RESEARCH ARTICLE Agricultural Science Digest, Volume 44 Issue 5: 823-829 (October 2024)

Agricultural Insurance Adoption in the Context of Climate Change: Influencing Factors in Benin (West Africa)

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10.18805/ag.DF-622

ABSTRACT

Background: Agricultural insurance has emerged as an effective climate risk management strategy in many African countries, but its adoption is still low in Benin. This study seeks to understand farmers′access and perception of agricultural insurance, while analyzing the factors that affect its adoption in the municipality of Ouèssè in Benin.

Methods: Using the method of snowball sampling, the research team collected data from 112 household heads, from six major maize-producing villages. With the data from focus group discussions and a structured questionnaire, we performed descriptive statistics and used the logistic regression model to analyze the factors influencing farmers′ agricultural insurance adoption.

Result: Our investigations revealed that almost all (95%) of the respondents have received agricultural insurance information at least once and about 94% of them found insurance useful for effective agricultural risk management. However, most of respondents (66.5%) lacked knowledge of loss assessment methods and 52% of them said that the insurance premium was too high for farmers. Most (95%) of the respondents who subscribed to agricultural insurance also received agricultural credit. The binomial logistic regression analysis revealed that adopting agricultural insurance is positively influenced by the farmers′ perception of the insurance, educational level, household size andaccess to agricultural credit. Implementing strategies that consider these influencing factors andpromote awareness, while building capacity and trust, could facilitate farmers′ adoption of agricultural insurance, especially in countries like Benin, where agricultural insurance is relatively new.

Key words: Adoption of agricultural insurance, Benin, Climate change adaptation, Risk management.

INTRODUCTION

Climate change is one of the greatest contemporary challenges in the world and influences agricultural production in many ways, especially in Africa, where most agricultural systems are rainfed (Dabesa *et al*., 2022; Gabriele *et al*., 2023). It has a direct and high impact on the agricultural sector, affecting food security, human health, economic growth anddevelopment in sub-Saharan African countries (Macassa *et al*., 2021). This impact is more keenly felt in developing countries where capital investment in agriculture is lower than in developed regions (Abeygunawardena *et al*., 2004). Benin, a developing country, located in West Africa, is one of the most vulnerable countries to climate variability and change in the world. According to the World Bank (2023), Benin ranks 152nd out of 182 in 2020, so it is considered a country with a high vulnerability level and a low readiness level, with critical adaptation needs that need financing. Climate change has already been felt in the country, with the latest decades being marked by mean annual temperature increases, fewer rainy days per year, with a shift of precipitation regimes andincreased frequency and intensity of droughts and floods (MCVDD, 2022). According to Aho *et al*. (2018), by 2100, temperatures may rise by as much as 2°C or even 4°C, while rainfall will become more erratic, within and between years, leading to more frequent flooding and droughts. In addition, the latest report of IPCC (2022) has projected significant declines in the performance of the most common crops in many African countries, including Benin, unless appropriate and anticipatory adaptation climate measures are considered. Several strategies will help to adapt to the dramatic effects of climate change. These include techniques for integrated soil fertility management, new drought-resistant crop varieties andagricultural insurance (Singh *et al*., 2018; IPCC, 2022).

Agricultural insurance (AI) is a modern, efficient risk management strategy which can make agricultural systems more resilient and allow farmers to manage climate change (Hari Krishna *et al*., 2019; Madaki *et al*., 2023). It makes livestock keepers, crop farmers, food security and household livelihoods more resilient (IPPC, 2018). Because of its importance and potential benefits, agricultural insurance is often regarded as one promising

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How to cite this article: Zoundji, G.C., Magnon, Y.Z. and Adjaka, F.N. (2024). Agricultural Insurance Adoption in the Context of Climate Change: Influencing Factors in Benin (West Africa). Agricultural Science Digest. 44(5): 823-829. doi: 10.18805/ag.DF-622.

Submitted: 11-05-2024 **Accepted:** 27-08-2024 **Online:** 24-09-2024

climate change adaptation strategies in the world (ARC, 2020). AI plays a key role in risk finance and contributes to climate change adaptation in many Asian and European countries in the world (Bucheli *et al*., 2023). AI could build farmers' financial resilience, reduce vulnerability andstrip away risk and uncertainty in face of climate impacts (Krishna Hari *et al*., 2019; Madaki *et al*., 2023). Raising awareness and helping farmers in developing countries, to assess of AI can be a viable tool to manage increasing climate risks and promote food security (Madaki *et al*., 2023).

