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Cassava Farmers' Perception on Climate Change: A Case Study in Van Yen District, Yen Bai Province

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Abstract

Situated in the Northern Mountain Region, one of the most climate-vulnerable regions of Vietnam, Yen Bai province is exposed to many climate risks. This study investigated how well Yen Bai farmers were aware of the impacts of the changing climate on production and their livelihoods and how they referred support programs from the central and local governments to make decisions on adaptation and resilience strategies. Data were collected through direct interviews of 488 cassava households in six communes of Van Yen district. Descriptive statistics, One-way ANOVA, and Chi-square test were used to statistically analyze the data. In addition, we employed the Partial Least Square Structural Equation Modelling (PLS-SEM) to study the relationships of three identified independent variables: (i) understanding of support programs/policies; (ii) access to weather information; and (iii) experience of climate risks and impacts, and farmers' perceptions of climate impacts. Results from the PLS-SEM model showed that farmers with higher positive scores in the three independent variables above had better perceptions of climate change and its possible impacts, from which better adaptation decisions and strategies could be derived. These research findings emphasized the need for improving the understanding of climate change that could impact farmers' livelihoods, farmers' access to accurate near-time and medium-term weather forecasts, and thoroughly using local knowledge on climate risks and effective native adaptation measures for better adaptation and mitigation strategies and actions in rural climate-vulnerable communities in Vietnam.

Keywords

Cassava farmers, climate change, farmers' perceptions, climate impacts

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Introduction

Over the past decades, Vietnam has obtained remarkable achievements in agriculture, e.g. obtaining national food security and being the world's 2nd rice exporter and top coffee producer (Bui *et al.*, 2020). Despite these, many challenges still exist, such as smallholder farming, limited commodity production capacities, value chain development, competitiveness on the international market, and climate change. Given the fact that Vietnam is among the five most climate-vulnerable countries, climate risks play a role as important limiting factors to the creation of negative impacts on Vietnam's overall development (Ngo *et al.*, 2018; Vu *et al.*, 2018), especially in the agricultural sector (Huynh *et al.*, 2018). Some examples are serious erosion and flash floods in mountainous regions (Nguyen, 2014; Tuan *et al.*, 2014); salinized arable land triggered by seawater intrusion in the Mekong River and more frequent droughts as in 2015-2016 in the Central Highlands (CGIAR, 2016); and increased pests and diseases due to global warming (Kiritani, 2013). Meanwhile, the adaptive capacities of the majority of farmers cannot yet cope with these impacts, largely because their perceptions of climate change have not been adequate (Huong *et al.*, 2017). Understanding how farmers perceive climate risks, their impacts and their strategies to adapt to climate change is crucial to plan adaptation strategies across climate-vulnerable agroecologies (Dang *et al.*, 2014).

At the global scale, many studies have investigated different farmers' perceptions of climate change for adaptation strategies. In Africa, Gandure *et al.* (2013) found that farmers in Gladstone, a rural village near the town of Thaba Nchu in the Free State Province of central South Africa, were more concerned about the impact of weeds, insects and worms than rainfall and temperature variabilities that, to them, had negligible impacts on their livelihoods. Adaptation strategies, therefore, are received quite differently among Gladstone farmers. The youth were not interested in farming; hence, they were not applying adaptation measures. Some farmers were not practicing measures of poorly guided policies. Findings of Bryan *et al.* (2013) indicated that Kenyan farmers and pastoralists with long farming experiences and from different agroecologies tended to understand well-changing temperature and rainfall patterns over a long period of time. Part of the study of Mulwa *et al.* (2017) in Malawi on farmers' perceptions of climate variability over the past decade revealed some major shocks, such as droughts and hailstorms. These shocks finally led to negative impacts of crop pests, diseases, and flooding. In Europe, Li *et al.* (2017) studied the perceptions of 1,940 farmers from the Transdanubian region of Hungary on climate risks by analyzing complex relationships between farmers' perceptions on climate change and their adaptation behaviors. The study found out that farmers noticed some climate changes through water shortages, extreme weather events, and increased temperature. They only became more aware of climate risks when seeing the effects of tested adaptation measures. In Asia, Alam *et al.* (2017) and Arunrat *et al.* (2016) found that farmers' perceptions on climate changes and extreme weather events were quite in accordance with observed climatic data in Bangladesh and Thailand, respectively. They could observe resulting impacts on their livelihoods and natural resources which they base their livelihoods on.

