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Fertilisers and chemicals use on vegetable farmers in Lao PDR

A thesis presented in partial fulfilment of the
requirements for the degree of

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Table of Contents

Abstract 1

Chapter 1 Introduction 3

1.1 Background 3

1.2 Food Safety 4

1.3 Context 5

1.4 Research objectives 6

1.5 Significance of the study 7

Chapter 2 Agriculture in Lao PDR 8

2.1 Characteristics of farming practices 8

2.2 The agriculture in the Lao economy 9

2.3 Agricultural input 9

2.4 Vegetable production 10

2.5 Agricultural markets 10

2.5.1 Exporting market 10

2.5.2 Domestic market 11

2.6 Sustainable Agriculture 11

2.6.1 Sustainable Agriculture in Lao PDR 12

Chapter 3 Agricultural Public Policy in Lao PDR 13

3.1 The 8th National Socioeconomic Development Plan 2016 – 2020 13

3.2 The 9th National Socioeconomic Development Plan (NSEDP) 2021 – 2025 14

3.3 The Green and Sustainable Agriculture Framework (GSAF) for Lao PDR to 2030 14

3.4 International Development Projects on Sustainable Agriculture 15

3.5 Agricultural rules and regulations 16

3.5.1 Agriculture practices 16

3.5.2 Fertiliser 17

3.5.3 Official recommended fertiliser rates 18

3.5.4 Chemical 19

3.6 Conclusion 20

Chapter 4 Literature review on the use of fertilisers and chemicals in vegetable farming in Lao PDR and regional countries. 21

4.1 Introduction 21

4.2 Fertilisers usage among vegetable farmers 21

4.3 Chemical use among vegetable farmers 22

4.4 Chemical use in vegetable farming practices 23

4.5 Factors that impact smallholder farmers' use of fertilisers and chemicals 24

4.6 Conclusion 24

Chapter 5 Research Methodology 26

5.1 Introduction 26

5.2 Research approach 28

5.3 Participant and interview method 28

5.3.1 Interview 29

5.4 Data Analysis 29

5.5 Ethical considerations 30

5.6 Conclusion 30

Chapter 6 Descriptive information on research context 32

6.1 Introduction 32

6.2 Geography 32

6.2.1 Location 32

6.2.2 Environment 35

6.2.3 Soils 35

6.3 Background information on agricultural farming in the study area 35

6.4 Farmland 36

6.5 Crops 36

6.5.1 The factors that contribute to the selection of the crop 38

6.6 Pest and disease 39

6.7 Farming practices 39

6.7.1 Farm practices vary by season 39

6.8 The sections below provide information on the stages of vegetable farming 40

6.8.1 Land preparation 40

6.8.2 Weeding 42

6.8.3 Seeds 42

6.8.4 Irrigation 43

6.8.5 Fertiliser application 45

6.8.6 Insecticide 47

6.8.7 Fungicide 48

6.8.8 Chemical application protection 48

6.9 Agricultural inputs 49

6.9.1 Price 50

6.9.2 Agricultural input inspection 50

6.9.3 Fertiliser and chemical storage 51

6.10 Harvest 52

6.11 Productivity 52

6.12 Vegetable price 53

6.13 Market 53

6.14 Customers 55

6.15 Product quality 56

6.15.1 Product safety 56

6.15.2 Vegetable products inspection 57

6.15.3 Product quality improvement 57

6.15.4 Agricultural support projects....57
6.15.5 Project effectiveness related to vegetable farming....59
6.16 Conclusion....60
Chapter 7 Result Analysis....61
7.1 Fertiliser and chemical usage analysis....61
7.1.1 Vegetable bed size....61
7.1.2 Soil test information....62
7.2 Fertiliser application....62
7.3 Chemical application....63
7.4 Coriander production....64
7.4.1 Fertiliser types use in coriander production....65
7.4.2 Fertiliser usage rate....65
7.4.3 How much fertiliser farmers apply in growing coriander....67
7.4.4 Chemicals used in coriander farming....70
7.4.5 Chemical usage rate....71
7.5 Tomato farming and production....71
7.5.1 Fertiliser use in growing tomatoes....71
7.5.2 Chemicals used in growing tomatoes....73
7.6 Annual fertilisers and chemicals are applied to grow coriander and tomatoes....74
Case studies:....74
7.7 Factors that influence the use of fertilisers and chemicals....75
7.8 Conclusion....76
Chapter 8 Discussion....77
8.1 Introduction....77
8.2 Fertilisers used in vegetable farming....77
8.3 Fertiliser types....77
8.4 Fertiliser usage rate....77
8.5 Characteristic of fertiliser use....78
8.6 Agro-chemicals use in vegetable farming....79
8.6.1 Chemical types....79
8.6.2 Chemical usage rate....79
8.6.3 Chemical application....80
8.6.4 Banned chemical products....80
8.6.5 Chemical storage....81
8.6.6 Protection of chemical application....81
8.7 Vegetable product safety....82
8.8 Vegetable market....82
8.9 Vegetable price....83
8.10 Conclusion....83
Chapter 9 Conclusion....85
9.1 Introduction....85
9.2 Fertilisers....85

9.3 Chemicals **86**
9.3.1 What is found to be challenging on fertiliser and chemical use in vegetable farming in the Lao PDR? 87
9.4 Contribute to knowledge **87**
9.5 Future research **88**
9.6 Practical implication **88**
9.7 Concluding thought **89**
References **90**

List of Tables

Table 1: Standard nutrient requirement for inorganic fertiliser in Lao PDR. 17
Table 2: The MAF recommended application rate for fertiliser in Lao PDR. 18
Table 3: The vegetable bed size found among interviewed farmers. 61
Table 4: Fertiliser types found among farmers interviewed 63
Table 5: Identified of chemical use among farmers interviewed 63
Table 6: Frequency of fertilser application in growing coriander 65
Table 7: Fertiliser types use in coriander farming 65
Table 8: Fertiliser usage rate per bed area 66
Table 9: Fertiliser usage rate and frequency 66
Table 10: The amount of fertiliser used in growing coriander, based on various types, quantities and frequencies of application in a 40 m^2 bed size. 68
Table 11: The amount of mixed fertiliser used in growing coriander, based on various quantities and frequencies of application in a 36 m^2 bed size. 69
Table 12: Details of the amounts of different fertilisers used in one of the mixed methods a farmer employs to grow coriander on a 30 m^2 bed. 70
Table 13: Information on coriander farmers' chemical use 70
Table 14: Fertiliser quantity used for tomato production with a usage rate of 50 kg per month for 1,600 m^2 growing areas. 72
Table 15: Fertiliser quantity used for tomato production with a usage rate of 100 kg per month for 2,000 m^2 growing areas. 72
Table 16: Chemical quantity used for tomato production, with a usage rate of 150 ml for 1,600 m^2 growing areas. 73

List of Figures

Figure 1: Lao PDR map 27
Figure 2: Districts Map in Vientiane Capital 27

Figure 3: Map of the Lao PDR and Vientiane capital city. 33
Figure 4: Vientiane and nine districts. The red circle indicates the location of the research conducted. source (JICA, 2011) 34
Figure 5: The conducted study area is highlighted in red. 34
Figure 6: Leaf vegetable crops among farmers interviewed. 37
Figure 7: Fruit vegetable crops grown among farmers interviewed. 37
Figure 8: Non-vegetable crops grown in the research area. 38
Figure 9: the Lao PDR provincial map. 56

List of Images

Image 1: A farmer uses a tool to make vegetable beds 41
Image 2: An overview of the vegetable bed 41
Image 3: A farmer covers vegetable beds with plastic 41
Image 4: Chilli pepper beds covered with plastic 42
Image 5: Covering vegetable beds with sunshade sheets after sowing seeds. 43
Image 6: A manual watering 44
Image 7: A manual watering 44
Image 8: Using the plastic tube for watering 44
Image 9: Using sprinklers 45
Image 10: applying method by combining fertilisers with water 46
Image 11: The farmer applies fertilisers to each plant 46
Image 12 and Image 13: Show how a farmer applies fertilisers by hand sowing. 47
Image 14: How a person sprays chemicals without wearing gloves and wearing surgical facemask 48
Image 15: The method of spraying chemicals 49
Image 16: A local fertiliser and chemical shop. 49
Image 17: Variety chemical inputs at the local shop 50
Image 18, Image 19, and Image 20: The ways of agricultural tools and inputs in the research area. 51
Image 21 and Image 22: fertiliser and chemical storage in the plastic bag. 52
Image 23 and Image 24: A trader packs and stores products in his car before going to the market. 54
Image 25: The KOICA project provides greenhouses to the farmers 58

Image 26: another perspective of the farmer's greenhouses supported by the KOICA project 58

List of Appendixes

Appendix 1: Coriander growing pattern 96
Appendix 2: Fertilisers type use among interviewed farmers 97
Appendix 3: Plant supplements use among farmers interviewed 99
Appendix 4: Insecticides use among farmers interviewed 100
Appendix 5: Fungicides used among farmers interviewed 102
Appendix 6: Herbicides use among farmers interviewed 103
Appendix 7: Soil amendment product used by a farmer interviewed 104
Appendix 8: Research informants 105
Appendix 9: Information Sheet in English 107
Appendix 10: Information sheet in Lao. 108
Appendix 11: Consent form in English 110
Appendix 12: Consent form in Lao. 111
Appendix 13: Photograph consent form in English 112
Appendix 14: Photograph consent form in Lao. 113
Appendix 15: Interview Topic guideline in English. 114
Appendix 16: Topic guideline for traders 121
Appendix 17: Interview guideline in Lao. 123

Abstract

The research study concentrates on vegetable production to study the use of fertiliser and chemicals in vegetable growing processes, which helps to improve our understanding of the characteristics and nature of fertiliser and chemical applications among farmers in the study areas. Vegetable farming is increasingly important to people as a source of food and for sustaining food security within the country. On the other hand, vegetable farming contributes significantly to the low-income community, especially in rural areas, where limited capital and few opportunities to access skills, markets, and other development opportunities. However, fertilisers and chemicals play a crucial role in crop production, which farmers who produce for commercial purposes describe as indispensable; without them, the desired quantity and quality of vegetable production would not be achieved. The expansion of the market is increasingly through commercial vegetable farming activities, which are related to the use of fertilisers and chemicals in commercial vegetable production. Given the importance of fertilisers and chemicals, as described by farmers, the study primarily focuses on how farmers use them in vegetable farming. This research study describes the vegetable farming in Lao PDR and how fertilisers and chemicals are used in vegetable production. The research also examined the nature and characteristics of vegetable farming practices, which help provide a deeper understanding and greater knowledge of farming.

This research is based on data from interviews with 25 participants, including 21 vegetable farmers, along with 4 key informants such as a village head of the agricultural group, a village head, a district-level officer, and a provincial officer. A qualitative methodology was employed to analyse the interview data, which was examined in terms of individual-provided information and categorised into themes, aligning with the study's aim to explore factors influencing the use of fertilisers and chemicals by vegetable farmers in the Lao PDR.

The study found that the farming practices among vegetable farmers were varied; individual farmers used different methods of applying fertiliser and chemicals. The use of fertilisers in vegetable farming revealed the existence of various types for growing the same crop (coriander— *Coriandrum sativum* L.) and the usage rate of fertilisers and chemicals was higher than the officially recommended rate. Unlabelled and banned chemical products were still found in active and regular use among most farmers interviewed, including plant supplements and liquid fertilisers. Most farmers who participated in the study expressed the challenge that farming is unpredictable and unstable, with variable vegetable market prices, which prevented long-term planning and led to unsustainable farming practices as the use of fertilisers and chemicals is based on vegetable prices, such as times of application, quantity, type and methods. The study findings presented evidence related to food safety, as some farmers grew vegetables in separate plots for consumption and sale. Growing vegetables for sale, they applied fertilisers and chemicals at higher rates and more frequently. For their own consumption, farmers grow separately and apply a lower level of chemicals. Farmers

expressed concerns about the safety of vegetables grown with high levels of chemical input. Based on the study, the vegetable products available in the market may contain high levels of chemical inputs, raising concerns about safe consumption. The study indicated that a high quantity of fertilisers and chemicals is used in vegetable farming, especially the use of unlabelled fertilisers and chemicals without instructions and chemical information. The market preference for vegetable production was for good appearance, while product safety and standards seemed to be ignored.

The study provides information on the use of fertilisers and chemicals, identifies factors that influence their application, and thus enhances understanding of farming practices, conditions, and farmers' perceptions as producers. The findings from this study can serve as initial data on vegetable farming production, offering valuable insights for further research to improve vegetable farming, the agricultural system, and effective policies that promote sustainable agriculture and a stable, safe, and secure food supply for the population.

