Pak. j. life soc. Sci. (2025), 23(2): 787-796 E-ISSN: 2221-7630;P-ISSN: 1727-4915

Pakistan Journal of Life and Social Sciences

www.pjlss.edu.pk

https://doi.org/10.57239/PJLSS-2025-23.2.00210

RESEARCH ARTICLE

Adaptation Strategies to Flooding Developed by Actors in the Maize Agricultural Value Chain in Southern Benin

Kolawolé Saïd Hounkponou[1,2]*, Rodéric Roland Singbénou Sagbo[2,3], Mondukpè Viviane Gbenou[3,4], Jules Laurent Mahouna Tchégnonsi[3], Sedjro Gilles Armel Nago[3,4], Jacob Afouda Yabi[1,2]

[1]Laboratory of Analysis and Research on Economic and Social Dynamics (LARDES), University of Parakou, Benin
[2]Doctoral School of Agricultural and Water Sciences, University of Parakou, Benin
[3]Laboratory of Ecology, Botany and Plant biology (LEB), University of Parakou, Benin
[4]Faculty of Agronomy, University of Parakou, Benin

ARTICLE INFO

Received: Aug 11, 2025

Accepted: Oct 2, 2025

Keywords

Climate Change
Adaptation Strategies
Maize Value Chain
Sociodemographic Factors
Benin

***Corresponding Author:**

kolawoles79@gmail.com

ABSTRACT

Maize is a cornerstone of the global economy, but its value chain is increasingly threatened by climate hazards like floods, particularly in developing countries such as Benin. This study examines the flood adaptation strategies of maize value chain actors in Southern Benin, hypothesizing that an actor's position and sociodemographic characteristics jointly determine their strategic choices. Using a mixed-sampling approach, we conducted semi-structured interviews with 1,128 actors across the value chain, including Input and seed suppliers, producers, animal feed manufacturer and suppliers, processors, traders, carriers, and consumers. Data on sociodemographic and adaptation strategies were analyzed using moderated logistic regression models. Our results reveal distinct adaptation strategies across actor groups. The most common strategy for Input and seed suppliers is selling in other municipalities (54.5%). The most common strategy for producers is drainage (28.3%), while animal feed manufacturer and suppliers most frequently adopt corn drying as strategy (75%). Processors most frequently adopt new income-generating activities (46%), while traders (41.3%) and carriers (55.1%) diversify by selling or transporting other goods. The most common strategy for consumers is the consumption of other products (34.9%). Crucially, our findings show that sociodemographic factors act as significant moderators. Gender strongly influences male consumers and processors' adoption of strategies. Age significantly moderates strategies for consumers and traders, while education level negatively moderates carriers' strategies, and positively moderates' processors and consumer' strategies. This research extends previous studies by providing a holistic, value chain-wide perspective, highlighting the need for targeted, context-specific interventions that account for the diverse characteristics of all actors.

INTRODUCTION

Maize is a globally significant crop, holding the top position in production volume (Ahangar et al., 2022) and playing a central role in the economy, nutrition, and culture (Alé Marinangeli et al., 2025). To optimize its yield, various approaches have been adopted, including sustainable techniques (Potratz et al., 2020), advanced pre-harvest yield prediction methods (Ma and Zhang, 2022), and genetic improvement (Díaz-Chuquizuta et al., 2025). However, the maize value chain faces considerable challenges from climate-related risks, which lead to reduced agricultural yields, increased grain prices, and difficulties in storage techniques (Yegbemey et al., 2014; Hounkponou et al., 2020; Gbedji et al., 2022).

Climate change presents a growing and multifaceted threat to global agricultural production (Fattahi et al., 2024). Extreme weather events like droughts and floods are particularly devastating for maize yields (Pickson et al., 2022; Fattahi et al., 2024; Wang et al., 2024) and hinder the development of rainfed crops (Teleubay et al., 2025; Mansoor et al., 2025). In response to these risks,

farmers adopt a cautious approach, especially as their crops are constantly threatened by abiotic and biotic stresses (Adnan et al., 2023; Mleziva and Ngumbi, 2024). The resulting losses and damages are receiving increasing attention (Liu et al., 2024). In developing countries, which are highly dependent on agriculture for income and employment, food security and local economies are severely impacted (Muslim, 2024).

In West Africa, these challenges are particularly pressing. Benin, a country highly vulnerable to climate hazards, sees its maize production heavily affected by floods (Ayedegue et al., 2020; Hounkponou et al., 2020). Flooding, a major abiotic stressor (Ngumbi and Ugarte, 2021), leads to a decrease in yields (Tian et al., 2020) and overall production (Yiran et al., 2022). This has cascading consequences for the entire value chain, including rising prices and storage difficulties (Yegbemey et al., 2014; Gbedji et al., 2022).

