



The assessment of resilience capacity of Participatory Guarantee Systems cabbage-growing households: Empirical evidence from the Red River Delta of Vietnam

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Abstract

This paper examines the resilience capacity and determines the relationship between resilience and economic performance in Participatory Guarantee Systems (PGS) cabbage-growing households in Vietnam's Red River Delta by using the resilience capacity index (RCI) and Resilience Structure Matrix (RSM), with data collected from the winter-spring crop season (2023–2024). The findings indicate that Social Safety Net (SSN), Assets (AST), and Access to Basic Services (ABS) are the three most crucial pillars for household resilience. Key SSN variables include *local farmer groups* and *organizations*, while AST is significantly influenced by *the number of vegetable crops, animals, trees, and water-saving equipment*. ABS is represented by *access to markets and schools*. The study also shows a positive correlation between the Resilience Capacity Index (RCI) and economic performance, with highly resilient households experiencing high profitability. Profits for highly resilient households reached VND 174.8 million per hectare, whereas low resilient households saw a sharp decline, with a loss of VND 212 million per hectare. We derived core indicators of the three RIMA pillars: supporting *local farmer groups*, promoting *diversified vegetable crops*, and enhancing *accessibility of the agricultural market* to obtain a high resilience capacity and increase premium economic benefits. The paper recommended that enhancing RIMA pillars be addressed to maximize economic benefits and resilient capacity for PGS cabbage-growing households.

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Introduction

Organic agriculture has arisen as an alternative farming approach to lessen industrialized agriculture's environmental and public health implications, which has dominated the global food supply since the second part of the twentieth century (Anselmi & Vignola, 2022). This kind of agriculture has demonstrated various benefits, including addressing international and domestic food demands, extending consumer food options, improving farm profitability, and promoting agricultural sustainability (Carlson et al., 2023; Chandre et al., 2019). According to Lernoud and Willer (2019), Paull (2023), and Willer et al. (2021), organic farming has gained popularity among consumers, producers, and policymakers. Notably, this sector constantly expands globally, with 71.5 million hectares, 2.5 million farmers, and a market worth 100 billion USD. However, Barrett et al. (2001) and Templer et al. (2018) found that around 80 percent of organic smallholders face limitations and risks associated with organic production. Therefore, organic farming has succeeded in Europe but not in poorer countries. The reason is that organic agriculture has to deal with obstacles resulting from technological complexity, fluctuating prices, and climate change. In addition, organic agriculture fulfills only a market niche, accounting for only 1 percent of agricultural acreage worldwide (Bellon & Penvern, 2014; Freyer & Bingen, 2015). Much previous research found evidence that organic farming produces lower yields compared to conventional farms, higher certification costs, and market barriers, dependency on exporters for certification, and the educational and research needs of small-scale (Araki, 2007; Chongtham et al., 2010; Jouzi et al., 2017; Nalubwama et al., 2014; Srivastava & Kumar, 2022). Additionally, poorer, younger, and less well-connected farmers were less involved in organic farming (Kamau et al., 2018).

According to Hoang et al. (2021), Nguyen et al. (2023), Oyedele et al. (2018), and Tiemann and Douxchamps (2023), small-scale farmers in developing countries in Asia, such as Vietnam, are among the most vulnerable group to climate volatility. In addition, various studies found that an enhanced resilience capacity of households is needed to react to unforeseeable events of climate change (Alinovi et al., 2010; Bogale, 2012; Ciani & Romano, 2012; Walker et al., 2002). As a result, assessing resilience has become essential and one of the terms in the policy debate on development (d'Errico et al., 2018). Furthermore, evaluating organic families' ability

to deal with obstacles is an essential step toward better understanding agricultural constraints and may help improve farming practices and households' well-being. As shown by Food and Agricultural Organization [FAO] (2018), building resilience includes a better understanding of the core reasons behind farm vulnerability, allowing for the design of more effective treatments.

Most organic regulations recognize third-party certification (TPC) as the official way of ensuring that products meet organic requirements. TPC is widely criticized for its unreasonable cost, which is rarely affordable to poor and smallholders in developing countries. Participant Guarantee Systems (PGS), an alternative and complementary approach to TPC, has just been adopted by local producer groups, associations, and cooperatives in many developing countries to control and improve organic farming practices. PGS has received substantial support from the International Federation of Organic Agriculture Movements (IFOAM), an international umbrella organization founded in 1972 to promote organic farming. Through everyday socio-economic interactions and linkages, PGS can assist in empowering farmers and stakeholders in the agri-value chain (Home et al., 2017).

