
Adoption of agricultural innovations by farmers in Enugu State, Nigeria

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Abstract Adoption issues in agricultural innovations is increasingly discussed in Africa. Notwithstanding the benefits of agricultural innovation, a lot of challenges still exists that hinder adoption in developing countries. The farmers' level of awareness, challenges in adoption and strategies for better adoption of agricultural innovations in agrarian state was established in Enugu State, Nigeria. Findings revealed among others that rural farmers are aware of and willing to adopt some agricultural innovations to improve their farming business. Major challenges reported uncertainty/fear of failure and cost implication among others. Important strategies believed to improve the rate of adoption but not limited to set up agricultural innovation centres, improving agricultural innovation system and offering some form of insurance in case of failure. The study added to the limited knowledge in the issues relating to agricultural innovations in Africa, particularly in Enugu State, Nigeria.

Keywords: Agricultural Innovation Systems, Adoption, Stakeholders, Nigeria, Rural farmers

Introduction

In most rural regions of the world, agriculture stands in as the major source of livelihood. In Sub Saharan Africa, Gross Domestic Product (GDP) growth from agriculture is estimated to be eleven times more efficient for poverty reduction than any other sector (Cooksey, 2013; Malesse, 2018). In Nigeria, agriculture contributes significantly to the nations' GDP and engages more than 60 percent of the labour force (National Bureau of Statistics, NBS, 2020). However, most farmers in Nigeria, rely heavily on traditional methods of production and this results to lower level of output (Mwangi and Kariuki, 2015) and the reason is because the indigenous cultivars used by these farmers have low yield, most of their crops are grown under rain-fed conditions and irrigation is used only in limited areas, little or no fertilizers are used and pest control is not adequate (Akudugu *et al.*, 2012; Malesse, 2018; Mariano *et al.*,

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2012; Mwangi and Kariuki, 2015). Although, agriculture produces food and offers opportunities for economic wealth for the world's poor, (Malesse, 2018; Mwangi and Kariuki, 2015) the sector faces challenges ranging from unstable climate conditions to weak advisory/extension services and poor diffusion of agricultural innovation (Amungwa, 2018; Malesse, 2018; Pretty *et al.*, 2011). Agricultural innovations are products or processes for improving production, income generation and quality of life for farmers. The absence of agricultural innovation and low- or non-adoption of recent technologies by farmers are reported to be among the major causes of poor productivity of agriculture in third world nations (Pannell *et al.*, 2006; Weyori *et al.*, 2018). It is often argued that rural farmers in developing nations cannot improve agriculture in 21st century by relying primarily on indigenous knowledge and linear technology transfer without a functional agricultural innovation system (AIS) (Aerni *et al.*, 2015).

AIS is a network of people and organizations determined to develop the novel products, services and processes in agriculture into economic use, alongside the institutions and policies that influence the way various agents relate, exchange and utilize information for the good of agriculture (Mariano *et al.*, 2012; Meijer *et al.*, 2015; Ragasa, 2012 and Aerni *et al.*, 2015). According to Weyori *et al.* (2018) promoting the usage of farm technologies involves a multi-layered interaction between various stakeholders harnessing the interdependence, networking and social interactions that occur among actors. These stakeholders interlink and communicate in a web-like way to share ideas and develop new technologies to increase productivity for farmers. With increasing number of agricultural innovations targeting improved farming practices, it is expected that farmers integrate certain technologies in agricultural production, processing, distribution, and marketing processes. Effective adoption of agricultural innovations in a functional AIS could potentially address the critical issues in agriculture such as productivity, climate change and resource management to ensure food security, poverty, hunger and malnutrition reduction. However, studies have shown that adoption of new technologies among farmers remains negligible (Egyir *et al.*, 2011; Weyori *et al.*, 2018) in some localities in Africa. There are many factors influencing the adoption of agricultural innovation, one of them being farmers' perception of innovations (Malesse, 2018; Ntshangase *et al.*, 2018).

