Coping Strategies and Vulnerability of Farmers

under the Moderating Effect of Associative Dynamics: Empirical Evidence from Farmers in the Highland Zone of the Baswagha Chiefdom in the Lubero Territory

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Abstract

In the Democratic Republic, as elsewhere, agriculture is a sector exposed to climate change. Its importance in the socio-economic balance of households is not to be denied. Atmospheric changes and rainfall instability keep agriculture exposed to climate stress and its consequences. Captured through exposure, sensitivity, and adaptive capacity, vulnerability is nothing more than a predisposition to experience damage. The exposure of agriculture in the sense of vulnerability is of two kinds. It is both intrinsic and extrinsic. This refers to the conceptual definition that vulnerability is both a factor specific to agriculture and a characteristic of the farmer himself. In addition to the sector, there are the socio-demographic and economic characteristics of each farmer. This article assesses the moderating role of associative dynamics on the coping strategies and level of vulnerability of farmers in the highland area of the Baswagha Chiefdom, in Lubero territory, Democratic Republic of Congo. The data presented are from a survey of 409 heads of households in 5 groups. The results are such that associative dynamics modify the direction of the relationship between coping strategies and vulnerability of farmers, who are exposed at 62.05%; sensitive at 57.54%; have a coping capacity of 35.45%, and are, therefore, vulnerable at 38.36%.

Keywords: vulnerability, exposure, sensitivity, adaptive capacity, coping strategies, associative dynamics
1. Introduction

The importance of agriculture is not the same in the North as in the South [1], [2] and is hard to be demonstrated. Small-scale farmers represent 75% of the world's agricultural area, 60% of employment, and produce more than 80% of food in developing countries [3]. It represents more than 23% of GDP in the third world, low-income countries, 10% in emerging countries, and 2% in developed countries. The active population engaged in agriculture does not exceed 30% in third-world countries [4]. The preponderant role recognized in agriculture is that it allows the population to ensure good health through food. Beyond its considerable benefits, agriculture is a sector, in all respects, is exposed to risks [5] and leads to climate change [6]. Higher temperatures, lack of rainfall, or abundance of rainfall reduce crop yields and threaten food security and lead to poverty [7]. The influence of agriculture on climate change is stated in comparison to the emission of greenhouse gases [8].

To minimize their exposure to risks and hazards, farmers choose very flexible and autonomous mechanisms [9], active or reactive [2], defensive or offensive [10] to the environment, and decide unilaterally on their importance [11], [12]. They take charge, very often in the reinforcement of their cooperative and/or mutualist capital [13] to reduce their sensibility as well as their vulnerability [11], [14]. Consequently, their resilience is based on the choice of strategies for anticipating and managing risks [10]. Upstream, mainly, they resort to informal finance and participate in networks and cooperatives to maximize the chances of reducing their vulnerability [11], [14].

Many farmers in developing countries experience recurrent problems in their field activities. Often it is the poverty-risk-shock interaction that determines their exposure and ability to cope or not [15], [3], [7]. The measurement of vulnerability is of particular importance when looking at the well-being of the poor [16], [6]. Farmers in developing countries evolve in a very difficult context and develop, in fact, instruments for forecasting, preventing, and mitigating risks to their occurrence [17], observed both by the irregularity of rainfall, rising temperatures, late start and early end of rains, rainfall breaks but also non-climatic factors such as salinization of land and soil degradation [18], [2], [7] that lead to poverty [19].

The Democratic Republic of Congo is not immune to this global consideration [20]. Congolese agriculture occupies nearly 70% of the active population and the malnutrition rate of children under 5 years of age is 30.70% in 1995; increase to 33.60% in only 7 years. Between 2010 and 2013, the situation is trying to improve and goes from 24.20% to 23.20% but its effects remain disastrous, with its potential, the country is capable of feeding about 2 billion people in the world [21].

There is no need to demonstrate that North Kivu Province is one of the provinces of the country that abounds in immense and fabulous human, economic, agricultural, mining, fishing, tourist, and commercial resources necessary to ensure its economic growth. 20] However, its economy remains under the yoke of poverty and continues to deteriorate as a result of crises.
Agriculture is an essential, if not the main, vector for job creation, wealth generation, and the channel for growth in North Kivu Province. The possession of fertile land (Masisi, Lubero, Walikale, Rusthuru, etc.) is an undeniable source of benefits. Despite the importance of these potentialities, almost the entire population of the Territory of Lubero manifests very acute food insecurity where satisfying food needs is the result of hard work that is more than proportional to the gains they make from it. Thus, they gradually come to understand the importance of joining village and peasant farmers' associations as a source of extrinsic protection. They unilaterally decide to join one or more associations in the growing area because of the benefits they hope to gain from joining.