In the early 2010s, the Danish International Development Agency (DANIDA) encouraged organic vegetable growing in Vietnam, with PGS being the first and most noteworthy example. Its impact has clear policy relevance. The Vietnamese organic standard (TCVN 11041-1) was released in 2017 and exists alongside various international organic standards such as Japanese Agricultural Standards (JAS) and the United States Department of Agriculture (USDA) Organic (Grovermann et al., 2024). In the National Food Transformation Program issued in early 2023, the Vietnamese government set a target of 2.5 percent of the agricultural area operating under organic practices by 2030 (USDA, 2023). Previous studies have shown that Participatory Guarantee Systems (PGS) enhance farm profitability and agroecological performance while providing farmers with more sales channel options, increasing community involvement, and strengthening trust among community members. However, PGS does not significantly impact labor returns and tends to lower crop yields (Böttinger, 2019; Grovermann et al., 2024; Enthoven, 2023). In other words, organic farming systems are considered less sustainable, while increasing farm resilience will improve sustainability. Therefore, finding ways to enhance the resilience of farming systems is essential to developing solutions for dealing with challenges (Reidsma et al., 2023; Soriano et al., 2023).

Resilience is commonly defined as the ability of social, economic, and environmental systems to adapt to change, whether predictable trends or unforeseen events, by responding and reorganizing in ways that preserve their core functions and identity (Berkas & Folke, 1994; Folke et al., 2010; Walker et al., 2004). FAO defines resilience as the ability of people, households, communities, countries, and systems to mitigate, adapt to, and recover from shocks and stresses to reduce chronic vulnerability and facilitate inclusive growth (FAO, 2016a). Resilience approaches focus on the interactions between social and ecological systems that seem to create the ability to cope with natural hazards. The sustainability in a farming system can be obtained through adaptability and change. We understand resilience as the ability of social-ecological systems to withstand stress factors and maintain their productivity and capacities to learn and adapt. (Folke et al., 2010) Milestad and Darnhofer (2003) defined resilience indicators in farming systems and demonstrated that these indicators align with the fundamental principles of organic agriculture as outlined by IFOAM. However, resilience is difficult to measure. Therefore, examining resilience using proxy measurement to combat these constraints is essential. In this study, a measurement of resilience was obtained using a latent variable (LVs) model with the RIMA-II approach as a systemic approach, termed MIMIC (Multiple Indicators Multiple Causes) (FAO, 2016b). This approach allows us to identify the key pillars that influence resilience and assess the households' overall resilience capacity index (RCI) of these households. We further examine the resilience structure matrix (RSM) to understand the relative contribution of each pillar and observed variables to the overall resilience capacity (FAO, 2022; FAO, 2016a; Novikova et al., 2013). Moreover, we also examine the relationship between RCI and economic performance. Therefore, we aim to answer the following questions: (1) *What are the pillars affecting the resilience of PGS cabbage-growing households under climate change?* (2) *How do these pillars contribute to overall resilience capacity?* and (3) *Is there the impact of resilience on economic outcomes?*

Literature Review

RIMA-II Approach to Measure the Resilience

The Resilience Index Measurement Analysis (RIMA) model developed by the Food and Agriculture

Organization (FAO) is a framework for assessing the resilience of households and communities to various shocks and stresses. It aims to comprehensively understand the factors contributing to a community's ability to withstand and recover from disruptions, such as natural disasters, economic downturns, or conflicts. RIMA's quantitative approach helps create household resilience to food insecurity by finding cause-and-effect linkages between resilience and its essential drivers (FAO, 2015). Some authors recently updated the RIMA-I paradigm to analyze rural household resilience to predict changes in well-being over time and test the potential of the Resilience Capacity Index (RCI) to estimate future food consumption (Ciani & Romano, 2014; Lanjouw et al., 2011; Moffitt, 1993). However, measuring resilience is challenging due to its complexity. The RIMA-II is a comprehensive program that blends direct and indirect approaches. The approach includes the Resilience Capacity Index (RCI) and the Resilience Structure Matrix (RSM) as key components of resilience assessment (FAO, 2016b). The Resilience Capacity Index (RCI) is a composite score that quantifies a household's overall ability to cope with and recover from shocks. On the other hand, the Resilience Structure Matrix (RSM) provides insight into how these resilience pillars interact and influence one another. The RSM identifies the relative contribution of each pillar to the overall resilience capacity and maps the dependencies and interrelationships among resilience factors. The latent variables and these definitions are presented in [Table 1](#).