To revive the agricultural sector and cope with climate change, the Government of Benin decided to establish the Mutual Agriculture Insurance of Benin (Assurance Mutuelle Agricole du Bénin, AMAB) with government and farmers' organizations as shareholders (Kestemont *et al*., 2020). AMAB is the only supplier of AI in Benin, offering various insurance products (multi-risk harvests, livestock mortality, conservation and storage of agricultural products) to farmers (Sagna *et al*., 2021). This program is designed to compensate the insurance subscriber in case of maize production losses resulting from climate change, in particular weather. AMAB program is based on climatic indexes to compensate the insurance subscriber. The amount of this compensation depends on the water deficit in the study area. Indeed, enough water for the crop growing is estimated beforehand using historical data on rainfall and crop yields. After assessing the quantity of water needed for the crop growing, an emergency release threshold is defined. Thus, the insurance institution compensates the insured in case of drought or flood. Generally, the period covered by the insurance contract is about four months, the crop growing season starting from May, June or July of each year. As an important condition, farmers must pay an insurance premium of 20 USD per hectare to subscribe to the AI. However, to encourage farmers to subscribe to AI, AMAB collaborated with a microfinance institution called ″SIAN′SON″ to provide agricultural credit to farmers. For several years, the AMAB has widely disseminated its products and services throughout the country. Unfortunately, after more than seven years of implementation, in 2019 AMAB stopped working, because of the low rate of AI adoption in the country (MAEP, 2021). Previous studies have focused on farmer awareness of AI (Hountondji *et al*., 2018), farmers′ participation in index-based insurance services (Hountondji *et al*., 2019) andthe contribution of index-based AI to strengthening the resilience of family farms (Aguida *et al*., 2021). Few studies have analyzed the factors that influence farmers′ adoption of agricultural insurance in Benin (Aguida *et al*., 2021). Hence, empirical research is needed on the main factors that affect the agricultural insurance adoption. The present research seeks to fill this knowledge gap, by understanding farmers′ access and perception of AI and analyzing the determining factors.

The theory of innovation adoption served as a guiding principle for this study. Indeed, many authors have shown that agricultural innovation adoption decision-making processes occurs in a complex and dynamic environment where farmers are exposed to several development conditions such as social, economic, political and ecological change (Hayden *et al*., 2021; Vyas *et al*., 2022). Agricultural innovation adoption is a nonlinear and social phenomenon, where farmers' capabilities, social networks anddecision-making are fundamental factors to guarantee success (Zoundji *et al*., 2020). Thus, decision-making theories, which analyse how people behave under risk and uncertainty, are often used by researchers to highlight the main role of extrinsic (characteristics of the technology and attributes of the external environment) and intrinsic factors (people′s knowledge, attitudes and perceptions) of innovation adoption (Meijer *et al*., 2015). The same author highlighted that farmers' perception refers to the views that they hold based on their needs, experiences, knowledge and expectations of profitability. This perception changes over time as the farmers gain new experiences and knowledge (Zoundji *et al*., 2020).

MATERIALS AND METHODS

Study area and sampling

The present study was conducted in the municipality of Ouèssè, which is located between 8° and 8°45′ North latitude and 2° and 2°10′ East longitude, in the department of Collines, in the central region of Benin. This municipality is a large food producing area and has experienced significant climate risks. This municipality was chosen first, because it is vulnerable to climate change, second, because it received the first office of AMAB in the country with the most agricultural insurance (AI) subscriptions andthird, due to the importance of maize growing, one of Benin′s main staple foods (Hountondji *et al*., 2018). Six villages were selected for study in the municipality: Ouèssè, Gbanlin, Odougba, Kilibo, Ikèmon andChalla-Ogoï. These villages were selected based on the importance of the agricultural insurance subscription, the importance maize crop production andthe accessibility of the villages.

Data collection

Data was collected in two phases from October 2022 to January 2023. The first phase was exploratory, consisted of making contact with people and organisations, reconnaissance andintegration into the study area. During this exploratory phase, an interview guide was used to gather initial data from the main key actors, such as the director of AMAB, the chairperson of the board of AMAB, the technician of the AMAB office in the study area, the person in charge of the Territorial Agency for Agricultural Development andthe agricultural extension officer. These actors participated in the AI implementation as resource persons. Discussions with them were organized in the form of exchanges on the AMAB's activities and their perceptions of the factors that explain the results obtained and perspectives.

In the second phase, the snowball sampling method (Vogt, 1999) was used to select 112 household heads that were involved in maize crop production from six main villages; 56 of them had subscribed to agricultural insurance and 56 had never subscribed to it. Maize farmers were selected for this study because AMAB worked in the study area to reduce the risks linked with climate change on maize production. Farmers were selected based on their willingness to participate in the study and if they had had a constant presence in the municipality since the beginning of AMAB activities.