In the face of these threats, actors in the agricultural value chain (AVC) for maize have developed various adaptation strategies. Southern Benin, a major maize-producing region (Pomalegni et al., 2019), is also one of the area's most vulnerable to flooding (Soglo et al., 2018). While several climatic and non-climatic factors influence the success of agricultural adaptation strategies (Kabir et al., 2021; Bambani and Vodouhe, 2025), individual strategies can also be influenced by the actors' sociodemographic characteristics (Kabir et al., 2021; Masih et al., 2025).

This study aims to analyze the flood adaptation strategies developed by actors in the maize agricultural value chain in Southern Benin. The hypothesis is that the effect of an actor's position in the maize value chain on the type of adaptation strategy they adopt is significantly moderated by their sociodemographic characteristics.

MATERIAL AND METHODS

Study Area

This study was conducted in Southern Benin, specifically in the municipalities of Athiémé, Dangbo, and Ouidah (Figure 1). These areas are significant maize producers within agro-ecological zone 8 and are also highly vulnerable to flooding. The region experiences a bimodal Sudanian climate with four distinct seasons: a long rainy season (mid-April to early July), a short rainy season (September to November), a long dry season (December to early April), and a short dry season (late July to early September) (Togbé et al., 2024; Legba et al., 2025). The average annual rainfall ranges from 900 mm to 1300 mm, with an average annual temperature of 27°C and a relative humidity of around 80%. Extreme temperatures can reach up to 38°C (Houinato and Sinsin, 2001). The soils in the area are predominantly ferralitic, with additional patches of lateritic, clay, and hydromorphic soils (Houinato and Sinsin, 2001). Farmers in this region cultivate a variety of staple crops during the long rainy season, including maize, rice, cowpea, groundnuts, cassava, and soybean (Legba et al., 2025). Maize cultivation is also predominant during the short rainy season.

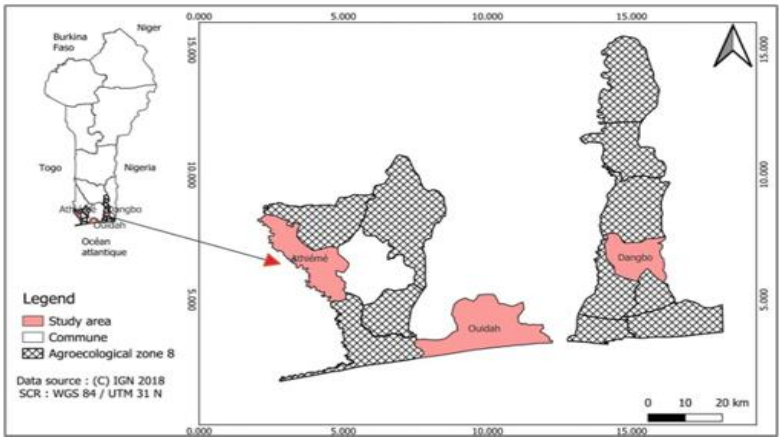

Figure 1: Study area

Sampling

A mixed-sampling approach (random and non-probabilistic) was used. The survey participants were actors from the maize agricultural value chain in the study area. An exploratory phase aimed to

identify all actors within the maize AVC, and the main survey phase was carried out. The types of actors surveyed were chosen based on the known links and participants within a typical value chain. A list of these actors was compiled from information obtained from relevant authorities. The sample size (Eq.1) was determined using the formula of Dagnelie (1998), as applied in previous studies by Ahononga et al. (2020) and Bambani and Vodouhe (2025):

$$n = (U^2_{1-\alpha/2}\, x\, p(1-p)) \,/\, d^2 \qquad (1)$$

where $U^2_{1-\alpha/2}$ (α =0.05) = 1.96, d the margin error = 5 %.

Due to the lack of updated or available lists of all value chain actors, a snowball sampling method was also used to identify additional survey participants (Johnston and Sabin, 2010; Naderifar et al., 2017). This mixed-sampling approach helped ensure a comprehensive representation of the various roles within the maize value chain.

In total, 1,128 actors (53% are men and 47% are women) over the age of 18 were surveyed, distributed as follows: Input and seed suppliers (16), producers (396), Animal feed manufacturer and suppliers (5), Processors (95), Traders (81), carriers (47), Consumers (488).

Data Collection

Data were collected from various local and communal actors involved at different levels of the agricultural value chain (AVC) through semi-structured interviews. Each survey was carried out after obtaining verbal consent from the participants (Gouwakinnou et al., 2019). The focus of the data collection was on their climate adaptation strategies and sociodemographic characteristics.

The data collected for this study included position in the value chain recorded as a binary variable (0=No,1=Yes) to indicate the actor's specific role; sociodemographic characteristics such as "Age": collected as a continuous variable, "Gender ": recorded as a binary variable (0=No,1=Yes), "Education level": categorized into an ordinal variable (0=None,1=Primary,2=Secondary,3=Higher), and adaptation strategies collected as binary variables, indicating whether a specific strategy was adopted (1) or not (0).