The significant components of RSM include four pillars (including Access to Basic Service (ABS), Assets (AST), Social Safety Nets (SSN), and Adaptive Capacity (AC)), indicators, and explanations used for household resilience assessment ([Table 1](#)). The indicators of each pillar were chosen by referring to the explanation of each pillar as definitions of FAO (FAO, 2016b, FAO, 2015). In addition, we conducted a literature review to find indicators that have been proven in previous studies (Ben et al., 2021). Furthermore, we organized a workshop with experts in the PGS field to gather opinions and feedback. Then, we selected indicators, ensuring that they accurately reflect the necessary factors in the research sites and via the VIF indicator. Finally, four pillars of twenty-three indicators were taken (three for ABS, seven for AST, eight for SSN, and five for AC), which are shown in [Table 2](#).

Table 1 Resilience and Its Pillars

Latent variables	Definitions
Resilience (R)	Resilience refers to the capacity of a system, community, or society exposed to hazards to withstand, absorb, accommodate, and recover from their effects in a timely and efficient way.
Access to basic Services (ABS)	Access to and effective use of basic services, such as schools, drinking water, electricity, and healthcare, serve as indicators of a system's capacity to meet the fundamental needs of its population.
Assets (AST)	Assets can be categorized as productive or non-productive. Productive assets, such as land and livestock, generate income or contribute to production processes. Non-productive assets, like homes, vehicles, and equipment, reflect an individual's or household's standard of living and wealth.
Social Safety Net (SSN)	The social safety net component assesses the effectiveness of mechanisms to assist households. These mechanisms include timely and reliable aid from international organizations, associations, NGOs, and support networks of relatives and friends.
Adaptive capacity (AC)	Adaptive capacity refers to the capability of a system to adjust to changing circumstances and implement innovative livelihood strategies.

Source: FAO, 2016b; FAO, 2022

Table 2 The Pillars of Resilience Capacity

Pillars (LVs)	Indicators	Type	Min	Max	<i>M</i>	<i>SD</i>
Access to basic Services (ABS)	Access market channels (ABS1)	1	1.00	3.00	1.45	0.68
	Access to school years (ABS2)	3	2.00	12.00	7.83	2.03
	The road network to access the market (ABS3)	2	0.00	1.00	0.41	0.49
Social Safety Nets (SSN)	Loan (SSN1)	2	0.00	1.00	0.13	0.33
	Exchange with neighbor (SSN2)	1	0.00	2.00	1.73	0.62
	Members of cooperative (SSN3)	2	0.00	1.00	0.54	0.50
	Members of local farmer group (SSN4)	2	0.00	1.00	0.56	0.49
	Members of farmer organization (SSN5)	2	0.00	1.00	0.58	0.49
	Members of the Women's Union (SSN6)	2	0.00	1.00	0.60	0.49
	Members of the other groups (SSN7)	2	0.00	1.00	0.02	0.12
	Extension agents visited (SSN8)	2	0.00	1.00	0.20	0.40
Asset (AST)	Gross annual household income from agriculture (AST1)	1	1.00	3.00	1.76	0.70
	Gross annual household income from non-agriculture (AST2)	1	0.00	3.00	2.18	0.99
	The cabbage area (AST3)	3	0.00	0.07	0.009	0.009
	Number of vegetable crops (AST4)	3	3.00	60.00	16.56	8.88
	Animals (AST5)	1	0.00	4.00	2.84	1.02
	Trees (AST6)	1	0.00	4.00	2.05	1.00
	Water saving equipment (AST7)	1	0.00	3.00	1.34	0.79
Adaptive Capacity (AC)	In charge of years (AC1)	3	0.00	40.00	13.51	8.13
	Dependency ratio (AC2)	3	1.00	1.00	1.00	0.00
	Synergies index (AC3)	3	0.11	1.00	0.43	0.24
	Efficiency Index (AC4)	3	12.50	68.75	41.12	10.84
	Recycling index (AC5)	3	43.75	93.75	69.74	12.63
Resilience (R)	Income stability (R1)	3	1.00	4.00	2.10	0.63
	Social protection (R2)	3	0.00	3.00	0.97	0.75
	Adaptive climate change (R3)	3	1.00	4.00	2.30	0.74

Note: These indicators belonged to three types: Categorical (Type 1), Binary (Type 2), and Continuous (Type 3).

