ASIAN JOURNAL OF AGRICULTURE
Volume 9, Number 2, December 2025
Pages: 712-726
E-ISSN: 2580-4537
DOI: 10.13057/asianjagric/g090239

Food security and resilience of smallholder nature-positive farmers in Quezon, Philippines

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Manuscript received: 10 July 2025. Revision accepted: 31 October 2025.

Abstract. *Landicho LD, Abadillos MAG. 2025. Food security and resilience of smallholder nature-positive farmers in Quezon, Philippines. Asian J Agric 9: 712-726.* The agriculture sector, particularly smallholder farmers, is highly vulnerable to climate and non-climate shocks, including extreme weather events, pest and disease outbreaks, and market price fluctuations. Promoting nature-positive food production, defined as the regenerative, non-depleting, and non-destructive use of natural resources, offers an important strategy to strengthen resilience and food security in farming communities. Agroforestry and organic agriculture are two farming systems that embody nature-positive principles by enhancing soil health, diversifying farm outputs, and minimizing dependence on synthetic inputs. Therefore, this study aims to assess the food security and resilience levels of smallholder farmers engaged in organic farming and agroforestry in Sariaya, Quezon, Philippines. This study assessed the food security and resilience of 159 agroforestry and 30 organic farmers in Sariaya, Quezon, Philippines, using household surveys, focus group discussions, and key informant interviews. Results showed that agroforestry and organic farmers achieved moderate to high levels of food security, with mean scores of 6.98 and 7.34, respectively, across the four dimensions of food availability, accessibility, stability, and utilization. However, financial and social capital remain the weakest links, limiting the overall resilience of smallholder systems. The study underscores that nature-positive approaches enhance both ecological integrity and household resilience. Strengthening institutional support, value-chain participation, and adaptive capacity can further sustain food systems under climate and economic stress.

Keywords: Agroforestry, climate change, livelihood assets, organic agriculture

INTRODUCTION

The agriculture sector is a cornerstone of food and livelihood security, but is also among the most vulnerable to shocks and stresses. Smallholder farmers, who dominate agricultural production in many developing countries, face multiple risks that compromise their productivity and well-being. These include climate change impacts, market and policy uncertainties, pest infestations, and health crises such as pandemics (Landicho et al. 2015; Evangelista et al. 2016; Harvey et al. 2018; Penalba 2019; Gu and Wang 2020; Gregorio and Ancog 2020; Middendorf et al. 2021). Such risks threaten both agricultural sustainability and rural household resilience, making it essential to identify production systems that reduce vulnerabilities while maintaining livelihoods.

Agriculture is highly sensitive to climatic conditions, with evidence showing that climate change alters crop growth cycles, increases the frequency of extreme weather events, and changes pest and disease dynamics (Yuan and Sun 2024). These processes negatively affect crop yield, quality, and food accessibility (Manucharyan 2025), while also influencing nutrition and overall food security (Aryal et al. 2019; Malhi et al. 2021). In response, global initiatives such as the United Nations Food Systems Summit emphasize "nature-positive food production," defined as regenerative, non-depleting, and non-destructive use of natural resources. Such approaches prioritize biodiversity stewardship, soil and water health, and climate regulation, while reducing dependence on synthetic chemicals. As Kaushal et al. (2025) highlight, lowering external inputs through organic and ecological practices not only reduces costs for smallholders but also minimizes adverse environmental impacts.

Two key systems within nature-positive agriculture are organic farming and agroforestry. Organic agriculture prohibits synthetic fertilizers, pesticides, and pharmaceuticals, emphasizing soil fertility management, crop variety selection, and biological or cultural practices that sustain productivity while protecting farmers, consumers, and ecosystems. Agroforestry, on the other hand, integrates crops with woody perennials, livestock, or aquatic resources, combining socio-economic productivity with ecological stability. Both systems embody holistic approaches that align agricultural output with environmental stewardship.

In the Philippines, organic and agroforestry practices are mostly adopted by smallholders (Landicho et al. 2014, 2024; Baliton et al. 2020). Globally, these systems are recognized for ecological services such as biodiversity conservation, carbon sequestration, and land restoration (Baliton et al. 2017; Castle et al. 2022; Smith et al. 2022; Gamage et al. 2023; Willmott et al. 2023; Malinowski et al. 2024; Sanders et al. 2025). Despite these well-documented environmental benefits, there is limited evidence on how these systems contribute to resilience outcomes for smallholder households in the Philippines. Some studies have assessed resilience in rice and vegetable systems (Fachrista et al. 2019; Heckelman et al. 2022), yet comprehensive assessments of farming systems remain scarce. Resilience, as defined by Walker et al. (2004) and Folke (2006), refers to the ability of a system to absorb disturbance, reorganize, and adapt while maintaining core functions and identity.

Likewise, empirical insights on the food security benefits of organic and agroforestry systems remain limited. Food security exists when all people, at all times, have access to sufficient, safe, and nutritious food that meets dietary needs and preferences (World Food Summit 1996). This multidimensional concept involves four pillars: availability, accessibility, utilization, and stability. While both organic and agroforestry systems are expected to contribute to these pillars through crop diversification, improved soil fertility, and reduced reliance on external inputs, few studies in the Philippine context have systematically examined these contributions.

Given the increasing exposure of smallholder farmers to climate and market stressors, alongside the promotion of nature-positive agriculture, it is timely to investigate the extent to which organic farming and agroforestry improve household food security and resilience. Such analysis can provide critical insights into whether these farming systems can ensure a sustained food supply, reduce vulnerability, and strengthen adaptive capacity in rural communities. Furthermore, the findings can inform targeted interventions and policy measures that enhance the sustainability of farming livelihoods.

Therefore, this study aims to assess the food security and resilience levels of smallholder farmers engaged in organic farming and agroforestry in Sariaya, Quezon, Philippines. Specifically, it evaluates food security across the four dimensions of availability, accessibility, utilization, and stability, and examines resilience through human, social, financial, and natural capitals within the Sustainable Livelihoods Framework. The results are expected to provide empirical evidence for designing strategies and policies that strengthen the adaptive capacity of nature-positive smallholders facing climate and non-climate stressors.

