

UTILIZATION OF AGRICULTURAL INNOVATIVE TECHNOLOGY BY FARMERS FOR SUSTAINABLE FOOD PRODUCTION IN NIGERIA

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Abstract

Agricultural technology is playing significant roles in enhancing productivity, especially in the current situation where food demand surpasses production capacity and Northwest, Nigeria in particular. The study focused on the Utilization of Agricultural Innovative Technology by Farmers for Sustainable Food Production in Nigeria. Three (3) research questions and hypothesis guided the study. A survey research design was used for the study. The sample size for the study was 225 comprising of 75 Extension Agents, 75 Agricultural Education lecturers and 75 farmers. A purposive sampling technique was used in selecting five State and two Local Government Areas from each of the State including respondents based on their strength and level of food production within the States. 33 items questionnaires covering personal information of the respondents and Utilization of Agricultural Innovative Technology by Farmers was utilized for data collection. The questionnaire was face validated by experts and was administered on respondents with the help of 10 research assistants. The data generated were analyzed using mean and standard deviation for answering the research questions, while t-test statistics was used to test the hypothesis of no significant difference at relevant degree of freedom. The findings of the study revealed a generally low level of awareness and utilization of agricultural innovative technologies by farmers as well as facing numerous challenges such as inability of the rural farmers to keep abreast of technological development due to lack of ability and/or financial resources among others. On the hypothesis tested, it was revealed that there were no significant differences on the responses of Agricultural Extension Agents and Farmers on hypotheses 1 and 2 but there was a significant difference on hypothesis 3 tested as the responses of Agricultural Extension Agents and that of Agricultural Education Lecturers on the strategies for enhancing the utilization of agricultural innovative technologies by farmers are significantly different from one another. The study recommended strategies for overcoming these challenges among which includes Agriculture technologist and policymakers should play key role in the distribution and or application of innovative technologies for immediate take-up and development agencies should foster the effectiveness of innovative interventions and take into account of existing technologies for smooth transition and adoption by farmers in Northwest, Nigeria.

Key words: Utilization, Agricultural Innovative Technology, Farmers, Sustainability. Food Production.

Introduction

Agriculture has played a significant role as the backbone of Nigeria economy at independence in 1960, by providing employment and source of livelihood for the increasing population and accounting for over half of the GDP of the Nigeria economy. However, this role has diminished over the years due to the dominant role of the crude oil sector in the economy. The increasing demand for food in Nigeria, with her abundant natural resources and potential to increase the volume of food production towards meeting the food and nutritional requirement of the rapidly increasing population and guarantee food security in the country become very essential. Food production worldwide according to Yang, Jiao, Feng, Ramasamy, Zhang, Mroczek & Zhang (2021) is usually carried out by small scale farm holders. Chen et al., (2014) emphasized that the magnitude of the production gaps is particularly large in developing countries, where smallholders face multiple challenges and constraints which contribute to these production gaps, including uncoordinated linkages between education, research and extension. The linkages between education, research and extension are often supply-driven and top-down, and unable to respond to the diversity of location-specific, locally adaptive and multiple knowledge demands as

smallholders are a diverse group in terms of incomes, knowledge, perceptions and farming practices. Farm Square (2022) stated that there has been a decrease in agricultural productivity in Nigeria because of farmers not accessing developed agricultural technology.

Adzenga and Dalap (2023) stated that in developing country like Nigeria, agricultural technology will play important role in driving growth of smallholder farmers towards increasing food production to meet the ever-increasing demand for food and raw materials for agr-industries. According to Food and Agricultural Organisation (2015) the world's population is expected to grow to almost 10 billion by 2050. This projected growth in the world's population would be concentrated in Africa and South Asia and in the world's cities. By mid-century, two-thirds of the global population will live in urban areas. Low-income countries will see large increments in the 15-24 years age group. The population will continue to grow in South Asia until mid-century and in sub-Saharan Africa until at least the end of the century. By the year 2100, Asia and Africa are expected to be home to a combined population of 9 billion, out of the projected 11 billion people who will inhabit Earth. Nigeria as the most populous black nation certainly will be at the center stage of this projection. Therefore, the need to enhance the practice of modern agriculture by teaching and encouraging farmers to evolve agricultural technology is inevitable.