Source: Author's calculations based on the survey data, 2023, Sources of indicators from PGS farmers and literature

Methodology

This study uses cross-sectional data from the project entitled *Agro-convert: Agroecological Transition and Organic Certification in Vietnam to Empower Rural Communities*. This project investigates economic resilience, governance, environmental integrity,

social well-being, and technical limitations faced by conventional and organic smallholder farms in Vietnam (Grovermann et al., 2024). A cluster random sampling approach was used to collect data from PGS-certified producing zones in the peri-urban areas surrounding Hanoi and nearby Ha Nam and Hoa Binh provinces (Figure 1).

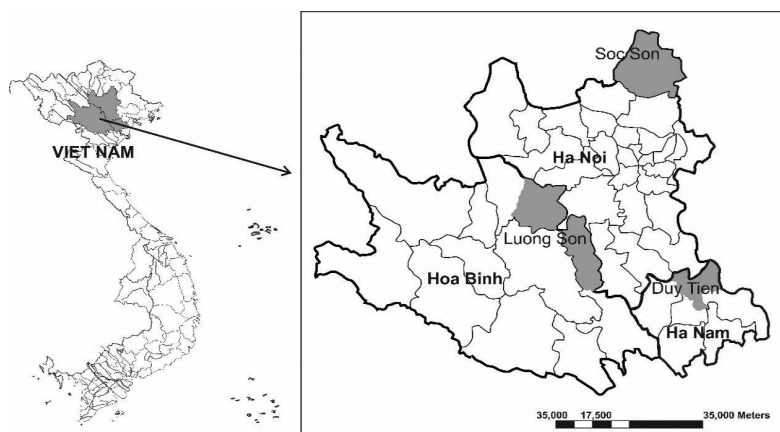


Figure 1 The research site

Source: The official administrative map of the Socialist Republic of Vietnam

Sample Design

The study relies on data from a survey conducted in northern Vietnam in March and April 2023 among peri-urban vegetable farmers producing white cabbage alongside other vegetables during the cropping season from August 2022 to March 2023. White cabbage was chosen as a focus crop as it is widely grown, commercially important, and representative of the local vegetable cropping system during the target farming period. The study covers nine districts of three provinces (Hoabinh, Hanam, Hanoi). The organic PGS-Vietnam scheme is active in this peri-urban area near the capital, Hanoi, and farmers supply vegetables to markets and supermarkets in the city (see map in Figure 1).

The project used a sampling strategy with multiple stages. Firstly, all 119 farmers from the PGS-Vietnam scheme growing white cabbage in the winter season of 2023 were included in the sample for the intervention group. This represents about 80 percent of the study area's 149 PGS-certified farms. Without similar studies in Vietnam or neighboring countries, averages and standard deviations for organic and conventional cabbage profitability were derived from expert opinions and compared to the global literature. The following approach was subsequently used to select farmers into the comparison group: For each of the nine districts with vegetable farmers, the main conventional white cabbage production villages (at least 50 farmers growing cabbage) were identified with the help of local extension officers. The randomized villages were listed in descending order. Subsequently, twenty farmers were randomly selected from a list of all cabbage farmers in each village. From those 20 farmers, between 10 and 14 available

cabbage farmers were determined by village heads for interviews. Selected villages were visited until 301 questionnaires were completed. The total sample size was 420 households with cabbage cultivation spreading over 26 villages in 9 districts, of which 119 farmers were PGS certified.

Calculation of the Resilience Capacity Index

The RIMA-II estimation follows a two-stage process (FAO, 2016b). The first stage involved assigning observable indicators to the four RIMA pillars (through factor analysis. Then, leveraging the factor analysis, a Multiple Indicators Multiple Causes (MIMIC) model was employed to generate a Resilience Capacity Index (RCI). The MIMIC model comprises two components: a structural equation model (SEM) that treats observed data as latent variables and a measurement model in which the observed variables are resilience indicators.