MATERIALS AND METHODS

Study sites

The study was conducted in Sariaya, Quezon, particularly in Concepcion Banahaw and Barangay Pinagbakuran and in Barangays Mamala I, Mamala II, and Balubal (Figure 1).

Sampling of respondents

The sampling population included farm households engaged in nature-positive food production, including organic agriculture and agroforestry. The sampling intensity for agroforestry farmers was computed using the following formula (Yamane 1967):

$$n= N\ (1+Ne^2)$$

Where:
n: Sample size;
N: Total population and
e: As the sampling error (5%)

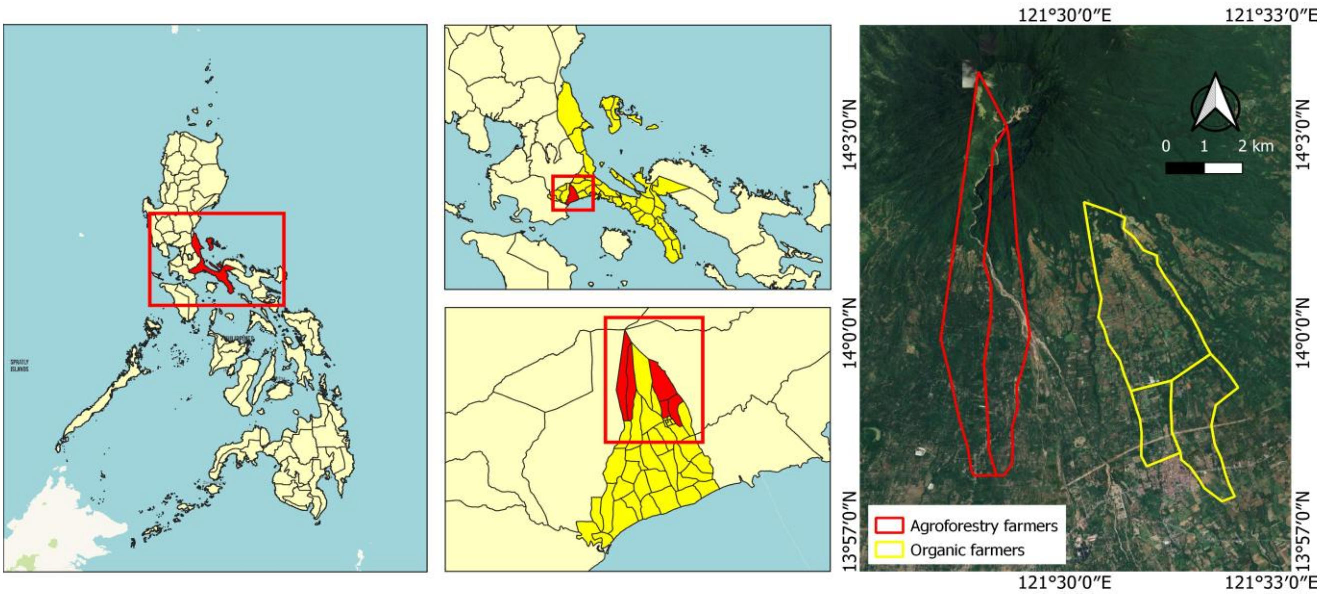

Figure 1. Study sites representing agroforestry systems (red line) and organic farms (yellow line) in Sariaya, Quezon, Philippines

Hence, the sampling intensity computed for agroforestry and organic is 159. The respondents were selected using simple random sampling. A complete enumeration of organic farmers, however, was employed because of the relatively small population (Table 1).

Data gathering

The data were gathered using a combination of farm household surveys, key informant interviews, Focus Group Discussions (FGD), and actual farm visits. One FGD session per study site was conducted involving a maximum of 12 participants.

Socio-economic and farm characterization

Farm household surveys were administered by the local field enumerators to the farm household respondents using a pre-tested survey questionnaire. The survey captured the socio-economic characteristics, farm characteristics, and other variables representing the social, human, financial, physical, and natural capitals, status of food availability, accessibility, stability, and utilization. Meanwhile, an actual visit to the farms was done to validate the farm characteristics and their biophysical conditions.

Vulnerability assessment

The vulnerabilities of the farming systems to climate and non-climate stressors were identified from the farm household survey and FGDs. Climate-related shocks or stresses include natural disasters and extreme weather events, and non-climate-related shocks such as pest infestation and changing market policies. The degree of vulnerability of farming systems to these shocks was determined through frequency counts of their occurrence.

Food security assessment

The food security potentials of agroforestry and organic agriculture systems were analyzed using four variables: food stability, availability, accessibility, and utilization. As shown in Table 2, each variable was measured through several indicators, which were rated 1 or 2, depending on whether they contribute positively to food security. Each indicator was then given a weighted score, which was computed by determining the frequency count for each item, multiplying it by the rate, and dividing it by the total number of respondents. The sum of the weighted scores across all indicators gave the total score for that variable, while the average of this sum gave the mean score. The mean of this sum represented the total mean score for that indicator, wherein a lower score (<1) means food is not available, stable, accessible, or utilized; a higher score (1.5-2) means the opposite or highly available, stable, accessible, and utilized. A mean score between 1-1.49 means moderate indicators. The food security status in the study sites was then computed by adding up the scores in each of the four indicators, divided by the total number of indicators. Questions on the four indicators of food security were incorporated in the survey questionnaire, and results were validated during the focus group discussion.