In Vietnam, farmers are becoming more aware and conscious of climate change and how its potential impacts can affect their current production and future livelihoods (Dang *et al.*, 2013; McKinley *et al.*, 2016). Dang *et al.* (2014) found that personal beliefs decide different levels of climate change perceptions. Those who believe in the changing climate and have experienced climate extreme events have a higher understanding and appreciation of climate risks than those who do not believe and/or do not care. The study of Huong *et al.* (2017) conducted in six provinces of Northwest Vietnam indicates farmers' perceptions of certain prominent risks, such as increased temperature both in the winter and summer; decreased rainfall in the winter, which lead to more droughts in the dry season; and shorter rainfall durations but higher intensities in the rainy season. Most of these risks were also confirmed by interviewed farmers in the study of Bui *et al.* (2020) implemented in Van Yen district, Yen Bai province of the northern mountain region (NMR) – a representatively climate-vulnerable province in the region. These research findings showed the importance of understanding farmers' perceptions of climate impacts and needs for change in making decisions for climate adaptation, mitigation, and production actions (FAO, 2013). This study, with a further focus on Yen Bai, aimed at investigating Van Yen farmers' perceptions on climate change and its impacts based on the following three research hypotheses: (i) **H1** – Accessibility to weather information decides the farmers' perceptions of climate change and its impacts; (ii) **H2** – Knowledge depth of support programs/policies/projects on climate actions decides the farmers' perceptions of climate change and its impacts; and (iii) **H3** – Experiences in encountering extreme weather events decide the farmers' perceptions of climate change and its impacts.

Materials and Methods

Conceptual framework

The conceptual framework in this study is described in **Figure 1**. The term "perceptions" refers to knowledge, beliefs, attitudes, concern, affect, and perceptions (Whitmarsh & Capstick, 2018). The perception process consists of three stages, namely selection, organization, and interpretation (Ou, 2017). Perception of climate change is the perception of all components related to climate change, including climate change platform, government policies and support agencies, climate change information, and its impact (Dal *et al.*, 2014; Nyanga *et al.*, 2011; Whitmarsh & Capstick, 2018).

Climate change is a matter that is of great interest to the whole world and all nations (IPCC, 2018). At the national level, countries set policies, strategies, and action plans to respond to climate change. Following the national guidelines, policies, and programs, the local governments, i.e., provincial or district authorities, have also issued a system of legal documents to respond to climate change. Besides, a large number of projects (development, research and development) to tackle climate change have been conducted in many parts of Vietnam, especially in the most vulnerable areas. If people were aware of these mentioned supports, they would perceive climate change's existence and its impacts on their livelihoods.

According to Van der Linden (2014), personal experience with extreme weather phenomena impacts is the most important factor affecting climate change risk perception. In this research, this structure was measured by the impacts of four dominant disasters, namely hot spells, acid rain, drought, and cold spells, which were perceived by cassava farmers.

Several studies explored the causal relationships between the amount of weather information farmers received and their perception of climate change (Reyes *et al.,* 2009; Bloodhart *et al.*, 2015; Simelton *et al.,* 2017). They concluded that weather forecast was associated with their beliefs and concerns about climate change. Therefore, natural disaster forecasts, crops calendar, daily weather forecast news, and extreme weather events were selected as the variables to measure farmers' access to weather information.

Study site and data collection

Van Yen (**Figure 2c**), a well-performed cassava producing district, has an average elevation of 500m a.s.l, an average annual temperature of 21-23ºC, and an average annual rainfall of 1800mm. A survey was conducted in six communes representing three main areas located in the southeast, center, and northwest of Van Yen district from October to December 2019. In each area, two cassava communes were selected, including Mau Dong and Ngoi A in the southeast; An Binh and Quang Minh in the center; and Lang Thip and Chau Que Ha in the northwest (**Figure 2**). Sample size for farmer interviews was determined using equation (1) of Iarossi (2006):

