ARTICLE | OPEN ACCESS

Discovery Agriculture

To Cite:
Alfred MC. Actors' decision-making process on scaling evidence-based climate-resilience innovation in pig farming in Enugu North Senatorial District. *Discovery Agriculture* 2024; 10: e3da1546
doi: https://doi.org/10.54905/disssi.v10i21.e3da1546

Author Affiliation:
Department of Agricultural Extension, University of Nigeria, Nsukka, Nigeria

*Corresponding Author
Department of Agricultural Extension, University of Nigeria, Nsukka,
Nigeria
Email: chinecherem.mbachu.247059@unn.edu.ng
ORCID: 0009-0007-6604-1234

Peer-Review History
Received: 09 November 2023
Reviewed & Revised: 13/November/2023 to 23/January/2024
Accepted: 27 January 2024
Published: 31 January 2024

Peer-Review Model
External peer-review was done through double-blind method.

Discovery Agriculture
pISSN 2347-3819; eISSN 2347-386X

Actors' decision-making process on scaling evidence-based climate-resilience innovation in pig farming in Enugu North Senatorial District

Mbachu Chinecherem Alfred*

ABSTRACT

The study examined the decision-making process in scaling evidence-based climate-resilience innovation in pig farming among input suppliers and Ministry of Agriculture (MOA) actors in Enugu North Senatorial District. The study aims to ascertain the evidence-based climate-resilience innovations employed by these actors in scaling evidence-based climate-resilience innovation, the factors influencing decision-making, the key actors involved, and the challenges. The study adopted a multi-stage sampling procedure in selecting actors and employed purposive and random sampling methods. The findings highlight the significance of female representation, with women comprising 60% of MOA personnel and input suppliers. Notably, most respondents possess formal education, with 80.0% of extension personnel holding tertiary qualifications. Evidence-based climate-resilience innovations such as insulation, water management, efficient watering practices, and feed management strategies were widely implemented in pig farming. However, variations in adoption levels were observed across different innovations. The study identified vital decision-making drivers, emphasizing knowledge and skills availability, government policies, cost-effectiveness, and social acceptability. The study recommends collaborative efforts and coordination among key stakeholders, including agricultural program staff, state ministries of agriculture, pig farmers, and consumers, to streamline decision-making processes and enhance the scaling of climate-resilience innovations.

Keywords: Climate change, climate-resilience innovation, pig farming.

1. INTRODUCTION

Pig farming is an important agricultural activity, particularly in pork production, providing income and nutrition for individuals and countries worldwide. According

to Ume et al., (2018), pig farming is practised in almost every part of the world, including Nigeria. Pig farming plays a significant role in Nigeria's agricultural output, providing a steady source of income, nutritional benefits, food security, sustainable farming, and export opportunities (Ahaotu et al., 2018). However, it is essential to note that the pig farming sector is vulnerable to the adverse effects of climate change. Globally, climate change has a lot of adverse effects on pig production through factors such as increased temperatures, changes in rainfall patterns, and pests and diseases (IPCC, 2014). In Nigeria, climate change has become one of the most significant challenges facing agriculture, and the impact has been felt in many sectors, such as livestock production (Mekonnen et al., 2021).

The pig farming system, amongst others, is one of the sectors vulnerable to the effects of climate change, resulting in a decline in production activities (Adeagbo et al., 2021). Also, climate change results in changes in weather patterns, making it more difficult for farmers in pig production to raise pigs. Thus, Enugu State, located in the southeastern part of Nigeria, is known for pig production, with farmers utilizing traditional methods to rear pigs (Onyekuru et al., 2020). According to Onyekuru et al., (2020), traditional methods often need more climate-resilient. Pig farmers face challenges ranging from inadequate knowledge of climate-resilience innovations in the face of changing weather patterns. To mitigate the effect of climate change vulnerability and improve output in pig farming, the need to develop an effective climate-resilient pig farming system through evidence-based climate-resilience innovations play a significant role (Shyaka et al., 2021). The evidence-based climate-resilience innovation in the pig farming system is essential to address the challenges facing the pig farming system (Shyaka et al., 2021).

These innovations include using improved pig breeds, improved feeding techniques, and biogas digesters for energy generation to improve the productivity and resilience of pig farming (Shyaka et al., 2021). In scaling evidence-based climate-resilience innovation, a series of decision-making processes by actors in the pig production system is essential. Actors play a significant role in scaling evidence-based climate-resilience innovation in the pig production system. These actors (pig farmers, input suppliers, government agencies, etc) play a vital role in the decision-making process and implementation of scaling-up climate-resilience innovations. However, to date, there have been relatively few studies to provide this evidence or to proffer innovation that could enhance the climate resilience in the pig production system. Empirically, there needs to be more information on actors' decision-making in scaling climate-resilience innovations in Enugu State North Senatorial District pig production systems.

For instance, studied the involvement of actors and stakeholders in the pig farming system, including their contributions, resources, roles, and interlinkages in West Papua, Indonesia. The study provides a valuable framework for understanding the complex system of pig farming while differing from this study on climate-resilience innovation in the pig farming system. Padu et al., (2022) investigated the level of motivation and factors that influence the adoption of climate innovation in pig farming in Southwest Sumba Regency, Indonesia, thereby providing insights into the factors that affect climate innovation adoption and the motivation of pig farmers. Furthermore, Ume et al., (2018) studied the technical efficiency of pig production in the Enugu North Agricultural Zone of Enugu State; Mekuriaw and Asmara, (2014) investigated the assessment of pig production and constraint in Ethiopia; Onyekuru et al., (2020) studied the economics of pig enterprises in Udi, Enugu State, Nigeria.

