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A review of agricultural extension roles in climate change adaptation and mitigation among farmers in Nigeria

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Abstract

This review aims to provide an overview of agricultural extension roles in climate change adaptation and mitigation. It deals with farmers' access to extension services, roles of extension services, climate change-related training needs of extension personnel, the influence of extension contact on adopting climate change adaptation strategies, and constraints experienced by agricultural extension from existing empirical studies. Preferred Reporting Items for Systematic Reviews and Meta-Analyses was used to retrieve and analyse 78 studies. The majority (89.6%) of the studies have shown that farmers do not have access to climate change-related extension services. Extension services focused more on the transfer of information (98.2%), provision of technical advice (48.3%), and support of indigenous adaptation and mitigation strategies (32.6%). The main training needs of extension personnel were skills in the utilization of information and communication technologies (76.5%) and assessment and utilization of climate change-related farming technologies (45.7%). Extension contacts had a positive influence on

climate change adaptation (95.7%), while the extension faced the challenges of poor funding (86.8%), inadequate manpower (76.4%), and lack of capacity (67.7%). The study concluded that agricultural extension plays an active role in climate change adaptation and mitigation and recommended more funding and capacity development should be provided for extension personnel. More studies are needed to identify the extent of the positive outcome of extension contact on climate change management among farmers.

***Key words**:* Access to climate change information, Climate change training needs, Capacity development, Indigenous adaptation strategies.

Introduction

All over the universe, the unfavourable influence of climate change is threatening livelihood, especially in developing nations. Africa is experiencing a reduction in agricultural output with the attendant decrease in food availability and food inflation, and this has affected the majority of small-holder rural households who rely on agriculture for their sustainable livelihood. Agriculture is the principal source of sustenance for small-scale farmers and their best alternative to attain food security. Within the sub-Saharan Africa, the sector is among the leading factors with immense influence on economic development as it contributes nearly 15.3% to the Gross Domestic Product (GDP) (World Bank, 2020). For Nigerians, agriculture has the capacity for income generation and poverty eradication given that it is the main provider of unprocessed materials while enhancing livelihood support for more than 75% of the citizens (Suvedi et al., 2023). It is therefore pertinent that rural farmers must be equipped to minimize their exposure to risk.

In a bid to achieve reduction in farmers' vulnerability in agriculture, farmers have been advised to adopt various adaptation and mitigation strategies. These strategies entail alterations in farming activities in reaction to variations in climatic conditions (Khalil & Thompson, 2024; Ankrah et al., 2023; Suresh et al., 2020). These changes will introduce appropriate criteria to reduce the detrimental influence of climate change (or utilize the advantageous outcome) through the establishment of ideal changes. It is the modification of natural or artificial procedures in reaction to anticipated weather stimuli to control adversity or take advantage of valuable possibilities (Suvedi et al., 2023). Adaptation targets to reduce vulnerability to losses, improve the ability to deal with inescapable losses, and make gains from emerging opportunities.

Among the greatest hindrances to adaptation and mitigation for farmers is the absence of basic capabilities around the administration of climate risk. There have been deficiencies in knowledge, attitude, and skills in regards with the basic

elements of climate change given that rural farmers may often not be aware of the facts that are obtainable and their appropriateness, and in other situations find it difficult to advance products that facilitate their resoluteness (Apeh et al., 2024; Izuogu et al., 2021; Atasie et al., 2017; 2019). The place of extension and advisory services cannot be overstressed within this sphere.