Farmers' perception of any introduced innovation is influenced by factors such as level of knowledge/education, amount of help available/functionality of AIS, local reports about the technology, gender, social and cultural inclination as well as cost implication in the adoption process (Feder *et al.*, 1985; Ntshangase *et al.*, 2018). Adoption, whether

individual or aggregate, is often expressed at various levels in any locality and time and is not a permanent behaviour (Malesse, 2018) because a farmer may decide to discontinue the use of an innovation for a variety of reasons relating to personal, economic, structural and social issues with the technology (Feder *et al.*, 1985). However, three approaches are majorly used to explain the behaviour and forces influencing the adoption of agricultural innovations: the innovation-diffusion model, the economic constraints model and the perception of adoption model (Feder *et al.*, 1985). According to Feder *et al.* (1985) the underlying premise of the “innovation-diffusion model is that the technology is technically and culturally” relevant. Economic constraints model focuses on the affordability of the technology by the local users, the cost implications in the adoption process and the expected returns. The perception model, explains the understanding of the attributes of the technology that affects farmer's adoption behaviour; which means that even with good intentions for inventing the innovation/technology, farmers will subjectively interpret the technology differently from scientists (Kivlin and Fliegel, 1967; Malesse, 2018). This buttresses the need for functional interlinks (AIS) among farmers, intermediaries/agents and the inventors/researchers. Consequently, understanding the perceptions of farmers about a given agricultural innovation is crucial in resolving adoption issues.

In Nigeria as with some African countries, even though rural farmers have the potentials to integrate innovative practices (which is barely the case) in their production processes, awareness of available agricultural innovations and level of adoption remain poorly documented. According to (Onasanya *et al.*, 2006) reported that farmers’ options and activities in Africa as it related to technology in agriculture is still limited when compared to the abundance of technology and innovation diffusion in western world. That study argued that understanding how the farmers perceived available agricultural innovations, the major challenges they are frequently reported and evaluating suggested strategies for innovation diffusions are important steps for policy reviews and refocusing AIS to be functional in a locality. This study is designed to evaluate rural farmers' awareness and willingness to adopt innovations, challenges that they currently face and possible strategies for the efficient use of agricultural innovations for better productivity in agrarian states like Enugu State.

Materials and methods

Research questions that guided the study were as follows:

1. what are the agricultural innovations that rural farmers are aware and willing to adopt in Enugu State?

2. what are the perceived challenges to rural farmers' adoption of agricultural innovations in Enugu State? and
3. what are the possible strategies for improving rural farmers' adoption of agricultural innovations in Enugu State?

Hypotheses to be tested as:

- Ho₁:** There is no significance difference in the mean response of male and female rural farmers on perceived challenges to effective adoption of agricultural innovations in Enugu State.
- Ho₂:** There is no significance difference in the mean response of male and female rural farmers on the possible strategies for improving the adoption of agricultural innovations in Enugu State.

The survey study was carried out in Enugu State. The State occupies an area of 71,161Km² with an estimated population of 3,257, 298 (NBS, 2020). The State has about 58.45% of her population living in rural areas, where farming is the most predominant means of livelihood (Emeka *et al.*, 2015). It is tropical climates marked by two distinct seasons; wet and dry. The vegetation is classified as derived savannah. The scarcity of firms for white-collar jobs in the State has made agriculture the most economically viable source of livelihood for the teaming population, especially for the people in rural communities. The State is divided into six agricultural zones; Agbani, Agwu, Enugu, Enugu-Ezike, Nsukka and Udi. The division into zones was to, among other reasons, help the government coordinate farming activities and manage programmes for farmers more efficiently at grass root level.

A total of 6,187 farmers were randomly approached across the six agricultural zones in the state. However, only 1,360 agreed to and willingly participate in the study. Upon (physical) contact with a possible respondent, the purposes of the study were explained to them and their consent to participate in the study was requested before the instrument was administered on them. All the respondents responded on the spot. This was to ensure better retrieval rate. This also ensured that any doubt relating to the study and potential misunderstanding in the items on the research instrument were clarified and most times translated in local language to help the farmers understand better, as majority of the farmers are less educated. The distribution of the respondents in presented in Table 1.