Chapter 1 Introduction

1.1 Background

Lao PDR is a landlocked country in Southeast Asia, a member of ASEAN, bordered by five countries: China to the north, Myanmar to the northwest, Thailand to the west, Cambodia to the south, and Vietnam to the east.

According to the FAO, Lao PDR is one of the most agriculturally dependent countries in the world. The agricultural sector is the backbone of rural livelihood, accounting for 67 percent of the total population (FAO, 2025). The agricultural sector is the third-largest sector of the Lao PDR's economy, contributed 13 percent of the economic output from 2019 to 2023 (FAO, 2025). At the same time, the agricultural sector plays a crucial role in ensuring the country's food security, serving as a foundation for its development. The agricultural sector employed 2.4 million people, about 60 percent of the national workforce, which contributed significantly to the livelihoods and incomes of most people (FAO, 2025). The FAO (2025) report indicated that factors affecting Lao PDR's food security included limited agricultural labour, as many labourers migrated to neighbouring countries for higher wages, resulting in a shortage of labourers for agricultural production. On the other hand, inflation driven by rising food prices in the country increased agricultural production, raised input costs for farming, and reduced investment returns, which in turn limit farm production (FAO, 2025). This highlighted the need for stable input costs, improved market prices for farmers, and maintained food access for people (FAO, 2025).

The country has an estimated agricultural land of over 2 million hectares, representing about 10 percent of its total area, making it one of the smallest agricultural zones in Southeast Asia (ADB, 2021; FAO, 2023). According to the ADB 2021 report, arable land covers 1.4 million hectares, with over 58,000 hectares dedicated to crop farming and more than 500,000 hectares used for livestock. The country's four main farming systems are lowland, upland, plateau, and mixed systems (ADB, 2021). Most farms are located in the lowland area, which accounts for 51 percent, followed by 25 percent in the upland, 23 percent on the plateau, and the remaining in mixed systems (ADB, 2021). There are two primary farming practices: irrigated farming along the Mekong River and slash-and-burn farming, primarily practised in uplands (FAO, 2023).

The Lao agricultural sector is characterised as low productivity and limited experience in agribusiness enterprises; fallow land remains of significant importance for development in agriculture (FAO, 2021b). The agricultural system has more than half of the cultivated land dedicated to annual crops, mainly rice, while the other half is used for perennial crops such as coffee, banana, cassava, sugarcane, and rubber (FAO, 2023; World Bank, 2022). Ninety percent of the poorest rural population, with a low level of education, still depends on subsistence agriculture, and 70 percent practise farming as their primary source of consumption and income (ADB, 2021; FAO, 2021a; World Bank, 2022). The main agricultural production in rural areas is rice-based, primarily for consumption, with

only 5 percent being commercial (World Bank, 2022). According to the 3rd Lao Census of Agriculture 2019/2020, the total number of agricultural households in Lao PDR in 2020 was 851,000, representing an 8.6 percent increase since 2011, with nearly 85 percent of these households located in rural areas (LSB, 2021). The average agricultural land ownership was 2.8 hectares in 2020, a 0.4-hectare increase over the past decade. Rice remains the dominant crop, covering 60 percent of the total agricultural land, while approximately 180,000 hectares are used for vegetable production and more than 204,000 hectares for livestock farming (FAO, 2023; LSB, 2021).

In 2023, the total GDP grew by 4.2 percent, with the agricultural sector contributing 21 percent, and expanded by 3.7 percent divided into cropping 3.6 percent, livestock 4.2 percent, fishery 3.7 percent, and forestry and logging 4.6 percent (BOL, 2024). The main agricultural exports in 2023 were cassava, fruits, rubber, and coffee, with a total value of 1 billion USD, reflecting a decrease of 200 million compared to 2022 due to high input costs and weather (World Bank, 2024). Livestock production steadily increased due to demand for imports in China and Thailand (FAO, 2023). The trend towards commercial vegetable production improved significantly because of the export-oriented and domestic demand, and contract farming, which increased vegetable farming areas from 100,000 hectares in 2010 to 185,000 hectares in 2021, with an estimated 1.4 million tons of vegetable production (FAO, 2023). The main destinations for agricultural exports are China, Thailand, and Vietnam, with an export value exceeding 300 million USD of the total agricultural export value (FAO, 2023; World Bank, 2024).

Vegetables are vital for the Lao people, serving as key sources of nutrients, and they are an important part of local and regional dishes. Notably, vegetable production had significantly benefited rural communities and smallholder farmers, who were major contributors to the nation's economy (Douangboupha & Sommany, 2012). The average vegetable intake was estimated at 149g per day, amounting to a total consumption of 54,942 tonnes in Vientiane Capital (Kethongsa et al., 2004). The study by Kethongsa et al. (2004) found that 80 percent of consumers preferred to buy fresh, insecticide-free vegetables. Traditional local dishes often feature fresh vegetables as a key component, and most meals are served with them. Vegetables make a substantial contribution to domestic demand, supporting society’s and people’s food security. However, there are notable risks associated with vegetable consumption, particularly concerns that farmers were not subjected to any form of regulation regarding production standards and food safety regulations, which contributed to high production costs with low yields due to limitations in crop management, as well as pest and disease problems (World Bank, 2018). Promoting the country’s shift towards sustainable agriculture will significantly enhance our understanding of how vegetable farmers, who play a crucial role in providing nutrition, perceive sustainable practices in cultivation.

1.2 Food Safety

Before 2000, Lao PDR ranked among the countries in the world with the lowest fertiliser and chemical use. The development of commercial agriculture has led to a significant increase in pesticide imports in Lao PDR, which surged by 3,696 percent from 2006 to 2016 (Shattuck, 2021). Lao consumers were concerned about food safety, particularly

regarding vegetable safety risks, and have called for a reduction in the use of agricultural chemicals (Van Nguyen et al., 2020). The overuse of agrochemicals in fresh farm products adversely affects the health of both producers and consumers (Makino & Inthalangsee, 2023). Lao PDR had established agriculture policy aimed at promoting the reduction of chemical use in agriculture and encouraging clean production that serves both domestic and regional markets (Makino & Inthalangsee, 2023). In 2015, the country endorsed the principles of cleanliness, safety, and sustainability, following the establishment of the ASEAN Good Agricultural Practices (GAP) in 2014, which focused more on exports. These measures have not addressed food safety issues in the country (FAO, 2021a). The FAO (2021a) stated that some policies support the promotion of food safety, but more enforcement was necessary. In addition, the FAO (2021a) reported that the lack of knowledge regarding the proper use of agrochemicals among producers has led to the improper application of chemical inputs, especially among vegetable farmers; reports indicate that 59 percent have overused pesticides. Small-scale farmers are increasingly applying agrochemicals in their farming practices, which were previously considered organic by default (Shattuck, 2021). In the FAO report (2021), several studies revealed significantly high chemical contamination in food products within local markets. The monitoring of the food safety system is weak, as the rising number of people poisoned from pesticide misuse contributes to chemical contamination in water, adversely affecting the environment and resulting in escalating social welfare and public health issues (FAO, 2021a; Shattuck, 2021). The government's enforcement of regulations faces challenges due to most farms being situated in remote areas, coupled with a lack of financial support and the necessary skills to help farmers implement clean agricultural practices (FAO, 2021a).

1.3 Context

Lao farmers encounter multiple challenges in agriculture, including limited access to technological tools, low fertiliser use, and ineffective practices (World Bank, 2022). Declining soil fertility, related to ineffective farming practices, further exacerbates these challenges. Extension services were limited in reach, and access to irrigation and drainage remains a challenge (World Bank, 2022). Most farming occurs in rural, smallholder, or disadvantaged communities, making it challenging to adopt improved techniques due to limited knowledge and access to technical assistance (FAO, 2021a). A lack of innovation, diversification, proper land selection, and effective post-harvest management contribute to output losses and food insecurity in rural areas (FAO, 2021a). Since most activities take place in these regions, farmers face high transaction costs due to the absence of cooperatives and steep transportation expenses resulting from inadequate rural infrastructure and connectivity. This situation leads to elevated transportation prices, restricting farmers' access to inputs and markets (World Bank, 2022). It also increases their vulnerability to economic, environmental, and health risks, as well as socio-economic shifts, due to their limited capacity to adapt (FAO, 2021a).

The primary agricultural producers in Lao PDR are small farms and traditional farmers with limited commercial experience (FAO, 2021b). The rising concern over food safety has become a significant issue; research conducted on blood tests for food contamination in 1,000 samples from children, farmers, and consumers in a northern

province found 96 percent showed signs of contamination (FAO, 2021a). Based on the study about the overuse of insecticides in vegetable farmers in Vietnam, Laos, and Cambodia, it was found that 60 percent of Lao vegetable farmers use more pesticides than economically optimal; the main drivers of the use are misconceptions, shop advice, and limited knowledge of the benefits of the products (Schreinemachers et al., 2020a). The use of chemicals in traditional farmlands, which were considered organic by default, was also found to be on the rise, resulting in significant contamination from pesticide residues on farm products in the local market, including both domestic and imported goods (FAO, 2021a). Poor practices in the use of insecticides by agricultural farmers often lack adequate handling, proper procedures, and protection measures (FAO, 2021a).

According to the FAO food systems profile of the Lao PDR in 2021, the initiative to adopt a market economy, by increasing exports to China and ASEAN countries, contributed to the transition from subsistence agriculture to commercial and permanent agriculture (FAO, 2021a). This shift to commercial agriculture transformed farming practices by increasing the use of chemical fertilisers, pesticides, technological equipment, and seeds to boost productivity. The import of agricultural chemical inputs surged by 3,696 percent from 2006 to 2016, with some of these imports being illegal and certain products prohibited. However, commercial practices have led to environmental issues, including land concessions, health impacts, reduced soil fertility, and lower yields (FAO, 2021a). The move away from indigenous seed selection has contributed to a decline in agrodiversity and increased vulnerability to climate disasters, such as drought and heavy rainfall. Farmers' ability to employ appropriate ecological and socio-economic sanitary practices is limited (FAO, 2021a). The lack of technical assistance and support for knowledge and information on agroecological practices has led to the use of inappropriate methods and misconceptions about sustainable agriculture among farmers (FAO, 2021a). Food safety awareness is minimal, and farmers have limited access to information.

Vegetable production is becoming increasingly important in Lao PDR as a source of food for locals and as a source of income for smallholder vegetable farmers. Traditionally, crops were grown organically; however, the widespread use of chemicals for pest and disease control and fertilisers has increased. Evidence highlights that many farmers use poor application and storage practices with chemicals and fertilisers, which have implications for human health, food safety, and the environment. Little research to date has explored the reasons behind farmers' use and application of chemicals and fertilisers, or the on-farm and off-farm factors that influence their practices.

1.4 Research objectives

Research question: How do vegetable farmers in Lao PDR use fertilisers and chemicals and why?

This research aims to understand how vegetable farmers in Lao PDR utilise fertilisers and chemicals in their production practices and to explore the factors influencing farmers' decisions regarding their use. It also seeks to identify on-farm factors (e.g., crop type, farming practices, pest and disease management) and off-farm factors such as market

demand, policy regulations, and access to agricultural inputs that impact the utilisation of chemicals and fertilisers. The findings provide information on farming practices, the vegetable farming environment, and characteristics. It also examines how vegetables are produced from farmers' perspectives on fertiliser and chemical application, along with their awareness of the risks and benefits associated with chemical and fertiliser use.

1.5 Significance of the study

This study offers valuable insights into vegetable farming practices and farmers in the Lao PDR. It fills information gaps on vegetable farming in Laos, enhances updated knowledge, and supports further research and agricultural development in the Lao PDR. The results will help us understand how vegetable farmers in the Lao PDR produce their crops, especially their use of fertilisers and chemicals, aligning with the country's policies to improve food quality and safety in vegetables. Recognising these factors can inform strategies to promote sustainable farming among small-scale producers. Understanding the challenges and opportunities faced by farmers can assist both public and private sectors in designing support systems tailored to farmers' needs.

This research will fill a gap in the current literature on sustainable agriculture in the Lao PDR by focusing on the vegetable farming sector, a vital part of the agricultural economy. Investigating farmers' perceptions and practices will improve understanding of the challenges and opportunities in adopting sustainable farming practices in developing countries, ensuring a sustainable, stable, secure, and safe agricultural sector. This will set the foundation for future studies on similar topics in Lao PDR and other nations in Southeast Asia.