Data Analysis

After descriptive statistics, we ran moderated logistic regression models (Han and Jia, 2022) using R Studio (Posit team, 2024). The analysis used the dplyr, stats, broom, and purrr packages. These models were executed to investigate how sociodemographic variables moderate the relationship between an actor's position and their chosen adaptation strategies. The models were found to be globally significant, as the residual deviance was significantly smaller than the null deviance.

RESULTS

Figure 2 shows the different actors within the maize agricultural value chain (AVC) in the study area. Consumers represent the largest group of respondents, accounting for 43.3% of the sample. They are followed by producers (35.1%), processors (8.4%), traders (7.2%), and carriers (4.2%). The smallest groups are input and seed suppliers (1.4%) and animal feed manufacturers and suppliers (0.4%). The findings confirm that the maize AVC is composed of several key links: Supply (Inputs and seed suppliers), Production (Producers), Processing (Animal feed manufacturers and suppliers, and Processors) and Marketing (Traders, Carriers, and Consumers).

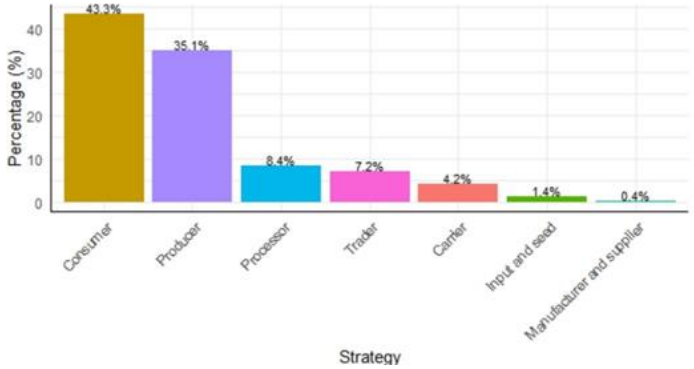

Figure 2: Distribution of main actors in the maize value chain

Adaptation Strategies to Flooding Developed by Actors in the Maize Agricultural Value Chain

Figure 3 presents the frequency of different adaptation strategies implemented by Input and seed suppliers. The most common strategy, cited by 54.5% of suppliers, is selling in other municipalities. This approach allows suppliers to meet demand in alternative locations when their primary markets are affected by flooding. The least adopted strategy is the sale of other goods, mentioned by 45.5% of suppliers.

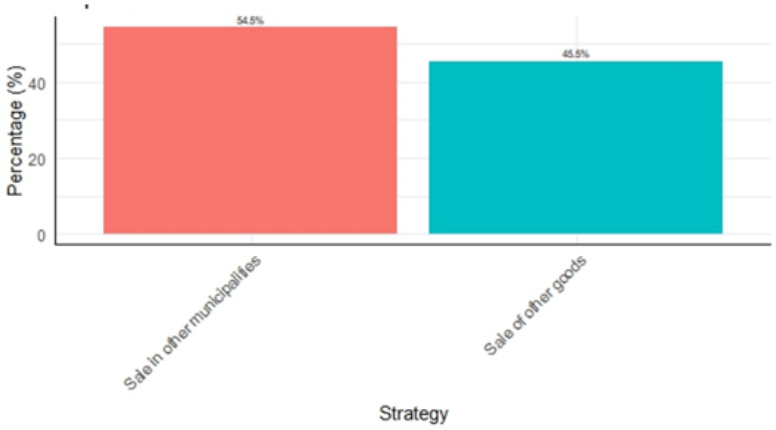

Figure 3: Frequency of Citation for the Different Adaptation Strategies Implemented by Input and Seed Suppliers

Figure 4 presents the frequency of different adaptation strategies implemented by Producers. Drainage is the most used strategy, cited by 28.3% of producers. This suggests that managing excess water is a primary concern for maize producers in this region. In contrast, the use of short-cycle seeds is the least adopted strategy, mentioned by only 0.8% of producers.

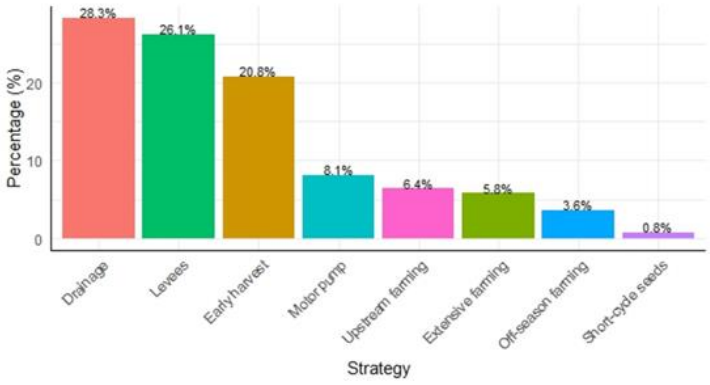

Figure 4: Frequency of Citation for the Different Adaptation Strategies Implemented by Producers

Figure 5 presents the frequency of different adaptation strategies implemented by Animal feed manufacturers and suppliers. The most strategy used by 75% of actors is corn drying. This is followed by the strategy of using corn as animal feed (25%), which involves using grains that are no longer suitable for human consumption due to the impacts of flooding.