Understanding actors' involvement in the decision-making processes of scaling evidence-based climate resilience innovations in pig production systems with the local realities that influence the decision-making process scaling of evidence-based climate-resilience innovation in Enugu State North Senatorial District informed this study to adopt a mixed research method. This study, therefore, aims to assess the actors' involvement in the decision-making processes of scaling evidence-based climate resilience innovations in pig production in Enugu North Senatorial District. The actors focused on in this study include the input dealers and the Ministry of Agriculture personnel. This study is crucial to enable actors, decision-makers, and change agents within rural and peri-urban communities in pig production systems to improve day-to-day performance towards agroecological and climate-resilient. In line with the study, the broad objective is to empirically examine the actor's decision-making process in scaling evidence-based climate-resilience innovations in pig production systems in Enugu North Senatorial District, Enugu State, Nigeria.

The specific objectives are to examine evidence-based climate-resilience innovations advised by the input suppliers and the Ministry of Agriculture personnel in the pig farming system in Enugu North Senatorial District, investigate the factors that influence the decision-making process of these actors in the scaling of evidence-based climate-resilience innovation by actors in pig farming in Enugu North Senatorial District; identify the key actors involved in the decision-making process for scaling evidence-based climate-resilience innovation in pig farming systems; and determine the challenges for scaling evidence-based climate-resilience innovation in pig farming systems. However, the subsequent section of this study includes section two, focusing on the materials and methods, and

section three, an evaluation of the research findings and discussion. Finally, section four discussed the conclusion and recommendations.

2. MATERIALS AND METHODS

Location

The study was conducted in Enugu North Senatorial District, Enugu State, Nigeria, between Latitude: 6.5260° N and Longitude: 7.5085°E. The senatorial district is one of the three (3) senatorial districts in Enugu State made up of six (6) local government areas of Igbo-Etiti, Igboeze North, Igboeze South, Nsukka, Udenu and Uzo-Uwani.

Sampling Procedure

The study adopted a multi-stage sampling procedure. In stage one, out of the six local government areas (LGAs), namely (Igbo-Etiti, Igbo-Eze North, Igbo Eze South, Nsukka, Udenu and Uzo-Uwani), two LGAs were purposively selected. For the input supplier, two popular markets were purposely selected from the two local governments due to the number of pig traders in the markets. These are the Orba and Ogige markets in Udenu and Nsukka LGAs, repetitively. A list of all the input suppliers was obtained from the chairman of the farm input trader from the needs. From the list, twelve (12) input suppliers were randomly selected from 17 input suppliers in the Orba market in Udenu LGA. In contrast, in the Ogige market in Nsukka LGA, twelve (12) input suppliers were randomly selected from a list of 21 input suppliers. The Ministry of Agriculture staff selection in each LGA involves getting the population of all the staff in each LGA. The Ministry of Agriculture in Nsukka LGA consists of 12 extension personnel, five (5) of whom were randomly selected. Udenu, which falls under Igbo-Eze North, has 14 extension personnel, of which five (5) were chosen randomly.

Data Collection

The study employed a mixed research case study approach involving a survey, interviews with key actors and a review of relevant literature. A well-structured questionnaire was adopted to elicit information from the farmers based on the study's specific objectives. However, the interview method was used to collect data from government officials such as the Ministry of Agriculture staff.

Method of Analysis

The data collected for this study was analyzed using the Statistical Product and Service Solution (SPSS) IBM version. Descriptive statistics such as frequencies, percentages, mean and standard deviations, and the Likert scale were incorporated to provide the quantitative measures of actors' relationships and influence.

3. RESULT AND DISCUSSION

Socioeconomic characteristics of actors involved in the decision-making process in scaling evidence-based climate-resilience innovations in pig production systems

Table 1 shows that the majority (60.0%) of the Ministry of Agriculture personnel are female, while (40.0%) are male. The same goes for most Input suppliers in the same Table, Table 1, which shows that most pig farming input suppliers are (54.2%) female and (45.8%) male. This is in accordance with Adebayo and Worth, (2022) postulation that women farmers generally prefer working with women extension advisors. In many parts of the world, it is culturally more acceptable. Also, data in Table 1 shows that a significant proportion (30.0%) of the Ministry of Agriculture personnel are from the age of 41-45 years of age, 20.0% of them were 46-50 years and >51 years, respectively, 10.0% were <35 years of age, with the mean age being 44.2 years. This implies that the respondents are in their economic age. They are energetic and actively contribute to increasing technological advancement. Table 1 shows that a significant proportion (24.9%) of input suppliers are within the age of 36-40 years and 41-50 years, respectively; 21% are <35 years of age, and 16.7% are >51 years of age.

There is a slight decline in numbers among those aged 46-50 at 12.5%, with the overall mean age being 42.17 years. The age of respondents is in line with the OECD (2023), which states that the working-age population is those aged 15 to 64. Furthermore, Table 1 reveals that the majority (90.0%) of MOA were married, 10.0% were widowed, and none were single or divorced. Also, Table 1 shows that a significant number of input suppliers (70.8%) were married, 20.8% were single, and 4.2% were widowed and divorced,

respectively, which aligns with the findings. In addition, Table 1 shows that the majority (80.0%) of Ministry of Agriculture personnel attained tertiary education, 20.0% had secondary education, and none had formal and primary education, respectively. The educational level of the input suppliers shows that the majority (58.3%) of the respondents had secondary school education, 33.3% had tertiary education, 8.3% had primary education, and none had formal education. This implies that a more significant proportion of the study's respondents had formal education. This would be a great advantage to disseminating climate-resilience innovation to pig farmers.