Table 1. Demographics of Respondents

		N=1,360	
Class	Group	F	%
Agricultural zones	Agwu	262	19.3
	Agbani	278	20.4
	Enugu	92	6.8
	Nsukka	187	13.8
	Enugu-Ezike	283	20.7
	Udi	258	19.0
Gender	Male	643	47.3
	Female	717	52.7
Age (years)	<25	301	22.1
	26-40	487	35.8
	>41	572	42.1
Farming experience (years)	0-10	587	43.2
	11-20	253	18.6
	>20	520	38.2
Educational level	Primary	564	41.5
	Secondary	357	26.3
	Tertiary	439	32.2
Member of any cooperative society	No	708	52.1
	Yes	652	47.9
Number of visits by extension agent per month	Does not visit	529	38.9
	Once	347	25.5
	Twice	298	21.9
	More than twice	186	13.7
Access to credit facilities as a farmer	No	999	73.5
	Yes	361	26.5

F = Frequency, % = Percentage

A structured questionnaire was used to collect data. The questionnaire was divided into four sections aimed at collecting the following data; 1) demographic characteristics of the respondents; 2) the common agricultural innovations that rural farmers are aware and willing to adopt; 3) perceived challenges to rural farmers' adoption of agricultural innovations; and the 4) possible strategies for improving rural farmers' adoption of agricultural innovations in Enugu State. Section 1 of the questionnaire had open-ended items which elicited information on rural farmers' socioeconomic data. Section 2 had 14-item statements with a 2-point response options of Yes or No (weighted 2 and 1, respectively). Section 3 and 4 had 15 and 11-items respectively with a 4-point response options of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) weighted 4, 3, 2, and 1 respectively.

A copy of the first draft of the questionnaire was validated by seven experts experienced in agricultural innovations and diffusion of innovation, contacted on ResearchGate. The experts reviewed the draft and made valuable contributions to number of items, clarity and adequacy of the questionnaire. A pilot study was carried out and the observations were used to correct anomalies that could have occurred during the actual study.

Data collection spanned a period of nine months, between March and November, 2019, and was through physical contact. The collected data were managed and analysed using SPSS (Version 21). The collected data were interpreted using frequency count and simple percentages for respondents' demographic information and research question one, whereas mean and standard deviation were used to answer research questions two and three. Decisions were made at mean criterion value of 2.50. To arrive at 2.50 criterion value, the average of the mean weights was calculated. Items with mean values equal or greater than 2.50 were regarded as "Agreed," while items with mean value below 2.50 was considered "Disagree". Any hypothesis with the *P*-value exceeding 0.05, was upheld but where the *P*-value is less than 0.05, the hypothesis of no significant difference was not upheld.

Results

Awareness and willingness to adopt agricultural innovations

The agricultural innovation practices that rural farmers were aware of and willing to adopt for better productivity as shown in Figure. 1. Findings indicated that more than 60% of the respondents were aware of technology/innovations relating to improve the production using genetically modified seeds (such as high yielding and drought tolerant varieties) and

breeds, integrated soil fertility management, improved feed and forage, soil and water conservation techniques, nutrition sensitive agriculture among others. However, their level of willingness to adopt the innovations were varied. For example, 90.4%, 96.3%, and 62.5% were aware of innovations relating to soil and water conservation, genetically modified seeds and organic farming respectively, but 78.2%, 70.2% and 96.4% were trying to adopt the respective innovations. While 48.5% and 38.7% revealed to be aware of innovations relating to green house and automated farming, as much as 98.9% and 98.7% are willing to adopt the innovations. From the findings, indicated that farmers in Enugu State were aware and tried to adopt agricultural innovation for improving productivity.