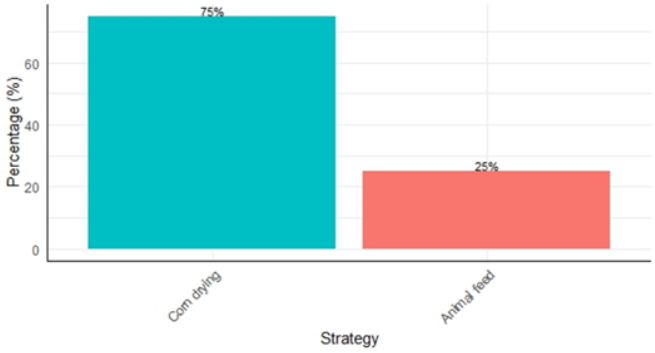

Figure 5: Frequency of Citation for The Different Adaptation Strategies Implemented by Animal Feed Manufacturers and Suppliers

Figure 6 shows the frequency of different adaptation strategies implemented by Processors. The most frequently used strategy in response to the high cost of maize caused by floods is new income-generating activities, cited by 46% of processors. This indicates that processors are actively seeking alternative sources of revenue to cope with rising raw material costs. Conversely, the least adopted strategy is corn drying, mentioned by only 10.3% of processors.

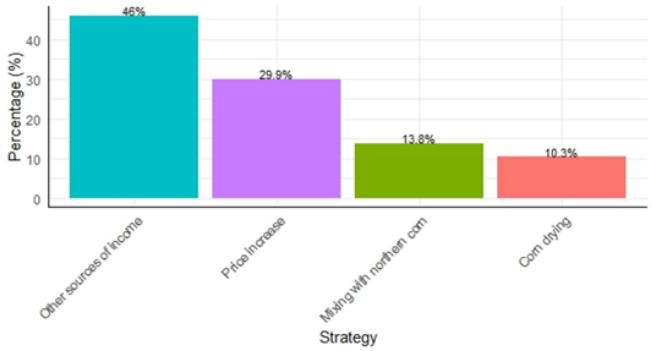

Figure 6: Frequency of Citation for the Different Adaptation Strategies Implemented by Processors

Figure 7 shows the frequency of different adaptation strategies implemented by Traders. The most common strategy, cited by 41.3% of traders, is the sale of other food products besides maize. This suggests that traders are diversifying their inventory to maintain economic resilience in the face of flood impacts. In contrast, the least adopted strategy is the development of new income-generating activities, mentioned by only 8% of traders.

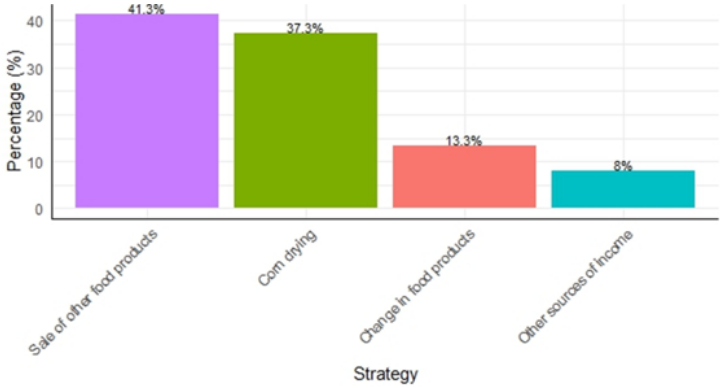

Figure 7: Frequency of Citation for the Different Adaptation Strategies Implemented by Traders

Figure 8 illustrates the frequency of different adaptation strategies implemented by carriers. The most common strategy, cited by 55.1% of these actors during flood periods, is the transport of other products besides maize. This indicates that carriers are diversifying their services to maintain their livelihood in response to disruptions in the maize value chain. In contrast, the least adopted strategy is the production of red oil, mentioned by only 4.1% of carriers.

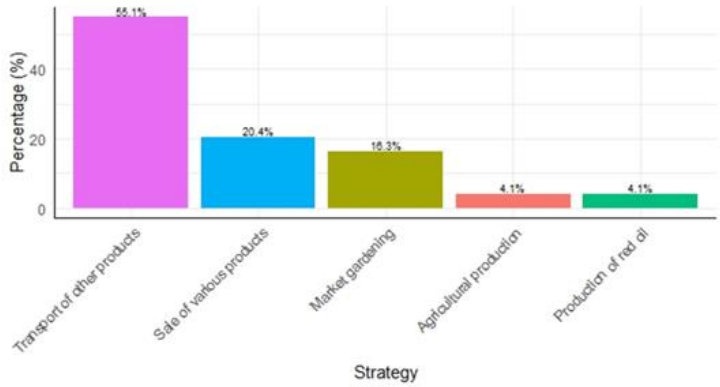

Figure 8: Frequency of Citation for the Different Adaptation Strategies Implemented by Carriers

Figure 9 shows the frequency of different adaptation strategies employed by consumers. The most frequently cited strategy is the consumption of other products, mentioned by 34.9% of consumers. This is a common response to the high cost of maize. Conversely, the least cited strategy is the development of new income-generating activities, mentioned by only 5.3% of consumers.

