



TECHNOLOGICAL CAPABILITIES OF EXTENSION AGENTS IN THE MAIZE INNOVATION SYSTEM IN ADAMAWA AND TARABA STATES, NIGERIA

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ABSTRACT

This study analyses Technological Capabilities of Extension Agents in the Maize Innovation System in Adamawa and Taraba States, Nigeria. was carried out to examine the technological capabilities investment of extension agents in maize innovation system and human resources, identify the sources of information among the extension agents, identify the types of linkages, and linkage mechanism existing among extension agents and farmers; determine constraints in acquiring technological capabilities of the extension agents and identify strategies for improving technological capabilities among extension agents. Respondents were sample through Multistage sampling procedure. Data were analysed using descriptive statistics and varimax rotated factor analysis. The result showed that 90.0% of extension agents indicated that their agencies made investments in various maize innovation system and 95.0% attested that their agencies invested in human resources with regard to maize innovation. Also, majority (98.1%) of the extension agents have built-in-mechanism for acquiring new information from other actors. 90.3% of the extension agents in the technology transfer sub-system obtain technical information from other extension agents. The results showed that the major type of linkage between extension agents and other actors is formal except for educators which are poor. Constraints perceived by extension agents in the maize innovation system were insecurity ($\bar{x}= 3.7$), inadequate fund to procure equipment ($\bar{x}= 3.7$) and inadequate remuneration for extension agents and inadequate provision of resources by extension agencies. The study revealed that improvement of security during extension activities ($\bar{x}=3.71$) and provision/improvement of information and communication technologies to enhance effectiveness and efficiency of technology transfer ($\bar{x}= 3.63$) were the major strategies for improving technological capabilities. It was recommended that extension agencies and partners should strengthen research-farmer linkages and should ensure the security of actors in the maize innovation system to enable them carry out maize innovation activities for better livelihood.

Keywords: Technological, Capabilities, Extension Agents, Maize Innovation System.

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INTRODUCTION

Nigeria produces about ten million tons of maize with the largest volumes produced in the Northern region with Adamawa State as one of the leading States Odusunya (2018). However, up to twelve million tons (12tons) per acre can be realized if there is more collaboration between actors in the innovation system especially the extension agents (Udegbumam, 2019). The key aspects contributing to low maize productivity in the study area include weak institutional structures, often with little or no contact between the extension agents and farmers.

Poor technological capability remains one of the major constraints to African's effort to achieve sustainable development (African Development Bank Group, 2014) and Adamawa and Taraba State in the Northeast zone of Nigeria are not an exception. Improved agricultural technologies are known to enhance and improve agricultural production among farmers in a nation. Maize production in Nigeria and particularly in Adamawa and Taraba State has not been sufficient enough to meet the needs of people and livestock feeds (Zalkuwi, Ibrahim & Kanapwa, 2014). Many maize technologies have been developed in national research stations but most of them are yet to be adopted by farmers (Oginiyi, & Olagunju, 2015). This is connected to lack of technological capabilities by agricultural extension agents (Boniface *et al.*, 2019).

The concept of innovation has long been interpreted in the Nigerian agricultural system in terms of focusing only on research, to the exclusion of other components of an innovation system. (Philip, *et al.*, 2016). Less work has been collaboratively carried out between extension agents and farmers because of the historical disconnect between them and this has negatively impacted the effort to get improve technologies and practices into their hands, and used by stakeholders who needs them: farmers, processors, input providers, traders, and others along the value chain. Farmers also lack agricultural information and this factor promotes ignorance of modern farm technologies (Mgbenka and Mbah, 2016); hence, impeding technological capabilities of extension agents. This scenario is not different from the present situation in the North-eastern States of Adamawa and Taraba.

Similarly, there are few studies addressing the technological capabilities of extension agents in maize innovation systems. Among other studies conducted are; that of Chidike and Udeanya (2019); Modirwa and Oladele (2017); Dimelu and Emordi (2012); Obiora (2014); and Wambura *et al.* (2016). None of these studies focused on the technological capabilities of extension agents in the maize innovation system in Adamawa and Taraba States. It is against this background that the study intends to fill the existing gap.

