Mediterranean and Middle East countries where the demand for sesame seed has become quite high (Carre and Pouzet, 2014). It has been estimated by Tunde-Akintunde, Oke and Akintunde (2012) that only 300,000 hectares of land is currently being used by farmers to cultivate the sesame seed out of a total of 90 million hectares of land. This land can be used for cultivation if the government of Nigeria invest more in upgrading the techniques for sesame seed production. In this way, the annual revenue generated from sesame export can increase from N30 billion to N120 billion per annum (Anagor, 2019).

There is a need to utilise the technology efficiently in producing a significant output of sesame seed for export. However, studies reveal that there exists a wide gap in the actual yield and potential yield of sesame seed in Nigeria because of lack of utilisation of advanced technology (Ogbonna and Ukaan, 2012; Kanton et al., 2013). The inability to fully use the potentials of automation in the agriculture sector resulted leads to less efficient sesame production. The additional reasons for low production include limited access to resources for farmers, insufficient utilisation of finances, inefficient tools and inadequate technical efficiency (Pii et al., 2019). Sesame seed is the extensively cultivated seed of Nigeria yet its productivity, as well as its profitability, do not meet expectations. Productivity is defined as "the ratio of agricultural outputs to agricultural inputs" (Coeli, Rahman and Thirtle, 2002). This means that if there is higher production output the farm will be considered as more productive and vice versa. Hence, yield productivity can be improved by implementing and applying automated technology and utilising the modern techniques in production such as technologically advanced equipment, water irrigation system, spraying of pesticides and fertilizers etc. (Pii et al., 2019).

Therefore, this study aimed to evaluate the role of modern technology and automation in improving the efficiency of production of sesame seed in Nigeria. Through this study, the researcher aims to explore the perception of automation and the use of technology in sesame seed farming. The farmers will provide their viewpoint and their understanding in relation to the use of automation, which may further help the government to improve the agricultural sector and its resources. The implications of the research in this regard, are more progressive growth towards the advancement of agricultural practices particularly in relation to a sesame seed. The research aims to highlight the significant role of technology and automation in the field of agriculture that is widely being utilised in developed and other developing countries. Those countries have been successful so far in strengthening their production and practices of agriculture. However, in developed countries, the initiation of efficiency in production started when their farmers, seed-producing companies and associated stakeholders highlighted the issues in agriculture. Similarly, through this research, the Nigerian agricultural sector can benefit in the long run by enhancing seed production and agriculture practices. The lacking in production and agriculture system will be identified by conducting interviews with farmers that will give an overview of their level of awareness and knowledge regarding the use of automation.

Research Aims and objectives

The main aim of the research is to identify the role of automation in the sesame seed production in Nigeria for which interviews are conducted with farmers. Following are the objectives which go along with the main aim of the study that can be attained well through interviews from farmers as they have detailed knowledge of farming:

1. To examine the role of automation in enhancing sesame seed production in Nigeria.

2. To evaluate whether or not the seed production resources are efficiently being utilised in Nigeria.

3. To identify the challenges in sesame production in Nigeria.

Research Questions

1. What is the role of automation in enhancing sesame production through the use of technology?

2. Is the agriculture sector efficiently utilising the resources for sesame production in Nigeria?

3. What are the major challenges for sesame production in Nigeria?

Summary of Dissertation

The dissertation is devised to evaluate the role of automation in the agriculture industry by particularly focusing on sesame seed production in Nigeria. The study is comprised of five chapters in total; with the first chapter an introductory chapter which provides an overview of the Nigerian agriculture industry and the significance of sesame production. The second chapter covers the theoretical and empirical findings related to automation in the agriculture sector. In this chapter the literature gap is also identified which provides the motivation to conduct the study. The third chapter focuses on outlining the qualitative methodological choice based on which the whole report is carried out. The fourth chapter provides interview findings with the help of thematic analysis and the final chapter presents the conclusion and recommendation of the study.

Chapter 2 Literature review

Introduction

This chapter is based on reviewing the literature findings with relevance to the agriculture sector and the impact of automation. The section is further divided into the theoretical findings, empirical findings and discussing the framework of research. In addition to this, by the end of this section, the literature gap is also identified.

Theoretical View

Theory of Agricultural Development

Reiji and Water-Bayer (2014) defined agricultural development as a multi-sectional practice that provides supports to the economy and brings positive change in the urban and rural areas. However, its major purpose is an improvement in revenue generation, social welfare and increasing the livelihood of farmers. Therefore, agricultural development is mostly considered as part of rural development, because these two are concepts that are inherently associated with each other. Udemezue and Osegbue (2018) determined that agriculture cannot be separated from the rural areas and thus the development of rural areas is highly dependent on agriculture enhancement. It has been estimated that around 90% of the rural population carry out agricultural practices as it is their main source of income (Udemezue and Osegbue, 2018).

Nigeria is considered as one of those countries who have gradually progressed in agriculture, seed system and crop production and has become a leading economy in Africa. It has observed to be playing a major role in the economic and political affairs at the international level (Suberu et al., 2015). Since a majority of the people in Nigeria depends on agribusiness to earn their livelihood, the state needs to make effort in speeding up the economic growth by focusing on investment in agriculture (Tersoo, 2014). In the coming decade, it is expected that Nigeria's economic development can be enhanced by focusing more on the agriculture sector and bring advancement through technology and automation (Omorogiuwa, Zivkovic and Ademoh, 2014). The following agriculture models are vital to understand the need for automation in the agribusiness of Nigeria:

Conservation Model

The first model in relevance to agricultural development is a conservation model that has been evolved from the advancement of crop production and livestock husbandry. This model has been adopted from the concepts of soil exhaustion from German soil scientists and the English agricultural revolution (Udemezue and Osegbue, 2018). Soil exhaustion is a loss of nutrients from the soil when the same crop is farmed with similar techniques over and over again. This happens because of the poor management of seeds and soil that will eventually stop supporting plant life (Pannel, Llewellyn and Corbeeels, 2014). The conservation model emphasises the development and advancement of cropping systems, production, and use of physical facilities that can effectively make the land sustain longer. In many areas of the world, the conservation model has improved agriculture production 1.0% per year over relatively long periods of time (Olayinka, 2019). In Nigeria, this requires the use of more advanced technical resources to make the soil supportive. According to Olayinka (2019), the conservation model is relevant to agriculture as it emphasises on the evolutionary practices to address the complexity of land and use of labour-intensive cropping system. According to this model, the capital should be invested in the use of physical facilities to use the land and water resources more effectively. Further sections discuss the latest models in relevance to agricultural development over time.

High-Payoff Model

The latest model in the transformation of conventional agriculture system is the High-payoff model (Van der Ploeg, 2019). According to this model, the agriculture sector is a vital source of economic growth and to make it a more productive investment it is important to make it modern (Udemezue and Osegbue, 2018).This is the most relevant model to this study as it emphasises on high-payoff inputs to the farmers of poor and developing countries. In many countries, this model is used to invest more in the inputs in order to attain high productivity, variety in grain and high-yielding production. It has been well implemented in Mexico and the Philippines in the early 1960s (Van der Ploeg, 2019). In early years, the various inputs were the use of chemical, fertilizers, effective soil and water management. However, in relevance to high payoff inputs the high returns are now associated with the adoption of the new technical inputs and management practices. Omorogiuwa, Zivkovic and Ademoh (2014) observed that in traditional agriculture system the resources were allocated by the peasants who had limited economic and technical opportunities. In many developing countries the key to transform the traditional agriculture sector into a productive resource for the growth of the economy, is the high-payoff model. This is done by investing more in making the equipment, tools, practices

and procedures more modern as to deliver high-payoff deliverables to the farmers of poor countries. According to Chavas and Naugues (2020), the model of High-Payoff inputs is categorised into three parts:

1. There should be enough capacity in public/private research institutions that can provide new technical knowledge.

2. The industrial sector should have adequate capacity to produce and market new technical inputs.

3. The farmers should be capable enough of acquiring new knowledge and using new inputs effectively.

The above models are relevant to the progress and advancement in the agricultural sector. In this section relevant theoretical models are presented that provides an insight about the need and significance of the use of automation and new technology in the agriculture sector of Nigeria. In the next sections, the characteristics of the robust seed systems and modern techniques are discussed in order to highlight the advantages and effectiveness of technology predominantly in the seed system.

Characteristics of robust seed systems

Gaffney et al. (2016) argue that the seed system in Africa requires a robust approach because there is a limited region's ability to attain agricultural sustainability goals. The key challenges are inadequacy of infrastructure that can support professional seed system, limitation of farmers in accessing the markets and less effective technology to improve seed and crop production. Hence, technological advancement is the key to enable an efficient and robust seed system in Africa (Gaffney et al., 2016). Globally, various approaches have been adopted for bringing technological advancements in seed production. For instance, the use of software, robotics and artificial intelligence for the purpose of seed management, use of fertilizers and understanding the condition of the soil (McGuire and Sperling, 2016).

