INQUIRIES INTO FARMERS' PERCEPTION OF BIODIVERSITY: A SYSTEMATIC ANALYSIS IN A TROPICAL COUNTRY

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Abstract

Conserving biodiversity has become more important for tropical countries, where agricultural production is featured by a large number of small farms scattered in wide areas conducting increasing intensified production to meet rising demand on both quantity and quality. Whether small farmers have an appropriate perception about biodiversity conservation and what are the main barriers preventing them from practicing biodiversity conservation are still open questions. Based on four focus group interviews with a total of 39 farmers in two key vegetable production sites in Vietnam and four expert interviews, which were conducted using semi-structured questionnaires from July 2022 to February 2023, the qualitative analysis reveals several findings. Firstly, Vietnamese vegetable farmers already have a certain level of awareness of biodiversity and biodiversity conservation production practices. Secondly, improving health of the farmers and people in their community stand out as the most important perceived benefits of biodiversity conservation vegetable production practices. Thirdly, the main barrier to biodiversity conservation vegetable production practices is the short-run income viability for the farmers' family. Finally, biodiversity conservation should be effective if farmers are supported by joint actions from both the government and businesses.

Keywords: Biodiversity, Conventional farming, Farmers' perception, Vegetable, Vietnam

1. Introduction

To meet increasing demand on the quantity and quality of the agricultural products in both local and international markets, the agricultural systems in tropical countries, which used to be endowed with rich biodiversity, are suffering from the rapid depletion of biodiversity (Raven & Wagner, 2021). As the intensified agricultural production is widespread, it becomes more susceptible to pathogens, pests, bacteria, and virus (Bidoglio et al., 2023). As a result, an increasing amount of synthetic fertilizers and pesticides has been used to protect crops and ensure income of farmers (Srivastav, 2020). The overuse of these inputs has negative consequences on the environment and biodiversity (Dubbert et al., 2023). Hence, the conservation of biodiversity and the delivery of ecosystem services on which agricultural production and society depend have become more difficult (Maas et al, 2021).

In addition, understanding about biodiversity, barriers to biodiversity conservation and measures to conserve biodiversity has not been equal across agricultural stakeholders (Buxton et al., 2021). Indeed, biodiversity is a technical concept, which is even controversial among scientists. The concept of biodiversity is, thus, not easy to be accepted among non-scientists (Frank, 2021). Nevertheless, biodiversity has been well perceived at the social level. For example, Cappelli et al. (2022) identify how plant diversity enhances soil carbon through the influence on microorganisms by observations and data synthesis. Côte et al. (2022) evaluate conditions for obtaining biodiversity in tropical areas. Riva et al. (2023) conduct international panel of experts from 275 articles to examine the factor influence agro-ecosystem. These studies focus on bio-technique, cognitive, socio-political, and organizational issues, which influence the agro-ecosystem transition in tropical regions and highlight the socio-political context underlying this transition. These studies also propose conceptual frameworks to understand how biodiversity affects other economic and social issues. Moreover, various policies and measures in agricultural production have been long raised and implemented at governmental and organizational levels to reduce the loss of biodiversity across the world (Namiotko et al., 2022).

While biodiversity is largely well perceived at the social broad level, it is limited at the farmers' level although it is widely agreed that understanding farmers' perception of biodiversity is an effective strategy to reach agricultural sustainability (Herzon et al., 2018; Jaeger et al., 2023). Studies about farmers' perception of biodiversity in agricultural production is limited (Amato & Petit, 2023). Among a few exceptions, Kelemen et al. (2013) evaluate farmers' perception in France, Italy, and other countries having similar cropping conditions and temperate climates. They find that farmers with organic products tend to have a more homogeneous approach to biodiversity, while the other farmers show a greater heterogeneity. Akintunde and Obayelu (2016) examine farmer's perception of conservation of cassava biodiversity in Nigeria and find that agro-biodiversity conservation is a prerequisite for sustainable production and this can be enhanced by improving farmers' positive perception. Other studies examine factors influencing other stakeholders' perception of biodiversity conservation and present various barriers to biodiversity conservation (Ramli et al., 2018; Amato and Petit, 2023). Understanding about farmers' perception about biodiversity is, thus, limited, particularly in tropical regions.

To bridge the research gap, this study examines the perception of biodiversity by farmers growing cruciferous vegetables in a tropical climate in Vietnam. Vietnam is chosen for this research due to several reasons. Firstly, the tropical climate of Vietnam is favorable for various crops such as vegetables, rice, and fruits (General Statistics Office of Vietnam, 2019). The tropical climate is also a good condition for a variety of pests and diseases. Secondly, Vietnam's agricultural production is fueled by increasing demand for higher-quality agricultural products from the domestic market due to rapidly rising income and from the export markets (Tran et al., 2022). Thirdly, the growth of labor wages has resulted in rising labor costs in agricultural production in Vietnam. To save input costs, farmers use more machines, chemical fertilizers, and pesticides to replace man power (Lee et al., 2019; Shabanzadeh-Khoshrody et al., 2023).