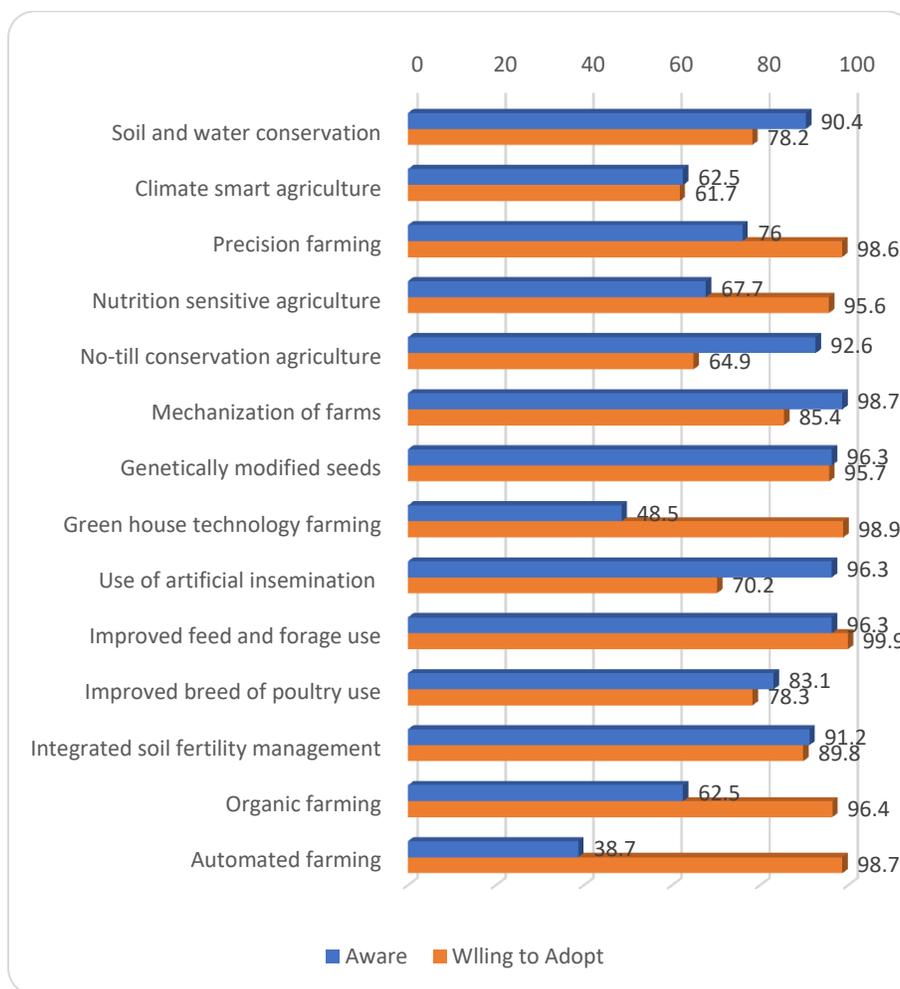


Figure 1. Common agricultural innovations that rural farmers are aware and willing to adopt for productivity in Enugu State

Perceived challenges to adoption of agricultural innovations by rural farmers

The values of the means of both genders ranged from 3.22 to 3.40, revealed that the respondents who indicated the items as challenges they faced in the adoption of agricultural innovations (Table 2). The value for the standard deviation ranged from 0.57 to 0.78, which showed that the responses were clustered around the mean and that respondents were not far apart in their response pattern.

Table 2. Mean and Standard Deviation Ratings on the Perceived challenges to adoption of agricultural innovations by rural farmers for enhance productivity with respect to gender