Etwire, Ariyawardana and Mortlock (2016) determined three main components of modern seed systems including formal, informal and quasi-formal seed system. The chain of a formal seed system initiates with the breeders for seed production by research councils and ends with the farmers in the form of a final consumer (Forbes et al., 2020). The formal system mainly consists of genetic modification or genetic resources in order to provide farmers with the improved seed

varieties thereby seeds can yield better production (Mazon et al., 2019). On the other hand, the informal seed system is carried out by farmers with locally organised activities.Quasi-formal seed system contains multiple seed delivery channels (Etwire, Ariyawardana and Mortlock, 2016). It is important to consider adopting automation and innovation as a vital factor for improving farms productivity and for the welfare of farmers by the state government of Nigeria. This is possible with the establishment of a formal seed system. Otherwise, the state should introduce effective information to support the informal sector by providing sufficient resources. Next section will provide more insights about modern techniques in seed production.

Modern techniques in seed production

Globally it has been observed that in recent years many new agricultural automation technologies are being developed. These developments are done with the purpose of improving the effectiveness and efficiency of traditional agricultural practices and bring improvement in production (Suprem, Mahalik and Kim, 2013). Automation and modern techniques have given rise to new opportunities that can address the current agronomic requirements, radically in a much different way. The study of Duckett et al. (2018) discussed systematic concepts that are relevant to the use of modern techniques in the agriculture sector.

1. Phyto-technology: This technology focuses on developing an autonomous machine that can take care of each type of plant production according to its specific needs. For this purpose, the plant needs are defined accurately, and operations are carried out with improved specifications by smarter and efficient machines (Blackmore, 2009).

2. Agricultural Robotics: Another, globally used technology is agricultural robotics. Ducket et al., (2018) determined that the agriculture field is progressing day by day and the demand for a new generation has become more robust, smart and flexible. Therefore, it is important that farms should have interconnected and autonomous robotic systems that can work alongside human co-workers in farms seamlessly. The study determined the benefits of interoperable robotic systems as self-organised, multi-modal and synchronised with the human practices (Suprem, Mahalik and Kim, 2013). For a sustainable intensification of the agriculture sector, Ducket et al. (2018) emphasised on the application of factory robots and electric farms with robotic grasping technology, sensors and low-tillage solutions. However, this is comparatively a costly approach for developing and under developing states.

3. Crop Monitoring using IoT: Sreekanth and Kavya (2017) discussed that the internet of things has changed and remodelled agricultural capabilities. It has enabled the farmers to utilise a wide range of smart technology to deal with the challenges of field and production such as precision and sustainable growth. IoT in agriculture sector works in providing assistance to collect information about various conditions such as temperature, weather, the fertility of the soil, moisture etc. (Chavas and Nauges, 2020). IoT can also be used for online monitoring of crops by enabling the detection of the level of water, animal intrusion, weed detection, crop growth, weed detection and production. It provides leverage to farmers to remain up to date and informed about farm fields from anywhere and at any time (Sreekanth and Kavya, 2017). In many countries, wireless cameras are used for remotely viewing the farm conditions in the form of video or images. Smartphones are also being used for the latest updates about the land and its ongoing conditions (Chavas and Nauges, 2020). This method is cost-effective and can enhance the productivity of conventional farming.

Empirical view

After analysing the theoretical aspects, it is also important to evaluate the practical findings in relevance to automation and use of modern technology in the seed production. It is because it provides a practical implementation across the world of the selected topic and previous findings. A study of Gallardo and Sauer (2018) examined the use of labour-saving technology in the United States and revealed that these technologies have always been effective in the progression of agriculture and also contributed in the economies of nations. In this study, researchers with the help of economic theories included empirical applications which concluded the effectiveness of technology adoption. The study determined that there is a positive and productive impact of technology adoption and automation on crops production and livestock. Gallardo and Sauer (2018), based on the new economic and societal structure, suggested to implement labour-saving technology such as Auto-guidance system. This system involves various automation systems that are used for the feasibility of farmers and efficiency in the production level (Dehghani, Kaparvarfard and Koushkak, 2016). There is an automated vehicle navigation system used in agriculture areas of America and other developed regions which have automated operator-assisted steering system. This is being controlled by global positioning application also known as GPS and guides vehicles to work automatically (Gong, 2017).The wide adoption of these vehicles has improved farm performance, for instance, less labour cost, speedy production, less energy consumption and better control and monitoring. Mousazadeh (2013) also determined that successful implementation of the autonomous system

has addressed the challenges of large land areas in Australia, uneven surfaces, environmental conditions, safety, cultivation operations and low-cost outputs in agribusiness. This has been conducted in developed countries like USA and Australia however these are the developed countries with greater capital and expenditure to spend on the agriculture sector. In Nigeria, the government can make initial steps to make advancement in technology by increasing the share of agriculture in the national budget.

Another widely used technology is an information and communication system which is comparatively economic to be utilised in developing countries. A study has been conducted in a Slovak republic by Lateckova, Bolek and Sxabo (2018) that explored the significance of information system and communication technology in agricultural enterprises. The findings of the study reveal that information and communication technology is the current need of every sector. Just like other industries, agricultural enterprises also face many challenges they can solve with the application of ICT which is directly associated with the progress of agriculture (Young, Meyer and Woldt, 2014). The significance of the ICT is to bring automation in every process and provide more accuracy for the farmers to make an appropriate decision. Production planning and resource management can be supported by Enterprise Resource Planning systems (Gong, 2017). The findings reveal that it is effective in resource allocation, planning and management of key internal processes and can also handle the difficulties at an operational and tactical level of production (Kviz and Kroulik, 2017). The selected variables of the study were functions and benefits of information system on agriculture seed production which revealed the increased level of satisfaction for farmers and producers (Hoff and Bashir, 2015).

Acemoglu and Restrepo (2018) also analysed the empirical evidence and explained that artificial intelligence and robotics are the major advancements in agriculture and other sectors. It is expected that the future of agriculture will be more spectacular as automation and advancement in technology is predicted to transform and change the nature of farm work across the globe. However, the study provides evidence that along with pervasive automation, there are fewer employment opportunities for the labour, farmers and another farm workforce. This is disadvantageous for the poor labour force, yet the benefits have been a continuous improvement in the production of seeds and crops. Frey (2019) has presented the efficiency of automation and technology in the field of agriculture with the help of historical development. Automation in the 19th and 20th centuries provided the transformation by advancing factory work, fieldwork and production while displacing the demand for workers (Acemoglu and Restrepo, 2018). The mechanisation of agriculture in the United States is the best example of

workers replacement with efficient machinery. Negrete et al. (2018) determined that separation of seed is an intensive process for labour workforce; its automation has brought a major revolution in agriculture by using technologically advanced machines that can be used for separating seeds after harvest. Later on manual threshing and winnowing were also replaced by horse-powered threshing machines and fanning mills respectively improving the fieldwork of seed production and harvest in agriculture (Frey, 2019). The relevancy of this information shows that the impact of automation is positive for the agriculture sector predominantly in seed production.

In the above studies, the results show that developed countries have been using advanced technology in agro-production for a long time. After exploring the developed countries, it is also important to review the studies conducted in developing countries. Suma et al. (2017) explained that just like in Nigeria, agriculture is considered as a primary occupation of India. In order to overcome issues in different processes, the country has used smart agriculture techniques for instance GPS system, temperature and moisture sensing devices, remote-controlled surveillance, security, intruders scaring techniques and advance irrigation facilities. Parithibha, Hongal and Jyothi (2017) also affirmed the findings and revealed that India is continuously making progress in the agriculture sector by making use of wireless sensor networks that enable easy documenting of environmental factors and soil properties. Gondchawar and Kawitki (2016) discussed that since 70% of the Indian population is dependent on farming, therefore, modernisation of conventional methods is the only solution to implement the best farming practice. The automation system in India includes the use of robots for weeding, spraying and other farm activities. Moreover, the smart GPS based system to control all these activities is also available. However, wide-range implementation of these technologies is still limited in India and other developing countries (Gondchawar and Kawitki, 2016). Another important study was conducted by Krishna and Shafiya (2017) who explored the use of real-time automation in agriculture. The focus of the study was the efficient management of water in order to develop a watering system for arid and semi-arid areas required for the production of crops. The study revealed that a wireless system with the real-time application provides improved results in crop field areas such as better monitoring of water and also the notification about low water level (Krishna and Shafiya, 2017).