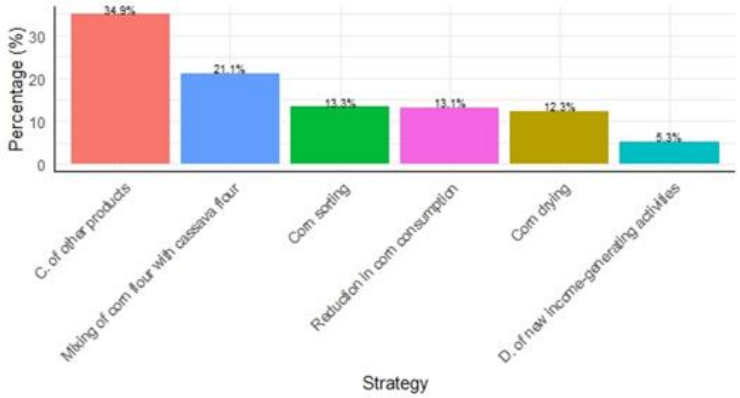

Figure 9: Frequency of Citation for the Different Adaptation Strategies Implemented by Consumers

Table 1 shows the moderation effects of socio-demographic characteristics on the relationship between maize value chain actor position and adaptation strategy.

Table 1. Significant Moderation Effects of Socio-Demographic Characteristics on the Relationship Between Maize Value Chain Actor Position and Adaptation Strategy

Model	Term	Estimate	p.value
Consumer vs CD	Consumer: Gender1	4.04	3.35e-10
Consumer vs MCFCF	Consumer: Gender1	4.68	7.04e- 9
Consumer vs SOFP	Consumer: Gender1	4.07	2.42e- 5
Consumer vs SOFP	Consumer: Age	0.0966	3.14e- 4
Trader vs SOFP	Trader: Age	-0.0889	1.13e- 3
Consumer vs RCC	Consumer: Gender1	2.67	2.82e- 3
Consumer vs NIGA	Consumer: Age	0.0537	7.12e- 3
Processor vs MCFCF	Processor: EL1	1.87	9.25e- 3
Carrier vs NIGA	Carrier: EL2	-3.04	1.29e- 2
Consumer vs NIGA	Consumer: EL1	1.69	1.62e- 2
Consumer vs RCC	Consumer: EL2	2.80	1.94e- 2
Trader vs CD	Trader: Age	0.0674	3.55e- 2
Processor vs CD	Processor: Gender1	2.88	4.51e- 2

Legend: (ISS: Input and Seed Suppliers; AFMS: Animal Feed Manufacturer and Supplier; CAP: Consumption of Alternative Products; MCFCF: Mixing of Corn Flour with Cassava Flour; CS: Corn Sorting; RCC: Reduction in Corn Consumption; CD: Corn Drying; NIGA: New Income-Generating Activities; SOFP: Sale of Other Food Products; DN: Drainage; LV: Levees; EH: Early Harvest; MP: Motor Pump; UF: Upstream Farming; EF: Extensive Farming; OSF: Off-Season farming; SCS: Short-Cycle Seeds; PI: Price Increase; AF: Animal Feed; TOP: Transport of Other Products; MG: Market Gardening; SVP: Sale of Various Products; PRO: Production of Red Oil; SOM: Sales in Other Municipalities).

The analysis of the data indicates that age, gender, and education level significantly moderate the relationship between an actor's position in the maize value chain and their chosen adaptation strategies.

Gender significantly moderates the strategies of consumers and processors. Specifically, being a consumer has a distinct influence on the adoption of strategies, as evidenced by the high coefficients for MCFCF, SOFP, CD and RCC for men compared to women. The coefficients (4.68, 4.07, 4.04, and 2.67) suggest that men are significantly more likely than women to adopt these four strategies. Furthermore, gender has a moderating effect on the CD strategy for processors, as indicated by a coefficient of 2.88 for men. For producers, carriers, traders, ISS, and AFMS, gender does not appear to be a significant moderating factor (p-value > 0.05).

Age significantly moderates the strategies of consumers and traders. Among consumers, a higher age is associated with an increased likelihood of adopting the SOFP and NIGA strategies, as shown by the positive coefficients of 0.0966 and 0.0537, respectively. Conversely, for traders, age has a mixed moderating effect. The negative coefficient of -0.0889 for SOFP indicates that the older a trader is, the less likely they are to adopt this strategy. However, the positive coefficient of 0.0674 for the CD strategy suggests the opposite: the influence of a trader's position on adopting this strategy increases with age. Age is not found to be a significant moderator for producers, carriers, processors, ISS, and AFMS (p-value > 0.05).