A mixed method approach (qualitative and quantitative) was used for data collection. A mixed method research is increasingly recognized as valuable, because it can potentially capitalize on the respective strengths of quantitative and qualitative approaches (Östlund *et al*., 2011). In addition, qualitative insights can strengthen or complement the statistical analyses from quantitative data (Leech *et al*., 2007). The qualitative approach aimed to acquire a better understanding of the mechanisms related to access to agricultural insurance and the perspectives of farmers. Qualitative data were collected through 12 focus group discussions (FGD) (two per village). A FGD included a maximum of ten people and a minimum of eight, per Greenbaum (1999) who suggested seven to ten people for a FGD. The main themes of the FGDs were farmers' access and perception of AI and influencing factors of adoption. A semi-structured questionnaire for household heads was used to collect the quantitative data related to farmer's socio-economic characteristics, their perception and adoption of an AI.

Data analysis

Descriptive statistics were used to calculate the means, frequencies and standard deviations of the various socioeconomic indicators. We used the logistic regression model to analyze the factors influencing agricultural insurance adoption. The choice of this model is based on its capability to operationalize distribution calculations (Gujarati *et al*., 2004; Iortyom *et al*., 2018). This model has been used by previous studies of technology adoption (Hountondji *et al*., 2019; Gbemavo *et al*., 2014). This is one of the simplest approaches for establishing connections between the probability of choice and the variables that can explain that choice.

The theoretical model is as follow:

$$Y = f(X, e) \quad ...(1)$$

With

Y: Dependent variable.

X: matrix of variables likely to explain the variation of Y.

e: logistical error of distribution.

Let Pi be the probability that the Logit associates with the survey unit.

$$Pi = F(I_i) = \frac{1}{1+e^{-It}} \quad ....(2)$$

And $I = \alpha_0 + \alpha_1 X_{i1} + \alpha_2 X_{i2} + \alpha_3 X_{i3} + \ldots\ldots\ldots + \alpha_n X_{in} + e_j$

With:

I_i: Vector which represents the characteristics of the survey unit, its environment and the object of its choice; α_i: Coefficients of the explanatory variables.

X_{in}: Explanatory variables.

The empirical model is written in the form:

$$Y = \alpha 0 + \alpha 1 \text{PERCEPTION} + \alpha 2 \text{ACTIVITY} + \alpha 3 \text{PROXIMITY} + \alpha 4 \text{EDUCATION} + \alpha 5 \text{HOUSEHOLD} + \in i$$

Results obtained from the quantitative data were discussed and interpreted by using the qualitative data.

Results and Discussion

Socio-economic characteristics of respondents

Most farmers surveyed were men (88.4%), mainly from the "Mahi" ethnic group, the most widely spoken local language of the respondents (52.7%), with an average age of 52 years. Most were married (91%). There was an average of seven household members. Most respondents (67.9%) had a primary school education andtheir main occupation was agriculture (67.0%). Most (75.9%) respondents were members of farmers' associations, with more than 23 years' experience in agriculture and 55.4% of them had access to agricultural credit.

Access to agricultural insurance (AI) services or benefits requires farmers to have a broad understanding of these services. To achieve this, AMAB established an information dissemination mechanism based on awareness. This was done through two main sources, the AMAB field agents and informal networking (peers, relatives, other farmers). AMAB field agents held awareness campaigns at the AMAB office in the municipality, where the agent explained to farmers the conditions and procedures for subscribing to the agricultural insurance. Awareness-raising sessions were also held once a week on Ouèssè rural radio, with the AMAB field agent who proposed a theme for each weekly broadcast. About 95% of respondents received AI information at least once. Most of them (64%) got information via the radio, 21% by awareness campaigns in the AMAB office and 15% through the informal networking (peers, relatives, other farmers).

Respondents' perceptions of agricultural insurance

The respondents described agricultural insurance (AI) in various ways, based on their farmers' level of education and their ethnic group (Table 1). Those with less formal education refer to agricultural insurance as "AMAB," which is the name of the organization that provided the services. In contrast, those with more education simply refer to it as AI: "assirance gléton" (in local language "Fon" or "Mahi"). About 94% find AI useful for effective agricultural risk management and 95% appreciate potential benefits such as access to agricultural credit. Among non-subscribers, 12.5% consider AI to be uneffective. Most respondents (65.2%) dislike the AMAB management style. About 60% of

respondents find the AI program to be relevant; 51.5% of them perceive that the insurance premium is high, but the amount and timing of compensation payment are in line with the farmers′ expectations. However, most (66.5%) respondents lack knowledge of loss assessment methods.

