FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

ADOPTION OF AGRICULTURAL TECHNOLOGIES: HOW FAR HAVE FARMERS GONE?

By

PROF. UMAR SHESHI ISAH
B. Agric. (UDU, Sokoto), M.Sc. (ATBU, Bauchi), PhD (FUT, Minna) MAESON, MRUSAN, MFAMAN
Professor of Agricultural Extension and Rural Development

INAUGURAL LECTURE SERIES 99

10TH FEBRUARY, 2022

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

ADOPTION OF AGRICULTURAL TECHNOLOGIES: HOW FAR HAVE FARMERS GONE?

By

PROF. UMAR SHESHI ISAH

B. Agric. (UDU, Sokoto), M.Sc. (ATBU, Bauchi), PhD (FUT, Minna) MAESON, MRUSAN, MFAMAN

Professor of Agricultural Extension and Rural Development

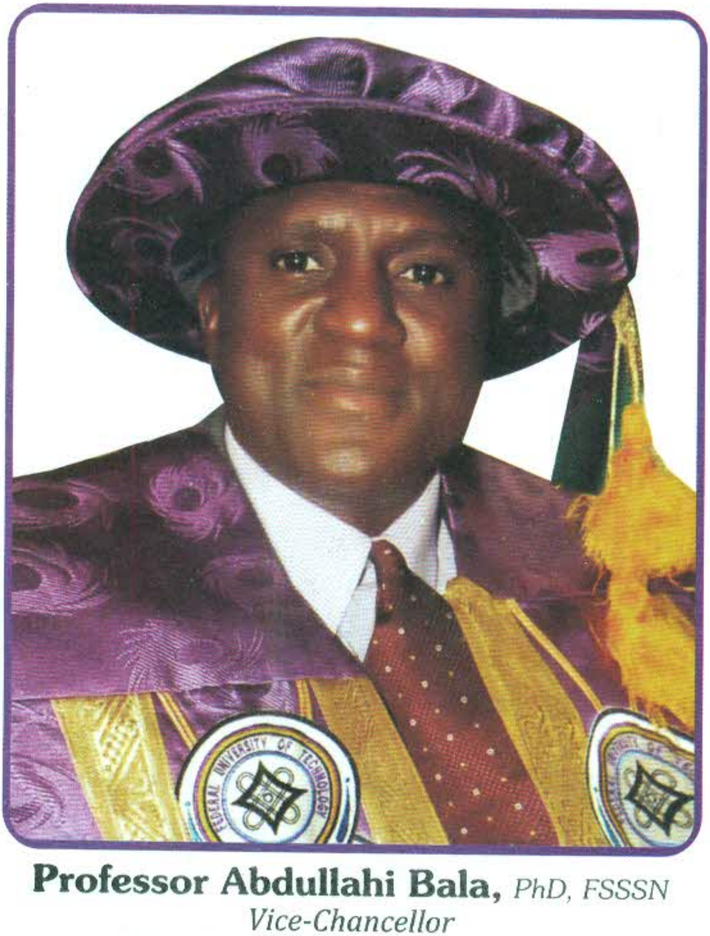
INAUGURAL LECTURE SERIES 99

10TH FEBRUARY, 2022

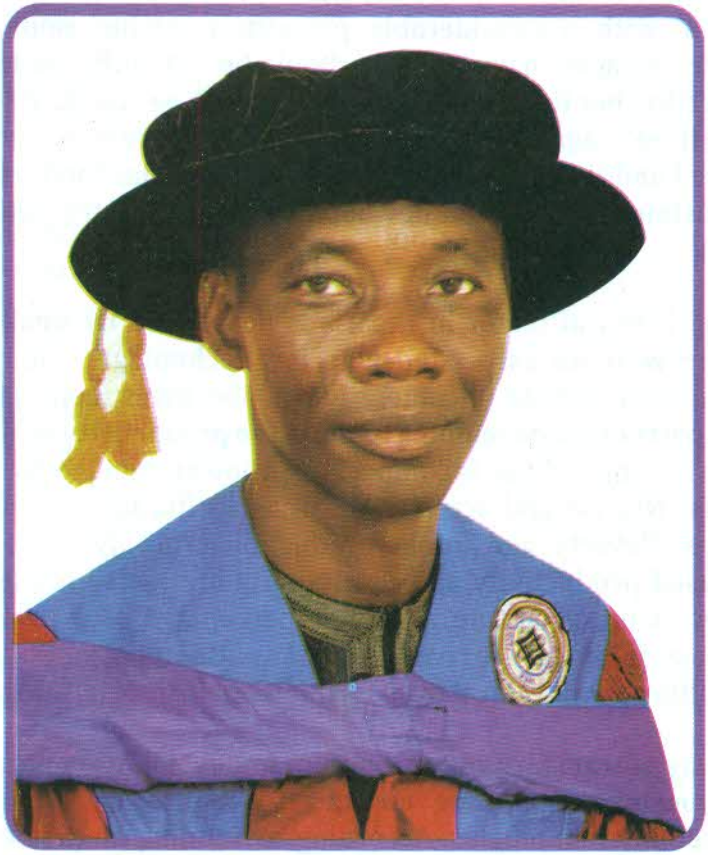
Published by:

University Seminar and Colloquium Committee,

Federal University of Technology, Minna.



Professor Abdullahi Bala, *PhD, FSSSN*
Vice-Chancellor
Federal University of Technology, Minna
Chairman of the Occassion



PROF. UMAR SHESHI ISAH

B. Agric. (UDU, Sokoto), M.Sc. (ATBU, Bauchi), PhD (FUT, Minna) MAESON, MRUSAN, MFAMAN

Professor of Agricultural Extension and Rural Development

1. Introduction

Agriculture remains the foundation of the Nigerian economy despite the country's heavy dependence on oil for several years. Nigeria, with a considerable proportion of her population directly engaged in agriculture, should be self-sufficient in food production but for the peasant nature of the agricultural sector, the nation's agricultural potentials are far from being fully realized and this has unpalatable implications for food security and sustainable economic development of the country (Olomola, 1995).

The agricultural sector in Nigeria is dominated by small farm holders who are associated with low technologies' adoption, productivity, output, income, savings and investment. Like in other parts of the developing nations, the productivity of most of the farm commodities is comparatively lower than the potential yield in Nigeria and actual yield in agriculturally progressive nations. Poverty and hunger reduction crucially depend on increased productivity and profitability of diverse small-scale farmers who constitute a greater percentage of the farming populace. It is for these reasons that any attempt at modernizing agriculture should aim at transforming small-scale farming.

One way of transforming agriculture in developing countries is by exposing small-scale farmers to improved agricultural production technologies. According to Sunding and Zilberman (2000), technological change has been a significant factor driving modernization and improvement in agriculture in the recent past. For instance, a comparison of agricultural production patterns in the United States of America in 2000 and 2011 indicates that cultivated land declined from 945,080 to 916,990 million acres. Yet gross farm income in 2011 was $425.0 billion as against the figure of $225.0 billion in 2000 (United States Department of Agriculture, 2012). This shows that agricultural productivity increased. The main explanation for such increase is changes in agricultural production methods, topmost among which is the use of innovative technologies such as improved varieties.

In realization of the importance of technological innovations to agricultural development, successive governments in Nigeria established several agricultural research institutes across the country to champion the course of developing improved agricultural technologies for adoption by farmers in Nigeria. The established agricultural research institutes include Cocoa Research Institute of Nigeria (CRIN), Ibadan; Institute for Agricultural Research (IAR), Zaria; National Animal Production Research Institute (NAPRI), Zaria; National Cereal Research Institute (NCRI), Baddegi; National Institute for Fresh-Water Fisheries Research (NIFFR), New Bussa; National Institute for Horticultural Research (NIHORT), Ibadan; National Root Crops Research Institute (NRCRI), Umudike; National Veterinary Research Institute (NVRI), Jos; Institute for Agricultural Research and Training (IAR&T), Ibadan; Nigerian Institute for Oil-palm Research (NIFOR), Benin; Nigerian Stored Products Research Institute (NSPRI), Ilorin; Rubber Research Institute of Nigeria (RRIN), Benin; National Agricultural Extension Research and Liaison Services (NAERLS), Zaria; Lake Chad Research Institute (LCRI), Maiduguri and Forestry Research Institute of Nigeria (FRIN), Ibadan.

Also, Nigeria has over 45 Faculties or Schools of Agriculture in Federal, State and Private universities, as well as three specialized Universities of Agriculture and several Colleges of Agriculture/Polytechnics, in addition to the four International Agricultural Research Centres present in Nigeria namely International Institute of Tropical Agriculture (IITA), Ibadan; International Livestock Research Institute (ILRI), Ibadan; West African Rice Development Association (WARDA), Ibadan and

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Kano (Saliu *et al.*, 2009). All these institutions individually and jointly serve as sources of agricultural innovations to the agricultural extension agencies for introduction to the farmers with the hope of improving the nutritional and food security status. It is also hoped adoption of the innovations would enhance yield and income as well as stimulate economic activities and by extension improve the living condition of the farmers.

2. Concept of Technology/Innovation

Technology is any scientific product, technique, skill, method and process used in the production of goods and services or for practical purposes, especially in industries such as agriculture. Innovation is an idea, practice, product, object, method or technique that is perceived or regarded as new by an individual or group of people or the community concerned. Innovation may not always be the result of recent research and what is an innovation in one locality may not be regarded as an innovation in another place depending on the perceived newness. In agricultural extension, innovation and technology are used as synonyms because most of the new ideas, practices, improved seeds or breeds e.t.c. are technological inventions, which at the beginning or starting point are regarded as innovations. Thus, in this lecture, the two words are used interchangeably. In agriculture, innovations or technologies come in form of crop varieties, livestock breeds, feeds, fish species, farm equipment, fertilizers, recommended practice, planting date, spacing, seed rate, fertilizer dose, harvesting time as well as vaccines and agricultural chemicals for weed, disease, insect and pest control.

2.1 Types of Technology/ Innovation

There are two categories of technology/innovation in agricultural extension namely material and knowledge-based technology. Material technology is also known as a hardware component. These are technological products, materials or physical objects such as farm machinery and equipment, agrochemicals, improved crop varieties, improved livestock breeds, fish species, fertilizers and vaccines. While knowledge-based technology is also known as a software component. These are information base and regarded as technical knowledge and management skills which emanate from scientific research such as recommended practice, planting date, spacing, seed rate, fertilizer dose, harvesting time and other information that will assist the farmer to maximize the yield (Van den Ban and Hawkins, 1996). Most crop and livestock technologies have both hardware and software components that are complementary. For instance, a material technology like improved crop variety can only produce the expected yield if the complementary package of agronomic practices (like recommended planting date, spacing, seed rate, fertilizer dose) is fully applied. But in some cases, a technology may comprises only information such as sustainable forest practices, soil conservation practices and sustainable fishing practices.

