RELATIONSHIP BETWEEN KNOWLEDGE, ATTITUDE AND PRACTICE TOWARDS ADOPTION OF IMPROVED VARIETIES OF PEARL MILLET AMONG FARMERS IN NORTH-EASTERN NIGERIA

MOHAMMED GALADIMA

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By

MOHAMMED GALADIMA

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

October 2019

DEDICATION

This Thesis is largely dedicated to my late irreplaceable mother ' ' *Ummi Aisha Ibrahim Dagona,* ' whose maternal care, wisdom and prayers lifted me, but Allah who loves her most, carried her to the final abode, In Shaa Allah, Jannatul Firdausi. Indeed, the death of my mommy had created a huge vacuum for my life. For my mom, that's what she's always been quoted to say whenever I try to share my story about my academic career with her.' 'To *her, In Shaa Allah, if it is all about educational attainment, you would certainly reach the highest level.* " Now, the mission has been accomplished!!! As Allah (SWA) answered her prayers. Henceforth, she's not with me to celebrate the success of my Ph.D. May the Mummy returned to the Omnipotent, the Omnipresent and the Merciful, be infinitely better than for her being alive. My indispensable aged Father, " Malam Galadima Alhaji Shuaibu Dagona " whose parental and emotional attachment has raised me in an immeasurable way. May Allah continue to increase his faith, provide him with sound health, to guide him on the right path, as he dedicates his life to my well-being and, that of my siblings. Last but not the least, the thesis is also dedicated to my late Sisters Salma, Fahdimatu Zahra, and to all other well-wishers and relations who have gone unnoticed but, fondly remembered, May Allah Subhanahu Wataala kindly admits them to Jannatul Firdausi.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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October 2019

Chairman : Salim Hassan, PhD
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Agriculture remains the fundamental tool for economic growth, poverty reduction and enhancement of food security. In Africa, almost 70% of the population that are involved in agriculture are small-scale farmers, working on a small portion of land, on average of not more than 2 hectares of land. However, in Sub-Sahara Africa, Nigeria is one of the major pearl millet producing countries with an average annual production of 4.8 million tons. Indisputably, pearl millet production is mostly carried out in North-eastern region of Nigeria, although, it is often below the expected production, because of low level of adoption, resulting from inadequate level of knowledge, attitude and practice on the improved technology, coupled with the *insurgency*, which had displaced millions of farmers. Hence, farmers mostly relied on traditional production method. These situations craved for this research, which was designed to determine the relationships between knowledge, attitude, practice and adoption of improved varieties of pearl millet by farmers in North-eastern Nigeria. Specifically, the objectives were to: 1) determine the level of knowledge, attitude, practice and adoption; 2) determine the relationship between knowledge, attitude, practice and adoption and 3) determine the most contributing independent factors to adoption of improved varieties of pearl millet among farmers in North-Eastern Nigeria. Hence, various relevant literatures were reviewed to buttress the study.

The study adopted quantitative, cross-sectional correlational design for the study. Purposive and systematic sampling technique were used to select (477) pearl millet farmers in North-eastern Nigeria. Primary data were collected by using validated and pilot tested self-report questionnaire. Descriptive, correlation and regression were used for the analysis. The data revealed that, (92.8 percent) of respondents were male and (91.9 percent) were married. About (72.6 percent) had a family size of (8-

14 persons). Majority were middle aged, between (20-50) years and (78.80 percent) had only primary and secondary education. While, (56.6 percent) had no extension contact and (84.6 percent) were members of cooperative societies whereas, greater number about (62.8 percent) had experience between (11-20 years) in pearl millet production. More than half (74.9 percent) cultivates between 1.6 to 3.5 hectares of land. Respondents monthly income ranged between N10, 000 (USD 28.00) and above ₦30, 000 (USD 84.00) from pearl millet farming. Results on the level of knowledge revealed that, majority of respondent (91.6 percent) recorded high level of knowledge, attitude (81.9 percent) moderate level, practice (53.2 percent) recording High and adoption level 64.5 percent high among respondents. Results of the correlation analysis revealed positive significant relationship between knowledge, attitude, practice and adoption at ($p<0.01$). The findings of the Regression analysis further revealed that, knowledge and practice were significant towards adoption at $p<0.05$ determinants. From the outcome knowledge contributes with a ($\beta= 0.283$, $p= 000$). Whereas, practice contributes with a ($\beta=0.493$, $p=000$). Though, attitude was insignificant towards adoption as confirmed by its ($\beta=0.047$, $p=0.623$). Hence, adjusted R^2 of 0.366 indicates that, knowledge and practice contribute 36.6% of variance towards adoption. The outcome of the decisions on the hypothesis tested showed that there was a direct positive relationship between knowledge and practice towards adoption. While the decision on the hypothesis concerning the contributing factors to adoption indicates that knowledge and practice have made a significant contribution to the adoption of improved varieties of pearl millet. While, attitude was not significant and thus, did not contribute.

The study concluded that knowledge, practice and adoption level among respondents was high and attitude was moderate. Results of the correlational analysis revealed that, positive significant relationship existed between knowledge, attitude, and practice towards adoption. While, the regression results revealed that, knowledge and practice contribute more towards adoption whereas, attitude did not contribute. Hence, practice had the highest contribution towards adoption with a Beta value of .493. Thus, based the study implication, the study suggests that, farmers should be encouraged towards developing positive attitudes in the cultivation of improved pearl millet in the study area. Government and other relevant agencies should provide farm inputs, funds, access to improve seeds at affordable prices, available, and as well as provide adequate support towards extension mechanism, in their efforts to intensify farmers level of awareness on the use of improved pearl millet technologies. More extension agents be employed by the government to improve farmer-extension agents' relationship in North-Eastern Nigeria. Further studies be conducted, considering other factors such, as the cultural belief and practices, insurgency, farmers' level of mechanization which might had been considered and could play an important role in influencing adoption among farmers in North-eastern Nigeria.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

HUBUNGAN DIANTARA PENGETAHUAN, SIKAP DAN AMALAN TERHADAP PENERIMAAN VARIETI BARU SEKOI MUTIARA DIKALANGAN PETANI DI TIMUR LAUT NIGERIA

Oleh

MOHAMMED GALADIMA

Oktober 2019

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Sektor pertanian kekal sebagai asas kepada pertumbuhan ekonomi, pengurangan kemiskinan dan penambahbaikan dalam kelangsungan jaminan makanan. Di Afrika, hampir 70% daripada penduduk yang terlibat dalam pertanian adalah petani kecil, bekerja di sebahagian kecil tanah yang secara purata berkeluasan tidak melebihi 2 hektar. Nigeria adalah negara penghasil sekoi mutiara utama dengan purata pengeluaran tahunan sebanyak 4.8 juta tan. Walaupun pengeluaran sekoi mutiara kebanyakannya dijalankan di rantau Timur Laut Nigeria, namun pengeluaran hasil sering di bawah sasaran yang dijangkakan, hal ini kerana tahap penerimaan yang rendah, tahap pengetahuan, sikap dan amalan yang rendah pada teknologi, ditambah pula dengan pemberontakan, yang telah mengusir berjuta-juta petani. Oleh itu, kebanyakan petani bergantung kepada kaedah pengeluaran tradisional. Keadaan ini seterusnya menjurus kepada kajian yang dirancang untuk menentukan hubungan di antara pengetahuan, sikap dan amalan terhadap penerimaan varieti baru sekoi mutiara di kalangan petani di Timur Laut Nigeria. Khususnya, objektifnya adalah: menentukan tahap pengetahuan, sikap, amalan dan penerimaan; 2) menentukan hubungan di antara pengetahuan, sikap, amalan dan penerimaan dan 3) menentukan faktor-faktor yang paling menyumbang kepada penerimaan varieti baru sekoi mutiara di kalangan petani di Timur Laut Nigeria. Oleh itu, pelbagai literatur yang berkaitan digunakan untuk meneliti kajian ini. Kajian ini menggunakan kaedah kuantitatif dan reka bentuk keratan rentas untuk kajian. Teknik persampelan bertujuan (purposif) dan sistematik digunakan dalam memilih (477) petani sekoi mutiara di Timur Laut Nigeria. Data utama dikumpulkan melalui penggunaan soal selidik berstruktur. Kaedah deskriptif, korelasi dan regresi digunakan untuk menganalisis data. Hasil kajian menunjukkan bahawa (92.8%) responden adalah lelaki dan (91.9%) telah berkahwin. Sebanyak (72.6%) mempunyai keluarga (8-14 orang). Majoriti berumur di antara (20-50) tahun dan (78.80%) hanya mempunyai pendidikan rendah dan menengah. Tambahan pula, (56.6%) tidak mempunyai