The study is conducted using the qualitative methodology with information from in-depth interviews and focus group interviews with farmers in two key areas of vegetable production, one in Northern Vietnam and another in Southern Vietnam. The results show that Vietnamese vegetable farmers already have a certain level of awareness of biodiversity and biodiversity conservation production practices. In addition, improving health of the farmers and people in their community stand out as the most important perceived benefits of biodiversity conservation vegetable production practices. Also, the main barrier to biodiversity conservation vegetable production practices is the short-run income viability for the farmers' family. Moreover, biodiversity conservation should be effective if farmers are supported by joint actions from both the government and businesses.

The remainder of this paper is structured as follows. The literature review is presented in Section 2. Section 3 presents the methodology and data. Results and findings from the focus group and in-depth interviews are presented in Section 4. Section 5 concludes the paper with policy implications and limitations of the study.

2. Literature review

2.1 Biodiversity in agriculture

Biodiversity concept

The Convention on Biological Diversity (1992, Article 2) defines biodiversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". This definition focuses on the variability at three levels: 1) within species (genetic measure or/and population measure); 2) between species; and 3) within ecosystems (landscape/regional measures including major vegetation biomes). This definition can be used to extensively explain for all ecosystem service assessment (Mace et al., 2012). Another definition is proposed by Noss (1990), Sanderson and Redford (1997), and Redford and Richter (1999), of which biodiversity is "the variety and natural variability among living organisms, the ecological complexes in which they occur naturally, and how they interact with each other and with the natural environment". Biodiversity is this definition is based on three attributes: 1) composition (diversity of elements in each component); 2) structure (physical pattern of elements); and 3) function (ecological/evolutional processes between elements). This definition has concentration on the measures that are most useful in determining the potential impact of human actions on biodiversity.

In agricultural production, Duru et al. (2015) argue that biodiversity is a powerful ecological and eco-centered way to modernize agriculture and to promote fertility, productivity, and resilience to external forces. Three common components of agro-biodiversity are planned diversity of crops, landscape heterogeneity including composition and configuration of the surrounding habitats and related diversity with immigrant populations from around and invade fields to find food or shelter. In general, biodiversity is often based on diversification and enhancement of natural interactions between different biophysical components of agro-ecosystems, with a focus on the role of the ecosystem processes and natural services that are delivered through different functional groups (Bredemeier et al., 2015; Jones et al., 2023).

With the definition proposed by the Convention on Biological Diversity (1992), biodiversity in agriculture can be classified into generic, species and ecosystem types (Kelement et al., 2013; Vidaller and Dutoit, 2022; Drechsler et al., 2022). Generic biodiversity is used in organic agriculture for obtaining pest and disease resistance while species biodiversity is adopted in organic and conventional agricultural systems (Kelement et al., 2013; Flohre et al., 2011).

Ecosystem biodiversity is difficult to address in agricultural land as it occurs within and between farms of different sizes (Kehinde and Samways, 2012; Nemes et al., 2023).

Drawing from these prior studies, in this paper we look at biodiversity in agriculture from the ecosystem aspect, which is adapted from the Convention on Biological Diversity (1992), and the functional aspect, which is adapted from Redford and Richter (1999) and Duru et al. (2015). Therefore, biodiversity is a farming concept with a system perspective that aims to achieve food production sustainability, in which biodiversity is the main driver.

Technical and non-technical aspects of biodiversity

The previous studies about farmers' perception of biodiversity also discuss the technical and non-technical aspects of biodiversity. Regarding the technical aspect, Duru et al. (2015) demonstrate that biodiversity conservation agriculture is achieved through increasing input efficiency by optimizing and synchronizing the supply of biological needs through reducing artificial inputs. Biodiversity conservation agriculture is in contrast to conventional agriculture, in which factors that limit production are removed by the heavy use of artificial inputs. Biodiversity conservation agriculture is moving along side with redesigning the farming systems without significantly reducing agricultural output (Ponisio et al., 2014; Lee et al., 2019). Vidaller and Dutoit (2022) suggest that land use management (soil, water, and climate conditions) is the key to increase the biological process. Schmid et al. (2022) and Altieri (1999) propose that a variety of cash crops, forage or cover crops and livestock are main inputs to create biodiversity. Anupama et al. (2023) argue that associated biodiversity provide input services such as all organisms living in cultivated areas/surrounding habitats, pests, natural enemies and their pollinators. Fahrig et al. (2011) also agree that the landscape diversity including grasslands and semi-natural interpreted areas is important for biodiversity. Table 1 presents the technical inputs of biodiversity implementation.

Table 1: The technical aspects of biodiversity

No.	Input	Description	Sources
1	Land use management	Soil, water, and climate conditions	Vidaller and Dutoit (2022)
2	Planned diversity	The variety of cash crops, forage or cover crops and livestock	Schmid et al. (2022) and Altieri (1999)
3	Associated diversity	All organisms living in cultivated areas/surrounding habitats, pests, natural enemies and their pollinators	Anupama et al. (2023)
4	Landscape heterogeneity	Grasslands and semi-natural interpreted areas	Fahrig et al. (2011)
5	Land use management, planned diversity, associated diversity, landscape heterogeneity	All the four listed descriptions mentioned above	Duru et al. (2015)

Source: Authors' compilation

The major concern of farmers is not only in the technical aspect but also in the non-technical factors such as input costs, market, price premiums, logistics and distribution system, and prospective rates of returns to farmers (Warren et al., 2020; Schuit et al., 2021; Irungu et al., 2007; Matita et al., 2021). For example, agricultural products of farmers are often sold through traders, with unstable prices in the output markets (Van, 2021). Therefore, farmers wish to supply directly vegetables to buyers to get higher profit (Thuy et al., 2022). These are important issues that farmers take into account in agricultural production while considering biodiversity conservation.