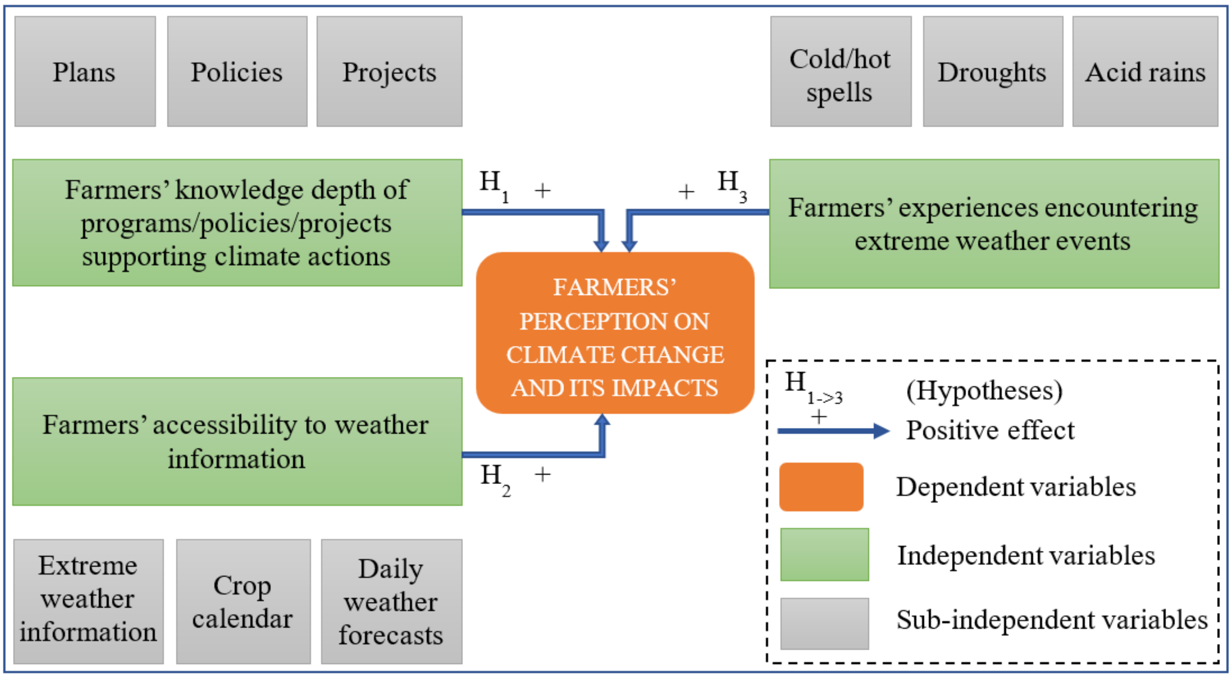

Figure 1. Research conceptual framework

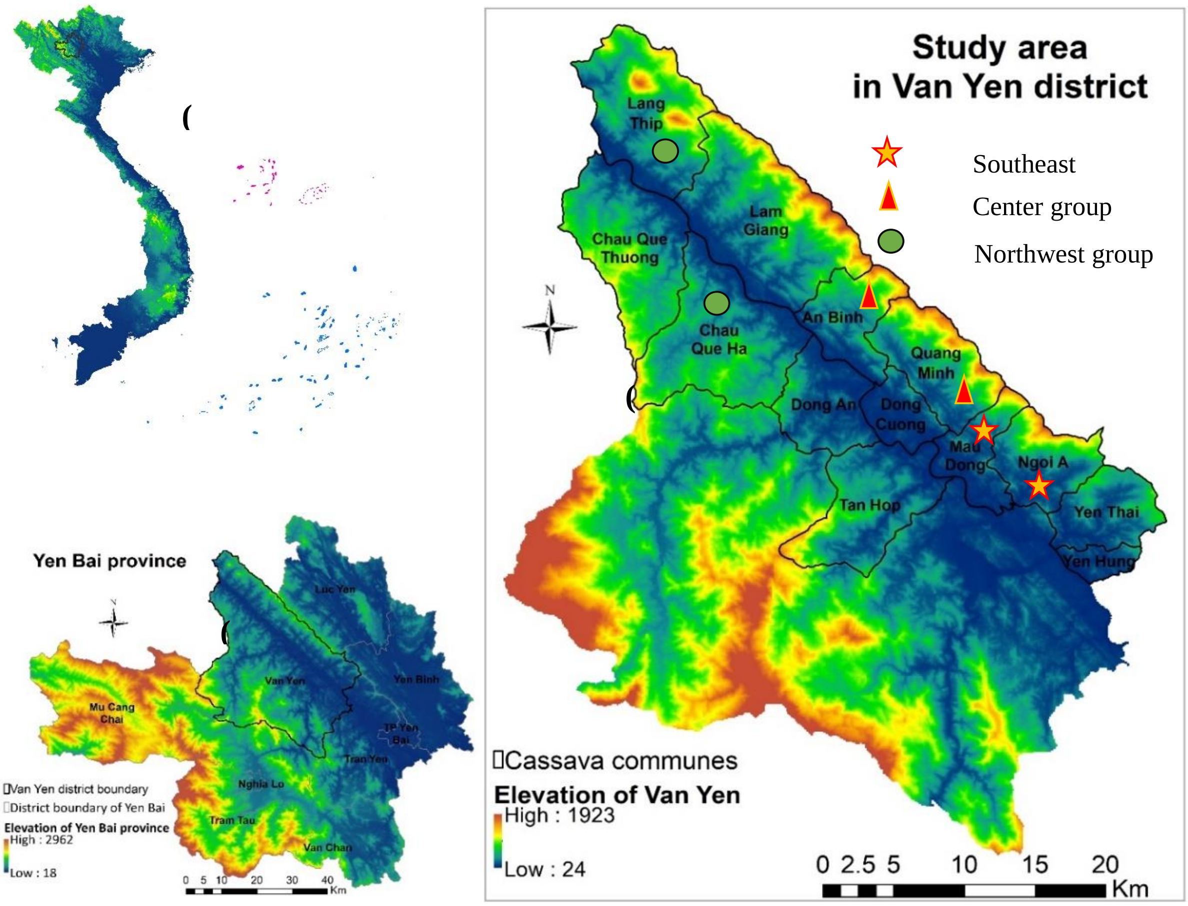

Figure 2. Study area in Van Yen district (c), Yen Bai province (b) of the NMR of Vietnam (a)
Out of 26 communes and 01 town of Van Yen, 13 communes (c) have cassava plantations (Bui *et al.*, 2020)

$$n = \frac{z^2.S^2}{e^2 + z^2.\frac{S^2}{N}} \quad (1)$$

n: sample size

N: total observations (population size)

z: reliability value

e: expected error

S: tandard deviation

S^2: population variance

There were a total of 33,247 households (N) in Van Yen district, with S = 15%, z = 99%, and e = 1.8%. Computation of sample size showed the need of 455 households for the survey. The total sample in this study is 488 households (Bui *et al.*, 2020).

The questionnaire answered by respondents was the main data collection tool employed in this study. Most of the questions used a Likert scale (Likert, 1932) which is a popular method used to measure knowledge and perceptions. The questionnaire contained questions about farmers' perception of climate change and its impacts, farmers' understanding of climate change adaptation plans and disaster prevention, farmers' access to weather-related information, and climate phenomena impacts. The target group of the survey was cassava farmers.

Macroscopic inspection on the liver surfaces

