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Sustainable Agricultural Practices and Livelihoods: a Study of Farming Systems in Northern Vietnam

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Declaration

I hereby declare that I have worked on my dissertation titled "Sustainable Practices and Livelihoods: A study of Farming System in Northern Vietnam" solely and completely on my own and that I have marked all quotations in the text. The literature and other material I have used are mentioned in the references section of the dissertation.

In Prague, 28th January 2022 ____________________

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Abstract

From 1995, Vietnam started setting new safety standards for agricultural products to deal with environmental problems and health issues resulting from the intensification of farming methods and increasing awareness of food safety. This research aims to characterize the typical current farming systems, analyse the linkages between farming systems (conventional, Safe and organic) and livelihood, and identify the determinant factors in adopting ecological farming practices (composting technology and eliminating use of agrochemicals) in sub-urban areas of Hanoi. Data collection involved a survey based on a structured questionnaire, key informants' interviews, and focus group discussions conducted in 2015 with a sample size of 312 respondents. Three forms of farming systems: conventional, Safe, and organic were identified. A multiple linear regression model was applied to identify factors that affect cash incomes from agricultural activities. A logistics binary regression was employed to determine factors influencing the adoption of compost and willingness to decrease chemical pesticide use on farms. This research found a direct correlation between the ecological factor of farming systems and respondents' cash income from agricultural activities. Additionally, the amount of family labour and respondents' level of education and farm experience appeared to positively influence cash incomes from agriculture. On the other hand, farm size and membership in farmers' associations were identified as the major factors that negatively affect agricultural cash income in the study areas. Available information was the most determining factor for the adoption of composting techniques. Willingness to decrease the use of chemical pesticides directly correlated with respondents' level of education. Collective action played an important role in improving household livelihood of respondents who practicing organic farming system.

Key words: urban agriculture, conventional farming system, Safe farming system, organic farming system, compost, pesticide, collective action.

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1. Introduction

Population growth has always been the main driver for food demand worldwide. It is predicted that the world population will reach 9 billion in 2050. Asia is projected to be the second largest contributor to future global population growth, adding 0.9 billion people between 2015 and 2050 (UN 2017). The countries in this area are making efforts to solve the problem of increasing food demand. However, answers to this problem may result in conflict with the benefits of natural resource preservation and food safety (Spiertz & Ewert 2009). Agricultural growth plays an important role in encouraging the development of livelihoods and the welfare of rural areas by raising the income of farmers and their families. The improvement of farmers' livelihoods is one of the major elements contributing to maintaining agricultural sustainability (Coxhead et al. 2010).

After reunification in 1975, Vietnam attempted to apply large-scale agricultural collectivization to the whole country, but collective agriculture performed poorly. By the mid-1980s, Vietnam was facing difficulties in providing food security for the population of 60 million due to unsuccessful policies on collective agriculture (Kerkvliet 1995). Hence, after the Sixth National Party Congress in December 1986, the Vietnam Communist Party officially announced a policy of Renovation *(Đổi Mới)*. Vietnam's economy has since transformed from a centrally planned model to market-oriented. Thanks to relevant policies, Vietnamese agriculture has achieved many significant accomplishments (Nguyen 2006). As a result of rapid agricultural growth, Vietnam has shifted from a subsistence-based economy to one of sound food security and has become a strong exporter of agricultural products. Food surplus has helped keep to a low cost of living and correspondingly low real wages for labour transferred from agriculture to the non-agricultural sector (Dang 2009). Later, the growth of food production supported the stabilization of food prices, increasing real wages, and creating opportunities for farmers to participate in more profitable, higher-value farming and non-farm activities (Minot & Goletti 2000). While Vietnam transcended any food shortages, new challenges in agriculture have arisen due to critical problems caused by rapid urbanization and environmental issues (Nguyen 2010).

Agricultural intensification is one way to mitigate the effects of urbanisation, including the problem of decreases in the availability of arable land in Vietnam. Agricultural intensification makes use of more efficient inputs. However, it may involve environmental problems and health issues. It often demands a high volume of agrochemicals that leaves toxic contaminants in the soil, water sources, and agricultural products (Drebold 2017, Wertheim-Heck & Spaargaren 2015). Agricultural sustainability in Vietnam needs to address the following issues: low household income, irrigation water shortages, declining soil fertility, increasing occurrence of pests and diseases, and dependence on high rates of chemical fertilizers and pesticides (Pham & Smith 2013). On other hand, crop intensification that combines good agrochemical application with good agricultural practices not only prevent the interception of weeds and insects on plants but also contribute to higher yields (Hussain et al. 2017). There are several discussions on-going in the search for solutions in supplying food in Vietnam, from new administrative perspectives, to providing knowledge, education, and training for farmers (Figuié & Moustier 2009).

Since 1989, in order to maintain agricultural sustainability and improve the livelihoods of farmers in rural and sub-urban areas, various sustainable farming systems have been supported by the Government and NGOs in Vietnam (Dung et al. 2010, Pham et al. 2019). Practicing the right farming system is the most important step for farmers to assure their livelihoods. However, the lack of scientific data and information about the efficiency of specific farming systems confuses farmers. Thus, this dissertation is going to explore the characteristics of the current typical farming systems in Vietnam, analyse the linkages between distinct farming systems and livelihood and identify the determinant factors in the adoption of ecological farming practices occupying sub-urban areas of Hanoi, Vietnam.

The literature review in this dissertation provides readers with a theoretical framework of urban agriculture concepts and practices of sustainable agriculture in the urban area in Vietnam (typical farming systems and potential of sustainable agricultural waste management).

Research tools such as interviews and focus group discussions were implemented in sub-urban Hanoi to gather empirical data for analysis and findings of the dissertation. The analysis of the research data addresses three main research concerns of the dissertation, including characteristics of typical farming systems in suburban area Vietnam and its role in farmers' sustainable livelihood; the factors influencing farmers' decision to adopt sustainable agricultural practices; and farmers' motivations toward a more ecological farming system and its benefits on farmers' livelihood.

The findings of the dissertation are being prepared for peer-reviewed publications. The finding on the first research concerns, the characteristics of typical farming systems and its economic benefits, was published in 2022 in the journal Sustainability 14(3), 1466. The article is titled “Can Ecological Farming Systems Positively Affect Household Income from Agriculture? A Case Study of the Suburban Area of Hanoi, Vietnam”.

The other research findings will be published in two articles that are currently being prepared to be submitted for peer-review. The proposed titles of these articles are:

- Factors affecting the adoption of composting technology among sub-urban farmers. A case study in the sub-urban area of Hanoi, Vietnam.
- Motivation towards an organic farming system and the benefits of collective action. A case study of Thanh Xuan village, Hanoi, Vietnam.

2. Literature review

2.1. Urban Agriculture and Sustainable Livelihoods

Nearly all incomes in rural households in developing countries are related directly or indirectly to agricultural activities. Agricultural growth plays an important role in encouraging the development of the livelihoods and welfare of rural areas by raising the incomes of farmers and their families (Coxhead et al. 2010). The agriculture sector is the primary source of livelihood for developing countries in both farm and non-farm sectors and sustainability in agriculture means enhancing rural livelihood systems (Acharya 2006).

2.1.1. Urban agriculture

With rapid urbanization, developing countries need to feed urban populations and urban agriculture plays an important role in the livelihood strategies of poor and not-so-poor households (Binns & Fereday 1996). Urban agriculture contributes to the alleviation of poverty and food insecurity and reduces other issues such as the lack of green spaces, the formation of heat islands, and the limited biodiversity in the city which all contributes to the future sustainability of cities (Deelstra & Girardet 1999).

Urban agriculture can be subdivided into intra-urban and peri-urban agriculture. Intra-urban agriculture usually occurs within the inner city, such as in community gardens, home gardens, institutional gardens, rooftop gardening, cultivation in cellars and barns. Intra-urban agricultural focus on family and small community consumption rather than commercial production of agriculture products. Unlike intra-urban agriculture, peri-urban agriculture is located in the urban periphery, usually include small to medium-scale farms with commercial production of agricultural products. Urbanization changes the agricultural production systems in peri-urban areas by shifting the purpose of land use in the these areas, producing mostly small-scale farms that are forced to adopt intensive production techniques to cope with the rapid increase in demand for agricultural products due to the rapid increase in urban population and the continuously decreasing farm land (Veenhuizen & Danso 2007).

Urban agriculture uses urban resources such as land, labour, urban organic waste, and water, and produces goods for urban citizens. Nevertheless, the land source is limited due to the occupying agricultural land for cities growing during urbanization. Thus, it is crucial to have relevant strategies to utilise the land source for agriculture efficiently. Mougeot (2000) distinguishes between urban and rural agriculture, not by its location but by the type of products grown. Mougeot (2000) also argued that urban agriculture is an integral part of any urban economic, social or ecological development strategies. His definition of urban agriculture is widely used:

"Urban agriculture is an industry located within (intra-urban) or on the fringe (peri-urban) of a town, a city or metropolis, which grows or raises, processes and distributes a diversity of food and non-food products, (re-)using largely human and material resources, products and services found in and around that urban area, and in turn supplying human and material resources, products and services largely to that urban area." (Mougeot 2000)

Urban agriculture with Functions of urban agriculture contribute to:

- Urban food security and nutrition: Supplying and distributing food from rural areas and other cities to urban areas raises the cost of food. Consequently, it decreases the access to food for low-income urban citizens. Promoting urban agriculture is the most effective way to enhance food security and nutrition. (Argenti 2000)

- Local economic development: urban agriculture can increase the income of poor people via selling agricultural production and saving household expenditures by growing their own food. It also supports micro-enterprises and services in agricultural production. (Carvalho 2001; Moustier and Danso 2006)

- Social impacts: urban agriculture integrates rural and sub-urban households into the urban network (Garnett 2000, Smit and Beilkey 2006). Especially in the case of Vietnam where many rural areas are being incorporated into big cities to provide better access to lands for urbanisation as Harms (2011) observed in Hoc Mon district of Ho Chi Minh city.

- Urban environmental management: Urban agriculture can solve waste disposal problem in cities by using sustainable technologies for waste management to turn urban waste into productive resources, such as via compost production, vermiculture, and irrigation with wastewater (Cofie et al. 2006). It also has a positive impact on the greening of cities, the maintenance of biodiversity, and the reduction of the city's ecological footprint (Konijnendijk 2004).

There are, however, potential disadvantages in urban agriculture associated with health risks and damage to the environment. Intensive irrigation might lead to the spread of malaria and water-borne diseases. Overuse of fertilizer and pesticides contaminates water and soil sources and destroys biodiversity. Agricultural production in the cities faces challenges of production in a polluted environment and of how to limit the negative impact on the environment and urban citizens' health. (Bon et al. 2008, Stewart et al. 2013)

2.1.2. Sustainable livelihoods

Livelihood is defined as the activities, the assets and the access that determine the living gained by an individual or household (Ellis 1998). Rural livelihood structure comprises mostly of agriculture, with part of the population diversifying into off-farm activities to achieve a sustainable livelihood and get a better income for their households (Mphande 2016). The concept of Sustainable Livelihoods (SL) was first introduced in 1992 by the Brundtland Commission on Environment and Development, encouraging sustainable livelihoods as a general goal in eradicating poverty. The concept of SL constitutes the basis of different "Sustainable Livelihood Approaches" (SLA). It has been adapted by different development agencies such as the British Department for International Development (DFID), the Cooperative for Assistance and Relief (CARE), the Oxford Committee for Famine Relief (Oxfam) and the United Nations Development Programme (UNDP) (FAO 2018).

The DFID has developed a "Sustainable Livelihood Framework" (SLF), one of the most widely used livelihood frameworks in development practice. The DFID framework (Figure 1) consists of five elements: the context in which people act, the resources they have at their command, the institutions that mediate access to these resources, the range of activities and choices that people can undertake, and their goals (DIFD 2001).

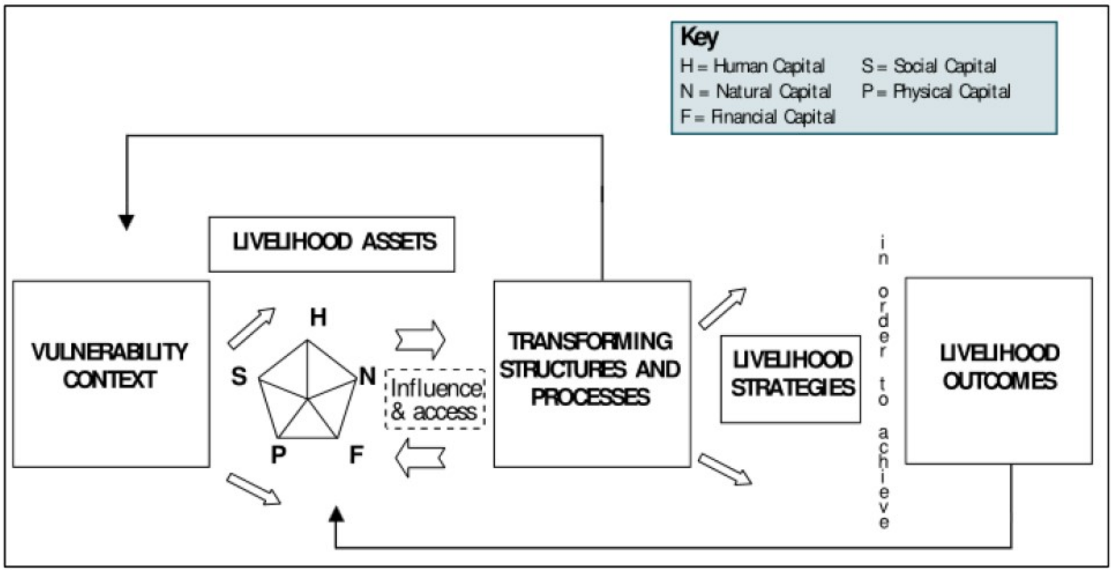

Figure 1: The Sustainable Livelihood Framework (DIFD 2001)

The main elements of the SLF can be summarized as follows:

"…The framework depicts stakeholders as operating in a context of vulnerability, within which they have access to certain assets. Assets gain weight and value through the prevailing social, institutional and organizational environment (policies, institutions and processes). This context decisively shapes the livelihood strategies that are open to people in pursuit of their self-defined beneficial livelihood outcomes." (Kollmair & Gamper 2002).

The idea of assets is central to the SLA. Instead of determining poverty simply as low income, the SLA considers assets based on people's need to sustain an adequate income to live. DFID stresses the importance to livelihoods of "capital assets" and distinguishes five aspects of such assets: natural, social, physical, human, and financial. According to Majale (2002), assets that are recognized within sustainable livelihoods theory can be summarized as:

- Human capital: good health, skills, information, knowledge, and ability to labour.
- Social capital: the social sources that people draw on to make a living (relationships of trust, membership of groups, networks, access to wider institutions)
- Natural capital: The natural resource stocks that people can draw on for their livelihoods (land, forest, water, air, etc.)

- Physical capital: The basic infrastructure that people need to make a living, the tools and equipment they use (housing, sanitation, energy, transportation etc.)
- Financial capital: final resources available (savings, in whichever form, access to financial services and inflows of money)

The more assets a household has access to, the less vulnerable and the more secure their livelihood will be.

In many developing countries, urban agriculture makes a significant contribution to the livelihood of the urban population, in providing food security and income generation. Urban and peri-urban agriculture is a dynamic concept that comprises various livelihood systems ranging from subsistence production and processing at the household level to more commercialized agriculture. Many citizens have turned to urban and peri-urban agriculture as a livelihood strategy and as a source of income for a substantial number of urban households (Veenhuizen & Danso 2007).

2.2. Urban Agriculture in Vietnam

2.2.1. The agrarian reform process in Vietnam

After achieving independence from France in 1954, the country divided into two countries, the Democratic Republic in the north and the Republic of Vietnam in the South with opposing ideologies. Northern Vietnam adopted a socialist ideology influenced by China and the Soviet Union; Southern Vietnam pursued a capitalist ideology influenced by the United States (Nguyen 2010). In Northern Vietnam, in the system of agricultural collectives, groups of households formed production brigades, which were made responsible for meeting government quotas for agricultural production (Do & Iyer 2003).

Following reunification in 1975, large-scale agricultural collectivization was attempted in the whole country. Yet by 1980, only 24.5 percent of farm households belonged to a collective in the south (Kerkvliet 1995). Collective agriculture performed poorly. In 1976 and 1977, agricultural production contracted by 0.5 percent and 6.6 percent, forcing the government to increase grain imports sharply (Chu et al. 1992). By the early 1980s, Vietnam faced an economic crisis. The unpopular system of collective agriculture was on the verge of a spontaneous breakdown (Fforde & Vylder 1996).

Under the Renovation policy - Đổi Mới in 1986, the collective agriculture system began to be dismantled. The reforms sought to develop the private sector, increase and stabilize agricultural output, and attract foreign investment. Resolution 10 obliged agricultural collectives to contract land to households for 15 years for annual crops and 40 years for perennial crops. Households could trade within production quotas. The private sector was allowed to engage in food marketing. Production amounts and prices were fixed for five years. Then, from 1987 to 1991, the government relinquished control over prices and opened the market for both domestic and international trade (Fforde & Vylder 1996; Akram-Lodhi 2002).

From 1989 to 1992, agricultural growth jumped, reaching 3.8 percent a year. Vietnam became the world's third-largest exporter of rice in 1989, alleviating national food shortages (Dang 2009). Success in agriculture became a key driver of overall economic growth. By 1992, the economy's growth rate climbed to 8.7 percent (Dollar 1994).

From 1993 to 2000, the agricultural sector grew at 4.6 percent annually, and the non-agricultural sector grew by more than 8 percent. Even during the Asian financial crisis 1997-2001, Vietnam maintained strong economic performance and agricultural growth averaged 3.9 percent per year (Akram-Lodhi 2002; Nguyen 2006).

The twenty-first century is known as the first urban century, with over 50 percent of the global population living in urban areas. By 2045, the world's urban population will increase to 6 billion. This trend is stronger in developing countries (World Bank 2019). Vietnam is one of the Asian countries recently experiencing rapid demographic, economic and social changes. After decades of growth, the population reached about 95 million in 2017, out of which one third live in urban areas (FAOSTAT 2017; World bank 2018b). The urban areas were primarily concentrated in the two economic and political centres, the capital city Hanoi in the North and Ho Chi Minh City in the South of Vietnam (Hoang et al. 2013).

In recent years, urbanization has been occurring very fast in the peri-urban areas of Vietnamese cities. Rural districts need to change economic and land-use structures to urban units, reducing agricultural activities. When a district's status changes to urban, the district is subjected to modernization of either a residential or industrial character. Thus, farmers of technically rural origin become urban residents just by a signature on a piece of paper (Van Cu et al. 2014). In 2010, almost 70 percent of the urban households in Vietnam earned parts of their income from cultivating crops. This indicated the importance of urban agriculture in Vietnamese cities. (Orsini et al. 2013).

Urban and peri-urban agriculture in Vietnam was aimed at supplying consumption by the capital Hanoi and Ho Chi Minh City with an emphasis on vegetable and fruit production in the peri-urban areas (Pulliat 2015). Urbanization is linked to higher demand for food and stimulated local production. The rapid growth of the urban population and their income has led to increased demand for high-value agricultural products such as meat, fish, fruit and dairy products. Many rural areas have converted from low-profit rice farming into fruit and vegetable growing to satisfy consumer demand (Hoang et al. 2005). Vegetables are cultivated mainly in the Red River and Mekong River Delta. In 2013, vegetable cultivation accounted for 160,300 ha in the Red River Delta and 227,200 ha in the Mekong River Delta, representing 19.2 percent and 27.2 percent of total vegetable areas in the country (Ly et al. 2014). Conversion to cash crops has helped generate local economic benefits, improving livelihoods and sustaining household food security (Hoang et al. 2013).

The ever-increasing urbanization and industrialization rate in Vietnam has strongly impacted the livelihood of farmers. The role of agriculture reduces in value when economic development diversifies occupation structure. However, agriculture still plays an important role in the population's livelihood in rural areas and urban areas, especially in Hanoi, where peri-urban agriculture is a longstanding feature (Mai & Nguyen 2016; Lee et al. 2010).

2.2.2. Farming systems in Vietnam

Restructuring and diversification of agriculture in Vietnam have been considered important for regional economic development in general, and rural development in particular. If rice farming was a priority for food security in Vietnam before 1999, aquaculture, animal husbandry, and fruit production have since become important for agricultural development (Dang et al. 2005). Since 1989, the so-called VAC farming system has been encouraged by the Vietnamese government to develop agriculture in rural areas. The abbreviation VAC stands for gardens (*Vườn*), fishponds (*Ao*) and animal sheds (*Chuồng*) as functional units of the VAC model. The VAC system is considered an ecological way of using farm products in natural cycles and has had remarkable results from economic, health and nutrition perspectives (Dung et al. 2010). The model consists of three components, gardens for vegetables, fishponds and livestock, raising pigs and poultry. These three components support each other by providing feed and fertilizer. The residual from vegetables can be used to feed livestock and fishponds, and the manure from livestock can support the garden. A household using this model can self-supply up to 60 percent of food demand and has an additional income from selling products to the local market (Trinh et al. 2003). The basic characteristics of the VAC model are small, scattered, low productivity units, with high-input prices but unstable output. The traditional VAC method directly discharges raw animals/human manure into fishponds or lakes which contaminates water sources. Moreover, incorrect utilization of fertilizers, pesticides, and animal feeds cannot assure hygienic conditions and food safety (VACVINA 2018). Thus, other ecological models such as VACB (Figure 2), RVAC (where V: garden, A: pond, C: livestock, R: forest, B: biogas) have been used commonly to mitigate pollution in rural areas in Vietnam (Hai et al. 2015).