2.2 Emerging Agricultural Technologies

Although there are several inventions in the agricultural industry, the seven emerging advanced technologies that can literally change the agricultural landscape in the coming years are:

i. Precision Agriculture: This is a new trend of farming that provides farmers with more accurate methods of growing crops. In precision agriculture, farmers can distribute **soil and water sensors technologies** throughout their farmlands for many benefits. For instance, these sensors can detect moisture and nitrogen levels and the farmers can use this information to know when to water and fertilize. That results in more efficient use of resources and lowered the cost of production. It also helps in conserving water, limiting erosion and reducing fertilizer leaching.

ii. Indoor Vertical Farming: This latest farming technology is a practice of growing plants stacked one above another in a controlled and closed environment. The use of vertical shelves allowed the farmers to grow more crops in stacked layers. This technology enables the farmers to grow plants within the urban environment. It also reduces environmental impact and shortens the distance in the supply chains.

iii. Weather Tracking Technology: Farmers can use this technology to get the information necessary to protect the plants and reduce crop losses. This technology can give farmers advanced notice of hail, frost and other weather information for precautionary measures or at least mitigate losses to a greater extent.

iv. Satellite Imaging: This technology allows real-time crop imagery which can be used by the farmers to control plant growth without the necessity to visit certain farm locations. This can save a farm a considerable amount of time and money. Furthermore, this technology can be integrated with crop, soil and water sensors for farmers to receive a notification when danger thresholds are met.

v. Agricultural Robots: In the modern agricultural industry, robotic innovations, drones, robotic harvesters, seeding robots or autonomous tractors are now widely used. These agricultural robots or so-called agbots simplify farm activities such as harvesting, fruit picking and soil maintenance.

vi. Minichromosomal Technology: Mini-chromosome is a tiny structure within a cell that may be used to provide a plant with dozens of new traits without altering the original chromosomes of the crop. This assists in producing more agricultural products to maintain living standards.

vii. Radio Frequency Identification (RFID) Technology: FRID is a technology that uses radio waves to identify a tagged object. The technology provides information that is associated with farming yields. For example, a bag of potatoes can have a tag or label that you can scan with a smart phone in order to access information about the soil that yielded the farm products.

3. Innovation Development Process

Innovation development process consists of all the decisions, activities and impacts that take place from recognition of a need or problem, through research, development, and commercialization of innovation, through diffusion and adoption of the innovation by farmers, to its consequences (Rogers, 1983).

3.1 Recognizing Need or Problem

The innovation development process starts with the recognition of a problem or need, which stimulates research and development activities to come up with an innovation to solve the identified need or problem. In some cases, researchers may perceive a future problem and initiate research to find a solution.

3.2 Basic and Applied Research

This stage involves scientific research activities and investigations as well as the interplay of the scientific methods and practical operations. Here, scientific knowledge is put into practice in order to design an innovation that will solve the perceived problem or need. The difference between basic and applied research is that basic research is investigations for the advancement of scientific knowledge that do not have the specific objective of applying the knowledge to practical problems. On the other hand, applied research consists of scientific investigations that are intended to solve practical problems or needs.

3.3 Development

The development of an innovation is the process of putting a new idea in a form that is expected to meet the needs of the target farmers and potential adopters. This stage occurs after research but prior to the innovation that results from research. Researchers in most cases develop or build a prototype model of the innovation for private companies to produce.

3.4 Commercialization

The packaging of research results is usually done by private firms; this stage in the technology/innovation development process is known as commercialization. The activities involved in the commercialization phase of the innovation development process are production, manufacturing, packaging, marketing and distribution of a product that embodies an innovation.

3.5 Diffusion and Adoption

This is the stage of diffusing or disseminating the technology/innovation through communication channels to the farmers for adoption to solve social problems/needs. Some innovations do not diffuse rapidly and for such innovations, the rate of adoption is usually slow. Success in this stage largely depends on the effort of the change agent and attributes of the technology.

3.6 Consequences

Consequences are the changes that occur to individuals or group of farmers in the community following the adoption of an innovation. Consequences can be desirable or undesirable, direct or indirect, and anticipated or unanticipated. Here the initial problem or need that necessitates the entire process is either solved or not by the innovation. Often new problems/needs may be caused by the innovation thereby prompting another cycle of the innovation development process.

Figure 1 illustrates innovation development process. 4.

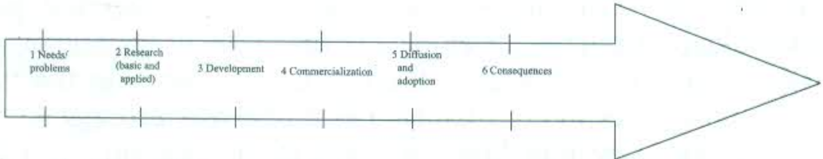


Figure1: Six main phases in the innovation development process.
Source: Globe (1973)

Technology Adaptation

Technology adaptation is a process or act of fitting new technologies to habitats to suit or conform to different environmental conditions as well as improve their chance of survival for better performance. This is done through on-farm adaptive research to validate, modify or calibrate a new technology on specific soils, climate and socio-economic or environmental characteristics of a given area. Often the knowledge, adaptation and utilisation aspects are overlooked by the researchers and institutes when generating new technology. Hence, those engaged in research and extension activities should comprehend this system and know how to make sure the technology generation, adaptation and utilisation take place. It is equally important that there is feedback through this system so that future research and adaptation work is appropriate for the needs of the farmers. Figure 2 depicts the process of technology adaptation.

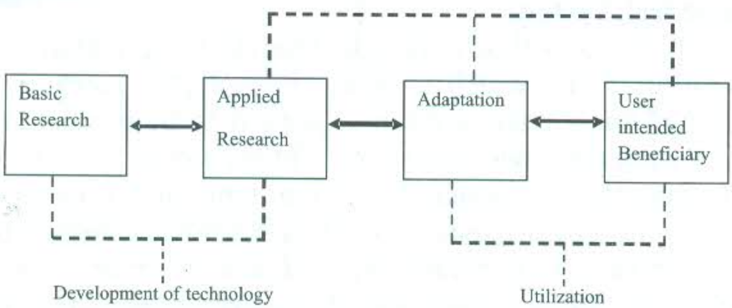


Figure 2: Technology Adaptation Source: Swanson (1996)

5. Technology Transfer

Transfer of technology is a process of transferring new technologies from the developers to the target users; and in this regard, from researchers to the end-user farmers. In the top-down model, technology transfer is a one-way process where technologies developed by the scientists are passed on to the extension service agencies to be transferred to the farmers. The process of generation, transmission and application of the new farm technology is a long-drawn one. A perspective view of this process covers five elements namely research system, extension system, farming system, research-extension linkage and extension-farmer linkage. Figure 3 below represents the summary of the process of technology transfer.

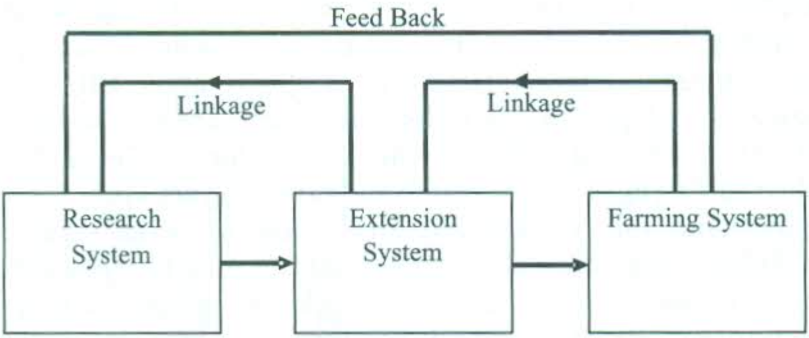


Figure 3: Process of Technology Transfer
Source: Swanson (1996)

5.1 Research System

This is the system that is responsible for the creation of new information from which a new technology emerges. Such creation of knowledge is often supposed to be in response to farmers' important felt needs and field problems. But it is noted that frequently the research system functions somewhat in isolation, whereby the sensitivity of the research scientists to the field conditions is considerably reduced. Further, it is also observed that the development of research information is no always oriented to extension communication needs. The issue here is that the production of information in this system is largely publication-oriented rather than application-oriented.

5.2 Extension System

In the context of agricultural development, the extension system operates between the research system and the farming system. The manner in which new farm technology flows through this system depends on certain factors. One of them is the understanding of individuals and groups regarding the purpose and manner of handling the new technology. Another is the number of links in the communication chain or the levels of hierarchy within the system. The observation sometimes made is that the extension system is not entirely composed of people who are equipped to do this job efficiently. Their knowledge and skills of both the technology and the manner of its transmission lend themselves to improvement.

5.3 Farming System

This consists of clientele groups concerned with the utilisation of new farm technology. The efficiency with which the new knowledge is utilised by this system depends upon a variety of factors which could be broadly categorized as personal and situational factors. Another relevant factor is the communication network within the rural communities transmitting technical information. The observation often made is that either the factors affecting individual adopters or the factors in the environment operate to hinder or facilitate the adoption process.

5.4 Research-Extension Linkages

There is no research system that is efficient in itself. Similarly, there is no extension system that is efficient enough. The linkages between the two systems become imperative in the flow of new technology from the research system to the extension system. These linkages could be formal or informal, systematic or adhoc. But there is a greater advantage if these linkages are many, systematic and operate frequently. This would promote a wider understanding of the available information, its outflow from the research system and a feed back as well. But as it is now, these linkages have not been developed systematically and adequately.

5.5 Extension-Farmer Linkages

The destination of new farm technology is of course the farms and homes in the rural areas. The extension system has the responsibility of not merely receiving research information and processing it into practical farm practices, but also presenting it to the rural communities in an effective manner. The extension methods and techniques play their role in this point.

6. Diffusion of Innovation

Diffusion is the process by which innovation is communicated through certain channels over time among members of a social system. Diffusion is a special type of communication concerned with the spread of messages that are new ideas. It is this newness of the idea in the message content that gives diffusion its special character. The four main elements in the diffusion of innovations are innovation, communication channels, time and social system. Innovation is a new idea, practice or object. Communication channels are the means by which messages about new ideas get from one person to another. Time is the length of time from first knowledge of an innovation by the farmer to its adoption, which determines innovativeness and rate of adoption. A social system can be a village, community or society where diffusion occurs in which their social structure and norms affect the diffusion of innovation (Adekoya and Tologbonse, 2005).