Objectives of the Study

The overall objective of the study was to examine the technological capability of extension agents in maize innovation system in Adamawa and Taraba states. The study was specifically designed to:

- i. examine the technological capabilities investment of extension agents in maize innovation system and human resources;
- ii. identify the sources of information among the extension agents
- iii. identify the types of linkages and linkage mechanism existing among extension agents and farmers;
- iv. determine constraints in acquiring technological capabilities of the extension agents and;

- v. identify strategies for improving technological capabilities among extension agents.

METHODOLOGY

Study Area

The study was carried out in Adamawa and Taraba States. Adamawa, is a State in North-eastern Nigeria, it occupies about 36,917 square kilometres. It is bordered by the states of Borno to the North West, Gombe to the west and Taraba to the South west. Its eastern border forms the national eastern border with Cameroon. It is a mountainous land crossed by the large river valleys-Benue, Gongola and Yedsarem. The valleys of mount Cameroon, Mandara Mountains and Adamawa plateau form part of the land scape (Adamawa State, 2021). Adamawa State lies between the coordinates latitude $11^{\circ} 17' 31''$ E to $13^{\circ} 48' 42''$ E and longitude $7^{\circ} 19' 45''$ N to $10^{\circ} 56' 5''$ N.

The Adamawa State Agricultural Development Programme (AADP) was established to raise productivity, income and standard of living of rural farmers in Adamawa State. It consists of four agricultural zones namely zone I (Mubi zone), zone II (Gombi zone), zone III (Mayo Belwa zone) and zone IV (Guyuk zone). The ADP consist of fourty (40) blocks and 287 cells evenly distributed in the block areas. Each cell consists of at least 1000 farm families. The number of extension agents as at 2021 stood at one hundred and two (102) and Fadama III has twenty-two (22) extension staff across the twenty-one (21) local governments. The numbers of maize farmers in the State as recorded by ADP in 2020 was 88,289, (Adamawa Agricultural Development Programme [AADP], 2021).

Taraba State is located in the North Eastern part on Nigeria. Taraba State is bounded in the west by Nassarawa and Benue States, bounded to the northwest by Plateau State, to the north by Bauchi and Gombe States, and to the northeast by Adamawa State. Taraba State has an international border with the Republic of Cameroon at the east and south. Taraba State has an estimated land area of about 54,428 sq. km, lies between coordinates latitude $9^{\circ} 3' 32''$ E to $11^{\circ} 55' 3''$ E and longitude $6^{\circ} 24' 30''$ N to $9^{\circ} 41' 32''$ N Taraba State is in the Northeast geopolitical zone of Nigeria and lies largely within the tropical zone with a vegetation of low forest in the southern part and grassland in the northern part. Population of Taraba State as of 2006 was 2,294,800 and population projection as of 2018 was 3,342,762 (National Population Commission [NPC], 2018).

Taraba Agricultural Development Programme has four agricultural zones namely zone I (Zing zone), zone II (Wukari zone), zone III (Takum zone) and zone IV (Gembu zone). The number of extension agents as at 2021 in the ADP stands at 17 and Fadama II project has 16 extension agents (Taraba State Agricultural Development Programme, [TADP], 2021). The number of registered maize farmers across all 16 local governments is 3,807 (Maize Farmers Association of Nigeria [MAAN], 2021).

Sample and Sampling Technique

Two agricultural zones were randomly selected from four (4) zones of each State. In Adamawa State, zone II & III were selected while in Taraba State, zone I & II were selected. All extension agents in the four zones were included as sample. AADP had 52 extension agents while Adamawa Fadama III project had twenty two (22). The two zones I and II considered in Taraba State had thirty three (33) extension agents; Taraba Agricultural Development Programme had seventeen (17), while Taraba Fadama III programme has sixteen (16) bringing the total of

extension agents in the four (4) zones to one hundred and seven (107). In selecting the extension agents, all thirty-seven (37) blocks in the selected four zones were considered for the study.

Method of Data Collection

Structured questionnaires were used for data collection. Information were solicited from extension agents in the four sub-systems (Research, education, technology transfer and farmers).