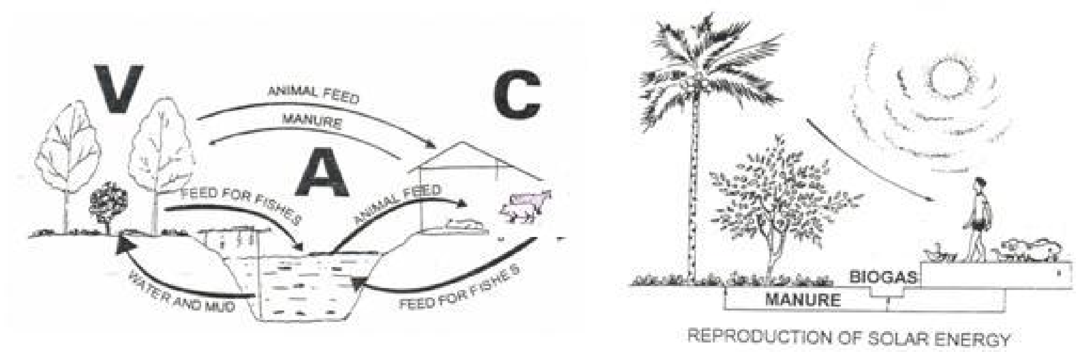

Figure 2: The VACB model in Vietnam (mohinhVAC, 2013)

Due to the lack of arable land caused by urbanization, cities in Vietnam require an intensification of farming methods. Intensive cultivation of more perishable crops, such as vegetables, will occur closer to the market, whereas less perishable crops, such as grain, would remain in the city's rural areas. Agricultural intensification uses inputs more efficiently but may involve environmental problems, health issues and raising awareness of food safety. Although the laws on food safety are well defined, the government cannot enforce them efficiently (Drebold 2017). Due to the issue of food safety, farm classification can also be defined according to farm outputs, and not only based on farm activities. New farming classifications are formed and named based on the certified labelling of agricultural products. These classifications are "*thông thường* – conventional" (uncertified), "*an toàn* – Safe" (local name for agricultural products produced under the "Safe Vegetable" or VietGAP programme), and "*hữu cơ* – organic" (under an organic programme of NGOs or certified by TCVN).

Conventional Farming

Conventional farming systems vary from farm to farm and from country to country, variously called "conventional farming", "modern agriculture", or "industrial farming". In general, a conventional farming system can be characterized by rapid technological innovation; single crops grown continuously over many seasons; extensive use of pesticides, fertilizers, large-scale farms, large capital investment, high labour efficiency and dependency on agribusiness. (USDA 2007).

There is no doubt that a higher yield in food production will satisfy the rising food demand in a country. However, in developing countries, where the population is rapidly increasing, like Vietnam, suitable agrochemical application in agriculture faces many challenges. The first problem comes from farmers' lack of knowledge of fertilizer and pesticide use. Overuse of chemical elements on land and crops endangers both the environment and human health in the long term (Akhtar et al. 2000). The second problem stems from the industrial production of fast, cheap and toxic chemical fertilizers to supply the local markets. The third problem is the lack of policies from local governmental institutions to adequately support the education and training of local farmers (Huang et al. 2015).

Chemical input has also affected biodiversity, as toxicity in land and water has significantly reduced the number of useful species and changed the rural living conditions. The lack of modern irrigation systems, temperature changes and soil erosion have posed complex challenges for the farming activities in developing countries in East Asia (Schellenberg et al. 2012). Human health has also suffered from critical problems resulting from chemicals in farming. Contamination has resulted in decreased water consumption for people in rural and urban areas exposed to environmental pollution. With low income from agricultural production and potential harm from pollution, rural livelihoods became vulnerable to the threats of unexpected diseases and poverty (Huffman & Orazem 2007).

In Vietnam, a major shift in labour towards the industrial sector has affected the agricultural sector since 2006. The young and skilled workforce has left rural areas and joined manufacturing in pursuit of higher incomes (Epprecht & Robinson 2007). Eventually, those who stayed behind in the farming sector were mostly the old and unskilled farmers with limited knowledge and training in AgroSciences. Moreover, Vietnam's farming land and water have been polluted by dangerous toxins from two sources: industrial manufacturing and agrochemicals used by farmers (Thuy et al. 2012). With low income from agriculture, cheap and old pesticides have been widely chosen by Vietnamese farmers to increase production. Uninformed farming practices have resulted in land and water pollution (Lamers et al. 2011).

Since 1986, Vietnamese agriculture has undergone substantial restructuring: crop diversification, more cash crop production (including of vegetables), and increased agrochemical inputs. Vegetables are important crops in the Red River Delta in the Northern part of Vietnam. Income from vegetable production contributed 83 – 89 percent of total income from crop production in peri-urban areas of the capital Hanoi and rural areas of the Red River Delta. On the other hand, vegetable production demands a large quantity of pesticides (Anh 2002, Pham et al. 2013b). A study on fruit and vegetable imports from Vietnam into four European countries had found pesticide residues above maximum residue limits in 33 percent of samples (Skretteberg et al. 2015). The long-term effect of absorbing chemicals in contaminated food is generally believed to be cancerogenic in the community. Hence, consumers were highly concerned with food risks associated with chemical residues (Nguyen et al. 2018).

The main threat to food safety in Vietnam is the extensive use of pesticides in agriculture (Xuyen & Dinh 2006). Although the potential issues were identified in the late 1990s, the social problems started to emerge a decade later (Pham et al. 2011). Several state organs were established to control the food supply and discourage the farmers' extensive use of pesticide. In the early 2000s, Vietnam restricted the importation of pesticides. However, the quantity of agrochemicals in the domestic market remained unchanged. The main reasons behind the state's failure to regulate pesticides in the market lay in issues of the governance, such as large-scale corruption, informational distortion, and failings in the legal system (Pham et 2013c). On the other hand, agricultural models in Vietnam were based on small households and family employment. Farmers lack knowledge, education and training in farming practices. Planned solutions were difficult to apply in reality (Pham et al. 2013b).

Besides tremendous gains in productivity and efficiency, the conventional farming system has created concern in ecological systems, economic and social problems, and negative consequences on human health (USDA 2007). The Vietnamese conventional farming system is facing a series of challenges that hamper the development of a sustainable food system. The availability of cheap agrochemicals and farmers' lack of awareness about their adequate use has led to an overuse of fertilizer and pesticides, especially in rice and vegetable production (Rikolto 2017).

Safe Farming

Food safety refers to the quality of food in the market. Different from food security, the goal of food safety is to ensure a healthy life for consumers. Its standards relate to providing a fresh and clean food supply chain to the end-users (Uyttendaele et al. 2015). Food safety is a scientific discipline that describes, handles, prepares, and stores food that prevents health hazards. Food safety problems exist worldwide. Even in developed countries, food safety is connected to health and socio-economic sectors such as tourism and the attraction of service industries (Gossling et al. 2011).

During 1990 – 2004, most farmers believed that the use of three inputs: seed, fertilizer, and pesticides in large quantities would positively impact the number of crops. Consequently, there were increased uses of seed by 50 percent, a doubling in the amount of fertilizer used and frequently spraying with pesticides (Huan et al. 2009). Responding to the issue, in 2003, the government of Vietnam launched the programme, "Three Reductions Three Gains (3R3G)", firstly in Can Tho province in Southern Vietnam. Three Reductions means to reduce the use of three inputs in agriculture. Throughout 2005 – 2006, more than three million farmers in Vietnam adopted 3R3G program". Because of the positive achievements of the programme, in 2006, The Ministry of Agriculture and Rural Development launched a 3R3G programme as a national priority (Heong et al. 2010). Continuing after the 3R3G programme, the Vietnamese government conducted the "1 Must Do (1M5R)" programme in 2008, which means using certified seed lines while reducing the use of several other seeds, fertilizers, pesticides, water, and water post-harvest loss. This programme aimed to answer the requirements of improving agricultural product quality after Vietnam's joining the World Trade Organization (WTO) (Presilla 2018).

In 1995, public interest in safe vegetable production led the Vietnamese Ministry of Agriculture and Rural Development to implement the ambitious "*Rau an toàn* – Safe Vegetables" programme focused on more ecological farming methods, beginning in Hanoi. The programme educated farmers in the reasonable use of fertilizers, pesticides, water from wells and non-polluted rivers. Similar programmes were organized by NGOs (Pham et al. 2009). "Safe Vegetables", in general, became a local term used to refer to vegetables grown with the correct application of pesticides to avoid excessive residues (Pham et al. 2019).

Safe Vegetable production certificates are awarded by the Plant Protection Department of Hanoi municipality to cooperatives and companies meeting specific conditions of soil and water quality in the area and in compliance with restrictions on the use of chemicals (Bac et al. 2017). They also regulated pesticide use in agriculture by directly regulating pesticides and their application. Unlike conventional agricultural production, Safe Vegetable production uses less-toxic pesticides and must follow specific conditions and procedures, including strict pest management practices (Nguyen & Pensupar 2018).

Some cooperatives received support under programmes to get access to retailing points or enter contracts with distribution companies, canteens, schools, shops and supermarkets and have their vegetable output labelled as "Safe", including an indication of the place of production. These outlets charge premium prices. However, the "Safe Vegetables" certification is highly inconsistent because of different programs and different standards. However, by 2008, only 27 agricultural cooperatives held Safe Vegetable production certificates in Hanoi, representing around 2 percent of Hanoi's total vegetable surface (Pham et al. 2009). Despite the massive demand for Safe food, farmers using "Safe Vegetable" cultivation frequently complain about their income. Not all farmers are successful in finding traders to buy their vegetables at premium prices (Wang et al. 2014).

At the same time, cases of food poisoning started to increase. The number of food poisoning cases related to chemical residues in vegetables increased from 4233 cases (59 deaths) in 2000 to 7829 cases (62 deaths) in 2008. Unsafe vegetables have been a major threat to people's health (Dao et al. 2012). With the increasing number of food poisoning cases, Vietnamese consumers realised the importance of food safety (Xuyen & Dinh 2006).

In response to the concern about unsafe vegetables, on January 28^{th}, 2008, the Ministry of Agricultural and Rural Development (MARD) in Vietnam issued Decision 379/QD-BNN-KHCN on implementing the Vietnamese Good Agriculture Practice (VietGAP) policy for vegetable and fruit production. Hanoi was selected as a pilot locale for the VietGAP programme because Hanoi is the main vegetable region of Vietnam with a 12000-ha vegetable planted area (Nguyen & Pensupar 2018). The policy is based on the Hazard Analysis Critical Control Points (HACCPs) principles of AseanGAP. The objectives of VietGAP are to improve food quality and food safety, protect workers' health and consumers' health, improve social welfare, protect the environment, and ensure product traceability based on preventing and minimizing the risk of hazards which occur during production, harvesting and post-harvest handling (Nicetic et al. 2010). To obtain VietGAP certification, producer groups need to record the practices of farmers in chemical use. They need to organize an internal inspection of production and post-harvest operations using various criteria to gauge food safety. An external auditor checks the internal monitoring system. This aligns with the Food Safety Law adopted in June 2010 by the National Assembly. The law makes it compulsory for food producers to organize self-inspection, give information on the safety of their products and cover the expenses of sampling and testing. The problem is that such regulations are virtually impossible to enforce for small-scale producers with limited income (Moustier & Nguyen 2010). To facilitate the adoption of VietGAP, the central government has promoted it to farmers by providing extension services and incentives. In cooperation with the national and provincial centre for Agricultural Extension, the Provincial Department of Agriculture and Rural Development have introduced extension programmes to demonstrate the benefits and applicability of VietGAP. Through the Commune People's Committee, local government has provided financial support to farmers if they adopted VietGAP (Hoang 2018). However, the result of the six-year implementation was not as good as expected. In 2013, 376 Safe Vegetable demonstrations received a VietGAP certificate, with a total area of 1,997.82 ha – accounting for 0.23 percent of the total vegetable area (Duong 2013).

Many cooperatives in Hanoi have received financial support from the City of Hanoi, covering all fees for labelling VietGAP production. Farmers do not seem to have many incentives to apply standards despite all these efforts. Therefore, the number of farms that have certified vegetables has increased only slowly (Pham 2017). Thus, most Safe food certification and labelling in the Hanoi area still relate to "Safe Vegetables" rather than to VietGAP (Wang et al. 2012). There is limited understanding of how the VietGAP programme is being implemented and why it has not been adopted by the majority of farmers (Hoang 2018). The area of Safe Vegetable production in Hanoi to 2011 fluctuated unstably. However, from 2012 to 2015, the area of Safe Vegetables increased significantly to 2245.30 ha in 2015. The cause of the increase lay in Hanoi's policies in promoting clean vegetable sources to supply the market to ensure food safety. The status of Safe Vegetable production is presented in Figure 3 and Figure 4 below (Dinh et al. 2016).

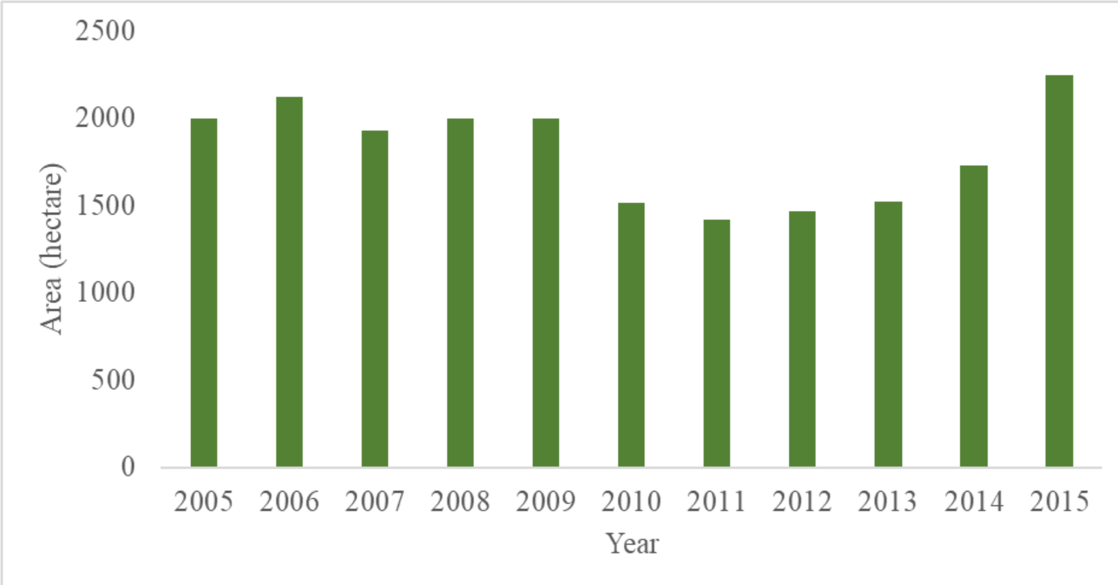

Figure 3: Status on area of Safe Vegetable in Hanoi (Own adjustment based on Dinh et al. 2016)

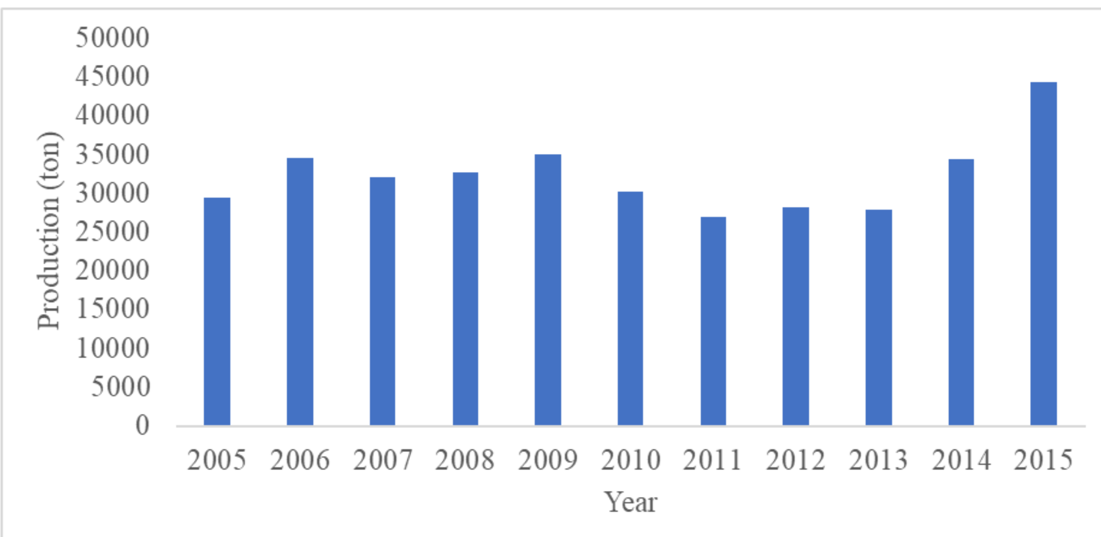

Figure 4: Status on production of Safe Vegetable in Hanoi (Own adjustment based on Dinh et al. 2016)

Organic Farming

The organic farming system (Organic Agriculture) is defined as a food production system that sustains the health of soils, ecosystems, and people, relying on ecological processes, biodiversity, and cycles adapted to local conditions (Tietengerg & Lewis 2012). In other words, the organic farming system does not rely on agrochemicals and mechanizations, which damage the surrounding environment and ecology in the agricultural systems. The organic farming system can be applied from small-scale households to large collective communities (Suh 2015). However, the share of organic agriculture in the sector was still relatively small and under national protection. In 2010, organic agricultural land reached 37 million hectares, which accounted for 0.9 percent of agricultural land worldwide (Stolze & Lampkin 2009).

The largest non-government organic farming organisation is the International Federation of Organic Agriculture Movements (IFOAM). Established in 1972, IFOAM was soon recognized worldwide with its Organic Guarantee System. Its primary function is to harmonize the movement of organic agricultural products via regulation and trade (Luttikholt 2007). IFOAM is the most reliable organization in setting production standards and certification procedures for organic goods (Eernstman & Wals 2009).

Compared to European countries, organic farming in Vietnam is still relatively new. However, the idea of recycling in organic farming was applied for decades in rural areas of Vietnam. It is found in the most typical model of Vietnamese rural households: the home garden. The home garden emphasizes agrobiodiversity at the small scale of family. "Hữu cơ – organic" is the third option for safety standards for Vietnamese agricultural products. It was introduced in 2004 by Agricultural Development Denmark Asia (ADDA). The Vietnamese government recognised the organic label in 2006. "Safe Vegetable" and "VietGAP" have been fully elaborated by public entities while "organic" is still under a private protocol, certified only by NGOs in Vietnam or international organizations (Pham 2017), not by the government. By 2015, the Vietnamese Ministry of Science and Technology promulgated a standard for organic agricultural systems: TCVN 11041:2015, which contains a manual for implementing, producing, labelling, and marketing organic food. However, only small sections of the TCVN 11041:2015 are publicly available. The full content of the document is only available to those who have purchased a license from the Ministry of Science and Technology. Hence many regions, cooperatives and state institutes do not know about this standard. According to a study from the organization Vietnam Participatory Guarantee System (PGS), current organic standards implemented in Vietnam come mainly from non-governmental organizations or foreign organizations (Vietnamorganic 2018b).

A study by Nguyen (2017) of organic farming in Vietnam found three main types of organic farmers. The first type of farmer is the traditional organic farmer. They apply traditional methods in their production system, such as composting, crop rotations, and manually protect plants from pests and diseases without synthetic external inputs. The second group are *reformed organic farmers* who have stopped using agrochemicals on their farms because of the adverse effects on their health and the environment. Third, *certified organic farmers,* who have the certificates for their organic products after undergoing standard controls. Such certificates are, for example, connected with the popular organic label PGS Vietnam, which IFOAM supports via the organization Vietnam PGS (Nguyen 2017a). In response to the neoliberal regulation of organic agri-food, PGS - Participatory Guarantee Systems advocated for their potential to promote food sovereignty, inclusivity and grassroots empowerment (Vietnamorganic 2018c). The general process for obtaining PGS certification (Figure 5) for farmers included 8 steps which are summarised in the following (IFOAM 2011a):

Step 1: Individual farmers contacts a Producer Group to join (participation in training in PGS organic standards is obligatory)

Step 2: Verification by Inter-Group leading to peer review by Producer Group

Step3: The farmer and the farm are inspected by other members of their Producer Group

Step 4: Based on the inspection reports (e.g., on soil and water testing), the certification status of the farm is decided by the Inter-Group Certification Committee.

Step 5: The Coordination Group enters information of the farmer into database with an identification number and send the certification to the farmer with validation for one year.

Step 6: The Inter Group Certification Manager manages the re-inspection process each year.

Step 7: The inspection, decision-making and approval process follows step 3 – 5 above.

Step 8: The Inter-Group Certification Manager randomly reviews ten percent of inspection reports. The Inter-Group also re-inspects the farms and reports to the Inter-Group certification committee. The Certification Committee considers these reports and takes the decision to confirm or change the status of the farmer.

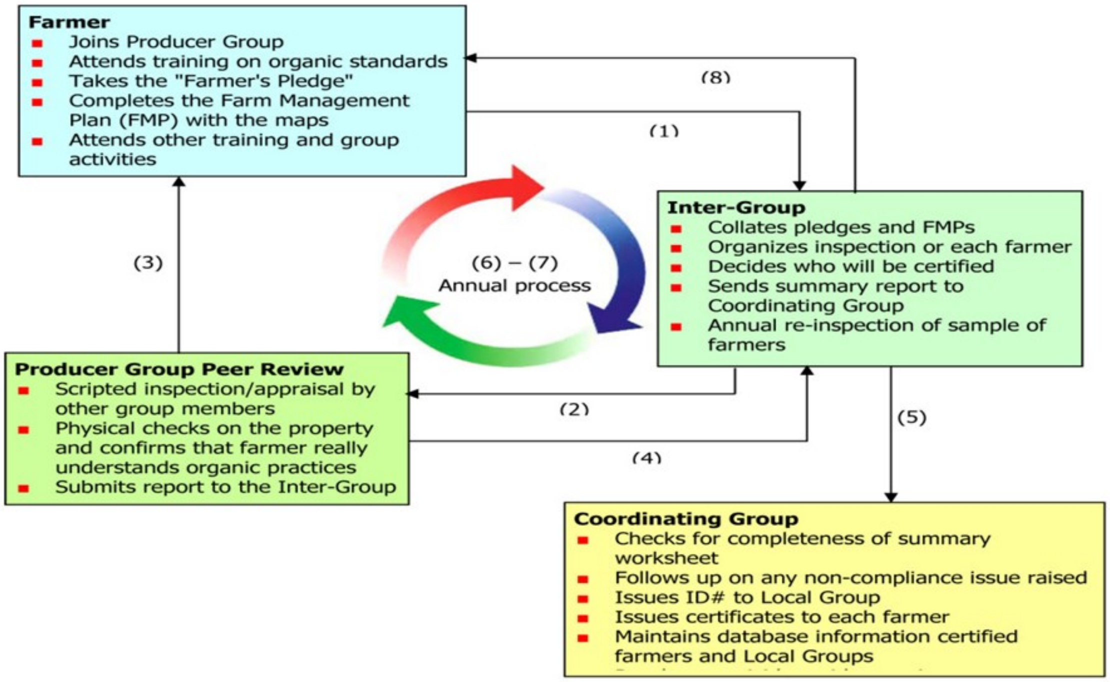

Figure 5: Process of PGS certification (Vietnamorganic, 2018c)

Organic farming, under the control of PGS Vietnam, involves following certain principles taken from the international standards of IFOAM, which aim to ensure ecosystem crops, for example: avoiding the sue of synthetic fertilizers and pesticides; respecting the balance of natural ecosystems, optimizing health and the productivity of soil life, plants, animals and humans; and supporting the adoption of sustainable agricultural technologies (Vietnamorganic 2018a). PGS Vietnam provides training in organic farming practices for interested farmers and ensures the condition of soil and water on agricultural land. Farming procedure residue measurements are then monitored by training inspectors. Final products are labelled using PGS standards and marketed to consumers in the local markets and urban areas (Vietnamese organic 2018b). PGS Vietnam has been developed in cooperation with the Organic Agriculture Project in 2008 and 2009 between ADDA and Vietnamese Farmers' Union. It has involved producers, consumers, supporting organizations (NGOs), and organic traders (companies). The PGS has developed its labelling based on the National Basic Standards for organic products in Vietnam issued by the Ministry of Agriculture and Rural Development (IFOAM 2019). After 10 years of existence in Vietnam, local PGSs have successfully implemented organic and Safe vegetable production. By 2018, PGS had been applied in 6 provinces in 9 districts and involved 725 farmers (Rikolto 2018a).