Accordingly, the RCI combines the average value of the four pillars mentioned above. This index initially helped determine the actual position of the resilience of households on PGS production. For the RCI calculation, observable factors related to resilience are grouped into different pillars, each representing a critical dimension of resilience. These scores are then normalized using a min-max scaling method, standardizing them on a scale from 0 (indicating low resilience) to 1 (indicating high resilience) (Mondal et al., 2023).

Econometric Analysis

To build a predictive model for resilience, we adopt a PLS-SEM approach, which is less sensitive to small

sample sizes compared to another statistical method, making it suitable for our research. Combined with the RIMA-II framework, this method offers a unique advantage for assessing and explaining agricultural system resilience by leveraging SEM’s latent variable estimation and explicit measurement error testing with RIMA-II’s structured approach (Novikova et al., 2013). The indicators of the PLS model are combined with four latent variables in Table 2.

The following function expresses the resilience capacity (R_i) of the i household:

$$R_i = f(ABS_i, AST_i, SSN_i, AC_i)$$

Economic Assessment

To reach deeper into the impact of resilience on economic outcomes, we meticulously calculated the financial performance of households. Our goal is to determine if those households that score higher on the resilience capacity index enjoy more significant benefits.

The profit indicator gauges the economic performance, calculated explicitly for the autumn/winter period of 2022/2023. Here is the breakdown of how the profit was determined (Commission, 2016):

$$Pr_i = (Y_i P_i - C_i) - L_i$$

where Y_i is the gross value of the cabbage production outputs of the household i , and P_i is the farm-gate price of cabbage. The cost of production denoted by C_i is related to inputs (e.g., herbicides, fertilizers, pesticides, compost, hired labor, or energy). L_i is family labor cost. In addition, a one-way ANOVA is used to analyze the difference in profitability across RCI groups. We checked model assumptions (residual normally distributed with equal variance). We have also consolidated the post-hoc pairwise comparisons into a single table using Tukey’s HSD test. A non-parametric Kruskal -Wallis test was performed if they were not fulfilled.

Table 3 The PGS farmers’ characteristics

Items	N	Min	Max	<i>M</i>	<i>SD</i>
Gender respondents (1=Male)	119.00	0.00	0.00	1.00	0.35
In charge years (Years)	119.00	0.00	0.00	40.00	8.13
Head gender (1=Male)	119.00	0.00	0.00	1.00	0.49
Years of schooling (Years)	119.00	0	12.00	2.73	0.35
Age (Years)	119.00	31.00	83.00	55.7	8.6
Member of a group (0= No)	119.00	0.00	1.00	0.98	0.12
Involved people (People)	119.00	1.00	6.00	1.78	0.84

Source: Surveyed data, 2024

Results

Characteristics of Cabbage Growing Respondents

The table presents the characteristics of respondents involved in cabbage growing farmers. The gender distribution shows that 35 percent of the respondents are male. The average year of experience managing cabbage farming reaches approximately 8.13 years, indicating a wide range of experience levels within the group. Regarding household leadership, nearly half (49%) of the household heads are male. Educational attainment among respondents averages 2.73 years of schooling, suggesting a generally low level of formal education. The age of respondents is quite high, with an average age of 55.7 years, indicating a relatively older demographic engaged in cabbage farming. Nearly all respondents (98%) are members of a group, reflecting a high level of community involvement. Additionally, the number of people involved in cabbage farming activities per household ranges from 1 to 6, with an average of 1.78 people. This highlights that a small number of household members typically manage these farming activities (Table 3).

Structure Model

These steps attempted to assess the reliability and validation of the structural model. Additionally, the model’s predictive capabilities for collinearity and the relationship between the constructs were confirmed by examining the variance inflation factor (VIF) values of all sets of these constructs. The indicators of R^2 (explained variance), structural path coefficient size, and statistical significance are metrics for evaluation (Fan et al., 2016).

The results show that the VIF values are below the threshold of 2, indicating that collinearity is not a critical issue in the structural models. Thus, there is significant relevance to the structural model relationship. In addition, the coefficient of determination (R^2) was 0.415, and the R^2 adjusted was equal to 0.462 (Figure 2). In the next step, an evaluation of the significance and relevance of the path coefficient was conducted.