This agrees with who stated that education helps spur innovation and technology. Also, data in Table 1 shows that all Ministry of Agriculture personnel (100.0%) reside in rural areas. This shows the Ministry of Agriculture's interest in scaling climate-resilience innovation in pig farming in rural communities. Moreover, about 58% of input suppliers reside in rural areas, while 41.7% reside in peri-urban areas. It was observed in Table 1 that a good number (40.0%) of Ministry of Agriculture personnel earn between N41,000 - N45,000 monthly, 30.0% earn N46,000 - N50,000 monthly, 10.0% earn N36,000 - N40,000, N31,000 - N35,000, and ≤ N30,000 respectively, with their mean income being N 42,400. The result of the input supplier's income shows that the majority (60.7%) earned ≤₦30,000, about 21.8% earned N46,000, while 8.7% earned N31,000 - N35,000. Only 4.4% earned > ₦36,000-₦40,000 and ₦41,000-₦45,000, respectively, with their mean income being 28833.33. Ministry of Agriculture personnel mostly earn between ₦41,000 and ₦45,000 monthly, indicating moderate income levels, potentially allowing them to invest in innovations.

Input suppliers have a diverse income distribution, with a significant portion earning ≤₦30,000, which poses challenges for adopting expensive innovations. Strategies are needed to make innovations accessible to a broader income range. Some input suppliers earning over ₦46,000 have the potential to drive innovation with support and resources. Furthermore, the result shows that the majority (80.0%) of Ministry of Agriculture personnel had >15 years of experience, and 10.0% have ≤7 and 8-14 years of experience, respectively. Meanwhile, a significant percentage (70.8%) of input suppliers had ≤7 years of experience, 20.8% had 8-14 years of experience, and 8.4% had >15 years of experience. Furthermore, Table 1 shows that the majority (80.0%) of the Ministry of Agriculture personnel belong to cooperative societies, while 20.0% do not belong to any cooperative society. Meanwhile, the majority (75.0%) of the input suppliers do not belong to a cooperative society, while 25.0% belong to a cooperative society.

Table 1 Respondents' socioeconomic characteristics (Ministry of Agriculture Personnel)

Variables	Ministry of Agriculture Personnel (MOA)		Input suppliers (INS)	
	Freq. (N=10)	**%**	**Freq. (N=24)**	**%**
Sex				
Male	4	40.0	11	45.8
Female	6	60.0	13	54.2
Age	(M=44.2 yrs)		(M=44.17 yrs)	
≤35	1	10.0	5	21
36-40	2	20.0	6	24.9
41-45	3	30.0	6	24.9
46-50	2	20.0	3	12.5
≥51	2	20.0	4	16.7
Marital status				
Single	-	-	5	20.8
Married	9	90.0	17	70.8
Widowed	1	10.0	1	4.2
Divorced	-	-	1	4.2
Educational level				
Primary education	-	-	2	8.3
Secondary education	2	20.0	14	58.4
Tertiary education	8	80.0	8	33.3
Geographical location				

Rural	10	100.0	10	41.7
Peri-urban	-	-	14	58.3
Average income	M= ₦42, 400		M= ₦28833.33	
≤₦30,000	1	10.0	14	60.7
₦31,000-35,000	1	10.0	2	8.7
₦36,000-40,000	1	10.0	1	4.4
₦41,000-45,000	4	40.0	2	4.4
₦46,000	3	30.0	5	21.8
Years of experience	M=16.9		M = 7.08	
≤7	1	10.0	17	70.8
8-14	1	10.0	5	20.8
>15	8	80.0	2	8.4
Association with Cooperative society				
Yes	8	80.0	6	25.0
No	2	20.0	18	75.0

Note: M= Mean Source: Field survey, 2023

Evidence-based climate-resilience innovation advised by the Ministry of Agriculture personnel

Table 2 indicates that most respondents (90%) have advised using insulation measures to improve the housing conditions of pigs in response to climate challenges. Also, all respondents (100%) have reported on the use of integrated water management strategies to manage heat stress among pigs, considering changing climatic conditions.

Table 2 Evidence-based climate-resilience innovation advised by the Ministry of Agriculture personnel.

Variables	**Frequency (N=10)**	**Percentage (%)**
Have advised on integrated water management strategies to manage heat stress among pigs, considering changing climatic conditions.	10	100.0
Have advised on implementing efficient watering practices to enhance water management and conservation in our pig farming operations.	10	100.0
Have advised on adopting feed management techniques that consider climate variability and aim to improve the resilience of pigs.	9	90.0
Have advised on the implementation of insulation measures to improve the housing conditions of pigs, considering climate-related challenges.	9	90.0
Have advised on collaborations or partnerships with other stakeholders to enhance climate resilience in pig farming.	8	80.0
Have advised on training programs or received professional advice on climate-resilience innovations in pig farming.	8	80.0
Have advised on the genetic selection methods to breed more resilient pigs to climate-related challenges.	4	40.0
Have advised on implementing of nutrient management measures to reduce greenhouse gas emissions associated with pig farming activities.	4	40.0
Have advised on implementing of manure application measures to reduce the environmental impact of pig waste and utilize it efficiently.	3	30.0
Have advised on innovative vaccination strategies to manage disease risks in pigs, considering the influence of climate change.	3	30.0

Source: Field survey, 2023

Furthermore, all respondents (100%) have indicated advice on implementing efficient watering practices in their pig farming operations. Thus, efficient water management is essential for conservation, cost reduction, and maintaining the health of the pigs. Also, most respondents (90%) have advised adopting feed management techniques that consider climate variability to improve pig resilience. The Ministry of Agriculture personnel are saddled with the responsibility of transferring technology and providing advisory services to rural farming households in many developing countries, including Nigeria (Olorunfemi et al., 2019).