7. Innovation Decision Process

The innovation decision process is the process by which farmers pass from first knowledge of an innovation to forming an attitude towards the innovation, to a decision to adopt or reject, to implementation of the innovation, and confirmation of the decision. This process consists of series of actions and choices overtime in which farmers and communities evaluate innovations and decides whether or not to incorporate the new technology into existing practice. Based on the work of Rogers (1983), the process for simplicity is summarized into five stages namely: knowledge, persuasion, decision, implementation and confirmation.

i. **Knowledge** occurs when an individual farmer or group of farmers are exposed to the innovation's existence and gains some understanding of how it functions. At the knowledge stage, the farmer mainly seeks information on the technological innovation to reduce uncertainty. At this stage, the farmer or group of farmers wants to know what the innovation is and how it works. Mass media channels can effectively transmit such information. The characteristics of the decision-making unit or farmers' socio-economic characteristics, personality attributes and access to communication channels play a very important role at this stage.

ii. **Persuasion** is when a farmer or group of farmers form a favourable or unfavourable attitude towards the innovation. The main type of thinking at the persuasion stage is affective feeling. Here, the individual farmer becomes more psychologically involved with the innovation. At this stage, a general perception of the innovation is developed. The perceived characteristics of the innovation such as relative advantage, compatibility, complexity, trialability and observability are especially important at this stage.

iii. Decision stage in the innovation-decision process occurs when a farmer or group of farmers engages in activities that lead to a choice to adopt or reject the innovation. At this stage, farmers try out innovation on a partial basis as a means of reducing the uncertainty associated with most innovations. This small-scale trial is often part of the decision to adopt. Most farmers who try an innovation then move to adoption decision. The perceived relative advantage of the innovation at this stage facilitates subsequent implementation of the innovation.

iv. Implementation occurs when a farmer or group of farmers puts an innovation into use. Until the implementation stage, knowledge-persuasion-decision stages are mostly a mental exercise. But implementation stage involves overt behavioural change, as the innovation is put into practice in farms. At this stage, a certain degree of uncertainty about the outcome of the innovation still exists among farmers, even though the decision to adopt has been made previously.

At the implementation stage, re-invention occurs for some innovations and adopters. Re-invention is the extent to which an innovation is modified or changed by the user farmers in the process of adoption and implementation. Re-invention can be beneficial to adopters because flexibility in the process of adopting an innovation may reduce mistakes and promote customization of the innovation to fit it more appropriate to the local and changing conditions. As a result of re-invention, an innovation may be more appropriate in matching the social systems' peculiarities and more responsive to new problems that arise during the innovation-decision process.

v. Confirmation stage: at this stage, an individual farmer or group of farmers seeks reinforcement for the innovation-decision already made, but farmers may reverse this previous decision if exposed to conflicting messages about the innovation.

During the confirmation stage, the farmers want supportive messages that will prevent the rejection of the innovation. Therefore, at the confirmation stage extension agents have a special role and additional responsibility of providing supporting messages to the farmers who have previously adopted the innovation. Stages in the innovation decision process are illustrated in Figure 4.

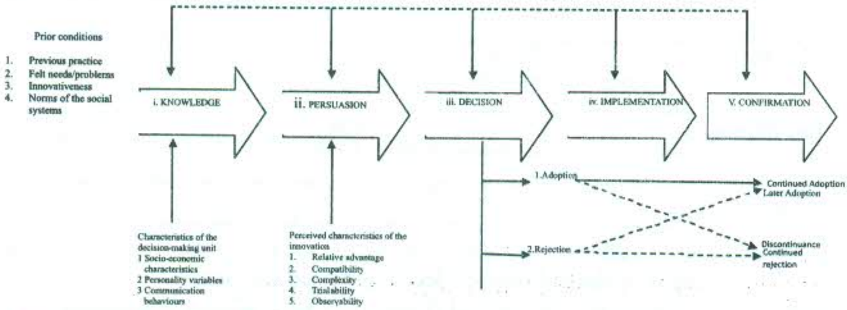


Figure 4: Stages in the innovation-decision process
Source: Roger (1983)

The innovation-decision process can lead to either adoption, which is a decision to make full use of an innovation, or to rejection, i.e. a decision not to adopt an innovation. Such decisions can be reversed at a later time; for example, discontinuance is a decision to reject an innovation after it had previously been adopted. Discontinuance may occur because a farmer becomes dissatisfied with an innovation, or because the innovation is replaced with an improved innovation or idea. It is also possible for a farmer to adopt the innovation after a previous decision to reject it. Such later adoption and discontinuance occur during the confirmation stage of the innovation-decision process. The innovation-decision process involves time in the sense that the five stages usually occur in a time-ordered sequence of knowledge, persuasion, decision implementation and confirmation. Exceptions to the usual sequence of the five stages may occur, such as when the decision stage precedes the persuasion stage. As stated by Beal and Rogers (1960), the innovation-decision period is the length of time required to pass through the innovation-decision process as depicted in Figure 5.

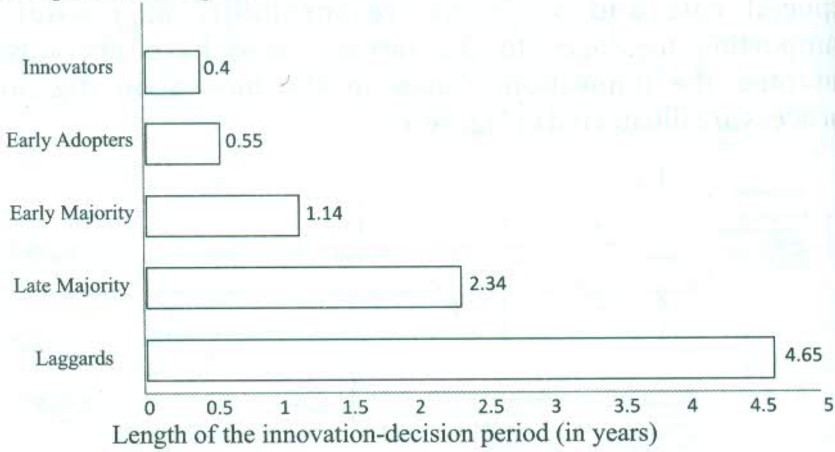


Figure 5: Innovation-decision period (Innovators have shorter innovation-decision period than laggards)
Source: Beal and Rogers (1960)

7.1 Innovation Decision Types

The social system plays a vital role in the diffusion of new ideas or technologies. Innovations can be adopted or rejected by individual farmers or by the entire social system, which can decide to adopt an innovation by a collective or an authority decision. An innovation-decision can be conceptualized as a system of legislation that paves way for the adoption of an innovation. Rogers (1983) observed that there are four innovation decision types namely:

i. Optional innovation decisions are choices to adopt or reject an innovation that are made by an individual farmer regardless of the decisions of other members of the community, although, the individual's decision may be influenced by the norms of the social system and by his or her interpersonal networks. The specialness of optional innovation decisions is that the individual is the unit of decision making, rather than the social system.

ii. Collective innovation decisions are choices to adopt or reject an innovation that are made by consensus among the members of a social system. Usually, all the units in the social system must conform to the system's decision once it is made. The freedom of choice allowed the individual depends on the nature of the collective innovation-decision.

iii. Authority innovation decisions are choices to adopt or reject an innovation that are made by a relatively few individuals in a social system who have power, status or technical expertise. The individual member of the system has little or no influence in the innovation decision; he or she simply implements the decision.

These three types of innovation-decisions range on a continuum from optional decisions (where the adopting individual has almost complete responsibility for the decision), through collective decisions (where the individual has some influence in the decision), to authority decisions (where the adopting individual does not influence the innovation-decision). Collective and authority decisions are more common than optional decisions in formal organisations such as factories, schools and organisations, in comparison with other fields like agriculture, where most of the innovation decisions by farmers are optional. Generally, the fastest rate of adoption of innovations results from authority decisions, while optional decisions are usually made more rapidly than collective decisions, although, authority decisions are often circumvented during their implementation. The type of innovation-decision for a given technology or idea may change or be changed over time.

iv. Contingent innovation decisions are choices to adopt or reject that can be made only after a prior innovation-decision. Hence, it is a sequential combination of two or more innovation-decision types. For example, an individual member of a social system may be free to adopt or not to adopt a new idea or practice only after his or her system's innovation-decision. Also, the adoption of milking technology is dependent on that of rearing livestock such as cattle. It is also possible to have other types of contingent innovation decisions in which the first decision is of an authority sort followed by a collective decision. The distinguishing feature of contingent decision-making is that two or more tandem decisions are required. The social system is directly involved in collective, authority and contingent innovation-decisions and perhaps indirectly in optional innovation decisions.

8. Concept of Adoption

Adoption is regarded as a decision to make full use of an innovation by an individual or group of farmers as the best course of action available over the existing practice. In agriculture, when a new technology is adopted, the old method or practice of farming is rejected. Adoption of innovation is not a snapshot activity, but a process that takes place over time. According to Adekoya and Tologbonse (2005), the adoption process consists of five stages or steps that an individual goes through in adopting an innovation namely:

i. Awareness stage starts when an individual first hear (aware) or find out about the existence of the innovation or technology. The individual at this stage lacks details concerning the way it works, how to use it, the cost and benefit of the innovation apart from probably knowing its name.

ii. Interest stage is when the individual develops an interest and actively seeks further information about the innovation such as how it works and what its potentialities are. The individual is very much interested in the cost factors and the time it will take to get the investment back if adopted.

iii. Evaluation stage is when the individual weighs up the advantages and disadvantages of using it by going through a mental evaluation by asking self-questions such as is it worth it? can I do it? do I have enough resources? will it be beneficial to me and my family? If the advantages outweigh the disadvantages especially with regards to the capital outlay against what else, they might do with the same amount of money and the satisfaction they will get from these alternatives. The evaluation stage is terminated when an individual decides to whether reject or accept the innovation.

iv. Trial stage is usually experienced by most individuals that decide to accept innovation and involves the testing of the innovation on a small-scale to determine the relevance and usefulness of the innovation. This is in order to answer questions asked in the evaluation stage.

v. Adoption stage is the final stage when the individual applies the innovation on a large-scale and continue to use it in preference to old methods. This, however, does not mean that the adopter will continue to use the innovation forever, but will tend to use it until when a better innovation comes along or has a problem with the present one. The stage is based on the mental or practical evaluation by the individual to make a final decision as to whether to adopt or reject. The adoption process stated above does not always follow the sequence in practice and depends on the technology and the individual in question.