Analytical Techniques

Frequency, mean score and percentages were used to analyse the technological capabilities of extension agents in the maize innovation system. Linkages among the extension agents was analysed using percentages and mean score. Constraints to technological capabilities of extension agents in the maize innovation system was analyzed using mean score and varimax rotated factor analysis. Only variables with loadings of 0.4 and above (10% overlapping variances) was used in naming the factors while variables that loaded high in more than one factor were discarded (Comrey, 1962) while mean, standard deviation, ranking and factor analysis were used to determine strategies for the acquisition of technological capabilities of extension agents in the maize innovation system in the study area.

RESULTS AND DISCUSSION

Technological Capabilities Investment of Extension Agents in Maize Innovation System

Table 1 show that 90.0% of extension agents indicated that their agencies made investments in various maize innovation system. About 87.0% invested in pre-planting, 86.6% on planting, 85.0% in weeding/weed control, 83.6% in the improvement of soil fertility, 80.0% in pest control, 78.0% in storage and 30.0% in tractor equipment with regards to maize innovation in the last three years, while 75.0% of extension agencies invested in fertilizer application, 52.3% on harvesting and 50.0% on processing equipment with regards to maize innovation in the study area. This implies high investment capabilities in equipment and is probably not far from the fact that they are technology transfer agencies whose mandate is to ensure the movement of specialized knowledge and innovations from research institutes to farmers for adoption through extension agents.

Table 1: Technological Capabilities Investment of Extension Agents in Maize Innovation

Investment capabilities	% (n = 103)
Investment in equipment	90.0
Pre-planting	87.2
Planting	86.6
Weeding/weed control	85.0
Improvement of soil fertility	83.6
Fertilizer application	75.0
Pest control	80.0
Harvesting	52.3
Processing	50.0
Storage	75.0
Tractor	30.0

Source: Field Survey, 2021
(Multiple responses)

Extension agents' investment in human resources

Table 2 shows that 95.0% of extension agents indicated that their agencies invested in human resources with regard to maize innovation by training them in various maize production activities. About 87.0% were trained on pre-planting operation, 75.0% on planting, 83.2% on fertilizer application, 81.0% on weeding/weed control, 78.3% on pest control and 76.0% on harvesting operations, while 82.0% on the improvement of soil fertility, 40.0% on use and maintenance of equipment, 50.0% on processing and storage, and 30.0% on marketing operation. This implies that extension agencies have high human resources investment capabilities. Building capabilities through training and retraining of extension agents by agencies (organize workshops, seminars and monthly technologies review meetings) will increase and improve their performance.

Table 2: Extension Agent's Investment in Human Resources

Human Resources	%* (n = 103)
Any investment in human resources	95.0
Pre-planting operations	87.6
Planting	75.0
Improvement of soil fertility	82.0
Fertilizer application	83.2
Weeding/weed control	81.0
Pest Control	78.3
Harvesting	76.0
Processing	50.0
Storage	50.0
Marketing	30.0
Use and Maintenance of Equipment	40.0

Source: Field Survey, 2021

*(Multiple responses)

Extension Agent's Sources of Information

Table 3 shows the distribution of extension agents' sources of information. The result shows that 90.3% of the extension agents in the technology transfer sub-system obtain technical information from other extension agents. This is probably because not all extension agents attend the monthly review meetings by their agencies only the key officers do after which any technical information is passed across to the block extension officers to meet to share ideas and if there is any technical information, it is passed across to them. This implies that extension agents have adequate access to technical information. The availability of information enables them to efficiently and effectively transfer technologies to farmers which will increase the adoption rate among maize farmers, hence better their livelihood. This is in line with the findings of Uwandu *et al.* (2018) that the Agricultural Development Program ranked highest as the most accessed source of agricultural information by the respondents, which is probably due to favourable extension approaches used by extension agents to extend proven agricultural technologies/innovations to farming households in Imo state, Nigeria. The result further reveals that 78.6% obtained information on maize innovation from professional meetings, 74.8% from journals, annual reports and research bulletins/publications, 72.8% from input suppliers, 65.0%

from television, 31.2% from researchers and research institutes and 35.0% from Non-governmental organizations (NGOs). Others are internet 41.7%, educators 29.1%, consumers association 34.0%, marketers association 30.9%, processors association 20.6% and maize producers association 17.5%. Professional meetings organized by extension agencies are part and parcel of the functions of extension agents. It is during such meetings that extension agents share information, knowledge and skills that help them to acquire technological capabilities that would enable them to perform their functions efficiently and effectively. Journals, annual reports, research publications and bulletins are important and reliable sources from which extension agents obtain information. This will help enhance their technological capabilities and effective technology transfer to farmers.