2.3. Potential for good practices in agricultural waste management in Vietnam

Sustainable agriculture considers long-term interests rather than only short-term interests such as profit. Conventional agriculture may offer the chance of short-term gain but is unsustainable in the long term. There has been an increasing demand in recent decades to produce larger quantities and achieve development towards more sustainable agriculture (Wezel et al. 2014). Agricultural sustainability considers three components: economic profitability, social justice and environmental friendliness (Gómez-Limón & Sanchez-Fernandez 2010). Water pollution and waste management in both residential and agricultural contexts are increasingly environmentally problematic (Hoang et al. 2015). Along with food security, urban agriculture also aids in waste management (Cofie et al. 2006). Processing agricultural waste is a global issue because the vast majority of it is currently buried or burned, causing air and water pollution and global warming (Koul et al. 2022). Urban agriculture plays an important role in three approaches to waste reduction: reducing the amount of waste, re-using what can be re-used, and recycling the remainder. The relationship between urban agriculture and waste management is most pronounced in converting organic waste into useful material for agricultural production. (Deelstra & Girardet 1999, Koul et al. 2022). Waste management in urban agriculture can help keep the urban environment clean and boost the production of fresh food through composting from organic waste (Orsini et al. 2013).

2.3.1. The structure of agricultural waste in Vietnam

Agricultural waste can be divided into three categories depending on the type of agricultural activities carried out: hazardous wastes, animal wastes and crop residues. Their composition depends on the systems and types of agricultural activities (Obi et al. 2016).

Hazardous waste generated from agricultural production activities are one of the major emerging problems in the rural areas of Vietnam. It includes the residues of pesticides, fertilizers, and packaging materials. Around 11,000 tons of pesticide and 240,000 tons of fertilizer packaging materials were generated in 2008 in Vietnam. This increased together with the growth in the use of pesticides and fertilisers (Nguyen 2017b). These wastes can cause unpredictable environmental consequences such as food poisoning, unsafe food hygiene and contaminated farmland due to their potentially lasting and toxic chemical contents (Dien 2006).

Waste from livestock activities includes solid waste such as manure and organic materials in the slaughterhouse; wastewater such as urine, cage wash water, wastewater from the bathing of animals and from maintaining sanitation in a slaughterhouse; air pollutants such as H2S and CH4; and odours (Obi et al. 2016). In June 2018, Vietnamese farms generated around 153.4 million tons of solid waste from livestock husbandry (the volume of solid waste generated from livestock by species is shown in Figure 6), including food waste and dead animals (MARD 2018).

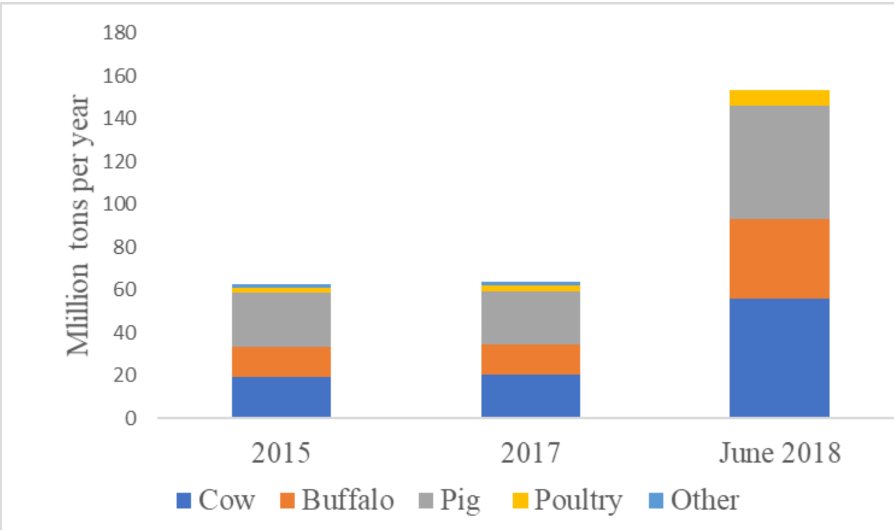

Figure 6: Solid waste generated from livestock husbandry by species in Vietnam (own adjustment based on MARD 2018)

About 80 percent of livestock manure is generated by small scale farms, the remainder comes from larger commercial farms. An estimated 36 percent of total animal manure is discharged directly into the environment (dumping in landfill, fishponds, canals, rivers, and so on). Livestock waste causes different types of pollution, including water, soil, and air pollution. (Dinh 2017, MARD 2018).

Intensification of agricultural production has been accompanied by the generation of a huge quantity of crop residues. Crop residues are usually generated after harvesting in the forms of rice straw, can trash, coconut shells, etc., or from industrial processing on rice husks, cassava peels, peanut shells, etc. During 2013 – 2015, 67.6 million tons of paddy straw, 4.4 million tons of maize by-products and 0.7 million tons of coffee husk were generated each year in Vietnam (Nguyen 2017b). Crop residue open burning has been used as the fastest and traditional method for decades (Kanabkaew & Oanh, 2011). Smoke from the open burning of crop residues negatively affects human health. There are serious concerns in society regarding forest fires. Crop residue open burning is a kind of low-temperature combustion of the vegetation; hence, it can release toxic air pollutants such as particulate matter with black carbon and organic carbon components, carbon monoxide and volatile organic compounds (Estrellan & Iino 2010).

Vietnam is one of the countries with the fastest growth in greenhouse gas (GHG) emissions in the region. Vietnam's agricultural sector is responsible for a third of the country's GHG emissions. Total GHG emissions from Vietnam's agricultural sector are projected to increase to 109 mil tCO_2 by 2030 (CCAC 2019, Mulia et al. 2020).

GHG emissions generated in Vietnam by agricultural sectors in 2016 are shown in Table 1. Emissions from rice cultivation contributed the largest share with 59 percent. The second largest share comes from agricultural soil with 26.9 percent, followed by enteric fermentation with 14.8 percent, and manure management with 7.3 percent. Vietnam needs to deal with the emissions from agricultural residue burning and promote friendly crop residue management practices for example biogas production or composting (UNFCCC 2020).

Table 1: GHG emissions generated in Vietnam by agricultural sectors in 2016 (Own adjustment based on UNFCCC 2020)

GHG source	CO2	CH4	N20	Total net emissions
Rice cultivation		49 693.02		49 693.02
Enteric fermentation		12 421.74		12 421.74
Manure management		3 131.36	2 960.27	6 091.63
Indirect emissions from manure management			221.90	221.90
Cropland	3 637.60			3 637.60
Emission from biomass burning		1 298.52	325.61	1 624.13
Liming	565.79			565.79
Urea application	1 436.11			1 436.11
Direct emissions from managed soils			7 754.11	7 754.11
Indirect emissions from managed soils			3 752.55	3 752.55

Unit: ktCO2e

2.3.2. Utilization of organic agricultural waste in Vietnam

Organic agricultural wastes are non-product outputs of the production and processing of agricultural products that may contain material that can be of benefit. Organic agricultural waste has the advantages of a wide range of sources, low cost and being renewable. It has good prospects for comprehensive utilization of resources when used for environmental pollution control (Dai et al. 2018).

Findings from the research of Khanh & Thanh (2010) and Dai et al. (2018) reveal that organic agricultural waste in Vietnam can be utilized in various ways. At present, we can identify mainly the following aspects of resource utilization of agricultural waste (for example how straw can be used in Vietnam in renewable utilization is described in figure 7):

- Feed utilization: the crop residues such as crop straw can be used as feed for animals.
- Fertilizer utilization: converting agricultural wastes into organic fertilizer helping to enrich organic content, for example, by compost technology.
- Industrialization: agricultural waste can be used as a raw material for papermaking and creating polymer panels instead of using wood.
- Energy utilization, mainly including anaerobic fermentation (biogas production) and direct pyrolysis (combustion of agricultural waste to create electricity).

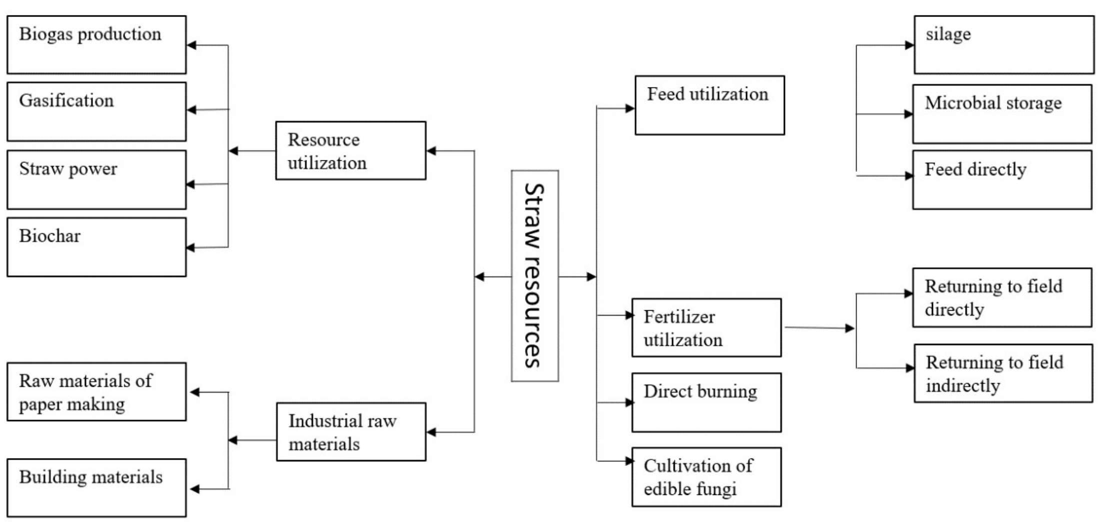

Figure 7: Ways of utilizing straw resources in Vietnam (Khanh & Thanh 2010)

Using composting technology to manage agricultural residues in Vietnam could easily be adopted by farmers; it can reduce the accumulation of farm wastes at the same time as helping to improve the environment (Truc 2011). Moreover, with increased urbanization, municipal waste in Vietnam has also increased together with the greater amount of agricultural waste. In 2008, Vietnam generated 9,078,000 tons of agricultural waste per year (Sen Safety Environment Network 2012). The composition of waste in Vietnam is mostly of organic origin that has a high potential in the reuse of bio-waste, especially treating agricultural residues by composting (Dai 2018).

The most important benefit of using compost is increasing soil organic matter. Composting is a controlled process that breaks down organic fractions of waste into stable substances. The process of compost recycles various organic materials otherwise regarded as waste products and produces a soil conditioner (Karanja et al. 2005). The most-used agrochemical fertilizers in developing countries in Asia were Nitrogen fertilizers (N). At the same time, organic waste contains a high level of Nitrogen, Phosphorus, Potassium and organic matter important for improving the nutrient status of soils in peri-urban agriculture (Zhanga 2015, Sabiiti 2011).

Composting of organic residues and compost in agriculture bring back plant nutrients and organic matter to the soil. Many vegetable crops respond favourably to compost fertilization (Erhart & Hartl 2010). Composting offers several benefits such as enhanced soil fertility and soil health, thereby increased agricultural productivity, improved soil biodiversity, reduced ecological risks and a better environment (Misra et al. 2003). The recycling of organic waste by composting could constitute a win-win strategy by providing a sustainable solution to the dual problem of waste management and poor soil fertility (Lim et al. 2016).

Despite the advantages of recycling organic agricultural waste, farmers in developing countries rarely see their situation regarding agricultural residues. However, farmers' opinions will determine the adoption and increased use of agricultural residues at farm-scale levels (Brunerova et al. 2018).

In Vietnam, the composting of agricultural waste has recently begun. Due to the lack of investment, Vietnamese farmers use animal waste and crop residues as fertilizers using very simple treatments. Popularly, straw and manure were piled up together and used after weeks. This practice may be introduced as the simplest method of composting in Vietnam (Bui 2012, Hoang 2018). There has been increasing interest in using vermicompost in Northern Vietnam to restore fertility and plant growth in soils degraded by erosion (Doan et al. 2015).

2.4. Conceptual framework

In recognising the adverse effects of intensive agriculture practices in urban and sub-urban areas on human health and the environment, the Vietnamese government has implemented various programs focusing on developing ecological farming systems. Moreover, in section 2.3, we have shown that Vietnam has a high potential to adopt sustainable agricultural practices. However, as mentioned in section 2.2, despite all the efforts of the Vietnamese government to promote sustainable agriculture practices in urban areas, the number of Vietnamese farmers practising ecological farming systems was not achieved as expected. Furthermore, while the reason why the majority of farmers are not interested in adopting sustainable farming practices is one of the important factors that underpinned the development and implementation of sustainable agriculture in Vietnam, very few research have explored the lack of impetus for farmers to adopt ecological farming systems even when there are a number of favourable conditions for them to do so as mentioned in 2.2. Understanding the challenges and motivations to adopt ecological farming systems is essential to establishing effective strategies for sustainable urban agriculture and increasing the possibility of farmers' successful adoption of environmentally friendly farming systems in Vietnam.

However, due to the rapid urbanisation in Vietnam, developing a sustainable urban agriculture is essential to the development of the city and provide the ideal logistic for food security for the urban population. Paradoxically, while sustainable urban agriculture is optimal for urbanisation, rapid urbanisation also forces sub-urban and urban farmers to navigate between agricultural productivity and economic pressure, and the protection of the environment and human health due to the rapid decrease in farming land (Rikolto 2017, Pham et al. 2013b). Traditionally, research on the efficiency of farming systems widely utilise farming system research (FSR) which places high importance on productivity and profit (Drinkwater et al. 2016). Nevertheless, Drinkwater et al. (2016) argued in their own research which employed FSR that researchers must shift from measuring farm "performance" such as yield or profit to evaluating the success of a farming system by analysing the complex interaction between farming practices and environmental and social impacts. Such research can generate information that improves farming systems to sustain farmers' income while protecting the environment and maintaining human health. Additionally, Darnhofer et al. (2012) and Drinkwater et al. (2016) pointed out that FSR approach is still an optimal approach for research related to farm’s economic performance while understand how economic performance affects farmers' decision-making process and actions and how their actions affect the production, farm economic, social aspects, and environment and vice versa. Although there is no one-size fits all approach for farming system research, many researchers realised that when analysing a farming system, at least three sets of interacting elements need to be considered (Figure 8): farm characteristics (e.g., production methods, farm assets, labour resources), farmer characteristics (e.g., personal and vocational background), and environment (e.g., social network) (Darnhofer et al. 2012).

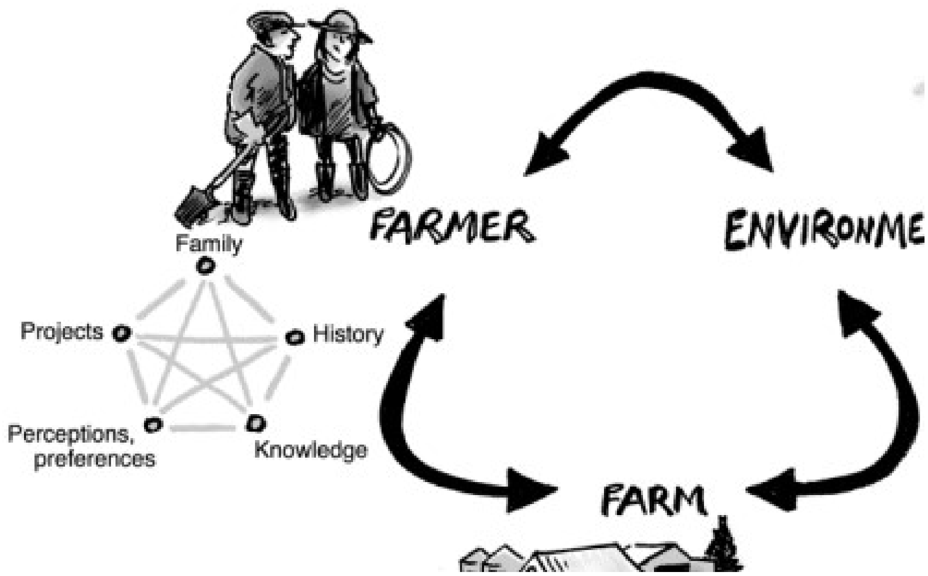

Figure 8: Farming system research (Darnhofer et al. 2012)

Having acknowledged that FRS can be a useful research approach for the efficiency of agricultural system, we also argue that agricultural research based solely on yield, profit, and economic factors cannot address farmers' hesitancy in adopting sustainable agriculture in Vietnam. In Vietnam, as elsewhere in the global South, rapid urbanisation and environmental issues are the most pressing complications for economic and social development. Previous research sustainable agriculture practices are the solution to the negative impact of intensified agriculture system on the environment (Delaroche 2020). Governments and public agencies worldwide have provided many support programs to encourage farmers to change their agricultural practices more sustainably. Despite significant state support, farmers still have problems with the long-lasting adopt sustainable farming practices (Delaroche 2020). Since the 1990s, various agricultural system research has demonstrated that extrinsic factors alone, such as economic factors, farm characteristics and technology cannot fully explain farmers' decision-making process (Edward 2006, Yoder et al. 2019). Because human activities are the main factors that cause environmental issues, thus, the changes in human behaviour can address these issues (Oskamp 2000). Researchers started to add social-psychological elements such as attitudes, perception, norms, and values to explore the role of intrinsic factors in farmers' decision-making process (Edward 2006, Yoder et al. 2019).

Researchers have widely used the theory of planned behaviour (ToPB) to understand and predict people's intention to perform or not to perform a behaviour. Intention function combines three main elements (Figure 9): *attitude toward the behaviour*—the degree to which a person feels like perform the behaviour; *subjective norms*—the perceived social pressure to perform or not perform the behaviour; and *perceived behavioural elements*—the perceived ease or difficulty of performing the behaviour (Ajzen 1991). It has been applied to a large variety of cases such us to explore intentions to improve environmental behaviour in a workplace or pro-environmental farmers' adoption of conservation practices (Greaves et al. 2013, Delaroche 2020). ToPB has been used in agricultural research to study adoption of sustainable agricultural practices to comprehend farmers' decision-making and strengthen agricultural sustainability (Ansari & Tabassum 2018, Delaroche 2020).

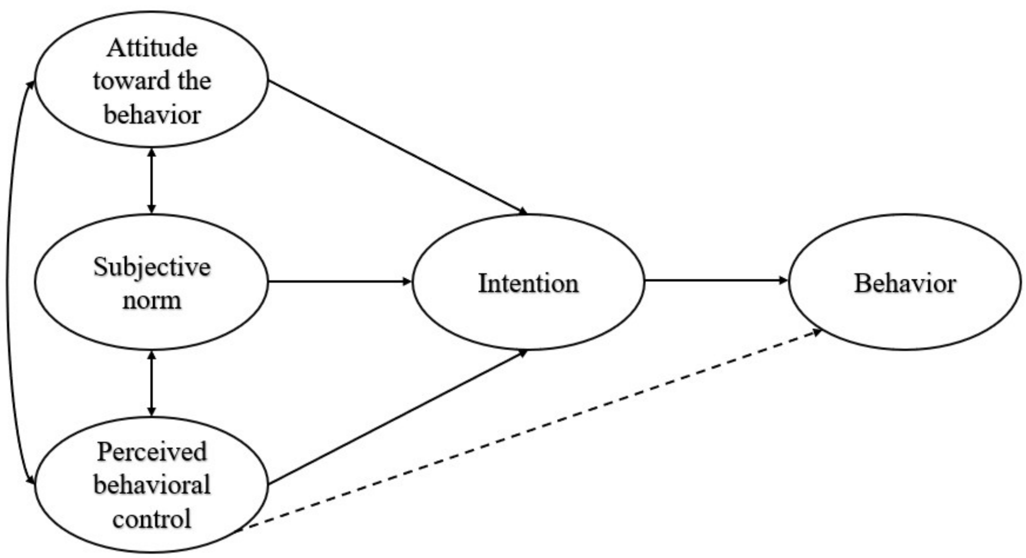

Figure 9: Theory of planned behaviour (own adjustment based on Ajzen 1991)

ToPB also includes non-motivational factors such as the availability of requisite opportunities and resources (e.g., personal skills, assets etc.) (Ajzen 1991). ToPB was applied in Mosler et al. (2008) research to determine the factors that influence waste recycling, composting, and reuse in Cuba. In 2015, Monfared et al. used the ToPB to analyse why farmers in Boushehr Province in Southern Iran continue to use pesticides. In this research, we argue that combining the FSR approach and the ToPB will allow us to better understand the relationship between the production, farm economic, social aspects, and environment, and farmer's decision-making process.

We use the similar structure of the ToPB to describe the determinants influencing the farmers' attitude, subjective norms, and perceived behavioural control toward ecological farming practices while also applying some of our own modifications that are better suited for the study areas and objective of the research. First, the objective of our research was to not test a certain model as a conventional ToPB research. Second, the research participants in our study area were not responsive the initial full-length questionnaire designed following Ajzen's conceptualisation of the ToPB model. As such, a shorter and simplified questionnaire was designed to aid researchers in the data collection process as we will detail in the data collection below. However, the limited length of the questionnaire would have made it improbable for us the measure and analyse the ToPB factors as Ajzen did. In our modified ToPB, subjective norms are determined by the popularity of the behaviour in the surrounding areas and the encouragement of organisations including NGOs and Governmental organisation for the adoptions of the behaviour. We further consider access to composting information and technology as the main descriptive factor of the perceived difficulties of adopting certain behaviour. We emphasise that our research objective focus on behavioural intention rather than the behaviour itself as outline in the research objective below.