The level of education significantly moderates the strategies of processors, carriers, and consumers. For processors, education level (EL1) significantly influences the adoption of the MCFCF strategy, as indicated by a coefficient of 1.87. For carriers, a higher education level (EL2) is negatively associated with the adoption of the NIGA strategy, with a coefficient of -3.04. This suggests that carriers with an EL2 education are significantly less likely to adopt this strategy compared to the reference group (EL0). Among consumers, education level moderates the RCC and NIGA strategies, with coefficients of 2.80 (EL2) and 1.69 (EL1), respectively. Education level is not a significant moderating factor for producers, traders, ISS, and AFMS (p-value > 0.05).

The findings collectively indicate that while sociodemographic factors do not influence the strategic choices of all actors in the maize value chain, they play a crucial role for consumers, traders, processors, and carriers.

DISCUSSION

Influence of Sociodemographic Characteristics of Actors in the Maize Agricultural Value Chain on Flood Adaptation Strategies

This study analyzed the flood adaptation strategies of actors in Southern Benin's maize value chain, confirming our central hypothesis that the influence of an actor's position on their chosen strategy is significantly moderated by sociodemographic characteristics. Our findings not only validate existing research on agricultural adaptation but also extend it by taking a holistic, value chain-wide approach, which is often overlooked in favor of producer-centric studies.

The results confirm that adaptation is a complex, multi-faceted process influenced by an actor's intrinsic characteristics, such as gender, age, and education level. We found that these factors have a powerful moderating effect on the strategic choices of consumers, traders, processors, and carriers. For instance, male consumers were significantly more likely to adopt specific strategies, aligning with studies by Acevedo et al. (2020) and Adeagbo et al. (2023) that underscore the role of social differences in adaptation. Similarly, age-related patterns among consumers and traders and the significant effect of education level on the choices of processors, carriers, and consumers is also consistent with the literature, highlighting the importance of knowledge and human capital in building resilience (Yegbemey et al., 2014; Bedeke et al., 2018; Asare-Nuamah et al., 2021; Kabir et al., 2021; Takpa et al., 2022).

However, it's also notable that for certain groups, such as producers, input and seed suppliers, and animal feed manufacturers, these sociodemographic factors did not show a significant moderating effect. This suggests that other variables may be more influential for these actors (Bedeke et al., 2018; Acevedo et al., 2020; Yegbemey et al., 2020; Kabir et al., 2021; Bambani and Vodouhe, 2025).

For producers, factors like access to agricultural extension services, input availability, and membership in associations may play a more dominant role, as suggested by Kabir et al. (2021) and Bambani and Vodouhe (2025). This underscores that a one-size-fits-all approach to promoting climate resilience is ineffective and that interventions must be tailored to the specific needs and contexts of each actor type.

Implications of Results and Future Research Perspectives

Our findings have significant implications for policymakers and development organizations. To effectively strengthen the resilience of the maize value chain, interventions must move beyond general recommendations and consider the specific sociodemographic profiles of the targeted actors. Similarly, support for traders and carriers should recognize their primary strategy of diversifying their goods and services.

This study's value-chain approach and focus on moderation effects open several avenues for future research. While our research highlights the importance of gender, age, and education, further studies could explore the moderating effects of other factors, such as: social capital (How do factors like membership in associations, access to credit, and participation in awareness activities influence adaptation choices?), perception of risk (How do an actor's individual perceptions of climate change and flood risks mediate their adaptation behaviors?), and value chain-specific factors (What are the roles of agricultural assets, farm size, and access to inputs and extension services for producers, and how do they interact with sociodemographic variables to shape adaptation decisions?). By delving into these additional factors, future research can provide a more comprehensive understanding of the complex dynamics of climate change adaptation within agricultural value chains. This will enable the design of more precise and impactful interventions to build true resilience in vulnerable communities.

CONCLUSION

This study provides a comprehensive analysis of flood adaptation strategies across the entire maize value chain in Southern Benin. We confirmed our central hypothesis that sociodemographic characteristics specifically gender, age, and education level significantly moderate the relationship between an actor's position and their chosen strategies. Our findings highlight that while some actors, like producers, rely on traditional methods such as drainage, others, including consumers and traders, primarily adapt through diversification by changing their consumption or sales patterns. Adaptation is then a context-dependent process. The significant moderating effects we found demonstrate that a one-size-fits-all approach to resilience building is ineffective. Our research, by examining the entire value chain, provides crucial insights for policymakers and development organizations. Future interventions must be tailored to the specific characteristics of each actor to truly strengthen the resilience of the maize value chain. Further research could explore the roles of social capital and risk perception to provide a more holistic understanding of these complex dynamics.

Authors' Contribution

KSH performed the conceptualization, data collection, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, visualization, writing – original draft, writing – review and editing.

RRSS participated in the conceptualization, data curation, formal analysis, methodology, visualization, writing – review and editing.

MVG participated in the data curation, formal analysis, visualization.

JLMT participated in the data curation, formal analysis.