The study used means and rates of the descriptive statistical analysis method to describe socio-economic characteristics of cassava farmers. Frequencies were compared using Chi-squared test. In this study, the χ^2 test (for independence) was used to test whether categorical variables (three sites) were independent or associated with demographic characteristics, i.e., wealthy ranking and household education (Jawlik, 2016). The one-way analysis of variance (ANOVA) was used to explore different mean values for more than two groups (Jawlik, 2016), equivalent to different research sites. Internal consistency was calculated using Cronbach's Alpha (**Table 1**), with a value higher than 0.60 being an acceptable cut-off point for reliability (Peterson, 1994).

To develop theories in the exploratory research, we employed Partial Least Square Structural equation modeling (PLS-SEM). PLS-SEM approach has become a key research method in the social sciences in recent decades for having some advantages. For example, the method can be applied to a small sample size, data without normal distribution, or case studies with many latent and manifest variables that can only be estimated (Hair *et al.*, 2016). In this research, we applied the Smart PLS 3.0 software for data analysis. All constructs were modeled as a formative measurement which was tested through variance inflation factor (VIF), outer weight, and outer loading. All VIFs were below the value of 5, indicating that collinearity among indicators is not an issue in SEM model. Four out of 15 outer weights were insignificant; however, their corresponding item loadings were significant and higher than the threshold 5. All manifest variables were, therefore, retained in the model (Hair *et al.*, 2016).