Table 3: Extension Agents' Sources of Information

Institution/Organizations	%* (n=103)
Researchers/Research institutes	31.2
Tertiary institution	29.1
Television	65.0
Extension agents/Agencies	90.3
Internet	41.7
Maize producers association	17.5
Input suppliers	72.8
Non-governmental organizations (NGOs)	35.0
Journals, annual reports and research bulletins/publications	74.8
Professional meetings	78.6
Processors association	20.6
Marketers association	30.9
Consumers association	34.0

Source: Field Survey, 2021 (*Multiple responses*)

Types of Linkage Used by Extension Agents

Table 4 shows the distribution of respondents based on the types of linkages used by extension agents in the study area. The result reveals that the types of linkage existing between extension agents and other extension agents as formal (97.1%), informal (83.5%), top-down (3.9%), bottom-up (53.4%), internal (52.4%) and external (47.6%). This implies that even though the major types of linkages existing between extension agents and other extension agents is formal; they also utilize informal linkage in interacting with one another which will enable them to build confidence in one another and strengthen their linkage. Top-down allows for diffusion of technologies from key officers (zonal extension officers) to the block extension officers for onward dissemination to farmers with the ultimate purpose of adoption. The table further shows that the type of linkage between extension agents and researchers/research institutes is formal (65.0%), informal (1.9%), bottom-up (23.3%), and external (5.8%). Types of linkage between extension agents and educators as formal (23.3%), informal (5.8%) and top-down (7.8%). Types of linkage between extension agents and farmers/farmers group as formal (85.4%), informal (87.4%) and top-down (66.0%). This implies that the major type of linkage between extension agents and researchers/research institutes is formal. The linkage between extension agents and educators is poor. The type of linkage between extension agents and farmers/farmers groups is formal, informal and top-down. The formal linkage allows the actors to interact and share knowledge, information and resources which will translate into the dissemination of maize technologies and ultimate diffusion of the same to farmers for better livelihood. Usually, such information are the feedback and enables researchers, extension agents and farmers to determine progress, set agenda, establish priorities and plan future

programmes. This result corroborates the findings of Afolabi (2018) where the major type of linkage between extension agents and other actors in the maize innovation system in North Central Nigeria is formal. Information flow between extension agents and educators is minimal and could limit the adoption of maize technologies. If the development of technologies will translate to adoption, then there must be a platform that will bring educators and extension agents together so that the knowledge generated in the educational institutions can benefit farmers who are outside the four walls of the institutions, that way, knowledge and maize technologies can be utilized. This means that apart from linkages that are specified and agreed upon by the organizations, they also have direct person-to-person contact so there will be a free flow of information based on their practical experiences which will probably strengthen their linkage capabilities. Also, the top-down linkage will allow for onward dissemination of information to farmers which may help improve their technological capabilities.

Table 4: Types of Linkages Used by Extension Agents

Actors	Type of Linkage	%* (n = 103)
Tertiary institution	Formal	23.3
	Informal	5.8
	Bottom-up	7.8
Researchers/Research Institute	Formal	65.0
	Informal	1.9
	Bottom-up	23.3
	External	5.8
Farmers/Farmers groups	Formal	85.4
	Informal	87.4
	Top down	66.0
Extension agents/Agencies	Formal	97.1
	Informal	83.5
	Top down	3.9
	Bottom-up	53.4
	Internal	52.4
	External	47.6

Source: Field Survey, 2021

(Multiple responses)