A question arisen is that which of these two aspects, i.e. technical and non-technical aspects, play a key role in the decision-making process of farmers in agricultural production with biodiversity conservation.

Values of biodiversity

Kelement et al. (2013) suggest that biodiversity has social and ethical, economic, and ecological values. The social and ethical value is defined according to the obligatory approach. It refers to the components of values that do not derive from any utilitarian calculation (Khan et al., 2021). These components that form the social and ethical value can be identified including the beauty and diversity of nature, its contribution to the human sense of belonging to nature, and the fact that nature exists as a living element on Earth (Khan et al., 2021; Karlsson and Björnberg, 2021). With this value, biodiversity brings benefits for human health and well-being, while mitigating the negative impacts of climate change (Marselle et al., 2019).

The economic value of biodiversity results from a calculus logic, which reflects a utilitarian perspective. The economic value, which can be measured in monetary terms, is gained in the market (Perlman and Adelson, 1977). Maas et al. (2021) and Zira et al. (2023) address examples of the economic value of biodiversity including profits from agricultural sales, cost reduction from pesticide decrease, increase in crop and livestock yields. Taking a look from the economic aspects, conserving biodiversity can be costly in the short run. Nevertheless, farmers will receive adequate returns in the long run (Pimentel et al., 1997).

Regarding the ecological value, Feger and Mermet (2022) argue that biodiversity consists of ecological processes which form the basis for lives on Earth. Values of biodiversity from the ecological perspective are extensively discussed with soil formation and biological pest control (Pimentel et al., 1997); pollination, maintenance of soil fertility, resistance to pests and diseases, and water filtration (Forbes et al., 2022); forest sequestering carbon dioxide and water quality

(Hagger et al., 2022); habitats supporting for different species and climate maintenance (Crawford et al., 2022); and environmental protection and forest conservation (Chi, 2022).

2.2 Farmers' perception of biodiversity

Individual perception is considered the way individuals perceive a certain phenomenon, which is determined by social and cultural contexts (Bromley, 2006). Perception is influenced by individual beliefs, knowledge, competencies, habits and social-demographic characteristics (De Rito et al., 2022). Bennett and Banyard (2016) define perception of biodiversity as the way humans understand, interpret, and value biodiversity and ecosystem services. In this paper, farmers' perception of biodiversity is the farmers' knowledge and understanding about biodiversity.

A large number of studies agree that while most people understand about biodiversity, they often use different terminologies (Wezel et al., 2018; Savari et al., 2023). Nevertheless, there exist contradictory findings about whether farmers know what biodiversity is. Herzon and Mikk (2007) demonstrate that while biodiversity is highly valued by farmers, their perception of biodiversity in agriculture is unclear. Junge et al. (2009) and Soini and Aakkula (2007) suggest that farmers find it difficult to have a comprehensive knowledge about biodiversity in the context of agriculture even though biodiversity is appreciated. Similarly, Savari et al. (2023) concern about the farmers' knowledge of biodiversity. They employed the Theory of Planned Behavior to identify farmers' behavioral intention toward biodiversity conservation and found that farmers do not desire to engage in biodiversity conservation. Others previous scholars also addressed that farmers' concept of biodiversity is more related to wild nature rather than agricultural production (Fischer and Young, 2007; Lecuyer et al., 2021)

In contrast, Akintunde and Obayelu (2016) highlight that biodiversity can be affected by farmers' positive perception and deliberate actions by farmers to reach the threshold of social reproduction. Amato and Petit (2023) also agree and argue that farmers are well aware of the biodiversity concept although they do not know the way to obtain biodiversity in their farms. Five barriers to biodiversity perception are identified including negative perceptions of roadside vegetation, management bodies, lack of effective conservation programs, farmers thought that long-term planning under 30 years have not enough time to promote ecosystem conservation, and lack of natural resource management information. Otherwise, the research of Abesha et al. (2023) reveals that the majority of farmers had a positive attitude of biodiversity and understood the biodiversity' contributions to rural development. On the other hand, farmers understand the opportunities for their involvement in biodiversity, however they face the obstacles in accessing to government subsidy policies (Alblas and van Zeben, 2023).

Drawing from these contradicting observations, this study contributes to the literature by providing additional evidence on farmers' knowledge of biodiversity in agricultural production taking an example of vegetable farmers from a tropical country of Vietnam. Also, this study will explore determinants of conserving biodiversity by farmers in Vietnam.