Literature Gap

The literature has been presented to show the relevancy of seed production in agriculture with the impact of automation in the industry. It has been revealed through the literature findings that many of the technological advancements and automation is done in developed countries so far (Acemoglu and Restrepo, 2018; Negrete et al, 2018). Very few or limited studies show the availability and application of robotics, machinery or smart technologies in developing countries and Nigeria (Suma et al., 2017). With regards to sesame seed production in particular, no study has been conducted in Nigeria that shows the impact of automation or modern technology. Therefore, the current study aims to interview farmers who can provide knowledge in relation to the use of resources in sesame seed production in Nigeria. The current study explores the qualitative perspective of farmers to utilise new technology in agri-production and particularly in sesame production. This study will add more information on the effective sesame production with the use of technology which has not been discussed before within the context of Nigeria. Findings and interview questions are in accordance with the literature review both theoretical and empirical aspects to explore seed production in Nigeria. The questions are derived from the empirical resources used and variables are selected based on the theoretical aspects of the previous studies.

Chapter 3 Methodology

Introduction

This section is devised to present the details about the selected methodology. The study aims to evaluate the impact of automation on sesame seed production in Nigeria for which it has adopted a qualitative research approach. The research methodology section is based on a known and widely used research onion model as explained below:

Saunders' Research Onion Model

The pioneers of presenting the research onion framework were Saunders and his co-authors, Thornhill and Lewis (Melnikovas, 2018). This framework is a complete model which contains all the vital elements of a research. This model was selected because, with the help of Onion research framework, the qualitative approach can be clearly explained and understood (Mitchell and Education, 2018). The model has been utilised by many businesses as well as research students. The figure below shows the six main layers of the onion model including philosophy, approaches, strategies, choices, time horizon, techniques and procedures (Amolo, Migiro and Ramraj, 2018). The sub-sections are categorised as per the model in accordance with current research objectives.

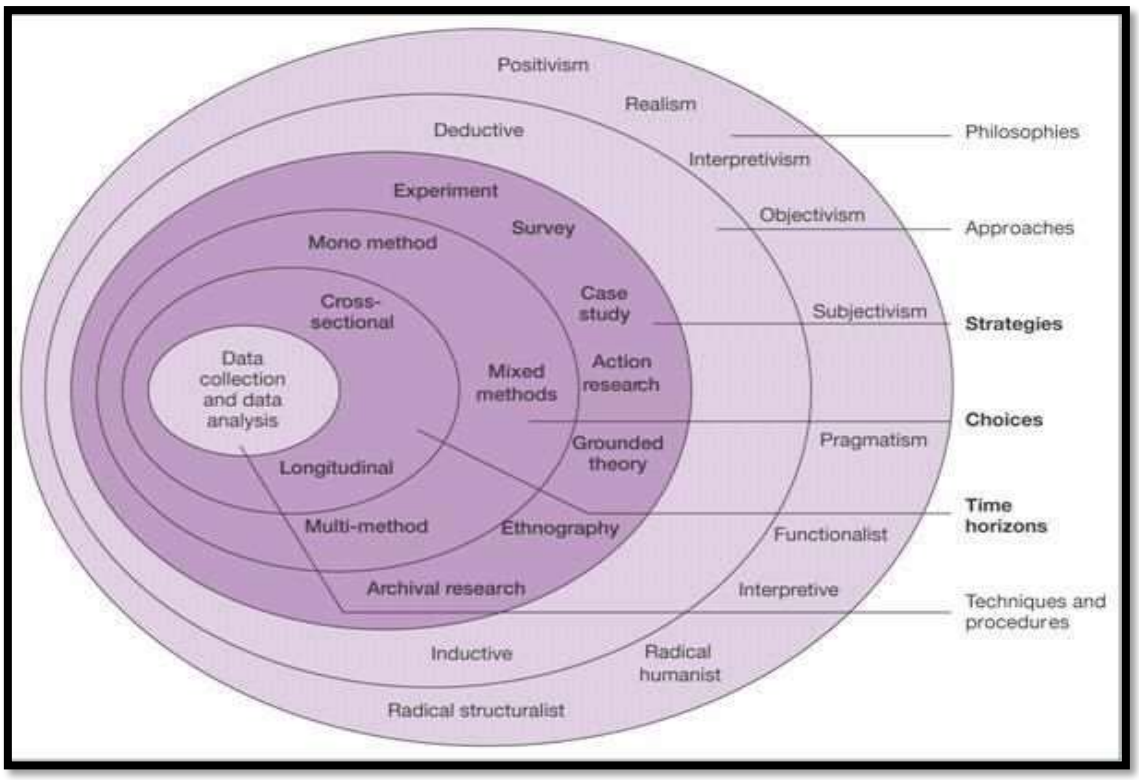


Figure 1 Saunders Research Onion Model

Research Philosophy

Research philosophy is mainly referred to as the set of principles that has been set by previous philosophers and experts to explain what belief or direction has been selected to conduct research (Iovino and Tsitsianis, 2020). The philosophies are categorised mainly into four types having different views and beliefs including positivism, interpretivism, positivism and realism. In the current study, to acquire qualitative data for evaluating the impact of automation on sesame seed production, interpretivism philosophy is selected. The interpretivist belief is interpreting the data or information which involves human interaction based on human interest (Melnikovas, 2018). This philosophy is selected because the current study aims to interview farmers and farm owners in Nigeria who are looking after sesame seed production and agriculture.

This philosophy is different from positivism which only focuses on factual outcomes and numerical testing. Interpretivism supports the objectives of this study by observing human perception and their understanding of reality (Creswell and Creswell, 2017). Where positivism approach focuses more on quantitative findings, interpretivism promotes and encourages qualitative interpretations. Moreover, the approach is socially constructed for gaining access to reality with the help of shared meanings, language and discussion (Longbottom, 2016). The

main aim is to attain non-numerical data and gain more in-depth insights about the farming, seed production and agriculture from the Nigerian farm owners and farmers.

Research Approach

Uncovering the second layer of the onion research model, there are two major approaches to carry out research systematically in a specific direction; inductive approach and deductive approach. Inductive approach initiates with observing facts and ends up in developing a new theory (Quinlan et al., 2019). On the contrary, a deductive approach is a more feasible and widely used approach; in which researcher aims to set specific objectives and based on general theory it reaches to final research outcomes (Fletcher, 2017). The current study thus evaluates the outcomes of using automation on sesame seed production by interpreting the interview responses based on the theories of agriculture development, conservation model and high pay-off model (discussed in the literature review). For the current study, the deductive approach is more appropriate as it aims to reach a specific conclusion after testing the theory with qualitative analysis (Fletcher, 2017).

Research Strategy

Research strategy is defined as a plan of action for research on which the entire study is based and considering this strategy a study is conducted in a defined direction (Bresler and Stake, 2017). However, the strategy is directly affiliated with philosophy and approach. In the current study interpretivism, philosophy and deductive approach support survey strategy for gathering and acquiring data. The data is therefore attained through interview questions with farmers and farm owners of Nigeria which will later interpret through thematic analysis based on study objectives. According to Ledford and Gast (2018) surveys are conducted to gather information from large cohort population and analyse with the same technique. Thus, for taking an interview survey strategy is best suited for the current study.

Interview Questions

For evaluating the impact of automation and to determine whether seed production resources are being used efficiently in the Nigerian agriculture sector or not, interviews are conducted. These interview questions were derived from the research objectives and research questions. The interview questions were based on five vital characteristics included open-ended, goal-driven, structured, formal and controlled and balanced (Kumar, 2019). There were seven interview questions that were asked to gather the qualitative data. The questions were mainly

focused on sesame seed production enhancement strategies, evaluation of current use of resources, the significance of automation and technology and identifying the major challenges that farmers are facing during sesame seed production in Nigeria. Findings and interview questions are in accordance with the literature review both theoretical and empirical aspects to explore seed production in Nigeria. The questions are derived from the empirical resources used and variables are selected based on the theoretical aspects of the previous studies.

Research Choice

The research choice is the fourth vital layer of Onion research framework; here researcher decides to adopt a more specific approach. Research choices are of three types including mono-method that is either qualitative or quantitative, mixed-method including both qualitative and quantitative while the third type is multi-method that has a combination of more than one research choice (Mitchell and Education, 2018). Based on the interpretivism philosophy, deductive approach and survey strategy the researcher has selected mono-method approach in which the qualitative data is gathered and analysed (Kumar, 2019). A qualitative approach is selected because farmers and farm owners are inquired about the current conditions of sesame seed production and their views about the use of automation and technology are analysed.

Time Horizon

Within the aspect of time, there are two types of researches one is longitudinal and other is cross-sectional. In a longitudinal type of research, the time duration is relatively longer, and study is conducted over regular or repeated intervals. These studies are observational and carried out with randomised control experiments (Creswell and Creswell, 2017). On the other hand, cross-sectional studies are more commonly used by researchers because it is carried out within the specifically selected timespan and illustrates the current image of the situation (Longbottom, 2016). The current research is a cross-sectional study in which interview responses are attained from Nigerian farmers representing the subset of the population within a specific point of time.

Sampling

Sampling is the most vital part of research methodology as it describes the subset that is chosen for representing the population of the study (Kumar, 2019). In the current study, the sample populations are Nigerian farmers and farm owners predominantly engaged in sesame seed production. The population is selected because they can easily provide knowledge in relation to the use of resources in the sesame seed production of Nigeria. With the help of interview questions, the study explores the qualitative perspective of farmers by knowing their views on utilising new technology in Agri-production and particularly in the sesame production (Fletcher, 2017).