Chapter 2 Agriculture in Lao PDR

2.1 Characteristics of farming practices

The characteristics of agriculture in Lao PDR are mainly subsistence-based and mostly occur in rural areas. Farmers tend to possess traditional skills and knowledge about farming practices, leading to low incomes and production standards, which puts them at a disadvantage in market competition with neighbouring countries (ADB, 2018). In 2018, access to agricultural inputs and equipment was limited due to high costs and poor logistics, resulting in a decrease in both quantity and quality of agricultural output, as well as increased production costs (ADB, 2018) . According to the FAO and WFP (2023) report on crop and food security assessment in Lao PDR, the overall use of fertilisers in the sector was below the government-recommended rate because of high prices and farmers' belief that soils were already sufficiently fertile. Specifically in rural areas, fertiliser application to rice crops was low due to high transportation costs, with most crops treated using organic fertilisers like manure and liquid extracts, along with leaves from trees (FAO, 2023). The FAO and WFP (2023) reported that the most productive rice farming applied a high quantity of fertiliser as recommended at 250 to 300 kg per hectare of NPK, while farmers in other areas applied only 50 to 100 kg per hectare. The chemical fertiliser import reports were from Thailand, resulting in high costs and causing some farmers to use low-quality and ineffective products (FAO, 2023). The use of fertiliser and chemicals in rice farming in Lao PDR, as highlighted in the FAO (2023) report, underscores the uncertainty among agricultural producers about fertiliser use due to unstable input costs, which impact agricultural productivity.

The FAO and WFP (2023) identified several chemical products, including chlorpyrifos, diazinon, fipronil, deltamethrin, abamectin, and imidacloprid, that farmers use for pest control. The report also found that farmers' use of chemicals to manage pests and diseases was low, mainly due to limited application skills (quantity and timing), as well as concerns about health, the environment, and high costs. Common pest control methods mentioned in the report included hand removal of insects and homemade pesticides made from minerals and plants. Some imported insecticides from Thailand are available in local stores, but some farmers choose ineffective or counterfeit products because of their lower price (FAO, 2023). Limited crop diversification has led to high production costs, along with low productivity and quality. Additionally, the minimal use of machinery in agricultural practices results in poorer product quality, lower operational efficiency, and limited physical capacity, which hinders product improvement (World Bank, 2018; World Bank, 2022). Based on the available information, it suggests that chemical use in agricultural production is limited, with manual labour and homemade solutions remaining the primary methods for pest control. The report also highlights the challenges faced by agricultural producers in Lao PDR, who generally have low awareness of proper chemical handling, including application techniques, protective measures, and correct usage rates.

2.2 The agriculture in the Lao economy

The overall Lao PDR agricultural sector increased by 3.7 percent in 2023, compared to a 1.4 percent growth in 2024, which contributed 21.4 percent to the GDP (LSB, 2024, 2025). The Lao economic performance in 2024 and the trend 2025 report found that crop production declined significantly by 1.4 percent, with a large drop in vegetable production of 40 percent compared to 2023 (LSB, 2025). Rice production in 2024 was 3.7 million tonnes, and was 3.9 million in 2023, while cash crop production in 2024, such as maize, beans, cassava, bananas, and tea, increased (LSB, 2025). The report indicates that the agricultural sector is expected to grow between 2.5 and 3.5 percent in 2025, driven by crop production to meet both domestic and international demand (LSB, 2025). Additionally, vegetable production in 2024 was 847,290 tonnes, a decrease of 564,860 tonnes from 2023, indicating a significant decline in vegetable output due to floods, despite vegetables remaining a key food source in Lao society. The overall perspective provides the information on overall agricultural production in Lao PDR, where the primary production is rice and cash crops (mainly for exports and foreign investment); however, the information highlights the significant decrease in vegetable production, which is essential for the research study and information on Lao agriculture.

2.3 Agricultural input

Most agricultural inputs used in the Lao PDR, such as fertilisers, are imported, with 138,000 tonnes of NPK fertilisers imported in 2024, marking a 26 percent increase compared to 2023 (FAO, 2025). However the imported fertiliser did not indicate the application rate of the small farm producers. The majority of the imported fertiliser supports larger industries, making it difficult to track usage among small-scale farmers. The report also indicated that small-scale farmers primarily rely on local import shops within their villages to support the local demand and also reported that the prices were high (FAO, 2025). The informal market for agricultural inputs also exists locally, where fertilisers and chemicals often lack clear origin and labels, which are found to be used in agricultural production. The report found that the prices of agricultural inputs in the Lao PDR are expensive, which hampers farmers' ability to meet their needs, with product prices ranging from 21 to 65 percent higher than in Thailand (FAO, 2025). The cost of these inputs contributes significantly to farming expenses; data from the FAO and WFO 2025 report showed that fertiliser alone accounts for 50 percent of production costs for small-scale farmers. If farmers adopt GAP procedures, the cost of production to farmers increases by 5 percent above the farmers' actual cost (FAO, 2025). Given that agricultural production in Lao PDR largely depends on imported inputs, which are distributed at a cost that elevates production expenses, the overall cost of production remains high. This is compounded by an insufficient supply of fertilisers, which can significantly affect agricultural output (FAO, 2025). The report noted that fertiliser prices vary from as low as $NZ 46 (600,000 LAK) in some areas to as high as $NZ 70 (900,000 LAK) per 50 kg bag in remote regions. This price disparity impacts most agricultural activities, especially in rural areas, exerting a greater burden on smallholder farmers.

The chemical products used for pest and disease control were imported from Thailand (FAO, 2023). Farmers access pesticides through various channels, such as local shops,

product sellers, and across the border (FAO, 2023). However, the pesticide import information in the Lao PDR was found to be unavailable in statistical quantities. The pesticide market in Lao was found to be primarily through informal channels, where the formal importers were insufficient to distribute in remote areas (World Bank, 2021). In 2014, about 95 percent of pesticides available in the market were found not to be labelled in Lao, which requires informal imports to have a Lao label (World Bank, 2021).

2.4 Vegetable production

Vegetable production makes up about 19 percent of Lao PDR's overall agricultural output (FAO, 2021a). In 2021, the area used for vegetable farming increased from 100,000 hectares in 2010 to 185,000 hectares in 2021, driven by higher local demand and foreign companies' contract farming, leading to a total output of 1.4 million tonnes (FAO, 2023). The growth in domestic demand and internationally supported contract farming contributed to the expansion of vegetable production, shown by the shift from traditional rice farming to commercial vegetable cultivation (FAO, 2023). Most vegetable production remains traditional, averaging 0.32 hectares per farm, often lacking proper crop management, diversification, and pest control, which results in production losses and increased costs (World Bank, 2018). Furthermore, vegetable farmers are not required to adhere to specific production standards or food safety regulations, complicating quality and safety control for both producers and consumers — most vegetables in the country are supplied in unprocessed form for domestic consumption through traditional wet markets.

2.5 Agricultural markets

The market plays a significant role in the agricultural sector in Lao PDR, and understanding the agricultural market there highlights differences in agricultural production. This research primarily focuses on vegetable production, which mainly supplies domestic markets. However, Lao agricultural export markets are based on cash crops such as cassava and bananas, mainly from foreign agricultural investments. By examining both domestic and export markets, which are two existing types of markets, we can better understand the agricultural landscape in Lao PDR. As primary agricultural production for supplying both domestic and international markets, these have a significant impact on farming practices, especially farmers' use of fertiliser and chemicals in agricultural production.

2.5.1 Exporting market

The agricultural export market is expanding and now makes up one-fifth of the country’s exports. In 2021, the value of agricultural exports was $ 1,200 billion; however, by 2023, this had decreased to $US 1,000 million (World Bank, 2022; World Bank, 2024). The drop in agricultural export value was notable due to limited supply-side capacity in livestock (World Bank, 2024). Still, some agricultural products faced challenges in meeting food safety standards because of importing countries' quality requirements (World Bank, 2022). The main agricultural export products are cassava, bananas, and rubber; cassava accounted for more than 30 percent of the export value in 2023, exceeding $ 300 million.

Rubber also represented over 30 percent, with more than $US 300 million, while bananas made up over 20 percent, worth about $US 200 million (World Bank, 2024). There has been an increase in foreign investment and demand in neighbouring countries (World Bank, 2022). Banana plantations, supported by significant Chinese investments, are mainly located in the northern region near China, with most banana exports- 90 percent- going to China (World Bank, 2022). Smallholders primarily produce cassava through contract farming, with 80 percent exported to Thailand. Livestock production has been growing since 2016, driven by rising demand from Vietnam due to rapid economic growth and urbanisation (World Bank, 2022). Coffee, rice, and maize account for less than 15 percent of total agricultural exports; the main markets are China, Vietnam, and Thailand, with most coffee exports heading to Japan. In 2020, the total vegetable export contributed 2 percent of the Lao total agricultural export, the vegetables were more than 70 percent to Thailand, 26 percent to China and 2 percent to Vietnam. The vegetable export in 2020 experienced a decrease of 30 percent since 2016, while other cash crops increased. In contrast, fruit exports remain steady, valued at $US 25 million, with the majority of shipments going to China.

2.5.2 Domestic market

The domestic food and beverage market, including agricultural products, was valued at $US 3.9 billion in 2019, accounting for nearly 22 percent of the national economy. Due to a population increase of 1.46 percent per year, the market size is projected to grow to $US 5.7 billion by 2025 (World Bank, 2022). Notably, there was a significant rise in food product imports, increasing from $US 3.8 million in 2016 to $US 5 million in 2020. The domestic supply of rice and vegetables has been sufficient to meet demand; however, there is an insufficient supply of meat and fish, which only cover half of the total market demand, requiring ongoing imports (World Bank, 2022).

The supply of vegetable produce in local markets can be affected by seasonal changes; the rainy season poses production challenges, leading local markets to rely on imported goods, especially from Thailand (Kethongsa et al., 2004). The study on vegetable markets in Vientiane revealed that about 60 percent of the vegetables supplied to markets in Vientiane came from Hadxayfong district, with 17 percent from Saythani, 13 percent from Saysettha, and 7 percent from Sisattanak.

2.6 Sustainable Agriculture

Sustainable agriculture emphasises the importance of agricultural development in achieving sustainable development, as outlined in the United Nations Sustainable Development Goals. The aim is to increase the profit and productivity of farms of all sizes while also protecting and minimising negative impacts on the environment, society, and health. In Lao PDR, improving the agricultural sector, especially vegetable production, towards sustainable agriculture is essential. Lao PDR Participated in international trade, such as through the WTO and ASEAN, which requires agricultural trade to meet specific standards. Notably, sustainable development goals and sustainable agriculture play a crucial role in vegetable production, particularly through sustainable practices. This

research studies on the use of fertilisers and chemicals in vegetable farming aligns with these development objectives.

2.6.1 Sustainable Agriculture in Lao PDR

International non-governmental organisations (NGOs) introduced the concept of sustainable agriculture and organic farming to the Lao PDR in the 1990s (Panyakul, 2012). The public sector and NGOs implemented sustainable agricultural practices and technologies through training activities for farmers across the country. In the 2000s, the public sector and NGOs recognised the potential of market linkage to organic agricultural products in eradicating poverty; the collaboration between the Lao government and HELVETAS led to the establishment of a project promoting organic farming and marketing in Lao PDR, marking a significant achievement for organic farming in the region (Panyakul, 2012).

In summary, the concept of sustainable agriculture in Lao emerged 20 years ago, after the late 1990s and early 2000s, as the government has demonstrated a strong commitment to supporting and promoting sustainable agricultural practices. Based on the review of information on sustainable agriculture in Lao PDR, which relates to the study of commercial vegetable production and farming practice in progress to sustainability. In the efforts from government and nongovernment organisations in working on agricultural development, especially improvement of vegetable farming standard practices, enhance farm strategies, achieve stable incomes and markets, and meet productivity standards that benefit health, the environment, and consumers towards sustainability. The next section provides a review of national policies towards sustainable development, with a particular focus on agricultural development policy.

Chapter 3 Agricultural Public Policy in Lao PDR

This section provides an overview of the country's agricultural policy, focusing on increasing production, enhancing the capacity to supply domestic markets, and expanding exports to international markets. By analysing the policy, we gain a clearer understanding of the government's direction, which aligns with global trends toward sustainability. The agricultural sector is the most vital part of the country's foundation, supporting food production and ensuring a secure food supply for the population. Reviewing the national policy helps us better understand the country's strategic plan from a broad perspective, thereby improving micro-level analysis. The review also offers insights into official perceptions, opinions, and views on agricultural production and practices. Additionally, it enhances knowledge of the aim of public policy related to actual vegetable farming.