The objective of this article is to measure the level of vulnerability of farmers in the highland zone of the Baswagha Chiefdom in the Lubero Territory of North Kivu Province. The aim is to analyze the level of vulnerability, and its relationship with the choice and use of coping strategies under the moderation of participation in agricultural organizations (associations/cooperatives).

Vulnerability is a composite variable, captured using three variables [22], [23], [16], [18], [17]. These are exposure, sensitivity, and adaptation. Its three components are essentially made clear considering the following figure:

**Figure 1: Components of vulnerability to climate change**

Vulnerability depends on the character, magnitude, and rate of climate change, the variations to which the system is exposed, its sensitivity, and its capacity to adapt [18].
From this figure, we can see that the potential impact is a direct function of the exposure to climate change and the sensitivity of the system. Vulnerability is then a consequence of the potential impact of adaptive capacity [23]. Indeed, vulnerability and security are dynamic [24]. These concepts correspond to a concern for some present and future changes. Insecurity is materialized by the fear that one's behavior, actions, and well-being will be altered by the occurrence of the risk. Vulnerability, taken separately, refers to the possibility of suffering deterioration, leading to poverty.

Exposure refers to the nature and degree to which a system is exposed to significant climate variations and/or hazards [18]. It is based on a dual conceptual approach [22], [23].

- For the extrinsic approach, the exposure to climate change is at the base of the farmer (level of education, age, gender, resources, level of experience in the sector, etc.). It is his social capital from the physical, financial (financial resource dispositions), and human point of view.

- From the intrinsic approach, the farmer is exposed to climate change because of the nature of the sector itself. Here the exposure reflects the climatic character in the true sense of the word, i.e. temperature, precipitation, wind, climatic water balance, etc.). This is the natural capital.

Sensitivity determines the degree of positive or negative effect or modification of a system by a given exposure as a result of climate-related stimuli [11]. The concept of sensitivity is related to resilience. It is defined as the ability of a system to recover from the shock [24].

The effect may be direct (e.g., a change in crop yield in response to temperature variability) or indirect (e.g., damage from increased frequency of coastal flooding due to sea level rise) [18].

Adaptive capacity is the ability of a system to adapt to climate change, including climate variability and extremes, to moderate potential damages, take advantage of opportunities, or cope with consequences [18], and assessment of this capacity involves livelihood analysis [23].

Adaptation alone cannot eliminate all negative impacts and mitigation is crucial to limit changes in the climate system [25]. Mitigation strategies are procedures or activities that help prevent or minimize the process of climate change [26], [27]. Mitigation and adaptation are complementary rather than mutually exclusive [28].

2. Materials and Methods

The measurement of the level of vulnerability is supported by the indicators adopted by [15], [3], [29], [18], [17], etc. having aggregated the IPCC model. Three variables are used to measure the level of vulnerability: exposure (temperature change, change in rainfall, population density, frequency of drought, and access to information on climate shock), sensitivity (irrigated land, landless population, dependent population), and adaptive capacity (physical/natural, social, human, economic and institutional). To have a common basis, they went through the
Coping strategies and vulnerability of farmers under the moderating effect ...

formulation \[\text{Indicesw} = \frac{(S_w - S_{\text{min}})}{(S_{\text{max}} - S_{\text{min}})}\], and the vulnerability is written by \(\text{Vid} = (ed - ad) \times sd\) considering 4-point measurement scales. The decision-making in this paper is conditioned by a series of statistical tests. These are chosen in the most accurate way possible. The Test underlies precision and has a scientific character [30] when justifying the answers to the research questions.

Two major statistical tests were chosen considering the type of measurement and analysis. These are the comparison of means/analysis of variance and the truncated regression. The first test is to relate the level of vulnerability to the socio-demographic characteristics of farmers, both bimodal (comparison of means) and multimodal (ANOVA) and the second is to measure the influence of the use of coping strategies on vulnerability under the moderation of associative dynamics.

Model 1: \(X = \alpha + \beta Y;\)  
Model 2: \(X = \alpha + \beta Y + \beta_{1}^{16} Z_{1}^{16} + \ldots \)  
Model 3: \(X = \alpha + \beta Y + \beta_{i}^{16} Z_{i}^{16} + \ldots \)  

Where \(X\) is vulnerability, \(Y\) is coping strategies, \(Z\) is the components of participation in associative dynamics, \(\alpha\) is the constant and \(\beta\) is the different slopes and \(i\) is the number of components of participation in associative dynamics.