The sampling population for this study will be 3 farmers and 3 farm owners from the sesame seed production in Nigeria. In this way, the researcher will be able to differentiate between the knowledge of both groups. The responses add more information on the effectiveness of sesame production in Nigeria with the use of technology and automation. This topic has not been discussed widely in the context of Nigeria. The lacking in production and agriculture system and challenges faced by farmers are the main focus of conducting interviews with the farmers that will give an overview of their level of awareness and knowledge regarding the use of automation. The data is acquired by visiting one or more sesame production farm and taking face to face interviews. However, it was difficult because local farmers did not understand English and questions needed to be processed in the local language.

Data Analysis Techniques and Procedure

There are many ways and techniques of analysing qualitative data including narrative analysis, grounded theory, thematic analysis, content analysis, discourse analysis and framework analysis (Quinlan et al., 2019). In the current study, thematic is selected to carry our qualitative analytical data analysis. The thematic analysis includes six vital steps to interpret the data in accordance to attain research objectives. The first step of thematic analysis is being familiarised with the collected data through interview transcripts; then the coding is performed based on similar content (Amolo, Migiro and Ramraj, 2018). The final step is to generate themes which meet the requirement of study objectives. In the current study, the main themes are sesame seed production enhancement strategies, evaluation of current use of resources in agriculture, the significance of automation and technology in farming and major challenges that are faced during sesame seed production in Nigeria.

Ethical Consideration

Ethics are the vital part of any research while conducting a study; the researcher must consider the important factors of ethics including confidentiality, anonymity and autonomy of the participant. This study is aimed to take prior consent from the participants and interview respondents in order to assure that they are willing to take part in the study. Moreover, the information will be kept confidential and will not reveal their name and identity. The researcher also provides autonomy to the participants that they can withdraw from the study at any point of time without any prior notice.

Limitations

Due to the current pandemic situation going on across the world, it will be difficult for the researcher to conduct face-to-face interviews with the participants by physically going to the sesame production farms in Nigeria. However, the researcher will find an alternative way to either wait for this pandemic to be over or to conduct phone interviews or maybe online interviews through video calling.

Chapter Summary

This section provided a detailed and in-depth overview of the selected methodology for evaluating the significance of automation and technology in the sesame seed production sector in Nigeria. It has been discussed in the chapter that the researcher used a qualitative approach to gather data with the help of interviews while thematic analysis is used for analysing the results. Furthermore, the chapter provided justification for the selection of interpretivism philosophy, mono-method study, deductive approach and survey strategy. Based on the above definite methods findings and analysis is presented in the section of the dissertation.

Chapter 4 Finding, Analysis and Discussion

Introduction

This chapter is comprised of analysing the six interviews transcripts which were attained in response to seven interview questions with farmers and farm owners of Nigeria. The transcripts are interpreted through thematic analysis based on study objectives. The major aim of the study is to identify the role of automation in sesame seed production in Nigeria. The interviews remained successful as the farmers and farm owners had detailed knowledge of farming. The responses helped in examining the role of automation in Nigeria with respect to sesame seed production.

Thematic Analysis Process

The researcher received responses from the interview sessions which were analysed by using the procedure of inductive thematic analysis. This method is described by the study of Braun and Clarke (2006) and as carried out within six steps. The data was read cautiously and then meanings were identified from the relevant text of the research topic. Similar units in the text which were about the same issue were categorised and tabulated within different definitions. There was more than one category for every unit text. Later the data were systematically reviewed for ensuring appropriate themes. Initial coding generated 3 themes later coding made 6 more categories and for the final five themes were generated (Frith and Gleeson, 2004). The data was recorded and transcribed with the help of Nvivo software. The six phases of thematic data analysis in this study are outlined as follows:

1. Familiarization with data: I transcribed the data, read and re-read the responses of farmers and noted down my initial ideas.

2. Generated initial Codes: I coded similar units/text of data in a systematic manner and collated data relevant to each code.

3. Searched for themes: I transformed collated codes into potential themes that I have mentioned in Table 1.

4. Themes Reviewed: I checked that themes were aligned with coded extracts, data set and the generated thematic map.

5. Naming Themes: Themes were then defined and named according to the similarity of unit/text.

6. Producing the report: In the analysis section, all the vital extracts of the farmers' responses were compiled and analysed (Braun and Clarke, 2006).

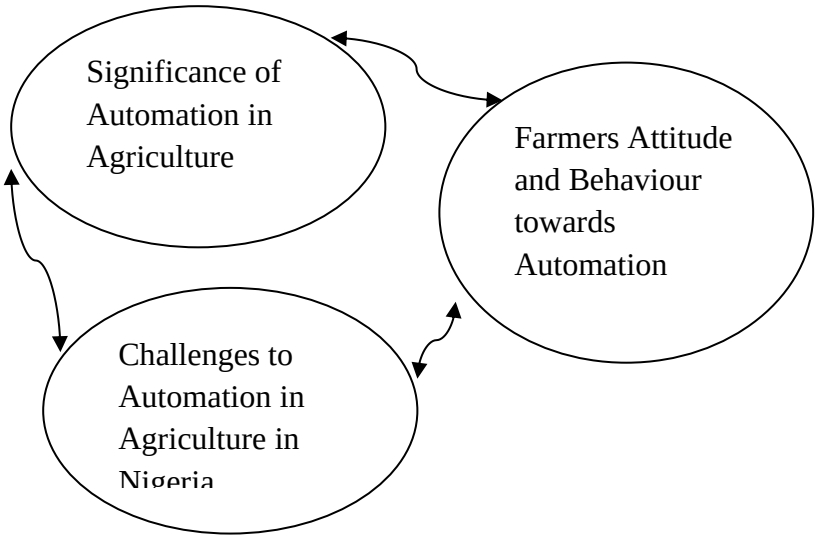
Coding Process

Coding was the vital part of thematic qualitative analysis in which the data was recorded in table format in order to identify the responses in the form of phrases, passages or texts. The coding process was the initial step in a thematic analysis which allowed the researcher to change the text into the index and then categorise to draw a research framework (Maguire and Delahunt, 2017). Following phases determine the coding procedure of the current study:

First Phase: Generating initial coding

The first phase of the coding process was to identify the initial codes based on the similarities of study objectives and responses. The background information related to farmer's experience, attitude and knowledge were grouped together. Significance and role of automation in sesame seed was another group and challenges and adaptation to technology is categorised separately (Braun and Clarke, 2006). Following was the initial framework illustrated in the coding phase:

a. Coding Initial Framework



Second Phase: Searching and Reviewing Themes

The second phase was comprised of transforming index codes to axial codes for further break down of core themes. In this stage, first, the interview questions were categorised in one category and then their responses had broken them down in main themes for the purpose of deductive reasoning (Braun and Clarke, 2006). Through the second phase, the main themes identified were Agriculture System of Nigeria, Significance of Automation in Agriculture and Challenges for Technology adaptation in agriculture of Nigeria. The third table (c) shows the formation of the final theme:

b. Coding Developed: Reviewing and Naming themes

Table 1 Coding Development

Responses Reviewed	Grouping and Naming Initial Themes
I am the one who is more favourable in applying technology and automation practices in the agriculture system of Nigeria **There can be many advantages in using technology and automation practices in the agriculture system of Nigeria.**	**Agriculture System of Nigeria**
I have studied a lot about automation and use of technology in farming and so far I came to a conclusion that yes in order to increase the production and smoothed the yield of a sesame seed, Nigerian farmers need to be replaced by automated machines. **More advance devices or automation systems means more profit to the business, more environmentally friendly, safe and efficient practices.**	**Significance of Automation in Agriculture**
There so many difficulties and challenges in the sesame seed production but now I want to highlight the two most issues. Number one is	**Challenges for Technology adaptation in agriculture of Nigeria**

high production; sesame seed is always highly produced and in large amount which is very difficult to be managed manually. Secondly, there is a Post-harvest loss of grains. **Other than this, in past years we have seen that the major challenges are the use of traditional ways and technology in seed production.**	

c. Final Themes based on Coding: Naming Themes

Table 2 Finalising Coding

S. No.	Coding	Themes
1.	Previous or total Experience of farmers in agriculture and sesame seed production The use of techniques and strategies favorable for sesame seed production in Nigeria The difference in experience, attitude and knowledge of farmers and farm owners	Seed Production enhancement strategies of Sesame
2.	Types of resources in Agriculture sector of Nigeria Sufficient or insufficient resources used in the Agriculture sector of Nigeria	Use of Resources in Agriculture Sector of Nigeria
3.	Profit Timesaving Efficient Less manpower Enhancement of Sesame seed production Preventing loss Cost-effective	Significance of automation and technology in farming
4.	No funds to support technology and automation	Challenges faced during sesame seed production in Nigeria

	No prior experience of working on automation technology of farmers	
5.	Agriculture practices Culture of Technology education Efficient work Profit Opportunities Training and Education on technology and automation facilities	Adaptation to technology and Automation in Agriculture

Findings and Results: ***Producing the report***

In the current study, the main themes are sesame seed production enhancement strategies, evaluation of current use of resources in agriculture, the significance of automation and technology in farming and major challenges that are faced during sesame seed production in Nigeria. This section is therefore based on the interpretation of interview responses that based on the five selected themes as developed in the above coding process.