3. Methods and data

Applying the qualitative method to analyze information, this study follows a phenomenological logical approach (PLA), which is suggested by Giorgi (2009) to perceive an individual's perception through the experiencer's consciousness. Based on the PLA, the reality of the phenomena, themes and issues can be gained thoroughly and understood deeply (Dereniowska and Meinard, 2021) because the PLA is suitable for environmental analysis, which is so-called eco-phenomenology (Paul and Baindur, 2016). To evaluate cruciferous vegetable farmers' perception of biodiversity, we conducted the analysis with two stages including focus group and in-depth interviews. The procedure of the data analysis is provided in Figure 2.

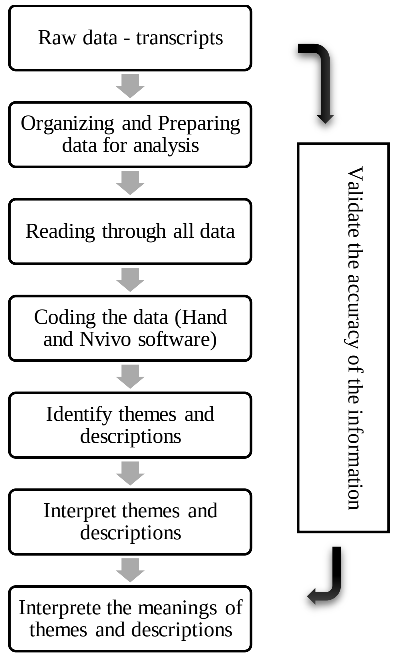

Figure 2: Data analysis procedures

Source: Creswell (2009)

In the first stage, focus group interviews were conducted. Focus groups are defined as "conversations in a small group about particular topic with the aim of finding out the group's point of view" (Guest et al., 2017). This methodology is useful due to the interaction between participants in forming their ideas, encouraging free flowing information, and facilitating the information sharing in a tolerant environment (Brinkmann, 2014). To conduct the focus group interviews, open-ended questions were employed to evoke farmers' opinion sharing. In addition, we used a number of probing questions as suggested by Strang and McLeish (2015) to encourage farmers' self-expression and identify farmers with different experiences and perceptions of biodiversity.

Four focus group interviews were conducted in two key vegetable production areas of Vietnam, which are Hanoi city in Northern Vietnam and Lam Dong province in Southern Vietnam, with total of 39 farmers. Each group consists of ten farmers. Two groups were interviewed in

Hanoi while the other two groups were interviewed in Lam Dong province. These interviews were conducted from July 2022 to February 2023.

Hanoi city and Lam Dong province are the main areas for vegetable production in Vietnam (Hoa et al., 2020). We conducted the focus group interviews in Hanoi city and Lam Dong province for additional reasons. Even though Hanoi accounts for about 4.5% of the country's total supply of vegetables, this city serves as an interesting case study for several reasons. Hanoi is the capital and the largest city located in the center of the Red River Delta, which is one of the two largest deltas for agricultural production in Vietnam. With a total production area of 12,000 ha, the vegetable production in Hanoi city meets 70% of the vegetable demand of the city population. The city actively supports the implementation of three standards in urban vegetable production, i.e., VietGAP, RAT, and Organic. The application of these standards is expected to produce safe vegetables to the seven million inhabitants of the city, who consume mostly local products (Pham, 2017).

Lam Dong province is the main source of vegetables in Vietnam. Among 63 provinces, the vegetable production of this province accounts for 12% of Vietnam's total production of vegetables. Lam Dong is the main source of vegetable supply for Ho Chi Minh City, which is the largest city in the Mekong River Delta and the largest delta for agricultural production in Vietnam. Ho Chi Minh City is the largest domestic market for vegetables (Nguyen et al., 2018). Hence, Lam Dong province is an essential area of study, which could potentially provide great understanding of current vegetable farming practices for biodiversity conservation.

Therefore, with information collected from interviews with farmers from Hanoi city and Lam Dong province, a comprehensive picture of current vegetable production in Vietnam can be painted. Information collected from these two study areas is representative and the analyzing results can help to understand farmers' perception of biodiversity, its influencing factors, and recommendations to policymakers in a tropical country. The focus group interviews with a sample size of 39 farms in these study areas ensures representativeness of the population. The focus group interviews were conducted and stopped until there was no further additional information that we could obtain. Therefore, the saturation in data collection is ensured.

In the second stage, in-depth interviews were conducted with nine respondents who have expertise and experience in agricultural production. These nine respondents include three directors of agricultural cooperatives, two agricultural extension officers, two farmers, and two agricultural university lecturers. The questions for in-depth interviews are open. Five respondents were interviewed in Lam Dong province. The other four respondents were interviewed in Hanoi. There are several advantages of conducting in-depth interviews. Detailed and specific information can be collected since interviewers gain diversified viewpoints to analyze the respondents' information through repeated conversations. In addition, it is easier to exchange knowledge, discuss questions and develop stories. Moreover, comments and answers are more constructive and contribute better to the research topic (Vermunt et al., 2020).

We recorded and transcribed all of the focus group and in-depth interviews. We then prepared the information collected from the interviews for our analysis using the Nvivo coding software. Following the suggestion of Basit (2003), since the goal of our study is to collect the data from focus group and in-depth interview, the role of coding is important. All the focus group and in-depth interviews were carried out in Vietnamese. The transcripts were subsequently professionally translated into English. We have a bilingual researcher assisting us with reverse translation to prevent bias. Another researcher then double-checked the two versions to verify that they have the same meaning (Nguyen et al., 2021).