In Nigeria, the agricultural extension service is among organized establishments that engage actively in assisting rural farmers and realizing advancements in farmers' adaptive capacity towards climate change. It connects researchers and farmers by availing farmers of ideas, innovations, and educational processes on climate change mitigation. For farmers to successfully adapt, there is a need for regular assessment and dissemination of innovations in an effective and well-timed manner, especially concerning climate change. The extension is an enabler since it helps farmers make optimal decisions and relay credible information for the desirable results in climate change management. It has demonstrated its ability to develop farmers' awareness and competence toward climate change adaptation through the dissemination of agricultural innovation. Studies show that agricultural extension services in many nations have achieved a great deal in the dissemination of climate change innovative practices (Grigorieva et al., 2023). Hence, enhancing agricultural extension services may be exceedingly efficient at persuading farmers to embrace modern practices as they respond to climate change. Agricultural extension service efforts toward climate change adaptation have been well-researched (Khalil & Thompson, 2024; Onyeneke et al., 2023; Osuji et al., 2023; Suvedi et al., 2023; Izuogu et al., 2021; Orifah et al., 2021; Ifeanyi-Obi & Henri-Ukoha, 2022) and presented at various seminars and conferences, and also published in several journals with mixed results. Most of these empirical researches focused on different states or geographical zones of the country which has made it difficult to use them as guides in the realignment of agricultural extension assistance to counter the adverse effects of climatic risk.

There are several review articles on how climate change influences agricultural extension (Ankrah et al., 2024; Ifeanyi-Obi & Henri-Ukoha, 2022; Izuogu et al., 2021; Yohannes, 2016). However, these articles did not go into the details of aggregating these roles and challenges of agricultural extension on a national scale. This has necessitated the need to harness previous empirical studies and draw a comprehensive conclusion on how agricultural extension services in Nigeria can offer assistance for climate change adaptation and what changes should be prioritized to facilitate its effective participation in promoting farmers' adaptation and mitigation practices. In line with climate change adaptation and mitigation, this review seeks to;

i. establish farmers' access to extension services,
ii. describe the essential roles of agricultural extension,

iii. profile the major extension personnel training needs,
iv. highlight the influence of extension contact,
v. establish the challenges of agricultural extension professionals,
vi. highlight the major recommendations for effective participation of agricultural extension services in climate change management.

Material and Methods

A review mechanism was established for the study before the search from 25 June to 13 August 2024 to profile, assess, and analyse the results that were important to the topic. At the initial stage, study questions were listed to guide the analysis of journal articles. Next was the definition of the search approach that assisted in identifying important sources that included Elsevier, Web of Science, ResearchGate, ScienceDirect, and Directory of Open Access Journals (DOAJ). The inclusion and exclusion criteria were defined after the retrieval of 132 articles from these databases. To be considered for the review, studies had to be empirical and peer-reviewed, published in the English language, within a time interval of 2014 to 2023, showing their titles, years of publication, and full text with abstracts. Furthermore, peer reviewed book chapters and such literature as reports and seminars were added.

After reading the abstracts and titles, 29 articles were deleted as they focused on areas outside the title of the review. Eighteen comprehensive text studies that did not answer any of the review questions were removed. From the remaining 85 articles, duplicates (7) were removed from the review file. Finally, 78 studies were recognized to be eligible for the systematic review.

Results and Discussion

Farmers' access to extension

Results presented in Figure 1 show that the majority (89.6%) of the studies (Oduntan et al., 2022; Salisu, 2022; Danso-Abbeam et al., 2021; Okpokiri et al., 2017; Oluwatayo & Ojo, 2016; Mesike et al., 2015; Nwaiwu et al., 2014; Owombo et al., 2014) reported that most of their respondents (farmers) lacked access to agricultural extension services. The few (10.4%) articles that reported that farmers had extension contact include Towolawi et al. (2023), Jellason et al. (2022), and Orifah et al. (2021).

Rural farmers' contact with extension services is an essential human capital that ensures that they are well-informed on issues relating to climate change. This provides quality information for farmers on how to solve the challenges arising from climate change both on their farms and within their

families. Extension services develop farmers' capacity to utilize responsive strategies in climate change adaptation. When these services are not obtainable, farmers are denied these essential facts. Nwobodo et al. (2019) blamed poor access to extension by farmers on the discontinuation of external funding from the World Bank which led to the underfunding of the Agricultural Development Programme (ADP) as well as the fluctuations in the national economy.