1. Productivity Enhancement of Sesame Seed Production

The farmers and farm owners that were selected for the purpose of interviews were experienced individuals in their field and hence have a vast knowledge about sesame production and other farming techniques. Based on the experience, all of them were expert in one way or the other and had enough knowledge about how seed production can be enhanced. The need for the enhancement strategies had been highlighted by one of the farm owners who stated that "…*in the last 3 years after the increasing demand for sesame seed, I started its production and enhancement at a large scale…".*This shows that in Nigeria, despite there is an intense demand of sesame seed production yet the most of the practices are being done with the human assistance in the form of farmers and other few technologies such as tractors, tube wells and transportation. One of the farm owners stated that he knows a lot about enhancement strategies and stressed that: *". in order to increase the production and enhance the yield of a sesame seed, Nigerian farmers need to be replaced by automated machines. In the time of farmer shortage, technology will be used to automate the seed production cycle."*

In the view of another farm owner, the sesame seed production can easily be enhanced when more skills farmers with more knowledge about the use of technology use of sprays for insects and pests are employed in the fields. Similar thoughts have been received when interviewed a farmer about enhancing the sesame seed production. Having 5 years of experience in farming, the farmer responded that: *"…Without prior knowledge about the sesame seed and crop, one can never expect successful farming and its enhancement"*. Why automation is important in this sector was a vital concern with relevance to sesame seed production. This has been clearly communicated by the respondents, both farmers and farm owners that the production sector of sesame is lacking in productivity. It has the potential to generate more yield than its current capacity, only if it is focussed properly. Majority of the responses were in favour that currently, sesame production in Nigeria is struggling. Since many years there have been major confronts of using traditional ways and technology in seed production. One of the farm owners informed *"So far, in my entire career as a farm owner, I have faced many difficulties to reach at this point. The struggle that has been made to make the sesame production successful is not an easy task. As a farm owner, you not only need to look after the finances and workforce but also look for the seasonal change, land quality, pesticide sprays, timely arranging the required material, these can help during enhancement".*

Sesame production is very crucial as it requires so many conditions to be fulfilled as a part of the enhancement plan. In Nigeria, farmers are only given with an opportunity to use oxen driven plough at a small scale. There is a need to look for moisture stress during critical growth stages of a sesame seed. At such crucial times, farmers need guidance, resources and facilities which are lacking in Nigeria. As one farming said "*Farming is not at all an easy job; there is a lot of difficulties and problems associated with it. Being an experienced farmer, I can tell you that you learn with time all the important techniques and use of tools for enhancement in productivity".*

2. Insufficient Use of Resources in Nigerian Agriculture

In response to the question about the use of resources, it has been observed that Nigeria have sufficient resources of land and natural assets, yet it has been not been able to fully utilise its potential strength in the field of agriculture. The interview responses from farmers and far owners gave revealed similar finding that there are financial constraints in Nigeria which limits the full utilisation of farming land and agriculture practices. The energy of human resources is

being used in most of the phases of agricultural practices. In the view of a farm owner as he explained his view: "…*I would like to mention that there are many resources such as land resources, human resources, financial resources, machinery, pesticide sprays and technology. The government have been providing assistance and helping in many of the domains, but I think we utilise the labour force as a human resource the most. Rest of the resources and their use are insufficient in Nigeria*". The findings of most of the responses attained through interviews were similar to this response however one of the farmers revealed his viewing highlighting another view of resource insufficiency in the agriculture sector of Nigeria. He shared his view by responding as: "…*but I can see a lack of resources in many terms. Our lands are not managed well, scarcity of water sometimes, we don't get enough pesticides and insecticides that can cure plant or crop diseases fast".* Findings show that the Nigerian agriculture sector is not well supported by the resources including physical and financial.

It has been affirmed by the responses and similar patters about insufficient use of resources in Nigeria that Nigerian agriculture has reached to a point where using maximum resources can yield maximum production. But in many of the sectors, not all the resources are being utilised fully. Most of the farmers and farm owners believe that Nigeria has much potential to lead in agriculture across the world because it has land resources, water resources, human resources and other favourable conditions that are required for large-scale farming and agriculture. But not all the resources are being utilised with their full potential and thus Nigerian agriculture sectors are lagging far behind in any kind of progress. The corruption is at peak and all the finances allocated to farming and agriculture never reach to the farmers in its true sense. A farmer responded that *"We rarely get enough resources for that can help us in farming. There are seasonal changes and other soil-related difficulties which we need to manage by ourselves using old traditional procedures which we have learnt from our ancestors. In farming, we need to train skilled workers, but I have seen that there are untrained personnel and no training or technical assistance which become a hurdle in seed production and marketing".* Out of all the six responses, one response was contrary to the majority and believed that there is sufficient utilisation of resources. According to the respondent *"There is sufficient resource utilisation I think because the agriculture sector in Nigeria is flourishing. Now policymakers and government have started emphasizing in this field. So far only technological resources are not appropriately been made and I think that is because of the reason that we Nigerian farmers lack is financial aids and resources".*

3. Significance of automation and technology in farming

The significance of automation and technology in the farming and agriculture of Nigeria have been appreciated by all respondents, predominately in the sesame seed production. However, most of the individuals belonging to farming highlighted the fact that they have not experienced any sort of benefit from automation themselves. Either some farm owners have studied the significance of automation and technology in agriculture studies or farmers have heard it over the internet. This has been a major concern so far in the Nigerian Agriculture industry and also for sesame production. It is because if advance technology is not being utilised in the farming appropriately then it will cause an impact of sesame and other seed production in the near future. The profit and revenue might face a severe fall because of low production, wastage or delivery issues. In response to significance, a farm owner stated more detailed knowledge as compared to farmers. A farm owner who studied about the automation explained that: "*…advanced technology can bring change in all the major operations of sesame seed production. Most importantly, labour cost can be minimised. By having technology is a one-time expense and can be utilised for a longer period…*". These findings were similar to the response of another farm owner who stated the use of a Site-specific application software technology: Automated crop production and seed processing systems are being used in all the developed countries…. Automation can turn agriculture into a more profitable business and also reduce ecological footprints due to farming activities". On the other hand, in the view of farmers "*The advantages include more production in lesser time".*

The responses received from the farm owners highlighted many advantages and thus revealed about the significance of automation in Nigerian Agriculture system. It should be kept in mind that all the respondents were experienced and have spent greater time in sesame seed production. All of them agreed to a point that the advantages are many such as Nigerian agriculture advancement, cost-effectiveness, reduction in time, reduction in wastage and fast seed deliveries. One of the responses shed detailed light on the significance of automation in Nigerian agriculture, *"If you see the global companies of agriculture and seed production, they have all gained more profit and revenues because of flourishing and technology advanced techniques. I don't see any disadvantage because the labour force can be utilised in some other manpower work. But to have a zero-defect efficiency in farming and agriculture automation and technology is favourable. Currently, in Nigeria, I think there is a long way to go for the automated working of agricultural robots in the field".*

In this regard, the concern is still there because everyone has acknowledged the significance, but no one was sure about its implementation in Nigeria. It is believed that though there are many advantages; however, it depends upon the user how to make the best use of technology. Many of them supported to apply technology and automation practices in the agriculture system of Nigeria. Because the production can be doubled with minimum use of manpower and in less time; also, there is less wastage of grains. But at the same time, it will cost a lot to import new machines, train employees and make use of them. In the view of a farm owner *"At least we need 6-7 years more to reach at that place".*

4. Challenges faced during sesame seed production in Nigeria

After interviewing farmers and farm owners it has been concluded that there are many challenges, issues and problems in the Agriculture sector of Nigeria. Particularly in the sesame seed production as it was the main focus of the study. The majority of the interview responses affirm that the Nigeria sesame production is going through under challenging situation which needs to be resolved as soon as possible or it will be difficult to overcome the issues. Most of the farm owners and farmers revealed different challenges and issues. This shows that there are a variety of challenges in sesame seed production in Nigeria as one farm owner informed: "*…the major challenges are the use of traditional ways and technology in seed production".* Another response received during the interview was: *"I have seen that climate and seasonal changes are also challenging for sesame seed production. Sometimes we see that global and domestic markets fluctuate a lot".*

In addition to the general responses, we also received specific challenges in which one farm owner acknowledged two vital issues. According to him, ". *I want to highlight the two most important challenges. Number one is high production; sesame seed is always highly produced and in large amount which is very difficult to be managed manually. Secondly, there is a Post-harvest loss of grains.".* It is because there are no automated and autonomous machines that can handle a large amount of production. Manual mishandling occurs at all the stages starting from seed processing, seed storage, seed packaging, transportation and also marketing. In a very distinct manner, he highlighted the need for automation in this sector. Coming towards the responses of farmers they also mentioned some points to ponder. A farmer stated that production of sesame seed is very crucial as it requires so many conditions to be fulfilled: *"…specifically to sesame, there are challenges like the use of new knowledge in its production and harvest. It is an ancient crop… leaf-curl and other insect disease are sometimes*

uncontrollable and damage the entire crop". Many of the participants also mentioned high rate of corruption as the biggest hurdle in the progress of agriculture in Nigeria. The lacking is also found in the Nigerian learning process that is associated with the field. There is a lack of knowledge and therefore farmers and workers in this field might take much time to first learn to work on automated machines.