3. Research outline

3.1. Objectives

This dissertation main aims to determine the factors affecting the decision to adopt ecological farming systems by small-scale sub-urban farmers in Hanoi, Vietnam through the analysis of the challenges, facilitating factors, and remedies for these farmers to implement sustainable agricultural practices. To develop the main objectives, five specific objectives are derived as follows:

1. To explore the characteristics of farms in the area related to type of farming systems in terms of sustainable livelihood assets.
2. To analyse factors affecting cash incomes from agriculture activities in the three identified farming systems.
3. To identify the factors affecting the adoption of composting technology in agricultural residues management in the study area.
4. To determine the factors affecting the willingness of farmers to decrease and eventually eliminate the use of chemical pesticides on their farms.
5. To discover changes in livelihoods after converting to organic farming systems.

3.2. Study area

Our study area was the suburbs of the Vietnamese capital city, Hanoi (Figure 10), located in the Red River delta region. Until 2007, the urban population rate of Hanoi (65.3 percent) was still left far behind Ho Chi Minh City (74.7 percent). Nevertheless, the drastically increased urban population growth rate in Hanoi within the last fifteen years cannot be ignored (Nguyen 2011). Responding to the increase in population in urban areas, in 2008, Hanoi extended its city boundaries to meet commercial and residential demands and designated 57 percent of the province as dedicated to farmland (Pulliat 2015). Even though urban and peri-urban farming is a long-standing feature in Hanoi, the city continues to face many issues that could militate against the sustainability of this practice (Lee et al. 2010).

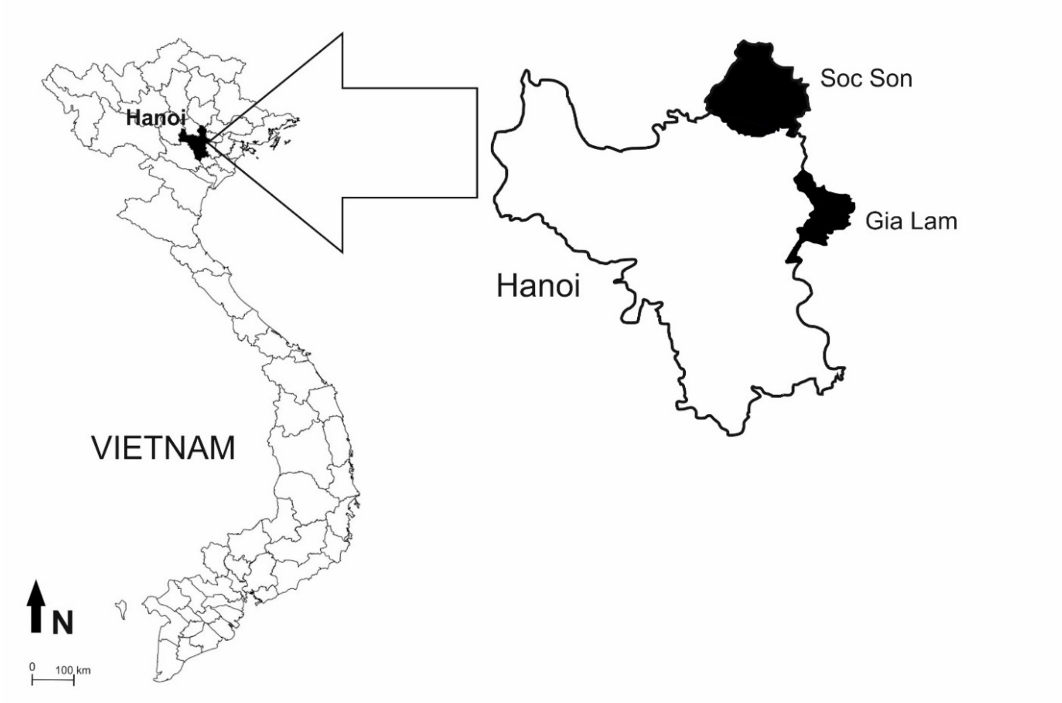

Figure 10: Area of research (own adjustment based on the national map)

A high level of urbanization increased the demand for available land for urban development and rapidly displaced Hanoi suburbs' agricultural and rural landscapes (Nguyen 2011). Urbanization of Hanoi has led to decreasing arable land and has caused an intensification of vegetable production, often with high inputs of chemical additions. Farmers tend to over-use agrochemicals to maximize yields (Pham et al. 2013). After the huge food scandal of "dirty" vegetables (contaminated by chemicals) in the biggest supermarket chains of Hanoi at the beginning of 2015, consumers in Hanoi had more concerns about clean products and, therefore, the demand for "Safe Vegetables" with restricted chemical inputs and post-harvest regulation is fast increasing (Ha et al. 2018). It is clear from recent developments that Hanoi needs a clearer master plan to sustain urban agriculture, such as for the effective management of plots, greater coordination in transportation and marketing of urban agriculture produce, and the adoption of innovative agricultural technologies (Lee et al. 2010).

As a part of the Red River Delta region, Hanoi has a tropical monsoon climate with three seasons: hot and wet from May to September; cool and dry from October to January; cool and humid from February – to April (Pham et al. 2013). Roughly 56.4 percent of its land is used for agriculture, forestry, and fisheries. About half of all vegetable production in Hanoi occurs within a 30 km radius of the city centre. This area is called the Hanoi green belt. Agricultural production in the green belt is highly profitable and is an essential source of income for local suburban farming households (Pham 2017). As such, the study area of this research is wholly situated in Hanoi's green belt.

The survey was firstly conducted in the Cu Khoi sub-district of Gia Lam district. Since 2008, the Ministry of Agriculture and Rural Development of Vietnam has selected Gia Lam and Thanh Tri district in Hanoi as the pilot localities for the VietGAP programme. It has become one of the leading cities in the VietGAP programme (Loan et al. 2016). Gia Lam has 5,070.40 ha for growing annual crops (77.0 percent of total agricultural land) and 864.04 ha for growing perennial crops (13.2 percent of total agricultural land). Gia Lam district focuses on agricultural development via urban eco-agriculture. Urban eco-agriculture is an agricultural ecology in cities, towns and urban areas which develops practices towards the application of technologies to boost productivity and quality, ensure food safety to meet consumer demands and is associated with environmental protection, enhancing biodiversity, balancing, and improving green spaces in the region. Gia Lam also focuses on agricultural development towards specialization in agricultural commodity growing regions such as in the production of Safe fruit and vegetables (Gia Lam 2018).

Data was also collected in the Thanh Xuan village of Soc Son district (Hanoi). From 2010 to 2012, Soc Son district (Hanoi) and Luong Son district (Hoa Binh) were selected for "The project of organic agriculture development" supported by the Danish non-governmental organization ADDA. Soc Son district has 13,559 ha of agricultural land and 4,557 ha of forest (Soc Son 2018). The developmental strategy of Soc Son district has among its objectives the upgrading of urban agriculture and consumption supports, as well as marketing and quality improvement of local agricultural production (Soc Son 2017).

3.3. Sampling procedure

According to the General Statistics Office of Vietnam (GSO), there were 1,637 farms in Hanoi in 2014 (GSO 2015). However, only limited data about the types of farming systems used in the region were available throughout the research. While the VietGAP system publishes lists of groups, cooperatives, or companies certified by VietGAP on their official website, details about the number of farmers involved in each group or company were not published (VietGAP 2018). Heads of the local farmers' union revealed that about 120 and 70 farmers were practising Safe farming systems in Cu Khoi and Thanh Xuan, respectively. Only PGS Vietnam provides detailed public information about organic farm production and inter-groups, including the names of farmers in each production group, particularly farmers excluded from the PGS system (vietnamorganic 2012). Counting to June of 2013, organic farmer inter-groups in Thanh Xuan remained ahead in PGS organic production, with nine PGS-certified production groups (IFOAM 2013). The smallest production group had five farmers, and the largest one had 13 farmers (IFOAM 2011b).

According to the heads of the farmers' union, after reforms redistributed farmland in 1986, all residents in rural districts received a single patch of land. Every person who wanted to farm in Hanoi was given one "sào" (360 m2). This was either in the form of paddy land, vegetable fields or fishponds. Hence, small-scale farmers made up most of the study area, with around two hectares. Small-scale farms are locally defined as non-industrial farms characterised by limited land, limited labour force, and limited technologies. Most farms in the study area are around two hectares, while the average farm size in Vietnam is five hectares (Bnews 2017). These farms focus on producing products for local consumption.

Three farming systems (conventional, Safe, and organic) were identified in the study area. However, the lack of official statistical data made it impossible to employ random sampling. As such, a purposive sampling method—a non-random technique of sampling without a set number of participants—was chosen as the most appropriate method. Employing such a method, the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of knowledge or experience (Etikan et al. 2016). The sampling criteria included only small-scale farmers practicing one of three different farming systems, growing vegetables and fruits, and leaving out those involved in livestock production.

3.4. Data collection

Most of the data was collected between June and August 2015. Interviews were carried out face to face at farmers' houses or individually at a local cultural centre where group discussions were also organised. Interviews were based on a semi-structured questionnaire with closed and open-ended questions (Table 2). 312 respondents (n = 312), who fulfilled sampling criteria, were interviewed.

Recognising the complexity of analysing the farming systems and their effect on livelihoods, we decided to conduct FGDs to understand farmers' perception of the changes in their livelihoods and health after adopting organic farming system. This data is then compared with the data collected in 2013 as part of the Summer Organic Project 2013, we carried out a FGD in August 2013 with 12 organic farmers in Thanh Xuan and one key informant – president of PGS Vietnam – at a local cultural centre. The Summer Organic Project 2013 was financed by Agnes Scott College (Georgia, US) and Hanoi Organic Roots JSC. 10 of the 12 farmers participated in the previous research also participated in this research. FGDs comprise groups of ten to twelve small-scale farmers. Five FGD sessions (three in Cu Khoi and two in Thanh Xuan) were conducted with a mixture of conventional, Safe, and organic farmers. These farmers were invited for interviews and group discussions by heads of residential groups or leaders of farmers' cooperatives. The FGDs focused on farmers' opinions about the current quality of farmland, farmers' perception about their farming system and other factors related to economy, environment, satisfaction, and factors associated with the adoption of farming technologies. One FGD was made up of only organic farmers to gather more information about why farmers wanted to switch to growing organic vegetables and how they evaluated the organic farming system after five years of practising organic farming.

To understand the situation of targeted groups and particularly gather the information that is not public, key informants (n = 8) were interviewed before and after conducting interviews and focus group discussions (FGDs) with target farmers. These informants provided a better understanding of the local situation. Key informants were heads of the local farmers' union (n = 2), leaders of farmers' groups (n = 2), and leaders of farmers' cooperatives (n = 4). Each interview with key informants took around 30 minutes. The questions focused on these data that were not publicly available (statistics on farmers practicing Safe Vegetable farming), the functioning of national agricultural extension in the targeted area, the support programme for farmers among conventional, Safe and organic farming systems, and their ideas about compost and ecological farming systems.

Despite our efforts to gather as much information as possible with the assistance of the heads of the local farmers' union or leaders of farmers' cooperatives in the target areas, some limitations affected the data collection process. Farmers did not take our interviews seriously because we were not affiliated with any state institution. Furthermore, farmers could not calculate the exact operational costs of their farming activities. Thus, they could only vaguely estimate the cash incomes generated from farm activities. Additionally, respondents withheld information about the quantity and variety of chemical pesticides used on their farms.

Table 2: Research design

Research's Objective	Research question	Theory	Type of data collection	Data collection tool
1.	- What are the main farming systems of respondents in the area? - What are the households' characteristics and livelihood assets related to the farm? - What kind of fertilizer and pesticide do farmers use on their farm and its cost? -How do respondents manage the crop residuals? - How do respondents think about conventional, safe and organic farming system?	SLF	- Secondary data - Primary data (Quantitative and qualitative data)	- Informant keys' interview - Respondents' interview based on structured questionnaire - FGDs
2.	- What are the sources related to cash income generated from the farm? - How do respondents manage the agricultural residues? - What is the level of education of respondents and their experience on farm? - What are the relationships of respondents with other farmers in the area and with agricultural extension?	FSR	- Primary data (Quantitative and qualitative data)	- Respondents' interview based on structured questionnaire - FGDs

3.	- Do respondents adopt composting technology on their farm? - What is the opinion of farmers about the composting technology - How and what do farmers think and feel about adopting compost? (Perception towards environmental protection) - How are farmers supported to adopt compost on their farm? (Access to technical information, encouragement from surroundings, support from government)	ToPB	- Primary data (Quantitative and qualitative data)	- Farmers' interview based on structured questionnaire - FGDs
4.	- Do farmers use only chemical fertilizer and pesticide on their farm? - How and what do respondents think and feel about the willingness to decrease agrochemical application on their farms? (Perception towards environmental protection, opinions about health status when applying agrochemicals on the farm) - How are respondents supported to decrease agrochemicals on their farm? (Access to information on agrochemicals, encouragement from surroundings, support from government)	ToPB	- Primary data (Quantitative and qualitative data)	- Farmers' interview based on structured questionnaire - FGDs

5.	- Why did organic farmers decide to convert/continue to practice the organic farming system? - What are the obstacles when farmers practice organic farming system? - What are the changes of livelihood assets after successful practice of the organic farming system? - How are organic farmers satisfied with the PGS system?	SLF	Primary data (Quantitative data)	FGDs

3.5. Data analysis

Data collected from questionnaires were categorized and coded using the statistical software package SPSS 25. Information gathered from FGDs was transcribed, organized, and classified into categories using Microsoft Office Excel.

Descriptive analysis such as frequencies, cross-tabulations, mean, median etc. was used to describe characteristics of the farming systems, livelihood assets of target groups, use of natural resources and modes of agricultural waste processing. To determine the differences between three typical farming systems in cash income generated from the farm, as well as in health and environment, the author used hypothesis testing methods such as a Chi-square test, independent t-test, and the non-parametric Kruskal-Wallis test.

Multiple linear regression

To investigate the factors which affect the annual cash income from farms in millions of VND (USD 1 = VND 22,200 on 15 August 2015) from agricultural activities per each local area measurement unit "sào" (360 m2) of farmers in target groups, the multiple linear regression was applied, considering that the dependent variable has continuous values. Linear regression analysis is one of the most commonly used statistical methods to find relationships between dependent variables and independent variables and predict the value of dependent variables based on the independent variables determined (Anderson et al. 2008). For example, linear regression was used to identify determinants of farming income and productivity in Brazil (Herrera et al. 2018) and to examine the relative profitability of organic and conventional vegetable production and factors that affect profit from vegetable production in Vietnam (Pham & Shively 2019).

The quality and adjustments of the values obtained in the regression are measured with an R^2 index. If there is one dependent variable (Y) of p independent variables (X1, X2, ..., Xp), then multiple linear regression models can be written as follows (Anderson et al. 2008):

$$Y = X_\beta + \varepsilon$$

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_p X_p + \varepsilon \quad (1)$$

Based on the theory of FSR, to analyse the dependent variable "farm income" (the annual cash income from agricultural activities measured in VND millions per *sào*, calculated based on data gathered from respondents' estimated income), nine independent variables divided into three groups (farm characteristics, farmer characteristic and environmental factors) were assumed to have influenced the agricultural cash income. These variables were the farm characteristics, which include “farm system”, “farm size”, “family labour”; the farmer characteristics, which include “sex”, “age”, “education”, “experience”; and the environmental factors, which include “association”, and “cooperation”. A description of the variables in the multiple linear regression model is presented in Table 3.

Table 3: Operationalisation of variables in multiple linear regression

Variable	Type	Description	Previous study
Farm Income	Continuous	Income in the form of cash generated from agricultural activities (million VND/ *sào* /year)	Herrera et al. 2018, Pham & Shively 2019
Farm System	Ordinal	Type of farming system regarding ecological level (1 = conventional—environment unfriendly, 2 = safe—middle environment friendly, 3 = organic—the most environment friendly)	Pham & Shively 2019
Farm Size	Continuous	Total area of the farm (*sào*)	Herrera et al. 2018, Pham & Shively 2019
Family Labour	Continuous	Number of family members working on farm (person)	Pham & Shively 2019
Sex	Dummy	Sex of respondent (0 = female, 1 = male)	Herrera et al. 2018, Pham & Shively 2019
Age	Ordinal	Age of respondent (1 = up to 15 years old, 2 = from 15 to 60 years old, 3 = above 60 years old)	Herrera et al. 2018, Pham & Shively 2019
Education	Ordinal	Education level of respondent (1 = can read, 2 = primary school, 3 =	Pham & Shively 2019

		secondary school, 4 = high school, 5 = university)	
Experience	Continuous	Total number of years respondent has been working on farm	Pham & Shively 2019
Association	Dummy	Respondent's membership in any farmers' association (0 = no, 1 = yes)	Herrera et al. 2018
Cooperation	Dummy	Respondent's share of farming tasks with other farmers (0 = no, 1= yes)	Herrera et al. 2018

Binary logistic regression

Binary logistic regression is a commonly used statistical method to identify the most determinant independent variables affecting the dependent variable (Menard 2012). It has been widely applied in adoption studies. For example, this model is applied in analysing factors affecting the adoption of compost in Tropical Caribbean islands by Paul et al. (2017) and vegetable farmers' behaviour and knowledge related to pesticide use and related health problems (Akter et al. 2018), or farmer's adoption of water harvesting technologies in Jordanian Arid Area (Akroush et al. 2017). A Chi-square test was applied to assess the fit of model, and for goodness-of-fit, Hosmer and Lemeshow was used. If the p-value of a Chi-Square is less than 0.05 and the p-value of Good-of-fit is larger than 0.05, then the model is well-fitting (Zampaligre 2014). The formula for binary logistic regression can be written as follows (Rabe-Hesketh 2004):

$$E(Yi|Xi) = \frac{\exp(\beta' Xi)}{1+\exp(\beta' Xi)} = \frac{1}{1+\exp(-\beta' Xi)}$$

Where:

Yi = dependent variable

Xi = independent variable

$$\text{E(Yi|Xi)} = \beta'_0 + \beta'_1 X_{1i} + \beta'_2 X_{2i} + \ldots + \beta'_p X_{pi} \qquad (2)$$

In this dissertation, we ran a binary logistic regression with the determinants identified through our modified ToPB to explore the factors that affect the adoption of compost technologies among respondents and the willingness of respondents to decrease chemical substances on the farm because both dependent variables are binary. Binary logistic regression is a popular statistical technique in which the probability of a dichotomous outcome (such as adoption or non-adoption) is related to a set of explanatory variables. The dependent variable in the model ranges from 0 to 1 (Akroush et al. 2017).

Thus, to analyse the factors affecting the adoption of compost, the dependent variable "compost" was defined as a dummy variable (if a respondent makes compost or not). Twelve independent variables were suggested to have an impact on the dependent variable: "farm system", "farm size", "family labour", "sex", "age", "education", "experience", "association", "cooperation", "environment", "surrounding", "information" and "encouragement". The description of variables in the model is presented in Table 4.

Table 4: Summary of variables for analysing the probability of adopting compost

Variable	Type	Description	Previous study
Compost	Dummy	Respondent adopts compost technique on his/her farm (0 = no, 1= yes)	Paul et al. 2017 Folefack 2015 Zhou et al. 2018
Farm System	Ordinal	Type of farming system regarding ecological level (1 = conventional—environment unfriendly, 2 = safe—middle environment friendly, 3 = organic—the most environment friendly)	Paul et al. 2017
Farm Size	Continuous	Total area of the farm (*sào*)	Paul et al. 2017 Folefack 2015 Zhou et al. 2018
Family Labour	Continuous	Number of family members working on farm (person)	Paul et al. 2017 Folefack 2015 Zhou et al. 2018
Education	Ordinal	Education level of respondent (1 = can read, 2 = primary school, 3 = secondary school, 4 = high school, 5 = university)	Paul et al. 2017 Folefack 2015 Zhou et al. 2018

Experience	Continuous	Total number of years respondent has been working on farm	Paul et al. 2017 Folefack 2015 Zhou et al. 2018
Association	Dummy	Respondent's membership in any farmers' association (0 = no, 1 = yes)	Paul et al. 2017 Folefack 2015 Zhou et al. 2018
Cooperation	Dummy	Respondent's share of farming tasks with other farmers (0 = no, 1= yes)	Paul et al. 2017 Folefack 2015
Sustainable practices	Dummy	Respondent adopts any sustainable agricultural practices on farm (0 = no, 1 = yes)	Folefack 2015
Environment (Attitude)	Ordinal	Respondent feels the need to protect environment (1= no, 2 = rather no, 3 = I don't know, 4 = rather yes, 5 = yes)	Own adjustment based on Greaves et al. 2013
Surrounding (Subject norm)	Dummy	Are there many farms around you adopts composting technology on their farm (0= no, 1 = yes)	Own adjustment based on Greaves et al. 2013
Information (Perceived behavioural)	Dummy	Some-one/organization provides you with knowledge about composting (0=no, 1= yes)	Zhou et al. 2018
Encouragement (Subject norm)	Dummy	Some-one/organization encourages you to adopt compost (0=no, 1= yes)	Own adjustment based on Greaves et al. 2013

Furthermore, to determine the factors affecting the willingness of respondents to decrease the usage of chemical substances on the farm, the "agrochemical" variable was introduced as a dummy dependent variable (if the respondent uses only chemical additions or not). Eleven independent variables are assumed to increase the respondents' willingness to decrease utilization of agrochemicals such as "farm system", "farm size", "family labour", "education", “experience”, “association”, “cooperation”, “health”, “environment”, “information” and “encouragement”. An overview of all these variables is shown in the Table 5.