4. Results and discussion

4.1 Overall information of the respondents

Table 2 provides the timeline of the focus group and in-depth interviews. A summary of the profiles of the respondents is also reported in Table 2. The respondents' professional backgrounds range from government officials, farmers, and lecturers in the agricultural field. In our focus group of 39 farmers, 18 respondents are female (46.15%) and 21 respondents are male (53.85%). Further demographic information of research participants such as age, name, etc. was not obtained to ensure the intrusiveness of the research and potentially increased information sharing throughout the talks with the respondents. Only two respondents are under 35 years old. The majority of the respondents are senior or middle-aged farmers.

Table 2: Timeline and respondents' profiles of the focus group and in-depth interviews

Month /year	**Code**	**Location**	**Occupation**	**Group size**	**Age range**	**Gender/ Gender split (f:m)**
5/2022	EX1_DL	Lam Dong	Lecturer	1		Female
5/2022	EX2_DL	Lam Dong	Farmer - organic farming	1		Male
7/2022	EX1_HN	Hanoi	Lecturer	1		Female
7/2022	EX2_HN	Hanoi	Government official	1		Male
7/2022	G1_DL	Lam Dong	Farmers - conventional farming	11	40 - 50	2:9
7/2022	G2-DL	Lam Dong	Farmers - conventional farming	14	27 - 50	5:9
2/2023	G1_HN	Hanoi	Farmers - organic & conventional farming	6	50 - 70	4:2

2/2023	G2-HN	Hanoi	Farmers - conventional farming	8	50 - 70	7:1

Source: Authors' compilation

The three most common vegetables that are produced by the focus group respondents are cabbages, tomatoes and mustard greens. Farmers in Lam Dong province have a larger production scale in both groups. The average farming size of the G1_DL group farmers and the G2_DL group farmers in Lam Dong province is 1.36 and 1.42 ha, respectively. The average farming size of the G1_HN group farmers and the G2_HN group farmers is 0.225 ha and 0.184 ha, respectively. These findings are similar the difference in farming sizes in Southern and Northern Vietnam, respectively (The and Minh, 2015; Van et al., 2007).

From the transcript, five topics emerge. These topics include awareness of biodiversity conservation practices, motivations for biodiversity practices, barriers of biodiversity practices, government interventions and market interventions. We then grouped these topics into two main themes: 1) perceptions of farmers towards biodiversity conservation practices; and 2) suggestions to promote biodiversity conservation practices. Table 3 illustrates how these two themes are interpreted from the five topics which have been identified in our coding process. In the next section we will discuss further the important takeaways from such theme.

Table 3: Coding scheme overview

Item/Topic	**Theme**
Awareness of biodiversity conservation practices Motivations for biodiversity practices Barriers of biodiversity practices	Perception of biodiversity conservation practices
Government interventions	

Market interventions

Suggestions to promote biodiversity conservation practices

Source: Authors' compilation

4.2 Perception of biodiversity conservation practices

4.2.1 Awareness of biodiversity conservation practices

In our interviews, crop rotation and crop diversification are already common practices among the vegetable farmers. In fact, the most prominent attributes of biodiversity conservation practices in Vietnam is the variation of plants (Schmid et al., 2022; Altieri, 1999). This fact is confirmed by the farmers that:

> In order to sell vegetables more easily in the market, we cultivate a variety of products. If we just grow one type of vegetable, it will be harder to serve the market (G1_HN; G2_DL). Buyers need a variety of vegetables, preferably several types for each season. We need to meet their demand (G2_HN; G1_DL).

In certain ways, Vietnamese farmers comprehend biodiversity through planned diversity of their plants, akin to Schmid et al. (2022) and Altieri (1999). Indeed, biodiversity is regarded more holistically. The awareness of farmers about biodiversity is confirmed by a government official in the field of vegetable production:

> Most of farmers know three important steps in biodiversity conservation vegetable production. The first step is to decide which crops should be cultivated in the farm, where vegetables are primary. The second step is to decide whether or not to plant a variety of crops simultaneously. The next step is to choose what pesticides are safe for the natural enemies of pathogens, pests, bacteria, and virus. Natural enemies include predators, parasitic fungus, helpful ants, and useful insects (EX2_HN).

This statement is in line with Wezel et al. (2018) and Savari et al. (2023), confirming that the farmers already have a broad understanding of biodiversity conservation vegetable production practices despite their usage of a variety of terminologies for biodiversity. The vegetable farmers have already practiced some sort of biodiversity conservation practices. Through our interviews, knowledge of the farmers about biodiversity has been uncovered through their confirmation of use of lure plans, preparators, and pest in farming seasons.

> Usually during January to February in the lunar calendar, there are white buterfflies. They then lay earthworms, a lot. We often plant flowers to lure these butterflies (G1_HN; G2_HN).

> Earthworms are great for our vegetable production because they loosen and aerates the soil in our farms (G1_HN; G2_HN; G1_DL; G2_DL).