Linkage Mechanisms Used by Extension Agents

Table 5 shows that joint training ($\bar{x} = 2.6$) and joint workshop and seminar ($\bar{x} = 2.4$) was the linkage mechanism used by extension agents with researchers/research institutes. Joint planning ($\bar{x} = 3.0$), joint programming and priority setting ($\bar{x} = 2.1$), joint workshop and seminar ($\bar{x} = 2.4$), joint training ($\bar{x} = 2.6$) and joint evaluation ($\bar{x} = 2.0$) is the linkage mechanism used by extension agents with other extension agents/agencies. Joint training ($\bar{x} = 2.6$), joint programming and priority setting ($\bar{x} = 2.2$), joint workshop and seminar ($\bar{x} = 2.4$) and joint training ($\bar{x} = 2.6$) were the linkage mechanism used by extension agents with other extension agents. This implies that there is the link between extension agents and other actors in the innovation system on the linkage mechanisms used. The extension agent linkage mechanism used with farmers and researchers was inadequate which may impede the dissemination of information to farmers for adoption. The development of an appropriate technology alone does not lead to its adoption until they are involved in various stages of dissemination processes to ensure that it reaches the user of the technology, who are the farmers. This corroborates the findings of Suvedi, Ghimire and Kaplowitz (2017) that a

significant percentage of farmers learning about appropriate technology through extension channels, in turn, adopted it. Information on maize innovation. If the linkage mechanism frequently used between actors is inadequate, it may create a gap in information and knowledge.

Table 5: Linkage Mechanisms Used by Extension Agents

Other Actors	Linkage Mechanism	Mean Score (\bar{x})
Research/Research Institutions	Joint Planning	1.5
	Joint Programming and priority setting	1.2
	Staff exchanges between organizations	1.1
	Joint research among stakeholders	1.3
	Exchange of resources	1.1
	Joint workshop and seminar	2.4*
	Joint training	2.6*
	Joint evaluation	1.3
Extension Agents/Agencies	Joint Planning	3.0*
	Joint Programming and priority setting	2.1*
	Staff exchanges between organizations	1.4
	Joint research among stakeholders	1.8
	Exchange of resources	1.6
	Joint workshop and seminar	2.4*
	Joint training	2.6*
	Joint evaluation	2.0*
Farmers/Farmers group	Joint Planning	2.6*
	Joint Programming and priority setting	2.2*
	Staff exchanges between organizations	1.0
	Joint research among stakeholders	1.5
	Exchange of resources	1.5
	Joint workshop and seminar	2.4*
	Joint training	2.6*
	Joint evaluation	2.1
Educators	Joint Planning	1.1
	Joint Programming and priority setting	1.0
	Exchanges between organizations	1.4
	Joint research among stakeholders	1.0
	Exchange of resources	1.1
	Joint workshop and seminar	1.5
	Joint training	1.6
	Joint evaluation	1.0
Non-Governmental Organizations (NGOs)	Joint Planning	1.3
	Joint Programming and priority setting	1.1
	Staff exchanges between organizations	1.1
	Joint research among stakeholders	1.0
	Exchange of resources	1.1
	Joint workshop and seminar	1.2
	Joint training	1.2
	Joint evaluation	1.2

* = Significant at 2.0, Multiple Responses

Source: Field Survey, 2021

Constraints to Technological Capabilities of Extension Agents

Table 6 shows factors constraining the technological capabilities of extension agents in the study area. Based on variable loading, three factors were identified and named. Factor one was

named organizational/information related factor. Factors that loaded high under it were inadequate remuneration for extension agents by agencies (0.50), inadequate resources to enable extension agents carry out extension activities (0.63), unavailability of information and communication technology (0.67), a weak collaboration between extension agents and researchers (0.59), and lack of information on new maize technologies (0.83), lack of collaboration between extension agents and agencies in the State (0.87), lack of collaboration between extension agents and farmers (0.79) and insecurity in terms of the inability of extension agents to carry out physical extension activities (0.83).

Inadequate remuneration for extension agents and inadequate provision of resources, either human capital by extension agencies can hamper or reduce the capabilities of extension agents. Extension agents can be motivated through adequate remuneration and provision of adequate resources (human and capital) to enable them carry out the responsibility of technology transfer to farmers. Therefore, adequate remuneration and adequate provision of resources by extension agencies are important for technology transfer to farmers. The provision of teaching materials, teaching aids, motorbikes, information and communication technology (ICT) and provision of training opportunities will enable extension agents to acquire knowledge on new technologies for dissemination to farmers.