Evidence-based climate-resilience innovation engaged by the input suppliers

Table 3 presents findings on evidence-based climate-resilience innovations from pig farming input suppliers. The results indicate that many input suppliers have provided climate-resilience innovations to pig farmers. Notably, most input suppliers (83.3%) actively promote feed management techniques to enhance pig resilience in response to climate variability. Additionally, a substantial portion (75.0%) provides insulation measures to improve pig housing conditions, showcasing a proactive stance in addressing climate-related challenges. Moreover, a majority (62.5%) advises on genetic selection methods to breed climate-resilient pigs, demonstrating a strong focus on breeding practices that enhance resilience. Alongside this, a significant portion (62.5%) recommends water management strategies to manage heat stress in pigs, considering changing climatic conditions.

Further underscoring their commitment, a majority (58.3%) actively participate in training programs or seek professional advice to stay informed about climate-resilience innovations in pig farming. Finally, about 45.8% of input suppliers recommend innovative vaccination strategies to manage disease risks in pigs, considering the impact of climate change, indicating a moderate yet notable involvement in disease management influenced by climate factors. These findings collectively highlight a dedicated and comprehensive effort among input suppliers to address climate-related challenges in pig farming, which agrees with the roles stipulated by the National Centre for Biotechnology Information.

Table 3 Evidence-based climate-resilience innovation engaged by the respondents (Input suppliers)

Variables	Frequency (N=24)	Percentage (%)
Have recommended feed management techniques that consider climate variability and aim to improve the resilience of pigs.	20	83.3
Have supplied insulation measures to improve the housing conditions of pigs, considering climate-related challenges	18	75.0
Have recommended water management strategies to manage heat stress among pigs, considering changing climatic conditions.	15	62.5
Have advised on genetic selection methods to breed more resilient pigs to climate-related challenges.	15	62.5
Have participated in training programs or received professional advice on climate-resilience innovations in pig farming.	14	58.3
Have recommended efficient watering practices to enhance water management and conservation in our pig farming operations.	13	54.2
Have recommended innovative vaccination strategies to manage disease risks in pigs, considering the influence of climate change.	11	45.8
Have recommended manure application measures to reduce the environmental impact of pig waste and utilize it efficiently.	10	41.7
Have recommended nutrient management measures to reduce greenhouse gas emissions associated with pig farming activities.	10	41.7
Have established collaborations or partnerships with other stakeholders to enhance climate resilience in pig farming.	3	12.5

Source: Field survey, 2023

Factors that influence the Ministry of Agriculture personnel in the decision-making processes of scaling evidence-based climate-resilience innovation in pig farming

Table 4 shows that the significant factors that influence the decision-making processes of MOA include the knowledge and skills required for technology implementation (M=3.80; S.D=0.63), government policies (M=3.70; S.D=0.68), the cost of adopting and implementing climate-resilience (M=3.60; S.D=0.70), and the social acceptability of climate-resilience innovation within the pig farming community (M=3.50; S.D=0.53).

Table 4 Factors influencing the decision-making processes of the MOA personnel in the scaling of evidence-based climate-resilience innovation in pig farming

Variables	Mean (M)	S. D
Having the necessary knowledge and skills to implement the technology influences adopting climate-resilience innovations.	3.80*	0.63
Government policies on climate change influence the decision to adopt climate-resilience innovations.	3.70*	0.68
The cost of adopting and implementing climate-resilience innovation is justifiable.	3.60*	0.70
Climate-resilience innovation is socially acceptable within the pig farming community.	3.50*	0.53
The potential benefit of adopting and implementing climate-resilience innovation is acceptable.	3.40*	0.97
The support of the community and customers is crucial for successfully adopting climate-resilience innovations.	3.40*	0.70
The need to reduce the environmental impact of pig farming motivates the adoption of climate-resilience innovations.	3.30*	0.68
The availability of reliable technology is crucial for adopting climate-resilience innovations.	3.20*	0.63
The availability of government support for climate-resilience innovations impacts the decision-making process.	3.10*	0.88
The Risk involved in adopting and implementing climate-resilience innovations is acceptable.	2.30	0.82

Note: Cut off mean ≥ 2.5 * Major factors that influence actors' decision-making process
S.D = Standard Deviation
Source: Field survey, 2023

Furthermore, other major factors influencing the MOA personnel decision-making process include the "Potential benefits of adopting and implementing climate-resilience innovation" (M=3.40; S.D=0.97), which underscore the influence of community dynamics and perceived advantages in driving adoption. The "Support of the community and customers" (M=3.40; S.D=0.70) and the "Need to reduce the impact of pig farming on the environment" (M=3.30; S.D=0.68) further emphasize the significance of societal and environmental considerations.