8.1 Adopter Categories

Adopters of technology in a farming community can be grouped into five categories namely: Innovators who adopt first but are a very small minority (2.5%); the early adopters (13.5%); the early majority (34%); the late majority (34%); and, the laggards (16%) or farmers who are very slow and latest to adopt a new technology (Rogers, 1983; Adekoya and Tologbonse, 2005).

i. Innovators (Venturesome)

Innovators are very eager to try new ideas. This interest leads them out of a local circle of peer networks and into more cosmopolitan social relationships. Innovators have several attributes such as control of substantial financial resources to absorb the possible loss owing to an unprofitable innovation and the ability to understand and apply complex technical knowledge. The salient value of the innovators is venturesomeness. While the innovators may not be respected by the other members of the community, they play an important role in diffusing or launching the new idea in the social system by importing the innovation from outside of the system's boundaries. Therefore, the innovators play a gatekeeping role in the flow of new ideas into a social system.

ii. Early Adopters (Respectable)

Early adopters are more integrated into the local social system than the innovators. Whereas innovators are cosmopolites, early adopters are localites. This adopter category has the greatest degree of opinion leadership in most social systems. Potential adopters in communities look for early adopters for advice and information about the innovations. The early adopter is considered by many as the individual to check with before using a new idea. This Adopter category is generally sought by extension agents to be a local facilitator for speeding up the diffusion process. They serve as a role model for many other members of a social system and they are well respected by other members.

iii. Early Majority (Deliberate)

The early majority adopt new ideas just before the average member of a social system. The early majority interacts frequently with their peers but seldom hold leadership positions. The early majority's unique position between the very early and the relatively late to adopt makes them an important link in the diffusion process. The early majority may deliberate for sometime before adopting an innovation. This category follows with deliberate willingness in adopting innovations but seldom lead.

iv. Late Majority (Skeptical)

The late majority adopt new ideas just after the average member of a social system. Adoption by this category may be as a result of economic necessity and increasing network pressures. Innovations are approached with a skeptical and cautious air, and the late majority does not adopt until most others in their social system have done so. The weight of system norms must favour the innovation before the late majority is convinced. Because of their relatively scarce resources, almost all of the uncertainty about new ideas must be removed before the late majority feels safe to adopt.

v. Laggards (Traditional)

Laggards are the last in a social system to adopt an innovation. The point of reference for the laggards is the past. When laggards finally adopt an innovation, it may already have been superseded by another more recent innovation that is already being used by the innovators. Laggards tend to be suspicious of innovations and change agents. While most individuals in a social system are looking ahead for change, the laggard's attention is fixed on the rear-view mirror. The laggard's precarious economic position forces these individuals to be extremely cautious in adopting innovations. In every community, technologies/innovations are adopted at different times and the distribution of farmers who adopt new technologies follows a normal curve as shown in Figure 6 below.

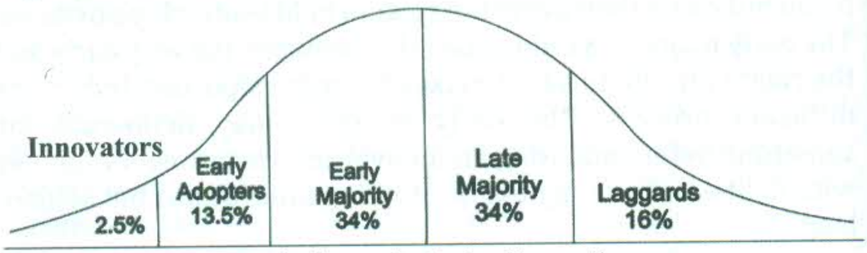


Figure 6: Adopter categorization on the basis of innovativeness
Source: Rogers (1983)

8.2 Attributes of Innovations and Rate of Adoption

The rate of adoption is the relative speed with which an innovation is adopted in a community. It is measured as the number of farmers who adopt a new technology within a specified period and community. One of the most important factors that determine the rate of adoption of an innovation is its perceived attributes in terms of relative advantage, compatibility, complexity, trialability and observability. Hence, innovations that are perceived by the farmers as having greater relative advantage, compatibility, trialability, observability and less complexity will be adopted more rapidly than other innovations. In addition to these perceived attributes of an innovation, other factors that affect the rate of adoption of an innovation are the innovation-decision type, nature of communication channels used to diffuse the innovation, type of the social system and extent of extension agents' efforts in diffusing the innovation.

9. Non-Adoption of Technologies

Non-adoption which is a situation where there are innovations but not adopted by the farmers is a major reason for low productivity among small-scale farmers. One major reason for non-adoption is that technologies are finalized before farmers get to see them, and technologies that do not match farmers' conditions or needs are usually rejected (Rolings and Pretty, 1996). Also, poor transfer of information between research and extension has been identified as being responsible for the non-adoption of improved technologies by farmers (Lele *et at.*, 1989). Non-adoption of recommended technologies is often caused by a non-technological factor such as social, psychological, cultural and economic problems. Farmers were reported to reject available technologies not because they are conservative or ignorant but because they rationally weigh the changes in incomes and risks associated with the adoption of technologies (Nagy and Sanders, 1990).

Constraints at the farm level usually result in the non-adoption of improved technologies that were developed outside the system. Apart from unexpected cultural resistance which is a common occurrence among the intended beneficiaries, complementary services are not usually available. Another aspect with regards to the non-adoption of technologies by the farmer may be connected with the inability to make communication a two-way process in which the farmer is allowed to function as a sender. The inability of a farmer to adopt technologies may also be due to inadequate information feedback, which if present could have facilitated technology transfer in the shortest possible time.

10. Why is the Adoption of Technologies Important in Agriculture?

Presently, agriculture has to fulfill diverse objectives and needs to be internationally competitive, produce agricultural products of high quality while meeting sustainability goals. To remain competitive, farmers need rapid access to emerging technologies. The importance of the adoption of technologies is further justified by the fact that farmers are faced with many more constraints and opportunities. In addition to being profitable, they need to meet environmental standards and regulations.

10.1 Why is the Adoption of Technologies an Issue in Agriculture?

i. Technologies that target pests and diseases more precisely: The need for pest control agents in agriculture is not likely to disappear any time soon. Thus, technological advances in pest control are expected to continue to produce chemical control agents that over time are as effective in controlling pests as the ones they replace, but which are also less toxic, less persistent and less mobile through the soil.

ii. Technologies that administer nutrients more efficiently: Continuous increase in agricultural inputs like fertilizer necessitate the wider application of technologies that administer fertilizers only at the appropriate places, times and in the amounts needed to increase crop yields further while reducing leaching and runoff of nutrients.

iii. Technologies that administer water more efficiently: Many of the technologies still used for irrigating crops are as old as civilisation itself. These technologies which convey water through open channels and furrows are wasteful; much of the water evaporates before it reaches the root zone. Technical efficiency can still be achieved through greater application of technologies for accurate measurement of actual crop needs in order to deliver water more accurately and in more precise dosages.

iv. Technologies that reduce post-harvest wastage: Post-harvest losses are high among farmers. Some further reduction in post-harvest losses is achievable. The use of technologies to harvest, process, store, transport, and distribute farm commodities are highly efficient and expected to result in much lower levels of wastage, as every part of crops and animals are recovered for some commercial uses.

v. Technologies that disseminate information: The Internet provides further developments in the dissemination of information on sustainable technologies. Furthermore, the adoption of technologies will always be an issue in agriculture because the agricultural profession is highly dynamic and progress in the sector is almost a daily affair. Hence technologies will be needed to take the information to the doorstep of the farmers in the rural areas, most especially at times of awareness, emergency, pest infestation or disease outbreak.

vi. Technologies that produce more food for the growing population: The agricultural sector is faced with the problem of improving output to cater for the ever-growing population in the present time. According to United Nation (2009), in the coming 50 years, world agriculture will undergo far-reaching economic and physical changes of which population increase will drive the demand for more food. To feed the world's increasing population projected to exceed nine billion in 2050, farmers are expected to use innovative technologies to produce more food for the growing population.

vii. Technologies for climate-smart agriculture: Agriculture is the most widely integrated sector of the economy worldwide. Therefore, when the patterns of land use, water use, temperature, rainfall, crop growth behaviour and input use change due to global warming and change in climatic conditions; agriculture has to change to fit into or to acclimatize the changed process. To do this, farmers' technological practices must continuously change to suit the need of time to mitigate or adapt to climate change.

11. My Contribution to Knowledge

11.1 Sources of Awareness for Adoption of Technologies

Awareness is the basis for the adoption of innovations by the farmers. In agricultural extension, there are three major sources of awareness namely individual, group contact and mass media sources. Individual source entails interpersonal communication and interaction between the farmer and extension agent or other informal sources to pass information. For group contact source, group activities are organized for up to fifty farmers to give information, create awareness and arouse interest in innovation. While mass media source is a non-personal communication which involves the use of electronic and print media to reach a large number of farmers at a time. The sources of awareness or information for adoption of agricultural technologies or practices by farmers, as obtained by the author through empirical researches are presented as follows: In a study by Umar *et al.* (2006) in Niger State, it was found that the major individual source of awareness for rice production technologies to farmers were friends with 86.84% response rate. Among group contact sources, cooperative societies were the main source of information for rice production technologies. It was also discovered that the farmers rely more on radio/television as means of getting information through the mass media as was reported by 90.79% of the farmers. On the whole, village extension workers ranked 5^{th} after Radio/TV, friends, village heads and cooperative societies (Table 1). This is probably due to the use of friends, village heads and cooperative members as contact farmers. Therefore, extension agents had contacts with only few farmers.

Table 1: Distribution of rice farmers according to sources of information on rice production technologies

Source of information	Rice farmers	Percentage
Individual sources		
Friends	66	86.84[2]
Village heads	38	50.00[3]
Village extension workers	26	34.21[5]
Private firms	15	19.74[7]
Group contact sources		
Cooperative Societies	28	36.84[4]
Farm centres	12	15.79[8]
Demonstration plots	1	1.32[11]
Experimental station	2	2.64[10]
Mass media sources		
Radio/Television	69	90.79[1]
Posters	4	5.26[9]
Newspapers/Magazine	18	23.68[6]
Extension Bulletin/Leaflets	4	5.26[9]

Source: Umar *et al*. (2006), Note: Superscripts 1-11 are rankings of sources of information

In a related study of sources of awareness for practice of safety measures, Umar *et al.* (2013) also found that majority (55.00%) of the farmers got awareness on safety measures from friends and relatives through conversation. This was followed by cooperative societies and radio jingles, while extension agents ranked fourth as a source of awareness on safety measures (Table 2). Yet in another research conducted on the adoption of sustainable forest practices in Niger State, Umar *et al.* (2017a) reported that 88.0% of the farmers got the awareness for the adoption of sustainable forest practices through village heads which ranked 1st. Other sources of information were in this order: radio, cooperative societies, village meetings and extension agents, respectively which ranked 2nd, 3rd, 4th and 5th (Table 3). As shown by the result of these studies, it would be right to state that majority of the farmers had more interaction with non-professionals like village heads, friends and cooperative members than the extension agents who are supposed to be a more reliable and better source of awareness on improved technologies and practices. Thus, there is a likelihood of misrepresentation of the messages to the farmers.