hubungan dengan pegawai pengembangan dan (84.6%) adalah anggota koperasi manakala jumlah yang lebih besar (62.8%) mempunyai pengalaman di antara (11-20 tahun) dalam pengeluaran sekoi mutiara. Lebih separuh (74.9%) menanam diantara 1.6 hingga 3.5 hektar. Seterusnya, responden berpendapatan bulanan antara ₦10,000 (USD, 28.00) dan di atas ₦30,000 (USD 84.00) dari pertanian sekoi mutiara. Hasil kajian juga menunjukkan bahawa majoriti responden (91.6%) mencatatkan tahap pengetahuan yang tinggi, sikap (81.9%) mencatatkan tahap sederhana, amalan (53.2%) merekodkan tahap yang tinggi dan tahap penerimaan yang tinggi iaitu 64.5% di kalangan responden. Hasil kajian korelasi pula menunjukkan hubungan yang signifikan di antara pengetahuan, sikap, amalan dan penerimaan iaitu ($p < 0.01$). Penemuan analisis regresi seterusnya menunjukkan bahawa, pengetahuan dan amalan terhadap penerimaan adalah signifikan pada $p < 0.05$. Dari hasil kajian, pengetahuan menyumbang dengan ($\beta = 0.283$, $p = 000$). Manakala, amalan menyumbang dengan ($\beta = 0.493$, $p = 000$). Walau bagaimanapun, sikap tidak signifikan terhadap penerimaan ($\beta = 0.047$, $p = 0.623$). Oleh itu, nilai R^2 yang selaras (0.366) menunjukkan bahawa pengetahuan dan amalan menyumbang 36.6% varians terhadap penggunaan varieti baru sekoi mutiara di kalangan responden. Hasil kajian melalui hipotesis yang telah diuji menunjukkan terdapat hubungan positif di antara pengetahuan dan amalan terhadap penerimaan petani. Hasil kajian menunjukkan faktor penyumbang kepada penerimaan adalah pengetahuan dan amalan yang memberikan sumbangan penting kepada penerimaan varieti sekoi mutiara. Namun, sikap menunjukkan hasil yang tidak signifikan dan tidak menyumbang.

Kajian ini merumuskan bahawa pengetahuan, amalan dan tahap penerimaan di kalangan responden adalah tinggi dan sikapnya sederhana. Keputusan analisis korelasi menunjukkan bahawa, hubungan yang signifikan wujud diantara pengetahuan, sikap, dan amalan terhadap penerimaan. Sementara itu, keputusan regresi mendedahkan bahawa pengetahuan dan amalan menyumbang lebih kepada penerimaan sedangkan sikap tidak menyumbang. Manakala, amalan mempunyai sumbangan tertinggi terhadap penerimaan dengan nilai Beta .493. Oleh itu, berdasarkan implikasi kajian, kajian menunjukkan bahawa petani digalakkan untuk membangunkan sikap positif dalam penanaman sekoi mutiara yang lebih baik di kawasan kajian. Kerajaan dan agensi-agensi lain yang berkaitan harus menyediakan input, dana dan akses untuk meningkatkan hasil dengan harga yang berpatutan, serta memberikan sokongan yang mencukupi ke arah mekanisme pengembangan dalam upaya mereka untuk meningkatkan tahap kesedaran para petani mengenai penggunaan teknologi sekoi mutiara. Malah, lebih banyak ejen pengembangan yang diperlukan oleh kerajaan untuk meningkatkan hubungan ejen pengembangan dengan petani di Timur Laut Nigeria. Seterusnya, kajian lanjut perlu dilakukan dengan mempertimbangkan faktor-faktor lain seperti kepercayaan dan kebudayaan petani, pemberontakan, tahap pengetahuan teknologi petani yang dapat dipertimbangkan dan dapat memainkan peranan penting dalam mempengaruhi penerimaan di kalangan petani di Timur Laut Nigeria.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

ADP	Agricultural Development Programme
APP	Agricultural Promotion Policy
ATA	Agricultural Transformation Agenda
CBARDA	Community Based Agricultural & Rural Development Approach
DIT	Diffusion of Innovation Theory
DFID	Department for International Development
ERGP	Economic Recovery and Growth Plan
FAO	Food and Agricultural Organization
FAOSTAT	Food and Agriculture Organization Statistical Data base
FMARD	Federal Ministry of Agriculture and Rural Development
GDP	Gross Domestic Product
KAP	Knowledge, Attitude, Practice
ICRISAT	International Crops Research Institute for Semi-Arid Tropics
IAR	Institute of Agricultural Research
IFAD	International Fund for Agricultural Development
IDPS	Internally Displaced Persons
IIDS	Institute of Integrated Development Studies
ILO	International Labour Organizations
LGA	Local Government Area
LCRI	Lake Chad Research Institute
MDG	Millennium Development Goals
MT	Metric Tons
NBS	National Bureau of Statistics
NAERLS	National Agricultural Extension and Research Liaison Services
NGOs	Non-Governmental Organizations

NNAP	New Nigerian Agricultural Policy
NEPAD	New Partnership for African Development
NPC	National Population Commission
NSPFS	National Special Programme on Food Security
OECD	Organization for Economic Cooperation and Development
QPM	Quality Protein Maize
SSA	Sub-Sahara Africa
UNSDG	United Nation Sustainable Development Goals
UNDP	United Nation Development Programme
USDA	United State Department of Agriculture
USAID	United States Agency for International Development
TCP	Traditional Crops Project
TAM	Technology Acceptance Model
T & V	Training & Visit
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Agriculture remains the fundamental tool for economic growth, effective development, poverty reduction and enhancement of food security. This is largely true in developing countries and Nigeria inclusive (Benjamin et al. 2014 & World Bank 2010). Indeed, no region of the world has ever developed a diverse and up-to-date economy, without initial foundation of a successful base on agriculture. Today in Africa, virtually more than half (70%) of the populace that are engaged in agribusiness are Small-scale growers, working on a small portion of land on average of not higher than 2 hectares of farmland. As such, agriculture remains Africa's positive system of increasing wide-range of financial prudence and generating decent jobs, that are meant for able-bodied men mostly youths (AGRA, 2017). Indeed, in Sub-Saharan Africa, Nigeria all-encompassing, growth and development engendered by agriculture is eleven times further effective in dropping poverty than GDP growth in other portions of the economic sector (IFAD, 2013)

However, crop farming in the Arid and Sub-Saharan Africa regions is of great challenge to the regions, due to factors such as, the harsh climatic conditions, dependence on rain-fed agriculture, smallholder land holdings, low-level of mechanization and most notably, low adoption of improved crop varieties resulting from a limited knowledge, which facilitates attitude and practice on the improved agricultural technologies among farmers (FAO, 2016; Mwangi & Kariuki, 2015). These factors contribute significantly to low food production, which leads to food insecurity persistently experienced in the Arid and Sub-Saharan African (SSA) regions, which are home-based to nearly two third of the world's population (AGRA, 2017)

Furthermore, International Labour Organization ILO (2017) suggested that, the Sub-Saharan Africa (SSA) in question, which Nigeria is also a great component part, is seen as the world's undeveloped and fastest developing region. The zone represents an excess of 950 million persons, roughly 13% of the world populace. As a result, more than half of the poorer classes are living in the SSA, like Nigeria. Nonetheless, the number of these poorer classes in the region has risen by 9 million, with 413 people who survive on less than US$ 1.90 per day as at 2015, which is more than all other regions, combined in Africa, and Nigeria taking the lead, with the number of the poorer classes rising to around 86.6 million persons, recording about 46.7% (World Bank, 2018). In the same vein, the SSA region, was noticed to have sluggish record of low safe staples and nutritious security, which had been credited to low response to the adoption of improved technologies, which translated into low level of productivity on the agricultural proceeds(Melisse, 2018, FAO, IFAD and WFP, 2015).