Thus, the availability of "reliable technology" (M=3.20; S.D=0.63) is a crucial factor in driving adoption, while "Government support for climate-resilience innovations" (M=3.10; S.D=0.88) holds sway over decision-making, indicating the importance of external backing. Meanwhile, perceived Risk involved in adopting and implementing climate-resilience innovations" (M=2.30; S.D=0.82) suggests that a certain level of acceptable Risk influences decision-making. The mixed responses from the Ministry of Agriculture personnel are in accordance with the study done by Ezeano et al., (2018) in southeast Nigeria, highlighting the reasons for these behaviors.

Factors that influence the decision-making processes of actors in the scaling of evidence-based climate-resilience innovation in pig farming (Input suppliers)

Table 5 provides valuable insights into the factors influencing the decision-making processes of input suppliers on the scaling of evidence-based climate-resilience innovations in pig farming. Furthermore, Table 6's mean scores and standard deviations assigned to each variable clearly indicate the relative importance of these factors. Notably, possessing the requisite "Knowledge and skills" (M=3.88; S.D=0.34) emerges as a prominent catalyst for technology adoption, emphasizing the significance of expertise in implementing innovations. The potential "Benefits of adopting and implementing climate-resilience innovations" (M=3.75; S.D=0.44) are pivotal, highlighting that the likelihood of adoption increases when the advantages outweigh associated costs. Similarly, the justifiability of the "Cost of adopting and implementing climate resilience" (M=3.71; S.D=0.46) underscores the role of cost-effectiveness as a driving factor. Furthermore, the "Availability of reliable technology" (M=3.46; S.D=0.51) holds sway over decisions, underlining the importance of dependable resources for innovation uptake.

Table 5 Factors that influence the decision-making processes of actors in the scaling of evidence-based climate-resilience innovation in pig farming (Input suppliers)

Variables	Mean (M)	S.D
Knowledge and skills: Having the necessary knowledge and skills to implement the technology influences the decision to adopt climate-resilience innovations.	3.88*	0.34
Potential benefits of adopting and implementing climate-resilience innovations: The potential benefits of adopting and implementing climate-resilience innovations outweigh the associated costs.	3.75*	0.44
Cost of adopting and implementing climate-resilience: Adopting and implementing climate-resilience innovations is justifiable.	3.71*	0.46
The availability of reliable technology: The availability of reliable technology is crucial for adopting climate-resilience innovations.	3.46*	0.51
Need to reduce the impact of pig farming on the environment: The need to reduce the environmental impact of pig farming motivates the adoption of climate-resilience innovations.	3.29*	0.81
Social acceptability of climate-resilience innovation within the pig farming community: Climate-resilience innovation is socially acceptable within the pig farming community.	3.29*	0.69
Support of the community and customers: The support of the community and customers is crucial for successfully adopting of climate-resilience innovations.	3.08*	0.97
The risk involved in adopting and implementing climate-resilience innovations: The risk involved in adopting and implementing climate-resilience innovations is acceptable.	2.92*	0.97
Government policies: Government policies on climate change influence the decision to adopt climate-resilience innovations.	2.79*	1.25
Government support for climate-resilience innovations: The availability of government support for climate-resilience innovations impacts the decision-making process.	2.00	0.89

Cut off mean ≥ 2.5; S.D = Standard Deviation

Source: Field survey, 2023

Environmental considerations also play a crucial role, as the "Need to reduce the impact of pig farming on the environment" (M=3.29; S.D=0.81) prompts action to align with sustainability goals. The "Social acceptability of climate-resilience innovation within the pig farming community" (M=3.29; S.D=0.69) and the "Support of the community and customers" (M=3.08; S.D=0.97) emphasize the

role of social dynamics in shaping adoption decisions. The "Risk involved in adopting and implementing climate-resilience innovations" (M=2.92; S.D=0.97) and the influence of "Government policies" (M=2.79; S.D=1.25) and "Government support for climate-resilience innovations" (M=2.00; S.D=0.89) further highlight the multifaceted nature of factors influencing decision-making processes, including perceived Risk and the regulatory context. These factors that affect the input suppliers are in accordance with the studies by (Ezeano et al., 2018).

The Ministry of Agriculture personnel's responses on key actors involved in the decision-making process of scaling climate-resilience innovations

The Ministry of Agriculture personnel's responses highlight several key actors significantly influencing the decision-making process of scaling climate-resilience innovations. These significant actors include Agricultural Development Program (ADP) Staff (M=3.70; S.D=0.48) and State Ministries of Agriculture at both local and general levels (M=3.70' S.D=0.48) emerge as pivotal decision-makers, demonstrating a high level of influence. At the same time, Pig Farmers (M=3.60' S.D=0.70) and Consumers (M=3.60' S.D=0.52) equally assert their substantial sway in shaping these critical decisions. The implications for prominent actors are that the strong presence of ADP Staff, State Ministries of Agriculture, Pig Farmers, and Consumers showcase their essential role in driving the scaling of climate-resilience innovations.

In addition to the significant actors, there are several other contributors with varying degrees of influence: Veterinary Professionals (M=1.60; S.D=0.70) and Agricultural Companies (M=1.60; S.D=0.52), though exerting comparatively lower influence, provide valuable insights and perspectives. Universities (M=2.10; S.D=0.74) and Financial Institutions (M=2.00; S.D=0.94) contribute to the decision-making process, albeit with slightly less impact. Furthermore, Research Institutions (M=2.70; S.D=0.95), Input Dealers (M=2.70; S.D=0.68), and Agribusinesses (M=2.20; S.D=0.79) display substantial involvement, indicating their meaningful contributions to the decision-making process, although not reaching the same level of influence as the principal actors. The implications for minor actors are that even though these actors may have a lower level of influence compared to the significant actors, their contributions are still valuable. Thus, it is essential to recognize and leverage their expertise and resources to enhance the effectiveness of climate-resilience initiatives. These actors are in concordance with the reports of the study (Olorunfemi et al., 2019).