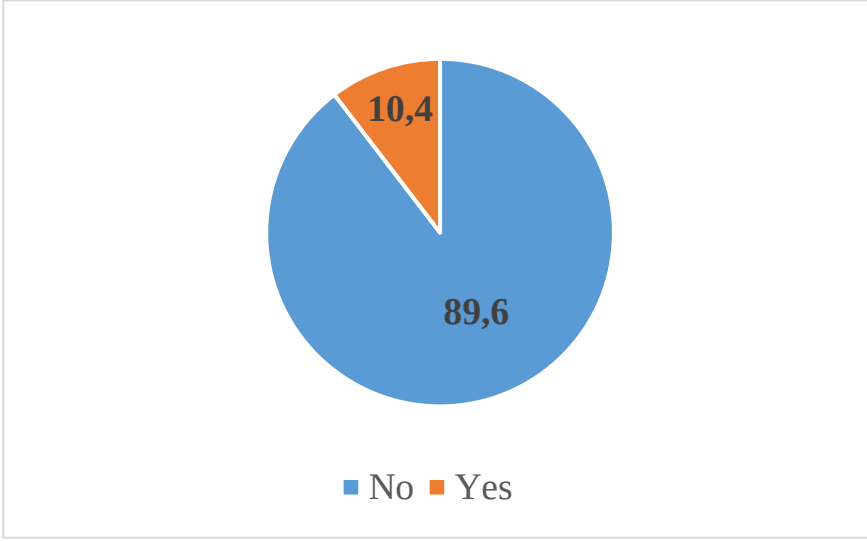

Figure 1 Farmers' access to agricultural extension services

Roles of extension in climate change adaptation and mitigation

The major roles of extension services identified in the articles were transfer of information (98.2%), provision of technical advice (48.3%), support of indigenous adaptation and mitigation strategies (32.6%), and linkage between farmers and government (10.4%). Agricultural extension capacity in rural areas has exceeded the traditional roles of mere transmission of farm production innovation as the system is challenged with the need to disseminate information and services that will ameliorate farmers' vulnerability (Izuogu et al., 2024; Sylvester et al., 2024; Eta et al., 2023; Ojo et al., 2021; Shittu et al., 2021; Atasie & Izuogu, 2017; Nwajiuba et al., 2015). In doing this, the extension serves as a medium of exchange of knowledge, attitude, and skill among farmers and a connection between rural farmers and other collaborators in the agricultural sub-sector.

Extension agents educate farmers on the utilization of effective strategies through various training workshops, mass media, field days, and seminars, among others. These facilitate positive responses in farmers' knowledge,

attitudes, and skills and improve their adaptive and resilience capacities (Solaja et al., 2024; Kolapo & Kolapo, 2023; Tabe-Ojong et al., 2023; Phiri et al., 2022; Jellason et al., 2021; Ojoko et al., 2017).

Climate information services will advance set fundamental purposes in agriculture exclusively when accessible, prompt, precise, and supplied through proper establishments and media. Access to credible information consistently supports the alleviation of the adverse consequences of alterations in climatic variables while consolidating the resilience of the agricultural sector.