Through our conversations with the farmers, it is revealed that they adopt similar biodiversity conservation practices, which resembles what have been discussed in the previous studies in the literature. They have practiced land use management taking into the conditions of soil, water, and climate (Vidaller and Dutoit, 2022), crop diversification (Schmid et al., 2022; Altieri, 1999), and landscape diversification (Fahrig et al., 2011). In a nutshell, Vietnamese vegetable farmers in all four focus groups show a high degree of awareness of biodiversity and biodiversity conservation vegetable production practices. These findings suggest that impediments to biodiversity conservation in agricultural production in Vietnam may not be due to a lack of knowledge about biodiversity and biodiversity conservation practices.

4.2.2 Motivation for biodiversity conservation practices

Two farmers in our focus groups in Hanoi city and three farmers in our focus groups in Lam Dong province have been adopting the VietGAP (Vietnamese Good Agricultural Practices) standard in their vegetable production. The VietGAP is a popular standard for agricultural production in Vietnam aiming for creating clean and safe agricultural products, particularly fresh food. The VietGAP vegetables are of higher quality. Therefore, they are usually sold in vegetable shops or supermarkets at a higher price than regular vegetables sold in open air markets. The procedures to grow VietGAP vegetables are less stringent than those to grow organic vegetables. The VietGAP vegetable production is more environmental friendly and biodiversity conserving than conventional vegetable production practices. When the government official and the farmers with VietGAP were asked why they adopt VietGAP, benefits related to health of the farms and their family members are reported by all farmers.

> Farming with a VietGAP certificate may increase the cost of vegetable production at the beginning. However, it allows farmers to save money in the future, at least in terms of farmers' health. You cannot count your assets when they are intangible, can you? To achieve that, farmers must change their entire cognitive approach, and it takes time for them to comprehend it (EX2_HN).

> The foremost benefit of adopting VietGAP is the safety for the environment and for our health. What benefits the community comes afterward (G1_HN).

This fact is further confirmed with reports from other farmers without adopting VietGAP. They do know that using chemical pesticides is dangerous for their health. The focus group farmers in both study areas report that:

> We are fully aware of how hazardous it is to our health, our family members' health and the health of other people in the community when using chemical pesticides in vegetable farming. We have many health problems (G1_DL; G2_DL; G1_HN; G2_HN).

The VietGAP adopting farmers claim that they gain from "peace of mind" as well as monetary benefits. Brigance et al. (2018) and Soto et al. (2018) find comparable results, in which organic farmers express satisfaction with their profession. They have a sense of belonging to the land, of social and environmental responsibility which enhance their human and social capital (Brigance et al., 2018; Soto et al., 2018). Monetary benefits follow gradually when farmers are offered a premium for their VietGAP vegetables.

> The monetary benefits will become apparent over time as the farm accumulates its reputation in the market (G1_HN).

> Even though our price is higher, customers are willing to buy because they know our vegetable is safer (G1_HN).

It is agreed in the literature that farmers are motivated to move towards organic farming by environmental stewardship, lifestyle, personal and family health, as well as potentially greater crops and livestock prices (Peterson et al., 2012). Farmers may adopt organic farming because they have strong motivation or because they find it little or without constraints. Their viewpoints and conditions will affect how they conduct organic farming (Fairweather, 1999). For the farmers who already have a mindset of biodiversity conservation farming, initiatives that transform attitudes needs to be promoted since they are more easily persuaded.

4.2.3 Barriers of biodiversity conservation practices

Fears of short-term loss

The vast majority of our respondents are engaged in conventional farming, where chemical pesticides are widely used. It also represents the reality of agricultural production in Vietnam. Chemical pesticides are frequently taken as an immediate response to pest growth. Farmers are deterred by the fear of losing short-term crops and income despite appreciating the benefits of low-pesticide agricultural production methods. Low pesticide use is typically associated with concerns such as "unstable yield", "weather dependable", and "easily spoiled organic vegetables". The focus group farmers report that they have to use more chemical pesticides.

> The problem with chemical pesticides is that pests become more resistant to pesticides over time. Therefore, we have to use more and more chemical pesticides for vegetable production even though it is costly (G1_DL; G2_DL; G2_HN).
>
> Although the cost of organic pesticides is lower than chemical pesticides, the effectiveness of the former is relatively low in intensified vegetable production. Therefore, we have to use chemical pesticides in intensified farming more in comparison with the conventional farming (G2_DL; G2_HN).

When being asked why many farmers abandon environmentally conscious (and less costly) methods and use more chemical pesticides, the most popular responses are related to the financial unviability of low-pesticide farming practices.

> The possibility of immediate successful crop is lower and crop loosing is higher due to pests with low-pesticide farming practices as compared to the use of chemical pesticides (G1_HN; G2_DL).
>
> Our main problem is who can guarantee our crop and income if we use low-pesticide farming practices (G2_HN; G1_DL; G2_DL).

The financial viability and stability are clearly the main concern of the focus group farmers. Using known inputs and their expertise with a reasonably assured financial return, conventional farming offers stability (Fairweather, 1999). Organic farming may be beneficial to small-scaled farmers and rural communities since they can be direct connected to the markets with premium prices (Constance, 2008). However, others are skeptical about the economies of scale in organic farming practices (Warren et al., 2015). Many believe that financial barriers are the main obstacles for biodiversity preservation practices. Once farmers have more secure financial position, organic farming will be considered more seriously (Warren et al., 2015).