Table 1. Sampling frame of the two study sites

	Agroforestry		Organic
	Concepcion Banahaw	Concepcion Pinagbakuran	Mamala 1 and 2 and Balubal
N	96	103	30*
e^2	.05	.05	
n	77	82	

Note: n: Sample size, N: Total population, e: As the sampling error (5%), *: Complete enumerations

Table 2. Quantitative and adjectival rating of indicators of food security

Measures of food security dimensions	Quantitative and adjectival rating
Food availability	
Level of availability (always available, sometimes available, not available)	1.50-2.00 (Food is highly available)
Households' eating frequency per day	1.00-1.49 (Food is moderately available)
Experiences of food shortage	<1.00 (Food is not available)
Experiences of skipping meals and hunger	
Food accessibility	
Whether the household consumes farm produce	1.50-2.00 (Food is highly accessible)
Whether households can buy food items not available on their farms from the market	1.00-1.49 (Food is moderately accessible)
Whether households can meet their basic food needs	<1.00 (Food is not accessible)
Food stability	
Whether farming systems are able to produce multiple crops throughout the year	1.50-2.00 (Food is highly accessible)
Whether crop components can withstand extreme weather events and pests, and diseases	1.00-1.49 (Food is moderately accessible) <1.00 (Food is not accessible)
Food utilization	
Whether farm households consume their own produce	1.50-2.00 (Food is highly accessible)
Whether other members of the local community consume farm produce, and outside the community	1.00-1.49 (Food is moderately accessible) <1.00 (Food is not accessible)
Types of food items utilized in the household	
Food security status	
The sum of scores of the four indicators of food security divided by the total number of indicators	7.00-8.00 (High level of food security) 6.00-6.99 (Moderate level of food security) 5.00-5.00 (Low level of food security) <5.00 (Food insecure)

Source: Landicho et al. (2017)

Resiliency assessment

DFID (2000) argues that social capital, human capital, natural capital, and financial capital shape the sustainability of a livelihood project. Different variables were identified under each of the four indicators of sustainability and resilience, as shown in Table 2. The corresponding weights of each indicator and variable were calculated following the Analytical Hierarchy Process (AHP). AHP allows users to assess the relative weight of multiple criteria or multiple options against given criteria in an intuitive manner (Saaty 1990). The weights and scores are achieved by pairwise comparisons between all options with each other (Kasperczyk and Knickel 2006).

A participatory scoring of the different indicators of resiliency was done using the AHP via an FGD session. The participants in each site were convened to provide weights based on the importance/relevance of the different parameters of resiliency. The weights of each of the variables and sub-variables were computed using the pairwise comparison variables, computing the criteria weight, and checking on the consistency ratio, following Saaty's process.

AHP was conducted in each study site, which resulted in varying weights of variables, depending on the priorities of the local stakeholders. Experts' judgments were likewise elicited. Average weights of the variables were then computed (Figure 2). These weights were then used to compute the scores of each variable shown in Table 3

This process generated the weights for each of the indicators and sub-indicators as shown in Figure 2. From the four capitals, human capital obtained the highest weight, followed by knowledge and information (0.22), innovations (0.14), leadership and governance (0.09), and institutions (0.04). Each of the five indicators has corresponding sub-indicators with respective weights (Figure 2).

The weight of each indicator and sub-indicator is multiplied by its corresponding score. The level of resilience is determined using the scale below, following Landicho et al. (2023):

0.0-0.33: Low
0.34-0.66: Moderate
0.67-1.00: High

Data analysis and validation

The data were analyzed using descriptive statistics such as percentages, frequency counts, means, and weighted scores. Data gathered from FGD and key informant interviews were analyzed using themes and categories. Results of the analysis served as the basis for formulating technical and policy recommendations towards enhancing the resiliency of farm households engaged in nature-positive food production systems. Results gathered from the farm household surveys, FGD, and key informant interviews were validated during the feedbacking and validation workshop.

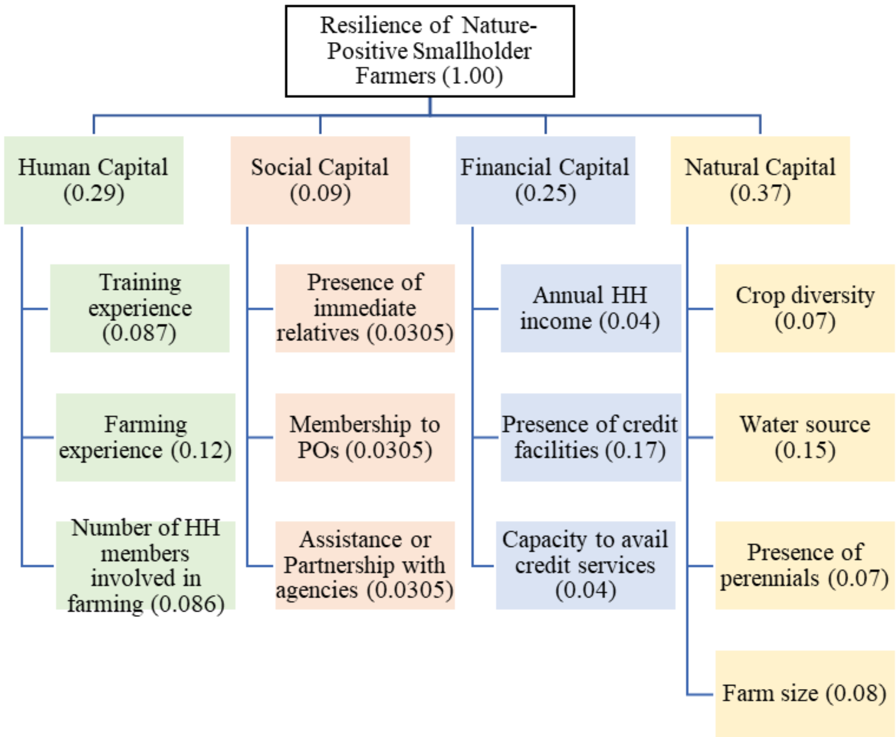

Figure 2. Weights of the resiliency indicators and sub-indicators/variables based on Analytical Hierarchy Process (AHP)

Table 3. Variables of each of the four indicators of resiliency and sustainability used in the study sites (Landicho et al. 2023)