The responses highlighted another key aspect of struggling phase as a challenge for farmers and farm owners. During the struggling period in farming, they experience and face trouble in getting a loan from the bank for seed production and agriculture. In addition to this one farm owner also explained that the labour resource is quite sufficient in abundance but now the seed production sector needs advance technology and more physical resources rather than human resource. Other than this country is facing some serious challenges in terms of economy and financial growth. Nigerian farmers lack financial aids and resources. The poverty and nutritional problem are common in the country and that is why resources are not fully used. Corruption is another challenging situation due to which there is lacking to keep check and balance system. Lack of funds allocated to this sector also makes it challenging for farm owners to progress.

5. Technology Adaptation in Nigerian Agriculture

Both farmers and farm owners are in the view that there needs a change in the Agriculture sector of Nigeria. It is because technology cannot be merged into farming and agriculture before its knowledge and wide-scale education. Therefore, the majority of the farmers stated that in order to bring technology, government and other authorities should look after this sector more as it generates more profit for their economy. According to the response of one farmer *"technology implementation is important, and the government should provide us with training and knowledge about them".* Similarly, other participants believe that there is a need for more awareness, education, availability of finances and resources which can drastically bring a change in the agriculture domain and farmers practices. Many of the farmers and farm owners also have a firm belief that the agriculture sector in Nigeria has progressed but it needs more adaptation in terms of accepting change. A farm owner responded to the question *"…first thing is to accept the fact that technology can change rather transform the agriculture sector in Nigeria. Sesame seed production is among the top exporters and other countries demand high quality. We need to assure that quality parameters are being met properly with the use of latest technology in agriculture".* This shows that farmers and farm owners are ready to bring change

and adaptability towards technology and automation, but they require help from the government and local agriculture authorities to provide education and training on automation in farming sector of Nigeria.

Summarising the important adaptations that are highlighted in the responses include the need to adopt a culture of innovation, technology advancement and seed production automation. Nigerian farmers must appreciate o learn to adapt to the biggest change that is education and learning. Education, on the whole, is highly being affecting the country. Most of the farmers employed in Nigerian farms are not education and mostly work on the basis of their experience. Therefore, education at a higher level should be promoted; there should be more agriculture and vocational universities that can teach farmers about new technology. The adaptation is only possible if farmers learn to accept the fact that technology can change rather transform the agriculture sector in Nigeria. Sesame seed production is among the top exporters and other countries demand high quality. Nigeria must assure that quality parameters are being met properly with the use of latest technology in agriculture. Suggested adaptations by respondents are agricultural advancement. The production of a sesame seed with relevance to technology requires more financial resources to afford and buy new systems, automatic machines and advance technology.

Limitations

In terms of data collection, data recording, coding and transcribing for thematic analysis, the researcher had to face many limitations. The foremost limitation was conducting online interviews which were difficult because due to the pandemic situation the researcher was not able to visit every participant individually. Secondly, there was a limitation in learning to code and transcribing of data because the researcher had to learn about the new software with the assistance of the expert.

Chapter Summary

This chapter is comprised of two main sections, first detailing about the steps of thematic analysis, formulation of themes and coding. The second part is findings and analysis based on primary responses received from the interviews. The findings conclusively revealed that in Nigerian agriculture system there is no concept of automation so far. Many of the scholars and agriculture experts have shed light upon the difficulties of farmers and the use of smart technologies in this sector but there has been no drastic change to be seen so far. In this regard

farmers and farm, owners emphasized on the spread of education and knowledge about automation in farming and agriculture practices. However, it has also been highlighted by the participants that there is more potential in Nigerian agriculture that is currently being used. There are many land resources which need the attention of authorities and policymakers and also human resources need to be education and training in the farming sector. The chapter presents a detailed discussion by showing the comparison of the current results with already existing empirical findings. It helped the researcher to reach to the conclusion of the study by meeting all the objectives set in chapter one of the dissertation.

Chapter 5 Discussion in the light of Literature

The research is based on identifying the impact of automation and technology usage on agriculture, particularly on the sesame seed production in Nigeria. The approach that has been selected to explore the topic was a qualitative approach in which interviews were conducted with farmers and farm owners with more experience and knowledge in this area. The findings and results from the thematic analysis were helpful in reaching to a conclusion that though automation is important and the current need of Nigeria farming industry, yet the sector is lagged behind in doing a major progress. According to the study of Elijah et al. (2017), a lot of attention is gained by the Nigerian agriculture sector with respect to technology. The authors identified that to diversify the economy, technology implementation is important. The two key gaps as discussed in the study of Elijah et al. (2017) were meeting the domestic requirement and to be capable to meet the export quality level which is needed for the global market success. In this regard, the study suggested to implement the use of smart technology, internet of things (IoT) and data analytics (DA) in the Nigerian agriculture sector.

There are other major issues as mentioned by the participants. According to the responses of farmers, climate and seasonal changes are among the most vital challenges that cannot be managed or handled in an efficient manner without the technology. The study of Comes et al. (2019) explained in detail that in order to achieve resilient and sustainable farming of sesame seed production it is important to utilise advance technology such as the internet of things. The technology help in informing about the extreme weather conditions and also help farmers to adapt to changing climate within a hostile environment. Udo (2019) also highlighted the importance of the use of technology in the agriculture sector of Nigeria as it can reduce extreme poverty of the country. He discussed that most of the people in Nigeria are working in the agriculture and farming sector therefore the GDP of Nigeria is highly impacted because of this sector. In order to eliminate poverty and improve the living conditions, the technology aspect needs to fix up. Udo (2019) emphasized on increasing agricultural productivity by the use of automation and technology by 2030. That is also believed by our participants that maybe, it will take 10 more years to bring advancement in this sector.

From the findings, it has been noted that Nigeria is under a lack of investment and there is an issue of commercialization. Many farm owners believe that there are many market fluctuation and commercialisation issues that are causing hurdle in the growth of this sector. In relevance

to sesame seed production, they want more investors and financiers to come forwards and promote agriculture in Nigeria. Lack of invest is the main issue due to which sesame seed production and other crops are being produced in limited quantity despite having more potential. According to the study of Ntukidiem (2015) who highlighted the same issue 5 years ago from today that there is a major need for development in the Nigerian agriculture sector. It seems like the problem highlighted by Ntukidiem (2015) still persists. In that study that major focus was yam tubers and cassava roots as Nigeria are among the largest producers of these two crops. Later Gyimah-Brempong, Johnson and Takeshima (2016) also discussed these findings in their book. It has been revealed that agriculture serves the major branch of the economy because it not only serves as a food-producing sector but also it provides employment to 70% of the people of Nigeria and hence the investment and commercialisation of this sector is highly important. The two other issues were also discussed by Ntukidiem (2015) that epizooty and droughts may damage this sector severely, particularly to the rural producers. The state government should look into this sector and give attention to promote its development.

There is also another issue of global and domestic markets fluctuation with respect to sesame seed production as informed by the participants. The study of Carre and Pouzet (2014) indicated that the export market for Nigerian's sesame seed is available in India, Korea, Mediterranean and Middle East countries where the demand for sesame seed has become extensively high. On the contrary, the study of Achille et al. (2020) recently discussed about the fluctuation and uncontrollable drop in the sesame seed production in the global market. The study revealed that sesame seed is an export crop and its global export is not only essential for farmers for their income security but also it has the ability to attract currency for the country. However, in order to meet the fluctuating demand, the sector must properly use demand and supply forecasting tools and techniques in the Nigerian Agriculture sector. The majority of the responses during the interview revealed that major challenges in Nigerian sesame seed production are the use of traditional way and old-fashion technology. Achille et al. (2020) thus focused on sesame seed production and stated that increasing its demand at the global level can become a reason for driving the economic growth of Nigeria. These findings are also affirmed by the studies of Ogbonna and Ukaan (2012) and Kanton et al. (2013) as they stressed on the need for advancement in technology. They speculated that there exists a wide gap in the actual yield and potential yield of sesame seed in Nigeria because of the lack of utilisation of advanced technology.