When a person can secure his finance, he or she will think about health and community. For young families who have not been in farming for a long time and need to focus on earning their livings, they may not be able to go beyond short-term money making. They need to make money as fast as possible. As a result, low-pesticide farming practices is determined by each farmer's perspective and financial conditions (EX_DL1).

The literature shows that farmers prefer to sell directly to wholesalers, local supermarkets, or catering services under a contract farming system (Thuy et al., 2022). Nevertheless, such contract farming system often lasts for a short period of time due to non-conforming or breach of agreement by either side.

After we sign the contract, supermarkets may not be able to buy all of our products (perhaps because they cannot sell or export it). The committed purchase is, therefore, reduced from 5 tons to 3 or 2 tons. We got a headache because the supermarkets' committed purchase often changes in the last minute. We got no negotiation power. Then, we had to sell in the open-air market at a lower price and suffered too much loss (G1_DL; G2_DL).

The catering service to a primary school signed a contract with us. But they were solely interested in covering their business with our VietGAP certificates. They only bought our products for a short period of time. After that, they reduced their buying from us and smuggled in the vegetables in the open air market, which are planted with a conventional farming method, to reduce their cost. It happened and we had to struggle to adopt VietGAP (G2_HN).

These findings suggest that biodiversity conservation methods can only be attained by those who do not endure short-term financial constraints. From these observations, effective policies to encourage biodiversity conservation practices should target farmers who have less financial constraints and could mitigate short-term loss of their crops. Instead of targeting low-income farmers, policymakers might start with middle-income and high-income farmers to gain good showcases. From there, these practices could be disseminated and upscaled.

Other operational barriers

For many farmers, farm size is an important factor influencing the success of the transition to low-pesticide farming practices. Farmers are not motivated to change if they have small or medium farm size. Perhaps, when they are small, they are not ready to lose the current crop for the future better ones. Also, the cost is too high for them to adopt low-pesticide farming practices such as VietGAP.

> We have too small farms with less than a hectare. For our farms with a small scale, it is too costly for us to apply VietGAP. Moreover, when our output is small, it is more difficult to find buyers. It is also too risky for us to lose our current crops (G2_DL; G2_HN).

> If we adopt low-pesticide farming practices such as VietGAP on our small farm while other surrounding farms still do conventional farming practices with high chemical pesticides, it will be counter-productive. The wind will spread chemical pesticides to our farms. Otherwise, pests and diseases will all move to our farms (G2_HN; G1_DL; G2_DL).

In fact, small farmers may work together, for example by forming farmer groups, to achieve economies of scale and adopt low-pesticide farming practices (Warren et al., 2015). However, it is not easy either as reported by some farmers in our focus group interviews.

> I do not want to be in any group with other farmers as I will lose my control of growing vegetables. I am doing fine in my own farm (G2_HN).

> It is quite difficult to ask all members of a group to follow a production time line or to cooperate with each other in buying inputs and selling products. I could see a lot of problems by joining a farmer group (G2_HN; G1_DL).

These findings suggest that even though farmer groups may be useful for promoting adoption of biodiversity conservation farming practices, there exist certain technical barriers among farmers to voluntarily form these groups. Without supports from the public sector, farmers may not organize themselves to overcome problems arisen from adopting biodiversity conservation farming practices.

4.3 Suggestions to promote biodiversity conservation practices

To encourage biodiversity conservation agricultural production practices, various programs have been implemented and a variety of measures have been applied in Vietnam (VNA, 2022). Among these efforts, great attention has been paid to improve farmers' awareness about biodiversity and biodiversity conservation agricultural production practices. To further understand the effectiveness of these existing programs and measures as well as suggest potential future solutions, in this study, we had questions to both farmers and experts. The governmental expert said that:

> Training on biodiversity for vegetable farmers has not been frequently offered. These training programs often depend on funding from local or international projects. In general, farmers in Hanoi have received more training than those in Lam Dong province (EX_HN2).

According to this expert, it is always challenging for him to keep farmers' attention throughout training session on biodiversity due to its technical contents and farmers' perception that biodiversity conservation vegetable production refers to more future looking forward activities. Our expert points out that it is difficult to communicate technical words to farmers during his lectures at seminar, conferences or trainings.

In many communes in Hanoi city, vegetable farmers have low education. For example, in one distant commune in Hanoi city, there are 15 vegetable farmers and still 8 of them are illiterate (EX2_HN).

We need to redesign our training programs to make them more effective for farmers. Trainings should include more sessions over a longer period of time with less training time per session. For example, an organic farming training often lasts from 4 to 6 days. Instead of having several consecutive days of training, we should divide it into a few blocks and deliver them in different weeks. Farmers should study, apply what they have learnt, and analyze the results to see if such changes are appropriate for their production (EX2_HN).