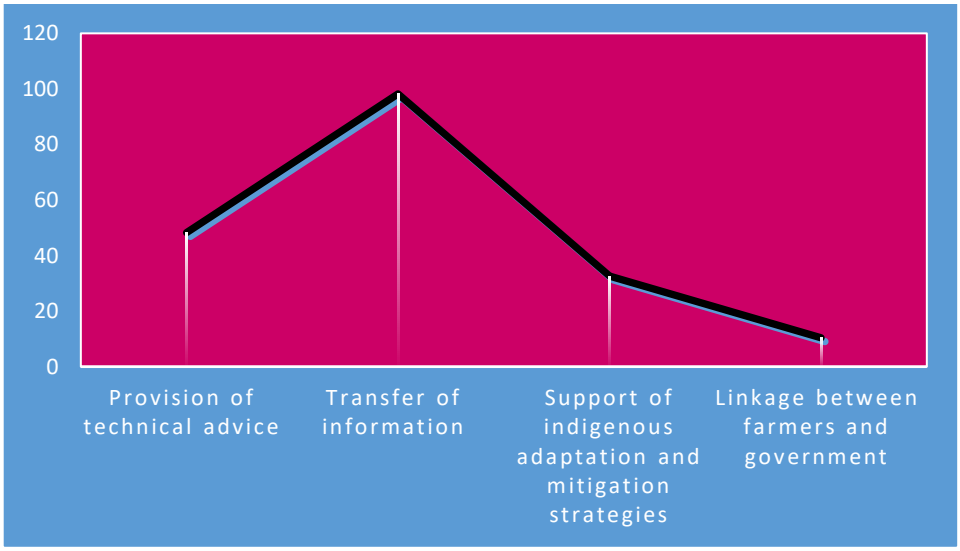

Figure 2 Extension roles in climate change adaptation and mitigation

Training needs of extension personnel for climate change management

Results in Table 1 show that the majority (76.5%) of the studies identified that the extension personnel require skills in the usage of information and communication technologies (ICTs) for climate change communication (Adamu et al., 2021; Godson-Ibeji et al., 2020; Chikaire et al., 2017; Okeowo, 2015). Other training needs identified by the studies (Alehile, 2023; Awoniyi et al., 2023; Alhassan et al., 2022; Ozioko et al., 2022; Olorunfemi et al., 2021; Adamu et al., 2021; Oyawole et al., 2020; Terdoo, 2020; Anka, 2016; Izuogu, 2015; Okeowo, 2015) include assessment and utilization of climate change-related farming technologies (45.7%), use of meteorological information (39.6%), use of resource conservation technology (21.2%), assessment of farmers' livelihood assets vulnerability to climate change (18.1), and utilization of indigenous ideas (20.5%), etc.

The acquisition of climate change management skills by extension officers will facilitate farmers' adjustment to new challenges arising from climate change. When compared to other institutions involved in the improvement of rural livelihood, field-level extension officers are known to possess a more comprehensive understanding of the extent of exposure of farming communities and the diverse community support and service connections (Orji et al., 2025; Alhassan & Umoru, 2024; Izuogu et al., 2021; Ifeanyi-obi & Ekere, 2021; Kombat et al., 2021; Tiamiyu et al., 2018). The degree of the challenges arising from climate change and the endless risk around its indications demands adaptiveness in the reaction of agricultural extension services to climate change.

Tab. 1 Training needs of extension personnel

Training needs	**Percentage**
Skills in the application of ICTs climate change communication	76.5
Assessment and utilization of climate change-related farming technologies	45.7
Use of meteorological information	39.6
Use of resource conservation technology	21.2
Utilization of indigenous knowledge for climate change adaptation	20.5
Assessment of farmers' livelihood assets' vulnerability to climate change	18.1

Influence of farmers' access to agricultural extension services on climate change management

Extension contacts influence farmers' adoption of climate change adaptation and mitigation strategies positively as shown in Figure 3. Only 4.3% of the reviewed articles reported extension contact negatively influenced utilization of climate change management procedures; viz Ekemini-Richard et al. (2022) indicated that the more farmers had contact with extension, the less their likelihood of planting underutilized indigenous vegetables (UIVs) as an adaptation method. They suggested that this may be due to the greater focus that extension services placed on cassava, maize, and rice at the front burner of research compared to UIVs.

Contact with extension officers improves the capacity of farming households to adjust to climate change given that the extension personnel educate farmers, for instance, on the means of developing and disseminating indigenous cultivars of flood-resistant seed varieties with credible information on its advantages and disadvantages (Ukwuaba & Ileka, 2024; Adeagbo et al., 2021; Barasa et al., 2021; Mesike et al., 2015; Izuogu et al., 2015).