3.1 The 8th National Socioeconomic Development Plan 2016 – 2020

The first mention of sustainable agriculture was in the Eighth National Socioeconomic Development Plan 2016 – 2020 (8th NSEDP), published in 2016. It prioritised improving the agriculture and forestry sectors to ensure the sustainable production of food and commercial goods (ADB, 2021). According to the 8th NSEDP on sustainable agriculture, the aim was to enhance agricultural output by encouraging local farmers to implement clean and organic agricultural inputs and urging producers to utilise modern and high-quality techniques in agricultural development. Sustainable agriculture was prioritised in the country's growth strategy to align with the United Nations' Sustainable Development Goals.

The Agricultural Development Strategy (ADS) for the year 2025 and Vision for the year 2030

The Agricultural Development Strategy (ADS) for the year 2025 and Vision for the year 2030 were established by Ministry of Agriculture and Forestry in 2015 to ensure the country's food security and enhance agricultural quality competitiveness through developing clean, safe, and sustainable agriculture by revolutionising toward a modern and resilient national agricultural economy with the active cooperation of rural development. Additionally, the ADS 2025 comprises three objectives: firstly, to improve the national economy by flourishing in the direction of industrialisation and modernisation, while implementing good agricultural production that provides people with adequate, nutritious food and is competitive in adapting to environmental challenges; secondly, agricultural production must adhere to hygienic principles, being clean and safe for all stakeholders and environmentally friendly, while supporting agricultural social development, particularly rural development, through reducing inequality whilst considering the protection and balance of the environmental ecosystem. The policy prioritises clean agricultural production and food safety by executing good agricultural practice (GAP) and organic agriculture (OA) through enhancing agricultural techniques and material infrastructure to produce quality agricultural products that meet international standards. It also aims to improve the

management system of agricultural input usage by monitoring and controlling fertiliser and pesticide application, including restrictions on prohibited inputs. This will ensure the safety and quality of the country's agricultural products for integration with ASEAN and international standards. Furthermore, sustainable agriculture will be promoted through farmer education by providing technical knowledge for agricultural practices and incorporating research and new technologies into farming activities, maximising resource use and offering appropriate sustainable techniques to combat environmental threats (MAF, 2015).

3.2 The 9th National Socioeconomic Development Plan (NSEDP) 2021 – 2025

The 9th NSEDP (2021 –2025) was adopted by the Ministry of Planning and Investment in 2021. It defines sustainable agriculture development as enhancing organic, effective, and sustainable agriculture production, preventing loss in fertility and biodiversity in soil by integrating crop rotation and diversification, and considering economic efficiency, technical feasibility, climate change, food security capacity, and nutritional value. Based on this policy, the government agricultural sector had been identified as the potential for the country's leading development part. The policy primary promoted on rich production in large farming land for agricultural activities because of less population density that was suitable for producing farming commodities, especially for clean, modern and sustainable agricultural that is highly in demand in domestic and international markets (MPI, 2021).

3.3 The Green and Sustainable Agriculture Framework (GSAF) for Lao PDR to 2030

The Green and Sustainable Agriculture Framework (GSAF) for Lao PDR through 2030 prioritises the development and implementation of green and sustainable agriculture programs and activities in Lao PDR. Created by the Ministry of Agriculture and Forestry in 2021, the GSAF 2030 aligns with the National Green Growth Strategy (NGGS), which was introduced in 2018 to integrate and balance economic and societal growth with environmental protection, proposing resilient economic development. The policy aims to connect the country's development with ecological impact maximisation through the implementation of clean, environmentally friendly policies and pollution reduction. The overall goals for the GSAF include improving Lao agricultural production by promoting sustainable, green practices that enhance agricultural productivity, support the country's growth, and strive to eliminate poverty, with a consistent commitment to environmental protection and clean, safe agri-food systems. The proposals aim to ensure sustainable production, prevent water and soil degradation, and guarantee high-quality outputs without harming stakeholders. Generally, the GSAF calls for clean, resilient, and secure agricultural production that limits the environmental impact of agrochemical use, such as greenhouse gas emissions, while enhancing farm systems to withstand climate change and disasters. The GSAF defines clean and green as "organic farming, conservation agriculture, low-input agriculture, agroecology, and agrobiodiversity, as well as efforts to make farming safer and more hygienic" (MAF, 2021). Green and sustainable agriculture (GSA) defined as a combination of environmental protection

practices, educated farmers, and adequate markets to achieve poverty reduction and resource conservation (MAF, 2021). The policy adopts good agricultural practices (GAP) as its standard, with principles focusing on agricultural product processing, environmental care, food safety, and animal welfare (MAF, 2021).

3.4 International Development Projects on Sustainable Agriculture

International organisations have been actively contributing to Lao agriculture development through bilateral and multilateral cooperation, along with non-governmental actors, especially in remote areas where agriculture is the main source of livelihood. These organisations have consistently supported vegetable production in the Lao PDR, helping farmers enhance their skills and obtain greater benefits. Additionally, numerous international aid projects collaborate with the government to develop vegetable production, aiming to improve sustainability in farming and production. Because of this, international organisations are key stakeholders for agricultural development, particularly in vegetable production in the Lao PDR. The paragraph below provides information on background international development projects in the agricultural sector in the Lao PDR.

Numerous non-governmental organisations (NGOs) and international government organisations (IGOs) have actively contributed to sustainable agriculture. Most projects focus on rural development, implemented across various provinces and incredibly remote regions, where poverty is prevalent and largely dependent on agriculture, since the introduction of sustainable and organic farming concepts by three NGOs into Lao PDR such as HELVATAS, JICA, and OXFAM (Panyakul, 2012). These three NGOs have been working to promote sustainable and organic agriculture in the Lao PDR. The collaboration between Helvetas and the Ministry of Agriculture and Forestry established the project to promote organic farming and marketing in Lao PDR (PROFIL) in 2004, marking the country's beginning in organic agriculture (Panyakul, 2012). The project enhanced the capacity of related public institutions and led to the establishment of organic agriculture standards, the certification of organic agricultural products, and the creation of organic farmer market (Gueneau et al., 2022; Panyakul, 2012). Helvetas defines sustainable agriculture as agricultural activities that incorporate ecologically friendly and diverse production to adapt to environmental changes, focusing on the sustainable use of natural resources that ensures resilience to environmental and economic impacts. Based on Sustainable Agriculture and Environment Development Association (SAEDA) website, the organisation founded in 2007, is one of the NGOs actively involved in sustainable agriculture development; its objective is to promote sustainable practices and environmental conservation through capacity and income development, viewing sustainable agriculture in conjunction with ecological protection, organic agriculture, agro-ecology, nutrition, and food security, alongside traditional seed conservation, natural resource management, climate adaptation, and pesticide risk reduction . the information from OXFAM website indicated the organisation worked in the Lao PDR since the 1980s; its definition of sustainable agriculture emphasises the protection and improvement of the environment, society, and economic conditions by producing safe and high-quality agricultural products without harming health and welfare.

3.5 Agricultural rules and regulations

This section reviews existing rules and regulations related to agriculture in the Lao PDR. Understanding laws and regulations can improve our knowledge of agricultural management, which can influence agricultural production in the country. This section also examines laws and regulations specifically related to vegetable production in the Lao PDR, including regulations on vegetable farming practices, recommendations, and input regulations, all of which play a significant role in vegetable farming. Also, to contribute to the knowledge on regulation implementation on vegetable production, related to the vegetable farmers' use of fertilisers and chemicals.

3.5.1 Agriculture practices

The government of the Lao PDR promoted the good agriculture practice (GAP) as the minimun standard for all agricultural production, which issued the latest version of the Decision of the Minister on Good Agriculture Practices (GAPs) for Food Safety Standards, No. 3004/MAF, on 15 June 2022, through the Ministry of Agriculture and Forestry. This decision defines the principles, regulations, and standards for managing and monitoring GAP for quality production and safe consumption, aiming to increase value and contribute to socio-economic development while integrating with regional and international markets. This regulation defines GAP as "Practices used to prevent or reduce the risk of hazards occurring during production, harvesting, and postharvest handling of produce." It provides information on implementing GAP from growing to harvest and demonstrates GAP procedures for preventing, maintaining, and 16tilizing chemical inputs on the farm. According to this regulation, the Department of Agriculture is responsible for issuing the GAP certificate. To obtain the certificate, farmers must compile documents including a letter of purpose, an agreement, a certification form needed for Individuals, legal entities, or institutions, and a cooperative licence for cooperatives. The department assigns officials for evaluation and inspection on the farms, and it takes 120 days to issue a certificate, which is valid for one year. The government's role in management and inspection is divided into three levels for implementing GAPs: the Department of Agriculture, the Ministry of Agriculture and Forestry at the Central level, the Provincial Department of Agriculture and Forestry, and the District Office of Agriculture and Forestry.

The duration of the GAP certificate does not sufficiently encourage farmers to improve practices; it requires a long process of 120 days to obtain the certificate, many detailed processes and the certificate lasts for one year, which does not align well with farmers' schedules.

The regulation on organic agriculture in the Lao PDR, by the decision of the Minister of Agriculture and Forestry regarding organic agriculture standards, no. 166/MAF, dated 30 December 2005, aims to promote clean agriculture applicable to all parties engaged in organic agriculture in Lao PDR. This decision outlines the principles, including the prohibition of chemical products in the agricultural production process. This regulation on the organic agricultural standard was one of the earliest to promote the improvement of agricultural production in the Lao PDR, particularly in vegetable production. However,

organic vegetable farming has been increasing, but it faces limitations in market expansion, which is one of the main limitations.

3.5.2 Fertiliser

The information on fertiliser regulations in the Lao PDR is presented, including the requirement for fertilisers, which plays a significant role in boosting productivity in commercial agriculture. The section below provides the regulations related to fertiliser management in the Lao PDR.

In accordance with the Decision on Fertiliser Management, No. 2169/MAF, dated 24 October 2013, which outlines the principles and rules for managing and inspecting all activities related to fertiliser operations in the Lao PDR. The regulation ensures that all fertiliser products comply with applicable laws, regulations, and international treaties to safeguard consumer rights, public health, animals, and the environment. Fertiliser management involves establishing fertiliser standards, which encompass packaging, labelling, advertising, unitisation, management, disposal, and business operations to ensure compliance with the technical principles and regulations of the Lao PDR. The decision specifies standards for all types of fertilisers, including chemical, organic, and bio. Each fertiliser must adhere to the standards outlined in this decision. Fertilisers that do not meet the standard requirements will be classified as unstandardised. Table 1 below presents the minimum rates of NPK and ingredients in various types of fertilisers in the Lao PDR, as specified by MAF in 2013.

Table 1: Standard nutrient requirement for inorganic fertiliser in Lao PDR.

Type	Standard
Ammonium sulphate	> 20 % of Nitrogen element < 3% of Moistness No adding color
Urea	> 44% of Nitrogen element < 1% of Violet < 3% of Moistness No adding color
Super Phosphate	> 20% Phosphorus (P2O5) < 0.5% Arsenic < 3% of Moistness No adding color
Double Super Phosphate	> 40% Phosphorus (P2O5) < 0.5% Arsenic < 3% of Moistness No adding color
Triple Super Phosphate	> 45% Phosphorus (P2O5) < 0.5% Arsenic < 3% of Moistness No adding color
Potassium Chloride	> 60% water soluble Potassium oxide (K2O)

	< 3% of Moistness No adding color
Potassium Sulphate	> 48% water soluble Potassium oxide (K2O) < 3% of Moistness No adding color

Table 1 displays the minimum government standards for fertiliser in Lao PDR. For ammonium sulphate, at least 20 percent of nitrogen is required, while urea must contain a minimum of 44 percent nitrogen and less than 1 percent violet (potassium content). All fertilisers used in Lao PDR must not contain any additional colour.

Activities related to fertilisers, such as production, import, export, sale, transportation, and storage, must be registered with the Department of Agriculture, Ministry of Agriculture and Forestry. The import and export of fertilisers must also be registered with the country of origin. The government bodies responsible for fertiliser management and inspection at the central, provincial, and district levels include the Department of Agriculture, Ministry of Agriculture and Forestry at the central level, the Provincial Department of Agriculture and Forestry, and the District Office of Agriculture and Forestry. Enforcement of regulations on fertilisers is challenging for officials due to informal and widespread trade between neighbouring countries. The review indicates that unidentified fertilisers or chemicals are still present in local shops and farms.