SGAN participated in the conceptualization, funding acquisition, formal analysis, methodology, validation, visualization, writing – review and editing.

JAY participated in the conceptualization, methodology, project administration, supervision, validation, visualization, writing – review and editing.

All authors read and approved the final manuscript.

Acknowledgments

The authors thank the Direction Départementale de l'Agriculture, de l'Elevage et de la Pêche (DDAEP) of Atlantique, Mono and Ouémé (Benin) for authorizations to collect data, the local populations, the local field assistant and the students who provided technical support for the work.

REFERENCES

Acevedo M, K Pixley, N Zinyengere, S Meng, H Tufan, K Cichy, L Bizikova, K Isaacs, K Ghezzi-Kopel and J Porciello, 2020. A scoping review of adoption of climate-resilient crops by small-scale producers in low- and middle-income countries. Nature Plants, 6: 1231-1241.

Adeagbo OA, AS Bamire, AA Akinola, AD Adeagbo, TS Oluwole, OA Ojedokun, TO Ojo, HS Kassem and CU Emenike, 2023. The level of adoption of multiple climate change adaptation strategies:

Evidence from smallholder maize farmers in Southwest Nigeria. Scientific African, 22: e01971.

Adnan KMM, SA Sarker, RAZ Tama, TB Shan, T Datta, MH Monshi, MS Hossain and K Akhi, 2023. Catastrophic risk perceptions and the analysis of risk attitudes of Maize farming in Bangladesh. Journal of Agriculture and Food Research, 11: 100471.

Ahangar MA, SH Wani, ZA Dar, J Roohi, F Mohiddin, M Bansal, M Choudhary, SK Aggarwal SA Waza, KA Dar and A El Sabagh, 2022. Distribution, Etiology, Molecular Genetics and Management Perspectives of Northern Corn Leaf Blight of Maize (*Zea mays L.*). Phyton-International Journal of Experimental Botany, 91: 2111-2133.

Ahononga FC, GN Gouwakinnou, SSH Biaou et S Biaou, 2020. Facteurs socio-économiques expliquant la déforestation et la dégradation des écosystèmes dans les domaines soudaniens et soudano-guinéen du Bénin. Annales De l'Université De Parakou - Série Sciences Naturelles Et Agronomie, 10: 43-60.

Alé Marinangeli G, CM Zabala and MC Páez, 2025. Maize cultivation in the northern Calchaqui Valley (Salta, Argentina) and its current importance for the food sovereignty of the local population. Historia Agraria, 95: 205-231.

Asare-Nuamah P, MS Mandaza and AF Amungwa, 2021. Adaptation strategies and farmer-led agricultural innovations to climate change in Mbire districtof Zimbabwe. International Journal of Rural Management, 18: 206-231.

Ayedegue LU, K Issaka and JA Yabi, 2020. Typologie et déterminants des stratégies d'adaptation aux changements climatiques en riziculture au Nord et Centre du Bénin. European Scientific Journal, 16: 206.

Bambani RC and FG Vodouhe, 2025. Impact of Integrated Soil Fertility Management on Farm Income in Corn and Soybean Production in Northern Benin. Pakistan Journal of Life and Social Sciences, 23: 826-835.

Bedeke SB, W Vanhove, MG Wordofa, K Natarajan and P Van Damme, 2018. Perception of and response to climate change by maize-dependent smallholders. Climate Research, 75: 261-275.

Dagnelie P, 1998. Statistiques théoriques et appliquées. Tome 1. Bruxelles : De Boeck et Larcier. pp: 1-517.

Díaz-Chuquizuta P, TW Jara-Calvo, HM Campos-Amasifuen, OA Valdés-Rodríguez and E Hidaldo-Melendez, 2025. Genetic advance through recurrent selection of half-sibling families cob per furrow, in hard yellow corn (*Zea mays*), in the tropics. Tropical and Subtropical Agroecosystems, 28: 1-13.

Fattahi S, KHA Ali and SA Mohammad, 2024. Climate change and economic sectors in developed and developing countries. Journal of Infrastructure Policy and Development, 8: 7137.

Gbedji BG, M-S Issa et E Ogouwale, 2022. Strategies d'adaptation des entrepreneurs en agrobusiness aux contraintes climatiques dans les communes d'Adjohoun et de Bonou au Sud Est du Benin. International Journal of Progressive Sciences and Technologies, 34: 134-148.

Gouwakinnou GN, S Biaou, FG Vodouhe, MS Tovihessi, BK Awessou and HSS Biaou, 2019. Local perceptions and factors determining ecosystem services identification around two forest reserves in Northern Benin. Journal of Ethnobiology and Ethnomedecine, 15: 1-12.

Han L and CX Jia, 2022. Treatments, Perceived Stigma, and Employment Outcomes among Substance Abusers in China. Healthcare, 10: 130

Houinato M et B Sinsin, 2001. Analyse phytogéographique de la région des Monts Kouffé au Bénin. Systematics and Geography of Plants, 71: 889-910.