Results and Discussion

Characteristics of the surveyed farmers' households

Table 2 presents the socio-economic characteristics of surveyed farmers. The rate of the poor increased from the southeast to the northwest. This is partly explained by the fact that the southeast is the district center and is closely linked to national highways and provincial

Table 1. Result of reliability analysis

Variable	Cronbach's Alpha
Farmers' perception on climate change and its impacts	0.80
Farmers' understanding of government implementation about climate change adaption	0.80
Farmers' access to weather information	0.87
Farmers' experiences of climate phenomena impacts	0.61

Table 2. Surveyed farmer household's characteristics

Criteria		Northwest	Center	Southeast	Grand total
Total numbers of surveyed households		194	196	98	488
Wealth ranking	Poor (%)	22.16	15.31	5.10	15.98
	Normal (%)	67.53	66.84	69.39	67.62
	Rich (%)	10.31	17.86	25.51	16.39
	p-value (Pearson chi Square-2 sided) by area = 0.00				
Household size	Members	4.28	4.41	4.15	4.31
	p-value (Bartlett's test) by area = 0.77				
HHH's sex	Male (%)	88.66	91.84	89.80	90.16
	Female (%)	11.34	8.16	10.20	9.84
	p-value (Pearson chi Square-2 sided) by area = 0.57				
HHH's years old	Years	43.21	45.52	49.17	45.33
	p-value (Bartlett's test) by area = 0.053				
HHH's ethnic	Kinh (%)	27.32	20.92	92.86	37.91
	Tay (%)	25.77	7.14	0.00	13.11
	Others (%)	46.91	71.94	7.14	48.98
	p-value (Pearson chi Square-2 sided) by area = 0.00				
HHH's education	Illiterate (%)	22.16	19.90	0.00	16.80
	Lower than primary school (%)	24.23	24.49	14.29	22.34
	Lower than secondary school (%)	23.20	28.57	33.67	27.46
	Lower than high school (%)	24.23	21.43	38.78	26.02
	High school and higher eduction (%)	6.19	5.61	13.27	7.38
	p-value (Pearson chi Square-2 sided) by area = 0.00				

Note: HHH = household head

roads, creating favorable conditions for economic development activities. Meanwhile, the northwest region has difficult transportation conditions and belongs to extremely difficult commune group (Bui *et al.*, 2020). In addition, Kinh people are the majority in the southern part of the research site compared to the rest. Concerning the education level, respondents from the southeast have higher average education background than in the northwest and the center. Statistically significant differences were found in the criteria of the wealth ranking, household education levels, ethnicity of households, and average age of household head among three parts ($P < 0.01$). On average, there were 4.31 members in each household and more than 90% of the household heads were male; however, the differences of the above mentioned indicators in three parts were not significant ($P > 0.05$).

Farmers' perception of climate change and its impacts

Description of farmers' perceptions of climate change and its impacts is presented in **Table 3**. Farmers tended to agree and strongly agree that climate change is a natural phenomenon with various types, i.e. global warming, melting ice, and sea-level rise. The majority (approximately 70%) of the interview respondents were aware of changes in temperature and rainfall variabilities as impacts of climate change. The resulting test shows that the difference was statistically significant among their responses ($P < 0.01$). Regarding climate change consequences, 86.89% of the households stated that climate change has negative impacts on their agricultural production activities.

Table 3. Farmer households' perception of the platform of climate change

Farmers' perceptions of climate change (CC) and its impacts	Percent of respondents (%)					p-value*
	1	2	3	4	5	
CC is a natural phenomenon, e.g. global warming, melting ice, and rising sea levels	0	0.20	32.58	48.16	19.06	0.015
CC is reflected in changes in the temperature, rain, and natural disasters	0	0.20	30.12	51.43	18.24	0.018
CC has a great impact on agricultural production activities of farmers	0.41	1.43	11.27	57.38	29.51	0.001

Note: Likert scale: 1 (totally disagreed) to 5 (totally agreed)

** p-value from Pearson chi Square-2 sided by area*

Table 4. Farmer households' perceptions of supporting climate actions

Perceptions	Percent of respondents (%)					p-value*
	1	2	3	4	5	
Adaptation plans related to climate change and disaster prevention at district level	33.61	27.05	25.41	5.12	8.81	0.000
Policies to enhance adaptation to climate change and disaster risk reduction for farmers	33.20	11.89	42.01	4.71	8.20	0.000
Some projects to help farmers adapt to climate change and mitigate natural disaster risks	33.81	21.52	31.35	4.10	9.22	0.000