S/No.	Perceived challenges to adoption of agricultural innovations by rural farmers for enhance productivity	Male		Female		Avg. M	Resp. SD
		M	SD	M	SD		
1	Weak extension and advisory services	3.14	.80	3.29	.73	3.22	.77
2	Lack of farmers participation in agricultural innovation programme development	3.19	.76	3.26	.80	3.23	.78
3	Lacking sufficient skills to apply the innovations in my farm	3.25	.70	3.19	.76	3.22	.73
4	Fear of crop/animal failure	3.29	.69	3.25	.68	3.27	.69
5	High cost of the purchase and adoption of the innovations/technology	3.32	.61	3.23	.65	3.28	.63
6	Potential for food and cash generation of the innovations	3.32	.66	3.25	.76	3.29	.71
7	Period of recovery of investment on innovations	3.29	.67	3.31	.63	3.30	.65
8	Lack of access to credit facilities/services	3.26	.66	3.28	.64	3.27	.65
9	Timeliness and or limited access to information on agricultural innovations	3.29	.69	3.28	.73	3.29	.71
10	Inappropriate transportation infrastructure	3.32	.66	3.35	.66	3.34	.66
11	Farm size	3.37	.52	3.43	.61	3.40	.57
12	Land tenure arrangements	3.29	.67	3.46	.53	3.38	.60
13	Previous experience with other agricultural innovations	3.29	.68	3.40	.58	3.35	.63
14	Socio-cultural limitations to the adoption of such innovations in my locality	3.32	.60	3.35	.57	3.34	.59
15	Unavailability of the agricultural innovation in our local market	3.35	.66	3.35	.59	3.35	.63

Strategies to improve the adoption of agricultural innovations by rural farmers

Mean responses and standard deviations of rural farmers on the possible strategies for improving rural farmers' adoption of agricultural innovations to enhance productivity are shown in Table 3. The values of the means of both genders ranged from 3.24 to 3.40, indicating that they agreed to all the items as possible strategies for encouraging farmers to adopt innovations. The value for the standard deviation ranged from 0.52 to 0.62 indicating that the respondents were closed to the mean and to one another in their responses.

Table 3. Mean and Standard Deviation Ratings on the Perceived strategies to improve the adoption of agricultural innovations by rural farmers for enhance productivity in respect to gender

S/No.	Perceived strategies to improve the adoption of agricultural innovations by rural farmers for enhance productivity	Male		Female		Avg Resp.	
		M	SD	M	SD	M	SD
1	Subsidizing the price of available agricultural innovations by government and other agencies to encourage rural farmers to purchase them	3.39	.60	3.41	.55	3.40	.58
2	Creating more awareness on potential benefits of agricultural innovations to attract rural farmers	3.38	.57	3.29	.57	3.34	.57
3	Granting crediting facilities to farmers interested in an innovation	3.27	.64	3.28	.59	3.28	.62
4	Effective extension service for reliable information on agricultural innovations available	3.19	.63	3.28	.54	3.24	.59
5	Making agricultural innovations available in local markets to enhance rural farmers' access to them	3.22	.57	3.35	.51	3.29	.54
6	Providing pilot or try-out lands for rural farmers who are willing to experiment with the innovation	3.28	.54	3.40	.49	3.34	.52
7	Localizing innovations to conform to socio-cultural factors at community level	3.26	.59	3.43	.50	3.35	.55
8	Provision of agricultural innovation insurance scheme for rural farmers in case of crop/animal failure	3.26	.52	3.41	.55	3.34	.54
9	Establishing adult education programme for rural farmers to bust their knowledge of agricultural innovations and adoption	3.22	.54	3.43	.53	3.33	.54
10	Establishment of agricultural innovation centres in rural communities where farmers can learn about agricultural innovation at close distance	3.32	.47	3.40	.63	3.36	.55
11	Offering any form of reward to rural farmers that successfully adopt agricultural innovations in their production	3.29	.57	3.35	.59	3.32	.59

Hypotheses testing

The t-test analysis on the challenges limiting the adoption of agricultural innovations indicated that there was no significant difference in the mean responses of the male and female farmers as $t = -0.351$, $P = .726$. Similarly, t-test analysis on the perceived strategies for improving rural farmers' adoption of agricultural innovations revealed no significant difference in the responses of the male and female rural farmers. The result showed that the P value exceeds the significance level of 0.05 at $t = -1.108$, $P = .270$. Therefore, the hypotheses of no significant difference (H_{01} and H_{02}) were upheld. Hence, it can be inferred that both male and female rural farmers share identical opinion on the perceived challenges to adoption and strategies for improving the adoption of agricultural innovations in their locality.