Information has been described as stimulating creativity, resulting in new outcomes and processes (Adio, 2016). Information obtained can help extension agents identify efficiencies that lead to higher productivity and profitability (Friedman, 2015). Therefore, accessibility to information plays a very vital role in ensuring that extension agents disseminate new maize technologies to farmers to boost their productivity. Information on new maize technology is supposed to get to the farmers through the extension agents. Therefore extension agencies must ensure that information on new maize technologies are available and accessible to extension agents and in good time for dissemination and adoption by farmers. This will result in increased maize productivity, higher income and better livelihood for farmers. Information on maize technology must be made accessible and available to extension agents because they are an important link in the maize innovation system. They are also the key sources of information for farmers. This corroborates the findings of Uwandu *et al.* (2013) that extension agents from agricultural development project was the most accessed information source and there was a significant relationship between use of agricultural information sources and the adoption of crop technologies among farming households in Imo State, Nigeria. Similarly, the findings of Ndaghu *et al.* (2018) show that information from extension officers was among other information sources utilized by respondents in Yola, Adamawa State, Nigeria.

Collaboration among actors will help in building the capabilities of actors. Moreover, capacity development activities like training or experiential learning through on-farm research trails, field based, agricultural shows, and workshops between extension agents and other actors can form a basis for connecting actors in the maize innovation system. Therefore, there is a need for all the actors to play their complementary roles to ensure the success of technology development, dissemination and adoption. Findings in the study by Yeboah *et al.* (2019) show that the research institutes collaborated with agricultural extension agents to conduct field trials on improved maize varieties. Research institutes had two-way relationships with agricultural extension services. Upon receipt of new variety related to improving technologies in agricultural extension service. Upon consultation with the community, choose suitable plots for field demonstration and farmers' field schools. There is an interaction between extension services and farmers in Ghana. Moreover, the UN, (2018) established that all actors in the innovation system should build capabilities to engage in different forms of information exchange to the formation of an innovative partnerships.

Factor two was name funding related factors. Factors that loaded high under it were the inability of agencies to invest in equipment for the improvement of maize innovation (0.72) and the lack of built-in mechanism for learning through feedback (0.57). The inability of agencies to invest in equipment for the improvement of maize innovation may be due to a lack of funds. The lack of built-in mechanism for learning through feedback is probably because of the weak linkages between extension agents and other actors.

Factor three was named Knowledge related factors. Knowledge related factors identified were poor learning opportunities for extension agents (0.56) and inadequate training opportunities for extension agents to acquire knowledge and build up their capacities in maize innovation (0.59). Favourable learning conditions and opportunities for extension agents to learn are important for building capabilities. Adequate training opportunities provided for extension agents by agents to acquire knowledge and build their capacities in maize innovation will enable effective and efficient technology transfer to farmers by extension agents. On training and knowledge about information technology-enabled systems (ITS), Boniface *et al.* (2019) in their findings suggested that training should be imparted to agricultural extensionists to create awareness and knowledge about the ITEs in Thrissur, Idukki and Mallapuram, India.

Table 6: Factors Constraining Technological Capability of Extension Agents

Constraints	Factor 1	Factor 2	Factor 3
Inability of the agencies to invest on equipment for improvement of maize innovation	-.239	.729*	.372
Poor learning opportunities for extension agents	-.002	-.314	.569*
Inadequate training opportunity for extension agents to acquire knowledge and built up their capacities on maize innovation	.141	-.305	.591*
Lack of built-in mechanism (routine or procedure) for learning through feedback	.217	.574*	.044
Lack of qualified man power for technology transfer	.207	.668*	.489*
Inadequate remuneration for extension agents by agencies	.506*	.326	-.113
Inadequate motivation for extension agents by agencies	.319	.392	.458*
Inadequate resources to enable extension agents carry out extension activities	.635*	-.299	.059
Poor access to information and communication technology	.714*	-.430*	.183
Unavailability of information and communication technology	.674*	-.263	.050
Weak collaboration between extension agents and researchers	.592*	.543*	-.008
Lack of information on new maize technologies	.838*	-.316	-.019
Lack of collaboration among extension agents in different agencies in the State	.855*	.145	-.108
Lack of collaboration between extension agencies and extension agents	.877*	.190	-.106
Lack of collaboration between extension agents and farmers	.797*	-.077	-.018
Insecurity in terms of the inability of extension agents to carry out physical extension activities	.839*	-.029	-.344

Extraction Method: Principal Component Analysis

a. 3 components extracted.