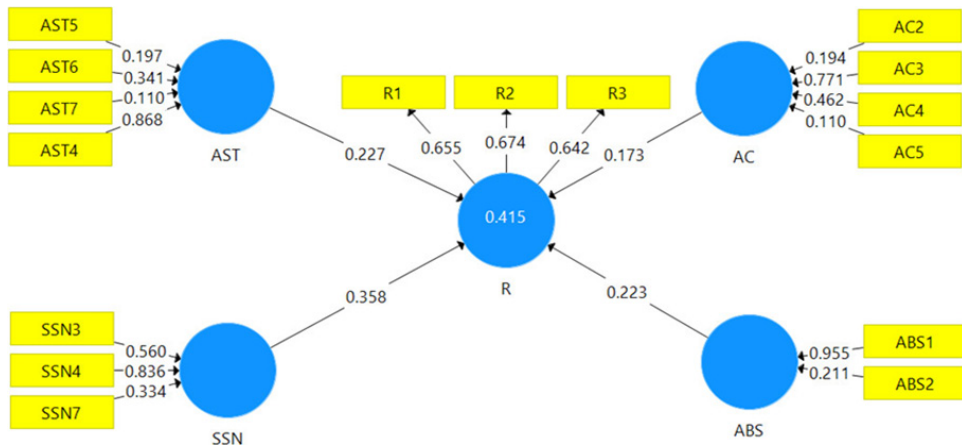


Figure 2 Resilience path model by estimated with Smart-PLS, all values are standardized

Relevance is indicated by path coefficient ranges from 0 to +1, meaning a positive relationship is significant at the 5 percent level (Hair et al., 2021). Accordingly, the path coefficients for SSN, AST, and ABS are significant at 0.05 level, while AC is not (Table 4). In other words, Table 4 reports the results of three pillars related to resilience capacity: SSN, AST, and ABS.

Table 4 Model path coefficient

Pillars	Path Coefficients	<i>p</i> values	VIF
ABS → R**	0.223	.019	1.127
AC → R	0.173	.074	1.053
AST → R**	0.227	.035	1.168
SSN → R**	0.358	.000	1.165

Note: ***p* value at .05, all values are standardized

Source: PLS-SEM output, 2023

Measurement Model

The SRMR value is 0.081, which falls within the generally accepted threshold range for PLS-SEM models, where values below 0.10 are typically considered acceptable, and values below 0.081 suggest that the model is satisfactory. In other words, our model has an acceptable fit based on SRMR standards. Regarding the Normed Fit Index (NFI), our model's NFI value is $0.43 < 0.9$, or the model is theoretically weak. However, Hair et al. (2019) and Hair et al. (2021) suggest that the fitness of SMARTPLS should not be assessed or assessed cautiously. Thus, we do not consider it a serious problem of our model.

Additionally, the formative measurement approach was tested for collinearity, which arises when two or more indicators are substantially connected, increasing

the standard error of the indicator weights (Hair et al. 2021). The study had no multicollinearity concerns since VIF is smaller than 2 for four pillars. The model continuously measured the statistical significance and relevance of indicator weights by regressing the construct on its indicators, using bootstrapping to generate robust standard errors and enhance the validity of significance testing (Hair et al. 2014).

In the formative model, outer weights are used to evaluate how to fit observed data to models via the bootstrapping technique. As Hair et al. (2014), the outer weights of the formative indicators, including AST4, SSN3, and SSN4, are well explained for latent variables with significance at the 5 percent level. Though ABS1, AC3, and AC4 are non-significance, the outer weights of these formative indicators were higher than 0.5, meaning that they have significance in explaining latent variables. Thus, they are preserved in the structure matrix. Moreover, the outer loadings of ABS2, AST5, AST6, AST7, SSN7, AC2, and AC5 range from 0.2 to 0.5, which are essential indicators for capturing some parts of resilience dimensions and PGS farmers (according to the RIMA-II approach) (FAO 2016b; Ben et al., 2021) (Table 5). Therefore, these indicators should still be retained in the model. The remaining indicators of ABS3, AST1, AST2, AST3, SSN1, SSN2, SSN5, SSN6, SSN8, and AC1 should be removed from the model due to non-significance, and low outer weights and outer loadings (Hair et al., 2013). On the other hand, the outer loadings of all reflective indicators for R1 and R3 are significant at the 5 percent level, while the outer loadings for R2 range from 0.4 to 0.7. Therefore, the model should retain these indicators (Table 5 and Figure 2).