Overall, 62.5% of the respondents have a favourable perception of AI, while 21.8% hold an unfavourable view. A few respondents (15.7%) are indifferent to agricultural insurance.

Factors influencing the adoption of agricultural insurance

Table 2 presents data from the logistic regression and reveals that the model exhibits good predictive and estimative properties. Of the five variables introduced into the model, three are significant. Agricultural insurance adoption is positively influenced by farmers′ perception of agricultural insurance, household size and education level. There was a statistically most significant relationship between producers' perception ($p \leq 0.01$) and their decisions to adopt agricultural insurance. This indicates that producers with a favorable perception of agricultural insurance tend to choose to adopt it rather than not. A statistically significant relationship was found between household size ($p \leq 0.05$) and producers′ decisions to adopt agricultural insurance. Farmers with a higher number of household members were more likely to engage in the agricultural insurance as climate change adaptation strategies. Education level ($p = \leq 0.10$) influence also on the farmers' decisions to engage in agricultural insurance for climate change adaptation. Educated producers tend to adopt agricultural insurance more than others.

Respondents' perception of agricultural insurance

Most farmers who took part in this study were aware of the agricultural insurance (AI) program, mainly because of rural radio. Rural radio plays an important role in disseminating AI information and increasing households′ level of knowledge of innovations in Africa (Ankrah *et al*., 2021). Agricultural innovation adoption depends on the farmers' perceptions (Meijer *et al*., 2015). In this study we found that respondents′ perceptions of agricultural insurance, level of education andhousehold size significantly influenced AI adoption. Farmers perceived AI as relevant for managing risks linked with the changing climate. However, farmers thought that the insurance premium was very high and that the AMAB management style was not inclusive. Farmers' negative perception of AI contributed to low insurance uptake (Mensah, 2023).

Farmers′ knowledge of AI explained their perceptions of it. For example, a farmer who can provide accurate information about the products offered by agricultural insurance, the insurance premium andthe claims process is likely to have a positive perception of AI. A farmer's

Table 1: Farmers′ perception of agricultural insurance.

Perceptions		Modality	Frequency (%)		
			Subscriber (n=56)	No subscriber (n=56)	Total
Benefits of agricultural insurance	Effective agricultural risk management	Yes	100	87.5	93.8
		No	0	12.5	6.3
	Possibilities of gaining benefits	Yes	100	89.3	94.7
		No	0	10.71	5.35
AMAB management and insurance importance	Management of AMAB	Good	44.7	25	34.8
		Bad	55.4	75	65.2
	Relevance of agricultural insurance	Relevant	51.8	68	59.9
		Irrelevant	48.2	32	40.1
Insurance premium	Premium to be paid by the farmer	High	42	61	51.5
		Acceptable	58	39	48.5
Payment of compensation	Amount and timing of compensation payment are in line with expectations	Yes	32	15	23.5
		Acceptable			
		No	57	42	49.5
			11	43	27
Loss assessment methods	knowledge of loss assessment methods	Yes	22	1	11.5
		Acceptable	41	4	22.5
		No	37	95	66.5
Global perception of agricultural insurance program		Favorable	85	40	62.5
		Unfavorable	7	36.6	21.8
		Indifferent	8	23.4	15.7

Table 2: Binomial logistic regression on the agricultural insurance adoption.

Variables	dy/dx marginal effect (Std.Err)
Overall perception	0,4109235 ***
	(0,4673119)
Main occupation	0,1835568
	(0,4869096)
Household size	0,2004961**
	(0,4443777)
Level of education	0,3604279*
	(0,4844739)
Proximity to the AMAB office	- 0,0879825
	(0,4536911)
Cons	(0,4401485)

N= 112; Log likelihood = - 62,619476; Pseudo R2 = 0,1934; Prob > chi2= 0,0000; LR chi2 (5) = 30,03; * = p≤0.10; ** = p≤0.05; *** p = ≤0.01.

experience with AMAB, such as non-compensation after a loss, or exclusion from certain services, can lead to a negative perception. When the products and services offered by AMAB do not align with farmers' needs or are difficult to understand, farmers may have a poor opinion of insurance. Perception can strongly influence AI adoption.