3.5.3 Official recommended fertiliser rates

Based on the FAO and WFP report on the Ministry of Agriculture and Forestry (MAF), recommended fertiliser usage rates, which are specified in Table 2 below.

Table 2: The MAF recommended application rate for fertiliser in Lao PDR.

Crop	**Fertilisers (NPK)**	**Annual recommend rate (kg/ha)**	**Total NPK ratio** Nritrogent (N) (Kg/ha/year)	Phosphorus (P) (Kg/ha/year)	Potassium (K) (Kg/ha/year)
Rice	16:16:16 46:0:0	250 165	116	40	40
Maise	16:16:16 46:0:0	300 200	184	48	48
Cassava	16:16:16 46:0:0	200 100	78	32	32
Sweet Potatos	16:16:16 46:0:0	100 0	16	16	16
Pulses	16:16:16 46:0:0	400 0	64	64	64

Source: the Food and Agriculture Organisation (FAO) and World Food Programme (WFP) special report on crop and food security assessment mission to Lao PDR, 2025.

Table 2 provides information on the government's recommendations for fertilisers use rates on specific crops, as noted, there are no recommendations for leafy vegetables. It suggests applying NPK (16:16:16) at 250 kg/ha per year and Urea (46:0:0) at 165 kg/ha per year for rice cultivation, which can be differentiated into 116 kg of nitrogen, 40 kg of phosphorus, and 40 kg of potassium per hectare annually. According to government recommendations, the advised amounts of nitrogen (N), phosphorus (P), and potassium (K) for growing maize are N: 184 kg, P: 48 kg, and K: 48 kg per hectare per year, respectively. The FAO and WFP (2025) report found that most farmers used rates below the recommended levels, especially in upland, remote areas, where inputs had higher prices due to transportation, and farmers believed that the soil had sufficient nutrients.

3.5.4 Chemical

The use of chemicals in vegetable production in Lao PDR was widespread, particularly in the influence of commercial agriculture, due to the rise in demand as well as foreign investment in cash crops production. The chemicals can be important tools for farm management, especially against insects and diseases. For commercial vegetable farming, chemicals such as insecticides, fungicides, and herbicides are essential because they provide the most benefit to the farmers, for instance, increasing and preventing loss of productivity. The paragraph below shows the existing standard regulations for chemicals used in agricultural production in the Lao PDR.

The Decree on Pesticide Management, No 258/GOV, adopted in 2017, outlines principles, regulations, and measures for managing and monitoring pesticide use to ensure safety for consumption and environmental protection, aligning with clean, green, and sustainable agriculture. Pesticide management involves monitoring pesticide use according to technical guidelines to prevent harm to the public and the environment. The decree classifies pesticides into five hazardous levels following WHO guidelines: extremely hazardous, highly hazardous, moderately hazardous, slightly hazardous, and unlikely to present an acute hazard. All production and import of pesticides for sale and use in the country must be registered with the Department of Agriculture, which the Insecticide Registration Board must approve. The registration certificate is valid for one year. For safety reasons, the regulation requires pesticides to be contained in solid containers or packages with clear labels in Lao, including instructions. Importers must obtain a permit to import pesticide products and comply with safety requirements, including packaging, labelling, transportation, and storage. Officials inspect products at the border for validity and integrity. All unregistered products are deemed prohibited under this decree. According to the Order of the Minister on Prevention of Unstandardised and Prohibited Pesticides in Lao PDR, No. 620/MAF, 13 July 2005, the prohibited pesticides under this order ban the ingredients of Parathion methyl and Monostrophan.

The Ministry of Agriculture and Forestry releases the list of banned insecticides in Lao PDR, No. 1766/DOA, dated 13 August 2019. The list comprises 13 types of prohibited herbicides, 51 types of insecticides, 50 types of fungicides, 2 types of rodenticides, 3 types of acaricides, and 1 type of molluscicide. Furthermore, the regulation on the control of pesticides in Lao PDR, No. 2860/MAF, dated 11 June 2010, outlines the

principles, rules, and measures for regulating activities involving pesticides in Lao PDR, aiming to protect human, animal, and plant health and the environment while ensuring alignment with international obligations and regulations that Lao PDR is committed to. This regulation also governs all parties involved in the insecticide business, including producers and import-exporters, who must adhere to regulations mandating them to register with the Ministry of Agriculture and Forestry. The chemical products must bear clear labels indicating ingredients and usage instructions. The regulation further stipulates that handlers must wear protective gear when applying chemicals.

3.6 Conclusion

This chapter provides an overview of agriculture in Lao PDR. The agricultural sector is crucial in Lao PDR, contributing not only to the economy but also to the social fabric. It establishes a solid basis for food security and income at the micro level, particularly in rural areas where agriculture is the primary livelihood. Lao PDR relies on imported inputs for farming; a variety of inputs are available and easily accessible. Although Lao PDR has adopted sustainable agriculture practices since 2008, many rules, regulations, and policies aimed at agricultural development attempt to promote sustainability and increase domestic production. However, many policies and set goals every five years have been difficult to meet. Farmers' practices often do not align with standards, and the farming system remains largely traditional. This raises concerns about safe production, as understanding farming practices is key to improving safety. The study aims to examine how farmers use fertilisers and chemicals on their farms, and what factors influence their use. The next chapter reviews existing research on fertilisers and chemicals use among vegetable farmers in Lao PDR, focusing on studies related to the use of fertilisers and chemicals in vegetable farming.

Chapter 4 Literature review on the use of fertilisers and chemicals in vegetable farming in Lao PDR and regional countries.

4.1 Introduction

Based on the FAO (2023) report, fertilisers use in Lao PDR was low, mainly due to high prices and farmers' beliefs about soil quality (FAO, 2023). It also found that the use of chemical products for pest and disease management was limited due to health and environmental concerns, high costs, and a lack of knowledge about their application. Most farmers control pests by hand removal, and homemade insecticides made from minerals and plants are the most common method of insect control. The report specifies that the insecticides imported from Thailand and commonly used daily include chlorpyrifos, diazinon, fipronil, deltamethrin, abamectin, and imidacloprid (FAO, 2023). Farmers usually obtain chemical products from local shops, and those near the borders often purchase them directly from Thailand (FAO, 2023). Pests and diseases affecting rice crops include brown plant hoppers, stem borers, thrips, leaf folders, snails, rodents, and crabs, all of which can be managed (FAO, 2023). The report also provides information on existing studies related to the use of fertilisers and chemicals among commercial vegetable farmers in the Lao PDR and neighbouring countries.

4.2 Fertilisers usage among vegetable farmers

The FAO and WFP 2025 report found that lowland farmers who grow rice, vegetables, and watermelon tend to apply more fertilisers on their farms; on the other hand, it indicated that fertiliser was not used in upland paddies, maize and cassava. According to the report, there was evidence of insufficient fertiliser application at the recommended rate, as the farmer applied a range of 0 to 250 kg of fertiliser per hectare in a lowland rice farm. The report also indicated that reliable data on fertilisers use and prices in the Lao PDR is lacking. For paddy plantation the report found used in high quantity of 46:0:0, and 16:20:0. In contrast, the report found the low amounts used of 15:15:15 and 16:8:8 (FAO, 2025). The standard types of fertilisers in vegetable farming included 46:0:0, 16:20:0, and 15:15:15 (ACIAR, 2020).

The ACIAR (2020) study involving 105 vegetable farmers in Lao PDR found that half of them used rice husk and manure, roughly 200 to 1500 kg/ha, purchased once or twice a year. The study did not specify fertiliser application rates, frequency, or plantation sizes. It noted that farmers often lack proper information on fertiliser efficiency and guidelines, which can lead to waste, improper nutrient levels, and potential toxicity from over-application, including chemical residues from pesticides. The study found that fertilisers use was not based on soil and crop information; the primary driving factor for application was cost (ACIAR, 2020). It indicated that NPK fertiliser application rates significantly impacted crop yields, with adjustments in phosphorus and potassium levels notably boosting broccoli production (ACIAR, 2020). The various NPK ratios tested on broccoli,

such as (N:260 kg, P:108 kg, K:322 kg per hectare per crop cycle), generated the highest yield increases of 5 kg and 10 kg compared to other formulations like (N:260 kg, P:130 kg, K:322 kg) and (N:260 kg, P:130 kg, K:130 kg) per hectare per crop cycle(ACIAR, 2020). As noted, the ACIAR study did not provide the specific types of NPK ratio of fertilisers but presented the recommended NPK ratio per hectare per annual crop. Based on this study, it demonstrated a 50 percent improvement in yield in leafy vegetables as applied to the recommended NPK standard while reducing fertiliser input in most cases. In Lao PDR, the use of NPK fertiliser did not meet the vegetable demand; the ACAIR demonstrated that applying appropriate NPK fertiliser to the crop demand could completely improve crop productivity. Nonetheless, fertilisers use in vegetable farming could benefit from more precise data on application rates, frequency, and specific areas of use.

One of the studies on peri-urban commercial vegetables in three districts—Sikhodtabong, Hadxayfong, and Saysettha—used a survey and descriptive statistics analysis, involving a total of 300 participants: 100 vegetable farmers, 100 market sellers, and 100 consumers. The study is relevant to this research as it involves vegetable farmers in the Hadxayfong district. The study analysed the influence of vegetable production. The average size of the vegetable production area in this study was 3,500 m^2 87 percent presented having farm less than a hectare. The main reasons farmers grew vegetables were to earn extra income, meet their families' consumption needs, and improve their livelihoods. The average yield for eggplants was 31,940 kg/ha, lettuce was 34,150 kg/ha, cucumber was 24,370 kg/ha, and tomato — *Solanum lycopersicum* L. was 26,720 kg/ha. However, the study did not provide a clear indication of the average yield per year or crop cycle. The study described farmers' seed selection based on producing good yields and tolerance to pests and diseases. The study demonstrated that the common fertilisers in vegetable farming were 61 percent of participants applied urea, 28 percent used 15:15:15, 7 percent used diammonium phosphate and 5 percent used ammonium sulphate and solophos.

The study report the average use if urea was 1,330 kg/ha (133 g/m^2) of urea (N: 611.8 kg/ha), 1,740 kg/ha of 15:15:15 (N: 261 kg/ha, P: 261 kg/ha, K: 261 kg/ha), and 900 kg/ha of diammonium phosphate. The average frequency of fertiliser application per crop cycle was three times for urea, twice for diammonium phosphate and 15:15:15—application frequency influenced by farmers' behaviour, fertiliser type, and crop. Additionally, animal manure and chicken dung were heavily utilised among vegetable farmers. Most vegetable farmers practice monocropping, growing the same crop in the same area over extended periods, which results in limited crop rotation (Potutan et al., 1998).

4.3 Chemical use among vegetable farmers

The study found that 99 percent of the vegetable farmers applied chemical to protect their crops from the threat of insects (Potutan et al., 1998). Based on the study by Schemaker (2017) on pesticide use among small vegetable farmers in Vietnam, Cambodia and Laos, it was found that there was a high dependence on insecticides for pest management. The types of chemicals found in vegetable farming included insecticides, herbicides, fungicides, and bio-pesticides, which farmers reported using in various brands. These included insecticides such as Karate, Lanate, Folidone, Malathion,

and Tamaron; herbicides like Gramoxon, Power, and Roundup; and fungicides like Daconil, Benlate, and Dithane(Potutan et al., 1998). The study found 96 percent of the farmers were not interested in organic farming. The use of chemicals in vegetable farming was for pest and disease management and to increase productivity. Farmers sprayed the chemical by using a spraying machine (knapsack sprayer), where the use rate was measured by tablespoon (75%), and the use of the measuring device was less than 10 percent. Farmers tended to mix different chemicals in a single spray, which farmers apply more frequently in Lao PDR than in Vietnam and Cambodia, due to the lower opportunity cost, while farmers in Vietnam and Cambodia applied at a higher rate than in Lao PDR (Schreinemachers et al., 2017). The frequency of chemical use in vegetable farming was 1 to 3 times per month (ACIAR, 2020). If farmers were dissatisfied with chemicals, they tended to try other products, consult with extension agents, and increase their usage rate. Getting advice on chemicals, farmers in Lao PDR tended to be friends and neighbours, and leading farmers (Potutan et al., 1998; Schreinemachers et al., 2017). Most farmers acquired the chemical using practice from reading the label (85%), personal experience (32%), sellers (17%), and other experienced farmers (11%) (Potutan et al., 1998).