More so, reliance on rain fed agriculture, high rates of population growth, political instability coupled with high level of insurgency is very much pronounce in the region. For example, the ongoing revolt in North-eastern region of Nigeria which was the primary area of this study and some areas of Niger Republic, Cameroon and Chad Republic to mention but few (Olanrewaju et al., 2019; Melisse, (2018); Leshie, & Henry, 2016; FAO, IFAD and WFP 2015). Note that, as from 1990 to 2013, the inputs such as, fertilizers, improved seeds varieties, agro-chemicals among others were estimated in SSA at US$ dollars expanded by 130% and the crop unit overwhelms the total agricultural production estimates of about 85% over 24-years (OECD/FAO, 2016). This offer varieties over the zone, running from 53% in Southern part of Africa to over 90% in West Africa countries, including Nigeria.

Pearl millet (*Pennisetum glaucum*) as the subject of this study, is an agronomic group of hardies, small-seeded cereals, that is so vital round the world mainly for staple and fodder, organic food, source of construction and fuel for cooking in countries that are mostly arid and semi-arid. In semi-arid, rainfall is not sufficient between (200-600 mml) in Africa and a few other countries in Asia(Lubadde et al. 2015; Izge & Song, 2013). The crop could however survive in the hottest and driest climatic regions ; (Izge & Song, 2013). It should be noted that, amongst the cereal families, pearl millet is positions 6th in worldwide area of production behind wheat, maize, sorghum and rice. Accordingly, the world area production for pearl millet was estimated to about more than 31 million ha, in over 40 countries (ICRISAT, 2017; Ullah et al., 2017). Hence, Africa alone yields 56 % of the world output, of which 99.9% is produced in Sub- Saharan Africa, where it is ranked as the 3rd most widely cultivated crop (FAOSTAT, 2015).

Similar appraisal had also confirmed that, the most important producers of Peal millet are India, Nigeria, Niger, Mali and in addition China, Burkina Faso and Senegal (USDA, 2015). Indeed, Nigeria, as one of the world's largest millet growing nations, produced more than half, which is about 40% of the production output in African continent (FAO, 2014). Accordingly, the annual output index for pearl millet in Nigeria was confirmed to be 4.8 million tons (USDA, 2015). Recent report by ICRISAT (2017) revealed that, Nigeria recorded over 150% productivity gain from the package of improved practices on Pearl millet.

Furthermore, Nigeria as a nation was placed second after India in worldwide millet production, and third nationwide after sorghum and maize amongst cereal crops. Indeed, Ndjeunga & Ajeigbe, (2012) reported that, research and development interventions resulting to higher uptake of modern Pearl millet varieties, among farmers might likely lead to increases in income, food security and welfare of millions of farmers. Based on the above, the system increases the pearl millet production in Nigeria with higher human food gains (Izge & Song, 2013). Hence, the introduction of the improved pearl millet technologies in question requires the need for adequate knowledge, positive attitude and practice to ensure success in the application of adoption practices, and such practices must include among others land preparation, sowing technology, thinning, weeding, pest and disease control

technology, harvesting, grading, packaging and modern transport technology (Ndjeunga & Ajeigbe, 2012; (Mitaru et al. 2012); FAO, 2011 & Ajeigbe, 2010).

However, in Nigeria, the northern part of the country was believed to be the backbone of millet production, due to its ideal agro-ecological condition for pearl millet farming throughout the north-east, north-west and north-central regions. For this reason, pearl millet is mainly produced and consumed in the regions, making it a staple food for more than 40% of the population as reported in the works of (Jirgi et al., 2010). Therefore, in numerous households, particularly among the underprivileged, in northern part of Nigeria, utilizes lots of tons of pearl millet as main food (Izge & Song, 2013; FAO, 2006). These same researchers also confirmed that, pearl millet grain is used to make a common deep-fried cake known as "masa." Its powder is also used in the cooking of "tuwo" in the Hausa language, a thick paste also known as "toh" in northern Africa. It encompasses 18% amino acids, rich in vitamin B, particularly niacin, B6 and ascorbic acid. It's mostly confined to flatbread, since it lacks gluten. It's a vital food in the Sahel, exclusively across most of northern Nigeria, Niger, Mali and Burkina Faso. It is often ground in form of flour, rolled into large balls, parboiled, dissolved within a milky mixture and then used up as a drink. This drink named "fura" in Hausa or "Bau" in Bade language is a common dish in northern Nigeria and southern Niger (Izge & Song, 2013; FAO, 2006).

(Izge & Song, 2013, Kumar et al. 2013) looked at other uses of pearl millet, the green fodder has high level of protein, calcium, phosphorus and other essential minerals. Further, glumes and pericarp "dussa" in Hausa is also used in the preparation of feed for animals, including poultry and stalks, for the production of mulches, and as fuel woods for cooking in most agrarian homes. Pearl millet also tends to be an important feed for other birds, namely doves, turkeys, songbirds, ducks and cows, to mention but a few.

However, Usman et al. (2014) demonstrated an analysis on the use of pearl millet suggesting that,78% of the proceeds produced in Nigeria were consumed as a staple food, 20% for beverages and other products, and 2% as feed and fodder for animals. Moreover, Akinsuyi (2011), noted the importance of pearl millet as a major source of revenue among Nigerian farmers, mostly small-scale farmers growing an average farm size of 2-3 ha, and the same farmers are taking on the burden of Nigeria's food supply, which accounts for about 80% of the population in the country.

Indeed, based on the crucial role that pearl millet plays in food security of the nation, and particularly in the dominant pearl millet producing regions, the Nigerian government established 'Lake Chad Research Institute (LCRI) ' in 1975, which is located within the region of the North-east, in Maiduguri, Borno State, Nigeria, with the mandate to promote research in the country's millet industry, by developing improved cultivars. Hence, based on available report as contained in the document LCRI, (2018), the agency has really gained positive results, over the decades by launching improved varieties such as LCIC MV-1 (SOSAT–C88), LCIC 9702 MV-2

and LCICMV-3 (Super SOSAT) which mature 60-70 days with a potential output of 3.0–4.0 tons ha-1, as against the local varieties that mature 70-100 days with an output of 1-1.5 tons ha-1 (Ibrahim et al. 2014 ;Bashir & Yakaka, 2013).

In addition, several concerted efforts to improve millet production has been implemented as of 2000-2003 and 2008, by ICRISAT and up to the present dispensation, coupled with other relevant NGOs, such as Food and Agricultural Organization (FAO), National Programme on Food Security (NPFS) to mention but few, to improve the adoption of improved varieties of pearl millet among farmers and subsequent increase in the level of Production in the regions and the country at large. It should further be noted that, previous research efforts were conducted by the Lake Chad Research Institute (LCRI) and the Institute for Agricultural Research (IAR) Samaru, Zaria, Kaduna State, Nigeria and the outcome has proven a three-time increase in the yield through the selection and use of improved pearl millet technology as against the local traditional varieties (Okeke-Agulu &Onogwu, 2014). Indeed, it was observed that, many farmers in West Africa, including Nigeria, has inadequate access to improved seed and technical knowledge of scientific farming, and this has hindered the growth and development of their farms. Some local farmers currently use rudimentary, and ineffective equipment to cultivate only a small area of land. In addition, inadequate knowledge of basic scientific methods of production has led to few yields in recent years(Garba et al. 2012).

However, the current average extension agents' ratio to farmers in North-eastern Nigeria is, 1:1964 compared to 1:1000 as recommended by FAO and the World Bank, as reported by (Haruna & Abdullahi, 2013). Moreover ICRISAT (2014) suggested that, inaccessibility to improved seeds, land, lack of funds, and other factors such as logistics, which facilitates the relationship between farmer-extension agent, is a barrier to adoption in the region. In addition, the current action plans of Nigerian government of directing policies in a way that support the promotion of rice production would further deteriorate millet farming industry and, therefore, the federal government of Nigeria on its parts has not provided substantial financial support, since the withdrawal of World Bank ''Tripartite funding'' arrangement of ADPs between (World Bank and the three tiers of Government (Federal, States and Local Government) throughout the country, which resulted in the winding up and incapacitation of the Agricultural Development Programme (ADPS) in Nigeria at early 1990s (Adebayo & Idowu 2001). Hence, based on the situation above, under funding of agricultural extension programmes has become the order of the day, which affect extension services and inputs supply, which equally serve as obstacles toward adoption of the improved varieties of pearl millet among farmers in the region.