The study population consists of heads of households, farmer members, and non-members of upland agricultural organizations (associations/cooperatives) in the Chefferie of Baswagha in Lubero territory, North Kivu Province, Democratic Republic of Congo. The Baswagha Chiefdom has nine groups that cover ninety-eight localities spread over two zones, the high altitude or highland zone and the low altitude or lowland zone. This article covers the entire highland zone, which is located in 23 localities and spread over five clusters, Buyora, Bulengya, Loungo, and Ngulo.

The choice of this part of the country is justified by two aspects. The highland zone of the Baswagha Chiefdom is the main source of production of cereals, oilseeds, tubers, vegetables, and other food products most consumed in the province. In contrast to the lowland zone, this area is the most secure and accessible, and almost all households make farming their main activity.

The sample size was obtained using the following formula:

\[n \geq Z^2 \times \frac{p(1-p)}{m^2}\]

where \(n\) is the sample size, \(Z\) is the confidence level according to the reduced centered normal (\(Z = 1.96\) for \(\alpha = 95\%\)), and \(p\) is the estimated proportion of the population that participates in the farmers’ organizations. In the Congolese context, empirical studies [31] show that the membership rate of farmers in associations is 46\% and \(m\) the margin of error. In this study, the accepted margin of error is 5\%. The judicious application of this formula led to a sample size of 382 farmers. To guard against the efficiency risks inherent in cluster sampling, a rate of 7\% was added. Thus, a sample size of 409 respondents in the different geographic areas was retained.
Due to the lack of a list of population units, cluster sampling was preferred. To allow for heterogeneity of units, and therefore a large variety of data, we favored a large number of small clusters instead of a small number of large clusters. For this purpose, the 23 localities (and hence the sub-localities) were formed into groups. Since population size is not known within clusters and clusters do not have the same population, the number of respondents in each village was based on the availability of farmers and the observed population density. This criterion resulted in numbers of respondents ranging from 16 to 20 in the villages involved in this study. Through a randomized procedure, farmers were contacted up to the required number in each village.

2. Results

As defined above, exposure to climate change refers to the nature and degree to which a system is exposed to significant climate variability and/or hazards [18]. Exposure to climate change refers exclusively to indicators of rainfall and temperature change [15]. These are explicitly the perception of the change of rainfall and all its manifestations (the average of the first eight items of the perception of rainfall manifestations), the frequency of drought (the ninth item), the change of temperature (the average of four items of the perception of thermal manifestations) as well as the occurrence of strong winds (the average of five items of the perception of wind manifestations, vortices, and dust mists).

As a result of the combination of the above indicators, farmers in the highland zone of the Baswagha chiefdom in Lubero territory are exposed to an average of 2.4819 or 62.05%. The distribution of farmers' exposure indices to change is concentrated around the average, given the coefficient of variation of 14.87% below the judgment threshold, i.e. 30%. The farmer most exposed to the consequences of climate change has a level of 3.7125 or 92.81%. Similar to the intrinsic approach, climate change exposure is a farmer-specific identity.

Climate change sensitivity is nothing but the degree to which a system is affected or modified positively or negatively by a given exposure as a result of climate-related stimuli [11]. In practical terms, a system can recover from the shock [24]. It is reflected in the possibility and/or capacity to irrigate the land, the possession of cultivable land, and the level of dependence on agriculture and agricultural goods. By approximation, the statistics are such that farmers in Lubero territory are sensitive to 2.3017 or 57.54%.

The ability to adapt is an identity of each farmer that is physical/natural, social, human, economic, and institutional [18]. All these factors were the subject of the first part of the variables where adaptive capacity is based, which mitigates the vulnerability of farmers to climate change. The descriptive statistics are such that on average, 0.2083 or 5.21%; 2.0141 or 50.35%; 1.9089 or 47.72%; 0.3433 or 8.58% and 2.6210 or 65.52% respectively for institutional, economic, social, human and physical/natural capacity.

Indeed, many of them have secondary activities other than agriculture (44.74% either trade and entrepreneurship, livestock, handicrafts, or paid work); a fairly
large number of fields they cultivate (92.42% cultivating at least 2 fields at a time) and those they own (91.44% have at least 1 field); of those who manage to save after all household expenses (83.13% whether at home, in associations, in a financial institution or kind); have already accessed credit (73.84%); earn a monthly income of more than 200 USD (78.48%); allocate less than 50% of their income to household food needs (30.56%) and whose products reach the last consumption market (75.55%).