Table 4. t-test results on challenges and strategies to adoption of agricultural innovations by rural farmers are for enhance productivity in Nigeria with respect to gender

Hypotheses	Group	N	M	SD	95% CI	t	Sig
Ho ₁ : (Challenges)	Male	643	49.28	6.60	47.6816- 50.8773	-0.351	.726
	Female	717	49.68	6.59	48.0799- 51.2730		
Ho ₂ : (Strategies)	Male	643	36.09	5.04	34.8677- 37.3087	-1.108	.270
	Female	717	37.03	4.86	35.8533- 38.2056		

Discussion

Awareness and willing to adopt

The study explored the awareness of rural farmers on agricultural innovation, adoption challenges and strategies for improving adoption among farmers. The percentage of farmers who revealed to be aware of various innovations is impressive. Over 60% of the farmers indicated that they are aware and willing to adopt innovations in soil and water conservation, precision agriculture, the use of modified seeds, artificial insemination, improved feed and forage, and integrated soil fertility management among others. The findings agreed with Mohamed and Temu (2008) and Ntshangase *et al.* (2018) that farmers were aware of some the available agricultural innovations. Possible factors are consider while explaining a high level of awareness and willingness

to adopt these innovations were likely the age, level of education and farming experience of the farmers (Egyir *et al.*, 2011; Ntshangase *et al.*, 2018).

Out of the 1,360 respondents, 788 farmers representing 57.9% are less than 40years old. Over 58% (796 farmers) who were either finished secondary school or higher institutions while more than 56% (773) was over 11years experience in farming (Table 1). The young age range, increasing level of education with years of experience in farming insightful were recorded. It is believed that education influences behaviour and attitudes, such as making one open minded, possibly more logical and capable of interpreting economic benefits of innovation for possible adoption (Dhraief *et al.*, 2018). It is suggested that millennial youths are becoming interested in farming, either at production, processing and packaging or marketing stages. This presents a possibility of closing the gap between aging farmers and youths. Thus, providing systematic replacement of aging farmers with youths. Their youthful age and the aggressive use of internet-enabled devices is believed to increase information (such as innovations in agriculture) consumption for people of such age bracket. However, this observation remains contestable and would require further research.

A major worry information is presented in the findings of this study on Fig. 1 which it was obviously disparity between awareness and willingness to adopt some innovations. Indication levels for the adoption of innovations in precision farming, nutrition sensitive agriculture, green house technology in farming, organic farming, and automated farming are found to be the way higher than the counterpart awareness levels. For some respondents, our interpretation of the innovations, at the point of data collection, is shown to be the first time they heard and actually understood the benefits of some innovations to farming. Most, quickly indicated interest in adopting the innovation upon availability to them which is in agreement with Weyori *et al.* (2018). Indications revealed that awareness of such technology/innovation at their locality was low. It likely revealed to poor AIS in the state, but mainly at community levels. According to Aerni *et al.* (2015), AIS especially in tropical regions of most developing nations remain unsatisfactorily to connect the local agricultural settings.

In regions with an active AIS, stakeholders quickly become aware of potentially beneficial innovation for sustainable farming in their locality. The awareness and involvement of relevant stakeholders is a function of active interactions among farmers, research institutions and other agencies. This is likely to be effective interaction among stakeholders ensures flow of the right information, responsive feedback, collaborations and supports when a functional AIS is in place. AIS emphasizes on knowledge generation, diffusion

and application, and the interactions among relevant key players in the agricultural sectors (Schut *et al.*, 2015). According to Ntshangase *et al.* (2018), Malesse (2018), Amungwa (2018), Weyori *et al.* (2018) state that the impacts of the agricultural innovation can only be realized if most farmers accept and adopt the technology. The result of this study suggested that rural farmers perceived agricultural innovation as an essential tool for enhancing their productivity. However, the farmers in developed nations, improved in farming, communities in Enugu state required the awareness and willingness to adopt innovations that significantly impacted on production and conform to cultural and economic affordability (Shakuntala and Anil, 2015; Njabulo *et al.*, 2018; Capstaff and Miller, 2018; Simtowe *et al.*, 2019). The hope of adoption of important innovations are to increase production and maximize income generation while minimizing the risk of failure (Neufeldt *et al.*, 2013).