Also, the Insurgency, which has displaced millions of farmers from their usual place of residences as reported by Olanrewaju et al. (2019);Lenshie & Henry, (2016);Obikaeze, (2016) is a barrier to adoption of the improved varieties of pearl millet among farmers in north-eastern Nigeria, where millet is mostly produced in large quantities, thereby overburdening the other two regions of north-west and

north-central parts of the country, as the main suppliers in the country. Hence, the need to improve farmers level of knowledge, attitude and practice in the region for subsequent massive adoption of the improved varieties of pearl millet, among farmers in North-eastern Nigeria, which is very crucial.

Recently, the acceptance and subsequent adoption of improved agricultural technologies available to farmers had been largely determined by the need to increase production output and income (Awotide et al., 2016;Mertens & Barrett, 2013& Amare et al., 2012). Thus, adoption, as the name suggests, is a decision by an individual or a group to accept and use technological innovation as the best course of action available (Rogers,2003&Rogers,1995). Agricultural growth and development, therefore, depend mainly on the adoption of improved agricultural technologies, associated with climate-friendly seeds and modern agricultural practices to mention but a few(World Bank, 2018 &UNSDG, 2018). Hence, this study employs a blend of the Technology Acceptance Model (TAM) and the Diffusion of Innovation Theory (DIT), that were assumed to be a new hybrid underpinning models to explain the antecedents of relationship between knowledge, attitude, and practice towards adoption of the improved varieties of pearl millet among farmers in North-eastern Nigeria. Note that, in most literatures reviewed, there were no studies that used the combination of the two Models in North-eastern Nigeria to the best of my knowledge. Therefore, the need to study and know more about the proceedings is very important.

1.2 Overview of Nigerian Agriculture

Nigeria is located in West Africa between 40-1400N latitude and 30-1500E longitude. Benin is bounded to the west, Niger to the north, the Republic of Cameroon and Chad to the east, and the Gulf of Guinea to the south. The nation has a land mass of 923,768 square kilometers and 13,000 square kilometers of water, with a marginal measure of 4,047 kilometers and a seashore of 853 kilometers. The climate and vegetation distribution include central in the South, tropical in the Central and Arid region in the North. Moreover, there are two distinctive seasons in the country: the rainy season and the dry season (NPC & NBS, 2016).

Indeed, the nation has an estimated population of one hundred and ninety-three million, three hundred and ninety-two thousand, five hundred and seventeen (193, 392.517) as contained in (NPC & NBS, 2016). It is a nation of 36 independent states and its Capital Territory, Abuja; with overall total of 774 local government councils, with a number of six geopolitical zones (North West, North East, North Central, South West, South East and South-South). It should be noted that, this study was conducted in the North-Eastern region of Nigeria, due to its high level of participation in pearl millet production. Furthermore, Nigeria is a multi-ethnic and socially mixed country with more than 450 ethnic groups, the largest of which are Hausa/Fulani, Igbo and Yoruba, who live dominantly in the north-east, eastern and western regions of the country respectively. Hence, the nation is rated as the Africa's major oil exporter and has the topmost natural gas reserve in the continent (Bank,

2017).

Undeniably, agriculture is the mainstay of Nigeria's economy before the discovery of petroleum products, and employs more than 70 percent of the nation's entire workforce (Yakubu & Akanegbu, 2015). Although, the sector faces many difficulties; in general, the unfashionable land tenure rules that limit access to land, reliance on rain-fed agriculture, very low levels of development in the water system, faulty outcome of the research findings and skills, high cost of farm inputs, inadequate mechanization, limited access to credit, inadequate compost-fertilizer purchasing power, and more, coupled with high post-harvest calamity, with an extremely very weak agricultural extension system among others (FAO, 2016).

Furthermore, history has shown that, the Nigerian agricultural sector produced an average of 57% of the nation's GDP as from 1960, to 1969 and producing 65 percent of its export earnings. In addition, from the 1970s to late 2000s, the contribution of agricultural sector to GDP and exports declined due to Nigeria's dependence on oil exploration (FMARD, 2016). It should be noted that, the agricultural sector in Nigeria is extremely focused on crop production, which accounts for about 90% of the output, while the remaining 10% are fish and livestock. Given this situation, the country's agricultural potential was high, as the nation possessed a total landmass of 92.4 million hectares, with 82, million, being solely arable land but, only 34 million hectares have indeed been cultivated (NBS, 2017).

According to a report conducted in 2014 with titled Nigerian Agricultural Sector Report ''All eyes on Goldmine" the outcome revealed that, the nation was rated as world's major producer of crops, such as Sorghum (6.90 million MT), Cocoyam (3.45 million MT), Yam (38 million MT), Cassava (54 million, MT), Dry cowpea (2.5 million, MT), Kolanuts (138,000 MT), Melon-seed (512,500 MT); the same report ranked Nigeria as the 2nd prime producer of crops, such as Cashew nuts (behind Vietnam-836,500MT in 2012), Millet (5 million MT) and Sweet potatoes (3.4 million MT) as contained in (Prosphare News, 2014).

Nonetheless, in Nigeria, between 1975 up to the present dispensation, various administrations focused on agriculture to diversify the economy, and several strategies/policies have been introduced in this respect. These policies/ strategies, include among others, Lake Chad Research Institute LCRI, which was established in 1975 with the aimed at assisting farmers by increasing their input and productivity as well as subsequent increase in their sustainable livelihood (Ibrahim et al., 2015). Another policy known as New Nigerian Agricultural Policy NNAP, introduced in 2001, aimed to achieve autonomy in basic food supplies and a comparative advantage in local expansion and export in the state. Similar, policy or strategy has also been launched and it is known as the National Special Program for Food Security NSPFS (2002), aimed at boosting agricultural production, through improved technologies for higher yields and incomes among farmers (Iwuchukwu & Igbokwe, 2012).

In addition, the Traditional Crops Project TCP, that had been launched in (2003), and whose aim was to boost income for smallholders and food security, through the development of traditional food crops, including maize, cowpea, and pearl millet. A strategy was also established and it is known as the Agricultural Transformation Agenda (ATA), launched in 2012, to boost farmers 'incomes, create jobs, set up food security scheme, coupled with the transformation of the country into a leading player in food market. Indeed, ATA was reported to have expanded agrarian yield by 11% to 202.9 million tons somewhere in the range of 2011 and 2014 (World Bank et al. 2016;FMARD, 2016).

Furthermore, it should be noted that, in 2016, the current administration of Muhammadu Buhari, propelled the Agricultural Promotion Policy (APP) with the mandate of resolving inadequacy in staples including millet as well, improving yield quality. In addition, the Economic Recovery and Growth Plan (ERGP) policy in Nigeria, with priorities to staple-food security is geared towards accomplishing independence in wheat, rice, and tomato paste adequacy as at the year 2017, 2018 and as well 2019/2020 and beyond. Indeed, based on the design of ERGP programme, the project is expected to improve agricultural production by 31%, that amounts to the tune of ₦21Trillion Nigerian naira, by 2020 (World Bank et al., 2016). Hence, despite all these strategies and approaches implemented, there is a decline in the production system particularly on the pearl millet output, as some of the programme did not give priority to pearl millet production like the recent ERGP program. Therefore, the need for the government to boast pearl millet production, considering its potentialities to the nation's economy and food security is very important.

1.3 Agricultural Extension System in Nigeria

To discuss Nigerian agricultural extension system, effort is being made to present global, regional and national highlight on its concept in broader perspectives. Extension is thus, a derivative Latin word "Extender" means "to extend". According to Hamisu et al. (2017) who posited that, the basic task of agricultural extension had been that of the exchange and means of sharing information, knowledge and skills for improved on livelihood regardless of its organization.