The economic size is very important in measuring the adaptive capacity of farmers in Lubero territory. Aiming at an area where business opportunities are immense, the population is not just stuck to agriculture. Farmers develop small income-generating activities that allow them to provide for the needs of their households, whose demographics raise questions (84.11% have more than 5 dependents, counting children under 6 years old and adults). The excessively overcrowded household is the one with a size of 16. And of these 16 individuals, 2 are under 6 years old and 7 are in school. The demographic dimension does not significantly explain economic capacity (for a value associated with the Fisher F-test of 0.251 or 25.10%).

Overall, from an institutional and human point of view, farmers in Lubero territory are vulnerable to an adaptive capacity of 4.69% and 8.36% respectively. In the lead, physical, social, and economic considerations beat the record, for 64.71%; 53.86%, and 51.27%. Thus, the vulnerability in this area of the country is enacted by both institutional and human trends. Many people live far from institutions, both social and commercial. This reduces their capacity to adapt to the situation, where the majority of farmers’ organizations meet in schools and at the market. They do not have access to information on climate change, its different manifestations, and its consequences because they are so far away.

### Table n°1. Descriptive statistics related to the dimensions of vulnerability

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Min</th>
<th>Max</th>
<th>average</th>
<th>Standard deviation</th>
<th>Median</th>
<th>Coeff. Of variation</th>
<th>95% confidence interval (relative to the average)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower Super</td>
</tr>
<tr>
<td>Exposition</td>
<td>0.3844</td>
<td>0.9281</td>
<td>0.6205</td>
<td>0.092</td>
<td>0.6203</td>
<td>0.1487</td>
<td>0.6107 0.6284</td>
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<tr>
<td>Sensibility</td>
<td>0.2888</td>
<td>0.8521</td>
<td>0.5754</td>
<td>0.1042</td>
<td>0.5749</td>
<td>0.1811</td>
<td>0.5649 0.5853</td>
</tr>
<tr>
<td>Capacity</td>
<td>0.2225</td>
<td>0.4600</td>
<td>0.35450</td>
<td>0.0452</td>
<td>0.3575</td>
<td>0.1274</td>
<td>0.3502 0.3589</td>
</tr>
<tr>
<td>Vulnerability</td>
<td>0.0707</td>
<td>0.6527</td>
<td>0.3836</td>
<td>0.0897</td>
<td>0.3866</td>
<td>0.2334</td>
<td>0.3747 0.3920</td>
</tr>
</tbody>
</table>

Source: Author's calculations using SPSS 23

The descriptive statistics in this table present the measure, in terms of central tendency and dispersion, of each of the components of the vulnerability of farmers in the highland zone of the Baswagha Chiefdom in Lubero territory. After approximation, on average, they are 38.36% vulnerable to climate change and all its manifestations, at 95% confidence, this level is between 37.47% and 39.20%.
In the highland area of Baswagha Chiefdom, all farmers are vulnerable to climate change to the same extent. This is evidenced by the coefficient of variation whose value is 23.34%. Graphically, the average scores are as follows:

Figure No. 2. Base of vulnerability to climate change

Vulnerability is a direct consequence of exposure and sensitivity to climate change and its consequences. Theoretically, adaptive capacity mitigates vulnerability via sensitivity. It has been noted in the literature that adaptive capacity measures decrease the effects of climate change on farmers, captured as a function of institutional, economic, social, human, and physical capacities. Even if they are all exposed to climate change, then it is the capacity of each that determines their vulnerability.

As stated above, adaptive capacity in measuring the level of farmers' vulnerability to climate change is inverse. This suggests that the most capable farmer is the least vulnerable. Statistically, there is a negative relationship between the level of adaptive capacity of each farmer and their vulnerability. This is based on a negative correlation coefficient of 0.385. The results are such that there is a statistically significant relationship between adaptive capacity and the level of vulnerability of farmers in the highland zone of Baswagha Chiefdom in Lubero Territory, i.e., a significance \( \alpha \) associated with the Pearson Correlation coefficient of 0.000 or 0%.

It is, however, positive with exposure and sensitivity, respectively for coefficients of 0.778 and 0.498 with associated significance \( \alpha \) of 0.000 or 0%.