Another study by Schreinemachers et al. (2020) on quantifying pesticide overuse in vegetable production in Southeast Asia (Vietnam, Laos, and Cambodia) indicated that farmers in the Lao PDR exhibit 59 percent of pesticide overuse, which the study measured as the percentage of the total value of pesticides used over the economic optimum. The overuse of pesticides in Vietnam was 100%, and in Cambodia, it was 70%. The study found that the factors influencing the overuse of insecticides among farmers were false information from input sellers and the belief in the effectiveness of chemical use. The study helps to explain the use of chemicals in the regional countries, where vegetable farming requires high chemical inputs that lack proper application (Schreinemachers et al., 2020b).

4.4 Chemical use in vegetable farming practices

For the protection of chemical use, the study found that none of the participating vegetable farmers had fully protected themselves as per the standard requirements, as their mouths, eyes, and hands were less commonly covered (Potutan et al., 1998; Schreinemachers et al., 2017). Both of the studies found that most farmers had a good awareness of the health effects of chemicals from their use, with 47 percent of farmers reported they had experienced illness from using chemicals, such as headaches, shortness of breath, chest pain and skin irritation. The awareness of chemical health risk was insufficient to affect rates of chemical use among farmers, as 4% of the Lao farmers reported feeling unconscious after spraying (Schreinemachers et al., 2017). The commercial vegetable farmers in peri-urban areas were dependent on the use of fertilisers and chemicals, and farmers tended to have little interest and believed in the ineffectiveness of biological products. Most farmers report being satisfied with the effectiveness of insecticides and the necessity for vegetable farming (Schreinemachers et al., 2017), which has helped them produce higher yields (Potutan et al., 1998). Based on the study by Schreinemachers et al. (2017), it is reported that among vegetable

farmers, mixing chemicals is believed to make them more effective and good insecticides, as they kill immediately (Schreinemachers et al., 2017).

4.5 Factors that impact smallholder farmers' use of fertilisers and chemicals

The impact of the use of pesticides among farmers found that shopkeepers were the most influential on the range of pesticides, while friends or neighbours had a moderate effect on the usage rate of farmers (Schreinemachers et al., 2017). However, the extensionists did not have a significant impact on chemical use (Schreinemachers et al., 2017). Farmers' awareness of health risks was not strongly associated with reduced pesticide use among farmers (Schreinemachers et al., 2017). Nonetheless, farmers who strongly believed in the effectiveness and necessity of pesticides tended to use more (Schreinemachers et al., 2017). The price of pesticides was negatively linked to farmers' use of chemicals, showing elasticity; a 1% increase in price led to a 1.1% decrease in pesticide use. Using biopesticides and handpicking insects were also associated with reduced chemical use. On average, farmers who applied biopesticides used 31% less pesticide (Schreinemachers et al., 2017).

The study on small farmers in Hebei Province, China, showed that farmers' firsthand experience and crop development, such as growth and density, were the most important factors influencing small farmers' decisions about fertiliser use (Zhou et al., 2010). The second factor was how effective the fertiliser impacted crop productivity. The research also revealed that the costs of fertiliser and the availability of capital were not seen as crucial in deciding to use fertiliser, as farmers would apply it at the right amount to ensure good crop yields (Zhou et al., 2010). Another factor influencing farmers' choices was that, if the soil was poor, more fertiliser was used (Zhou et al., 2010). Access to fertiliser also played a role; farmers in remote areas tended to use less because of limited access (Zhou et al., 2010).. The research found that fertiliser use (nitrogen) often exceeded recommended NPK balance levels, which was related to education levels (Zhou et al., 2010). Education plays a crucial role in reducing nitrogen overuse among small farmers (Zhou et al., 2010). A lack of guidance on selecting suitable fertiliser levels for their land may have led to excessive nitrogen fertiliser application (Zhou et al., 2010). Notably, the study also found that small farmers often lacked an understanding of soil nutrients, mainly due to inadequate extension services, which were insufficient to offer proper guidance on fertiliser use (Zhou et al., 2010). One of the factors influencing fertiliser application showed that farmers' self-interest, related to maximising profit, did not lead to reduced fertiliser use (Hamid et al., 2021). Farmers made decisions about fertiliser based on the belief that reducing fertiliser use could lead to a decrease in crop yield (Hamid et al., 2021). The case study found that farmers in Egypt think that increasing fertiliser use will boost crop growth and profits, so they tend to apply more fertiliser than necessary (Kassam & Dhehibi, 2016).

4.6 Conclusion

The literature reviews highlighted various fertilisers and chemicals used in vegetable farming in the Lao PDR and neighbouring countries with similar environments and

climates. The review revealed that many Lao farmers, particularly in remote and rural areas where economic benefits are low and access to inputs is difficult, use insufficient amounts of fertilisers and chemicals. For commercial vegetable farming, where farmers have adequate access to these inputs, many reports indicated that fertiliser and chemical application remains insufficient. The review offers an overview of vegetable farming practices and the levels of fertiliser and chemical use among farmers in the region. Factors influencing farmers' use of these substances are mainly linked to personal experience regarding their effectiveness on crops. Cost was identified as not being a primary factor affecting usage. Education was recognised as a valuable resource for promoting the proper use of chemicals, considering environmental and health impacts.

Chapter 5 Research Methodology

5.1 Introduction

This chapter describes the research method used to examine how vegetable farmers in Hadxaifong district, in the southern part of Vientiane Capital, Lao PDR, apply fertiliser and chemicals. The district is located along the Mekong River, which makes it ideal for agricultural activities, particularly vegetable farming, supporting the most populous province and generating revenue for other areas. This study employed qualitative methods to collect data for a deeper understanding of how small-scale vegetable farmers use fertiliser and chemicals. The procedures for selecting participants, gathering data, and analysing are outlined below.

Vientiane, the capital of Laos PDR, is located in the central region along the Mekong River, with a population of 840,940 in 2023 (KPL, 2024). Vientiane Capital plays a vital role in agriculture, as its geographical area is known as the Vientiane Plain, a key farming zone. Vegetable cultivation in Vientiane covers 8,428 hectares, producing 56,271 tonnes, with Hadxayfong district having a larger area and higher output than other provinces (NAFRI, 2007). Most vegetables were sold through small retail stores and traditional wet markets (World Bank, 2018). The vegetable farming system faces challenges such as poor crop management, limited crop diversity, and issues with pests and diseases, resulting in low yields, poor quality, and high production costs. The World Bank's 2018 report emphasised the need for stricter regulation of food safety standards and inspections among vegetable growers, which contributes to the production of low-quality produce and growing consumer concerns about food safety and sustainability. Furthermore, rapid urbanisation and the rising number of consumers with higher incomes and education levels have increased demand in Vientiane Capital for clean, safe vegetables that meet sanitary standards.

Vientiane Capital comprises nine districts, four of which (Chanthabouli, Sisattanak, Sikhottabong, and Xaisettha) were engaged in core commercial activities, while the remaining five (Sangthong, Naxaythong, Xaithni, Hadxayfong, and Pakngum) relied on small-scale farming (Ikeguchi & Onsy, 2011). The study was conducted in Hadxayfong, where a significant portion of vegetable production is supplied to local markets in Vientiane Capital, with approximately 50 percent of fruits and vegetables sourced from Hadxayfong. The Hadxayfong district is situated southeast, 19 km from Vientiane's city centre along the Mekong River. Its primary economic activity is agriculture, including rice farming. This district accounts for 60 percent of leafy vegetables and 45 percent of fruit vegetables; the total vegetable production here was 27,536 tonnes (Kethongsa et al., 2004; NAFRI, 2007). The target population for this study comprises commercial vegetable farmers in Hadxayfong, Vientiane Capital, who are actively involved in vegetable farming.

Figure 1: Lao PDR map

Source: laos-guide999.com



Figure 2: Districts Map in Vientiane Capital

Source: gaia-vita.com



5.2 Research approach

This research employed a qualitative approach and adopted a semi-structured interview medthod. This design was chosen because it allows the study to gain deeper insights into farmers' perceptions, experiences, attitudes, opinions, and motivations, rather than just facts or behaviours (Busetto et al., 2020). This method effectively explores perception and opinion (Barriball & While, 1994). It enhanced the investigation of key factors in vegetable practices that led to the use of fertilisers and chemicals. Importantly, the method also facilitated building trust and reducing suspicion, encouraging greater openness among the interviewed farmers, which aligned with the research objectives (Goto & Douangngeune, 2014). The study chose Hadxayfong district, which was identified as the most productive area for vegetable cultivation for commercial purposes. By applying a semi-structured interview, the research was able to explore further the reasons behind farmers' decisions, challenges, and understanding of factors influencing the use of fertilisers and chemicals in vegetable farming through the interviews (Ritchie et al., 2003). Semi-structured interviews enable the researcher to clarify concepts during conversations, ensuring responses accurately reflect farmers' perceptions. Moreover, this method captures the subtleties of farmers' views, including potential conflicts between their desire to farm sustainably and the economic pressures they face.

Initially, before conducting the interview for data collection, the researcher visited the field to observe the location, environment, culture, farmers, and community involved in commercial vegetable farming. The field visits for this research took place in December 2024. After exploring various vegetable farming areas in the Hadxayfong district, the study area was identified as the regions with large-scale commercial vegetable farming. The research aimed to engage directly with farmers during these visits, but this proved challenging due to timing issues. Farmers stuck to their work schedules, and when approached during working hours, they found it difficult to participate in the interviews. Furthermore, this approach was seen as unusual by the farmers, which contributed to their reluctance to take part. To overcome the limitations of the initial method, the researcher used a relationship-based approach to engage with farmers in the identified vegetable production areas. This strategy initially involved making contact through colleagues and friends familiar with some farmers in the study areas. The subsequent method involved a snowball sampling approach at the beginning and chain-referral sampling at the second stage, where interviewed farmers helped the researcher connect with other farmers they knew. By applying this approach, the researcher was able to build trust, allowing farmers to express themselves more freely, reducing false information, and minimising bias. The research methods for key informants such as officials, village leaders, and traders included both direct contact and referrals from farmers and colleagues.

5.3 Participant and interview method

A purposive sampling technique was used to select four key informants, and snowball and chain-referral sampling were employed for the farmers who participated. This research sampling method ensures inclusion of participants with specific

characteristics, such as diverse backgrounds and knowledge in commercial vegetable farming, in the study.

5.3.1 Interview

The semi-structured interviews collected data for this research, involving 25 participants (21 farmers and 4 key informants). A semi-structured interview allows researchers to gather in-depth information, while an interview guide ensures that key topics related to sustainable agriculture are addressed (Ruslin et al., 2022). This research is primarily based on information collected through the topic guide, which was designed differently for key informants and commercial vegetable farmers in Hadxayfong District, where the study was conducted. The semi-structured interview helped the researcher establish a relationship and trust with the interviewed farmers and officials. The topic guide and consent forms were initially prepared in English and then translated into Lao for use with farmers and key informants prior to the interview in Appendixes 1,2 and 3.

The interview followed the topic guide, divided into six main themes: participant background information, farm information and practices, input details, application of fertilisers and chemicals, production, markets, and knowledge of production safety. For the key informant, the information gathered covers overall output in areas such as policy, trade, and farming conditions across the study regions. Beyond the data this study aimed to collect, the experience from the interview helped the research explore the characteristics, culture, environment, and society of vegetable farming in the study area, strengthening the connection of this study to actual farming practices. During the interview, the researcher built a good rapport with some farmers, which enabled discussion of various agricultural topics and a deeper understanding of farmers' perceptions. The interview followed a structured topic guide, ensuring consistency and focus while allowing open-ended questions to explore both anticipated and unexpected themes. Each interview lasted approximately 30 to 120 minutes and was conducted in person from January to February 2025. All interviews were audio-recorded with the participants' consent. The information collected was transcribed into Lao and categorised in English for theme analysis in this research.

5.4 Data Analysis

The data collected from the semi-structured interviews were analysed using thematic analysis. This method was chosen because it identifies key themes and patterns across the dataset, enabling a comprehensive understanding of the farmers' perceptions of sustainable agriculture (Cristea et al., 2019). The following steps outline the process of data analysis:

All recorded interviews were listened to multiple times and transcribed into Lao. Each participant's interview was reviewed thoroughly, and their responses were transcribed accordingly. After transcribing interviews with all farmers and key informants, themes for the research study were developed based on the research objectives and design. Additionally, new themes emerged during the data analysis. Once the themes were established, the information from the interview transcripts was distilled, analysed, and

categorised into themes. The analysed information was then translated into English based on the Lao transcripts. The thematic process began with a line-by-line review to identify important concepts and recurring words, phrases, or ideas related to the farmers' perceptions, experiences, and challenges regarding the use of fertilisers and chemicals in vegetable farming. Some similar themes were categorised into more defined categories, helping to highlight relationships between different themes and allowing the researcher to refine the key themes emerging from the data. The most significant themes were identified and represented the core findings of this study.