Presently, agricultural practices face several challenges, the most pronounced of which are the extraordinary population growth, environmental degradation, access to natural resources, reduction of arable land, climate change, and declining productivity and profitability. Since agriculture is a significant sector in every country's economy, the traditional methods used for decades to produce food today cannot meet the greatly increasing demand for food globally and Africa and Asia in particular. Therefore, the urgent need to change production pattern through the adoption of agricultural technology especially among rural farmers, towards increasing food production could provide assurance of food availability for the future.

Agricultural technology' is a broad term that is used to describe equipment, genetic material, farming techniques, and agricultural inputs that have been developed to improve the broad range of productivity, health, welfare, and sustainability outcomes. According to Wikipedia (2024) Agricultural technology involve the use of technology in agriculture with the aim of improving yield, efficiency, and profitability. Agricultural technology can be products, services or applications derived from agriculture that improve various input and output processes. It is an important aspect of modern farming practices globally and its adoption by farmers helps in the improvement of crops and livestock yields, reduce production costs, and increase the overall efficiency of the agricultural sector. Adzenga and Dalap (2023) explained that technology involved the application of knowledge for practical purposes and it can be classified into two major categories which include material and knowledge-based technology. Material technology involves knowledge that is embodied in a technology product such as tools, equipment, agrochemicals, improved plant varieties or hybrids, and improved breeds of animals while knowledge-based technology includes technical knowledge, managerial skills, and other processes that farmers need to successfully grow crops or livestock management practices. Examples of some of these technology as identified by Bonneau (2017) includes the applications of digital technologies remote sensor such as meteorological stations on parcels, humidity sensors and soil scanners, yield mapping, satellite and drone images, the IoT and big data analytics, others are precision farming and robotics, which enable optimal sowing, fertilization and crop protection, precise irrigation, precise weed control and automated harvesting, and, finally, predictive and prescriptive analytics, which enable correct decisions to be made based on sensor data. Patricio, Luis , Rogelio and Angel (2023) stated that to achieve greater efficiency in natural resource management in agricultural production, production systems are shifting toward precision agriculture, evolving into smart agriculture and that this approach relies on technological innovations that enable the handling of vast amounts of data for decision-making during the application of fertilizers, insecticides, and herbicides. The most used tools are based on artificial intelligence, machine learning, drones, mobile apps and the Internet of Things, which facilitate soil and water management for efficient crop production.

Adzenga and Dalap (2023) stated further that to have a better understanding of the different roles that research, extension, input supply and other systems actors should play in the technology development and transfer process is to differentiate between the different categories of technology, as each category follows a different channel as new technology that can be transferred to farmers. They include crop technology, livestock technology, farming systems, soil and water management practices, farm mechanization, agro-forestry, post-harvest technology, and farm management. These technologies have both hardware and software components. For example, a new crop variety, as a type of material technology cannot be fully exploited without having a complimentary set of agronomic or crop

management practices. Likewise, improved breeds of livestock generally require higher levels of management, including improved nutrition, housing and preventive health services.

According to the report published by United States Department of Agriculture and the Global Agricultural Information Network (GAIN) stated that the Federal Government of Nigeria amidst concerns over the adoption of Genetically Modified Crops in January, approved the commercial release of four “Tela maize” varieties for commercial planting in the country. Also, the International Service for the Acquisition of Agri-biotech Applications (ISAAA), buttress the above statement that at least 33 major food crops have been genetically modified globally and out of these, only four (maize, cowpea, cotton and soybean) have been officially approved for commercialization by the Nigerian authorities, with Nigeria listed among the six African countries leading in biotech crop adoption across the continent. These reports portray the poor level of technology adoption and utilization in the continent and Nigeria in particular. The adoption of GM seeds by crop farmers has been a subject of intense debate among scientists, environmentalists and even food activists in Nigeria. Umar, (2022) stated that the transfer process for material technology is simpler than training and disseminating technical knowledge and management skills to large numbers of farmers in Nigeria. Therefore, the need to devise an appropriate means to enlighten farmers to understand and utilize these technologies will help to encourage transfer process and adoption which can lead to improvement in crop and livestock production and sustainable food security. Rafael (2022) stated that food security exists when “all people, at all times have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life”. Close to 800 million individuals do not have access to enough food, 2 billion individuals experience key micronutrient deficiencies and 60% of individuals in low-income countries like Nigeria are food insecure. Food insecurity negatively affects human physical, social, emotional, and cognitive development throughout their life. This study is therefore intended to find out the level of technology awareness and its utilization in enhancing food production activities among farmers in Nigeria.