Table 2: Distribution of farmers according to sources of awareness for safety measures

Source of awareness*	Frequency	Percentage
Extension agents	25	20.83
Television	18	15.00
Radio jingles	30	25.00
Friends/relatives	66	55.00
Posters	8	6.67
Cooperative societies	42	35.00
Extension bulletins	11	9.17
Newspapers/magazines	7	5.83
Neighbours	5	4.17
Instruction labels on containers	2	1.67

Source: Umar *et al.* (2013) *Multiple response

Table 3: Sources of information for sustainable forest practices

Sources*	Frequency	Percentage	Ranking
Individual sources			
Extension agent	137	58.8	5th
Friend/ neighbour	104	44.1	7th
Village head	205	88.0	1st
Relative	71	30.5	8th
Contact farmer	31	13.3	10th
Group contact sources			
Seminar/workshop	15	6.4	12th
Agric show	20	8.6	11th
Village meeting	150	64.4	4th
Cooperative society	169	72.0	3rd
Farm centre	10	4.3	14th
Research station	11	4.7	13th
Mass media sources			
Television	106	45.0	6th
Radio	199	85.0	2nd
Newspaper	37	15.9	9th
Magazine	4	1.7	15th
Bulletin	2	0.9	16th
News letter	2	0.9	16th

Sources: Umar *et al.* (2017a), *Multiple response

11.2 Adoption of Agricultural Technologies and Rate of Adoption

Usually, there are variations in the adoption of different components of technological packages by farmers in the same or different communities. Worthy of note is the fact that the extent of application of the package determines the level of adoption. Hence, farmers who are classified as low adopters may be in that category because the whole package is not adopted. While those who are categorized as high adopters may still have room for improving adoption. Therefore, it is essential to examine the adoption of technologies and their rate of adoption, not only to provide empirical information about the adoption status of the farmers but to also provide insight on the aspect of technologies that may require improvement in terms of adoption. Consequently, the author in conjunction with others conducted several type of researches on the adoption of agricultural technologies by farmers. For instance, the study of Umar *et al.* (2006) reveals that almost 80.00% of the respondents adopted fertilizer applications. This was followed by improved rice varieties and agro-chemicals for weed control with 77.02% and 60.81% responses respectively. Other technological practices such as milling/processing technology and new tillage operation had low adoption percentages, while the least adopted technology was plant spacing (Table 4). This result shows a low level of adoption of knowledge-based technologies. It is imperative to emphasize that the full benefit of technology adoption cannot be realized unless farmers adopt the whole technological package such as improved variety, fertilizer, agro-chemical, seed rate, sowing depth, appropriate plant spacing as well as planting and harvesting times, which must be applied at the recommended rates and times.

Further study on adoption was carried out on the practice of sustainable fishing regulations due to the fact that fish is a direct source of protein and micronutrients lacking in plants for millions of people especially in the developing countries, which its sustainability is being threatened due to over-exploitation of natural fish stock in water bodies. The result of the investigation by the author indicates that all the fishermen (100.0%) complied with the sustainable fishing regulation of a ban on the use of explosives (Umar, 2015). This finding is in accordance with that of Nwabaze and Erie (2013) who found that most fishermen obeyed the ban on the use of explosives in their fishing activities. Other sustainable fisheries regulations found to be widely practised by the fishermen were non-use of poisonous chemicals and fish fences. But there was low adherence to the fishing regulations of gear control and declaration of fish catch. Also, sustainable fisheries regulations such as effort control and closed areas/closed seasons were rarely practised by the fishermen (Table 5). This study points to low adoption or conformity to some of the input and output control measures of sustainable fishing by the fishermen.

Table 4: Adoption of improved rice production technologies by the farmers

Rice production technologies*	Frequency	Percentage
Improved rice varieties	57	77.02
Plant spacing practice	14	18.92
New tillage operation	23	31.08
Fertilizer application	59	79.72
Use of chemical for weed control	45	60.81
Milling/processing technology	32	43.24

Source: Umar *et al*. (2006), *Multiple response

Table 5: Practice of sustainable fishing regulations

Regulations*	Frequency	Percentage
Ban on use of explosives	228	100.0
Prohibition of fish fence	123	53.9
Ban on use of poisonous chemicals	182	79.8
Declaration of fish catch	47	20.6
Gear control	85	37:3
Closed areas and closed seasons	24	10.5
Effort control	28	12.3

Source: Umar (2015) * Multiple response

Similar research was also conducted on the adoption of recommended water and sanitation practices by rural dwellers because the outbreaks of water and sanitation-related diseases have become a reoccurring decimal. From the study, it was discovered that majority of the farmers adopted water and sanitation practice of collecting water from protected sources, storing clean water in clean containers and burning home garbage to control flies (Table 6). However, water and sanitation practices such as appropriate handwashing behaviours, defecating in toilets/latrines, filtering and disinfecting water at the point of usage and boiling of water before drinking were not widely adopted (Umar *et al.*, 2017b). This has great implications for diseases like cholera, diarrhea and typhoid fever, thus, the need for more enlightenment and enforcement of the practices by the relevant stakeholders.

Table 6: Adoption of water and sanitation practices

Practices	Mean
Collection of water from protected sources	2.89*
Boiling of water before drinking	1.08
Disinfecting / filtering of water at point of use	1.25
Storage of clean water in clean containers	2.73*
Appropriate hand washing behaviours	1.92
Burning of garbage to control flies	2.06*
Defecating in toilets and latrines	1.77

Source: Umar *et al*. (2017b), *Practice adopted

On the rate of adoption of technologies, the study by Umar *et al.* (2006) reveals that majority of the farmers were medium adopters (52.60%), while 26.30% were low adopters of the rice technologies. Only 21.1% of the farmers belong to the high adopter category (Table 7). Altogether, studies on the adoption of agricultural technologies and sustainable practices show a low level of adoption of the software component of agro-technologies. However, the results attest to the acceptability of some of the agricultural innovations and practices by farmers and rural dwellers. But still, the adoption of the technological packages is yet to be fully maximized by the farmers. So, to answer the question of how far have farmers gone? The farmers are in the medium level of adoption of agricultural technologies.

Table 7: Adopter categories of small-scale rice farmers

Adopters category	Adoption index range	Number of farmers	Percentage
Low	1-40	20	26.30
Medium	41-60	40	52.60
High	61-100	16	21.10
Total		76	100.00

Source: Umar *et al.* (2006)

11.3 Factors Influencing Adoption of Technologies

In developed nations, 49 to 87 percent of the variation in the rate of adoption is said to be explained by the five perceived attributes of technologies, in addition to other variables such as type of innovation-decision, nature of communication channels used, type of the social system and extent of extension agents' efforts in promoting the innovation (Roger, 1983). However, in the developing and under-develop nations, the situation may not be the same because the social, economic and cultural environments where the farmers operate are acknowledged to be backward, difficult and characterized by the high levels of poverty, illiteracy, poor perception and lack of motivation to change. To increase the frontier of knowledge, the author conducted further studies to bring to light other variables that will improve the rate of adoption of agricultural innovations in developing countries like Nigeria.

In one of those studies, the adoption index was used to categorize farmers into low, medium and high adopters and thereafter carried out a discriminant analysis to determine the variables that explain variation in the rate of adoption among farmers. From the research, it was discovered that six variables were significantly important for discriminating between the three categories of adopters. The six variables in their order of importance were farm income ($p< 0.01$), farm size ($p< 0.01$), number of rice farms ($p< 0.05$), number of visits to market outside locality ($p< 0.05$), distance of residence to market ($p< 0.05$) and farming experience ($p< 0.01$). From this result in Table 8, it is evident that the first three discriminating variables relate to farms, while the last three relate to exposure outside the locality. Thus, it would be correct to state that farm-level characteristics and cosmopoliteness, which exposed farmers to a greater understanding of the existing technologies, influenced adoption (Umar *et al.*,2014a).

Furthermore, Umar *et al.* (2017b) used multiple regression analysis to ascertain factors influencing the adoption of water and sanitation practices, and it was found that educational level, income and cooperative membership positively and significantly ($P< 0.05$) influenced adoption. However, the household size of the farmers had a negative influence on the adoption of water and sanitation practices (Table 9).

Table 8: Estimated discriminant function for adopter categories of farmers

Estimated parameters	Function
Estimated farm income	0.576**
Farm size	0.466**
Number of rice farm	0.406*
Number of visits to outside markets	0.390*
Distance of residence to markets	0.260*
Farming experience	0.178*
Distance of farm to residence	-0385
Household size	0.043
Age	-0.067
Group centeriods low adopters	-0.646
Group centeriods medium adopter	-654e-02
Group centeriods high adopter	0.971

Source: Umar *et al.* (2014a), *Significant at $p<0.05$, **Significant at $p<0.01$

Table 9: Socio-economic factors influencing adoption of water and sanitation practices

Socio-economic characteristics	Coefficients	T – ratios
Constant	15.04701	13.21
Age	-0.3593127	-1.87
Education	1.260948	9.88*
Income	0.5778393	4.52*
Extension contacts	0.0676713	0.52
Household size	-0.8005996	-7.87*
Cooperative membership	0.2321966	2.25*
Gender	0.0106026	1.80
R^2	0.6206	
Adjusted R^2	0.6086	
F – ratio	52.81	

Source: Umar *et al.* (2017b), *Significant

In yet another study, the author in collaboration with others researched the factors influencing the adoption of improved maize variety using multiple regression models, of which exponential equation gave the best fit. As expected, it was observed from the result of the lead equation in Table 10 that education ($p< 0.01$) and income ($p< 0.05$) had a significant positive influence on the adoption of improved maize variety. Surprisingly, the influence of incentive on the adoption of improved maize variety was positive and highly significant ($P< 0.01$). This point to the usefulness of offering an incentive in terms of giving the farmers free seeds of improved varieties to test in their farms during awareness to facilitate adoption. Similarly, awareness time was found to be positively signed and significant ($p< 0.01$); indicating that if improved varieties are introduced to the farmers prior or close to the time or season of use, it enables farmers to put them to use immediately, thereby speeding up the practical application of the improved technologies. However, farm size was negatively signed and significant ($p< 0.01$). This was unexpected because an increase in farm size increases the need for technological inputs like fertilizer, agrochemical, capital and information, which are usually limited in supply. Hence, it is assumed that the scarcity of these inputs required to fully adopt improved maize variety might discourage the farmers from allocating more land for the cultivation of improved maize variety. This underscores the need for adequate and timely provision of technological inputs to farmers by input providers (Umar *et al.*, 2021). In general, factors that will improve the adoption of agricultural innovations by the farmers are farm-level attributes, cosmopoliteness, educational level, higher income, cooperative membership, provision of incentive and appropriate time of awareness as shown by most of the studies.