Hounkponou SK, RRS Sagbo, SGA Nago, IA Hounkpe et JA Yabi, 2020. Perception et stratégies d'adaptation des producteurs et productrices de maïs de la commune de Dangbo face aux effets des changements climatiques. Revue ECD, 1: 105-124.

Kabir A, MN Amin, K Roy and MS Hossain, 2021. Determinants of climate change adaptation strategies in the coastal zone of Bangladesh: implications for adaptation to climate change in developing countries. Mitigation and Adaptation Strategies for Global Change, 26.

Legba EC, L Dossou, J Honfoga, L Pawera and R Srinivasan, 2025. Productivity and Profitability of Maize-Mungbean and Maize-Chili Pepper Relay Intercropping Systems for Income Diversification and Soil Fertility in Southern Benin. Sustainability, 17: 1076.

Liu S, Y-E Li, B Wang, A-D Cai, C Feng, H Lan and R-C Zhao, 2024. Challenges and countermeasures for developing countries in addressing loss and damage caused by climate change. Advances in Climate Change Research, 15: 353-363.

Ma Y and Z Zhang, 2022, A Bayesian Domain Adversarial Neural Network for Corn Yield Prediction. IEEE Geoscience and Remote Sensing Letters, 19: 1-5.

Mansoor, M., Khan, T. I., Jam, F. A., & Alasmari, M. (2025). From donations to devotion: how cause-related marketing frames drive brand evangelism through cognitive and social pathways in hospitality. *International Journal of Contemporary Hospitality Management*.

Masih, S., Punchanathan, U. E., Naqshbandi, M. M., & Ahmed, F. (2025). How inclusive leadership drives change-oriented extra-role behaviors via leader-member exchange and trust in leadership. *Global Knowledge, Memory and Communication*.

Mleziva AD and EN Ngumbi, 2024. Comparative analysis of defensive secondary metabolites in wild teosinte and cultivated maize under flooding and herbivory stress. Physiologia Plantarum, 176: e14216.

Muslim HS, 2024. The financial challenges of developing countries for climate change mitigation and sustainable development under UN Agenda 2030. Journal of Ecohumanism, 3: 1923-1935.

Pickson RB, P Gui, A Chen and E Boateng, 2022. Empirical analysis of rice and maize production under climate change in China. Environmental Science and Pollution Research, 29: 70242-70261.

Pomalegni SBC, NR Ahoyo Adjovi, CP Kpadé, DSJC Gbemavo, CM Allagbé, A Adjanohoun et GA Mensah, 2019. Capitalisation des études et autres travaux sur les chaînes de valeur du maïs au Bénin. Document Technique et d'Informations (DT&I). CNSMaïs, INRAB, ProCAD, MAEP, PPAAO/WAAPP, Bénin, 1-419.

Posit team, 2024. RStudio: Integrated Development Environment for R. Posit Software, PBC, Boston, MA. http://www.posit.co/.

Potratz DJ, S Mourtzinis, J Gaska, J Lauer, FJ Arriaga, SP Conley, 2020. Strip-till, other management strategies, and their interactive effects on corn grain and soybean seed yield. Agronomy Journal, 112: 72-80.

Soglo YY, C Amegnaglo et AF Akpa, 2018. Analyse de la perception des changements climatiques par les producteurs de maïs au Bénin. Cahiers du CBRSI: Lettres, Sciences Humaines et Sociales, 375-399.

Takpa OGMM, GP Tovihoudji, N Ollabode, PBI Akponikpe, et JA Yabi, 2022. Perception des producteurs des changements climatiques et stratégies d'adaptation dans les systèmes de culture à base de maïs (*Zea mays*) au Nord-Bénin. Annales de l'Université de Parakou Série « Sciences Naturelles et Agronomie », 12: 1-14.

Teleubay Z, SM Quiring and Z Leasor, 2025. Estimation of impacts-based drought thresholds for the U.S. Corn Belt. Agricultural and Forest Meteorology, 372: 110715.

Togbé EC, FA Ahohouendo, AA Badou, S Koènavoun Chogou and BC Ahohuendo, 2024. Diversity in agricultural practices among smallholder plantain-based farms across the Guineo-Gongolean zone of Benin Republic. Journal of Agriculture and Rural Development in the Tropics and Subtropics, 125: 175-184.

Yegbemey RN, JA Yabi, GB Aïhounton and A Paraïso, 2014. Modélisation simultanée de la perception et de l'adaptation au changement climatique : cas des producteurs de maïs du Nord Bénin (Afrique de l'Ouest). Cahiers Agricultures, 23: 177-187.

Yegbemey RN, S El hadj Imorou, DGB Aïhounton, JA Yabi, TA Kinkpe et M Atchikpa, 2020. Déterminants de l'adaptation des agriculteurs aux changements climatiques dans les zones du Nord Bénin et du Sud Niger. Annales de l'Université de Parakou Série « Sciences Naturelles et Agronomie », 10: 31-42.