Note: **Factor 1** = Organizational/Information related, **Factor 2** = Funding related, **Factor 3** = Knowledge related

Rotated Method: Varimax with Kaiser Normalization (Loading at .4 above)

Strategies for Improving Technological Capabilities as Perceived by Extension Agents

Table 7 shows extension agents' perceived strategies for improving their technological capabilities. The most prominent response ranked by extension agents was regular training in maize innovation for extension agents ($\bar{x}=3.83$), improvement of security in terms of the safety of extension agents during extension activities ($\bar{x}=3.63$) ranked 2nd, provision/improvement of information and communication technologies to enhance effectiveness and efficiency of technology transfer ($\bar{x} = 3.57$), ranked 3rd, increased extension visits to farmers ($\bar{x} = 3.52$), ranked 4th, effective and efficient dissemination of information to extension agents ($\bar{x} = 3.49$), ranked 5th. The Table also shows good remuneration for extension agents and more frequent agricultural show by extension agencies for extension agents ($\bar{x} = 3.41$) ranked 6th, adequate funding of activities on maize innovation ($\bar{x} = 3.35$) ranked 8th, joint funding of research project/programmes by farmers and NGOs ($\bar{x} = 3.28$) ranked 9th, extension agency to collaborates with donor agencies and NGOs to enable free flow of information among extension agents ($\bar{x} = 3.27$) ranked 10th, access to facilities for communication of technical information on maize innovation ranked 11th. The Table further shows that improvement of the feedback mechanism between extension agents and researchers ($\bar{x} = 3.24$) ranked 12th, improvement of the feedback mechanism between extension agents and farmers and improvement of the feedback mechanism between extension agents and researchers ($\bar{x} = 3.24$) ranked 12th are some strategies for improving technological capabilities of extension agents. Other strategies are the use of farmers' groups for training by extension agencies and other actors ($\bar{x} = 3.21$), which ranked 14th, availability of access to bulletins, annual reports and farm magazines by agencies to extension agents ($\bar{x} = 3.11$), ranked 15th, more frequent workshops and conferences between extension agencies and other actors ($\bar{x} = 3.10$), ranked 16th, agencies to invest in more frequent interaction between extension agents and farmers ($\bar{x} = 3.09$), ranked 17th, availability of more manpower in the extension agencies ($\bar{x} = 2.99$), ranked 18th, strong linkage among extension agencies in the state ($\bar{x} = 2.75$) ranked 19th and personal letters for free flow of information in the maize innovation system ($\bar{x} = 2.61$) ranked 20th respectively. This implies that strategies for improvement of technological capabilities as perceived by extension agents were regular training in maize innovation for extension agents, improvement of security in terms of safety of extension agents during extension activities and provision/improvement of information and communication to enhance effectiveness and efficiency of technology transfer. Regular training for extension agents by agencies is important for extension service delivery. It is through regular training that extension agents will be current in changes with regard to maize innovation. Research and development in maize technologies are dynamic, therefore, regular training for extension agents is required. This will enhance their technological capabilities in the dissemination of these innovations to farmers for adoption. Odoenlan *et al.* (2020) found that technologies are better disseminated by extension agents therefore, extension agents should undergo continuous training and retraining programmes to enable them dissemination technologies more efficiently.

Security is a major determinant of the effectiveness of extension service delivery and as Nwanegbo *et al.* (2017) establish, the rising incidences of insecurity and repeated patterns of attack and kidnapping of individuals have constituted challenge to smooth agricultural activities. In light of this, the improvement of security for extension agents is of paramount importance in the success of extension delivery in Nigeria. Extension agencies and non-governmental organizations need to regularly organize training workshops on the use of information and communication technologies to facilitate extension service delivery.