Table 5 Outer weights of formative constructs

Constructs	Variables	Outer weights	<i>p</i> value	Outer loadings	VIF
Access of Basic Services (ABS)	ABS1	0.805	0.077	0.941***	1.183
	ABS2	0.184	0.522	0.301**	1.016
Asset (AST)	AST4	0.852*	0.004	0.844*	1.186
	AST5	0.214	0.271	0.354**	1.152
	AST6	0.365	0.105	0.293**	1.072
	AST7	0.117	0.725	0.313**	1.255
Social safety nets (SSN)	SSN3	0.688*	0.020	0.411*	1.335
	SSN4	0.818*	0.003	0.742*	1.095
	SSN7	0.320	0.159	0.307**	1.137
Adaptive capacity (AC)	AC2	0.217	0.469	0.367**	1.084
	AC3	0.756	0.058	0.844***	1.067
	AC4	0.473	0.071	0.527***	1.015
	AC5	0.093	0.741	0.229**	1.048
Resilience (R)	R1	0.524*	0.012	0.651*	1.060
	R2	0.429	0.180	0.650***	1.089
	R3	0.571*	0.019	0.666*	1.029

Note: **p* indicator's outer weights and outer loadings; ** 0.2 < outer loading < 0.5 but important indicator. ***No significant indicator's outer weight, but its outer loading is high (above 0.50). VIF indicators are below 2

Source: PLS-SEM output, 2023

Discussion

The resilience structure matrix shows that the three pillars—SSN (Social Safety Nets), AST (Assets), and Access Basic Services (ABS)—are the most essential pillars for resilience capacity and have the most significant impacts on households' resilience. It implied that SSN, AST, and ABS are the most critical components of the resilience structure in PGS organic cabbage-growing households. In other words, SSN, AST, and ABS almost explain the resilience of PGS cabbage-growing households. Such plays a crucial role in enabling households to absorb, adapt, and recover from perturbations and climate shocks that are similar to the findings of other studies (Beyene et al., 2023; Ciani and Romano, 2014; FAO 2016b; Ben et al., 2021). The findings provide evidence to strengthen the integration of SSN, AST, and ABS and suggest a multi-intervention approach to building households' resilience capacities at the research site. When looking at the contribution of each pillar, SSN is ranked as the most critical contributor to the resilience capacity with a beta of 0.358 (Table 4 and Figure 2). The SSN pillar refers to a household's capacity to rely on formal and informal support from relatives, friends, governments, and other sources. The SSN is widely recognized as essential to buffer against the negative impacts of shocks and helps households smooth their income. The results implied that encouraging the development of diverse support networks should be considered in the coming

years. This is aligned with a study of organic farming in Bolivia, which found that local farmers' organizations, such as cooperatives, increased adaptive capacity and buffer capacity. Moreover, a robust social network and knowledge management are essential in building resilience (Jacobi et al., 2015).

This analysis was confirmed by a positive and significant correlation between SSN and three observed variables, namely, local farmer groups (SSN4), membership in cooperatives (SSN3), and other support networks (SSN7). In more detail, the PLS-SEM reveals that members of local farmer groups (SSN4) are the most important in determining SSN, with a Beta coefficient of 0.836. This can be explained by the meetings and interactions among farmers within groups to share best practices, knowledge, and resources which are considered to create platforms for collaboration and communication between PGS households. This finding aligns with (Hruschka et al., 2022), who collectively highlight the roles of self-help activities, community unions, and knowledge exchange in promoting peaceful coexistence, alleviating poverty, and enhancing resilience among PGS farmers. Interventions include strengthening farmer groups through (1) assisting farmers in accessing microfinance subsidies for farming techniques, (2) supporting farmer groups to enhance resilience against shocks via training courses in pest control, and market access.

Assets are also an essential component of households' resilience and can be used to buffer households against perturbations (Smith & Frankenberger, 2018). In this analysis,

those observed variables are the following: the number of vegetable crops (AST4), animals (AST5), trees (AST6), and water-saving equipment (AST7), which have positive impacts on the AST pillar. Besides, due to the importance of the number of vegetable crops, with a beta coefficient of 0.70 (Figure 2), interventions should focus on increasing the number of vegetable crops at the farms (e.g., through the support of seedling provision or technical training). In addition, raising farmer's awareness of the positive role of biodiversity in their overall farm should be the focus. This finding is consistent with Adjimoti and Kwadzo (2018) and Pellegrini and Tasciotti (2014) that crop diversification plays a role in household's resilience to food insecurity through the improvement of income and risk management. Furthermore, empirical evidence suggests that improving access to water-saving equipment for increasing crop productivity is essential for future farming under climate change.