Table 6 Ministry of Agriculture personnel responses on actors involved in the decision-making process of scaling climate-resilience innovations

Actors	Mean (M)	S.D
Ministry of Agriculture at the local level	3.80*	0.42
Agricultural Development Programme staff	3.70*	0.48
State Ministry of Agriculture	3.70*	0.48
Pig farmers	3.60*	0.70
Consumers	3.60*	0.52
Research institutions	2.70*	0.95
Input dealers	2.70*	0.68
Agribusinesses	2.20	0.79
Universities	2.10	0.74
Financial institutions	2.00	0.94
United Nations Framework Convention on Climate Change	1.80	0.79
Rural women	1.70	0.48
Veterinary professionals	1.60	0.70
Agricultural companies	1.60	0.52
Non-governmental organizations	1.40	0.97
Local communities	1.30	0.48

Agricultural scientist	1.30	0.68
Indigenous people	1.20	0.42

Cut off mean ≥ 2.5; S.D= Standard Deviation

Source: Field survey, 2023

Key actors involved in the decision-making process of scaling climate-resilience innovations. (Input supplier)

Table 7 shows the input suppliers' responses on the significant actors in the decision-making process of scaling climate-resilience innovations. The result shows that the pig farmers (M=3.92; S.D=0.41), Agricultural Development Programme staff (M=3.92; S.D=0.28), research institutions (M=3.75; S.D=0.44), the State Ministry of Agriculture (M=3.63; S.D=0.50), and the Ministry of Agriculture at the local level (M=3.75; S.D=0.53) were the principal actors. Other vital actors include financial institutions (M=3.79; S.D=0.59), the United Nations Framework Convention on Climate Change UNFCCC (M=3.88; S.D=0.34), agribusinesses (M=3.00; S.D=0.59) and agricultural scientists (M=3.00; S.D=0.51).

However, actors like consumers (M=1.83; S.D=0.48), rural women (M=1.83; S.D=0.64), non-governmental organizations (M=1.63; S.D=0.65), universities (M=1.54; S.D=1.02), indigenous people (M=1.46; S.D=0.59), local communities (M=1.42; S.D=0.50), and veterinary professionals (M=1.21; S.D=0.66), were minor actors in the decision-making of scaling climate-resilience innovation in pig production system. This distribution of means underscores the complex hierarchy of influence and participation within the decision-making process, with specific stakeholders playing more significant roles than others in the context of scaling climate-resilience innovations, which is in accordance with the study by (Ume et al., 2018).

Table 7 Key actors involved in the decision-making process of scaling climate-resilience innovations. (Input supplier)

Actors	**Mean (M)**	**S.D**
Pig farmers	3.92*	0.41
Agricultural development programme staff	3.92*	0.28
United Nation framework convention on climate change	3.88*	0.34
Financial institutions	3.79*	0.59
Research institutions	3.75*	0.44
Ministry of Agriculture at local levels	3.75*	0.53
State ministry of agriculture	3.63*	0.50
Agricultural companies	3.04*	0.62
Agribusinesses	3.00*	0.59
Agricultural scientists	3.00*	0.51
Input suppliers	2.21	0.78
Consumers	1.83	0.48
Rural women	1.83	0.64
Non-governmental organization	1.63	0.65
Universities	1.54	1.02
Indigenous people	1.46	0.59
Local communities	1.42	0.50
Veterinary professions	1.21	0.66

Cut off mean ≥ 2.5; S.D = Standard Deviation

Source: Field survey, 2023

The MOA personnel's perception of the challenges in scaling evidence-based climate-resilience innovations

The findings on the challenges Ministry of Agriculture personnel faced in scaling evidence-based climate-resilience innovations (Table 8) show that inadequate support from institutions and organizations plays a pivotal role as a significant barrier to scaling (M=3.70; S.D=0.48) is a major challenge. This underscores the need for more robust backing and collaboration in scaling. Similarly, limited access

to technology and innovation infrastructure (M=3.70; S.D=0.48), lack of financial resources (M=3.60; S.D=0.70), inadequate infrastructure and logistical challenges are also seen as impactful barriers (M=3.50; S.D=0.53), and absence of supportive policies and regulations is recognized as a challenge (M=3.40; S.D=0.70) were major challenges faced by the MOA personnel. These findings indicate the need to secure the necessary funding for the successful scaling of climate-resilience innovation and the signaling necessity for a conducive regulatory environment.

Other major challenges included limited awareness and understanding of the benefits of climate-resilience innovations are identified as a barrier (M=3.30; S.D=0.82), insufficient technical expertise and knowledge are acknowledged as hurdles (M=3.20; S.D=0.79), lack of coordination and collaboration among stakeholders is deemed problematic (M=3.20; S.D=0.63), and market barriers, such as limited demand or market access, are recognized as a hindrance to scaling climate-resilience innovation (M=2.50; S.D=1.35) of which these barriers affects the economic viability of these innovations. The findings suggest that addressing these challenges is crucial for successfully scaling evidence-based climate-resilience innovations in pig farming systems. Thus, it underscores the need for comprehensive strategies that focus on the technical aspects of innovation and tackle issues related to awareness, knowledge, collaboration, and market access, as noted by (Makate, 2020).