There is a need to improve information and communication technology for effective extension service delivery. The world is a global village and the availability and improvement of ICT to enhance the technological capabilities of extension agents, hence, an effective and efficient

innovation system. This agrees with the findings of Baruah and Mohan (2018) that despite the evident benefit of ICT integration into traditional extension services, the North-eastern Region (NER) in India still suffers from the basic problem of connectivity because of a lack of awareness, skills, in handling ICTs, training and practical exposure to ICTs among other. Furthermore, knowledge of ICT is limited to media such as mobile phones, television and radio. Therefore, the study suggested that for an enhanced scope of ICT media, as well as to raise the interest of farmers in using ICTs, there is a need for improvement of ICT for extension agents so that their technological capabilities can be enhanced. This agrees with the findings of Ifeanyieze *et al.* (2017) that constraints such as limited ICT resources impede effective linkages, the insufficient flow of feedback to research institutes from extension and farmers among others, hampers the effectiveness of innovation systems. Similarly, the findings of Boniface *et al.* (2019) show that the extensionist hindrance in using an information technology-enabled system is a lack of skills and training, therefore, training should be imparted to them for effective access to agricultural information in Thrissur, Idukki and Malappuram districts of India.

Table 7: Strategies for Improving Technological Capabilities as Perceived by Extension Agents

Strategies	Mean (\bar{x})	SD	Rank
Regular training for extension agents in the maize innovation system	3.83	0.422	1 st
Improvement of security in terms of safety of extension agents during extension activities	3.63	0.727	2 nd
Provision/improvement of information and communication technologies to enhance effectiveness and efficiency of technology transfer	3.57	0.571	3 rd
Increase in extension visit to farmers	3.52	0.698	4 th
Effective and efficient media for dissemination of information to extension agents	3.49	0.655	5 th
More frequent agricultural shows by the extension agencies for extension agents	3.41	0.755	6 th
Good remuneration for extension agents	3.41	0.733	6 th
Adequate funding of activities on maize innovation by agencies	3.35	0.667	8 th
Joint funding of research project/programs by farmers and NGOs	3.28	0.737	9 th
Agency to collaborate with donor agencies and NGOs to enable free flow of information among extension agents	3.27	0.528	10 th
Access to facilities for communication of technical information on maize innovation agents	3.25	0.479	11 th
Improvement of feedback mechanism between extension agents and researchers	3.24	0.474	12 th
Improvement of feedback mechanism between extension agents and farmers	3.24	0.618	12 th
Use of farmers group for training by extension agencies and other actors	3.21	0.571	14 th
Availability and access to bulletins, annual reports and farm magazines by agencies to extension agents	3.11	0.625	15 th
More frequent workshop and conferences between extension agencies and other actors	3.10	0.634	16 th
Agencies to invest in more frequent interaction between extension agents and farmers	3.09	0.562	17 th
Availability of manpower in the technology transfer agencies	2.99	0.679	18 th
Strong linkage among extension agencies in the state	2.75	0.737	19 th

Personal letters between extension agents and other actors for information on maize innovation	2.61	0.703	20 th
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Source: Field Survey, 2021

(Multiple responses)

CONCLUSION

Conclusively, this paper revealed that extension agents indicated that their agencies made investments in maize innovation system and that their agencies invested in human resources with regard to maize innovation by training them in various maize production activities. Also, constraints to technological capabilities as perceived by extension agents in the maize innovation system are insecurity, inadequate fund to procure equipment, inadequate remuneration for extension agents and inadequate provision of resources.

RECOMMENDATIONS

Based on the findings, the following were recommended:

- i. Government, extension agencies and private organizations should ensure the security of actors in the maize innovation system so that they will be able to carry out maize innovation activities for better livelihood.
- ii. Government, extension agencies and partners should ensure that research findings and agricultural information are made available to educators, extension agents and farmers as when due so it can be utilized effectively and efficiently for a successful maize innovation system.
- iii. Extension agencies and partners should strengthen research-farmer linkages at zonal blocks and cells levels
- iv. More frequent training and re-training programs for extension agents by extension agencies
- v. Extension agencies, partners and other stakeholders should encourage extension agents by improving their remuneration and for effective and efficient dissemination of maize technologies to farmers.

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