The study on farmers' perception of climate change, and adaptation strategies under the moderation of associative dynamics led to the conclusion that 6 strategies are significantly implemented by farmers in the highland zone of the Baswagha Chiefdom of Lubero territory. They are grouped into three major dimensions, leading to a reliable model with a Cronbach's Alpha of 63.60% and a total variance of 77.03%. They are adopted and used by farmers in Lubero territory at 70.60%; 68.77%; 64.55%; 79.34% and 73.47%. Considering the level of use of each of them, the level of vulnerability of farmers is associated with it.

Indeed, under linear regression, the results are such that the use of each of these strategies separately does not significantly explain the level of vulnerability of farmers. The associated Pearson correlation coefficients show that the relationships between vulnerability to climate change and the use of these strategies are both negative (STRAT1, STRAT2, STRAT4, and STRAT6, respectively for coefficients of 0.015; 0.083; 0.080, and 0.065) and paradoxically positive (STRAT3 and STRAT5 for coefficients of 0.019 and 0.035). The associated probabilities are all higher than the classical threshold of 5%, i.e. 75.7%, 9.30%, 70.4%, 10.6%, 47.7%, and 19.3% for the change of agricultural calendar, the modification of the sowing date, the abandonment of crops, the abandonment of crop varieties, the valorization of organic fertilizers and the cultivation of leguminous plants to reduce the use of synthetic inputs respectively. This means that by using any one of the six strategies, the farmer reduces his vulnerability but not significantly.
### Table 2: Moderating role of associative dynamics on adaptation strategies and vulnerability

<table>
<thead>
<tr>
<th>Variables</th>
<th>Modèle 1 Coef. et Std Err.</th>
<th>Modèle 2 Coef. et Std Err.</th>
<th>Modèle 3 Coef. et Std Err.</th>
</tr>
</thead>
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<td>Constante</td>
<td>3.603167**(0.5124615)</td>
<td>3.506715****(0.5448013)</td>
<td>2.006797(1.898461)</td>
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<tr>
<td>STRATEGIE</td>
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<td>-0.3392036*(0.1737346)</td>
<td>0.1776717(0.790)</td>
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<td>-0.2482787(0.2152533)</td>
<td>7.285599*(4.28777)</td>
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<td>NBreass</td>
<td>-0.2482787(0.2152533)</td>
<td>-1.086526(0.1320913)</td>
<td>1.732049(2.686332)</td>
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<tr>
<td>oldness</td>
<td>-0.0122064(0.0191939)</td>
<td>-0.0133886(0.0090914)</td>
<td>-0.0882436(0.0691058)</td>
</tr>
<tr>
<td>Frequency</td>
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<td>-1.347874(0.9623982)</td>
<td>0.2599065(0.5312934)</td>
</tr>
<tr>
<td>Intrants</td>
<td>0.1091619(0.3752685)</td>
<td>0.7038615(1.817584)</td>
<td>0.5651718(0.608707)</td>
</tr>
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<td>Formation</td>
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<td>-3.658843(3.58322)</td>
<td>-0.0857422(0.0941124)</td>
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<td>climatic adaption</td>
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<td>financial educ</td>
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<td>Pub admin</td>
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<td>0.0317868(0.0237908)</td>
<td>-0.2241846(0.2128266)</td>
</tr>
</tbody>
</table>

| Wald chi2                  | 6.59                        | 14.99                       | 20.16                       |
| Prob > chi2                | 0.0102                      | 0.5963                      | 0.9611                      |

Source: Author's calculation using STATA
This table shows the moderating role of associative dynamics on the relationship between the level of vulnerability of farmers and the strategies they develop to adapt to climate change.

The level of participation of farmers in the highland zone of Baswagha Chiefdom in Lubero Territory in associative dynamics was captured using sixteen items. A statistically significant relationship was found between the application of six optimal coping strategies vis-à-vis vulnerability. The Z-test of -2.57 is associated with a significance, noted as "***", of 0.010 or 1% less than 0.05 or 5%. The relationship between these two variables is negative with a coefficient of 0.4790833. The result of model 1 shows that when a farmer combines all these strategies, he reduces his vulnerability. The more he applies the 6 strategies, the less sensitive he is and the more he increases his adaptive capacity.

A farmer can better choose and use adaptation strategies, which increases his adaptive capacity but remains exposed to climatic hazards. This confirms the thesis that exposure to climate change has a dual approach. It is both intrinsic (internal or related to the sector itself) and extrinsic (external to the sector, related to the person in agriculture itself). The choice of adaptation strategies does not significantly explain exposure or sensitivity to climate change. The agricultural sector is itself a risk carrier.