The other part of the study was focused on highlighting the advantages and significance of the automation in the agriculture sector and sesame seed production in the view of Nigerian farmers and farm owners. It was revealed through the thematic analysis that the majority of the participants are in favour of implementing technology and automation. It is because they think that technology can enhance the production of a sesame seed, increase more profit and also reduce the dependency on manual procedures. In the view of farm owners, they stated that advanced technology can bring enhancement in major operations of sesame seed production. Predominately, in minimising the labour cost and because it is a one-time expense that can be utilised for a longer period. The study of Awotide et al. (2016) explained that technology is responsible for reducing the cost of labour and similarly it can impact the sector in the form of improved agriculture technology. Sesame seed production if supported by automation and technology can generate increase income and reduce the loss of grains in the post-harvest period (Awotide et al., 2016).

The interview of farm owners revealed that they are more concerned about reducing their cost rather than focusing to train the farmers. They assume the processing and production in the agriculture practices of the US and Europe have been enhanced because of technology advancement, robotics and artificial intelligence. Similarly, this can be done in Nigeria to produce a large amount of sesame seed. According to Gallardo and Sauer (2018) in the US, there is a trend of the use of labour-saving technology which has always been effective in the progression of agriculture and also contributed in the economies of nation. According to Mgbenka, Mbah and Ezeano (2016) Nigerian agriculture has very limited access to the modern technologies however, a tangible investment by government is important to progress more. The findings of Pii et al. (2019) also match to the information which stated that the inability to fully use the potentials of automation in the agriculture sector in Nigeria has resulted in the less efficient sesame production.

On the contrary, the farmers' view that has been revealed through the study is different. First of all, the farmers were not much aware of the advantages of automation because of lack of experience. Secondly, they were more afraid that technology may replace human labour and thus there will be no source of income for the labour force in Nigeria. Many of the farmers provided the same answer that they don't have much knowledge of how to incorporate and apply machine working in fields since in Nigeria all work is done by the labour force. Moreover, they don't know the usage of automation and technology in farming and Agri-

production activities. Keeping in view the lack of knowledge, Goldsmith (2019) stressed over the matter of building agricultural institutes in Nigeria.

Despite having no hands-on experience in automation and technology, farmers were aware that there are temperature control machines, moisture sensor machines, robots and other GPS technologies that can improve sesame production. This is because of the internet knowledge and the use of smartphones that have become quite common in Africa. According to the study of Wossen et al. (2019), there are many efficient tools and techniques used by farmers around the world such as automatic machines for ploughing, harvesting, storage and preventing disease. Hence the study shows that machines can reduce the manual workload and yield more sesame seeds. A more recent study has also presented a view in this regard that countries are progressing towards automation and thus Nigeria should also keep its pace high to establish technology advanced agriculture and farming system. According to Jha et al. (2019) food needs are increasing and therefore agriculture automation has become the main concern.

Our study also shows that traditional methods used by farmers are now not adequate to meet the increasing demand for sesame seed. Hence, Puranik, Ranjan and Kumari (2019) discussed various agriculture automated activities such as Deep learning, AI, Wireless Communication, IoT and Machine Learning. They identified that many areas of agriculture can be improved with the help of these automation techniques. The domains are crop disease control, weed management, pesticide control, irrigation, storage and harvest management and water management. According to Sarangi, Umadikar and Kar (2016) automation in agriculture can also help in leaf identification and leaf-curl and other insect diseases can also be controlled which are sometimes uncontrollable and damage the entire crop. This shows that automation and technology can improve a wide number of issues that are recently faced by the Nigerian agriculture sector and predominately for the growth of sesame seed production. The similar type of study was conducted in Mexico in which the authors Nedrete et al. (2018) suggested mechatronic technologies to apply in the agriculture sector of Mexico. It is a combination of both mechanical and electrical systems such as robotics and telecommunication systems.

In the view of farmers and farm owners, the issues are similar, but the solution can be different and thus their responses vary while answering about the adaptations towards technology in adoption in the agriculture sector of Nigeria. The farmers stressed on their training and education on new machines and technologies. On the other hand, the farm owners have the view that in Nigerian farms there is a need of more educated farmers, availability of finances

and resources which can bring a paradigm shift in the agriculture domain and farming practices. Also, they believe that adopting and accepting a culture of innovation, technology advancement and seed production automation is most important. The study of Guzueva et al. (2020) summarises the entire finding and states that innovation in agriculture can make agriculture practices more feasible. It stated that accumulation and stockpiling of seeds can be managed and data can be progressed in a more accessible manner. The overall findings match the available literature and thus it can be concluded that the condition of Nigerian Agriculture sector has remained similar since past 5 years and now in coming years it requires a drastic change to survive in the global economy.

Globally, there has been a great development in the agriculture sector and farming areas. Many of the countries have progressed so well that no human intelligence is being imitated by machines in the form of artificial intelligence. Some of the farm owners who have studied about the latest agriculture techniques have emphasized on this point that now robotic machines are being used in developed regions. The study of Smith (2020) has recently published its finds based on the significance and use of Artificial Intelligence in the agriculture sector. The value of AI is emphasized to change the shape of the agriculture sector in the coming decade. Smith (2020) explained that there are techniques that accurately detect and measure the land improving farming capabilities. This can later result in pre-informed alters to the farmers. Another significance is improved management of farms. Though Nigerian farmers and farm owners are far behind from this technology, yet they need more awareness about what is happening in the world. Similar though has been revealed through the interview responses as everyone was willing to learn more in the specific field. Farm owners also believe that in order to improve decision-making and production predictions in sesame production automation is necessary. Bannerjee et al. (2018) also highlighted the similar viewpoint that to harness the value of technology throughout the supply chain of seed production AI needs to be enabled in the farms. However, social and ethical aspects must be kept in consideration. The implication of AI and automation in agriculture as determined by Bannerjee et al. (2018) is an opportunity for farmers to be able to generate more food with sustainable massive production in less time.

The above-mentioned technology is though quite feasible in the agriculture of USA, UK and Australia because their economy is stable, and they are categorised as developed regions having greater capital and expenditure to spend on the agriculture sector. In Nigeria, the government can make initial steps to make advancement in technology by increasing the share of agriculture in the national budget. This has been suggested in the findings of the current study that there

should be increased share from the government because farmers and farm owners are already over-burdened with the other expenses to pay to workers, spend on animals, spend on pesticides and insecticides and other essential necessities required by their crop. This includes watering the crops and also planting seed; farmers emphasized that nourishing sesame seed is difficult as it requires specific temperature and environment.

According to Haruna (2011) although the sesame seed has drought-tolerant capabilities, yet it widely grows in the region north of Cross river and in Ebonyi, however, its growth in the Delta region did not produce much quantity of seeds. Another study by Dallas et al. (2017) studied challenges of sesame production such as pest infestation, diseases, drainage and irrigation problems. All these challenges lead to sever nourishment issues to the seed crops. Technology is also helpful in this regard as it can help farmers in monitoring growth and also while providing the personalised protein nourishment to plant. Hence, throughout the literature and findings, it has been assessed that though Nigeria lacks technology and automation in farming and agriculture, yet they are skilled individual, adaptive to learning and accepting challenges. There is a need that the state should give more focus to the agriculture sector of Nigeria. Furthermore, the farmers and farm owners have adequate knowledge of sesame seed production that can be helpful in the progress of this sector. The next section of the dissertation discusses the recommendations in detail.

Chapter 6 Conclusion and Recommendation

Main Conclusion

Africa is a land of greenery, forestry, plants and agriculture; with an increased number of populations in the region, there are also challenges of food production, drought conditions, weather changes and underdeveloped regions. The population is continuously growing but this is becoming more threatening to low farm productivity. Most of the farming communities are deprived of young people, funds and technology advancement. Nigeria is a known country of Africa and is famous for its wildlife reserves, natural landmarks and wide-scale crops production. However, the sector is still focusing on old-school practices of farming and agriculture. This is because there are a number of challenges in Nigeria to progress towards technology. Some major challenges are difficulty in getting finance for new machines, limited access to new technology, inadequate latest farming equipment, underdeveloped infrastructure and limited accessibility to internet devices. Nigeria is also known for sesame seed production in very large quantity, which is being exported to other continents to meet the market demand. However, the literature reveals that Nigeria can produce more sesame seeds if its production sector is improved. Many authors have suggested that automation and advancement in technology is the key to progress in agriculture. Keeping everything in view this study was carried out with the main aim to identify the role of automation in the sesame seed production in Nigeria for which interviews are conducted with farmers and farm owners.