Table 10: Factors influencing adoption of improved maize variety

Factors	Linear	Exponential	Cobb-douglas	Semi-log
Age	1379.771	0.006	0.860	91062.32
	(1.17)	(0.32)	(1.49)	(2.34)**
Education	4297.406	0.203	0.295	6400.291
	(1.29)	(3.81)***	(3.27)***	(1.06)
Income	1301.534	0.049	0.155	2810.32
	(0.95)	(2.23)**	(2.74)***	(0.74)
Farm size	12319.95	-1.265	-0.162	11671.14
	(0.53)	(-3.41)***	(-1.09)	(1.18)
F/experience	-2183.756	-0.042	-0.163	-40898.32
	(-1.32)	(-1.57)	(-0.75)	(-2.80)
Incentive	2560.992	0.154	0.639	15532.99
	(1.73)	(6.49)***	(10.87)***	(3.93)***
Household size	-0.062	7.00e-07	0.053	2681.373
	(-0.74)	(0.53)	(3.05)***	(2.31)**
Awareness time	0.135	0.000	0.044	-183.676
	(0.82)	(4.82)***	(1.15)	(-0.07)
Constant	-55514.76	7.245	4.578	-221554.9
	(-1.40)	(11.38)***	(2.36)**	(-1.70)*
R^2	0.122	0.582	0.695	0.257
R^2 – adjusted	0.043	0.545	0.667	0.190
F- ratio	1.54	15.51***	25.30***	3.85

Source: Umar *et al.* (2021) Note: ***=significant at 1%, **=significant at 5%, *=significant at 10%. Figures in the parenthesis are the t-values.

11.4 Perceived Effects of Technology Adoption on Livelihood of Farmers

One of the reasons for the adoption of agricultural technologies or practices by farmers is to increase agricultural production. Another critical objective is to increase incomes, with the ultimate aim of improving their living standards. To have a clear picture of the benefits of the adoption of agricultural technologies, the author together with other researchers conducted several studies to determine the benefits that accrue to the farmers as a result of adoption and how such adoption decisions improved their livelihood. For example, in one of the studies conducted on socio-economic benefits of adoption of rice technologies, a total of 81.36% of the farmers had an increase in personal incomes, which improved their health conditions, as the sales of improved variety produce assisted them to settle medical bills, and provided them with good sources of nutrient such as protein, carbohydrate and other essentials required for a good healthy living. It was further found that some farmers noticed significant changes in their children's education because the adoption of improved rice varieties helped them in paying children school fees with ease, purchasing of school materials and other learning necessities. Also, a considerable proportion of farmers (69.49%) reported that improved rice varieties provided good rice straw for feeding livestock such as cattle, particularly during the dry season when the cost of feeding the livestock goes up (Table 11). Considering the sizable number of livestock the farmers owned, this helped in cutting down the cost of feeding and by extension improved the nutritional status of the animals. Some of the farmers said their preference for some improved rice varieties was not based on grains yield alone, but also because of their straw yield for feeding animals (Umar *et al.*,2009).

Table 11: Socio-economic benefits of adoption of improved rice varieties.

Socio-economic benefits	Frequency	Percentage
Farm income		
Increased income	48	81.36
No observe increase	4	6.78
Don't know	7	11.86
Total	59	100.00
Health condition		
Health condition improved	31	52.54
No difference in health condition	17	28.81
Don't know	11	18.65
Total	59	100.00
Children education		
Encouraged education	28	47.46
No difference	31	52.54
Total	59	100.00
Rice Yield		
Noticed yield increase	47	79.66
No difference in yield	9	15.25
Noticed yield decrease	3	5.09
Total	59	100.00
Straw yield		
Provided good straw	41	69.49
No difference	18	30.51
Total	59	100.00

Source: Umar *et al.* (2009)

In respect of adoption of recommended forest practices, the study by Umar *et al.* (2017a) indicates that the farmers derived the following livelihood benefits namely: the sustenance of forest resources, improvement in living standards (in terms of income generation, foods, medicines and raw materials), increased livelihood diversification, protection of the environment, preservation of ecosystem and reduction in the adverse effects of climate change. It should be pointed out that these benefits are positive indications of sustainable livelihood (Table 12).

Table 12: Perceived benefits of adoption of sustainable forest practices

Perceived benefits*	Frequency	Percentage
Sustain forest resources	233	100.0
Improvement in the living standard of farmers	233	100.0
Protection of environment	198	84.9
Increase diversification of agricultural production	231	99.1
Reduce adverse climate change effects	128	54.7
Preservation of the ecosystem	173	73.1

Sources: Umar *et al.* (2017a), *Multiple response

In another study by Umar and Mohammed (2018) on the adoption of Faro 44 improved rice variety, a mean yield of 6,000kg/ha was recorded. However, when the output was converted into monetary value, the farmers realized a mean income of ₦675,000.00 which was equivalent to $1,824.32 at the exchange rate of ₦370.00. When the Dollar value of the mean income was further divided by a year, the farmers earned about five Dollars ($4.998) per day. This helps to enhanced agricultural activities, reduced poverty and empowered the farmers in many ways as shown in Table 13. The result further reveals that nearly 90.00% of the farmers used income from sales of improved rice variety to attend to their welfare needs. As expected, the majority (70.94%) of the farmers re-invested their proceeds in agricultural production by expanding their farmlands, acquiring more inputs as well as purchasing livestock for fattening or as a working bull. Also, 50.73% of the farmers utilised their income to buy landed properties. This was followed by sizable percentages of farmers who used their incomes for education, healthcare, social assets, other businesses and pilgrimage. This finding shows that farmers' livelihood improved through the adoption of Faro 44 improved rice variety. This finding strengthens the report of World Bank (2007) which showed that Ghana reduced rural poverty between 1990 and 2005 through the introduction and adoption of improved technologies.

Table 13: Output/yield and income of farmers

Output/Yield-Kg (Income- ₦)	Frequency	Percentage	Mean
≤ 6,000kg (≤₦540,000.00)	91	44.83	₦675,000 ($ 1,824.32)
6,001-12,000kg (₦540,001.00-₦1,080,000.00)	53	26.11	
12,001-18,000kg (₦1,080,001.00- ₦1,620,000.00)	33	16.25	
18,001-24,000kg (₦620,001.00- ₦2,160,000.00)	20	9.85	
24,001-30,000kg (₦2,160,001.00-₦2,700,000.00)	6	2.96	
Mean yield: 6,000kg/ha.			
Perception on Empowerment			
Re-investment in farming	144	70.94	
Acquisition of landed property	103	50.73	
Investment in other businesses	51	25.12	
Sponsor children to schools	85	41.87	
Settle health care bills	82	40.39	
Pilgrimage	12	5.91	
Attend to other welfare needs	182	89.66	
Purchase social assets	62	30.54	

Source: Umar and Mohammed (2018)

More recently, more detailed work on the empirical effect of adoption on the livelihood of farmers was published by Umar *et al.* (2021) titled "Influence of improved maize variety adoption on the livelihood of farmers in Niger State, Nigeria". In the study, the livelihood index was used to determine the livelihood status of the farmers. Based on the livelihood categories, the influence of adoption levels on the farmers' livelihood status was ascertained, of which the incidence of high livelihood for full adopters was about 70.0%. On the other hand, the incidence of low livelihood was more common among the partial adopters with 81.0% response rate; suggesting the need for extension agents to advise farmers to fully adopt technologies. The implication of this is that the proportion of farmers that were in the low livelihood category and possibly living in poverty was higher among the partial adopters than the full adopters, which could be a result of the positive economic effects of adopting improved maize variety on the full adopters (Table 14). Despite the moderate level of adoption of agricultural technologies, the result of these investigations indicates that farmers derived a lot of socio-economic benefits for sustainable livelihood, natural resources and environment from adoption of technologies.

Table 14: Influence of improved maize variety on livelihood status of farmers

Adopters	Livelihood status		
	Low livelihood Freq (%)	Moderate livelihood Freq (%)	High livelihood Freq (%)
Partial adopters (n=21)	17 (81.0)	4 (19.0)	- -
Full adopters (n=99)	5 (5.1)	27 (25.2)	69 (69.7)

Source: Umar *et al.* (2021)

11.5 Constraints to Adoption of Agricultural Technology

Myriad of constraints are known to retard or restrict the adoption of innovations by farmers for improved livelihood. However, the constraints to the adoption of technologies by farmers that were discovered by the author through empirical research were inadequate backup inputs, untimely delivery of inputs, lack of credit, inadequate extension services, unaffordability of technologies and complexity of some innovations (Umar *et al.,* 2006; Umar *et al.,* 2009; Umar and Mohammed, 2018). But, the one that was commonly reported by the farmers in most of the studies was inadequate extension services in terms of areas of coverage and frequency of extension services. These twin constraints of extension services attracted the research attention of the author and others for further investigation and way forward.

11.6 Coverage Areas of Agricultural Extension Services

In the study of Umar (2013), it was found that over ninety percent (91.5%) of the small-scale farmers received extension services mostly on the production aspect of farming, leaving out other vital components of farming (Table 15). This suggests that there is little or no extension services on the processing, storage and marketing aspects of farming, which have implications for value addition, shelf life and marketing of agricultural products as well as food security; necessitating the need for sufficient extension services on post-harvest technologies. Credible and timely information plays a crucial role in agricultural marketing, particularly for perishable crops. Due to lack of proper market information and interference of middlemen, the farmers have been exploited often and forced to sell their produce at lower prices at farm gates or in their nearby markets. The harvested produce can be sold at premium price information of the nearest alternative markets if disseminated to farmers. With relevant marketing information, farmers can make better decisions to harvest the produce at right time and send their consignment to a particular market where the market price is higher for their produce.

Table 15: Distribution of farmers according to the area of extension service coverage

Coverage Area*	Frequency	Percentage
Production aspect	345	91.5
Processing aspect	17	4.5
Storage aspect	24	6.4
Marketing aspect	12	3.2

Source: Umar (2013) *Multiple response

11.7 Willingness of Farmers to Pay for Demand-driven Extension Services

To assuage the constraint of inadequate extension services or visits for adoption of technologies, Umar *et al.* (2014b) carried out a study on the willingness of farmers to demand extension services where they will be required to pay. The study reveals that the majority of the farmers were willing to pay and the average amount farmers were willing to pay for services was about fifteen thousand Naira (₦14,991) per annum. This mean amount is fairly attractive and comparable to the US $ 3.50 consultation fee charged per extension visit by service providers in Kenya as reported by Nambiro *et al.* (2005). On the type of information/technologies for which farmers were willing to pay for extension services, it was discovered that the majority of the respondents were willing to pay for services on processing and storage technologies with 90.9% and 86.4% responses respectively. Other technologies or areas for which farmers were willing to pay for extension services include improved seed/planting materials, livestock breeds, and marketing strategies among others (Table 16). This result supports the claim of farmers of not receiving adequate extension services on processing, storage and marketing technologies as indicated in Table 15. Therefore, there is an existing demand and ready market for agricultural information on processing, storage and marketing technologies.