Indicators and variables	Scales/scores
Social capital	
Active membership in POs	Member=1, Non-member=0
Presence of immediate relatives	With relatives=1, No relatives=0
Partnership with local development organizations	Partnership =1, No partnership =0
Financial capital	
Annual household income	<Php100000=1, 101000-300000=2, 301000-50000= 3, >500000=4
Presence of credit facilities	With credit facilities=1, No credit facilities=0
Capacity to avail credit services	Can avail credit services=1, No capacity to avail = 0
Human capital	
Training experience	Attended trainings=1, No training attended=0
Farming experience	<10 years=1, 10-20=2, >20=3
HH members active in farming	One member=1, 2-3=2, 4-5=3, >5=4
Natural capital	
Farm size	<one hectare=1, 1-2 hectares=2, 3-4 hectares=3, >4 hectares=4
Crop diversity	2-4 crop components=1, 5-7 crop components=2, >7 crop components=3
Access to a water source	Rainfed =1, Rivers/Springs=2, Irrigation=3, Combination of water source=4
Presence of perennial crops	With perennial crops=1, No perennial crops=0

RESULTS AND DISCUSSION

Socio-economic characteristics of agroforestry and organic farmers

Table 4 shows that the majority of the agroforestry farmers were male (73%), while an equal percentage (50%) of male and female organic farmers was recorded. Both agroforestry and organic farmers are still in their productive years, having a mean age of 50 and 45, respectively. All (100%) of the respondents have reported farming as their main source of income. In terms of their social capital, all (100%) agroforestry and organic farmer-respondents have immediate relatives within the community. Most (63%) of the agroforestry farmers have been farming for more than 20 years. On the other hand, many organic farmers have been farming for less than 10 years. In general, agroforestry and organic farmer-respondents are considered as smallholder farmers, considering their farm size of 1.21 and 0.63, respectively.

Agroforestry farmers have higher income compared to the organic farmers, having a mean annual household income of Php188,108 and Php39,772, respectively. Furthermore, the agroforestry farmers invest in the production of fruit trees with high market demand, as shown in Table 4. The majority (59%) of the agroforestry farmers have diverse non-farm income sources.

Characteristics of agroforestry and organic farms

The recent challenge of balancing food production for food security and avoiding land degradation for environmental conservation and integrity calls for a paradigm shift towards sustainable food production and sustainable food systems. Hence, nature-positive food production and nature-positive food systems have now become a discourse for sustainable development. They offer potential to minimize destructive land management practices and enhance conservation efforts (World Economic Forum 2020). Lal (2020) highlighted that regenerative conservation agriculture and agroforestry are among the farming practices and approaches that are anchored on nature-positive food systems.

In this study, the farmers in Barangay Concepcion Banahaw and Concepcion Pinagbakuran are reportedly engaged in an agroforestry system. Table 5 highlights the characteristics of agroforestry and organic farms in Sariaya, Quezon. Results show that smallholder farmers in Sariaya, Quezon, own their farms as reported by 43% agroforestry farmers and 57% organic farmers. In general, these farms, which are situated in the upland barangays of Sariaya, Quezon, are rainfed, as mentioned by 67% agroforestry farmers and 63% organic farmers. They cultivate areas with flat to rolling topography and practice nature-based strategies for food production. For instance, many (44%) of the agroforestry farmers apply soil and water conservation measures, particularly in farmlands with relatively rolling and steep slopes. Mulching and the use of organic plant supplements are also practiced by 37% and 36% of the agroforestry farmers, respectively. On the other hand, almost all (93%) of the organic farmers use organic soil amendments, particularly organic plant supplements, to ensure soil health and crop growth. Most (83%) of them also practice organic pest control measures.

The farmers in Barangay Concepcion Banahaw and Concepcion Pinagbakuran practice an agroforestry system (Figure 3). Agroforestry is a land use management system that combines the production of short-term agricultural crops as sources of economic benefits and woody perennials as providers of ecological services, among others.

On the other hand, farmers in Barangay Balubal and Mamala I and II are engaged in organic vegetable production (Figure 4). Organic agriculture involves the use of natural or organic farm inputs instead of synthetic chemicals and pesticides, and makes use of locally-sourced or farm-based resources, with the intention of promoting ecological stability, economic productivity, and ensuring the health and safety of the farmer-producers and the consumers. Most of the organic farmers in Sariaya, Quezon, are engaged in annual crop production, particularly vegetables. Among the crops that they cultivate are carrots, tomatoes, sitao, leafy vegetables such as pechay, and root crops such as sweet potato, cassava, and ginger. There are also a few farmers who cultivate herbs such as thyme, Italian oregano, and rosemary, mainly for household income.

Table 4. Socio-economic characteristics of agroforestry and organic farmers in Sariaya, Quezon, Philippines

Variables	Frequency counts and percentages of responses	
	AF (%)	Organic (%)
Sex		
Male	73	50
Female	27	50
Mean age	50	45
Mean HH size	4	5
HH income sources		
Farming	100	100
Farm + Non-farm	95	33
Mean annual HH income (in Php)	188108	39772
Presence of relatives in the community	100	100
Presence of credit facilities	87	53
Without credit facilities	13	47
Membership in people's organization	60	57
Mean farm size	1.21	0.63
Number of years in farming		
<10	11	57
10-15	11	10
16-20	14	10
>20	63	23

Note: AF: Agroforestry Farmers

Table 5. Characteristics of agroforestry and organic farms in Sariaya, Quezon, Philippines based on respondents' interviews and farm visits, 2024

Variables	Frequency counts and percentages of responses	
	AF (%)	Organic (%)
Farm ownership		
Owned	43	57
Rented	14	20
Public land	8	0
Borrowed	34	23
Tenant	1	
Topography		
Flat	81	87
Rolling	4	30
Sloping	14	1
Source of irrigation		
Spring/river	38	30
Rainfall	67	63
Irrigation	15	23
Farm components		
Vegetables	96	100
Fruit trees	100	23
Forest trees	58	0
Livestock	92	90

Note: AF: Agroforestry Farmers

Figure 3. Typical vegetable-based agroforestry systems in Barangay Concepcion Banahaw, Sariaya, Quezon, Philippines

Vulnerabilities of agroforestry and organic farms

The agroforestry and organic farmers in the study sites are exposed to vulnerabilities such as natural hazards and extreme weather events brought about by climate change, and non-related shocks such as market uncertainties. These are confirmed by Murniati et al. (2017) and Gnonlonfoun et al. (2019).