Statement of the Problem

Agricultural technologies adoption for food production has long been promoted by governments and development organizations as effective ways to increase farm productivity and reduce poverty in Nigeria. However, adoption and practicing of many seemingly beneficial technologies remains low, even though. Technological innovations such as the use of chemicals like fertilizers, pesticides, precision irrigation and much more have shaped the history of mankind time and time again. The utilization of this technology towards improving agricultural production remain very uncertain as being currently manifested in the international market with continuous rejection of agricultural products from Nigeria due to non-compliance with set international standard in terms of safety and quality control. These challenges arise because of the ability of farmers to use technology appropriately. This may also arise due to poor dissemination of information on innovative technology to farmers. Even in our modern age where technologies are readily available and innovations plentiful, the process and impact of new agricultural technologies application is complex and challenging and it carries with it many unknown risks, when used indiscriminately and without proper assessment. Technological innovations can quickly displace older, proven, highly specialized and well-adapted systems, which may have a detrimental effect on sustainability and food security. In Nigeria today, there is high rate of poverty and hunger as the current food production level with high level of importation still cannot provide enough to feed her teeming population which is a sign that Nigeria is not food secure and therefore, there is need to step up efforts that can enhance food production through proper adoption and utilization of innovative technology and at the same time protecting the already existing practices for sustainable food production. This study therefore is intended to investigate awareness level and utilization of some improved agricultural innovative technology for agricultural production activities. **Purpose of the Study**

The main purpose of the study therefore was to investigate the level of awareness and utilization of agricultural innovative technology by farmers especially at the rural community for sustainable food production in Nigeria. Specifically, the study will find out the:

- a. Level of awareness and utilization of agricultural technology by farmers in Nigeria
- b. Challenges confronting farmers in the utilization of technology
- c. Strategies that could be adopted towards enhancing innovative technology utilization by farmers

Research Questions

The following research questions guided the study

- a. What is the level of awareness and utilization of agricultural innovative technology by farmers in Nigeria?
- b. What are the challenges confronting farmers in the utilization of agricultural innovative technology by farmers?
- c. What are the strategies that could be adopted towards enhancing the utilization of agricultural innovative technologies by farmers?

Research Hypotheses

The following hypotheses guided the study and were tested at the probability of 0.05 level of significant at relevant degree of freedom.

- a. There is no significant difference in the mean rating of the responses of Agricultural Extension Agent and Farmers on the level of awareness and utilization of agricultural innovative technology by farmers in Nigeria.
- b. There is no significant difference in the mean rating of the responses of Agricultural Extension Agent and Farmers on the challenges confronting farmers in the utilization of agricultural innovative technology by farmers.
- c. There is no significant difference in the mean rating of the responses of Agricultural Extension Agent and Teachers of Agricultural Education on the strategies that could be adopted towards enhancing the utilization of agricultural innovative technologies by farmers.

Significance of Study

The study is of significant as it provides information on the level of awareness on the utilization of agricultural innovative technology by farmers for sustainable food production, challenges confronting farmers in the utilization of agricultural innovative technology and strategies that could be adopted towards enhancing the utilization of agricultural innovative technologies by farmers. Its successes will add value to advancing technology utilization by farmers in food production, increase income generation by farmers and improvement in the socio-economic life of the rural farmers. The study also provided primary data for researchers and others in the field of agricultural production in Nigeria when the finding and recommendations of the study are fully implemented

Scope of the Study

The study was restricted to the investigation of the level of the utilization of agricultural innovative technology by farmers for sustainable food production. It covers the awareness and utilization of agricultural technology by farmers, challenges confronting farmers in the utilization of agricultural technology and strategies that could be adopted towards enhancing its utilization by farmers. The study was also restricted to collection of data using questionnaire from Agricultural Extension Agent, Farmers and Agricultural Education Teachers in the study areas.

Methodology:

The study was carried out in Northwest, Nigeria, comprising of seven states which include: Jigawa, Kano, Kaduna, Katsina, Kebbi, Sokoto and Zamfara. Descriptive survey research design was adopted and used for the study. The population for the study comprises of Agricultural extension agents, Teachers of Agricultural Education and farmers drawn from major farming communities from two Local Government Areas. A purposive sampling technique was used in selecting five State and two Local Government Areas from each of the State based on their strength and level of food production within the States. The States and the selected and the selected L.G.A. include Kaduna (Briningwari and Giwa), Kano (Kura and Bichi), Jigawa (Hadejia and Auyo), Zamfara (Rini-yarkofoji and Tungar Rairai) and Katsina (Bakura, and Dandume). The respondents were selected from the Local Government Areas and their communities based on their level of awareness and pre-census that was conducted as presented in the table below. A sample size of 225 were involved in the study. It comprises of 75 Agricultural extension agents, 75 Teachers of Agricultural education and 75 farmers. This is in consistent with the Central Limit Theorem which assumes that random samples of size equal to or larger than 30 have sample mean which approaches a normal distribution and is representative of the entire population (Islam, 2018).