Note: Likert scale: 1 (totally unknown) to 5 (totally known)

** p-value from Pearson chi Square-2 sided by area*

Farmers' knowledge depth of programs/policies/projects supporting climate actions

Table 4 shows the survey results of farmers' response to Van Yen's activities on climate change adaptation. Most farmers in this survey had a homogeneous understanding of climate change adaptation plans and disaster prevention issued by the government. In general, the respondents' perceptions of government policies and support agencies on climate change adaptation were limited. Only 13.93% of surveyed farmers knew climate change adaptation plans and disaster prevention at the district level. A majority (87.1%) of farmers did not know the policies that support the enhancement of climate change adaptation and disaster risk reduction. Most farmers did not know much about projects that could help them build adaptive capacities and resilience to climate change and mitigate natural disaster risks. To address climate-related issues, Van Yen district government had issued several climate change adaptation strategies/programs, e.g. sustainable farming on sloping land and greening barren land, etc. Beneficiaries from these programs were local people but not all. In general, those who benefited from the programs/projects were aware of what the local government/non-government organizations were implementing, others also understood through social communication or media.

Farmers' accessibility to weather-related information

A good weather information system plays a crucial role in farming systems. Useful weather information is one of the factors that affect farmers' decision-making in farming (Reyes *et al.*, 2009; Simelton *et al.*, 2017). In this research, the results as shown in **Figure 3** indicate that farmers often received warnings of extreme weather events (59.84%), daily weather forecast news (69.67%), seasonal calendar (53.69%), and natural disaster forecasts (56.77%). While television was a usual source of climate information, many used other technological means available to receive forecast updates, such as web-based applications which could be accessed using smartphones and/or computers.