Table 6 shows that vegetable crops are the most vulnerable to extreme weather events, pests, and market price fluctuations. It may be noted, however, that root crops are less vulnerable to these natural and market uncertainties. The FGD participants mentioned that these are low-maintenance crops, but market prices are quite low. Meanwhile, papaya and banana are among the most-cited perennials that are vulnerable to extreme weather events, pests, and market price fluctuations.

Table 6. Vulnerability of agroforestry and organic farm components in selected communities in Sariaya, Quezon, Philippines

Crops	Vulnerability to natural and market risks of agroforestry and organic produce							
	Typhoon		Drought		Pests/Diseases		Market uncertainties	
	AF	Organic	AF	Organic	AF	Organic	AF	Organic
Vegetable crops	68%	47%	78%	53%	79%	83%	88%	100%
Root crops	.006%	0	.012%	0	0	0	0	0
Cereals (rice/corn)	.012%	.06%	.012%	.03%	.012%	.03%	.012%	.03%
Fruit trees	(.04%)	0	(.006%)	0	0	0	0	0
Banana	0.21%	0.26%	0	0	0	0.20%	0.33%	0
Coconut	0.006%	0	0.006%	0	0	0	0.03%	0

Note: AF: Agroforestry Farmers, *: Survey results; validated during the FGD

Figure 4. Typical vegetable-based organic farm in Barangay Mamala, Sariaya, Quezon, Philippines

These vulnerabilities of agroforestry and organic farms are exacerbated by climate change. All (100%) farmer-respondents in Sariaya, Quezon are aware of climate change (Table 7). The farmers described climate change as having erratic rainfall and temperature patterns. The main source of climate change information is television, as mentioned by almost all of the agroforestry farmers (95%) and organic farmers (93%). Increased pest incidence was also observed by both agroforestry farmers (78%) and organic farmers (90%). It is worth noting, however, that only a few (27%) organic farmers have increased expenses on farm inputs. On the other hand, most (82%) of the agroforestry farmers have recorded increased expenses on farm inputs, because of reliance on externally-sourced inputs such as fertilizers and pesticides.

Food security status of farm households

Food availability is the physical presence or visibility of food in the marketplace, in households, produced in local farms, and generally present in the community (Landicho et al. 2017). As shown in Table 8, food is highly available as indicated by their mean scores ranging from 1.95-2.00. Their food is mostly sourced from their own farms, while other food items that are not available on their farms are purchased from the market (Table 9). Specifically, food is always available among the agroforestry and organic farm households. This could be because of their farming systems, which highlight crop diversification, integrating both short-term and perennial crops, including livestock.

The multiple products that the farm households derived from their farming systems enabled them to eat even more than the basic three times a day. Their crops are mostly short-term or early-maturing crops, which are integrated with woody perennials, which could immediately address their food needs. Almost all of these farm households eat three times a day, and some eat more than three times.

In terms of food stability, organic farming systems tend to be more stable than agroforestry systems. Table 10 highlights that the organic farming system is highly stable, having a mean score of 1.53. Since the organic farms of the respondent-farm households have diverse short-term agricultural crops, other crops may compensate for the loss or failure of one crop brought about by climatic and natural disturbances. On the other hand, while agroforestry farms also promote crop diversification, some of the crop components are woody perennials, which may not be the immediate food source of the households. It must be noted, however, that both farming systems could not withstand the impacts of climate change and extreme weather events, as reported by 100% of the respondents.

Table 7. Climate Change (CC) impacts on the agricultural production of agroforestry and organic farmers in Sariaya, Quezon, Philippines

Variables	Frequency counts and percentages of responses			
	AF	%	Organic	%
Awareness about CC	159	100	30	100
Indications of CC				
Experienced CC impacts				
Yes	151	95	30	100
No	8	5	0	0
CC impacts on agricultural production				
Lacks water for crop irrigation	104	65	20	67
Planting is delayed	96	60	7	23
Mortality of planted crops	28	18	20	67
Increased pests that damage crops	124	78	27	90
Low crop yield	109	68	21	70
Increased expenses on farm inputs	131	82	8	27

Note: AF: Agroforestry Farmers

Table 8. Food availability scores of agroforestry and organic farmers in Sariaya, Quezon, Philippines
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Indicators of food availability	Weighted scores on the different indicators of food availability*	
	Agroforestry farmers	Organic farmers
Food available at home		
(Yes=2)	1.90	1.86
(No-1)	0.04	0.06
Skipping meals		
(Yes=1)	0.13	0.13
(No=2)	1.73	1.72
Experience of hunger		
(Yes=1)	0.06	0.00
(No=2)	1.86	2.00
Food shortage		
(Yes=1)	0.16	0.06
(No=2)	1.66	1.86
Eating frequency		
(<3x a day=1)	.01	0.03
(3x a day=2)	1.63	0.75
(>3x a day=3)	0.53	1.70
Total means score	1.95	2.00
Adjectival rating	Highly available	Highly available

Note: *<1.00 (food is not available), 1.00-1.49 (food is moderately available), 1.50-2.00 (food is highly available)

Table 9. Sources of household food among the agroforestry and organic farmers

Sources	Frequency and percentages			
	Agroforestry farmers	%	Organic farmers	%
Own farm	120	75	30	100
Market	97	61	15	50
Food for work	3	2	0	0
Feeding program	2	1	0	0
Forests	3	1	0	0

As shown in Table 11, food is highly accessible to households of agroforestry and organic farmers, as indicated by a mean score of 1.99 and 2.00, respectively. Table 12 shows that farm produce is highly utilized within and outside the villages of agroforestry and organic farmers, as indicated by the mean scores of 1.60 and 1.81, respectively. Food accessibility is a situation when individuals and communities have adequate resources, like cash or production area, to obtain appropriate food (Landicho et al. 2017).