S/NO	States	Extension Agents and Teachers of Agricultural Education	Communities (Farmers)	Total No of Respondents		
01	Kaduna	1. Brinin Gwari	17	1.Brinin Gwari	09	26
		2. Giwa	13	2.Giwa	08	21
02	Kano	1. Kura	15	1. Kura	10	25
		2. Bichi	15	2. Bichi	07	22
03	Jigawa	1. Hadejia	19	1. Hadejia	08	27
		2. Auyo	11	2. Auyo	07	18
04	Katsina	1. Gonzaki	14	1. Gonzaki	08	22
		2. Dandume	16	2. Dandume	05	21
05	Zamfara	1. Rini-yarkofoji	17	1. Riniyarkofoji	08	25
		2. Tungar Rairai	13	2. Tungar Rairai	05	18
TOTAL		10 LGA	150	10 LGA	75	225

The instrument for data collection was a structured questionnaire titled: The utilization of agricultural innovative technology by farmers for sustainable food production in Northwest, Nigeria. The 33 items questionnaire was made up of section A which is meant to elicit information on personal data of the respondents and section B was used to obtain data on the level of utilization of agricultural innovative technology by farmers for sustainable food production in Northwest, Nigeria, challenges confronting farmers in the utilization of agricultural technology and strategies that could be adopted towards enhancing its utilization by farmers in Northwest, Nigeria. The section B part of the questionnaire has two sets of four-point response options for data generations as follows: Highly Utilized (HU), Averagely Utilized (AU), Partially Utilized (PU) and Not Utilized (NU) and Strongly Agreed (SA), Agreed (A), Disagreed (D) and Strongly Disagreed (SD). Agricultural Extension Agents and farmers will respond to items on awareness and utilization level and challenges confronting farmers in the utilization of agricultural innovative technology, while Agricultural Extension Agents and Teachers of Agricultural Education will respond to items on the strategies that could be adopted for enhancing agricultural innovative technology utilization by farmers with corresponding value of 4, 3, 2, and 1 respectively.

The instrument was face validated by three experts: one from the Agricultural Extension unit, Kano State Ministry of Agriculture and Natural Resources, one from Department of Crop Science, College of Agriculture Danbatta, Kano State and one from Agricultural Education Department, Federal College of Education (Technical) Bichi respectively. Their corrections and suggestions were utilized to improve the questionnaire before producing the final copies. A pre-test of the questionnaires was carried out prior to its administration. Twenty (20) Extension Agents, twenty (20) farmers were randomly selected from Nasarawa State for the pre-test. The results of the pretest were analyzed using Cronbach Alpha Reliability method to determine the internal consistency of the questionnaire items and a reliability coefficient of 0.76 was obtained. The data for the study were collected with the help of five (5) research assistants hired for administration and retrieval of the instrument in the sampled LGA from sampled States. In some instance, the research assistant interprets the questionnaire for those farmers who could not read and write in English. Copies of the questionnaires were retrieved from the research assistants after two (2) weeks at an agreed time and location for data analysis.

The data generated by the study were analyzed using mean and standard deviation for answering the research questions while t-test statistics were used to analyze the hypothesis of no significant difference at relevant degree of freedom. For decision making, any item with a mean value of 2.50 and above will be accepted, while those with mean value less than 2.50 will be rejected. Also, the hypotheses of no significant difference will be upheld for any item where t-calculated value was less than the t-table value and rejected for any item whose t-calculated was greater than the t-value at 0.05 level of significance at relevant degree of freedom.

Results

The results of the analysis were presented in the tables below:

Research Question 1: What is the level of awareness and utilization of agricultural innovative technology by farmers in Northwest, Nigeria?