This research presents the findings in the descriptive section that detail the nature of vegetable farming in the study area. The information in the explanatory section mainly draws on data collected, stories from farmers, interactions, and eyewitness experiences from field visits. These perspectives offer a clearer picture of vegetable farming as it was studied. It is also important to help understand why farmers do what they do, which will make the study more relevant to their farming practices.

The results are analysed in relation to the use of fertilisers and chemicals among vegetable farmers. The analysed results are based on information collected, such as bed size, fertiliser, chemicals, application practices, usage rates, and other factors. All relevant information was gathered and identified in the practices. The findings examine how fertilisers and chemicals are utilised in commercial vegetable farming. The study also looks at the factors influencing the use of fertilisers and chemicals, highlighting the key aspects of their application. The presentation of research findings synthesises the themes and insights from the analysis, presenting them clearly and in a structured manner to ensure the data analysis effectively addresses the study’s objectives.

5.5 Ethical considerations

Ethical approval for this study aligns with the Human Ethics Committee at Massey University classified as low risk. Before participating in the study, informed consent was obtained from all participants. The participants were informed of their right to withdraw at any point and assured that all data would be anonymised and kept confidential. The interviews were recorded with the participant’s permission. All data collection was securely stored at Massey University.

5.6 Conclusion

The methodology outlined in this chapter describes the approach taken to investigate the use of fertiliser and chemicals among vegetable farmers in Hadxayfong District, Vientiane, Lao PDR. The semi-structured data collection facilitates qualitative data gathering, enabling us to gain a comprehensive understanding of vegetable farming practices (Holton & Burnett, 2005). The data obtained from this research were analysed and presented in a narrative that reflects the nature of vegetable farming in the descriptive findings. The findings also highlighted the farmers' practices and the factors influencing the use of fertiliser and chemicals in vegetable production. The following chapter discusses the research and the results of the data analysis, based on the methods outlined above.

Chapter 6 Descriptive information on research context

6.1 Introduction

Vegetable farming is fundamentally significant to the country's infrastructure. It contributes to the social economy and provides food for people across all levels of society. According to the Food and Agriculture Organisation of the United Nations (FAO), the 2025 report states that Lao PDR is one of the world's most agriculture-dependent economies, with approximately 90 percent of the population engaged in agriculture. According to the community leader and head of the farm group in Hatkansa Village, approximately 80 to 90 percent of the villagers are involved in agricultural activities.

This research was conducted in Hadxayfong District, one of the nine districts in Vientiane, alongside the Mekong River, the largest river that borders Thailand. In this district, agricultural activities are very predominant. Most vegetable farming is traditional and mainly subsistence-based, while also engaging in market-oriented agriculture. The importance of agricultural output in this area lies in its provision of a sufficient food source for people in the province and its neighbouring provinces. According to a district official, no agricultural management system assists farmers in planning crop planting, stabilising prices, promoting the overproduction of specific crops, and aiding in diversifying crop planting. Farmers tend to grow crops based on predictions. There is no processed market, and only fresh products are consumed.

The descriptive chapter provides an overview of vegetable farming in the areas where the research was conducted. It also presents the characteristics and dynamics of vegetable farming, including farming practices in the context of studying fertiliser and chemical application. This chapter aims to offer insights for understanding the nature of vegetable farming. The information presented in this chapter is primarily based on data gathered from interviews with participating farmers, village heads, and officials, as well as official reports and publications. The descriptive information provides readers with details on farming practices in Lao PDR, including environmental, social, and cultural aspects related to farming.

6.2 Geography

6.2.1 Location

Hadxayfong District is in the southeastern part of Vientiane Capital, Lao PDR. It is situated along the Mekong River and borders Thailand. Figure 3 shows the country map and the capital city of Vientiane. This map provides a better understanding of the country's geography. According to the head of Hatkansa village and community, who also works for the district administration, the Hadxayfong district comprises 60 villages, including 35 located along the Mekong River. According to the Lao Statistics Bureau, the population in Hadxayfong District was 121,003 in 2025.

The research area is a mix of semi-urban and rural areas, and importantly, it borders both urban and rural zones. Figure 4 shows the areas of Vientiane, which consists of nine districts. The circled area is in the southern part of the Hadxayfong district where the research was conducted. Figure 5 provides a clearer view of the geographic research location highlighted in red. The area is in proximity to Vientiane; it is well-suited for commercial agriculture, particularly vegetable cultivation.

The river enriches this area by providing irrigation for agriculture and supporting fishing activities for the local population. The agricultural area is situated in a lowland region characterised by relatively flat terrain, fertile alluvial soils, and access to water sources from rivers, canals, and small-scale irrigation systems. These features enhanced the cultivation of a wide range of crops year-round, particularly during the dry season, when other areas lack sufficient water resources. The primary agricultural activities include vegetable, rice, fruit cultivation, livestock, and fish farming.

Figure 3: Map of the Lao PDR and Vientiane capital city.

Source: https://www.shutterstock.com/image-vector/vientiane-prefecture-location-on-map-laos-2214095057

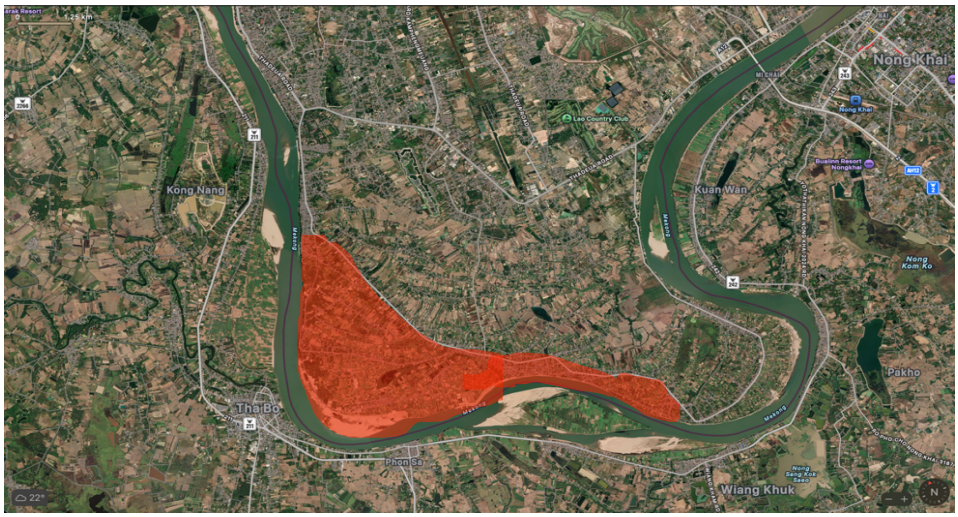


Figure 4: Vientiane and nine districts. The red circle indicates the location of the research conducted. source (JICA, 2011)



Figure 5: The conducted study area is highlighted in red.

Source: The map captured through Google Maps. The highlighted in red was by Paliphon Bounlu



Vientiane's agricultural areas encompass 10,000 to 11,000 hectares, producing over 100,000 tons of agricultural products, as reported by the provincial officer interview. The leaders of Hatkansa and Thakhek villages mentioned that 80 percent of the villagers are farmers, primarily engaged in vegetable farming. The district official provided information

on vegetable production in the Hadxayfong district, the largest vegetable producer in Vientiane, which contributed about 70 to 80 percent to the markets in Vientiane. This highlights the significance of vegetable supply in this area. A local trader also added that the supply of vegetables in these areas is not only for Vientiane but also extends to other provinces.

6.2.2 Environment

In the Lao PDR, there are two distinct seasons: the rainy season and the dry season. The rainy season, or monsoon, lasts from May to mid-October, while the dry season spans from mid-October to April (World Bank, 2021). Rainfall occurs from June to September, with substantial rainfall in June and July. According to the World Bank's (2021) report, the annual rainfall can reach up to 3,000 millimetres per year. According to some interviewed farmers, they described the climate patterns as follows: a cool climate of 20 °C to 30 °C from October to February, a hot environment of 30 °C to 40 °C from March to May, and rains start from June to September.

There are seasonal floods, and agricultural activities in these areas are at high risk. In September 2024, the Lao PDR was severely affected by widespread floods, impacting sixteen provinces (United Nations Lao PDR, 2024). Village heads and some farmers report that the flood had a significant effect on agricultural production. One farmer states that the water level on his farm rose to more than 1.50 metres. The flood destroyed farm plantations, causing farmers to lose a substantial investment in their properties. The head of Hatkansa village notes that the 2024 floods also disrupted the cultivation plan, forcing many farmers to switch to growing tomatoes, which resulted in lower prices.

6.2.3 Soils

The agricultural areas where the research was conducted are in a lowland alongside the Mekong River, characterised by relatively flat terrain. Soil tests in Vientiane revealed low to moderate nutrient levels, and soils used for vegetable production in Lao PDR are identified as having low fertility, often associated with acidic conditions, particularly Acrisols, including those found in the Mekong River valleys (ACIAR, 2020). However, most farmers interviewed reported that they never test their soil. Additionally, some farmers claim that the quality of their farms' soil is inadequate for growing their preferred crops due to nutrient deficiencies, which lead to crop mortality and hinder their growth and development.

6.3 Background information on agricultural farming in the study area

Hadxayfong District, especially the villages along the Mekong River, is known for growing tobacco, jujube, sugarcane, and sapodilla, according to the leaders of Thakhek and Hatkansa villages and some farmers. Some farmers who grow tobacco explained in interviews that cultivating tobacco involves a lot of work, including harvesting, drying, and cutting. The tobacco harvesting process takes about three months. However, falling tobacco prices had led to lower profits for growers, making the effort less worthwhile. In

the past, farmers heavily depended on insecticides to fight pests that damaged their crops.

Some farmers interviewed explained that in the past, crops grew better than under current farming methods. They said growing crops today is more challenging and requires higher amounts of fertiliser and chemicals to get a good yield. They believed that the soil had better quality and more nutrients in the past, with lower use of fertilisers and chemicals. Farmers also mentioned that the soil has lost nutrients because of the overuse of fertilisers and chemicals in farming. Today, nearly all farmers interviewed feel they are earning less than before, mainly due to high input costs and fluctuations in vegetable prices. Irrigation has improved compared to the past, as farmers now have better access to water.

A farmer notes that previously, for growing crops on a 1,600 m^2 area, he used one to two 50-kilogram bags per crop cycle. Nowadays, he says the usage has risen to at least three bags of the same size per cycle. The fertiliser application frequency in the past was less than twice per crop, but now it is three to four times per crop. Some farmers have observed an increase in pests, leading them to apply more insecticide.

The influence of urbanisation and the market has changed farmers' cultivation of crops. More people are growing vegetables, which are common food ingredients, including coriander, water spinach, coconut, tomato, eggplant, and chilli pepper.

6.4 Farmland

In Hadxayfong District, many vegetable farms are in seasonally flooded lowlands. These lowlands retain water during the rainy season, making them ideal for rice cultivation and subsequent dry-season vegetable production. In contrast, upland farms continue to produce vegetables during the rainy season. The farmlands range from 0.16 to 2.4 ha. According to the Head of the Hatakansa village, the average farm size in Hatakansa village is about 2 – 3 rai (3,200 – 4,800 m^2), and 80 percent of people are farmers. There are two types of farmlands: rented and owned, with about half of the participating farmers renting farmland at a payment range of 76.9 to 230 NZD[1] (1,000,000 - 3,000,000 LAK) for areas of 1,600 m^2 per year.

6.5 Crops

Farmers cultivate a wide range of vegetables, and each farmer grows more than two varieties of crops, including leafy and fruiting varieties. Based on the data obtained from the interviews, the leafy vegetables that most farmers grow are coriander, lettuce, choy sum, and dill. The fruit and vegetables grown by farmers include chilli peppers, cucumbers, long beans, and tomatoes, among others.

[1] . Exchange currency based on 1 New Zealand Dollar (NZD) = 13,000 Lao Kip (LAK)

Figure 6: Leaf vegetable crops among farmers interviewed.