However, Agricultural Extension and Advisory services are terms that are interchangeably being used to explain the concept of Agricultural Extension. Hence, all are important component of rural development, reduction in poverty, hunger and malnutrition, improvement in the adoption of modern technologies, productivity, as well as, capacity building and training of clientele. Nevertheless, there has been a paradigm shift globally for the past 20 years, in which the extension components have changed from technology-focused, public service-dominated, technology transfer approaches, to a much wider scope with various private and civil society stakeholders (Davis & Sulaiman, 2014).

It should be noted that, the idea of agricultural extension varies from one country to another and from one agricultural agency to the other. Hence, based on the above scenario, extension systems of some regions of the world would be briefly visualized to have a better understanding of the concept. Indeed, one of such regions is the United States of America (USA), where the country's extension system is more of cooperative service. While, in New Zealand and Australia, agricultural extension is operated as an advisory work. More so, in countries of Asia, particularly Eastern, South-eastern, and as well as Southern Asia, which has the leading extension mechanism worldwide (Swanson et al. 2014). For instance, East Asia in countries like China and Japan, operates public-private partnership extension system. While, South Korea and Taiwan, pluralistic extension system.

More so, in the South Asian sub-district, in countries like the Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka; Extension is kept running by the ministries. Though, in India and Bangladesh, it is highly pluralistic extension system. India, on the other hand, therefore has been a regionalized cooperative system, between the national and the governments with respect to the public extension service for the clients. While, in the South-eastern sub-region in countries like Cambodia, Indonesia, Singapore, Thailand, Malaysia, Myanmar, Philippines, and Vietnam all has the same public sector ministries and by extension pluralistic extension system (Swanson et al., 2014).

Moreover, in Africa, especially the case throughout the East African sub-region, various attempts have been made to reform extensions, including a range of privatization reforms; so far, clarification of governmental policies has often been clearly missing(Swanson et al., 2014). Though, sub-regional Central African countries tend to have established and moved towards a modern secular extension system. These countries include, Cameroon, the Central African Republic, Chad and Equatorial Guinea, amongst others. Moreover, many other Central African countries, had also aggressively used the Farmer Field School (FFS) model to advance the ' demand-driven ' agricultural extension system in countries such as Namibia, South Africa and Swaziland. Although government ministries are the dominant provider of extension information and training in South Africa, Botswana, Lesotho, yet there is still a move towards a more pluralistic approach to extension services (Swanson et al., 2014).

Moreover, in West Africa countries, Nigeria inclusive, the mechanism of the extension is divided between commercial and resource-poor farmers. The private industry operates more or less completely with commercial farmers, while farmer associations, NGOs and FFS programs appear to work with small resource-poor farmers. Thus, the public sector or ministry-led extension system in Nigeria has become the order of the day, but the participatory extension is slowly being built and, in some cases, demand-led with new market information systems (Swanson et al., 2014). Nonetheless, the authors further reported that, in African sub-region, comprising of Sudan, Egypt, Morocco, and Western, to mention but a few, the governmental sector is really the predominant providers of extension facilities or

otherwise known as local advisory services. Undeniably, from the above, the extension system of various regions of the world have been discussed above had given detailed insight for better understanding of the system.

It should therefore be noted that in Nigeria, various extension models and approaches were introduced in the past and currently being used, which include among others: the University Operated Extension, (UOE), Ministry of Agriculture Operated Extension, Commodity/Sectoral Agency Extension, Training and Visit (T&V) extension system, Special program for Food Security (SPFS), Community-Based Agricultural and Rural Development Approach (CBARDA), Sasakawa Global 2000 (SG 2000), the Farmer Field School (FFS), which is now being introduced and the latest one, which is still under gestation, is the participatory approach to extension services.

However, Hamisu et al. (2017) recommended that, among the approaches stated above, T&V extension approach, which was promoted by World Bank via various State Agricultural Development Project (ADPs) across Nigerian Federation, stood the most workable extension approach in Nigeria, in spite of its underperformance, sustainability, and as well as, its inability to meet the demand of farmers, coupled with the irregularity of the increasing stress in the part of the government, as implementer rather than a provider of public service. Indeed, the authors further argued that, there is a competing view of extension approach in Nigeria, characterized by the contributory approach to development, as mentioned above; that is the (bottom-up model), which is currently considered as an evolving model in the advancement belief and practices. Hence, the need for the government to provide adequate funding for extension in Nigeria is very crucial

1.3.1 ADPs as an Extension Service Provider in Nigeria

Generally, agrarian policies in Nigeria have progressed significantly from the pre-independence period up to date. In Nigeria, agricultural extension services are essentially delivered and funded by the government (it's more of the public, not a private extension services). It is designed in such a way that, the three arms of the Government; Federal, State and the Local government play their various roles in the delivery and funding of the extension services. Thus, Agricultural Development Programme (ADPs,) as the name suggest, is the soul extension agency, whose mandate in Nigeria is to provide agricultural extension services, including technical service, rural infrastructure, coupled with input supplies to clientele (Hamisu et al., 2017)

Undeniably, the approach of ADPs in Nigeria effectively began its operation in 1975, at the Northern part of the country as an enclave area in places like Funtua, Gusau and Gombe (Hamisu et al. 2017 & Chima, 2015). Thus, in view of the accomplishment of these enclave territory tests, prompted the foundation of state-wide tasks and in this manner, a multi-state ADPs, which was later structured by the

Federal Government through the Agricultural Co-ordinating Unit (FACU) up to the 36 states and Abuja inclusive. In fact, what we have today as ADPs is a joint effort of the Nigerian Government and the World Bank. It should be noted that, the authorized start-up of the ADP system was partly funded by the World Bank. This handles 66% of the total program cost in works, plants, vehicles, spare parts, practical demonstrations and consultancy. The Federal Government of Nigeria on its part, contributes 19% on input purchase, synthetic compounds and pesticides. While, the State Government in the same manner contributes 15% on staff salaries or wages, coupled with general administrations (Chima, 2015). However, the World Bank later withdrew from funding of the ADPs, due to lack of commitment on the side of the Nigerian government to pay its counterpart fund, so that, the services could continue which was stopped somewhere in the late 1990s (Hamisu et al., 2017;Adebayo & Idowu, 2001)

Today, ADPs in Nigeria had expected an undying status and currently perceived as the life-force open extension organization in Nigeria endowed with the order of extension administration in the country. Consequently, the organization don't participate in direct staple production. It rather provides extension services and outline supervisions to empower the farmers to do their activities appropriately (Chukwuemeka & Nzewi, 2011). Indeed, among the specific objective of the ADP approach in Nigeria, includes among others:

1. Upgrading the farm of smallholder growers by means of coordinated provincial modern programmes in the nation.
2. Backing the Federal Government of Nigeria on the part of food production, through the presentation of improved stimulated innovations on cassava, yam, maize, millet and rice among farmers;
3. Increasing the living standards of the rural population, who are mostly peasant farmers at the grass root level;
4. Revitalize and re-compose farming extension benefits through preparation and visitation framework approach, via the change agent, otherwise known as the extension personnel.
5. Marketing and increasing the existing farmstead framework delivery system in the country;
6. Provide all regular access roads to grass-root agrarian communities, through the foundation and support of rustic feeder streets, to boast transport network across the country.
7. Establishment of On-Farm Adaptive Research (OFAR) as a method for creating and publicizing data and Sponsors, which could empower the preparation, storing and showcasing of principal farm inputs (Chida, 2015;Chukwuemeka & Nzewi, 2011).

Indeed, it should be noted that, the structure and organizational set-up of ADPs in Nigeria is a kind of decentralized structure, where the Central Government (Federal) harmonizes the affairs of the state, via the Federal Ministry of Agriculture and Rural Development. In addition, the states convey out the extension services, manage and

regulate the activities and services up to the grass root level. Although, the ADPs were designed with a top-down approach; the same structure is currently being used by Nigerian public extension agencies and other donor agencies like the World-Bank Funded organizations, such as, the National Fadama Development Programmes (NFDP), Food and Agriculture organization (FAO), African Development Bank (AFDB), International Fund for Agriculture Development (IFAD), Community-Based Agriculture and Rural Development Programme (CBARDP), and relevant agencies to implement a bottom-up approach projects/programme, despite the fact that, the Nigerian government have not institutionalized the bottom-up approach, which is still under maturation. Hence, the need to institutionalize the bottom-up approach extension in Nigeria is very imperative.