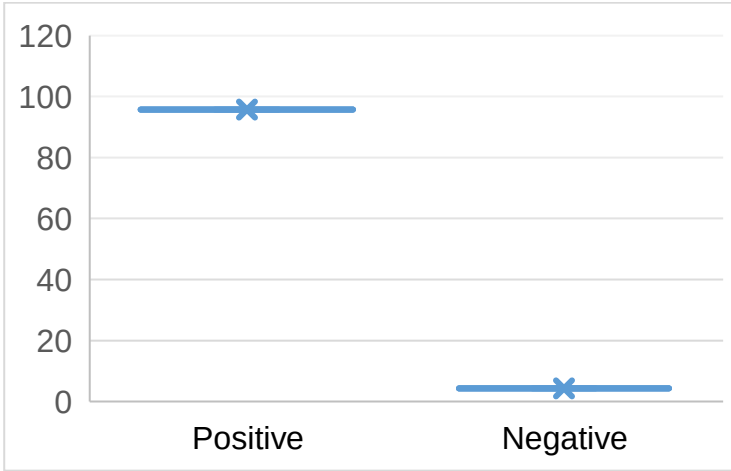

Figure 3 Influence of the extension in climate change management

Challenges of extension services in climate change adaptation and mitigation

Poor funding (86.8%), inadequate manpower (76.4%), lack of capacity (67.7%), and inadequacy of extension programmes (56.6%) were among the major constraints identified in literature facing agricultural extension services (Okoronkwo et al., 2024; Okoye et al., 2024; Izuogu et al., 2023a, 2025; Adeagbo et al., 2023; Igberi et al., 2023; Magesa et al., 2023; Chidiebere-Mark et al., 2022; Onyeneke et al., 2021; Olayide et al., 2016; Fanen & Olalekan, 2014).

Sa'adu et al. (2022) have indicated that in Taraba state, Nigeria, the majority (64%) of the extension personnel lack internet access skills as they cannot operate the internet, while 78% do not have an email address. Only 24% reported their use of the internet for climate change-related information.

Several studies (Njoku et al., 2025a; Adekoya et al., 2023; Gabriel et al., 2023; Wakweya, 2023; Igberi et al., 2022; Mashi et al., 2022; Ibrahim-Olesin et al., 2021; Ifeanyi-Obi et al., 2021; Mailumo et al., 2021; Godson-Ibeji et al., 2020) focused mainly on assisting farmers' utilization of adaptation strategies without assessing some challenges that have made it difficult for the extension service to be effective. The decrease in fiscal allocation to ADPs has drastically lowered the capacity of extension personnel to access and use climate change-related technologies. However, the use of the Internet has been advocated as an alternative (Njoku et al., 2025b; Izuogu et al., 2021; 2023b Ekpa et al., 2017). Internet services are yet to get to many rural communities and may not be as effective as expected due to the challenges of cost and other barriers such as poor level of infrastructural development e.g., electric power supply.

Budgetary allocations to agricultural extension services in many developing nations experienced a drastic reduction after World Bank aid was

terminated in 1996, and this led to a decrease in the quality-of-service delivery (Ekpa et al., 2021; Antwi-Agyei & Stringer, 2021; Emenyonu et al., 2020; Wassie & Pauline, 2018).

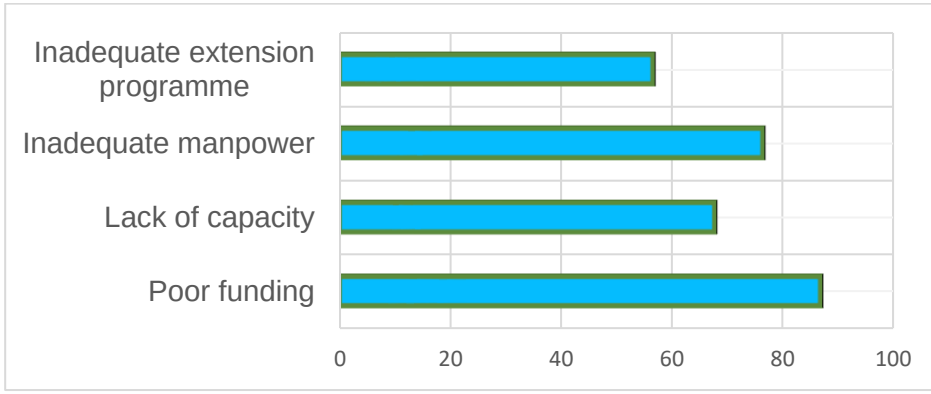

Figure 4 Challenges of extension services

Recommendation for effective participation of agricultural extension services in climate change management

The reviewed articles showed that adequate funding of extension (84.6%), consistent training and retraining of extension personnel (73.3%), realignment of agricultural extension mandate for climate change management (68.6%), development of the extension workers' capability to interface on climate change-related matters (38.4%), improvement on inter-agency collaboration between agricultural extension and other active participants in climate change adaptation advocacy (28.4%) were among the main recommendations to boost the roles of agricultural extension in climate change management (Emmanuel et al., 2025; Agyekum et al., 2024; Gbadebo et al., 2022; Oloruntoba et al., 2022; Adebayo et al., 2019).