Interactive discussion between farmers and experts should be encouraged during training programs. Farmers have their own experience and often compare their experience with the benchmark set by experts. The efficiency of the existing training programs is questioned by both experts and farmers in our sample:

Many training programs are not effective because the trainers do not understand and work with farmers. If we want to succeed, we must work with the farmers and observe any changes in the farming practices. (EX2_HN)

Most of the time, we farmers learn from each other. Many companies organize trainings just to advertise their certain pesticide brands. We are, thus, not happy with some training programs (G2_HN).

These findings are in line with Warren et al. (2015), which shows that organic producers appreciate interactive learning more than simple linear transfer of knowledge. Social learning and networking are important to provide farmers with information (Sagor and Becker, 2014; Warren et al., 2015). Therefore, biodiversity conservation production practices should be transferred from this social networking, which is gained from attending training programs.

As discussed in the previous section that the most significant entrance hurdle for biodiversity conservation vegetable production practices is financial stability and viability. Our experts and farmers again emphasize that more have to be done than just providing training and awareness raising programs to enable vegetable farmers to move towards biodiversity conservation production practices.

> After I provided training of biodiversity conservation production practices to farmers, they asked me promptly: "Now I can do biodiversity conservation production practices, but can anyone ensure my revenue?”. Indeed, farmers will only conduct biodiversity conservation production practices if they can sell their poducts at a reasonable price, which can cover their increased cost. If there is no profit, farmers can not survive. How can they think about biodiversity conservation then? (EX1_DL).

> It is more costly to conduct biodiversity conservation production of vegetables. Hence, we need the government to support us so that we can sell our vegetables at a premium price. If not, we cannot afford it (G1_HN; G1_DL).

> The government should help the farmers who produce vegetables with biodiversity conservation to have better access to vegetable shop chains or supermarkets to sell their vegetables at a higher price and cover their costs (G1_HN; G2_HN).

One expert suggests that the government should assist farmers in vegetable production and promoting biodiversity conservation:

> To make this happen, the government must play a more active role. There must be some governmental regulations or top-down initiatives. Actually, in many places, farmers are practicing organic farming and many farmers prefer it to conventional farming. How to sustain this trend is a question to the government (EX2_HN).

For many years, the Vietnamese government have already issued different ordinances to promote low-pesticide practices for biodiversity conservation. Decree No. 113/2017/ND-CP, which was issued by the Vietnamese government, provides five lists of regulated chemicals: 1) subject to conditional import or production; 2) restricted from trade or production (including aldrin, dieldrin, or chlordane, common chemical ingredients in pesticides); 3) banned; 4) hazardous; and 5) subject to compulsory declaration. Pesticide usage must adhere to Circular No. 10/2020/TT-BNNPTNT on the administration of pesticide products. To be used in Vietnam, a pesticide must be registered with the Ministry of Agriculture and Rural Development. Circular No. 10 also specifies a list of banned pesticides in agricultural production. There should be more to be done to ensure the conservation of biodiversity.

5. Conclusion

Analyzing information collected for focus group and in-depth interviews of vegetable farmers and experts in two key vegetable production areas in Northern and Southern Vietnam, this study contributes to the literature with four new folds. The study provides evidence to confirm that that Vietnamese vegetable farmers have a certain level of awareness of biodiversity and biodiversity conservation production practices. The study also reveals that improving health of the farmers and people in their community stand out as the most important perceived benefits of biodiversity conservation vegetable production practices. In addition, it is pointed out that the main barrier to biodiversity conservation vegetable production practices is the short-run income viability for the farmers' family. Moreover, biodiversity conservation should be effective if farmers are supported by joint actions from both the government and businesses.

This study provides several policy implications. First of all, it is crucial to understand farmers' financial viability to sustain biodiversity conservation agricultural production practices. A thorough analysis of a workable financial strategy including potential input costs, price premiums, and prospective rates of returns to farmers, may be warranted for this sustainability (Warren et al., 2015). Although the government is the main actor, who can initiate top-down policies for raising awareness of biodiversity conservation agricultural production practices, it is important to have supports from wide range of other institutions, including universities, research organizations, promotional agencies, and private enterprises. Private companies are a key player to create technology, promote new models of farming, sell the concepts to small farmers, and provide technical assistance and pay premiums to farmers in biodiversity conservation agricultural production (Warren et al., 2015). As private firms cannot guarantee purchase of farmers' biodiversity conservation agricultural products in an unpredictable market, this study calls for the interconnectedness of stakeholders' shared interests in biodiversity conservation. Our research aims to highlight potential policy ramifications for the continuing biodiversity conservation initiatives.

6. Limitations and future research

There remain several limitations of this study. First, focus group and in-depth interviews were conducted in two key areas of vegetable production in Vietnam, which may not represent all types of agricultural production in a tropical country with a wide variety of agricultural products. Future research should extend to other agricultural products and make necessary comparison across different types of agricultural products. Second, the qualitative method is solely employed in this study, which could not measure the magnitude of the impact of technical and non-technical factors in biodiversity conservation. Future research should apply both qualitative and quantitative methods for gaining comprehensive information about determinants of promoting biodiversity conservation in agricultural production in tropical areas. Finally, this research was limited to a Vietnamese farming context. As such, its external validity needs to be tested more in other tropical countries. Replicating the study with a population of farmers from different tropical countries with different development contexts would enhance the generalization of the findings.

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