Responses of Agricultural Extension Agents and Farmers on the level of awareness and utilization of agricultural innovative technology by farmers in Northwest, Nigeria? (AEA=75, Farmers=75=150)

RESPONDENTS		Agricultural Ext. Agent Response (75)				Farmers Response (75)			
S/NO	ITEMS	No.	mean	SD	Remark	No.	mean	SD	Remark
01	Application of Geographical Information System in land mapping (Identifying soil types, crop fields among others)	75	1.49	.623	Rejected	75	1.46	.664	Rejected
02	Practicing farm automation/smart farming such as automatic watering and seeding	75	1.33	.600	Rejected	75	1.12	.327	Rejected
03	Utilizing green house (controlled environment) for crop production	75	2.04	.936	Rejected	75	1.53	.794	Rejected
04	Practicing urban agriculture for effective space management.	75	1.08	.273	Rejected	75	1.21	.740	Rejected
05	Practicing Hydroponic agriculture	75	1.00	.000	Rejected	75	1.04	.197	Rejected
06	Use of Genetically modified crops especially approved Tela Maize, Cotton, Cowpea and other higher yielding crops	75	1.78	.904	Rejected	75	2.68	1.26	Accepted
07	Using fertilizers and other chemicals to specification in crop production	75	2.25	1.42	Rejected	75	2.46	1.16	Rejected
08	Practicing organic farming	75	3.65	.479	Accepted	75	3.42	.640	Accepted
09	Practicing mechanization (using farm machines)	75	2.46	1.28	Rejected	75	2.10	1.15	Rejected
10	Practicing regenerative agriculture	75	1.72	1.05	Rejected	75	1.85	1.00	Rejected
11	Use of mobile Apps to cloud-based platform to manage crop from planting to market prices	75	2.04	1.21	Rejected	75	2.28	1.04	Rejected
12	Practicing crop monitoring and prediction system, using technology	75	1.16	.369	Rejected	75	1.06	.251	Rejected
13	Use of laser scarecrows to deter pest from crops	75	1.18	.392	Rejected	75	1.05	.226	Rejected

The findings in table 1 above revealed a generally low level of awareness and utilization of agricultural innovative technologies by farmers in Northwest Nigeria, as indicated by the responses from both Agricultural Extension Agents and Farmers. Most of the assessed technologies were rated as "Rejected," showing limited understanding or adoption across the board. Out of the thirteen items responded to by Agricultural Extension Agents, 12 had their mean response below 2.50-1,2,3, 4,5,6,7,9,10,11,12 and 13 while item 8 had a mean score above 2.50 indicating that majority of the

items were rejected. The standard Deviation has its range from 0.00 to 0.936 while four items-7,9,10, and 11 had their SD range above 1.00. This also revealed that some of the Agricultural Extension Agents responses varied and are not close to one another. On the other hand, out of the thirteen items responded by farmers, 12 had their mean response below 2.50-1,2,3, 4,5,7, 8, 9,10,11,12and 13 while item 6 had a mean score above 2.50 indicating that majority of the items were also rejected. The standard Deviation has its range for all the items from 0.226 - 0.794 with 4 items had its range from 1.00 to 1.26 respectively. This further revealed that some of the farmers' responses varied and are not close to one another. Therefore, there is need to create more awareness on the advantage of using agricultural innovative technologies by farmers towards improving agricultural production in Northwest, Nigeria.

Research Question 2: What are the challenges confronting farmers in the utilization of agricultural innovative technology by farmers?

Responses of Agricultural Extension Agents and Farmers on the challenges confronting farmers in the utilization of the agricultural innovative technology by farmers?

(AEA=75, Farmers=75=150)

RESPONDENTS		Agricultural Ext. Agents (75) Respondents.				Farmers (75) Respondents			
S/NO	Items	No.	mean	SD	Remark	No.	mean	SD	Remark
01	In adequate supply of inputs such as seeds, chemicals, fertilizers, drugs, vaccines, feeds, farm machineries and equipment	75	3.40	.805	Accepted	75	3.86	.342	Accepted
02	In ability of the rural farmers to keep abreast of technical development due to lack of ability, education and/or financial resources	75	3.65	.647	Accepted	75	3.57	.497	Accepted
03	Difficulties in understanding innovative technology information even when it is readily available.	75	3.37	.647	Accepted	75	3.45	.501	Accepted
04	Inadequate technical support for small-scale farmers who are vulnerable, resource-poor and isolated while adopting novel technologies	75	3.39	.672	Accepted	75	3.66	.622	Accepted
05	Agricultural innovative technologies sometimes remain narrow in application and never spread beyond introductory stage and/or areas.	75	3.30	.958	Accepted	75	3.70	.539	Accepted
06	Understanding the social dimension of technologies is more challenging than focusing on the technical aspects of application.	75	3.02	.958	Accepted	75	2.97	.929	Accepted
07	Poor funding of R&D institutes, universities and commercial farming to allow for the development of innovative technology in agriculture	75	3.62	.486	Accepted	75	3.44	.620	Accepted
08	Poor level of collaboration between research institutes and actors in the industry,	75	3.54	.599	Accepted	75	3.28	.797	Accepted
09	The existing land tenure systems has limited land availability for commercial or large-scale farming.	75	3.86	.342	Accepted	75	3.54	.642	Accepted
10	Difficulties in managing climate change impact during agricultural practices.	75	3.74	.437	Accepted	75	3.66	.643	Accepted
11	Inadequate number of extension men with the available one lacking mobility and tools to improve on their service delivery	75	3.72	.452	Accepted	75	3.45	.793	Accepted