Challenges to rural farmers' adoption of agricultural innovations

The findings on challenges indicated that the participants agreed to the presented items as limiting factors to the adoption of agricultural innovations and strategies. Poor adoption (and in most cases non-adoption) of agricultural innovations by rural farmers is often linked with challenges, such as fear of failure of the innovation at the locality, limited access to information on agricultural innovations, high cost of agricultural innovations, weak extension and advisory services and lack of access to credit facilities/services etc. These challenges, if it is not addressed may continue to account for the apparent low adoption of agricultural innovations by rural farmers in Nigeria, particularly in Enugu State. These results supported by Amungwa (2018); Chukwuone *et al.* (2006) and Onasanya *et al.* (2006) who identified that lack of farmers' participation in innovative farming programme and development have been linked to high cost of implication and poor funding, faulty AIS (such as ineffective extension services), social and cultural misfit technologies/innovations for indigenous farmers. The findings of this study, Malesse (2018) posited that technicality, the period of recovery of investment, and local adoption patterns of the technology are the challenges facing rural farmers in agricultural innovation adoption. A weak AIS is characterised by poor extension and advisory services is one of the challenges faced by rural farmers in adoption of agricultural innovation. According to Mwangi and Kariuki (2015) stated that limited access to extension services was a key feature of technology adoption. The 38.9% which was the highest response class of the respondents revealed to have never visited by an extension agent, while 25.5%, 21.9% and 13.7% are visited once, twice and more than twice in a month

(Table 1). The number of extension workers in the state were very few, old, and not ICT inclined and found that it is difficultly conveyed to innovative practices from research institutions to rural farmers. According to Malesse (2018), a weak extension service is a factor that strongly (and negatively) influence adoption of innovations by rural farmers.

Fear of failure is also an important factor in hindering agricultural innovation adoption. Earlier studies on technology adoption determinants are reported to fear of crop and animal failure as an impediment to adoption (Retkoceri and Kurteshi, 2018). Most rural farmers are used to their traditional methods of farming which they believe are more reliable, cost effective and possibly more adaptive than suggested innovations. Most fear for failure of a technology is rooted in the perceived characteristic of the technology. Technology characteristics play a key role in the adoption decision-making process among farmers. Farmers who find the technology to be compliant with their needs and socio-culturally friendly are likely to embrace it (Ragasa, 2012). Also, the cost of implementing agricultural innovation was a barrier to the adoption of innovation in other regions of the world (Mwangi and Kariuki, 2015). As it is indicated by the respondents, a high cost of agricultural innovations prevented farmers from adoption. Cost associated issues and financial difficulties can create barriers to innovation (Mwangi and Kariuki, 2015).

Lack of access to credit facilities/services hinders adoption of agricultural innovation is indicated by the respondent farmers in the study. Result revealed that 999 farmers (73.5%) lack access to credit facilities in the locality (Table 1). It was quite low and had significant influence to innovation adoption. Farmers who did not accessed credits or funding find it difficult to expand their farming business through innovations adoption (Mwangi and Kariuki, 2015). For the farmers with access to credit facilities (361, 26.5%), and inaccessibility of the innovation are faced a major problem in most rural areas. Unavailability of the agricultural innovation in local market delays farmers' adoption (D'Este *et al.*, 2012). These challenges, if not addressed it is possible to continue to account for the apparent low adoption of agricultural innovations by rural farmers in Nigeria, particularly in Enugu State.