It should be recalled that participation in associative dynamics was influenced by variables such as marital status, level of education, farmers' ability to build up savings, access to credit, source of fertilizer, nature of the soil, and the distance between structures and households. Associated statistics, in turn, were presented in Chapter 1. The consideration of participation in associative dynamics starts from a binomial definition where the farmer is a member of one or more agricultural associations or is not a member at all.

Level 2 adds the components of participation in associative dynamics to the relationship between vulnerability and coping strategies. In reading the results of this table, it should be noted that not all the components of participation in associative dynamics explain the level of vulnerability, not even the fact of being a member or not of at least one agricultural organization (association/cooperative). At the 10% threshold, how farmers' structures finance their operations explains the level of vulnerability of farmers, for a significance $\alpha$ of 0.089 or 8.9%. All the other components of participation in associative dynamics do not explain farmers' vulnerability to climate change.

The result on moderation is such that, under the influence of the components of participation in associative dynamics, the choice and use of coping strategies have no statistical influence on the level of vulnerability of farmers in upland areas of Baswagha Chiefdom. To the coefficient of 0.1776717, a significance $\alpha$ of 0.790 or 79.0% is associated. Also, the following components are statistically significantly related at the 0.1 thresholds, i.e., 10%, after moderation: being a member of at least one farmers' organization ($\alpha = 0.091$, i.e., 9.1%) and participation in decision-making within the farmers' organizations where they are members ($\alpha = 0.061$, i.e., 6.1%).
V. Discussion

Agriculture is indeed a sector under the influence of climate change. Depending on the internal or external approach, farmers are vulnerable and their vulnerability stems from the agricultural sector itself. In America, Europe, Asia as well as in Africa, farmers are sensitive economic agents and are exposed to the manifestations of climate change and the various mutations it generates.

Several authors have demonstrated that the unequal possession of material, financial, human, and social resources, etc. is one of the major determinants of exposure, a signal of vulnerability [32], [22], [33], [34], [29], [3], [10], [35], etc.) The results of this study are such that farmers in the highland zone of the Baswagha Chiefdom have an adaptive capacity of 1.4180 or 35.45%. It is a sequence of institutional (0.2083 or 5.21%), economic (2.8522 or 71.31%), social (1.9089 or 47.72%), human (0.3433 or 8.58) and physical (2.6210 or 65.53%). It was found that the distribution of economic adaptive capacities of farmers is concentrated around the average. Farmers have almost the same level of economic adaptive capacity. Many of them combine agriculture with other activities, they have large areas of land to cultivate, which reduces their vulnerability and complements the results [18].

Above, it was noted that the measures of adaptive capacity mitigate the vulnerability of farmers [23], [18], etc. The statistics from this study support this view. There is a negative correlation between adaptive capacity and the level of vulnerability of farmers in Lubero territory. The negative Pearson coefficient of 0.381 is associated with a significance α of 0.000%, which means that, in concrete terms, farmers with highly developed adaptive capacities are the least vulnerable. The meaning of their capacity depends largely on the economic and physical aspects. These results are based, nevertheless, on the various indicators that have made it possible to capture adaptive capacity [18], considering the direction of the relationships, there is reason to say that adaptive capacity reduces the sensitivity of farmers to climate shock.

To adapt, several authors have reported on strategies developed by farmers. Coupling their different apprehensions to the territory of Lubero, the results here demonstrate that the application of 6 essential strategies significantly reduces farmers' vulnerability. This affirms the findings of [36]. While [10] speaks of integration with education, financial support, and sensitization structures, the results here are such that farmers resort to changing the agricultural calendar, modifying the sowing date, abandoning crops and crop varieties, using organic fertilizers, and growing legumes to reduce the use of synthetic inputs.

The decision to combine all three strategies changes the level of vulnerability of farmers. They choose the strategies they consider optimal by taking into account their seniority (correlation coefficient = -0.095 and α = 0.056). The choice of strategies is still driven by the experience of farmers and the mastery of different manifestations of the hazards imposed by climate change.

In Spain [29] as well as in Ethiopia [3], it has been demonstrated that the possession of large areas of land increases the adaptive capacity of farmers; those who have
large areas of land are the least vulnerable. Using statistics, it is proved that the number of fields cultivated by farmers and the number of fields owned by them increases their capacity respectively for correlation coefficients of 0.193 and 0.219 to which α significances of 0.000 are associated. The number of fields farmers own decreases their vulnerability. However, this relationship is not significant (α = 0.897). This means that considering the context of North Kivu Province, a farmer can, however, be vulnerable to climatic shocks even if he owns several fields. The fact that he cultivates several fields does not significantly affect his vulnerability.