Table 5: Summary of variables for identifying the respondents’ willingness to decrease agrochemical substances using on farm

Variable	Type	Description	Previous study
Agrochemical	Dummy	Does respondent apply only chemical fertilizer and pesticide on his/her farm? (0=no, 1= yes)	Akter et al. 2018
Farm System	Ordinal	Type of farming system regarding ecological level (1 = conventional—environment unfriendly, 2 = safe—middle environment friendly, 3 = organic—the most environment friendly)	Akter et al. 2018
Farm Size	Continuous	Total area of the farm (*sào*)	Akter et al. 2018
Family Labour	Continuous	Number of family members working on farm (person)	Akter et al. 2018
Education	Ordinal	Education level of respondent (1 = can read, 2 = primary school, 3 = secondary school, 4 = high school, 5 = university)	Akter et al. 2018
Experience	Continuous	Total number of years respondent has been working on farm	Folefack 2015
Association	Dummy	Respondent’s membership in any farmers’ association (0 = no, 1 = yes)	Folefack 2015
Cooperation	Dummy	Respondent’s share of farming tasks with other farmers (0 = no, 1= yes)	Folefack 2015
Health (Attitude)	Ordinal	Respondent thinks using chemical substances on a farm have a bad effect on their health (1= no, 2 = rather no, 3 = I don't know, 4 =	Akter et al. 2018

		rather yes, 5 = yes)	
Environment (Attitude)	Ordinal	Respondent feels the need to protect environment (1= no, 2 = rather no, 3 = I don't know, 4 = rather yes, 5 = yes)	Akter et al. 2018
Information (Perceived behavioural)	Dummy	Some-one/organization provides respondent with information about side effects and reasonable use of agrochemicals (0=no, 1= yes)	Own adjustment based on Greaves et al. 2013
Encouragement (Subject norm)	Dummy	Some-one/organization encourages you to eliminate chemical pesticide on your farm (0=no, 1= yes)	Own adjustment based on Greaves et al. 2013

Comparison analysis method for Focus Group Discussions

A thorough qualitative analysis of focus group discussion is used to explore the changes in livelihoods after converting to the organic farming system. The Constant Comparison Analysis method (Onwuegbuzie et al. 2009) is applied. This method consists of three stages. In the first stage, the data written in the transcript is coded, which means it is divided into small units, and each unit given a code. In the second stage, those units are classified, and this stage is called axial coding. In the final stage, the researcher develops several themes that express the group's contents. This method is considered appropriate for an insightful understanding of the situation in organic farming systems (Onwuegbuzie et al. 2009).

4. Results

4.1. Characteristics of respondents in conventional, Safe and organic farming systems

The field survey included 312 small-scale farmers from Cu Khoi and Thanh Xuan villages in sub-urban Hanoi. 52 percent of the total sample size were conventional farmers, 40 percent of respondents practiced the Safe farming system under the local Safe agriculture programme. Eight percent of them pursued organic farming supported by the organization PGS Vietnam. More than 57 percent of farms grew only fruit, which leaves 43 percent divided equally between vegetable farms and farms growing both fruit and vegetables.

The characteristics of respondents among the three farming systems were reviewed based on livelihood assets as in the figure 1 - Sustainable Livelihood Framework (DIFD 2001), which includes human capital, social capital, natural capital, physical capital, and financial capital.

4.1.1. Human capital

To describe the human capital, these main parameters were identified: age, educational level of respondents, total years of farming experience, household size and family labour on the farm (Majale 2002). About 77 percent of total respondents belonged to a labour force between 15 to 60 years old. The remaining 23 percent of respondents were older than 60 years. None of the organic farmers were older than 60 years old.

The educational level of respondents consisted of five categories (Figure 11): can read and write, primary school, secondary school, high school and university. Most respondents had a secondary level of education (46 percent). Nine percent of the respondents completed high school and a higher level of education. Only one respondent reached university level and was an organic farmer. A Kruskal-Wallis test was applied to determine the difference in the level of education between the three groups of farming system. The result showed a significant difference (p-value = 0.009 < 0.05) between the mean ranks of at least one pair of the groups. Dunn's pairwise tests were carried out for the three pairs of groups. There were significant differences between organic and Safe farming systems (p-value = 0.007 > 0.05, adjusted using the Bonferroni correction), and between organic and conventional farming systems (p-values = 0.039 < 0.05, adjusted using the Bonferroni correction). The median education level of respondents using the organic farming system (3.0) was higher than the respondents from the

Safe (2.45) and conventional (2.57) farming systems. There was no evidence of a difference between respondents who practiced Safe and conventional farming systems.

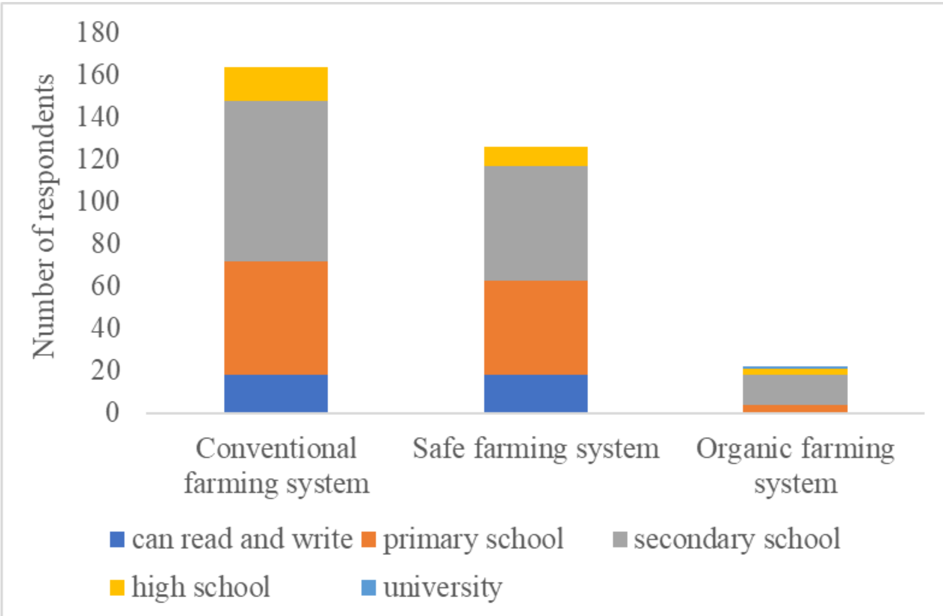

Figure 11: Educational level of respondents (N = 312)

The average amount of working experience on the farm among respondents was 29.8 years. Conventional farmers had the most extended farming experience with an average of 31.1 years, followed by Safe farmers with an average of 30.5 years and organic farmers had a farming experience of 22.7 years.

The household size of respondents varied from 1 to 8 persons. On average, the household size was about four persons. A Kruskal-Wallis test was carried out to determine the difference in family labour force among the three groups of farming system. The test provided very strong evidence of a difference ($p\text{-value} < 0.001$) between the mean ranks of at least one pair of the groups. Dunn's pairwise tests were used for the three pairs of groups. The result revealed significant differences between organic and Safe farming systems ($p\text{-value} = 0.001 > 0.05$, adjusted using the Bonferroni correction), and between organic and conventional farming systems ($p\text{-values} = 0.000 < 0.05$, adjusted using the Bonferroni correction). There was again no evidence of a difference between respondents who practiced Safe and conventional farming systems. The results showed that the organic farming system needed less labour force actively working on a farm with an average of 1.18 person, while conventional and Safe farming systems needed an average of 1.82 and 1.65 person, respectively.

4.1.2. Natural capital

Land and water resources are crucial natural capital. In term of the status of the land, Figure 12 shows the distribution of land holdings. About 35.9 percent of respondents owned the farmland. 20.5 percent of respondents held the right to use land shared by agricultural collectives during the period of Renovation (*Đổi Mới*) in 1986. Before the economic reform in 1986, a system of agricultural collectives and groups of households formed production brigades responsible for meeting government quotas for agricultural production (Do & Iyer 2003). Under the Renovation policy (*Đổi Mới*) in 1986, the collective agriculture system began to be dismantled. Agricultural collectives were made contract land to households for 20 years for annual crops and 50 years for perennial crops (Fforde & Vylder 1996; Akram-Lodhi 2002). Regarding our key informants, the agricultural collective was an old system before the economic reform in 1986. Under this system, farmers did not have permission to own the land. However, after Renovation, agricultural collectives were turned into lands for agriculture with limited rights of use from 20 to 50 years. However, the majority of farmers in Vietnam still do not own farming land due to policy on agricultural land in Vietnam. As such, about 33 percent of our respondents rented cultivated land from private parties or the state.

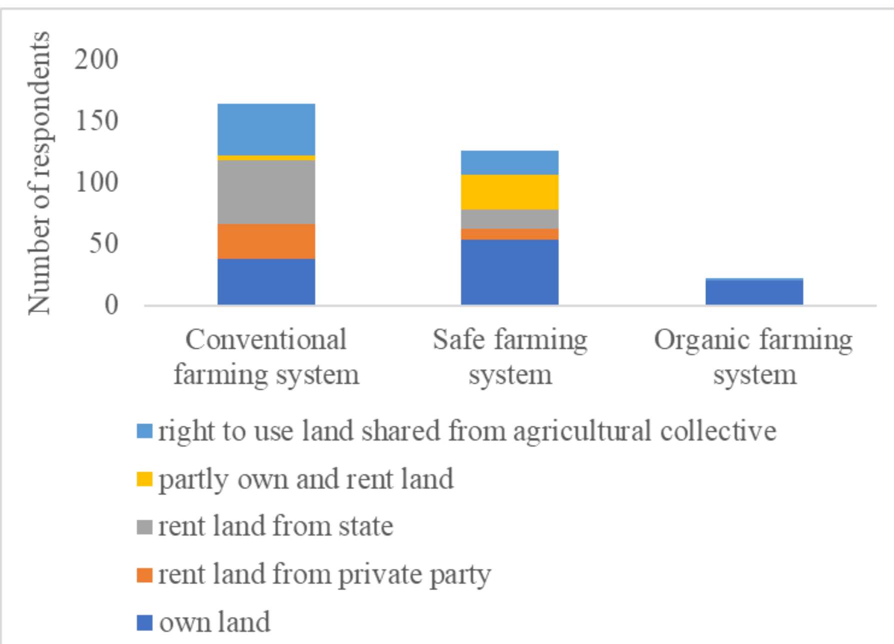

Figure 12: Land ownership of the respondents (N= 312)

The annual cost of renting farming land varied from 0.5 million to 1.5 million VND per *sào*. The cost of renting land from private owners was higher than from the state. The state figures indicated 0.8 million VND per *sào* per year for renting arable land in the study area. Some respondents had the opportunity to rent farming land cheaper than the official price indicated by the state. A cheaper rent for farming land is possible for these respondents because they rent lands from neighbours or relatives who are owners or have the right to use the farming land but are not interested in farming activities. The rest, 10.3 percent of respondents, belonged to farms that had partly owned and partly rented land. 100 percent of organic farmers own their farmland, or the land was divided after dismantling agricultural collectives. Conventional farmers cultivated on an average land area of ±6.5 *sào* (ranging from 0.5 to 12.5 *sào*), Safe farmers had an average of ±5.1 *sào* (ranging from 1 to 13 *sào*) and organic farmers practiced on land with an average of ±4.2 *sào* (ranging from 1 to 9 *sào*).

There are five water sources in the study areas, including private wells on farms, rivers, public irrigation systems, private irrigation systems, and from neighbours' wells (Figure 13). All of respondents from the organic farming system group had sufficient water for agricultural activities. Their water came from wells on their farms. They did not need to get water from external sources. About 3.6 percent of respondents from the conventional farming system group and 7.9 percent of respondents from the Safe farming system group had insufficient water for agricultural activities during the dry season from November to April. Notably, the Safe farmers who did not have enough water also had no access to external water sources. About 70 percent of respondents from the conventional farming system group and 46 percent of respondents from the Safe farming system group had enough water sources for agricultural activities without purchasing additional water from irrigation systems.

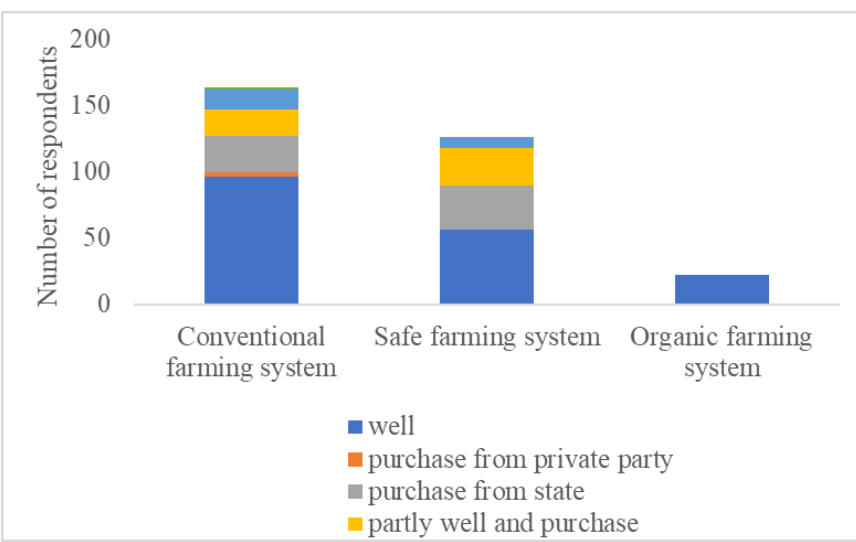

Figure 13: Irrigation water sources of the respondents (N=312)

The state provided the main water source through a local irrigation system with a fixed fee of 0.1 million VND per *sào* per month. The monthly fee also included electricity for pump operation. This fee for use of this water source was collected to maintain the irrigation system. Farmers could pump water from the regional irrigation system and pay the fee at the end of each month. The total cost for irrigation water was calculated based on farm size and individual consumption. The demand for irrigation water among organic farmers was covered by water from wells on the farm, and they did not need to use additional water sources from outside.

4.1.3. Physical capital

Physical capital is the available infrastructure that people need to make a living and the tools and equipment they use (housing, sanitation, energy, transportation, etc.) (Majale 2002). Respondents lived in the sub-urban areas in Hanoi, which is very well connected to the city centre and other provinces through a modern system of highways and roads.

All of the respondents had secure housing, which is usually a brick house of up to two floors with a small garden in the villages. Typical respondents' houses had a kitchen and toilet inside. Respondents had access to tap water provided by the state. Tap water in Vietnam is good enough for food preparation but it is not suitable for drinking directly without boiling or other treatment methods. It was not rare to see televisions, fridges, kitchens with gas or electric stoves, motorbikes, and bicycles at respondents' houses.

The respondents had a problem with electricity during the summer months between April and June when the state cut off electric access for a few hours per week due to a severe shortage in electric production in Vietnam. These rolling electrical blackouts applied to all major cities in Vietnam, including the study areas.

Interestingly, every residential group – *tổ dân phố* - in the villages had its own cultural centre. A residential group is an autonomous organization of the residential communities in commune-level administrative units in Vietnam. Cultural centres in the residential group were nicely equipped with tables, chairs, microphones, and loudspeakers, used for civil meetings and training. One of the cultural centres visited had exercise equipment on the premises. Respondents were used to doing sport and chatting with each other in the evening after the working day.

4.1.4. Social capital

In order to assess social capital, farmers were asked if they were a member of local farmers' unions or other agricultural associations and how actively they participated in the training activities of these associations.

The Vietnamese Government extension system was founded in 1993 and organized on five levels: national, provincial, district, commune and village. The commune and village level work in the form of local farmers' unions. Besides the government extension system – the key role of extension services in Vietnam, research institutions, universities, enterprises, and NGOs are also involved in providing extension facilities. Extension functions focus on providing model demonstrations of advanced techniques and organizing science and technology training for farmers (Nguyen 2012).

The local farmers' union is the smallest unit of the national agricultural extension system. Other agricultural associations in the study areas were created for certain groups of farmers, for example, the Safe farmers' association and the organic farmers' association. National agricultural extension is available for all types of farmers, but Safe and organic farmers mainly participate in extension services provided by enterprises or NGOs.

According to information from the heads of local farmers' unions, to be a member, a farmer must be more than 18 years old and pay 24,000 VND (around 1 USD) per year membership fee. However, in the case of poor farmers, they may be exempted from paying any fee. Safe and organic farmers must attend training by particular farmers' associations to obtain training in new technologies and maintain the system standard. Key informants (number two and three) gave us information that farmers in the target areas can join in the Safe farming system without payment because the regional programme has funded it.

According to key informant number five, there was no annual membership fee for organic farmers. However, organic respondents had to pay 3,000 VND per one kilogramme of production to maintain their production group and the other activities of the whole PGS organic system. A production group – *nhóm sản xuất* - consists of at least 5 farmer households who have farming land nearby and reside in close proximity. Collection of several production groups in a certain area creates a production inter-group – *liên nhóm sản xuất* - (Rikolto 2018c). The money organic respondents had to pay is higher compared to the membership fee of farmers' unions. However, it covered all the costs for the processing of organic certification, materials for making compost or organic pesticides, the purchase of other necessary equipment for their production group, marketing costs, and training activities on the application of sustainable agricultural technologies.

Safe and organic farmers were obligated to be members and participate in the activities of their particular farmers' associations. Hence 100 percent of respondents from Safe and organic farming system were in touch with at least one agricultural extension organization.

Conventional respondents had fewer connections with agricultural extensions than organic and Safe respondents. About 50 percent of the respondents who practiced the conventional farming system were not members of the local farmers' union, or they were, but rarely participated in the activities of the union. This is because after Renovation -*Đổi Mới*- conventional farmers in Vietnam are not obliged to become members of the local farmers' unions. Even when they are members, they do not have to actively participate in training or adopt the technologies offered by the unions.

Other questions were focused on the cooperation between respondents and other farmers in the study areas. Two forms of cooperation, informal and formal, were found in our research. Informal cooperation was organized by farmers based on their needs. Formal cooperation included Safe agricultural cooperatives and organic inter-groups. The types of cooperation practiced among respondents included cultivation support, technical knowledge exchange, chemical pesticide sharing, water sharing and complete cooperation (Figure 14).

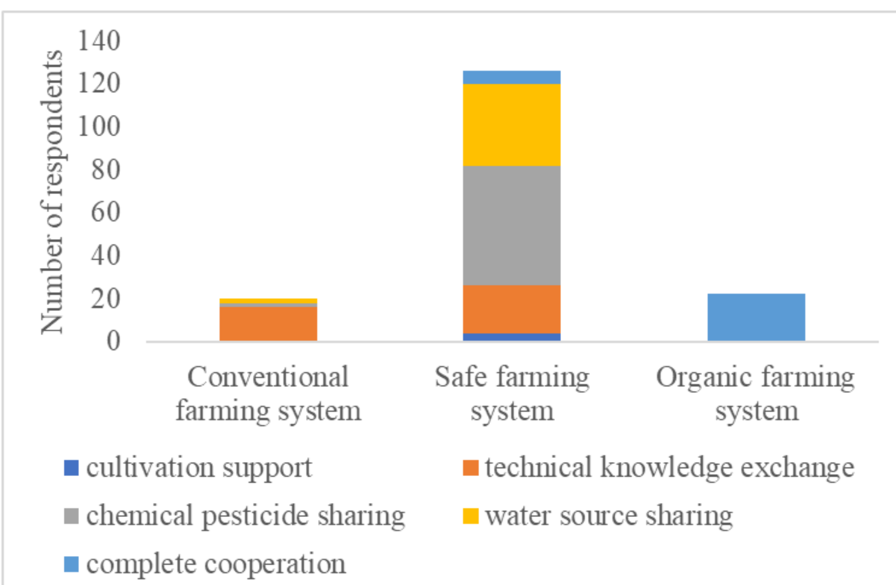

Figure 14: Types of cooperation practiced among respondents

In our study, complete cooperation means sharing input and resources except for land and labour. Only 12 percent of conventional farmers were party to informal networks of cooperation. All Safe farmers were obligated to join a Safe agricultural cooperative. All organic farmers had to actively participate in the production group of which they were a member and join in in the activities offered by the organic inter-group to which their production group belonged. Based on the conditions of their farming system, organic and Safe farmers were more likely to cooperate with other farmers.

1.2 percent of conventional respondents shared water sources with other farmers in the region. Another 1.2 percent shared the chemical pesticides sprayed on their farms. And about 10 percent of them tended to share knowledge about agricultural techniques with other farmers.

About 44 percent of Safe respondents shared chemical pesticides with other farmers in their region. Around 30 percent cooperated with others in the form of sharing water sources used for farming activities. 17.5 percent tended to exchange farming knowledge with other farmers. Only 2.8 percent helped each other with cultivation. Interesting was that 4.7 percent of Safe respondents cooperated completely with other farmers in farming activities.

While the majority of respondents did not want to cooperate with other farmers, 100 percent of organic farmers in our survey preferred to cooperate completely with other farmers in their production group. Due to the principle of small-scale farming in the organic farming system under the PGS Vietnam system, organic farmers are often neighbours on agricultural land. They work in production groups of minimal five farms to assure supply and control quality of water sources and other inputs to the farm. They not only shared experience and knowledge within the production group of which they are members, but they also had the opportunity to exchange knowledge with other inter-groups in other regions managed by PGS Vietnam.

4.1.5. Financial capital

Agriculture was not the only source of household cash income for 60 percent of respondents; usually, some members of the household conducted off-farm activities. The household cash income of 40 percent of respondents depended entirely on agricultural activities.

Nevertheless, 56 percent of conventional farmers, 65 percent of Safe farmers and 55 percent of organic farmers did not have any savings from farming activities due to high household expenses. A family of three generations living together is typical in Vietnam. Hence, respondents may have a household size of up to 6 members, with only one or two contributing to income generation. Other members may still go to school or be disabled or too old to work. Any savings are mainly spent for the family's needs or used as a reserve for the future. Only one percent of respondents invested savings back in the farm.

According to our key informants, the government has a policy of enhancing rural agricultural development via the Agricultural Bank with a micro-credit programme (decree number 55/2015/ND-CP on credit policy for agriculture and rural development). Farmers can apply for a micro-credit up to 100 million VND without collateral if their permanent address is in the same region where they engage in farming activity. If farmers do not fulfil this condition of address, then the programme allows a credit up to 50 million VND without collateral. Farmers can use this credit to pay for expenses related to production, business, and services related to their agricultural activities. A local farmers' union member can easily access micro-credit with a guarantee from the union.

Nevertheless, none of our respondents applied for this programme since they were worried about time-consuming and complex paperwork. Another problem was that respondents lacked information about this micro-credit programme. Their knowledge about the micro-credit programme mainly came from the negative experiences of other people in the region. Thus, they preferred borrowing money from a friend, relatives or the private sector.

4.2. Factors influencing cash income generated from agricultural activities

According to the results of our multiple linear regression analysis (Table 6), a significant regression equation was found ($F(9, 312) = 9.194$, $p = 0.000 < 0.05$). With an R^2 of 0.215, the model indicated that independent variables explained about 21.5 percent of the dependent variable.