Perceived strategies for improving rural farmers' adoption of agricultural innovations

The findings of the study revealed that creating more awareness on potential benefits of agricultural innovations to attract rural farmers begins with regular access to extension agents, provision of agricultural credits, provision of

agricultural innovation insurance scheme for rural farmers in case of crop/animal failure, and establishment of agricultural innovation centres in rural communities where farmers can learn about agricultural innovation at close distance. The findings agreed with Meijer *et al.* (2015) and Ntshangase *et al.* (2018) who pointed that regular access of rural farmers to qualified and experienced extension agents for information transfer, provision of agricultural innovation insurance scheme and easy access to credit facilities by rural farmers can improve adoption among farmers. Achieving a functional extension adversary service rely heavily on the functionality of AIS in the region. According to Weyori *et al.* (2018), improving the interaction between farmers and extension service are to be a way to enhance the individual innovation capacity of the farmers for productivity, especially in places where relevant governmental and nongovernmental agencies are responsive to their duties.

The respondents revealed that access to credit facilities, provision of insurance and subsidization of technologies by stakeholders such as government revealed to be a powerful strategy to encouraging adoption of agricultural innovation. Most rural farmers are indigent and always conscious of the cost of agricultural innovations before considering adoption. Farmers would be faced willing and able to adopt available agricultural innovations when the cost is subsidized or completely paid (Chukwuone *et al.*, 2006), or if it is insured against failure. The study found that provision of agricultural innovation insurance scheme for rural farmers in case of crop/animal failure was an effective strategy for farmers' adoption. Farmers were more likely to adopt an innovation, when there was security against failure. According to Meijer *et al.* (2015) and Ntshangase *et al.* (2018) stated that provision of agricultural innovation insurance scheme promote adoption among farmers. The insurance and subsidization of some innovations, awareness of strengths and weaknesses of technologies are a precondition for adoption by farmers. Creating awareness on potential benefits of agricultural innovations especially on internet and other electronic channels, it could increase young farmers' interest to adopt. Innovation awareness campaigns play the key roles in the adoption decision-making process of the farmers (Mwangi and Kariuki, 2015; Weyori *et al.*, 2018). It is also important to consider socio-cultural alignment of technologies when discussing adoption of innovations by farmers. Most farming communities have their indigenous belief systems to inform their decision process towards innovations. Agricultural innovations that conform with the culture of the farming community could promote adoption (Ragasa, 2012). Socio-cultural and economic factors surrounding innovations can be discussed at farmer innovation centres. Access to agricultural innovation centres that could be good influencing factor to encourage farmers' adoption of

technology (Ntshangase *et al.*, 2018). Data from the study, revealed that establishment of agricultural innovation centres in rural areas could be a good strategy for encouraging adoption innovation.

In conclusion, knowing the perception of farmers about agricultural innovations and what hinders or promotes adoption are revealed to be a vital and necessary in planning and implementing innovation related programmes for tackling the challenge of food shortage, particularly in Africa. The study added to the scanty discussion on agricultural innovation and technology adoption among rural farmers in Africa. The study revealed that the farmers were aware of some and willing to adopt most of the presented agricultural innovations. However, the willingness is not matched with corresponding action (actual adoption) due to several limiting factors. The study discussed possible strategies for improving adoption in the area. The study identified poor linkages among agricultural innovations actors such as farmers, extension agents, government, and research institutions. To overcome such situation, public-private partnership should work to strengthen interactions among actors in the agricultural sector to foster sustainable agricultural innovation systems (AISs). This is to promote the sharing of agricultural innovations, support adoption, and ensure sustainable interactions among farmers and other stakeholders. There is need for policy promulgation and subsequent implementation for the establishment of agricultural innovation insurance scheme to take care of phobias associated with trying out newly introduced or existing agricultural innovations. Presently in the study area, there are no agricultural innovation centres where farmers can keep abreast with latest innovation in agriculture. The centre could be a place where farmers gather to interact and discuss innovations relating to agriculture as well as a place for trying out novel ideas and technologies. The centre could also host exhibition of agricultural outputs of innovative strategies, and farmers can be rewarded for adopting innovative approaches in their farming business. An experience and qualified extension agent could act as an instructor for the centres.

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