1.3.2 Roles of Agricultural Extension on Adoption of Technology

Agricultural extension is a key player process of agricultural innovation and diffusion, therefore, with its robust and widespread grassroots approach, it is the main source of information for farmers in developing countries, including Nigeria (Agwu et al. 2017). The role of agricultural extension in national agricultural development is therefore relevant. Nonetheless, it was well known fact that, no nation could have significant growth and development in the agricultural sector, without active extension services (Anaeto et al., 2012). Indeed, the role of extension agent in the adoption of agricultural technologies should never be overstressed, and therefore, Farooq et al. (2010) and McLean, (1998) saw the role of change agents, which encompasses the various number of capabilities and the consequences of which an individual is capable to achieve. In contrast, Anaeto et al., (2012) confirmed that, the label role could be defined as an established duties, ethics and collaboration outlines related towards agreed group of persons.

Nevertheless, the effectiveness of the extension mechanism or change agents will remain largely determined by their success or dissatisfaction of the dissemination of information agenda. As a result, the experience of extensionist or the provision of extension facilities could be a single factor (predictor) that has appeared significantly in most of the technology adoption research projects. (Danso-Abbeam et al. 2017; Olatidoye et al. 2017;and (Udensi et al. 2012). Hence, a strong technical and institutional foundations would therefore be crucial, if agricultural extension systems in Countries of Africa were to be sustainable. In essence, the accessibility of extension services was strongly correlated with technological progress (Tiraieyari et al. 2013). Furthermore, a study reported that, where governments in Sub-Saharan Africa and Nigeria included had effective extension services, technology adoption processes would also be very efficient and quality of life would be increased at a remarkable pace. The provision of sufficient improved technology and extension services is vital to the establishment of productive services (Weldegiorges 2015).

However, a report from the Consultative Group of International Agricultural Research CGIAR (1999) confirmed that, most of the extension services and officers in Africa, including Nigeria, have been undermanned, but also undertrained with reference to their colleagues in Asia and Latin America for over past 20 years. Nonetheless, the majority of extension programs in Africa focus on technical problems and poorly-equipped, towards field operations or social implications required for technology adoption. Nagy & Sanders (1990) indicated that, one of the most important components of technology adoption support programs was professional extension officers. Although, Aremu et al. (2015) has a different contention that, the greatest constraints facing the innovation usage by farmers today isn't precisely, how to approach the clients in any case, but how to continue the utilization of innovation to address the future difficulties. In this way, utilizing suitable explored innovations to improved food security is a noteworthy need for some, underdeveloped countries, Nigeria inclusive.

Indeed, to be successful in technology adoption, extension workers must understand the farmers learning needs, problems, priorities and opportunities, as well as, the psychological process, semantic, physical and economic barriers to adoption. While, Muzari et al. (2012) proposed that, cutting edge scientists should try to comprehend the reason behind conventional smallholder growers' conduct in innovation usage. and This would make their future mechanical intercessions in smallholder agribusiness progressively powerful. It is recommended that, the adequacy of extension supervision is subjected to the capacity of change agents who stand to be competent, persuasive in their duties, as the entire extension procedure is reliant on them to transmit information to farmers.

Agwu et al. (2017) conducted a research carried out in Nigeria, and the findings confirmed that, the average extension visiting time for farmers by extension workers was approximately 13 times per year. Indeed, the authors further reported that, the food and Agricultural Organization (FAO) recommended that, farmers were expected to be visited at least once in every two week (fortnightly). It means, a minimum of 15 extension contacts in a farming season (Idrisa et al. (2012). However, despite the positive outcome as stated above, the frequency of extension visitation in North-eastern Nigeria, which served as the primary study area of this research is not frequent. This is because of the noticeable ratio of extension agents to farmers, which present a very wide ratio and this in itself serves as impediment to farmers adoption as reported by(Haruna & Abdullahi, 2013). According the report, in North-eastern region of Nigeria, the indices on farmers-extension agent ratio as at 2012/2013 farming season, the breakdown of the ratio have shown that Borno State recorded 1:1964 farmers, Yobe 1:2472, Gombe 1:1225, Bauchi 1:1731, Adamawa 1:1212 and Taraba 1:3200. Hence, the average ratio of Extension agent to farmers in the region stood at 1:1964 respectively. It should however, be noted that these figures are far beyond the ratio recommended by FAO & World Bank as mentioned above and this had posed a serious constraint to the extension service delivery, precipitated by logistic problems that hinder the daily routine activities of the extension agents, towards adoption of the improved varieties of pearl millet in North-eastern region. The need to need to develop and apply information technology

tools to facilitate the work of extension services among farmers, using a bottom-up approach extension so as to make extension Demand-Driven is very imperative.

1.4 Pearl Millet Production in North-Eastern Nigeria

Nigeria has increasingly been one of the largest pearl millet producing countries in Sub-Saharan Africa, over the last two decades (USDA, 2015). The outstanding performance in millet production is due to several inspiring factors, such as favourable climatic conditions, funding of research efforts, particularly improved seed development and supports from relevant donor agencies, such as World Bank, and other relevant agencies. Available records by Food and Agriculture Organization Statistics have ranked Nigeria as the 2nd global pearl millet producer with 5.3 metric tons between 1990-2000. Similarly, it also increased to 6.6 metric tons ranked second globally, between 2001-2010. However, between 2011-and 2018, the production has been observed with declining trend (FAOSTAT, 2018).

Indeed, the probable reason of such decline in millet production, might be as a result of inadequate funding of the extension system, the withdrawal of World Bank Tripartite funding arrangement in the early1990s in Nigeria, the incapacitation of ADPs, which handles the whole country's extension mechanism (Adebayo & Idowu 2001). Also, accessibility to the improved seed, which was precipitated by inadequate knowledge of the improved technologies, poor attitude and practice towards the improved pearl millet seeds (Okeke-Agulu &Onogwu, 2014). More so, the Boko-Haram insurgency particularly in the North-eastern part and some parts of North-west, North-central and few sporty areas, within the country had affected millet industry (Leshie & Henry, 2016). Thus, these challenges stemming from Boko-Haram insurgency, entirely hindered the economic, social and agricultural activities that claimed more than USD 3.5 billion of losses in the region (Olanrewaju et al., 2019; Lenshie & Henry, 2016;Obikaeze, 2016)). These and other observations on the overall performance of Nigeria's millet industry indicate the need for government's interventions in terms input subsidies and relevant agricultural programmes, that focus on intensive awareness, developing farmers attitude, and practice towards adoption of improved seeds and subsequent increase in the level of production.

Nonetheless, improved pearl millet varieties accounted for 34.8 million adoptions among farmers in 2009, with total cultivation of, 1154,261 ha across Nigeria's Sudan-Sahelian region (Ndjeunga & Ajeigbe, 2012). The analysis of nearly the last two decades of millet production, however, indicated that, the average national yield was 1170 kg ha-1 (FAOSTAT, 2018). The significant downward output from 2011 to the present dispensation, however, suggested that most smallholder farmers still produce as low as 500 kg ha-1 as the average output(Ajeigbe et al.2019). The current low yield could be due, not only to water supply variance associated with irregular rainfall patterns leading to water pressure at some critical stage of plant growth (Chakraborty & Newton, 2011).

Nevertheless, it was observed that, the adoption of improved varieties among farmers in North-eastern Nigeria was impeded by inadequate knowledge, attitude and practice towards the improved varieties of pearl millet. This was triggered by inadequate funding of the extension mechanism and limited number of extension agents, that would facilitate extension services to farmers. It should be noted that, within the region, the average ratio of extension agent to farmers as reported earlier by Haruna & Abdullahi, (2013) is 1:1964 as against 1:1000. This had crippled the frequency of the extension visit to farmers, thereby depriving them of adequate knowledge or awareness on the improved pearl millet technologies and subsequent development of attitude and practice among farmers. Indeed, it was also observed that, majority of the farmers in Nigeria, particularly in North-eastern region of Nigeria, prefer using crude tradional farm implement and local pearl millet seeds. This in itself impeded adoption and subsequent increase in the level of production among farmers (Okeke-Agulu &Onogwu, 2014;FAO, 2011; FAO, 2009).