On the other hand, food utilization refers to the way in which people use the available food, mainly determined by individual preferences or choices (e.g., vegetables and fruits or meat). Table 12 shows that both agroforestry and organic farmers have high levels of food utilization with scores of 1.60 and 1.81, respectively. This means that these smallholder farmers, as well as the members of the local communities, consume their farm produce.

The overall status of food security among farming households in the three study sites was computed by summing up the scores of the four indicators of food security (Table 13). Results show that organic farmers have a high level of food security, having a score of 7.34, while agroforestry farmers have a moderate level with a score of 6.98.

Table 10. Food stability scores of agroforestry and organic farmers in Sariaya, Quezon, Philippines

Indicators of food stability	**Weighted scores on the different indicators of food stability***	
	Agroforestry farmers	**Organic farmers**
Capacity of the farming system to produce crops throughout the year		
(Yes=2)	0.81	1.93
(No-1)	0.59	0.03
Capacity of the farming system to withstand climate variability and disturbances		
(Yes=2)	0.00	0.00
(No=-1)	1.00	1.00
Capacity of the farming system to meet the basic food needs of the household		
(Yes=2)	1.84	1.26
(No=1)	0.07	0.36
Total means score	1.44	1.53
Adjectival rating	Moderately stable	Highly stable

Note: *<1.00 (food is not available), 1.00-1.49 (food is moderately available), 1.50-2.00 (food is highly available)

Table 11. Food accessibility scores of agroforestry and organic farmers in Sariaya, Quezon, Philippines

Indicators of food accessibility	**Weighted scores on the different indicators of food accessibility***	
	Agroforestry farmers	**Organic farmers**
Produce is consumed at home		
(Yes=2)	2.00	2.00
(No-1)	0.00	0.00
Household's capacity to buy food		
(Yes=2)	2.00	2.00
(No=-1)	1.00	1.00
Market is accessible for food items not available on the farm		
(Yes=2)	1.97	2.00
(No=1)	0.01	0.00
Total means score	1.99	2.00
Adjectival rating	Highly accessible	Highly accessible

Note: *<1.00 (food is not accessible), 1.00-1.49 (food is moderately accessible), 1.50-2.00 (food is highly accessible)

Table 12. Food utilization scores of agroforestry and organic farmers in Sariaya, Quezon, Philippines

Indicators of food utilization	**Weighted scores on the different indicators of food availability**	
	Agroforestry farmers	**Organic farmers**
Produce is sold within the village		
(Yes=2)	0.33	1.27
(No-1)	0.80	0.36
Produce is sold outside the village		
(Yes=2)	1.37	1.60
(No=-1)	0.31	0.20
Produce is consumed at home		
(Yes=2)	2.00	2.00
(No=1)	0.00	0.00
Total means score	1.60	1.81
Adjectival rating	Highly utilized	Highly utilized

Note: *<1.00 (food is not utilized), 1.00-1.49 (food is moderately utilized), 1.50-2.00 (food is highly utilized)

Table 13. Food security status of agroforestry and organic farm households in Sariaya, Quezon, Philippines

Food security indicators	**Summary of weighted scores of each indicator**	
	AF	**Organic**
Food availability	1.95	2.00
Food stability	1.44	1.53
Food accessibility	1.99	2.00
Food utilization	1.6	1.81
Total scores	6.98	7.34
Adjectival rating	Moderate	High

Note: AF: Agroforestry Farmers, * <5.00 (food insecure), 5.00-5.99 (low), 6.00-6.99 (moderate), 7.00-8 :00 (high)

In terms of resilience, Table 14 indicates that both agroforestry and organic farmers have a moderate level of resilience, having a resilience index of 0.433 and 0.373, respectively. This was based on the scores of the four indicators, namely: social capital, human capital, financial capital, and natural capital (Figure 5). Results of this study also indicate that among the four capitals, social capital has the lowest score, with a mean score of 0.018 and 0.003 for agroforestry and organic farmers, respectively.

Figure 2 also highlights that the criteria weight obtained by the social capital using the AHP was 0.09, the lowest weight among the four capitals. This suggests that the smallholder farmers viewed social capital as the least indicator and contributor to their resiliency.

Meanwhile, human capital refers to the accumulation of knowledge and competencies of the farm households through attendance at training, access to agriculture information, experiences in farming, knowledge in agriculture/farming, and the active involvement of the household members in farming. Human capital is an essential indicator of resiliency, especially considering that the farmers are the main actors in farming/agriculture. Their physical involvement, as well as knowledge and experiences, help shape their farm, and at the same time, serve as a mechanism to address emerging problems and concerns related to farm development and improvement.

Table 14. Resiliency level of agroforestry and organic farmers in Sariaya, Quezon, Phhilippines based on four capitals

Indicators of resiliency	**Scores of the four capitals**	
	AF	**Organic**
Social capital	0.018	0.003
Human capital	0.165	0.18
Natural capital	0.16	0.14
Financial capital	0.09	0.05
Resiliency index	0.433*	0.373*
Adjectival rating	Moderate	Moderate

Note: AF: Agroforestry Farmers, *: 0-0.33 low, 0.34-0.66 moderate, 0.67-1.00 high

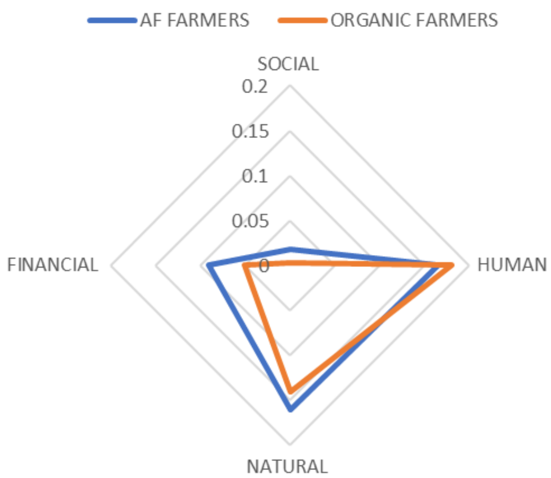

Figure 5. Scores of the four indicators of resilience among the agroforestry and organic farmers in Sariaya, Quezon, Philippines

As shown in Table 14, both agroforestry and organic farmers had low financial accumulation of 0.09 and 0.05, respectively. Specifically, these smallholder farmers did not accumulate savings as the income drawn from farming is also being plowed back and reinvested for the next cropping cycle. Furthermore, household income is utilized to meet the basic household needs.