The data in table 2 above indicated that farmers in Northwest Nigeria face numerous challenges in utilizing agricultural innovative technologies as identified by both Agricultural Extension Agents and Farmers. The responses of Agricultural Extension Agents show a mean range of 3.02 to 3.86 with standard deviation range of 0.342 to 0.959 while that of Farmers also have a mean range of 2.97 to 3.86 with standard deviation ranging from 0.342 to 0.927 respectively. This revealed that all the items in table 2 had their mean value above 2.50, while the standard deviation also showed that they are close to one another in their responses. Therefore, all the challenges identified in table 2 were accepted as challenges confronting farmers in the utilization of the agricultural innovative technology during agricultural production activities in Northwest, Nigeria.

Research Question 3: What are the strategies that could be adopted towards enhancing the utilization of agricultural innovative technologies by farmers?

Responses of Agricultural Extension Agents and Teachers of Agricultural Education on the strategies that could be adopted towards enhancing the utilization of agricultural innovative technologies by farmers? (AEA=75, TAE=75=150)

RESPONDENTS		Agricultural Ext. Agents. (75) Respondents				Teacher of Agricultural Education (75) Respondents			
S/NO	Items	No.	mean	SD	Remark	No.	mean	SD	Remark
01	Encourage Public-PrivatePartnerships for effective utilization of innovation in agriculture.	75	3.49	.760	Accepted	75	3.28	.814	Accepted
02	Encourage formation of farmers cooperatives to pool resources, share risks and provide access to technologies and innovation	75	3.82	.381	Accepted	75	3.60	.545	Accepted
03	Agriculture technologists and policymakers should play key role in the distribution and or application of innovative technologies immediate takeup.	75	3.54	.621	Accepted	75	3.20	.972	Accepted
04	Development agencies should foster the effectiveness of innovative interventions and take into account of existing technologies.	75	3.77	.621	Accepted	75	3.72	.452	Accepted
05	Proper integration of agricultural transformational education policies and programmes into all levels of educational system.	75	3.57	.596	Accepted	75	3.82	.381	Accepted
06	Adequate funding of agricultural innovative technology implementation at all level.	75	3.84	.369	Accepted	75	3.74	.437	Accepted
07	Regular training and retraining of agricultural extension agents on agricultural innovative technology implementation	75	3.89	.310	Accepted	75	3.58	.522	Accepted

08	Building farmers capacity on regular basis for technology adoption and utilization	75	3.76	.429	Accepted	75	3.61	.490	Accepted
09	Providing financial incentives, tax breaks, grants, and subsidies to encourage farmers and agribusinesses to adopt innovative technologies	75	3.24	.565	Accepted	75	3.56	.499	Accepted

The data in table 3 above showed the responses of both Agricultural Extension Agents and Teachers of Agricultural Education on the strategies that could be adopted towards enhancing the utilization of agricultural innovative technologies by farmers in Northwest, Nigeria. The responses of Agricultural Extension Agents revealed a mean range of 3.24 to 3.89 with standard deviation range of 0.310 to 0.760 while the responses of Teachers of Agricultural Education also have a mean range of 3.20 to 3.82 with standard deviation ranging from 0.381 to 0.972 respectively. This indicated that all the items in table 3 had their mean value above 2.50, while the standard deviation also revealed that they are close to one another in their responses. Therefore, all the strategies identified in the table were accepted for enhancing the adoption and utilization of agricultural innovative technology for improving agricultural production activities in Northwest, Nigeria.