Also, the level of vulnerability of farmers in Lubero territory is not homogeneous considering the different main crops they grow, with a Levene's Test of 1.098 associated with a significance α of 0.360. The most vulnerable farmers are those who grow mainly tomatoes (3.9791); peas (3.2893); cauliflower (3.0273); sweet potatoes (2.7981); leeks (2.6371); potato (2.5333); banana (2.4771); wheat (2.4629); corn (2.4204); cassava (2.3621); bean (2.2931) and lastly those making onions (2.1418). By ANOVA, at Fisher's F Test of 0.960; an α significance of 0.487 is associated. These statements remain, equally, open to criticism in the sense that farmer fragility is a polysemous concept. Locality-specific soil characteristics significantly determine exposure to climate shock (F = 7.747 and α = 0.006). The results of the research of [34] conducted in Ethiopia in 2018 are confirmed and those of [37] and [38] from an analysis conducted in Oyo State in Nigeria where cowpea farmers resort to strategies that allow them to increase production and thus cope with the climate shock. To the notion of vulnerability is added the characteristic of households and their capacity to adapt, which depends in large part on the availability of resources. And [33] adds, that the possession of resources both material, financial, economic, social, and human reduces the precariousness of farmers.

Having understood that agriculture is itself vulnerable to the drastic consequences of climate change, [39], [22], [2], [10], and [19], farmers are setting up mechanisms that are both active and reactive to the environment. The choice and use of adaptation strategies are not homogeneous. Farmers in the high-altitude areas of Lubero territory statistically highlight six strategies for which the choice and use explain their vulnerability to climate change. The decision to join the associative dynamics determines the level of vulnerability of farmers. The results are such that, among them, 47.19% are members of at least one agricultural association. Their average level of vulnerability is 2.4232. 216 are not members of any organization and their vulnerability is 2.5114. They are not vulnerable only because they do not participate in associative dynamics. This result contradicts [11] and [14], who noted that beyond individual design, farmers participate in networks and cooperatives and maximize the chances of reducing their vulnerability. Statistically, in this chapter, it is proven that resilience is a consequence of adaptive capacity.

Several authors, a few years ago, praised the benefits of microfinance, its greatly increased financial inclusion, and income generation, as a support to the associative and cooperative dynamism of farmers [39], [40], etc.). For them, agricultural associations and cooperatives are actors in local development and in concerting the efforts of farmers whose resources are very limited.
Access to basic financial services, such as credit, savings, and insurance, increases farmers’ resilience. Trying to associate microfinance with the model of [39], [40], etc., it is noted that 78.24% of farmers have already benefited from financial support and 83.13% manage to build small savings. Their average vulnerability level is 2.3728 and 2.3657 respectively. Given the significance of these results (T = 3.033 and α = 0.003; T = 4.290 and α = 0.000), there is reason to believe that farmers who can access financial support and build small savings are the least vulnerable, and both credit and savings appear to be a financial resource that enhances their economic resilience.

In Bangladesh, access to information about weather and different manifestations of climate change is changing farmers' perceptions. When it comes from credible sources, the information reduces exposure to climate change [41]. The problem of access to information on climate change is well documented in the Democratic Republic of Congo. Farmers find it difficult to learn about its different manifestations and the consequences they can expect. Farmers rely on their experience. The results showed that they get their information from almost everywhere, some from associations, friends and family members, local radio stations, etc., from less reliable sources, unless they are provided with figures from the past, and others rely on personal observation and thus evolve, almost blindly. Not being informed, their vulnerability is significantly explained by the lack of access to improved seeds (F = 3.156 and α = 0.025); the lack of equipment and innovative agricultural inputs (F = 6.853 and α = 0.000); the invasion of fields by a multitude of harmful insects (F = 2.632 and α = 0.050); the quality of the soil (F = 3.136 and α = 0.025); political insecurity where fields are invaded by armed bandits (F = 5.941 and α = 0.001); poor road infrastructure (F = 3.583 and α = 0.014); low income from field activities (F = 6.511 and α = 0.000); disregard for farmers (F = 3.639 and α = 0.013); and price level at the time of sale (F = 2.873 and α = 0.036) specifically Despite the fact that many of them access the market (88.51% or 362), the price level of food restricts the value chain of agricultural products.