Natural capital refers to the natural resource stocks (DFID 2000), where livelihoods are derived, and which provide ecological services such as nutrient cycling, soil erosion control, among others. Natural capital is therefore the backbone of farming. In this study, natural capital refers to the land that is being cultivated by the farmers, particularly the farm size, their access to water sources, crop diversity, the presence of perennial crops, and soil and water conservation measures.

Results show that agroforestry and organic farmers had relatively moderate levels of natural capital, having scores of 0.16 and 0.14, respectively. That could be because of the maximum utilization of their farms for crop production, which is dominated by agricultural crops. Hence, their farms are cropped throughout the year. The farm households also integrate perennial crops (fruit trees and forest trees).

Discussion

Food security status of nature-positive smallholder farmers

The recent challenge of balancing food production for food security and avoiding land degradation for environmental conservation and integrity calls for a paradigm shift towards sustainable food production and sustainable food systems. Hence, nature-positive food production and nature-positive food systems have now become a discourse for sustainable development. According to Jaramillo et al. (2023), nature-positive food systems are characterized by regenerative, non-depleting, and non-destructive use of natural resources. Numerous studies have claimed that agroforestry increases opportunities for socio-economic productivity (Landicho et al. 2017; Mukhlis et al. 2022; Ntawuruhunga et al. 2023; Willmott et al. 2023) while maintaining its ecological services (Baliton et al. 2017; Kay et al. 2019; Castle et al. 2022; Xiao and Xiong 2022). On the other hand, farmers in Barangay Balubal and Mamala I and II are engaged in organic vegetable production. Abdullah and Parvin (2024) noted improved livelihoods and income of smallholder organic farmers. While conventional farming has the potential to improve farm income as compared to organic agriculture, Feledyn-Szewczyk and Kopiński (2024) stressed that the former has higher direct costs than the latter. Thus, the economic efficiency of the agricultural production of organic farms was higher by 59% than conventional farms. Raz et al. (2024) noted the impacts of organic olive farming on the economics, ecological, and social values of the communities.

The agroforestry and organic farmers, who are considered smallholders, however, are vulnerable to climate and non-climate stressors. Rapsomanikis (2015) stressed that many of these smallholder farmers are poor, food insecure, and have limited access to markets and basic services. As such, smallholder farmers are generally vulnerable to climate change impacts (Evangelista et al. 2016; Landicho et al. 2016; Jamshidi et al. 2019; Ojo et al. 2024) and other agricultural risks (Harvey et al. 2014; Touch et al. 2024). These are also confirmed by Tolentino and Landicho (2013), Landicho et al. (2016), Murniati et al. (2017), Gnonlonfoun et al. (2019), Johansson et al. (2024) and Touch et al. (2024).

Despite their vulnerabilities, however, research results indicate that agroforestry and organic farmers have a high level of food security based on the four indicators: food availability, food accessibility, food stability, and food utilization. Farm households engaged in agroforestry and multiple cropping tend to have higher scores in food availability, given the multiple food products derived from the systems (Comia et al. 2017; Sudomo et al. 2023; Duffy et al. 2021; Ngango et al. 2024). On the other hand, Sahu et al. (2024) and Wekeza et al. (2024) highlight the contributions of organic farming to attaining the food and nutrition requirements of smallholder farmers. The potential of integrated organic farming systems for food security, though, can further be optimized by addressing the resource constraints of farmers. These findings are further validated by Nguyen et al. (2024), highlighting that nature-based solutions could improve food security, particularly along food availability, employing approaches such as intercropping and/or crop rotation of cereal crops and legumes.

In general, agricultural production is highly dependent upon weather conditions (Harkness et al. 2023), and hence, the food system, in general, is vulnerable to the impacts of climate change (Brzezina et al. 2016). Consequently, the changing rainfall patterns affect soil health, plant growth, reduce water availability, or make water more excessive, which leads to decreased or fluctuating crop yields (Bouteska et al. 2024; Yuan and Sun 2024) and stability. Landicho et al. (2017) define food stability as a situation where there is continuous supply, accessibility, and availability of food, regardless of policy, market, and weather or climatic uncertainties. Neither agroforestry nor organic farming systems could withstand extreme weather events, as indicated in the research results. This finding corroborates that of Landicho et al. (2015) and Comia et al. (2017).

Level of resilience of nature-positive smallholder farmers

The Sustainable Livelihoods Framework (DFID 2000) emphasizes assets and capitals as measures of resilience and adaptive capacity. These include human capital, social capital, natural capital, and financial capital. According to DFID (2000), human capital refers to the knowledge, skills, and attitude of people to enable them to undertake livelihood strategies; natural capital refers to the natural resource stocks, where livelihoods are derived, and which provides ecological services such as nutrient cycling, soil erosion control, among others; financial capital refers to the sources of household income, estimated annual household income, savings and livestock; and social capital refers to the social resources which people draw to carry out their livelihood activities. Social capital is classified into two types: the bonding capital, or the relationships between the community members, and the bridging capital, which refers to the relationship of the community with external institutions and organizations.