As (FAO, 2016b), Access to Basic Services could have the capacity to generate income. Results in Figure 2 demonstrate that market access and access to school significantly and positively impact the resilience of households, especially market access, which had the highest impact with a beta of 0.955. This finding aligned with (d'Errico et al., 2018) that those indexes are good indicators for constructing the ABS pillar. The study of (Navarrete et al., 2015) also showed that marketing is one of the three critical issues for improving sustainability in organic vegetable farming. This finding can be explained by the fact that PGS vegetables are sold through two main channels, cooperatives or local markets, which could increase farmers' profits through good vegetable distribution. This approach allows for establishing relationships with shops and restaurants, thereby gaining valuable insights into market demand and pricing strategies. Additionally, farmers can negotiate for higher prices based on the quality or unique characteristics of their products. It is particularly beneficial for those specializing in high-quality or niche products. This interaction can inform production adjustments to meet market needs better and potentially command premium prices.

The resilience capacity index (RCI) is measured to understand the capacity of PGS cabbage-growing households to overcome perturbations and climate changes. Using the ANOVA test, we also compare profitability across RCI levels to understand whether households with a higher resilience capacity index exhibit higher economic benefits. Because the RCI mean is 36.8 percent, the resilience capacity indexes are divided into three subgroups by equal probability intervals. This finding shows a positive relationship between RCI and economic performance at the 1 percent level (Table 6). More specifically, increased financial benefits across the resilient levels revealed significant household growth. The profitability of most resilience has recorded a massive value of 174.8 million VND per ha. However, the less resilient households had substantial losses, with 212 million VND per ha of profits.

The result implies that as households achieve higher RCI (measured by three pillars of SSN, AST, and ABS), their economic performance (profitability) also increases. This evidence aligns with previous studies (Gaisie et al., 2021; Haile et al., 2021; Hartwig & Nguyen, 2023; Lo et al., 2016) that households with higher RCI values (likely correlated with better socio-economic status) achieve higher profitability.

Conclusion and Recommendation

Overall, the results indicate that Social Safety Net (SSN), Assets (AST), and Access Basic Services (ABS) are the three pillars that play the most crucial role in a household's resilience, respectively. Observed variables important to SSN are *local farmer groups*, *farmer organizations*, and others (relative groups, PGS micro groups), while *the number of vegetable crops*, *animals*, *trees*, and *water-saving equipment* significantly are those critical in AST as well as the *access to market and school* are proxies of ABS. Furthermore, the study contributes to understanding the positive correlation between RCI and economic performance. The current study's findings suggest that improving core indicators of three key pillars, such as supporting local farmer groups,

Table 6 Relationship between Resilience capacity and profits

Household categories	M (%) 36.8	RCI (%)			p
		Low (<33.33)	Medium (33.33-66.66)	High (>66.66)	
Number households	-	54	58	7	-
Profit (Million VND/ha)	-58.8	-212.0 ^{a,c*}	55.6	174.8	.00**
(Leneve) $p = 0.00 < 5\%$					

Note: One-way ANOVA test and Turkey HSD test, ** $p < .01$.

Source: Surveyed data, 2023

promoting diversified vegetable crops, and enhancing the household's capacity to access the agricultural market, should be prioritized to obtain the premium benefits.

However, the study has a few limitations. The research only covers one crop season and focuses on PGS cabbage-growing households in the Red River Delta. This means the findings might not entirely reflect how resilience works throughout the year or across different areas and types of farming. Also, since the data come from just one season, it may not capture the impact of seasonal changes or broader climate conditions on household resilience and economic outcomes. Thus, future studies could expand the scope by comparing organic and conventional farming systems to understand resilience in various contexts better. Research could also be conducted in other regions of Vietnam or similar agricultural areas in different countries to make the findings more widely applicable. Additionally, collecting data over several seasons would offer a clearer picture of resilience changes.

Conflict of Interest

The authors declare that there are no conflicts of interest.

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