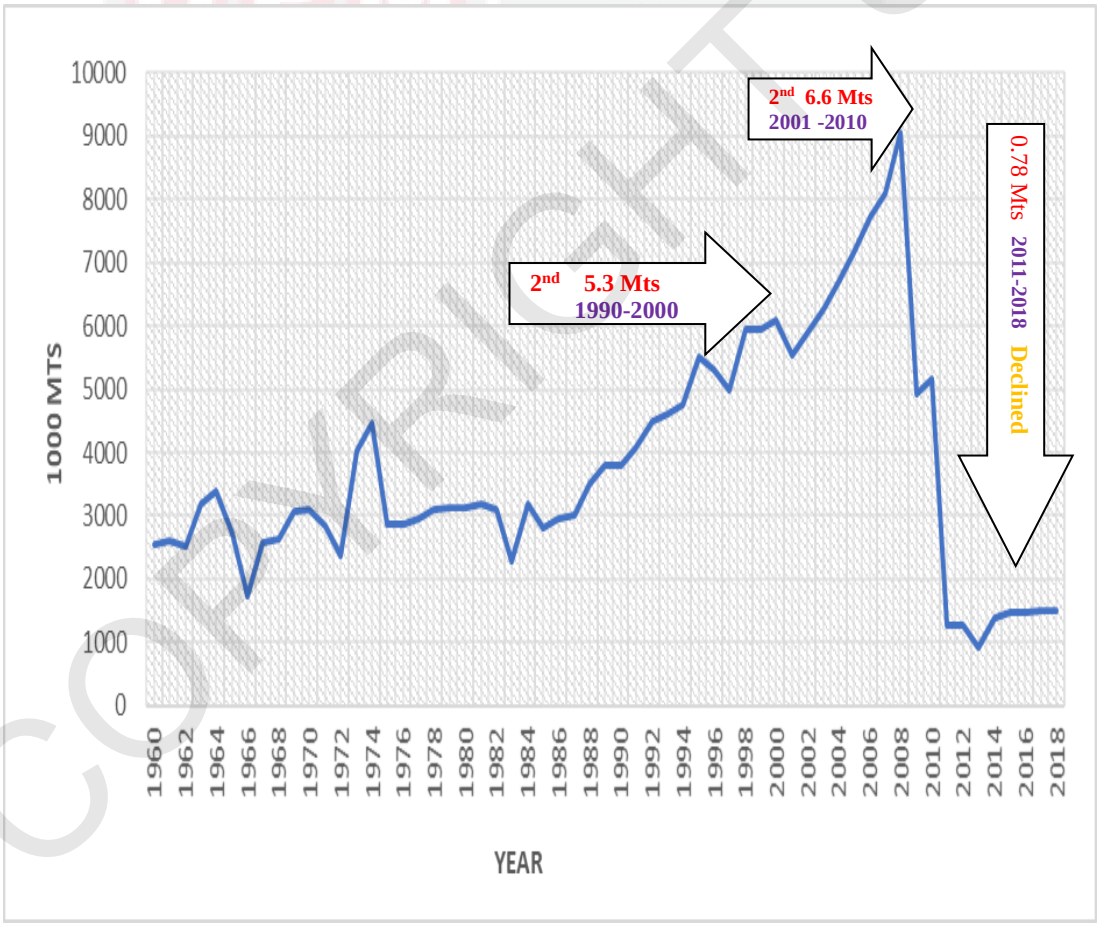

Figure 1.1 : Pearl Millet Production Trend in Nigeria by Year (1960-2018)
(Source: FAOSTAT, 2018)

As observed in Fig 1.2 pearl millet production increased from 3.7 -5.3 metric tons between 1990 – 2000. Similarly, it also increased to 6.6. Metric tons between 1990-2010. However, the trend started declining as from 2011 to date. Thus, the need for

massive adoption of the improved varieties of pearl millet using strategies and support by stakeholders by providing awareness, which would further encourage farmers to develop attitude and practice towards adoption.

1.5 Problem Statement

Pearl millet (*Pennisetum glaucum)* is a hardy cereal crop, which has been grown for many years in the *sudano-Sahelian zone* of North-eastern Nigeria for its nutritive and food security values. The main crop producers in the area are small-scale farmers, who have continuously grown local and low yielding unimproved varieties of pearl millet, which might include Maiwa, Buduma, Buduma- Damasak, Ex-Gashua, Ex-Tukur, and Zango, among others (Okeke-Agulu &Onogwu, 2014). According to research by Maryam et al. (2017), some improved varieties had been popularized in Nigeria, but adoption by smallholder farmers is weak, with only 24 percent using improved varieties and 75 percent using conventional local varieties. However, a similar scenario has also been noted that the adoption of improved agricultural technology, such as High Yielding Varieties (HYV), which could consequently lead into a significant improvement in agricultural output, thereby stimulating the transition towards productivity subsistence farming to a higher agro-industrial economy is very low, as reported in a study conducted (Bashir & Yakaka, 2013).

Nevertheless, it is a reality that improved pearl millet varieties have an innovative-maturity period that developed prior (60 to 70 days as against 70 to 100 days) for traditional local varieties. It is resistant to Striga spp, dry season, vermin and ailments. It also reacts perfectly to compost and other relevant practices. Additionally, the grain size is bigger, while the panicle is progressively compressed (Izge and Song, 2013). However, Rai et al. (1999); ICRISAT), (1993) confirmed that, only 40% yield is credited to the utilization of improved pearl millet varieties. Indeed, similar experience, in the north-eastern region has shown that, the adoption of improved varieties of pearl millet which has the potential of yielding more than 2.5–4 tons/hectare, as confirmed by FAOSTAT (2016), appears to be very low. This is because of seeming high total number of growers who still cultivate traditional conventional varieties, that only yield an output of 1-1,5 tons / ha or less, due to the inadequate knowledge, attitude and practice on improved technologies as reported by (Ajeigbe et al. 2019; FAO 2016;Izge & Song, (2013), which was precipitated by socio-cultural beliefs and practices among farmers. Inadequate extension services on the basis of high ratio of farmers per extension agents of 1:2500 as against 1:1000 as approved by World Bank & FAO (Haruna & Abdullahi, 2013).

More so, it was also observed that low-level of mechanization among farmers is an impediment to adoption of the improved varieties, as most of them use tradional crude implement, such as hoes and other related tools as a results of inadequate knowledge and skills, and illiteracy (Okeke-Agulu &Onogwu, 2014; FAO, 2011; FAO, 2009). Hence, farmers in North-eastern Nigeria were also faced with numerous kind of challenges resulting from Boko-Haram insurgency, which

distraught the economic, social and farming activities, that claimed over USD 3.5 billion-dollar losses in the region (Olanrewaju et al., 2019; Lenshie & Henry, 2016) In addition, the same insurgency in question displaced more than 3 million persons in the same region, in which nearly 80% of those involved are women, Youth and children. It is also on record that, over three-hundred thousand persons were documented as refugees in the neighbouring countries (Obikaeze, 2016; Lenshie & Henry, (2016).Therefore, internally displaced persons (IDPs) experiences a worsening situation of food insecurity and malnutrition in the region. This in itself obstructed all agricultural activities, which is the predominant occupation of the population (World Bank, 2016 & MDGs, 2015). In addition, all these contributed to low adoption of the improved pearl millet varieties, thereby drastically reducing the production output in millet industry.

Available literatures have shown that, there were no studies conducted, using the combined theories of Technology Acceptance Model (TAM) and Diffusion of Innovation Theory (DIT), particularly on the adoption of the improved varieties of pearl millet in North-eastern Nigeria and also, to the best of my knowledge, no studies was conducted using the approach of Knowledge, Attitude, Practice (KAP) as predictors towards adoption of the improved varieties of pearl millet among farmers, particularly in North-eastern region. Indeed, the study is however, conditioned that knowledge, attitude and practice are predictors towards adoption of the improved varieties of pearl millet among farmers in North- eastern Nigeria. Thus, the study seek to answers the following research questions.