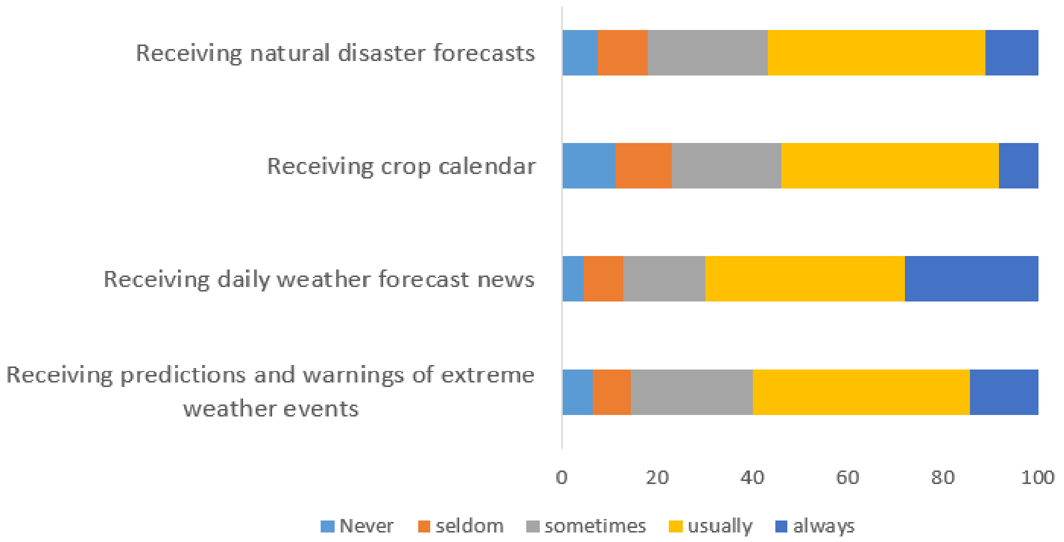

Figure 3. Farmers' accessibility to weather-related information

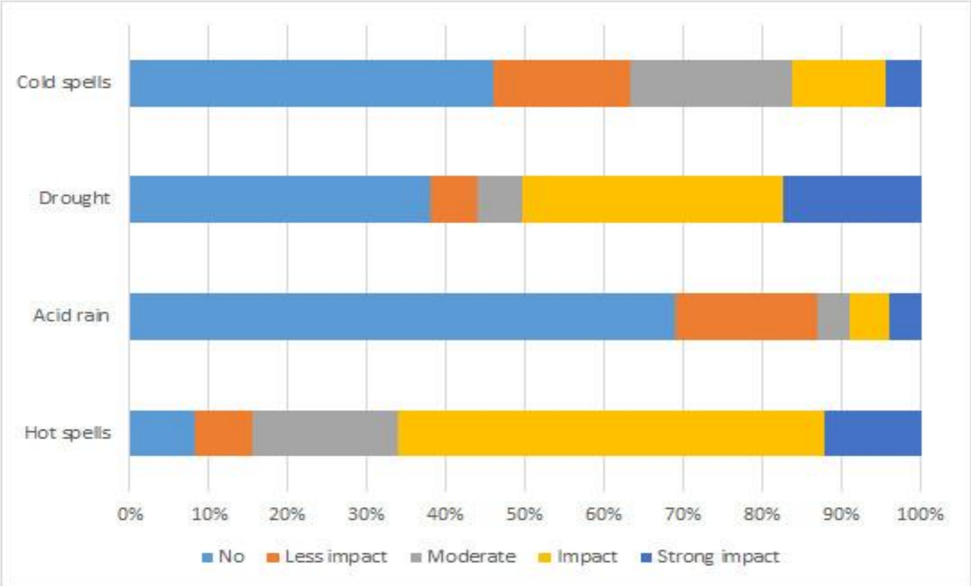

Figure 4. Farmers' experiences of extreme weather events

However, weather forecasts did not win all farmers' trust in the survey due to (i) their large geographical coverages. A young farmer stated that "*the weather information usually targets the entire region. It is vague in my specific location*"; (ii) The heterogeneity of respondents (i.e. education, ethnicity, and age) could also be the reason that not all people believed in weather forecast information, which was confirmed by previous studies such as Harris (2007) and Lazo (2009); (iii) due to the variety of weather information providers and multiple communication channels, this situation might create a complex and dynamic information environment.

Farmers' experiences encountering extreme weather events

Van Yen has a high level of vulnerability to climate risks, mainly hot spells, acid rain, drought, and cold spells. They have been greatly affecting socio-economic activities and human safety there (Bui *et al.*, 2020).

Figure 4 lists some impacts of climate phenomena in the study area. A larger number of farmers (84.43%) pointed out that hot spells had