Tab. 2 Major recommendations from reviewed articles

Recommendation	**Percentage**
Adequate funding of extension services	84.6
Consistent training and retraining	73.3
Realignment of extension mandate for climate change management	68.6
Capacity development of extension personnel	38.4
Active participation of extension in climate change advocacy	28.4

Conclusion

Seventy-eight articles in Nigeria have shown that agricultural extension is a key participant in climate change adaptation and mitigation irrespective of the various challenges that have hampered farmers' access to extension services. These challenges include inadequate extension personnel, insufficient funds, and inadequate agricultural extension programmes. The review has provided an overview of these current studies with clear evidence that extension services have positively influenced farmers' adoption of adaptation and mitigation strategies. It is evident from the review that farmers do not have adequate access to agricultural extension and advisory services. The lack of sufficient access to agricultural extension services is expected to adversely affect improvement of farmers' climate change resilience. Agricultural extension services in Nigeria are playing a very active role in the dissemination of climate change related information. H0owever, more is expected of the organization in providing technical advice to farmers. The study reveals a gap in several training needs among extension workers in the country, especially as it relates to skills in the implementation of information and communication technology (ICT), climate change communications, and the evaluation and adoption of climate change-related agricultural technologies.

This study highlights areas of further research and investment in agricultural extension roles towards climate change adaptation and mitigation. More studies should be carried out to identify the extent of the positive outcome of extension contact on climate change management. Access to agricultural extension services should be improved through the engagement of more personnel and the liberalization of the agricultural extension system to ensure that the private sector plays more active roles. A liberalized extension system will facilitate effective public private partnership and ensure that more funds are made available for extension programmes. Extension personnel should be adequately trained to develop their technical skills in combating the challenges of climate change. The government should put more effort to ensure that the major recommendations identified by the empirical studies are executed.

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Преглед улога пољопривредне савјетодавне службе у адаптацији и ублажавању климатских промјена међу пољопривредницима у Нигерији

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Сажетак

Циљ рада је да пружи увид у улоге пољопривредне савјетодавне службе у адаптацији и ублажавању посљедица климатских промјена. Анализирани су доступност савјетодавних услуга фармерима, улоге тих услуга, потребе савјетодавног особља за обуком везаном за климатске промјене, утицај контакта са савјетодавцима на усвајање стратегија адаптације на климатске промјене, као и ограничења са којима се пољопривредна савјетодавна служба суочава, на основу постојећих емпиријских истраживања. За проналажење и анализу 78 студија коришћен је метод „Preferred Reporting Items for Systematic Reviews and Meta-Analyses“ (PRISMA). Већина студија (89,6%) показала је да фармери немају приступ савјетодавним услугама које се односе на климатске промјене. Савјетодавне услуге биле су највише усмјерене на пренос информација (98,2%), пружање техничких савјета (48,3%) и подршку локалним стратегијама адаптације и ублажавања посљедица (32,6%). Главне потребе савјетодавног особља за обуком односиле су се на вјештине коришћења информационих и комуникационих технологија (76,5%) и процјену и примјену технологија у пољопривреди које се односе на климатске промјене (45,7%). Контакт са савјетодавцима имао је позитиван утицај на адаптацију на климатске промјене (95,7%), док су се савјетодавне службе суочавале са изазовима као што су недостатак финансијских средстава (86,8%), недостатак радне снаге (76,4%) и недостатак капацитета (67,7%). Закључак ове студије је да пољопривредна савјетодавна служба игра активну улогу у адаптацији на климатске промјене и ублажавање њихових посљедица, те се препоручују већа финансијска улагања у њен рад и развој капацитета савјетодавног особља. Потребна су додатна истраживања како би се утврдио

пуни обим позитивних ефеката контакта фармера са савјетодавном службом на управљање климатским променама.

Кључне ријечи: приступ информацијама о климатским промјенама, потребе за обуком у области климатских промјена, развој капацитета, локалне стратегије адаптације

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