Table 6: Result of factors influencing agricultural cash income of respondents (N=312)

Independent Variables	Unstandardized B	Coefficient Standard Error	Mean	Standard Deviation
Farm System	5.086**	1.442	1.54	0.63
Farm Size	-0.818**	0.138	5.83	4.23
Family Labour	1.837*	0.996	1.74	0.60
Sex	3.405	1.138	0.36	0.48
Age	0.945	1.366	2.22	0.43
Education	2.838**	0.684	2.54	0.83
Experience	0.028*	0.492	30.30	14.38

Association	-1.736**	1.106	0.49	0.50
Cooperation	-5.709	1.770	0.68	0.47
Constant	14.483			
R- square		0.215		

* Significant at level 90% ** Significant at level 99%

“Farming system”, “family labour”, “education”, and “experience” were responsible for the significant positive influence of the annual agricultural cash income. Two independent variables, “farm size” and “association”, negatively influenced agricultural activities’ cash income. According to the equation of multiple linear regression (1), the model of farm income can be written as follows:

Farm income = 14.483 + 5.086 farm system – 0.818 farm size + 1.837 farm labour + 2.838 education + 0.028 experience – 1.736 association

Our model also revealed that the more ecological the farming system, the more success agricultural income respondents achieved. The cash income of the farm increased by VND 5.086 million per year per *sào* when the farming system increased by one unit.

A Kruskal-Wallis test was performed to compare the annual agricultural income per *sào* between the conventional, Safe, and organic farming system groups. The test provided a statistical difference between at least on group pair with p-value = 0.033 < 0.05. Dunn’s pairwise tests were carried out for the three pairs of groups. The results revealed that farm income per *sào* of respondents from organic farming system significantly differed from the conventional and Safe farming systems (p-values = 0.031 and 0.041 < 0.05, adjusted using the Bonferroni correction). The median annual cash farm income per *sào* of organic respondents is higher than Safe and conventional respondents (Figure 15). There were no statistically significant differences between the conventional and Safe farming systems.

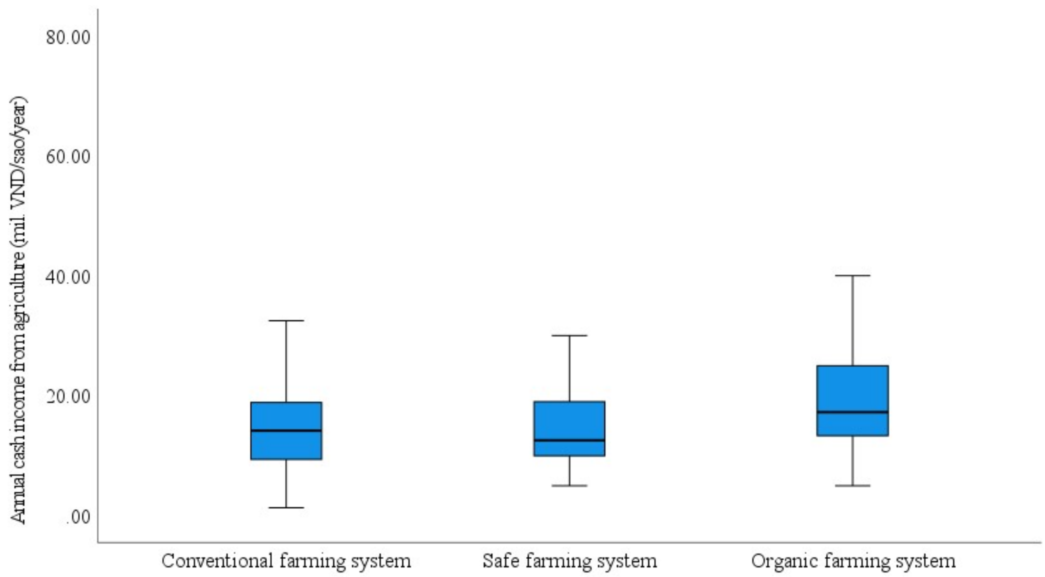

Figure 15: Annual farm income per *sào* among different types of farming systems (N=312)

None of the farms in our survey needed to hire any external labour force. Each farm had an average labour force of 1.74 members of the family actively working on a farm. The results showed that farm income was raised by VND 1.837 million when the respondent had one more family member working on the farm

Besides the size of the farm, this model revealed that the level of education of farmers significantly increased “farm income” by about VND 2.838 million when it increased by about one unit. Furthermore, farming experience also remained a significant factor positively affecting income from agricultural activities. The study showed that “farm income” increased by VND 0.028 million for every additional year of respondents' working experience.

The average farm size among our respondents is 5.83 (± 4.22) *sào*, which is defined as a small-scale farm in Vietnam. Farm size in the study is one of the negative factors that decreased “farm income” by VND 0.818 million when the farm extended to about one *sào*.

Another factor revealed as damaging was the level of education of farmers. Membership of any agricultural association decreased “farm income” by about VND 1.736 million. Nearly 72 percent of respondents were members of a local farmers’ union. Only 21 percent of conventional farmers valued local farmers’ union knowledge for their members. Nearly 30 percent of respondents who practiced Safe farming evaluated the services offered by the agricultural extension as good or very good. In total, 100 percent of organic farmers evaluated the knowledge from the local farmers’ unions as good and organic agricultural extension as very good. Conventional farmers rarely evaluated the information from the farmers' unions as value for their farming.

4.3. *Factors affecting adoption of composting technology*

Only 55 respondents managed to use the correct composting techniques on their farm, which represented an adoption rate of 17.6 percent. The highest adoption rate was found among respondents who practiced organic farming systems, with 40 percent of total respondents adopting compost. The rest were divided equally between respondents from conventional and Safe farming systems with 31 percent and 29 percent, respectively.

The contents of compost are mainly based on crop residuals mixed with poultry or cow manure. The compost adopters stated that they applied compost firstly for the purposes of adding organic matter to their farmland. Organic farmers used compost as an organic fertilizer and completely replaced chemical fertilizer with compost. The cost on average of using compost for their farm was ± 3 million VND per *sào*.

Other compost adopters from the conventional and Safe farming systems groups combined chemical and compost depending on the cultivation of their plots. The amount of organic or chemical fertilizer was depended on the specific plot. Participants of FGDs stated that to grow guava they needed to combine both chemical and organic fertilizer to improve the yield and quality of the fruit, but that chemical fertilizer was sufficient for vegetable production.

Binary logistic regression was employed to predict the respondent's probability of adopting composting technology on their farm. In the model, the dependent variable was defined as a dummy variable, where 1 meant the respondent adopted compost and 0 meant they did not. The model was well-fitting because a Chi-square test was significant at a level 0.05 (p-value = 0.000 < α = 0.05) and a Hosmer and Lemeshow test was not significant (p-value = 0.242 > α = 0.05). The fit performed using the logit model displayed an R-square of 0.56, with a level accuracy of 90.1 percent (i.e., the percentage of farmers correctly classified as adopters and non-adopters). Table 7 shows that six independent variables exerted a significant positive effect on compost adoption, which were: "education", "association", "cooperation", "environmental protection", "information", and "encouragement".

Table 7: Result of binary logistic regression analysis on compost adoption

Predictor	B	SE β	Wald's χ2	df	P-value	Odds ratio (exp β)
Farming system	0.075	0.451	0.028	1	0.867	1.078
Farm size	-0.009	0.053	0.032	1	0.858	0.991
Education	1.566	0.356	19.331	1	0.000**	4.786
Experience	-0.012	0.016	0.573	1	0.449	0.988
Family labour	-0.114	0.398	0.082	1	0.775	0.892
Association	1.362	0.462	8.697	1	0.003**	3.903
Cooperation	1.999	0.668	8.964	1	0.003**	7.383
Sustainable practices	0.579	0.58	0.997	1	0.315	1.784
Environment	1.854	0.306	36.831	1	0.000**	6.386
Surrounding	1.08	3.177	3.662	1	0.56	1.784
Information	3.401	1.187	8.203	1	0.004**	9.986
Encouragement	2.056	1.04	3.907	1	0.048*	7.811
Constant	-10.289	2.224	41.281	1	0.000	0.000
Test						
overall model evaluation			131.997	12	0.000*	
goodness-of-fit			10.342	12	0.242	

* Significant at level 95%   ** Significant at level 99%

Available information about composting techniques is the most determinant factor in the decision to adopt composting. With the odd ratio of 9.986, the decision to adopt compost increased nearly ten times when information about the composting technology was available to the farmers. When we interviewed farmers about their knowledge of composting technology, most respondents misunderstood the technique. They thought composting meant burning crop residue and letting it naturally decompose on the field. Respondents who had more information on composting understood how to process compost, the importance of making and using compost manure and eventually adopting it regularly on their farm.

Conventional farmers who adopted compost were typically the respondents who did not want to use any agrochemical on their farms, and they tended to practice the traditional organic farming system. Safe farmers mainly applied compost in order to process farm residue. Only organic farmers had opportunities to attend the training on composting techniques and were supported during implementation. All of them rated the extension service on composting provided by the organic farmers' associations as excellent.

Nearly 60 percent of compost adopters who practiced conventional and Safe farming systems did not get information about composting techniques from the local farmers' union, while all of them were members and actively participated in training activities of national and private agricultural extension services. They learned to make compost from friends who successfully adopted composting or experimented by themselves.

Around 80 percent of compost adopters expressed severe concern about environmental pollution due to agricultural activities.

About 70 percent of respondents who did not adopt compost complained about the quality of the arable soil. Participants of the FGDs indicated that the fertility level of the soil had decreased over time, which was the main reason why farmers used more fertilizer in both chemical and organic forms. The issue is more serious, especially in the case of perennial crops. Nearly 60 percent of compost adopters who used compost on their farms for more than two years did not complain about soil quality.

4.4. Factors affecting willingness to decrease use of chemical pesticides

In our study, respondents who practiced conventional and Safe farming systems were not able recall the exact amount of chemical pesticide used on their farm because of the insignificant cost of chemical pesticides compared to other costs of production.

Only three percent of conventional and Safe farmers combined biological and chemical pesticides or applied only biological pesticides. Organic farmers used organic pesticides, which were made by themselves. Organic pesticides were made from a combination of alcohol, ginger, garlic, and chilli. Sometimes organic farmers needed to buy biological pesticides due to specific insects that their organic pesticide did not work effectively on. The annual cost of pesticides in organic farming systems ranged from 0.8 to 1.2 million VND per *sào*.

A binary logistic regression analysed decreasing amounts of willingness to use chemical pesticides. In the model, the dependent variable is defined as a dummy variable, where 1 means that the respondent uses only chemical pesticides on their farm and 0 means that the respondent combines chemical and biological pesticides or uses only biological/organic pesticides. The model is well-fitting because the Chi-square test is significant at a level 0.05 (p-value = 0.000 $< \alpha = 0.05$) and a Hosmer and Lemeshow test is not significant (p-value = 0.15 $> \alpha = 0.05$). The fit performed, using the logit model, displayed an R-square of 0.78, with a level accuracy of 84.4 percent (i.e., percent of farmers correctly classified between chemical users and not only chemical users). Table 8 shows that the model revealed three independent variables as having a significant negative effect on using only chemical pesticides, which are “education”, “health” and “encouragement”.

Table 8: Result of binary logistic regression analysis on the use of chemical pesticides

Predictor	B	SE β	Wald's χ2	df	P-value	Odds ratio (exp β)
Farming System	-1.295	0.901	2.064	1	0.151	0.274
Farm Size	-0.048	0.08	0.352	1	0.553	0.954
Education	1.194	0.471	6.422	1	0.011*	3.299
Experience	0.017	0.026	0.447	1	0.504	1.017
Family Labour	0.605	0.578	1.098	1	0.295	1.832
Association	-0.674	0.625	1.163	1	0.281	0.509
Cooperation	1.695	1.07	2.511	1	0.113	5.448
Health	-4.101	0.74	30.706	1	0.000**	0.017
Information	1.015	0.725	0.346	1	0.175	1.371
Environment	0.557	0.672	0.686	1	0.408	1.745
Encouragement	-2.871	1.054	7.418	1	0.006**	0.057
Constant	15.101	3.612	17.481	1	0.000	1.990
Test						
Overall Model Evaluation			189.048	11	0.000*	
Goodness-Of-Fit			18.919	11	0.15	

* Significant at level 95%   ** Significant at level 99%

The most determinant factor on chemical pesticide use among our respondents was the educational level of respondents. The use of chemical pesticides decreases by 3.299 times when the level of education increases by one unit. Respondents with lower levels of education faced great struggles in understanding and following pesticide guidelines. They only knew the name of pesticides by a local term and mainly applied pesticides based on a recommendation from a friend or pesticide shop without reading the information on the package. Thus, they did not understand the side effects of excessive usage of their chosen chemical pesticide.

After applying chemical pesticides on the farm, eight percent of respondents got respiratory illnesses such as a dry cough and difficulty breathing, and 27 percent suffered from dizziness. Around 63 percent of respondents mentioned that they did not have apparent symptoms, but they trusted that chemical pesticide negatively affected their health. Respondents from Safe farming systems mainly hired a service for spraying pesticides on the farm together with other farmers in the region to avoid the harmful effects on health when applying chemical pesticides personally. Because respondents highly believed in the negative effect of pesticides on human health, as do consumers of agricultural products, the health issue could be one of the factors decreasing the usage of chemical pesticides.

Conventional and Safe respondents were willing to apply biological pesticide if they are supported with training and subsidies provided so as to change from chemical to biological ones. They admitted using biological pesticides instead of chemical pesticides when they got a few bottles of biological pesticides free of charge from the local farmers' union. Unfortunately, the programme of introducing biological pesticides to farmers in the region was only implemented for a very short time. They got samples of biological pesticides just two or three times, which was not long enough for respondents to compare effects between chemical and biological pesticides. Moreover, in the respondents' opinion, biological pesticides were more expensive than chemical ones. Hence, chemical pesticides were considered an economical choice by both conventional and Safe respondents. Respondents who practiced the organic farming systems were educated, trained, and supported by the organic farmers' association, without any interruptions, to use the organic and biological pesticides. Organic farmers were happy to continue applying only non-chemical pesticides on their farms. The practical utility of the organic farmers' association's support programme confirmed the results of binary logistic regression that the willingness to decrease the use of chemical pesticides increases if there is systematic economic support for respondents to eliminate the use of chemical pesticides on their farms.

4.5. Changes in livelihood after converting to organic farming systems

Over the ten years of operation since 2008, the production area of PGS organic vegetables in Thanh Xuan has increased from 7.7 ha to over 20 ha. Organic farmers in Thanh Xuan sold 30 - 40 tons of organic vegetables per month to buyers in Hanoi. In 2018, organic inter-groups in Thanh Xuan had approximately 30 regular buyers from the retail sector. Thanh Xuan has become a village with the most sustainable PGS organic model in Vietnam (Rikolto 2018).

A qualitative method of analysing Focus Group Discussion (FGD) was employed to explore the changes in farmers' livelihood after adopting an organic farming system. To fully understand the processes of change, an FGD with 12 organic farmers was designed with the same eight farmers who participated in the FGD of organic farmers in a previous study in

2013 (Pham 2015). The farmers in FGD 2013 had newly adopted the PGS organic system one to two years previously. In FGD number six in 2015, participants mainly practiced PGS organic systems for a longer time, 4 years and over. There were two participants that had remained in a transition period who joined the organic production group and had not achieved organic certification yet. The vegetables from the transition period were sold at the organic shop as Safe Vegetables during the transition period and, of course, at a lower price than an organic certificated vegetable. The price of vegetables from the transition period was 30 to 50 percent higher than conventional vegetables, while the price of organic vegetables was up to twice the price of conventional vegetables, though, the price of organic vegetables varies depended on the specific type of vegetables.

According to key informant number eight, organic production groups in Thanh Xuan were groups of five to nine farmers. Member of organic production groups were mainly small-scale farmers who wanted to produce food in sustainable ways.

Farmers, who wanted to do farming under the regulation of PGS Vietnam, had to submit a proposal to PGS Vietnam. If the farmers' proposal was approved, PGS Vietnam would form an organic production group with at least five farmers who were neighbours on the farmland. It was up to the members in a production group to discuss the specific structure of their group. A production group basically consisted of one group leader, one group vice-leader, and group members. The organic groups developed a production plan for themselves. Each production group was responsible for periodic cross checking with all group members to assure the group's production processes followed quality standards and the regulations of PGS Vietnam organic, ensuring fairness and avoiding conflict of interest between members, providing technical support and motivating members to achieve the goals of the group, and connecting farmers with inter-groups and the Coordination Committee.

As standard, an organic production group is obligated to join a production inter-group. The inter-group is made up of several production groups in a certain area. It establishes a Quality Assurance Committee which consists of a committee chairperson, accountant/secretary, a planning and technical unit, a marketing and sales unit and a certification unit. The inter-group supplies services and inputs for farmers depending on their needs. It coordinates management, production, and promotion plans for all member groups. It is responsible for inspecting and supervising production processes, proposing certificates, and dealing with fraud and violations. The inter-group also collects production data from farmers and reports to the Coordination Committee annually. Members of the Quality Assurance Committee also include external members such as consumers, traders, authorities, local professional agencies, farmer trainers and NGOs, so as to effectively support farmers while they practice organic farming and implement inspections.

The PGS Coordination Committee – *ban điều phối PGS* – is the highest level in the structure of PGS system. Its main roles and responsibilities are processing applications of new production groups, making decisions on the approval of certification for inter-groups, maintaining and updating standards, and processing the report from inter-groups.

4.5.1. Changes in organic farmers' livelihood assets

A part of the questions in the FGDs were designed to analyse the changes in respondents' livelihood assets after converting to the organic farming system. Five aspects of livelihood assets of the respondents – human capital, natural capital, physical capital, financial capital, and social capital (Majale 2002) had changed in a positive direction after adopting organic farming system.

Human capital

The respondents using the organic farming system reported that their health had improved because their organic farming practices no longer included the use of agrochemicals, which they claimed was the main negative factor for their health when they were conventional farmers. These respondents also reported that the organic fertilisers and biological pesticides with 100 percent natural ingredients had no negative effects on their health or the ecosystem. Moreover, organic farmers were able to benefit from regular training and accurate information about sustainable farming methods to gain more skills to improve their work.

A 52-year-old female respondent number 304 proudly shared: *"My children are teachers and doctors in central Hanoi. They are very proud of me because I am doing meaningful work. They said time and time again that I am a more skilled farmer"*.

Other farmers in the focus group agreed with this respondent. They all believed that not only was organic farming better for their health but also the health of their consumers. Furthermore, they reported that the training and information they received allowed them to be more confident in their farming skills and knowledge.

Natural capital

Thanks to the organic production group's principle of input cooperation, members in a group shared water sources with each other. This ensured that all members of the group had enough water for farming activities during the whole year. Furthermore, the organic farming system promotes planting different crops sequentially on the same plot and growing more species simultaneously in the same field, while encouraging farmers to avoid growing a single crop season after season. Crop rotation and mixed cropping helps to reduce erosion and increases nutrients available for crops.

Additionally, adoption of compost as an organic fertilizer also increased the soil fertility of the farmland. Thus, the FGD's participants reported that the soil quality of their farmland improved after just one year practicing the organic farming system, which increased the yield of the farm. Respondent number 295 happily reported: "*The fertile soil increased production, I calculated that this year's yield will be around 50 percent more than two years ago*".

Physical capital

Production groups had all necessary farm tools and expensive farm machines they needed, such as a small tractor for ploughing fields, and a small milling machine for preparing compost. The tools and machines belonged to the production group. However, group members could schedule among themselves when to use the equipment based on their needs and availability. The FGD's participants were very excited with the tractor because it helped them decrease their workload and be more independent in their work. This was an important contribution of the production group. Normally, small-scale farmers in Vietnam cannot afford to buy an expensive tractor on their own. As such, they usually plough their fields manually with pickaxes or with the help of cattle. This makes the process of ploughing the field a labour intensive and time-consuming task. Alternatively, farmers can also pay for a ploughing service provided by those who own tractors. However, ploughing services can be fully booked and costly during peak season. The jointly owned tractors of the production groups reduce labour and the time that farmers must spend ploughing the fields, while decreases the costs of the tractor for individual farmer. Furthermore, it provides farmers with the flexibility of ploughing their field based on need as opposed to scheduling a ploughing service.

The FGD with respondents practicing organic farming was implemented in a brick bungalow with a kitchen and toilet on the farm where members could take a break during working hours and used for meetings and training activities.

Organic farmers within the production groups in our study could easily access necessary physical capital for farming activities by sharing costs with other members.

Financial capital

As mentioned above, participants of the FGD could save more money for inputs for farming activities. They did not have to invest a lot of money to buy expensive farm equipment or pay for services. They could buy materials for making compost or biological pesticides at cheaper prices because they bought a large amount at once for a group of farms.

They reported that the yield after a few years using the organic farming system was higher. They assumed the higher yield related to better soil quality of their farmland due to the cropping method and use of compost as organic fertilizer. Moreover, they could sell their certificated products at a higher price. High yield, high sales' prices and high consumption of organic vegetables increased their farm cash income.

Female respondent number 295 said: *"I believe the fertile soil, after years of practicing the sustainable method of cropping and applying compost on my farmland, has increased our yield. We have a lot of customers, and we can also sell our organic products with quiet a high price. Actually, now I earn more money than when practicing the conventional farming system."*

Female respondent number 302 immediately continued after respondent number 295: "Apart from *working on the farm, I also work as shipper for our production group. I deliver our products to organic shops in the centre of Hanoi. I can earn around 2.5 – 3 million VND per month more for shipping goods."*

The household cash income of organic farmers in our study could also increase thanks to the off-farm jobs opportunity offered by their organic production groups.

Social capital

The system of organic production groups ideally creates social connections between respondents. Organic farmers in our study sometimes had the opportunity to participate in the regional meetings between all organic production groups and inter-groups supported by PGS Vietnam. In addition to this, their social network included the external members such as consumers, traders, authorities, local professional agencies, farmer trainers, NGOs, representatives of farmers' union or other farmers' associations also involved in the organic inter-group and PGS Coordination Committee.

Female respondent number 310 shared: *"I am looking forward every morning to going to work. I am happy to work with other members of our production-group. Working on the organic farm under the PGS Vietnam programme organization has given me opportunities to meet a lot of people and get valuable knowledge from them.*"

All FGD participants agreed with respondent number 310 that they had a broader connection with other members inside and outside of the PGS Vietnam organic environment. This network is an open door for them to find opportunities for joining in interesting agricultural as well as social activities in the future.