Factors influencing the adoption of agricultural insurance

Educational levels clearly influence the adoption of AI (Carrer *et al*., 2021). The present study showed that educated farmers tend to understand more about AI and grasp the concept more easily upon their initial contact with awareness agents. Literate farmers are more likely to understand concepts like premiums and compensation. In contrast, less educated farmers may require more time and help from an educated person to truly understand agricultural insurance. Nshakira-Rukundo *et al*. (2021) also found a positive effect of education on the farmers' decision to pay an insurance premium. Bharati *et al*. (2014) observed a positive impact of education on agricultural insurance adoption in Bihar, India. A study in Morocco showed that education significantly and positively influenced the adoption of agricultural insurance using a Tobit model, suggesting that education can be shown to influence agricultural insurance adoption, even when using different econometric models (Ezzahid *et al*., 2020). Education does not automatically lead to the adoption of agricultural insurance, but it facilitates the process and shortens the decision-making phase (Ankrah *et al*., 2021). Education is a key factor influencing the adoption of land management innovation as it enables a certain capacity for analysis and decision-making (Ighodaro *et al*., 2021; Adjiba *et al*., 2021). Farmers or those with secondary and university-level education are better equipped to comprehend information about agricultural insurance and recognize it advantages early on.

Few studies have considered household size when explaining the AI adoption. Our study showed that farmers with larger household are more interested in managing farm risks. To fulfill their role as heads of households, they invest more in reducing their risks. On the other hand, some farmers may not be interested because a smaller household does not allow them to invest without a clear benefit. They prefer to find alternative activities that are more profitable for them rather than buying AI. It may be more profitable for a farmer with a small household to subscribe to insurance than for a farmer with a large household. Household size can influence the adoption of AI and technologies (Ntukamazina *et al*., 2017). However, a study by Adjiba *et al*. (2021) found that the effect of household size is unclear since it can influence the adoption of agricultural innovations related to sustainable land management both positively and negatively.

The study has revealed another factor that can influence the uptake of agricultural insurance. To encourage farmers to subscribe to AI, AMAB collaborated with a microfinance institution called "SIAN'SON" to provide agricultural credit to farmers. The agreement was meant to improve access to agricultural credit and promote the subscription to AI. AMAB made it clear to farmers that it could help them obtain agricultural loans, but before getting these loans, they needed to join AMAB and buy agricultural insurance. The membership fee was 10 USD andthe insurance premium amounted to 20 USD per hectare. Each farmer could access up to 200 USD per hectare. This incentive led many farmers to subscribe to insurance and renew their insurance contract at least once. Linking agricultural credit and insurance can lead to greater adoption of AI.

Aguida *et al*. (2021) found low subscription and adoption of AI in northern Benin, where farmers genuinely need financial support for their activities. However, they often struggle to repay their debts. When they take out loans, they frequently face difficulties in repaying them due to unforeseen circumstances such as the effects of climate variability and change impacting their farming products, low crop prices andmore. AMAB also aimed to help farmers repay their loans in the event of a loss. This was the mistake of AMAB, as some farmers couldn't repay their debt to the microfinance institution, even when there was no loss. Thus, after two years of unpaid debts, the microfinance institution terminated its collaboration with AMAB. Farmers, accustomed to subscribing to agricultural insurance with the money coming from loans provided by the microfinance institution, were now required to renew their insurance contract at their own expense, which was difficult for them. AMAB subsequently saw significantly fewer subscriptions in the year following the termination of the partnership with the microfinance institution andover time, it eventually closed its doors.

CONCLUSION

Enhancing the resilience of farmers to face the adverse effects of climate change in Benin is a major challenge for

agricultural development. This study focused on the influencing factors of agricultural insurance adoption in the context of climate change, in Benin. Farmers perceived agricultural insurance as relevant for managing climate change risks. However, farmers thought that the insurance premium was very high and limited their adoption capacities. Farmers' perception of agricultural insurance, education level, household size andagricultural credit influence the agricultural insurance adoption. We conclude that the success of agricultural insurance depends on the quality of information disseminated to potential beneficiaries and on the quality of insurance products and farmers' experience with them. Measures should be taken to improve the services and offerings of institutions responsible for agricultural insurance and to incorporate agricultural insurance as a required farm expense to reduce the risk that farmers face.

A limitation of the study is that it does not distinguish between the different types of agricultural insurance products (multi-risk harvests, conservation, storage of agricultural products *etc.*) used by farmers in the study area. Future research on this limitation is needed to explore more the potential contributions of agricultural insurance in climate change adaptation.

ACKNOWLEDGEMENT

The authors are also grateful to the many farmers who generously gave their time to collaborate in this study. We thank the anonymous reviewers and journal editor for their helpful comments and suggestions.

Conflict of interest

The authors declare no conflict of interest.

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