The study identified a research problem based on available literature according to which there is a significant need to utilise the technology efficiently in producing a noteworthy output of sesame seed for export. Some studies also reveal that there exists a wide gap in the actual yield and potential yield of sesame seed in Nigeria because of the lack of utilisation of advanced technology. Research objectives were devised in accordance with the aim of the study and getting detailed insights from the farmers and farm owners. The first research objective was examining the role of automation in enhancing sesame seed production in Nigeria. Interview responses were analysed using thematic analysis and it was revealed that all of the participants were positive towards adopting new technology. Farming and particularly the sesame production are considered very crucial among the farmers of Nigeria. They reveal various requirements and needs for enhancing sesame seed production. They argued that still in many areas' oxen driven ploughing techniques are used which should now be replaced by tractors

and other advance machines. No doubt, human assistance is necessary, yet farmers should also be aware with latest tools used in the sesame seed production. Providing a few basic technologies such as tractors, tube wells and transportation is the right of every farmer in Nigeria because of its intense demand worldwide. The most important point in my view is measuring the moisture stress during critical growth stages of a sesame seed. At such crucial times, farmers need guidance, latest tools, resources and facilities which are highly lacking in Nigeria. Hence, the objective of the study met through findings that automation can be the one solution to enhance sesame production

The next objective of the study was to evaluate whether or not the seed production resources are efficiently being utilised in Nigeria. To this point, many of the participants disagreed because the Nigerian government and other authorities have failed to provide adequate resources to farms and farmers so that they can carry out farming and sesame production in an efficient manner. All the participants were in the same view of discussing the lack of resources to produce a good amount of sesame production. Many of the farmers take a loan and the rest of them use their own savings and investment in the farms to increase the production and yield more. Only human resource is being utilised in almost all the stages of sesame agricultural practices whereas there are financial constraints which limit the full utilisation of farming land. Hence, the second objective was also met, and it was concluded that in Nigeria the agriculture sector has a deficiency of resource and its proper utilisation.

The research objective of this research was to identify the challenges in sesame production in Nigeria. To my surprise, there have been many different challenges that were informed by participants. In general, the challenges are using traditional ways of farming and producing sesame seeds. Farmers have also stressed on the issue of climate and seasonal changes that are also challenging for sesame seed production. The market demand of sesame seed also does not remain the same throughout the year, many times there is market fluctuation at both global and domestic level. On the other hand, specific challenges were also highlighted that include high production of sesame in the time of high demand, manual mishandling of seeds by human labour and post-harvest loss of grains. Farmers believe that these challenges are due to no use of automated and autonomous machines that can handle a large amount of production. Hence, the third objective met by listing down major, minor, general and specific challenges in the agriculture sector of Nigeria.

Recommendations

From the study findings, it is quite obvious that the Nigerian agriculture system lacks technology advance, automation in farming, insufficiency in using resource and lack of agriculture education and training. Hence, the following recommendations have been made supported by the available literature studies conducted in Nigeria to improve and enhance the overall farming.

1. Nigerian government should put more effort into growing the agriculture sector by making a huge investment. The set of new policies should be created that can provide more support to farmers and farm owners in terms of finances, agriculture loans, infrastructure and other aids. There has been least consistency shown by the Nigerian government towards agriculture because of giving preference to black gold. Now it should show more interest in growing the agriculture sector. If not much the government of Nigeria must provide farmers with improved transportation, roads and electricity which can fulfil agriculture needs of infrastructure (Coomes et al., 2019).

2. In Nigeria, there are skilled individuals, farmers and farm owners who are adaptive to learning and accepting challenges. However, some are still living in an era where the plant is expected to grow with the phases of the moon and the use of traditional farming practices. There is a need to provide proper training and education to these individuals having adequate knowledge of sesame seed production that can be helpful in the progress of this sector. In this regard, more universities and vocational training institutes must be established in Nigeria and other parts of Africa to make agriculture studies common among Nigerian, thereby they don't have to go out of the country to have a degree in agriculture studies (Kviz and Kroulik, 2017).

3. There is a need to introduce new technology and automation in the agriculture sector of Nigeria. Aerial imaging technology as drones or satellites can be used for viewing the growth of crops. Weather forecasting should be done with the help of internet smart devices and GPS, Unmanned Aerial Vehicles or soil sensor devices can be used for the better growth of crops. This is how the crops are being managed in various countries in real time. The use of automated systems in seed production is suggested because it helps in proving early warnings if in case the seed is not showing signs of normal growth (Gong, 2017).

4. Another study of Elijah et al. (2017) recommended the use of Internet of Things for making the agriculture sector in Nigeria more sustainable. It is suggested that there should be more training facilities, internet accessibility, sensitization and access to online markets. The study suggested the use of IoT technology and other automated achiness for attaining precision in agriculture. This can be done through field monitoring, water and soil detection and also for irrigation, tracking and monitoring farm products, transportation and improved communication between consumers and farmers.

Limitations

The current study has been conducted successfully however; the researcher had to face limitations such as conducting interviews during the global pandemic crisis. It was difficult to access to the farmers through the use of the internet because of poor availability of internet in Nigeria. Selecting and identifying the sample profile for the current study was also difficult. Moreover, there were limitations to analyse the thematic analysis using accurate techniques and tools however, researcher overcame the difficulties and finished the research in the maximum available time.

Future Avenue for Research

The current research can be taken forward by interviewing more participants and government state officials to know their view about the policies and investment plan of the Agriculture sector of Nigeria. The research can also be done by considering the aspect of issues and challenges in the agriculture sector to provide a better solution. In the current study, the aspects are being evaluated through qualitative findings however, the quantitative analysis can also be performed by changing the sample population to the students of agriculture sector and taking their views.

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Appendix

Interview Questions

1. How long have you been involved in sesame seed production and agriculture in Nigeria?

2. In your opinion, how well are the resources being utilised for sesame seed production?

3. What are the difficulties that you face during sesame seed production in farming and agriculture?

4. Do you think introducing technology in the sesame seed production will enhance the process and its production?

5. What do you know about the use of automation and technology in farming and agri-production activities? Do you think they can reduce the manual workload and yield more sesame seeds?

6. In your opinion, what are the advantages and disadvantages of using technology and automation practices in the agriculture system of Nigeria? How long will it take to bring advancement in this sector?

7. What adaptations do you suggest for the agricultural advancement and sesame seed production with relevance to technology?

One Interview Transcript as Sample (Rest can be provided as per demand)

Interview Transcript 1 (Farm Owner)

1. By profession, I am an agriculturist and I have owned these farms after taking the ownership from my ancestors. It has been almost 6 years that I have been involved in the seed production and agriculture industry. And recently in the last 3 years after the increasing demand for sesame seed, I started its production at a large scale. Other than the sesame seed I am also dealing in other seed crops for many years. I think I enjoy being part of this profession.

2. I think Nigerian agriculture has reached to a point where using maximum resources can yield maximum production. But I am afraid that in many of the sectors, not all the resources are being utilised fully. First, I would like to mention that there are any resources such as land resources, human resources, financial resources, machinery, pesticide sprays and technology. The government have been providing assistance and helping in many of the domains, but I think we utilise the labour force as a human resource the most. Rest of the resources and their use are insufficient in Nigeria.

3. So far, in my entire career as a farm owner, I have faced many difficulties to reach at this point. The struggle that has been made to make the sesame production successful is not an easy task. As a farm owner, you not only need to look after the finances and workforce but also look for the seasonal change, land quality, pesticide sprays, timely arranging the required material. Other than this, in past years we have seen that the major challenges are the use of traditional ways and technology in seed production.

4. Yes, of course. There is no doubt that the introduction of technology that is advanced technology can bring enhancement in all the major operations of sesame seed production. Most importantly, labour cost can be minimised. By having technology is a one-time expense and can be utilised for a longer period. Processing and production, as I have observed in the agriculture practices of the US and Europe have been enhanced because of technology advancement, robotics and artificial intelligence.

5. I have studied a lot about automation and use of technology in farming and so far, I came to a conclusion that yes in order to increase the production and smoothed the yield of a sesame seed, Nigerian farmers need to be replaced by automated machines. In the time of farmer shortage, technology will be used to automate the seed production cycle.

6. The advantages are many such as Nigerian agriculture advancement, cost-effectiveness, reduction in time, reduction in wastage and fast seed deliveries. The only disadvantage that I see is the learning process that is associated with the field. We lack in knowledge and therefore our farmers and workers in this field will take much time to first learn to work on automated machines.

7. As I mentioned before, we first need to adopt a culture of innovation, technology advancement and seed production automation. First, we need to learn to adapt to the biggest change that is education and learning which is highly being affected in our country.

Copy of a Blank Consent Form

INFORMED CONSENT

I have read the invitation letter from **Nathaniel Idoko Saleh** and understood the nature of his/her proposed study titled "**Impact of Automation on Sesame Seed Production in Nigeria"**. I consent to participate in the study. I understand my participation in this research would be voluntary and I can withdraw from the study if I wish so or I can also withhold any information if I want so. I understand that I will be required to answer interview questions. I also understand that all information that I will share with the researcher through interview will be kept confidential. Furthermore, this information will be only used for academic purposes. I understand that my participation in this study will not lead to any financial benefits.

Participant's Signature: _____

Date: _____

Signature of person obtaining consent: _____

Date: _____