After analysing the changes in five aspects of livelihood assets of the FGD participants when converting from the conventional to the organic farming system, the role of collective action was found to be an important factor that improved organic respondents' livelihood. Collective action occurs when a group people work together to achieve mutual objectives. It plays an essential role in agricultural and rural innovation and boosts the relationship between people in the society and facilitates the generation, exchange, and exploitation of new knowledge (Basi et al. 2014). In this study, collective action is considered as sharing inputs, sharing materials, sharing equipment, and sharing an extensive support network. We found collective action among small-scaled organic farmers helped them to ensure water sources for farm activities by sharing inputs with each other. Sharing materials for making organic fertilizer and biological pesticides led them to saving money used to invest in farm assets or training activities that made them more skilled farmers. Collective action also facilitated the creation of an extensive network with other farmers, organisations, and customers. This extensive network allowed small-scale farmers have access to information from different agricultural support programmes, to receive better training and new knowledge about their farming practices and help them to expand their market to increase their income.

4.5.2. Motivation to adopt the organic farming system

Compared to our research in 2013, we found that health problems while using chemical fertilizer and pesticides was still the prime reason that led respondents to convert from the conventional farming system to the organic farming system in 2015. Chemical pesticides have already negatively affected their family members' health. They wanted to protect their family by avoiding use of agrochemical additives. Thus, they wanted to practice a farming system in a more ecological way.

Female respondent number 290 from Bai Thuong production group, who had practiced the organic farming system for more than 2 years, shared her story in the FGD with a wry face: "*I am really afraid of spraying chemical pesticide. I was getting serious trouble with a dry cough and dizziness practicing the conventional farming system. My neighbour also used a lot of chemical spray. A doctor from the hospital warned me that maybe I was being poisoned by the pesticide, and I needed better coverings when spraying it. When I applied the chemical pesticide on my farm, I was well covered with long clothes and a thick mask over my face, but it did not alter the bad effects of the chemicals on my health. Hence, my husband and I decided to join in in the organic farming production to protect my health as well my family's health*."

Other participants in the FGD highly agreed with her about the health problem when they had practiced conventional farming. They admitted health problems were the main motivation for adopting the organic farming system.

While in 2013, health problems were the main reason why farmers wished to practice organic farming, in 2015, by contrast, respondents had more motivations for adopting the organic farming system, such as perceptions of environmental protection, income generation, and increased happiness. Respondent number 290 reported: "*I feel very good to encourage environmental protection by reducing chemical use. And important is that I can earn money in a healthy working environment*".

The idea was confirmed by the FGD's other participants. A female respondent, number 302, who had only been practicing organic farming for 10 months and was still in the transition period - said: "*Yes, she is right, I also wanted to convert to organic system because I can see the friendly farming environment and how my neighbours earned good incomes with this system.*"

After years of adopting the organic farming system and seeing how organic farmers were doing, respondents recognised other benefits of this system. They did not only adopt the organic farming system because they could protect their health from the use of agrochemicals, but they also paid attention to environmental protection.

4.5.3. Challenges of practicing organic farming under PGS Vietnam

During the period 2013 - 2014, due to the novelty of organic production, the main challenge was consumers scepticism towards organic vegetables. A survey by VECO Vietnam in 2016 revealed that about 93 percent of Hanoi's urban population claimed to be concerned about food safety. However, only 3.2 percent of all vegetables sold in urban Hanoi are Safe. Furthermore, vegetable consumers were not familiar with stores selling Safe and organic vegetables. Additionally, only two percent of Safe and organic vegetable consumers had high trust in certification (VECO Vietnam 2016).

Our similar research in 2013 showed 3 mains challenges for farmers who practicing organic farming:

The first challenge was the application of the old points system from Vietnamese agricultural collectives before Renovation in 1986 to organic production groups. Members of the production group were divided according to several farming tasks. They worked on their own farmland and other members' farmland as well. The working hours of a farmer or farmer's family members was recorded and converted into points. Income from this organic farming system of farmers in a production group depended on the points they accumulated in a month. This system made respondents feel restricted because their income depended highly on the number of family labourers available. And they had the feeling of being an employee of the production group while they were owners of the farmland. They did not see any innovation in farming management, especially the older farmers who once practiced or remembered the old system of agricultural collectives before 1986.

The second challenge was the low consumption rates of organic vegetable. Vegetable consumers in the study areas trusted the shop owners more than the certificate labels on vegetable packages which led to low consumption of organic vegetables. Consumers also doubted the quality of organic vegetables because they did not look as physically appealing as vegetables from conventional farms.

The third challenge came from the huge workload of using the organic farming system compared to the conventional farming system. Respondents were used to the principles of conventional farming that depended on agrochemicals to boost production. In contrast, organic farming requires additional labour for weed elimination and pest control. The large workload with an uncertain income made respondents sceptical of organic farming practices.

Back to the study area in 2015, by then, two of the three main challenges were solved.

First, the organic production group applied a new system and farming principals which called for collective action rather than the points system. Group members could work on their own farmland and cultivated the vegetables that grew on their land.

Respondent number 301 said: "*Now we do not apply the points system like in 2013. We just put the land together to create the production group to easily share input and resources. I work on my farm area, cultivate vegetables from my land, and generate income from the product I grow".*

Other farmers agreed that the new management strategies of collective action within the production groups in 2015 worked better than the system used in 2013. They did not have to compete with other members in the production group for points by working longer hours but rather cooperated with each other to get higher income from agricultural activities. This new management strategy effectively solved the first challenge indicated in the previous study.

Key informant number six, who was a leader of an organic production group happily shared in FGD: *"Together we create a large area suitable for the organic system. Thanks to this large farmland, we can better control water sources, land quality, share the workload of compost processing and create our own environmentally friendly ecosystem inside the polluted land of the village."*

Despite the problem of low consumption in 2013, due to changes in consumer perceptions, the PGS organic label had become popular among vegetable consumers in 2015. The decision to include consumers and other groups in the control system by PGS Vietnam allowed the organic vegetable labels to gain consumer trust. Demand for organic vegetables was above the yield of organic products. Respondents could not produce enough vegetable for their customers.

"The good news is that now we have a lot of customers, sometimes we do not have enough vegetables to sell. Not like three years ago, customers have gotten used to organic vegetables, and they can tolerate the quality because they pay more attention not only on their health but also to environmental protection." respondent number 296 finished her speech with a satisfied smile.

In 2015, the large workload with uncertain income remained a barrier for new organic farming adopters. A male respondent, number 307, who had practiced the organic farming system for one year, said: *"I do not know how long I can continue with the organic farming system, actually it takes a huge workload, and the farm cash income is not really attractive. I am not sure if I can make more money with the organic farming system than the conventional one."*

Another challenge of practicing organic farming was finding innovative technologies to sustain the farm against external effects such as air and soil pollution from the conventional farms around.

4.5.4. Evaluation of agricultural extension from PGS Vietnam

Organic farmers in our study reported positive experiences with the support provided by PGS Vietnam while practicing organic farming. Many respondents were satisfied with the credibility, responsibility, and skills of the extension services from PGS Vietnam.

Agricultural extension from PGS Vietnam had successfully created linkages between farmers and customers, production, and markets. Besides, the extension regularly organizes training up-to-date and appropriate technology for farmers to solve problems with natural resources and boost production in terms of quantity as well as quality. Organic farmers called the agricultural extension from PGS Vietnam as "a friend of farmers".

Respondent number 312 said at the end of the FGD special designed for organic respondents in 2015 that: *"I really appreciate the PGS Vietnam. In 2013, I and some other farmers were confused about my choice at a hard time. But PGS Vietnam has been together with us, supported us to take us over the difficult time. It played an important role in our success. Today I did not regret converting to the organic farming system."*

5. Discussion

5.1. Factors Influencing Cash Income from Agricultural Activities

The effect of ecological farming systems on farmers' income is found to be different depending on the country involved. A study from Thailand revealed that organic vegetable farming in Mahasarakham province was much less financially attractive than conventional vegetable farming due to low yields and low pricing of the production (Rattanasuteerakul & Thapa 2012). However, another study in 2018 from the Kajiado and Murang'a counties of Kenya showed that the practice of organic agriculture was associated with higher agricultural income, stronger social networks, and higher access to information (Kamau et al. 2018). The higher income from ecological farming systems revealed in our study can be explained by the additional value of the products. Respondents who practiced Safe and organic farming systems admitted that the safety product label increased the price of their products. In 2013, Ngo et al. found that the average price of organic vegetables was about 70 percent higher than conventional vegetables in Vietnam. Other research also showed that the average price of Safe Vegetables is up to 30 percent higher than conventional vegetables (Vo et al. 2016).

Otsuka et al. (2013) show that large farms in developing countries could be more efficient than smaller farms. However, a study found that farm size is directly correlated with the quantity of input used; thus, a large farm requires more input combined in the right way with an educated and skilled labour force to increase farm productivity (Le 2021). Traditionally, Vietnamese rural farmers tended to rely on life experience and basic labour skills, which contributed to declining labour productivity in the agricultural sector in Vietnam (VUSTA 2011). In our research, larger farm size combined with low-skilled labour negatively affected agricultural activity income.

The cost associated with farming production includes the cost of hired labour, seed, fertiliser, pesticide, and other costs (Pham & Shively 2009). Hence, respondents in our survey could increase income by saving costs for hiring labour when they have more family members working on the farm.

In a study conducted in Southern Australia, Fielke and Bardsley (2014) found that a higher level of education related to increasing sustainability, particularly university education. They believed that further education allows farmers to compete effectively in a liberalized economy. Farmers with higher education have open minds and abilities to learn about agricultural technologies and manage farming tasks (Ajewole 2010; Folefack 2015). Long-term experience in farming activities also positively affected farmers' behaviour in the Jamalpur district in Bangladesh, where they grow vegetables for environmental protection (Akter et al. 2018). In line with these studies, our study found that a high level of education and more farming experience remained positive factors that increased agricultural cash incomes.

Agricultural association membership among larger farms in Rwanda increased income and reduced poverty (Verhofstadt & Maertens 2015). But interesting results showed in our study that to be a member of an agricultural association negatively affected farm income. In research, Nguyen (2012) has written that although farmers' unions are available in each village, they still have a top-down approach which is plagued with poor linkage, weak coordination, and lack of skilful use of human resources and lack of financial investment. Besides the public extension system in the form of farmers' unions which provide the main extension services in Vietnam, research institutions, universities, enterprises, and NGOs are also involved in providing extension facilities. Extension functions include establishing demonstration models and training of farmers. This finding in our study can inspire further research into the relationship between farming incomes and the quality of agricultural extension service.

5.2. Factors affecting adoption of composting technology

Paul et al. (2017) noticed that farm size, vegetable and fruit cultivation, and farmers' experience also affected the tendency to compost adoption in tropical Caribbean islands. He indicated that the labour intensity, cost of composting practices and lack of available information on compost quality were the main constraints on compost application. Zhou et al. (2018) similarly found that the greater the labour force on the farm, the more farmers were willing to use composting to reduce chemical fertilizer application in North China.

However, the result of our survey showed that the variables: farming system, farm size, farmer experience, and family labour force were not significant. We found other variables with a positive influence on the adoption of composting technology, such as level of education, membership of an agricultural association, cooperation with other farmers, attitude toward environmental protection, available information on composting techniques, and encouragement from agricultural extension services. Similar results were obtained in Oyo State of Nigeria and Yaounde in Cameroon (Sotamenou & Parrot 2013). The study showed that factors such as level of education, membership of a farmers' association, or cooperation with other farmers had a strong impact on the probability of adoption. A better educational level gave farmers a better understanding of composting technology and its beneficial effects on organic waste management and similarly of soil on crops (Ajewole 2010; Folefack 2015). Cooperating with other farmers in the area could help farmers reduce the workload of processing manual compost by increasing the labour force (Paul et al. 2017). In northern China, a study found that farmers who were more concerned about the ecological environment of farmland and natural resources were more willing to participate in sustainable farming practices such as composting (Zhou et al. 2018).

Contact with an agricultural extension provided farmers with easier access to information and support to adopt new technology (Folefack 2015). An increase in farmer training in composting and its utilization was mentioned in Malawi as a factor that increases the adoption of compost manure. Farmers adopted the technology because they were empowered with information (Mustafa-Msukwa et al. 2011). Furthermore, a subsidy policy for agricultural environmental protection focused on sustainable agriculture practices such as composting is essential. Government policy was a positive factor that supported farmers in adopting compost in North China (Zhou et al. 2018).

5.3. Factors affecting willingness to decrease use of chemical pesticides

In Tanzania, high rates of improper pesticide practices were also due to farmers' low level of knowledge about pesticide toxicity (Ngowi et al. 2002). Damalas and Hashemi (2010) found that the older farmers had difficulty changing their opinions and behaviour towards pesticide use. The reason may be that their lower level of education and lack of knowledge about pesticide toxicity all led to an increase in chemical pesticide use. Because of low levels of education, farmers in Vietnam still use chemical pesticides based on habit. Uneducated farmers have problems understanding the guidelines for products, and they usually choose and apply pesticides with the advice of chemical shops. In contrast, the regulation on management in the pesticide business is still weak and lacks controls (VEN 2018). Our research showed that a high level of education has positive effects on decreasing the use of chemical pesticides.

Chemical pesticide use poses significant threats both to human health and the environment. Annually, 3 million farmers are severely poisoned by pesticides, while 25 million farmers are mildly poisoned by pesticides, especially in the rural areas of developing countries (Zhang et al. 2011). 38 percent of chilli farmers in Thailand suffer from dizziness, 31 percent have a problem with nausea or vomiting and 37 percent incur headaches because of unsafe pesticide practices (Kachaiyaphum et al. 2010). However, the farmers do not believe that reducing chemical pesticide use could mitigate environmental pollution. The behaviour of farmers toward pesticides is highly influenced by the health problem experiences (Akter et al. 2018). Our research revealed a similar result that health issue factors can increase the willingness to decrease use of chemical pesticides. Nevertheless, the difference is that respondents who have no health trouble related to chemical pesticides also believed in its adverse effects on human health.

A study in Nigeria recommended that extension agencies and stakeholders implement powerful campaigns to change farmers' attitudes to agrochemical practices to ensure health safety and environmental protection. In our survey, support from agricultural extension was also a positive factor in increasing the willingness to decrease use of chemical pesticides.

5.4. Motivation towards practicing organic farming system

Previous research suggested that the decision to convert from conventional to organic farming often included three aspects which are: environmental (concern for the environment, food safety and family health), economic (low input, profitability of the farming system) and the ideological aspect (personal philosophy, lifestyle, antipathy to chemicals) (Kubala et al. 2008). However, a study about the motivation to adopt organic farming by farmers in Malopolska Province, Poland, Kubala et al. (2008) found that, while farmers were aware of the threats from conventional farming, the environmental aspect was not their main motivation. Furthermore, a study about the motivation to practice organic farming by tea farmers in the mountainous areas in Northern Vietnam indicated that economic factors were an important role in farmers' motivation while non-economic factors such as awareness of the environment and health benefits were not directly linked to their motivation (Bui & Nguyen 2021). Economic benefit also was found to be an essential motive of older or more experienced organic grain farmers in the United States in adopting organic farming. On the other hand, younger farmers, or farmers with less years of experience with organic farming were motivated to organic farming by environmental and lifestyle reasons more than economic factors (Peterson et al. 2012).

Our research indicated that concern about the negative effects of agrochemicals used in conventional farming on human health is the most important factor in a farmer's decision to convert to organic farming systems. Our study also verified that better cash income generation was also one of significant reasons that led our organic respondents to practice organic farming.

Despite the many respondents' positive experiences with PGS Vietnam, every year there are several farmers leave the PGS Vietnam organic system because they cannot fulfil its standards or do not want to continue with its practices. Some of our organic respondents were unsure about continuing in organic farming practices because the economic benefits they received did not match their expectations when converting to organic farming. Similarly, research of Han et al. (2021) revealed that personal motivations are necessary, but motivations alone are not sufficient. How well the perceived post-adoption benefits (economic benefit, addressed health concerns, environmental natural resources, values and belief validation, and social benefits) aligned with farmers' initial motivations and long-term goals had a significant effect the actual adoption of organic farming.

5.5. Social capital and collective action

Although the Vietnamese government encourages collective action among farmers to ensure collective decision-making and risk-sharing, collaborative action is seen only in terms of the application of standardized practices such as VietGAP and organic farming in a few regions. Collaboration outside production, such as in marketing, transportation, or product development, is rare (World bank 2020). The results of our study also showed that conventional respondents rarely collaborate with other farmers in practicing farming activities or sharing input for farming. They were not even interested in participating in the activities of farmers' unions or other agricultural associations. Cooperation practices appeared mainly among the group of Safe and organic farmers. Safe respondents cooperated with others in knowledge exchange, sharing of chemical pesticides, water sources and helping with cultivation. They did not cooperate in post-production activities. In contrast to conventional farmers, organic respondents tended to complete cooperation with other organic farmers in their production group. In addition, they not only shared farming input and resources but also implemented marketing strategies, transportation and discussed together and agreed on the development plan of their production group. We found that the more ecological the farming system, the more cooperation activities were practiced. Lubell et al. (2011) found cooperation practices to be an important factor in practicing sustainable agriculture effectively. And it required collective action on the part of farmers throughout a community.

The result of collective action enables farmers and other rural actors to improve their socio-economic performance and creates new opportunities for development (Basso et al. 2014). Research by Hellin et al. (2007) revealed that farmer organization was a formal expression of collective action. Farmer organization and collective action were key factors in enhancing farmers' access to markets particularly in high value products. It played an important role in contributing to reducing poverty and improving livelihood security in Mexico and central America (Hellin et al. 2007). Social networks were found to be essential factors for farmers' social learning, risk sharing, labour, and finance cooperation in the Sancha village of China. Thus, it created a solid social foundation for farmers' collective action to achieve sustainable agricultural development in Sancha (Renard & Guo 2013). In Yogyakarta, Indonesia, collective action was one of strategies to help small-scale rice farmers in improving production capacity, product quality, human capability, and bargaining power (Ahmad 2017). Similarly, we found collective action had positive effects on the sustainable livelihood assets of respondents practicing organic farming. It enhanced organic farmers to create a huge social network and indirectly increased their income by cost saving, off-farm job opportunities and access to markets.

The collective agriculture system was the only agricultural system in Vietnam between 1955 and 1986. There were 17 022 agricultural collectives until 1986. However, this were dismantled after the Renovation in 1986 in Vietnam (Nhan dan 2015). Currently, despite the benefits of collective action in agricultural collectives in Vietnam, farmers are not interested in agricultural collectives due to failures of the old agricultural collective system in the past. The failure of agricultural collectives in Vietnam can be explained by limited capital, outdated equipment, inability to build an agricultural value chain, unskilled management staff, weak connections between members and the agricultural collective in terms of cooperation and interests and, finally, the agricultural collective do not bring sufficient economic benefits for members (Dai doan ket 2017). For these reasons, our organic farmers complained about the function of organic production in 2013. At that time, although PGS Vietnam organic were able to create a complete agricultural value chain for organic products, the collective action of the organic production group was a failure in bringing economic benefits to the group's members due to the adoption of the irrelevant points system of the old Vietnamese agricultural collective system. Following improvements, the organic production group in our survey in 2015 was more efficient than the old agricultural collective system before the agricultural Renovation in 1986. Our research found that collective action in inputs, resources, and outside production, coupled with the self-responsibility of increasing the yield of one's own farmland could lead to an increase in farm income among organic respondents.

5.6. Limitation of the study

Research by Nguyen (2018) found that Safe farming system seemed to have more economic efficiency than conventional farming due to savings in production costs. Nevertheless, farmers earned less money because of high operational costs (e.g., packaging, transportation, quality inspection etc.). As mentioned in the subsection for sample collection, there is a limitation in our survey due to the lack of information on cost factors. Respondents could only vaguely estimate the cash incomes generated from farm activities. Although the cost variables may influence the result of the multiple linear regression model in our study, the information from the FGDs indicated that respondents typically did not calculate income from agricultural activities in detail. The overall cash income after each harvesting season was the main factor in evaluating the success of their farming activities. Furthermore, FSR has no "one size fit all" approach. Every FSR should be designed and tailored to a specific situation (Darnhofer et al. 2012). Thus, our model's dependent variable "farm income" can be analysed without taking the cost factor as one of the independent variables.

6. Conclusion and recommendations

The main goals of this study were to analyse the linkages between currently practised farming systems with livelihood and the probability of adopting sustainable farming practices (composting technology and eliminating the use of chemical pesticides) of small-scale sub-urban farmers in Hanoi, Vietnam.

We elucidated three main farming systems: conventional, Safe, and organic, based on the differences in product labelling and production principles. The conventional farming system faced urgent environmental challenges and increased awareness about human health due to the overuse of agrochemical additives. The Safe farming system was a solution for food safety but cannot solve the negative impact of agrochemicals on the environment. Even though the number of Safe farms has increased due to national support programmes over the last few years; farmers did not seem to have many incentives to apply Safe farming standards. The organic farming system was the most ecological of the three farming systems. The system respects a new balance in the ecosystem, avoids agrochemical use, and creates a strong farmer social network. The organic farming system was still unknown to farmers with limited information and was not supported by national programmes.

Farm cash incomes increased depending on the type of farming system. We found that the more ecological the farming method, the more positive impact on cash incomes. There was a statistical difference in cash income generation from agricultural activities between the organic and Safe and conventional farming systems. There was no statistical difference in cash income generation from conventional and Safe farming systems. However, the organic farming system's level of productivity did not satisfy the respondents' wishes even though the most ecological farming systems – organic - appeared economically competitive with Safe and conventional farming thanks to the higher price for products and the assurance of output. Based on regression results, a higher level of education, more extensive farming experience, and a higher number of family members in the labour force among respondents were also important keys in improving farm incomes. Larger farm size remained a negative factor that caused cash incomes from the farms to decrease. Interestingly, the results of multiple linear regressions found that the contribution of agricultural extension negatively affected cash incomes from farming activities. Safe and organic farmers were obliged to participate in the training given by agricultural extension services.

The majority of respondents apart from organic farmers had limited understanding of the composting techniques. Lack of information and training was why the composting adoption rate was meagre among respondents. Higher level of education, being a member of an agricultural association or cooperation with other farmers and raised perceptions of environmental protection were additional factors enhancing the adoption of compost. Thanks to quality training on compost use supported by the organic farmers' association, respondents who practiced the organic farming system successful adopted composting techniques, such as organic fertilizer, to enrich the soil fertility and sustainable methods for crop residue management.