Testing the Hypothesis (t-test)

HO₁: There is no significant difference in the mean rating of the responses of Agricultural Extension Agent and Farmers on the level of awareness and utilization of agricultural innovative technology by farmers in Northwest, Nigeria. The data for testing hypothesis 1 are presented in Table 4 below:

Table 4: t-test Analysis of Mean Rating of the Responses of Agricultural Extension Agent and Farmers on the level of awareness and utilization of agricultural innovative technology by farmers in Northwest, Nigeria.

N=150: (Agric Ext. Agent = 75; Farmers = 75

T- Test

	Paired Differences					t	df	Sig. (2tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair AEA - Famers	-.00718	.18290	.02112	-.04926	.03490	-.340	74	.735

The data in table 4 above on the responses of Agricultural Extension Agent and Farmers on the level of awareness and utilization of agricultural innovative technology by farmers in Northwest, Nigeria. can be interpreted using the results from the updated Paired Samples Test table. The comparison (AEA - Famers) shows a mean difference of -0.00718, with a standard deviation of 0.18290 and a standard error mean of 0.02112. The 95% confidence interval of the difference ranges from -0.04926 (lower bound) to 0.03490 (upper bound), indicating that the true mean difference could be either positive or negative and is very close to zero. The t-value is -0.340 with 74 degrees of freedom, and the p-value is 0.735. Since the p-value is much greater than the commonly accepted significance level of 0.05. Therefore, the null hypothesis is upheld. This result indicates that there is no statistically significant difference in the mean ratings of the responses between Agricultural Extension Agents and Farmers on the level of awareness and utilization of agricultural innovative technology is supported by the data in the table.

HO₂. There is no significant difference in the mean rating of the responses of Agricultural Extension Agent and Farmers on the challenges confronting farmers in the utilization of agricultural innovative technology by farmers in Northwest, Nigeria.

Table 5: t-test Analysis of Mean Rating of the Responses of Agricultural Extension Agent and Farmers on the challenges confronting farmers in the utilization of agricultural innovative technology by farmers in Northwest, Nigeria.

N=150: (Agric Ext. Agent = 75; Farmers = 75)

T- Test

	Paired Differences	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	df	Sig. (2-tailed)
					Lower	Upper			
					Pair AEA – Famers	-.00642			

Also, the data in table 5 above on the responses of Agricultural Extension Agent and Farmers on the challenges confronting farmers in the utilization of agricultural innovative technology," can be interpreted using the results from the Paired Samples Test table. The comparison (AEA - Famers) shows a mean difference of -0.00642, with a standard deviation of 0.11414 and a standard error mean of 0.01318. The 95% confidence interval of the difference ranges from -0.03269 (lower bound) to 0.01984 (upper bound). This interval includes zero, indicating that the true mean difference may not be significantly different from zero. The t-value is -0.487, with 74 degrees of freedom, and the p-value is 0.627. Since the p-value is greater than the commonly accepted significance level of 0.05. Therefore, the null hypothesis is upheld. This result revealed that there is no statistically significant difference in the mean ratings of the responses between Agricultural Extension Agents and Farmers on the challenges confronting farmers in the utilization of agricultural innovative technology is supported by the data in the table.

HO₃. There is no significant difference in the mean rating of the responses of Agricultural Extension Agent and Teachers of Agricultural Education on the strategies that could be adopted towards enhancing the utilization of agricultural innovative technologies by farmers in Northwest, Nigeria.

Table 6: t-test Analysis of Mean Rating of the Responses of Agricultural Extension Agent and Teachers of Agricultural Education on the strategies that could be adopted towards enhancing the utilization of agricultural innovative technologies by farmers in Northwest, Nigeria.

N=150: (Agric Ext. Agent = 75; Farmers = 75)

T- Test

	Paired Differences	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	df	Sig. (2-tailed)
					Lower	Upper			
					Pair AEA – Famers	.09037			

Finally, the data in table 6 above on the responses of Agricultural Extension Agent and Teachers of Agricultural Education on the strategies that could be adopted towards enhancing the utilization of agricultural innovative technologies by farmers, can be evaluated using the results from the Paired Samples Test table. The comparison (AEA - TAE) reveals a mean difference of 0.09037, with a standard deviation of 0.17396 and a standard error mean of 0.02009. The 95% confidence interval of the difference ranges from 0.05035 (lower bound) to 0.13039 (upper bound), and this interval does not include zero, suggesting a meaningful difference. The t-value is 4.499, with 74 degrees of freedom, and the p-value is 0.000. Since the p-value is less than the commonly accepted significance level of 0.05, Therefore, the null hypothesis is rejected. This result indicates that there is a statistically significant difference in the mean ratings of the responses between Agricultural Extension Agents and Teachers of Agricultural Education on the strategies to enhance the utilization of agricultural innovative technologies by farmers. Therefore, the initial statement of no significant difference is not supported by the data in the table.