Similarly, the resistance to change and reluctance to adopt new practices are identified as minor challenges (M=2.40; S.D=0.84), indicating a need for targeted strategies to encourage adoption. Socio-cultural factors and traditional practices are noted as posing minor challenges to scaling (M=1.60; S.D=0.70), reflecting the complexity of integrating innovations into existing environments. These findings highlight the intricate nature of the landscape, emphasizing the necessity for comprehensive strategies to overcome challenges related to finance, technology, regulations, and collaboration. Such strategies are crucial for the effective scaling of climate-resilience innovations within pig farming systems in accordance with (Oladele et al., 2019).

Table 8 Addressing Challenges in Scaling Evidence-Based Climate-Resilience Innovations for Ministry of Agriculture Personnel

Challenges	Mean (M)	S.D
Inadequate support from institutions and organizations involved in the scaling of climate-resilience innovations is a significant barrier	3.70*	0.48
Access to technology and innovation infrastructure is necessary to scale climate-resilience innovations.	3.70*	0.48
More financial resource is needed to scale climate-resilience innovations.	3.60*	0.70
Inadequate infrastructure and logistical challenges impede the scaling of climate-resilience innovations	3.50*	0.53
The absence of supportive policies and regulations discourages the scaling of climate-resilience innovations.	3.40*	0.70
Limited awareness and understanding of the benefits of climate-resilience innovations act as a barrier to their scaling.	3.30*	0.82
More technical expertise and knowledge help the scaling of climate-resilience innovations.	3.20*	0.79
The lack of coordination and collaboration among stakeholders impedes the scaling of climate-resilience innovations.	3.20*	0.63
Market barriers, such as limited demand or market access, hinder the scaling of climate-resilience innovations.	2.50*	1.35
Resistance to change and reluctance to adopt new practices hinder the scaling of climate-resilience innovations.	2.40	0.84
Socio-cultural factors and traditional practices pose challenges to the scaling of climate-resilience innovations.	1.60	0.70

Cut off mean ≥ 2.5

S.D = Standard Deviation

Source: Field survey, 2023

The Input Suppliers perception of the challenges in scaling evidence-based climate-resilience innovations

Table 9 presents a comprehensive assessment of challenges inherent in scaling evidence-based climate-resilience innovations, focusing on input suppliers. The Table showcases various challenges, their respective mean scores, and standard deviations. These mean scores gauge the perceived significance of each challenge. Notably, challenges are centred around resistance to change and hesitancy in adopting new practices (M=3.88; S.D=0.61), illustrating the difficulty in ushering in novel climate-resilience innovations. The lack of financial resources (M=3.67; S.D=0.70) is a substantial barrier, underscoring the financial strain of implementing these innovations. Limited access to technology and innovation infrastructure (M=3.63; S.D=0.71) emerges as a key impediment, indicating the necessity of accessible tools and systems for effective scaling. Market barriers such as restricted demand and market access (M=3.54; S.D=0.93) present additional hurdles, potentially stemming from inadequate awareness or understanding of the innovations' benefits (M=3.46; S.D=0.59).

Moreover, the dearth of technical expertise and knowledge (M=3.25; S.D=0.74) compounds challenges, as does the influence of socio-cultural factors and traditional practices (M=3.13; S.D=0.90), collectively contributing to the complex landscape of scaling climate-resilience innovations. These challenges are further echoed by inadequate infrastructure and logistical complications (M=3.08; S.D=0.78), highlighting the essential role of well-functioning systems in the scaling process. Additional challenges include inadequate support from institutions and organizations involved in scaling (M=2.38; S.D=1.14), the lack of coordination and collaboration among stakeholders (M: 2.04), and the scarcity of technical expertise and knowledge (M=2.08; S.D=1.06). While these challenges have lower mean scores, they still bear significance as barriers to input suppliers' broader adoption of climate-resilience innovations. While some challenges appear more pronounced than others, all these barriers pose obstacles to scaling climate-resilience innovations effectively, as highlighted by (Olorunfemi et al., 2019).

Table 9 Challenges in scaling evidence-based climate-resilience innovations (Input suppliers)

Challenges	Mean (M)	S.D
Resistance to change and reluctance to adopt new practices hinder the scaling of climate-resilience innovations.	3.88	0.61
The lack of financial resources is a significant barrier to scaling climate-resilience innovations.	3.67	0.70
Limited access to technology and innovation infrastructure impedes the scaling of climate-resilience innovations.	3.63	0.71
Market barriers, such as limited demand or market access, hinder the scaling of climate-resilience innovations.	3.54	0.93
Limited awareness and understanding of the benefits of climate-resilience innovations act as a barrier to their scaling.	3.46	0.59
Insufficient technical expertise and knowledge hinder the scaling of climate-resilience innovations.	3.25	0.74
Socio-cultural factors and traditional practices pose challenges to the scaling of climate-resilience innovations.	3.13	0.90
Inadequate infrastructure and logistical challenges impede the scaling of climate-resilience innovations	3.08	0.78
Inadequate support from institutions and organizations involved in the scaling of climate-resilience innovations is a significant barrier.	2.38	1.14
Insufficient technical expertise and knowledge hinder the scaling of climate-resilience innovations.	2.08	1.06
The lack of coordination and collaboration among stakeholders impedes the scaling of climate-resilience innovations.	2.04	0.81

Cut off mean ≥ 2.5

S.D = Standard Deviation

Source: Field survey, 2023

4. CONCLUSION AND RECOMMENDATIONS

The study focused on pig farming, examining the roles, decision-making processes and challenges the MOA personnel and input suppliers faced in driving the scaling of evidence-based climate-resilience innovations. Thus, it becomes evident that MOA personnel and input suppliers influence the decision-making process of climate-resilience innovation. Amidst this, the road to scaling climate-resilience innovations in pig farming has its challenges.