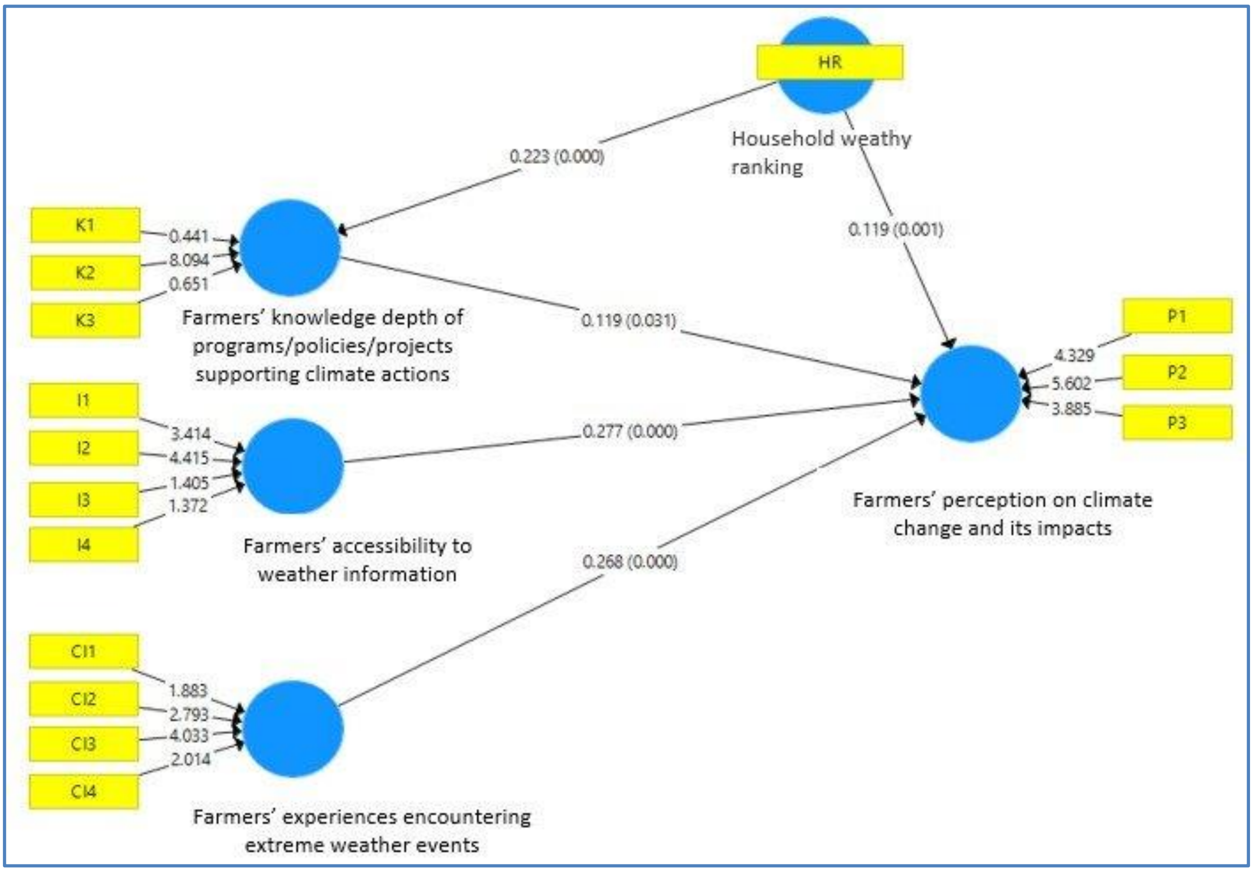

Figure 5. Significant pathways in the structural equation model

serious *impacts on theire livelihood. Two farmers stated that "In summer 2019, many trees died due to temperatures reaching 40°C'* (male, 45); *'heat has an effect on livestock, as buffalos do not want to graze and spend time in the shade'*. Approximately 60% of the surveyed households responded that droughts were having negative effects on agricultural systems, lives, and livelihoods alike. The following quotes illustrate some of the famers' responses *"In the first quarter of 2019, a period when plants needed a lot of water to grow, I could not irrigate due to lack of rain"* (male, 55); *"rice seedlings had withered due to drought"* (female, 43); *'it was hard for me to irrigate proactively as there was no rain at all in early 2019'* (female, 35). More than 80% of the interviewees reported that acid rain had a weaker influence on their livelihoods. Some said acid rains had negative impacts on production, such as changed leaf color of grapefruit and oranges, finally destroying the harvests.

Structure equation model

SEM results (**Figure 5**) show that the model is compatible with data research and conceptual framework. Overall, weather-related information had the largest influence on farmers' perception of climate change (β = 0.277, P< 0.05). That is, the more weather forecast information they received, the more they perceived about climate change. This result is in line with a previous finding (Bloodhart *et al.*, 2015). Moreover, whether farmers perceived climate phenomena impacts and whether they were aware of government implementations about climate change adaptation positively influenced farmers' perception of climate change (β = 0.268, P< 0.05; and β = 0.119, P< 0.05, respectively). These findings correlate fairly well with those of Van der Linden (2014) and Myers *et al.* (2013). Household wealth rank had a larger direct effect on farmers' understanding of policies related to climate change mitigation and adaptation (β = 0.223, P< 0.05) than farmers' perception of climate change (β = 0.119, *P*< 0.05). This finding indicates that well-off farmers had a better understanding of climate change and government supports to tackle climate change.

Conclusions

The results of this study showed that cassava farmers, in general, perceived climate change's existence and its impacts. Among the three independent variables, accessibility to weather information had the greatest influence on farmers' perceptions (marginal value = 0.277), followed by farmers' experience of extreme weather events (0.268) and their knowledge of supporting programs/policies/projects (0.119). Understanding these relationships is important for future relevant research.

Farmers received climate information quite often. However, only a few of them were aware of adaptation plans at the district level. They also needed accurate weather information for farming activities while many were not satisfied with the quality of weather information they received on the daily basis. Based on this, we recommend that weather forecasts should be downscaled to be more location-specific.

The research findings also suggested the investigation of farmers' perceptions of climate change and climate impacts prior to conducting priority setting for adaptation and mitigation measures to enhance adaptive capacity and resilience of farmers in climate-vulnerable regions in New Rural Development's 2021-2030 Strategy.

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