Generally, the agroforestry and organic farmers have been farming for 15 years. As such, they may have accumulated learnings from their farming experience, which enabled them to find solutions for farm-related problems. Human capital management is an important factor for building organizational resilience (Douglas 2021). Previous studies also point out the relevance of human capital, particularly farming experience in building resilience to water scarcity (Aguilar et al. 2022), as well as farmers' education in establishing resilience to climate change impacts in Ethiopia (Berhanu et al. 2024), and enhancing climate resilience of rice farmers in Java, Indonesia (Azhari et al. 2025). Social capital refers to the social resources that people draw on to carry out their livelihood activities (DFID 2000). It may be developed through network and connectedness, membership in formalized groups, and relationships of trust and exchanges. It could be built from among the community members themselves (bonding capital) or from establishing partnerships with other entities (bridging capital). Social capital is an important indicator of resiliency, as social relationships serve as the safety nets in terms of disaster, emergency, and other problems related to farm and community development. Social capital plays an important role in disaster resilience and recovery (Volker 2020; Panday et al. 2021; Xiang et al. 2021), adapting to climate change impacts. Moreover, social capital contributes to household resilience to drought (Anuradha et al. 2019) and community resilience (Ledogar and Fleming 2008; Aldrich 2017; Panday et al. 2021; Carmen et al. 2022; Liu et al. 2022). Membership in social networks, for instance, serves as a mechanism for interaction between people or community members, which also promotes knowledge sharing. Their continuous communication and interactions may contribute to awareness-building (Savari and Khalejhi 2023), which may also affect their beliefs and attitudes about sustainable agriculture and/or nature-positive food production.

Results indicate that both agroforestry and organic farmers have low accumulation of social capital, as many farmers have become inactive in their respective people's organizations and associations, and have limited networks with organizations and agencies outside their communities. This finding is similar to that of Grefalda et al. (2018), where the social capital of forest communities in Bicol Region, Philippines, was recorded as the lowest.

Financial capital serves as an equally important indicator of farm and community resiliency. It refers to the financial resources that people use to achieve their livelihood objectives (DFID 2000). Financial capital becomes a very critical asset in farming as it serves as the source of farmers' investments in farming. It also provides a buffer for the farm households in case agricultural production fails, brought about by pest infestation, natural calamities such as drought and typhoons, and market failure (Landicho et al. 2017). Both agroforestry and organic farmers have low financial accumulation. It could be explained by the limited income source of the households, which is mainly from farming. Houben et al. (2022) argue that non-farm income is a measure of the existence of alternative avenues for income and livelihood in rural areas. If there is non-farm income, the enterprise is less vulnerable to highly variable production and income from the farm. Recent literature also confirms that financial inclusion or access to financial products and services (Zetterli 2023; Hussain et al. 2024), such as access to credits (Maltou and Bahta 2019) and financial resilience or the ability to meet urgent financial needs (Hussain et al. 2024), can help achieve climate resilience.

Implications

Several studies have pointed out the contributions of organic farming in climate change adaptation (Muller 2009; Aravindakshan and Kunju 2010; Wani et al. 2013) and in building resilient food systems (Röös et al. 2021) through farm diversification and building soil fertility (Scialabba and Müller-Lindenlauf 2010). In their study, Panpakdee (2023) found that the highest score of resilience was recorded for organic farmers in Thailand, who had been creating opportunities for self-organization and rely on food and farm materials and resources that are locally available. Moreover, the ecological services of agroforestry offer their potential for enhancing the livelihood resilience of smallholder farmers (Quandt et al. 2018; Aryal et al. 2019; Zeratsion et al. 2024).

Results suggest the need to enhance the assets and capital of nature-positive smallholder farmers to take advantage of the numerous potentials of nature-positive food production. These include, among others, investment in training and capacity-building (Landicho and Ramirez 2023; Baiyegunhi 2024; Gong et al. 2025), linking farmers to markets (Castillo et al. 2021; Usman and Callo-Concha 2022), networking and cooperative behavior (Kitano 2025; Slidjper et al. 2021) and adoption and practice of climate-smart agriculture (Chandra and McNamara 2018; Labios et al. 2021; Ata et al. 2023; Safdar et al. 2024; Berhanu et al. 2024).

This study concludes that nature-positive agriculture significantly enhances the food security and livelihood resilience of smallholder farmers in Sariaya, Quezon Province, Philippines, while remaining vulnerable to both climate-related and non-climate stressors. Findings from 159 agroforestry farmers and 30 organic farmers indicate moderate to high levels of food security, with mean scores of 6.98 and 7.34, respectively, across the four pillars of food availability, accessibility, stability, and utilization. However, resilience levels were moderate, with indices of 0.43 for agroforestry and 0.37 for organic farmers, reflecting the uneven distribution of household capital. Human capital showed relatively high accumulation (0.165 and 0.18), while social capital registered the lowest values (0.018 and 0.003), highlighting a key constraint to resilience.

To strengthen the long-term sustainability of smallholder livelihoods, it is recommended that local governments and agricultural institutions expand financial and technical support for farmers adopting nature-positive systems. National and local governments are encouraged to implement programs that incentivize youth participation in agriculture, ensuring the sustainability of food production systems. Capacity-building activities, including farmer trainings, seminars, and technology-oriented educational initiatives, can enhance productivity and income diversification. Technical support services should also be expanded to improve farmers' ability to mobilize resources and adopt innovative practices. Finally, policies aligning with national food security and climate adaptation frameworks should prioritize smallholder inclusion to ensure that nature-positive agriculture continues to serve as a foundation for resilient, equitable, and climate-smart rural development.

This study was limited to a single province and one cropping cycle, which may not capture seasonal fluctuations and interregional variations in smallholder farming systems. The resilience assessment focused primarily on livelihood capitals and did not include detailed biophysical, institutional, or policy indicators that could offer a broader systems-level understanding. Moreover, the reliance on self-reported survey data may introduce response bias and limit the precision of quantitative measures such as income and production.

Future research should therefore adopt a multi-season and multi-site approach, integrating longitudinal data, geospatial analysis, and gender-disaggregated perspectives to better capture temporal dynamics, spatial variability, and social equity dimensions of nature-positive and climate-resilient farming systems.

ACKNOWLEDGEMENTS

The authors acknowledge the funding support of the University of the Philippines Los Banos Basic Research Program, Philippines, without which this research may not have been carried out. We also thank the smallholder farmers in Sariaya, Quezon, Philippines, for their active engagement as research participants.

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