The use of chemical pesticides was a sensitive topic that respondents did not want to share in detail. However, farmers admitted that chemical pesticides had adverse effects on human health. The educational level of farmers was the most determining factor that encouraged respondents to eliminate use of chemical pesticides. Adverse health experiences with chemical pesticides and encouragement from organizations increased the willingness to reduce the use of chemical pesticides.

Health concerns, attitudes toward environmental protection and economic benefits were the main motives of organic respondents to adopt organic farming. However, the economic benefit was also the biggest challenge to continuing in organic farming. The principle of organization in the organic farming system was experimented with for over a decade in the targeted areas. Meaningful adjustments were made. Due to suitable changes in management, effective training and continuous support, the cash income of organic farmers was improved by both different on-farm and off-farm activities. In addition to the economic benefits, the livelihoods of respondents from organic farming systems were also improved, especially when it created a comfortable working network and healthy working conditions. Collective action on inputs, resources, and outside production coupled with the self-responsibility of increasing the yield of one's own farmland played an important role in improving organic respondents' household livelihood.

Regarding the results of our study, we suggest the ecological farming system combined with collective action be widely adopted in the study area to achieve sustainable agriculture and livelihood. Even when farmers have a strong motivation towards the ecological farming system, adoption of sustainable agricultural practices requires other additional factors such as personal adoption capacity (including the farmers' ability to learn and implement) and institutional resources (policy support, financial resources, social networks, market infrastructure) (Han et al. 2021). For these reasons, we also have recommendations for agricultural extension in Vietnam and respondents in our study.

The critical role of the function of agricultural extension services in supporting respondents to sustain farming activities was found in all the study models. It is important to have trusted agricultural extension with effective activities. Hence, we suggest Vietnamese government agricultural extension pay attention to these things below:

- Inform farmers more in detail about the principle of chemical pesticide and fertilizer use (purpose, dosage, timetabling, unexpected effects of chemical use on environment and human health and how to avoid them).
- Provide farmers with alternative methods to replace agrochemicals on the farm and manage agricultural residue in sustainable ways, such as composting.
- Provide a long-term support programme when farmers adopt new technologies and provide continuous assistance during implementation.
- Provide more opportunities for farmers to join social networks for collaboration.
- Facilitate and motivate farmers to act collectively

Conventional farmers in our study lacked information about sustainable agricultural practices and did not really have a social network. Thus, we recommend conventional farmers to:

- Actively contribute to local and private agricultural extension training to improve knowledge about reasonable use of agrochemicals and sustainable farming practices.
- Join a farmer network for knowledge exchange and other potential opportunities such as access to markets.
- Think about converting to the ecological farming system for their own benefit such as increasing income via higher prices and avoiding health problems due to agrochemical application.

The Safe farming system in our study forms part of the ecological farming system in general. Adoption of Safe farming helps enhance environmental protection by using less agrochemicals compared to conventional farming. Cooperation practices between Safe respondents existed; however, their social networks and collective action were not strong. Income from Safe farming was not as high as organic farming. Hence, below are our recommendations for Safe farmers and their associations:

- Safe farmers should continue with ecological farming systems to protect the environment and their health.
- Safe farmers can adopt collective action in sharing input and resources like organic farmers to save production costs.
- Associations of Safe farming need to provide to Safe farmers more practical training activities on sustainable technologies such as composting.
- Associations of Safe farming can help Safe farmers improve economic benefits by increasing collective action.

Although the practices of organic farming in our research were quite complete and worked successfully, organic respondents still had to deal with a huge workload and high dependence on the weather. Thus, to increase the income, we suggest organic respondents together with the organization PGS Vietnam organic:

- Keep going on practising organic farming with the current management system.
- Think about other strategies to increase incomes besides selling organic products, such as via ecotourism or increased profitability by adding value to agricultural products, for example, dried fruits or vegetables.

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8. Annexes

Annex 1: Questions for interviewing farmers in study area

Annex 2: Protocols of key informant interviews

Annex 3: Protocols of focus group discussions

Annex 4: Pictures from field survey

Annex 1: Questions for interviewing farmers in the study

1. **Farm's characteristic**

Number	Question	Values
1	Location	1. Cu Khoi 2. Thanh Xuan
2	Farming system	1. Conventional 2. Safe 3. Organic
3.1.	Total area of the farm (*sào*)	Number
3.2.	What kind of landownership?	1. Own 2. Partly rent partly own 3. Rent from private 4. Rent from state 5. Shared from agricultural cooperative
3.3.	Area of respondent's own land (*sào*), 1 *sào* = 360m2	Number
3.4.	Area of respondent's rented land from private (*sào*)	Number
3.5.	Area of respondent's rented land from state (*sào*)	Number
3.6.	Area of respondent's land which shared from agricultural cooperation (*sào*)	Number
3.7.	Cost for land per year (million VND/year)	Number
4.1.	What kind of water resources on the farm?	1. Well 2.buy from state 3.buy from private 4. Partly buy partly well

		5. Free from neighbour
4.2.	Is water sufficient for your farming activities?	1. Yes 2. Not enough for dry season 3. Not enough at all
4.3.	Cost for water on the farm (million VND/year)	Number
5.1.	What kind of plant does respondent grow?	1. Vegetable 2. Fruit 3. Vegetable + fruit
5.2.1.	Area of vegetable growing (*sào*)	Number
5.2.2.	Total year of cultivation of vegetable plot? (year)	Number
5.2.3.	Yield of vegetable per year (kg/*sào*/year)	Number
5.2.4.	Profit from vegetable plot per year (mil. VND/year)	Number
5.3.1.	Area of fruit growing (*sào*)	Number
5.3.2.	Total year of cultivation of fruit plot?	Number
5.3.3.	Yield of fruit per year (kg/*sào*/year)	Number
5.4.4.	Profit from fruit plot per year (million VND/year)	Number
6.1.	What kind of pesticides do you use in general?	1. Chemical 2. Chemical + organic 3. Organic
6.2.	What kind of pesticide do you use for vegetable?	1. Chemical 2. Chemical + organic

		3. Organic
6.3.	What kind of pesticide do you use for fruit?	1. Chemical 2. Chemical + organic 3. Organic
6.4.1.	Does chemical pesticide have negative effect on your health?	0. No 1. Yes
6.4.2.	If yes, what negative effect of chemical pesticides on health is?	Open answer
6.4.3.	Does organic pesticide have negative effect on your health?	0. No 1. Yes
6.4.4.	If yes, what negative effect of organic pesticides on health is?	Open answer
6.4.5.	How many pesticides does respondent use for vegetable plot? (Million VND/ year)	Number
6.4.6.	How many pesticides does respondent use for fruit plot? (Million VND/ year)	Number
6.4.7.	Cost of pesticide (Million VND/ year)	Number
7.1.	Current quality of the farmland	1. Not fertile 2. Average 3. Fertile
7.2.1.	Type of used fertilizer for vegetable	1. Chemical 2. Chemical + organic 3. Organic
7.2.2.	How much chemical fertilizer do you use on farm per year for vegetable (kg/year)	Number
7.2.3.	Cost of chemical fertilizer used on farm per year for vegetable (Million VND/year)	Number

7.2.4.	How much organic fertilizer do you use on farm per year for vegetable (kg/year)	Number
7.2.5.	Cost of organic fertilizer used on farm per year for vegetable (Million VND/year)	Number
7.3.1.	Type of used fertilizer for fruit	1. Chemical 2. Chemical + organic 3. Organic
7.3.2.	How much chemical fertilizer do you use on farm per year for fruit (kg/year)	Number
7.3.3.	Cost of chemical fertilizer used on farm per year for fruit (Million VND/year)	Number
7.3.4.	How much organic fertilizer do you use on farm per year for fruit (kg/year)	Number
7.3.5.	Cost of organic fertilizer used on farm per year for fruit (Million VND/year)	Number

2. **Household’s characteristic**

Number	Question	Values
1.	Number of family members	Number
2.	Age of each family members	1. <15 years old 2. From 15 to 60 years old 3. >60 years old
3.	Education level of each family members	1. Can read and write 2. Primary school 3. Secondary school 4. High school 5. University
4.	Occupation of each family members	Open answer
5.	Status of respondent' s healthy	1. Very bad 2. Not good 3. Normal

		4. Good 5. Very good
6.	Does any family member have bad health?	0. No 1. Yes
7.1.	Total family income? (Mil. VND/year)	Number
7.2.	Family income from agriculture? (Mil. VND/year)	Number
7.3.	Do you have some saving?	0. No 1. Yes
7.4.	How you spend your saving?	Open answer
7.5.	Do you have enough money for emergency cases?	1. No 2. Rather no 3. I don't know 4. Rather yes 5. Yes
8.	Do you have access to national program for agricultural loan?	1. No 2. Rather no 3. I don't know 4. Rather yes 5. Yes
9.	Are you a member of agricultural association (group)?	0. No 1. Yes
10.1.	Do you cooperative with other farmers in the region?	0. No 1. Yes
10.2.	If yes, what kind of work you are sharing with other farmers?	Open answer
11.	Total year of working on farm? (year)	Number

3. **Evaluation of agricultural association (extension)**

Number	**Question**	**Values**

1.	Do you have access to an agricultural extension?	1. No 2. Rather no 3. I don't know 4. Rather yes 5. Yes
2.	Name of agricultural association which you participate	Open answer
3.	How often do you participate in any agricultural association?	1. Rarely 2. Sometime 3. Normally 4. Often 5. Always
4.	What kind of support does agricultural association provide you?	Open answer
5.	Does the offered information by agricultural association relevant for you?	1. No 2. Rather no 3. I don't know 4. Rather yes 5. Yes
6.	How you evaluate the offered information by agricultural association?	1. Very bad 2. Not good 3. Normal 4. Good 5. Very good
7.	Do you apply the technologies which provided by agricultural association?	0. No/ 1. Yes
8.	If not, why?	Open answer
9.	Do you think the agricultural association which you are a member effectively works with	1. No 2. Rather no

	farmer?	3. I don't know 4. Rather yes 5. Yes

4. **Factors influence adoption of compost**

Number	Question	Values
1.	How do you process the crop residues?	Open answer
2.	Don't you want to find other methods to manage the crop residues?	1. No 2. Rather no 3. I don't know 4. Rather yes 5. Yes
3.1.	Does anyone or organization guide you how to operate compost?	0. No 1. Yes
3.2.	If yes, who?	Open answer
4.1.	Do you pay attention on environmental protection?	1. No 2. Rather no 3. I don't know 4. Rather yes 5. Yes
4.2.	Do you think your farming activities pollute the ecosystem?	1. No 2. Rather no 3. I don't know 4. Rather yes 5. Yes
5.	Do you apply any sustainable technology to process the crop residues?	0. No 1. Yes
6.1.	If you know technology how to sustainable process your agricultural waste, will you	1. No 2. Rather no

	apply it?	3. I don't know 4. Rather yes 5. Yes
6.2.	Are there many farms around you that adopted composting technology on their farm?	0. No 1. Yes
6.3.	Is there any one or organization encourage you adopt composting technology?	0. No 1. Yes
7.	Do you adopt compost?	0. No 1. Yes

5. **Factors influence willingness to decrease using agrochemical on the farm**

Number	Question	Values
1.	Do you think using chemical substances on your farm can lead to bad effect on your health?	1. No 2. Rather no 3. I don't know 4. Rather yes 5. Yes
2.	Does anyone or organization provides you with information about side effects and reasonable use of agrochemicals?	1. No 2. Yes
3.	Does anyone or organization encourage you to eliminate chemical pesticide on your farm?	0. No 1. Yes

Annex 2: Protocols of Key informant interviews

Protocol number: 1

Place: Cu Khoi sub-district, Gia Lam, Hanoi

Date: 2.7.2015

Key informant: Head of local farmers' union of Cu Khoi village

Interview completed by: Marie Phamova

Questions:

1. What are the main crops in the village?
2. What types of farming systems do currently exist in the village or in Hanoi?
3. What are the differences between these farming systems?
4. How many farmers do practice in each farming system in village or in Hanoi?
5. What are criteria for small-scale farm?
6. How do farmers process the agricultural residue?
7. Do local farmers' association have program to train farmer about composting technology?
8. Does government encourage farmers to decrease amount of agrochemical?
9. Does government have any program support farmers in safe and organic farming system?

Protocol number: 2

Place: Cu Khoi sub-district, Gia Lam, Hanoi

Date: 2.7.2015

Key informant: Leaders of r*au an toàn* – safe vegetable farmers' cooperative Cu Khoi

Interview completed by: Marie Phamova

Questions:

1. What are the main crops farmer grow on safe farming system?
2. What are the differences between conventional, safe and organic farming systems?
3. What are criteria for joint in safe farming system?
4. What is the principle of inspection in safe farming system?
5. How do farmers process the agricultural residue in safe farming system?
6. Do safe farmers' association have program to train farmer about composting technology?
7. Does safe farmers' association encourage farmers to decrease amount of agrochemical?
8. What are support programs for safe farmers and how does it work?

Protocol number: 3

Place: Cu Khoi sub-district, Gia Lam, Hanoi

Date: 5.7.2015

Key informant: Leaders of VietGAP vegetable farmers' cooperative Cu Khoi

Interview completed by: Marie Phamova

Questions:

1. What are the main crops farmer grow on VietGAP farming system?
2. What are the differences between conventional, safe/VietGAP and organic farming systems?
3. What are criteria for joint in VietGAP farming system?
4. What is the principle of inspection in VietGAP farming system?
5. How do farmers process the agricultural residue in VietGAP farming system?
6. Does VietGAP farmers' association have program to train farmer about composting technology?
7. Does VietGAP farmers' association encourage farmers to decrease amount of agrochemical?
8. What are support programs for VietGAP farmers and how does it work?

Protocol number: 4

Place: Cu Khoi sub-district, Gia Lam, Hanoi

Date: 5.7.2015

Key informant: Leaders of VietGAP guava farmers' cooperative Cu Khoi

Interview completed by: Marie Phamova

Questions:

1. What are the main crops farmer grow on VietGAP farming system?
2. What are the differences between conventional, safe/VietGAP and organic farming systems?
3. What are criteria for joint in VietGAP farming system?
4. What is the principle of inspection in VietGAP farming system?
5. How do farmers process the agricultural residue in VietGAP farming system?
6. Does VietGAP farmers' association have program to train farmer about composting technology?
7. Does VietGAP farmers' association encourage farmers to decrease amount of agrochemical?
8. What are support programs for VietGAP farmers and how does it work?

Protocol number: 5

Place: Thanh Xuan village, Soc Son, Hanoi

Date: 25.7.2015

Social position: Head of local farmers' union of Thanh Xuan village

Interview completed by: Marie Phamova

Questions:

1. What are the main crops in the village?
2. What types of farming systems do currently exist in the village or in Hanoi?
3. What are the differences between these farming systems?
4. How many farmers do practice in each farming system in village or in Hanoi?
5. What are criteria for small-scale farm?
6. How do farmers process the agricultural residue?
7. Do local farmers' association have program to train farmer about composting technology?
8. Does government encourage farmers to decrease amount of agrochemical?
9. Does government have any program support farmers in safe and organic farming system?

Protocol number: 6

Place: Thanh Xuan village, Soc Son, Hanoi

Date: 25.7.2015

Key informant: Leaders of r*au an toàn – safe vegetable* farmers' cooperative Thanh Xuan

Interview completed by: Marie Phamova

Questions:

1. What are the main crops farmer grow on safe farming system?
2. What are the differences between conventional, safe and organic farming systems?
3. What are criteria for joint in safe farming system?
4. What is the principle of inspection in safe farming system?
5. How do farmers process the agricultural residue in safe farming system?
6. Do safe farmers' association have program to train farmer about composting technology?
7. Does safe farmers' association encourage farmers to decrease amount of agrochemical?
8. What are support programs for safe farmers and how does it work?

Protocol number: 7

Place: Thanh Xuan village, Soc Son, Hanoi

Date: 16.8.2015

Key informants: Leader of organic production group Thanh Xuan

Interview completed by: Marie Phamova

Questions:

1. What are the main crops farmer grow on organic farming system?
2. What are the differences between conventional, safe and organic farming systems?
3. What are criteria for joint in safe farming system?
4. What is the principle of inspection in organic farming system?
5. How do farmers process the agricultural residue in organic farming system?
6. Do organic farmers' association have program to train farmer about composting technology?
7. Does organic farmers' association encourage farmers to decrease amount of agrochemical?
8. What are support programs for safe farmers and how does it work?

Protocol number: 8

Place: Thanh Xuan village, Soc Son, Hanoi

Date: 16.8.2015

Key informants: Leader of organic production group Bai Thuong

Interview completed by: Marie Phamova

Questions:

1. What are the main crops farmer grow on organic farming system?
2. What are the differences between conventional, safe and organic farming systems?
3. What are criteria for joint in safe farming system?
4. What is the principle of inspection in organic farming system?
5. How do farmers process the agricultural residue in organic farming system?
6. Do organic farmers' association have program to train farmer about composting technology?
7. Does organic farmers' association encourage farmers to decrease amount of agrochemical?
8. What are support programs for safe farmers and how does it work?

Annex 3 - Protocols of Focus Group Discussions

Protocol number: 1

Place: Cu Khoi, Gia Lam, Hanoi

Date: 17.7.2015

Group interviewed: 12 farmers included conventional and safe farmers

Interview completed by: Marie Phamova

Questions:

1. Do you satisfy with the farm income? If no, why?
2. What are your obstacles now to do farming?
3. What are the reasons you want to convert to safe farming system?
4. Do you get any support from local government? If yes, what and how do you think about it?
5. Do you know safe and organic farming system? Do you know what are the differences?
6. Do you want to adopt safe or organic farming system? And why?
7. Does your farm land still fertile enough for your farming activities?
8. Can you tell briefly information about composting technology?
9. Do you want to adopt compost on your farm and why?
10. Why you use chemical pesticide and fertilizer?
11. Do you think agrochemical can damage the environment? And why?
12. How do you evaluate the function of local farmers' association? And why?

Protocol number: 2

Place: Cu Khoi, Gia Lam, Hanoi

Date: 23.7.2015

Group interviewed: 12 farmers included conventional and safe farmers

Interview completed by: Marie Phamova

Questions:

1. Do you satisfy with the farm income? If no, why?
2. What are your obstacles now to do farming?
3. What are the reasons you want to convert to safe farming system?
4. Do you get any support from local government? If yes, what and how do you think about it?
5. Do you know safe and organic farming system? Do you know what are the differences?
6. Do you want to adopt safe or organic farming system? And why?
7. Does your farmland still fertile enough for your farming activities?
8. Can you tell briefly information about composting technology?
9. Do you want to adopt compost on your farm and why?
10. Why you use chemical pesticide and fertilizer?
11. Do you think agrochemical can damage the environment? And why?
12. How do you evaluate the function of local farmers' association? And why?

Protocol number: 3

Place: Cu Khoi, Gia Lam, Hanoi

Date: 30.7.2015

Group interviewed: 10 farmers included conventional and safe farmers

Interview completed by: Marie Phamova

Questions:

13. Do you satisfy with the farm income? If no, why?
14. What are your obstacles now to do farming?
15. What are the reasons you want to convert to safe farming system?
16. Do you get any support from local government? If yes, what and how do you think about it?
17. Do you know safe and organic farming system? Do you know what are the differences?
18. Do you want to adopt safe or organic farming system? And why?
19. Does your farm land still fertile enough for your farming activities?
20. Can you tell briefly information about composting technology?
21. Do you want to adopt compost on your farm and why?
22. Why you use chemical pesticide and fertilizer?
23. Do you think agrochemical can damage the environment? And why?
24. How do you evaluate the function of local farmers' association? And why?

Protocol number: 4

Place: Thanh Xuan, Soc Son, Hanoi

Date: 6.8.2015

Group interviewed: 11 farmers included conventional, safe and organic farmers

Interview completed by: Marie Phamova

Questions:

1. Do you satisfy with the farm income? If no, why?
2. What are your obstacles now to do farming?
3. What are the reasons you want to convert to safe or organic farming system?
4. Do you get any support from local government? If yes, what and how do you think about it?
5. Do you know safe and organic farming system? Do you know what are the differences?
6. Do you want to adopt safe or organic farming system? And why?
7. Does your farm land still fertile enough for your farming activities?
8. Can you tell briefly information about composting technology?
9. Do you want to adopt compost on your farm and why?
10. Why you use chemical pesticide and fertilizer?
11. Do you think agrochemical can damage the environment? And why?
12. How do you evaluate the function of local farmers' association? And why?

Protocol number: 5

Place: Thanh Xuan, Soc Son, Hanoi

Date: 15.8.2015

Group interviewed: 12 farmers included conventional, safe and organic farmers

Interview completed by: Marie Phamova

Questions:

1. Do you satisfy with the farm income? If no, why?
2. What are your obstacles now to do farming?
3. What are the reasons you want to convert to safe or organic farming system?
4. Do you get any support from local government? If yes, what and how do you think about it?
5. Do you know safe and organic farming system? Do you know what are the differences?
6. Do you want to adopt safe or organic farming system? And why?
7. Does your farm land still fertile enough for your farming activities?
8. Can you tell briefly information about composting technology?
9. Do you want to adopt compost on your farm and why?
10. Why you use chemical pesticide and fertilizer?
11. Do you think agrochemical can damage the environment? And why?
12. How do you evaluate the function of local farmers' association? And why?

Protocol number: 6

Place: Thanh Xuan, Soc Son, Hanoi

Date: 28.8.2015

Group interviewed: 12 organic farmers

Interview completed by: Marie Phamova

Questions:

1. Do you satisfy with the farm income? Why?
2. What are the reasons you want to convert to organic farming system?
3. What are your obstacles now to do farming?
4. Do you get any support from local government? If yes, what and how do you think about it?
5. What are the changes after adopting organic farming system compared to conventional farming system?
6. Does your farmland still fertile enough for your farming activities?
7. Can you tell briefly information about composting technology?
8. How do you want to adopt compost on your farm?
9. Why do you not use chemical pesticide and fertilizer?
10. Do you think agrochemical can damage the environment? And why?
11. How do you evaluate the function of local farmers' association? And why?
12. How do you evaluate the function of organic farmers' association and the PGS system? And why?

Annex 4: Pictures from field survey

Picture 1: Leader of an organic production group showed a member how to use milling machine for making compost

Picture 2: A member of an organic production group practised using the milling machine after training.

Picture 3: Plan and rules of growing Safe guava following VietGAP standard

Picture 4: Area of farms practising Safe farming system

Picture 5: Interviewing a respondent by a volunteer at a cultural centre of a residential group

Picture 6: A focus group discussion implemented at a cultural centre of a residential group