Tessema and Simane [17] combined the three-dimensional approach to vulnerability with climate, ecosystem, agriculture, atmosphere, technology, infrastructure, community, and social aspects. Their study leads to the results that farming on a plain increases the level of vulnerability. They combine quantitative data collected from the National Meteorological Agency and mention the increasing trend of temperature and decreasing precipitation levels increase the level of vulnerability of farmers.

Using a vulnerability base, their results are such that the relationship between sensitivity and adaptive capacity is the basis of vulnerability. From this combination, there are statistically significant relationships between vulnerability and characteristics of the agricultural ecological system. These include the educational level of the head of household, the age of the head of household, the number of days without fieldwork during the month, the time spent accessing road infrastructure, the time spent accessing the nearest school, the time spent to access health services, the distance to water sources, the access to a piped water source, time spent to access ingress/egress to market, distance to savings and credit...
institutions, access to savings and credit institutions in times of need, access to electricity, access to a telephone line and radios, all of which have significant levels of 0.000 or 0% below the standard 5% threshold.

**Conclusion**

Agriculture is a sector, in itself, exposed to climate change. Atmospheric changes and rainfall instability keep agriculture exposed to climate stress and its consequences. Having understood that agriculture is exposed in an intrinsic sense, farmers all over the world are developing strategies and very practical tools to increase their capacity to adapt and even their resilience. Captured through exposure, sensitivity, and adaptive capacity, vulnerability is nothing more than a predisposition to experience damage. Indeed, the ability to anticipate risks, to maintain them, is specific to farmers. To increase their capacity, many farmers choose to combine fieldwork with other small income-generating activities, thus increasing their economic capacity, which mitigates exposure to climatic stress, and some decide to join local agricultural organizations, basing their decision on the benefits that these structures bring. The exposure of agriculture in the sense of vulnerability is of two kinds. It is both intrinsic and extrinsic. This refers to the conceptual definition that vulnerability is both a factor specific to agriculture and a characteristic of the farmer himself. In addition to the sector, there are the socio-demographic characteristics of each farmer. The purpose of this paper was to analyze the effect of integration and/or participation in associative dynamics on the relationship between coping strategies and the vulnerability of upland farmers in the Baswagha Chiefdom in Lubero territory. Following a decisive process, sharpened and informed by statistics. The results are such that the farmers of the highland zone of the Baswagha Chiefdom in the territory of Lubero are exposed on average to 62.05% to climate change. They are, equally, resilient and robust at 57.54%. This leads to an average vulnerability of 38.36%. There is a statistically significant relationship between the choice and use of six adaptation strategies vis-à-vis vulnerability. The Z-test is associated with a significance $\alpha$ of 0.010 or 1%. The relationship between these two variables is negative with a coefficient of 0.4790833. When a farmer combines all these strategies, he reduces his vulnerability, that is, as he applies the six adaptation strategies, he becomes robust, and less sensitive and increases his adaptive capacity. Under the moderation of the components of participation in associative dynamics, the choice and use of coping strategies have no statistical influence on the level of vulnerability of farmers. At the coefficient of 0.0086564, a significance $\alpha$ of 0.790 or 79.0% is associated. Associative dynamics modify the relationship between coping strategies and the level of vulnerability of upland farmers in the Baswagha Chiefdom. This work measured the moderating role of associative dynamics on the relationship between coping strategies and the vulnerability of upland farmers in Baswagha
Coping strategies and vulnerability of farmers under the moderating effect of

Chiefdom, Lubero Territory. The conceptual model is based on three main variables. These are participation or integration in associative dynamics, coping strategies, and vulnerability. Vulnerability is a combination of exposure, sensitivity, and adaptive capacity.

The limitation of the work is stated in terms of the methodology for measuring the intrinsic exposure of the agricultural sector in North Kivu Province. The unavailability of quantitative data on rainfall/rainfall, temperature, the occurrence of strong winds, manifestation of drought, etc. characterizes several sectors in the Democratic Republic of Congo. Information on the different manifestations of climate change is a very deep need of farmers as well as social and natural scientists. The vulnerability measurement approach stopped at the primary data from the survey conducted in April and May 2022.

Many farmers do not know where to get information about climate change and the chances of survival in the event of an upcoming event. This increases the vulnerability of farmers and hinders research, so that vulnerability remains poorly known in this part of the country. They find it difficult to join local agricultural organizations (associations/cooperatives) only that these structures have almost no added value to the daily life and development of their activities. Participating in the associative dynamics does not significantly modify the vulnerability of farmers. Therefore, many rely only on their appreciation of strategies to adapt to climate change.

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