Table 16: Distribution of farmers based on the amount they are willing to pay for extension services

Amount willing to pay (₦)	Frequency	Percentage
1,000 - 10,000	166	44.1
10,001 – 20,000	131	34.7
20,001 - 30,000	57	15.1
30,001 – 40,000	22	5.8
40,001 – 50,000	1	0.3
Total	377	100.0
Mean	14,991	
Information/technology*		
Improved seeds/planting materials	307	81.2
Chemical fertilizer	195	51.7

Soil water conservation	131	34.7
Crop management	252	66.8
Weed control	144	38.1
Storage technologies	326	86.4
Livestock breeds	264	70.0
Livestock pasture/feeds	219	58.0
Agroforestry	45	11.9
Beekeeping	2	0.5
Aquaculture	128	33.9
Processing technologies	343	90.9
Marketing strategies	261	69.2
Leadership skill training	92	24.4
Veterinary services	227	60.2

Source: Umar *et al.* (2014b), *Multiple response

A further study was carried out by Umar *et al.* (2014c) to ascertain the effect of quality service indicators on the willingness of farmers to pay for demand-driven extension services using multiple regression. In the study, the willingness of farmers to pay for demand-driven extension services was regressed against the explanatory variables of quality service indicators of content accuracy, timeliness, relevance, effectiveness and efficiency of extension services. From the lead equation result in Table 17, all variables had significant effects on the farmers' willingness to pay for demand-driven extension services ($P<0.05$). The result also indicated that the R^2 value was 0.623 and the relationship between the dependent and independent variables was significant as revealed by F- value ($F=122.878$, $P<0.01$), which is an indication that the effectiveness of the combination of the independent variables in predicting farmers' willingness to pay for demand-driven extension services could not have occurred by chances. This result points to the fact that farmers are willing to pay for extension services if content accuracy, relevance, timeliness and effectiveness of services are guaranteed to complement public sector extension services and lessen the constraint of inadequate extension services for adoption of improved technologies.

Table 17: Effect of quality service indicators on farmers' willingness to pay for extension services

Variables	Coefficients	Standard error	t-value	P-value
Constant	3.516	.039	91.050*	.000
X_1 accuracy	.117	.015	7.864*	.000
X_2 relevance	.070	.013	5.374*	.000
X_3 timeliness	.065	.015	4.382*	.000
X_4 effectiveness	.043	.015	2.824*	.005
X_5 efficiency	-.025	,013	-.1.950*	.052
Std error 06510				
R^2 0.623				
F-value 122.878				

Source: Umar *et al.* (2014c) * = Significant at 5% level

12. Conclusion and Recommendations

From the findings of the studies, the author concludes that the major sources of awareness for the adoption of agricultural technologies were non-professionals such as village heads, friends and cooperative members than the extension agents. The adoption of the software components of agro-technologies by the farmers is low. Therefore, the adoption of agricultural innovations is yet to be maximized. Factors that will improve the adoption of technologies by farmers are farm-level characteristics, cosmopoliteness, educational level, higher income, cooperative membership, extension contact, incentive and appropriate awareness time. Notwithstanding, the adoption of agricultural innovations alleviated poverty, empowered the farmers and improved their livelihood. Major constraint to the adoption of agricultural innovations was inadequate extension services in terms of coverage and frequency of service. There were little or no extension services by the public sector extension services on post-harvest technologies. Thus, farmers are willing to demand and pay for extension services on processing, storage and marketing to improve the quality, value and marketability of farm products; if the services will be accurate, relevant, timely and effective. Consequently, it was recommended that:

1. Agricultural extension personnel with the appropriate training should provide regular and follow-up information to the farmers to prevent them from being misguided by non-professionals like village heads and friends.
2. In order to maximize yield from adoption of improved varieties, extension agents should provide timely information to the farmers to educate them more on the software components of improved varieties such as plant spacing, planting depth and appropriate planting time.
3. Agricultural fairs should be re-introduced by agricultural extension organisations to expose farmers to greater understanding of the existing technologies.
4. Agricultural extension organisations and improved varieties' promoters should offer incentives to farmers in terms of free seeds for testing in their farms during awareness to facilitate adoption.
5. Time of awareness by extension agents or promoters should synchronize with time or season of the use of the improved varieties i. e. improved varieties should be introduced to the farmers prior or close to the time of use to enable farmers to put them to use immediately, in order to speed up the practical application of the improved technologies and reduce the gap between agricultural innovation development and usage by the farmers.
6. The development of improved seed varieties by the researchers should target both quality grains and straw yield to meet farmers' requirements and preferences.
7. Extension agencies and their agents should advise farmers to fully adopt farming technologies for significant improvement in their livelihoods.
8. Also, backup inputs such as fertilizers and agrochemicals should be made available to the farmers adequately and timely by relevant agencies and agro-allied companies.
9. Agricultural advisory services by extension agencies should be extended from production-led extension services to market-led extension services to improve the quality, value and marketability of farm products as well as the income and livelihood of the farmers.

10. The strong effects of the quality service indicators on the willingness of farmers to pay for demand-driven extension services is a sign of receptiveness of farmers to private sector services, Therefore, it is suggested that government policy should be created to favour demand-driven extension service providers to function where they have a comparative advantage in providing farmers with relevant services.
11. Through cooperative societies, farmers growing the same type of crops should pool their resources together to demand extension services to complement public sector extension services to enhance technologies' adoption. This will also improve access to inputs and institutional credits as well as serve as a channel for information dissemination.
12. The result of the studies indicates that the farmers are willing to pay for extension services on storage and processing technologies, which suggests the existence of demand. To take advantage of the existing demand and market, the service providers should logically package their services to adequately train farmers on processing and storage technologies as well as on marketing to enable them to produce farm products of high quality that will meet buyers' preferences for maximum profit.
13. The quality service indicators had significant positive effects on farmers' willingness to pay for demand-driven extension services. It is thus recommended that the service providers should always strive to provide high-quality services (in terms of content accuracy, relevance, timeliness and effectiveness of extension services) to their clients to sustain farmers' willingness to participate in demand-driven extension services.

Final Thoughts

Technology is transforming every facet of our modern lives including farming. Hence, farmers will flourish and the varieties of food that will be on our dining tables tonight will have gotten there faster, fresher, finer and more nutritious and cost-effective if farmers adopt leading and cutting-edge technologies in agriculture.

Acknowledgments

I will start by expressing gratitude to Almighty Allah for making it possible for me to get to the peak of my academic career. I am most grateful to my parents, late Alhaji Isah Jibrin and Hajiya Aishetu Isah for their love, care and support to see that I get educated to the highest level. I also want to appreciate my late uncle, Alhaji Muhammadu Sheshi for his support and guidance. May Allah reward them with Al-Jannah Firdaus.

I wish to express my gratitude to the Vice-Chancellor, Prof. Abdullahi Bala for his kindness and encouragement. Moreso, I am grateful to the principal management officers of the University. I wish to express my sincere gratitude and appreciation to Prof. R.S. Olaleye my Ph. D supervisor for his guidance and support. Furthermore, the efforts of other supervisors (Prof. J.N. Nmadu and Prof. B. O. Adeniji) and other lecturers such as Prof. K.M. Baba and late Dr. F.S. Gana are highly appreciated. I use this medium to thank my lecturers at UDU, Sokoto, particularly Prof. H.M. Bello and Prof. B. Faruk. My sincere gratitude also goes to late Dr. B.M. Hamidu of ATBU, Bauchi. May Allah rest his soul in peace.

Let me also show my appreciation to members of my immediate and extended family, in particular my wife (Hajiya Fatima Umar), children (Isah, Hassan, Hussaini and Sadiq), brothers, sisters, nephews and nieces for their support. The contributions of my brothers namely Alhaji Hassan Mokwa, Alhaji Abubakar Isah, Alhaji Sani Isah, Alhaji Usman Sheshi, Captain Isah Isah (rtd), Engineer Mohammed Sheshi, Alhaji Mohammed Mohammed, Barrister Abdullahi Mohammed, Alhaji Yahaya Sheshi, Engineer Abubakar Sheshi to my educational career cannot be overemphasized. Also, my brother, Alhaji Usman Liman, deserves my special appreciation for his encouragement and support. I also acknowledged and thank all the people that supported me in one way or the other towards my advancement in life.

The staff of the Department of Agricultural Extension and Rural Development of FUT, Minna deserves my special commendation. I enjoy working with the HOD, Prof. J. H. Tsado, Dr. O.J. Ajayi, Dr. I.S. Tyabo, Dr. M. Ibrahim, Dr. H. M. Usman, Mr. M. Yakubu. Mrs. S. Jibrin, Mr. A. Abdulwahaab, and Mr. J. A. Ndatsu. In my former Department, I will not forget to appreciate Prof. L. Tanko and Dr. M.A. Ndanitsa for their cooperation. I will also not forget the cooperation I enjoyed from other colleagues like Dr. E.S. Yisa, Dr. U.S. Mohammed, Dr. A. Abdulazeez, Mrs. R. Usman, Mrs. H. Sallawu, Mall. Y. L. Tauheed, Mall. A. Umar and all others. I am sincerely grateful to all member of staff of SAAT, FUT, Minna especially the Dean, HODs, Professors, Academic and Non-Academic staff as well as students for their support.

My gratitude goes to Prof. M. Y. Auna, Provost COE, Minna and Alhaji A. B. Arah, DG Niger State SDG for their assistance. Also acknowledged are Prof. A. F. Lawal and Dr. I. Ndagi for their support. I appreciate all my friends especially Dr. M. L. Rabba, Mall. A. Salihu Mall. A. Pichifu, Dr. A. Yabagi, Mall. M. Kudu, Dr. M. Koloche, Dr. O. Fortune, Mall. M. Adamu and others for your support. My associates in persons of Prof. M. Murtala of ATBU, Bauchi, Dr. S.M. Sadiq of FUD, Dutse and Dr. M. Usman of IBBU, Lapai are also appreciated. To members of QAP Office of FUT, Minna, particularly Prof. I. Adai (Director) and other staff such as Mr. I. Taiwo, Mr. B. Lucious, Mr. Z. Anderson and Mrs. I. Lilian, I appreciate your support and co-operation.

Also appreciated is the Chairman of the University Seminar and Colloquium Committee and other members of the Committee for working round the clock. Space and time will not permit me to write and mention the names of all the individuals who have contributed to making this occasion a success. Please note that your contributions are well acknowledged. For those who travelled from different places to grace this occasion, be assured that you are highly appreciated. May Almighty Allah take you back to your various destinations safely. Thank you all.