Discussion of Finding

The findings in table 1 above revealed a generally low level of awareness and utilization of agricultural innovative technologies by farmers in Northwest Nigeria, as indicated by the responses from both Agricultural Extension Agents and Farmers. Most of the assessed technologies were rated as "Rejected," showing limited understanding or adoption across the board. The findings of this study are in line with the findings of Okopi (2022) who conducted a study that investigated the management of agricultural innovations: implications on food security in Nigeria. The study found hydroponic-No soil needed, aeroponics-growing plants in midair, aquaponics, water reduction intake and utilization by both plants and livestock, Harvest Quality Vision-HQV among others as various methods of agricultural innovations available to farmers but not yet adopted and put to practice.

Also, the data in table 2 revealed the challenges confronting farmers in the adoption and utilization of the agricultural innovative technology by farmers in Northwest, Nigeria. The findings of this study is in line with the findings of Adeyemo., Adel, Dominic, Hosam, Mosab, and Adedoyin (2024) on technological innovation and agricultural productivity in Nigeria amidst oil transition: ARDL analysis which revealed that, Nigeria despite its vast farmland endowment, lags due to backwardness in agricultural technology. weak institutional support, a deficient educational system, brain drain, underfunded educational systems, and inadequate infrastructure were identified as significant barriers hindering technological advancements in Nigeria. The study further noted that, communication emerged as a major obstacle to agricultural innovations among rural farmers in Nigeria, prompting Ejem e t al. in Adeyemo e t al.(2024) to advocate for a more effective two-way communication approach within Nigeria's extension system to disseminate global agricultural practices.

Okopi (2022) further established that, the extent to which these innovations are beneficial to farmers is dependent on the availability of the methods. Although, farmers perceived the importance of innovation as a medium to improve food production if innovators manage their innovations through farm organization. The study found that farmers often encountered high cost of innovations, poor level of awareness and environmental factors as constraint towards adopting agricultural innovations. The study concluded that, to ensure food security in the country, there is the need for adoptable innovations. Therefore, platforms made for management of innovation should be made effective to further encourage farmers towards adoption and continuity.

On the hypothesis tested, it was revealed that there were no significant differences on the responses of Agricultural Extension Agents and Farmers on hypotheses 1 and 2 tested indicating that their views are not too far from one another and were upheld for all the items ranging from awareness level and challenges. But there was a significant difference on hypothesis 3 tested as the responses of Agricultural Extension Agents and that of Agricultural Education Teachers on the strategies for enhancing the utilization of agricultural innovative technologies by farmers are significantly different from one another as reflected in table 6 above.

Conclusion

The prospects for achieving an impressive agricultural production in Nigeria and in the Northwest is high considering the diversify ecological conditions such as abundant human resources, land and water resources for production. Again, with about 65 percent of its over 200 million populations engaged in one form of agricultural activities or the other, the food and agricultural sector presented opportunities to create wealth and diversify the economy. With the huge, untapped potential in the agricultural sector, it offers the best prospect for addressing the complex socioeconomic challenges presently confronting the nation. Today Nigeria is facing two key gaps in agricultural production sectors which include her inability to meet domestic food requirements and inability to export at high quality levels for market success (FMA&RD, 2016). Therefore, adoption of innovative agricultural technologies which offers improved

varieties, quality training for farmers, proper regulation of input utilization among others will certainly change the scenario on the long run thereby leading to production of improved and high-quality agricultural products that meet domestic needs.

Recommendations

The study recommended the following based on its findings.

1. Reinvigoration of agricultural education curriculum in schools to focus more on skill-based learning using innovative technology as a primary source of technology transfer in agricultural practices for would be farmers.
2. They should provide an adequate supply of input for innovative technology practices to schools, extension agents and farmers to enhance training in line with specification for positive results.
3. Proper training and re-training of agricultural extension agents on the utilization of innovative agricultural technologies towards improving sustainable quality food production.
4. The welfare of agricultural educators, extension agent in terms of transportation, accommodation at rural level and allowances should be promptly provided for motivation and concentration on service delivery.

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