The actors are faced with enormous challenges, including resistance to change, financial constraints, limited technology access, market barriers, awareness gaps, shortages in technical expertise, socio-cultural factors, and logistical complexities. The understanding of these challenges and addressing these challenges is paramount to the successful implementation of innovative practices. There is a need for improvement in harmonizing collaboration and coordination between MOA personnel and input suppliers, which could lead to more effective decision-making and better outcomes for scaling climate-resilience innovations in pig farming in Enugu North Senatorial District.

Based on the findings, the following recommendations were proffered:

1. There should be adequate provision of continuous training and capacity-building programs for the MOA personnel and input suppliers by research institutes to enhance their knowledge and skills in climate-resilience innovations. In line with these, they should be empowered through training and workshops, access to resources, and financial support.
2. Government policies should incentivize and support the scaling of climate-resilience innovations in pig farming, which encompasses financial incentives, regulatory frameworks, and assistance in accessing technology.
3. Pig farming actors should be aware of the benefits of evidence-based climate-resilience innovations through targeted education campaigns, and the potential positive impacts on productivity, profitability, and environmental sustainability should be highlighted.
4. Collaboration and partnerships are paramount between MOA personnel, input suppliers, pig farmers, and other stakeholders. Thus, efforts towards inclusive collaboration are essential to enhance the adoption and scaling of climate-resilience innovations.
5. Finally, financial support or grants to pig farming actors to offset the initial costs associated with scaling/adopting climate-resilience innovations should be made available to encourage wider scaling/adoption, especially among smaller-scale farm actors.

Acknowledgement

I acknowledge the participants and respondents who were all contributed samples to the study. Also, I will like to thank the guides, professors and lecturers from the department of Agricultural Extension, University of Nigeria, Nsukka, Enugu State, Nigeria.

Conflicts of interests

The authors declare that there are no conflicts of interests.

Informed consent

Oral informed consent was obtained from individual participants included in the study.

Ethical approval

Not applicable.

Funding

The study has not received any external funding.

Data and materials availability

All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Adeagbo OA, Ojo TO, Adetoro AA. Understanding the determinants of climate change adaptation strategies among smallholder maize farmers in South-west, Nigeria. Heliyon 2021; 7(2):e06231. doi: 10.1016/j.heliyon.2021.e06231

2. Adebayo JA, Worth SH. Women as extension advisors. Res Glob 2022; 5:100100.
3. Ahaotu EO, Osuagwu CO, Ihenacho RA, Nwachukwu EO. Studies on production performance of indigenous pig breeds of Delta State, Nigeria. Livest Res Int 2018; 6(2):48-51.
4. Ezeano C, Smiles U, Gbughemobi B. Effect of climate change on pig production and choice of adaptation strategies by farmers in southeast, Nigeria. Int J Res Dev 2018; 3(2):858-868.
5. IPCC. Climate Change 2014: Impacts, Vulnerability and Adaptation. Part B: Regional Aspects Contribution of the Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press 2014.
6. Makate C. Local institutions and indigenous knowledge in adoption and scaling of climate-smart agricultural innovations in sub-Saharan smallholder farmers. Int J Clim Chang Strateg Manag 2020; 12(2):270-287.
7. Mekonnen A, Tessema A, Ganewo Z, Haile A. Climate Change Impacts on Households Food Security and Farmers Adaptation Strategies. J Agric Food Res 2021; 6(1):100197.
8. Mekuriaw Y, Asmare B. Assessment of pig production and constraints in Mecha district, Amhara region, Northwestern Ethiopia. Adv Agric 2014. doi: 10.1155/2014/329254
9. Olorunfemi TO, Olorunfemi OD, Oladele OI. Determinants of the Involvement of Extension Agents in Disseminating Climate Smart Agricultural Initiatives: Implication for Scaling Up. J Saudi Soc Agric Sci 2019; 19(4).
10. Onyekuru NA, Ukwuaba IC, Aka EO. Economics of Piggery Enterprise in Nigeria: A Case Study of Udi Local Government Area of Enugu State, Nigeria. J Trop Agric Food Environ Ext 2020; 19(2):6-12.
11. Padu HU, Nalle AA, Nono OH, Lalus MF, Sembiring S. Level of Motivation and Adoption of Climate Innovation at Pig Farming in Southwest Sumba Regency. J Sain Peternak Indones 2022; 17(2):110-118.
12. Shyaka A, Quinnel RJ. Rujeni N, Fevre EM. Using a Value Chain Approach to Map the Pig Production System in Rwanda, Its Governance, and Sanitary Risks. Front Vet Sci 2021; 8:720553. doi: 10.3389/fvets.2021.720553
13. Ume SI, Ezeano CI, Onunka BN, Agu CI. Technical Efficiency of Pig Production in Enugu North Agricultural Zone of Enugu State, Nigeria. Int J Res Rev 2018; 5(9):61-69.