References

Adekoya, A. E., and Tologbonse, E. B. (2005). Adoption and diffusion of innovations. In Adedoyin, S.F. (eds) *Agricultural extension in Nigeria.* Ilorin, Published by Agricultural Extension Society of Nigeria/ Agricultural and Rural Management Training Institute. Pp. 33-35.

Beal, G.M., and Rogers, E.M. (1960). *The adoption of two farm practice in a Central Iowa Community*, Ames, Iowa. Agricultural and Home Economics Experiment Station, Special Report 26.

Globe, S. (1973). The interactions of science and technology in the innovative process: Some case studies, Columbus, Ohio, Battelle-Columbus Laboratories, Report to the National Science Foundation.

Lele, U., Kinsey, B.H., and Obeya, A.O. (1989). Building agricultural research capacity in African: Policy lessons from MADA countries. Paper presented for joint TAC/CCIAR Directors Meeting, Rome. Retrieved from http://pdf.usaid.gov on 15th /04/2021.

Nagy, Y.G., and Sanders, H. (1990). Agricultural technology development and dissemination within farming systems perspective. *Agricultural Systems*, 23: 305-320.

Nambiro, E., Omiti, J., and Muguneri, L. (2005). Decentralization and access to agricultural extension services in Kenya. Strategies and Analysis for Growth and Access, SAGA Working Paper No.9. Pp 1-11.

Nwabaze, G.O., and Erise, A. P. (2013). Artisanal fisheries use of sustainable fisheries management practices in the Jebba Lake Basin, Nigeria. *Journal of Agricultural Extension,*17(1): 123-134.

Olomola, A. S. (1995). Source of growth and performance trend in Nigeria. Agriculture 1960 - 1992. In: Ikpi, A.A. and Olayeme, J.K. (eds) *Sustainable agricultural and economic development in Nigeria*. Winrock International Institute for Agriculture Development Arlington. Pp 43-56.

Rogers, E.M. (1983). *Diffusion of innovation*. New York, Macmillan Publishing Company, Inc. Pp 453.

Rolings, N., and Pretty, J.N. (1996). Extension role in sustainable agricultural development. In: Swanson, B.E., Bentz, R.P., and Sofranko, A.J. (eds). *Improving agricultural extension: A Reference Manual,*165-172.

Saliu, J.O., Obinne, P.C., and Audu, S.I. (2009). Trends in agricultural extension services in Africa: Option for new approaches. *Journal of Agricultural Extension and Rural Development,* 1(3): 71-76.

Sunding, D., and Zilberman, D. (2000). *The agricultural innovation process: Research and technology adoption in a changing agricultural sector*. A handbook of agricultural economics.

Swanson, B.E. (1996). Strengthening Research-Extension Linkages. In: Swanson, B.E., Bentz, R.P., and Sofranko, A.J. (eds). *Improving agricultural extension: A Reference Manual*. Pp 165-172.

Umar, I. S., Hamidu, B.M., and Illiyasu, Y. (2006). Adoption of improved rice production technologies in Lavun Local Government Area of Niger State. In: Madukwe, M.C., Olowu, T. A., Igbokwe, E. M., Garfouth, C. J. and Dube, M. A. (eds) *Changing Perspective in Extension Innovation System in Nigeria*. Proceedings of the 11th Annual Conference of Agricultural Extension Society of Nigeria, held at University of Agriculture, Abeokuta, Nigeria. 3rd – 6th April, 2006, pp.18-24.

Umar, I. S., Ndanitsa, M. A., and Olaleye, S. R. (2009). Adoption of improved rice production technologies among youth farmers in Gbako Local Government Area, Niger State. *Journal of Agricultural Extension,* 13 (1): 1-8.

Umar, I. S. (2013). Impact of extension services on the adoption of agricultural technologies by farmers in Niger State, Nigeria. *ATBU Journal of Technology and Educational Research,* 6 (2): 33- 37.

Umar, S. I., Olaleye, R. S., Ndanitsa, M. A., Ibrahim, M., Tsado, J. H., and Sadiq, M. S. (2013). Capacity building needs of farmers for safe agro-chemical use/application in Niger State, Nigeria. *Journal of Agricultural Extension,* 17 (1): 152-161.

Umar, I. S., Iliyasu, A. Y., Ndanitsa, M. A., and Ibrahim, M. (2014a). Socio-economic and farm-level characteristics influencing adoption of rice production technologies in Lavun Local Government Area of Niger State, Nigeria. *Dutse Journal of Agriculture and Food Security,* 1 (1): 13-18.

Umar, I. S., Olaleye, R. S., Adeniji, B. O., and Nmadu, J. N. (2014b). Assessment of farmers' willingness to pay for demand-driven extension services in Niger State, Nigeria. *International Journal of Physical and Social Sciences,* 4 (4): 374-384.

Umar, I. S., Ndanista, M. A., Tyabo, I. S., and Ibrahim, M. (2014c). Effect of quality service indicators on the attitude of farmers towards demand-driven extension services in Niger State, Nigeria. *Research on Humanities and Social Sciences,* 4 (21): 88-93.

Umar, I. S. (2015). Practice of sustainable fisheries regulations in Niger State, Nigeria. *International Research Journal of Agricultural and Aquatic Sciences,* 2 (3): 120-123.

Umar, I.S., Tsado, J. H., Ahmed, I. I., Ajayi, O. J., and Yisa, E. S (2017a). Adoption of sustainable forest practices by farmers in Niger State, Nigeria. *FUW Journal of Agriculture and Life Sciences*, 2 (1): 52-61.

Umar, I. S., and Mohammed, U., and Yakubu, D. H. (2017b) Assessment of adoption of water and sanitation practices by rural dwellers in Niger State, Nigeria. *Journal of Agricultural Economics, Environment and Social Sciences*, 3 (1): 104-110.

Umar, I. S., and Mohammed, U. (2018). Increasing rice production through adoption of improved variety in Niger State, Nigeria. *Journal of the Bangladesh Agricultural University*, 16 (2): 182-186.

Umar, I.S., Mohammed, U., Mohammed, Y., Abdullahi, A., and Abubakar, U. (2021). Influence of improved open pollinated maize variety adoption on livelihood of farmers in Niger State, Nigeria. *Journal of Agripreneurship and Sustainable Development*, 4 (1): 1-9.

United Nations (2009). World population prospects: The 2008 revision, United Nation, New-York. Retrieved 13th June 2011 from http://www.ifpri.org/sites/defaul/files/dsqc pdf

United States Department of Agriculture (2012). National Agricultural Statistics Service. Retrieved 24th September 2020 from http://www.usda.pdf

Van den Ban and Hawkins, H.S. (1996). *Agricultural extension* Second Edition. Blackwell Science Limited, London. Pp 96-119.

World Bank (2007). *World Development Report: Agriculture for Development*. The World Bank, Washington, DC.

BRIEF PROFILE OF THE INAUGURAL LECTURER

Umar Sheshi Isah is a Professor of Agricultural Extension and Rural Development. He was born on 10th February, 1972 to the family of late Alhaji Isah Jibrin and Hajiya Aishatu Isah at Mokwa, Mokwa Local Government Area of Niger State, Nigeria. After his childhood, He was entrusted to the guardianship of his uncle Alhaji Mohammadu Sheshi. He started his primary educational pursuit at Kpege Primary School Mokwa in 1975 and completed in 1980. He then gained admission into Government Teacher's College, Mokwa in 1980 and passed out in 1985 with a Teacher's Grade II Certificate. He proceeded to Federal College of Education, Kontagora where he obtained NCE in 1991. He furthered his education at Usman Dan-fodio University Sokoto and graduated with a B. Agric. in Agricultural Economics and Extension in 1997, after which he went for National Youth Service Corps (NYSC) at Ogun State Ministry of Agriculture, Abeokuta in 1998.

Professor Umar took appointment with Federal University of Technology, Minna in August 2001 as a Graduate Assistant in the Department of Crop Production, from where Department of Agricultural Economics and Extension Technology was created and later bifurcated into the Departments of Agricultural Economics and Farm Management and Agricultural Extension and Rural Development, which is his present Department. After joining Federal University of Technology, Minna, he got admission to Abubakar Tafawa Balewa University, Bauchi for his M.Sc. programme in Agricultural Extension which he completed in 2006. Thereafter, he enrolled for his Ph.D programme in Federal University of Technology, Minna in 2009 and graduated in 2013 with Ph.D in Agricultural Extension and Rural Sociology.

Professor Umar rose through the ranks and became a Professor of Agricultural Extension and Rural Development in 2019. He has published over 70 articles in both international and national reputable journals and conference proceedings. Also, he has written many chapters in academic textbooks. Similarly, he has been reviewing manuscripts for many local, national and international journals. He has attended and presented papers in several national and international conferences within and outside Nigeria. Professor Umar's research interest is on adoption of agricultural technologies and practices, capacity building needs, rural development and women in agriculture. He is a member of several professional associations which include

Agricultural Extension Society of Nigeria (AESON), Rural Sociological Association of Nigeria (RUSAN), Farm Management Association of Nigeria (FAMAN), Nigerian Association of Agricultural Economists (NAAE), Scholarlink Research Institute and Association of Quality Assurance and Productivity Professionals.

Professor Umar has over the years been building the capacity of high-level manpower in the area of agriculture and rural development through teaching, project/thesis supervision, research, community services and workshops. He has successfully supervised and graduated three PhD degree holders, 20 M.Tech. degree graduates, 4 Postgraduate Diploma degrees and several B. Tech. degree holders. Professor Umar has held many administrative responsibilities at the Departmental, School and University levels. He has also carried out many community services at the University, State and National levels. Professor Umar is a member of the University Board of Survey and has also served as a Chairman and Member in many Committees in the Department, School and the University. Other academic administrative responsibilities held by Professor Umar in Federal University of Technology, Minna include undergraduate level adviser and seminar coordinator for both undergraduate and postgraduate students. Presently, he is the Deputy Director of Quality Assurance and Productivity of the University.

For community services outside the University, he has served as External Examiner to Usman Dan-fodio University, Sokoto and Abubakar Tafawa Balewa University, Bauchi. Professor Umar provided consultancy services for Fadama III Project Baseline Survey for Niger State, Technical Cooperation for Development Planning on the One Local Government One Product (OLOP) Programme for Revitalizing the Rural Economic in Niger State, Impact Study for Community and Social Development Project in Niger State, Capacity Building for Fadama Production Groups/Clusters in Niger State and Technical Assistant on Advisory Services/Input Implementation for Niger State Fadama Farmers, where he served as a Supervisor, Sociologist/Economics, Rural Sociologist, Consultant Trainer and Consultant respectively. Prof. Umar also served as a Sub-Consultant for Sustainable Development Goals' Youth Empowerment Programme in Niger State. Professor Umar is married to Hajiya Fatima Jiya Umar and they have four children, namely Isah, Hassan, Hussaini and Sadiq.