1.6 Research Question

The research questions for this study were:

1. What is the level of knowledge, attitude, practice and adoption of the improved varieties of pearl millet among Farmers in North-Eastern Nigeria?
2. What is the relationship between knowledge, attitude, and practice towards adoption of improved varieties of pearl millet among farmers in North-Eastern Nigeria?
3. What is the contribution of knowledge, attitude and practice towards the adoption of improved varieties of pearl millet among farmers in North-eastern Nigeria?

1.7 Objectives of the Study

General Objectives

The overall objective of the study is to determine the relationship between knowledge, attitude and practice towards adoption of improved varieties of pearl millet among farmers in North-Eastern Nigeria.

The Specific Objectives

Specifically, the objectives of the study were:

1. To determine the level of knowledge, attitude, practice and adoption of the improved varieties of Pearl millet among farmers in North-eastern Nigeria.
2. To determine the relationship between knowledge, attitude, and practice towards adoption of improved varieties of pearl millet among farmers in North-eastern Nigeria.
3. To determine the contribution of knowledge, attitude and practice towards adoption of improved varieties of pearl millet among farmers in North-eastern Nigeria.

1.8 Research Hypotheses

This section captures related hypothesis to the specific objectives of the study which was derived, based on relevant theories and literatures as contained in the study

1. H_a1: There is a direct positive relationship between knowledge and adoption of improved varieties of Pearl millet among farmers in North-eastern Nigeria.

2. H_a2: There is a direct positive relationship between attitude and adoption of improved varieties of Pearl millet among farmers in North-eastern Nigeria.

3. H_a3: There is a direct positive relationship between practice and adoption of improved varieties of Pearl millet among farmers in North-eastern Nigeria.

4. H_a4: Knowledge has positive significant contribution towards adoption of improved varieties of pearl millet among farmers in North-eastern Nigeria.

5. H_a5: Attitude has positive significant contribution towards adoption of improved varieties of pearl millet among farmers in North-eastern Nigeria.

6. H_a6: Practice has positive significant contribution towards adoption of improved varieties of pearl millet among farmers in North-eastern Nigeria.

1.9 Significance of the Study

The study is very important, it would enable us to determine the level of knowledge, attitude, and practice towards the adoption of improved varieties of pearl millet in North-eastern Nigeria. This would go a long way in improving agricultural practices of farmers as well as improve their standard of living. Furthermore, it would determine the relationship between knowledge, attitude, and practice towards adoption of improved varieties of pearl millet. This would unveil how the

knowledge, attitude and practice interplay in the adoption of improved varieties of pearl millet in the study area. Finally, the study would enable us to know the most contributing factors towards the adoption of improved pearl millet varieties in the study area. This study would be useful to guide quite number of stakeholders, particularly, farmers, Nigeria government, through the Agricultural Development Programme (ADPs), Planners, pearl millet consumers, such as, breeders, industrial bakers and brewers, nutritionists, millers, animal feeds producers, agro-inputs suppliers and traders to have an insight on the adoption of improve pearl millet and subsequent increase in the level of production output in the study area. In addition, the study would also provide a good background information for further studies on the adoption of improved pearl millet production in the region.

1.10 Scope of the Study

The scope of this study is on the adoption of improved varieties of pearl millet in relation to Knowledge, Attitude, and Practice (KAP) among pearl millet farmers under the Agricultural Development Programme ADPs in North-eastern Nigeria. Hence, the adoption level of pearl millet farmers, level of knowledge, attitude and practice, on the improved varieties of pearl millet, as well as, the relationship between knowledge, attitude and practice towards the adoption of improve varieties of pearl millet and their contributions would be evaluated.

1.11 Limitations of the Study

This study is limited to pearl millet farmers in North-eastern Nigeria and therefore, any generalization made from the findings, must be confined to this group of farmers. The study is however, restricted to the independent factors knowledge, attitude and practice (KAP), which serve as predictor towards the dependent variable adoption of the improved varieties of pearl millet among farmers, which would be assessed. More so, another limitation of the study, is the difficulty of getting information easily, due to language barrier more especially respondents from Borno State and some parts of Yobe State that are more conversant with ‘‘Kanuri’’ as their native language. Some of these information from the farmers are not written, they are information that, the farmers could recollect off-hand. Another limitation of the study, is the high level of insurgency in the study area. Most of the selected communities have been infiltrated by the insurgents, leaving the residents with fear of availing information to government officials and the likes.

1.12 Definitions of Terms

This section presents the key terms that were used in this study, which have been both conceptually and operationally defined. Hence, this was an attempt to clearly define those important variables, which were involved in the research for precision and clarity, and subsequently serve as a guide to the study, as well the researcher in the process of conducting data collection and analysis respectively.

1.12.1 Adoption

a). **Conceptual Definition:** refers to a decision of an individual or group to accept and make full use of an innovation or technology as the best course of action available (Rogers, 2003).

b). **Operational Definitions:** refers to the integration and acceptance of an innovation into farmers' normal farming activities over an extended period, which can be measured in terms of low, moderate and high level of adoption.

1.12.2 Knowledge

a). **Conceptual Definition:** refers to the capacity of an individual to establish, capture facts, methods, principles, techniques, experiences, which is sufficient enough to apply it, in the course of making things to happen (Anand & Singh, 2011)

b). **Operational Definition:** in this study, refer level of awareness, experience, principles, techniques, education, cognitive and intellectual ability of a farmer on the improved varieties of pearl millet, which could be measured in terms of low, moderate and high level of knowledge.

1.12.3 Attitude

a). **Conceptual Definition:** refers to the motor sets of an organism or individual that guides towards some specific or general stimulant, which were integrated, through learning within the social environment (Anselme, 2010).

b). **Operational Definition:** in this study, attitude, refers to behaviour change by pearl millet farmers towards improved varieties of pearl millet, which could be evaluated as low, moderate and high level of attitude.

1.12.4 Practice

a). **Conceptual Definition:** refers to a production method or techniques, utilized to produce the insured crop and allow it to make normal progress towards maturity and produce, at least the yield used to determine the production guarantee (USDA, 2014).

b). **Operational Definition:** in this study, refers to the farmer's ability to adapt to new improved pearl millet varieties themselves and apply it in their local context, which could be measured in terms of the low, moderate and high level of practice.

1.13 Organization of the Thesis

This thesis was structured based on chapterisation. It is organized into five chapters. Chapter one was structured to present the Background of the study, overview of Nigerian Agriculture, Agricultural Extension system in Nigeria, Agricultural Development Programme (ADPs) as an Extension Service provider in Nigeria, Roles of extension on adoption of Technology, Pearl millet production in North-eastern Nigeria, Problem Statements, Research questions, Objectives, Research hypothesis, Significance of the Study, Scope of the study, Limitation of the study, Definitions of Terms respectively.

Chapter two presents all the relevant literatures, starting with introduction, concept of adoption, approaches to measurement of adoption, previous findings on adoption of improved agricultural technology, Concept of Knowledge, Attitude and Practice (KAP); overview on knowledge and its measurement, overview on attitude and its measurement, overview on practice and its measurement. Relevant underpinning theories adopted for the study that is Diffusion of Innovation Theory (DIT) and Technology Acceptance Model (TAM) reviews on the relationship between knowledge and adoption, attitude and adoption, practice and adoption as well as theoretical framework adopted for the study.

Chapter three outlined the methodology employed in the study. Under this chapter, introduction, Conceptual framework, Research design, Study location, Population of the study, Sampling Design and procedure, Sample Size of the Study, Instrument for data collection, Pilot study, Data collection procedure, and Data analysis Technique respectively.

Chapter four presents result, and discussion of the findings obtained from the study with respect to each specific objective. The first sub-headings presented the descriptive analysis of the demographic profile of sampled respondents, followed by findings on objective 1: To determine the level of knowledge, attitude, and practice towards adoption among farmers in North-eastern Nigeria, then Findings on objective 2: To determine the relationship between knowledge, attitude, and practice towards adoption. The fourth sub-headings also present the findings on objective 3: To determine the contribution of knowledge, attitude and practice towards adoption, Summary of the hypothesis and decisions and finally, contribution of study in both theory, practice and policy wise.

Chapter five, present summary of the study, with an outline of the background and objectives of the study, methodology and main findings and as well conclusion, which was drawn stemming from the findings as well as the theoretical, practical and policy implications of the research. Also, recommendations for practice and policy were also presented, including the recommendations for future research.

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