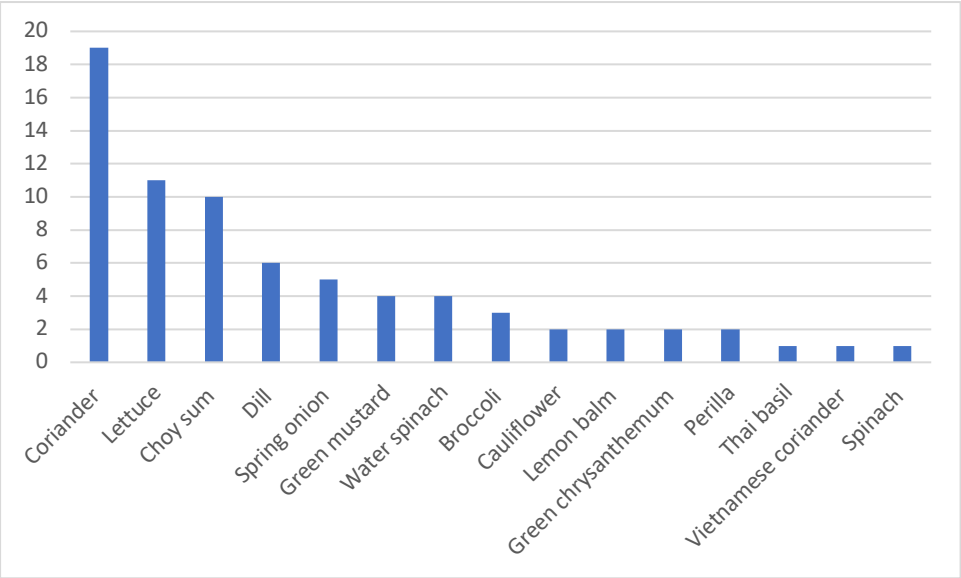


Figure 6 shows the number of farmers interviewed grew different kinds of leafy vegetables. Most farmers have experience growing coriander, while lettuce and choy sum are the second most popular crops on their farms. Crops like dill and spring onion are commonly used in everyday Lao family meals. However, these crops require different farming techniques, which will be discussed in a later chapter. Figure 6 illustrates the trends among farmers interviewed regarding leafy vegetable farming and also shows a variety of crops cultivated in these areas.

Figure 7: Fruit vegetable crops grown among farmers interviewed.

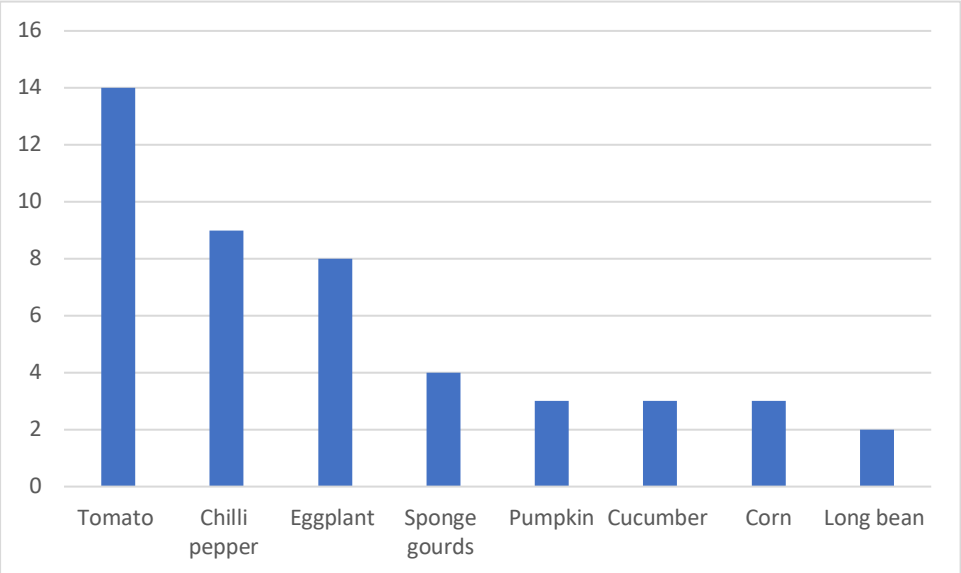


Figure 7 shows the number of farmers interviewed grew different fruits and vegetables that most farmers grow. According to the research data, most farmers interviewed reported growing tomatoes. Chilli pepper and eggplant are ranked as the second preferred crops to grow. Other crops, such as sponge gourds, pumpkins, cucumbers, long beans, and corn, are found growing in the area. Figure 7 provides information on the fruit-type vegetables that farmers grow on their farms.

Figure 8: Non-vegetable crops grown in the research area.

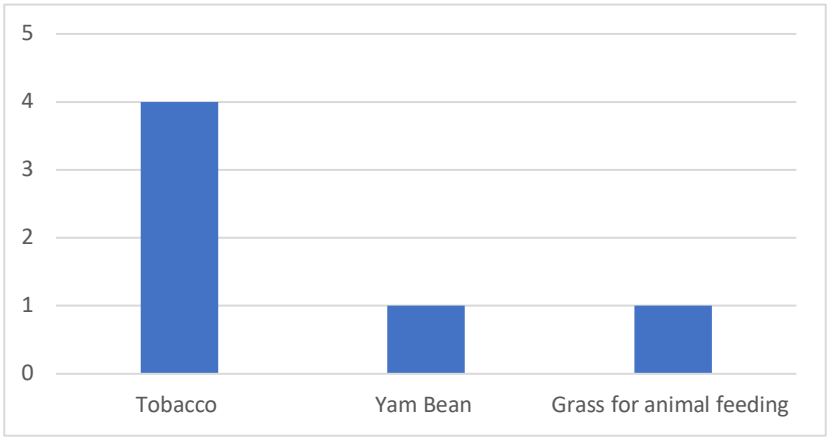


Figure 8 shows non-vegetable crops that interviewed farmers also cultivate on their farms. Some farmers grow tobacco and vegetables at the same time. According to the data, a few farmers grow yam bean, jujube, and feed grass. This figure gives a clear overview of the farms, where farmers grow a variety of crops.

6.5.1 The factors that contribute to the selection of the crop

Based on the research data, most interviewed farmers consider that crop growth largely depends on seasonal factors and their assessments of which will be the most profitable. Some farmers mention that environmental conditions affect the type of crops, which in turn influence farmers' decisions because certain types of crops perform well in specific weather conditions. Vegetable prices, market demand, and investment cost contribute significantly to farmers' decisions on selecting a crop. Different crops require different farm practices. For example, growing sponge gourds and cucumbers requires high costs for poles and ropes.

Cultivating a wide variety of vegetable types provides options for traders and reduces risk for farmers when certain crops have low prices. A farm typically grows between two and six different kinds of crops. Additionally, pests are a factor that influences crop selection, as some farmers prefer to use fewer insecticides. Soil quality has a significant influence on crop selection, with some farmers reporting that their soil is unsuitable for growing certain vegetables. The choice of crops also relates to their productivity; some farmers opt to grow crops with longer production cycles, such as eggplant, chilli pepper, sponge gourd, and tomato. A growing trend also impacts farmers' decisions, with some aiming to cultivate crops that are not widely grown.

6.6 Pest and disease

Based on the research information from farmers interviewed, most farmers described the pest population as particularly intense during the dry season, especially in the hot temperatures from March to May and during the rainy season. Farmers provided details on common pests in the area, such as aphids, worms, flea beetles, thrips, caterpillars, mealybugs, spider mites, and cabbage loopers, as well as mildews. Conversely, diseases tend to occur during the rainy season, which, according to most farmers, lead to problems with leaf spot disease, root rot, and leaf rot.

6.7 Farming practices

Most farming in the researched areas is typically small-scale and commercial. Participating farmers mainly rely on traditional techniques and limited mechanical agricultural equipment, conducting farm operations manually. Research data indicate that there are typically fewer than three workers per farm, often comprising family members. The farm owner is primarily responsible for every stage of farm management, although some farmers hire labourers to help during harvest time. Fertilisers and chemicals are applied in vegetable farming in the areas, contributing to productivity and market demand. Most farmers use fertilisers and chemicals based on their experience, perceptions, and knowledge gained from seasoned farmers, as a district official states that farmers learn from one another. If a farmer produces a good yield, other farmers often emulate the same methods for agricultural inputs. The head of the Hatkansa village notes that each farmer has their approach to farming.

6.7.1 Farm practices vary by season

Rainy season

Most farmers reported that growing vegetables during this season is challenging due to root and leaf disease, which often causes rot. Farmers have to increase the height of the vegetable beds, improve drainage in the beds and avoid root rot. The rainy season requires additional farm equipment such as poles, ropes, and sunshade sheets. Seed germination in the rainy season also poses a risk, as heavy rainfall causes crops to rot and be affected by disease, requiring farmers to apply more chemicals to prevent productivity loss. However, few farmers report that they prefer to grow choy sum and coriander during the rainy season. Growing choy sum during the rainy season is less challenging due to fewer insects, and coriander tends to have a higher price because of low productivity caused by diseases. The village head of Hatkansa states that many villages in the area grow rice during the rainy season and vegetables in the dry season. Due to some areas being low-lying, which become wetlands during the rainy season.

Dry season

The dry season is divided into two distinct climates: cool and hot. These different climates help provide a better understanding and connection to the information

presented by the surveyed farmers, which aims to describe their experiences to the researcher.

From October to February, farmers describe a cool climate that they believe is optimal for vegetable cultivation. They explain that during this period, crops thrive and have high yield. Pests and diseases are minimal, and fertilisers and chemicals are used sparingly. However, vegetable prices in 2025 have fluctuated and decreased.

From March to May, in a hot climate, most farmers report that growing vegetables during this period takes longer. The challenge of growing vegetables is the hot weather, which can cause crops to wither and die. Additionally, the rise in pests due to high temperatures complicates matters for farmers, necessitating the use of insecticides to combat increasing insect populations. In this hot climate, farmers use sunshade sheets to limit sunlight exposure on their crops. Some farmers consider these months the most challenging for cultivating choy sum, as managing insects, especially flea beetles, becomes particularly difficult.

6.8 The sections below provide information on the stages of vegetable farming

6.8.1 Land preparation

Before cultivating any crop, all participating farmers prepare their land by ploughing and harrowing with a large tractor. Most farmers pay between 38 – 46 NZD (500,000 to 600,000 LAK) to plough and harrow 1,600 m^2 of land. After this, they use a walking tractor to plough a second time. Image 1 shows a farmer making vegetable beds using a manual row maker. After making beds, image 2 shows the overall picture of the characteristics of a vegetable bed. The size of the beds is typically wide, ranging from 1.20 to 1.50 metres in width and 25 to 30 meters in length. However, the bed size is based on the land's characteristics and must accommodate the dimensions of the sunshade sheet. Some farmers cover the beds with plastic to prevent weeds, as shown in images 3 and 4. The pictures below illustrate the process of making vegetable beds and their characteristics.

Image 1: A farmer uses a tool to make vegetable beds

Source: Paliphon Bounlu (2025)



Image 2: An overview of the vegetable bed

Source: Paliphon Bounlu (2025)



Image 3: A farmer covers vegetable beds with plastic

Source: Paliphon Bounlu (2025)



Image 4: Chilli pepper beds covered with plastic

Source: Paliphon Bounlu (2025)



6.8.2 Weeding

Most farmers involved in vegetable growing use herbicides to manage weeds. Usually, they applied herbicides after preparing the land, either before or after sowing seeds. They might also spray herbicides after seed germination if they notice weeds. Herbicides were mixed with 20 litres of water and applied to the vegetable beds. Some farmers were unaware of the product's name or ingredients because they purchase small quantities. However, about seven out of twenty-one farmers interviewed chose not to use herbicides at all, instead ploughing and digging out weeds or covering beds with plastic, as shown in image 3 and 4. The reason for covering with plastic is to prevent the application of herbicides, which can degrade soil quality and pose potential health risks.

6.8.3 Seeds

Most farmers get their seeds from local agricultural shops that import seeds from Thailand, Vietnam, or China. Some farmers produced their vegetable seeds using local seeds or the original local crop genetics. For planting coriander, dill, and choy sum, farmers sow the seeds and cover the beds with sunshade sheets to encourage germination, as shown in image 5. In contrast, for tomatoes, cucumbers, and eggplants, farmers initially plant the seeds in trays or separately until the plants are ready to be transferred to the beds.

Image 5: Covering vegetable beds with sunshade sheets after sowing seeds.

Source: Paliphon Bounlu (2025)



6.8.4 Irrigation

Most participating farmers depend on groundwater, while those near a river use water from the river or ponds. They employ a pump irrigation system. Farmers water their crops using methods like manual watering, sprinklers, and plastic tubes with small holes along the planting beds. Images 6 and 7 show how some farmers manually water their vegetable plants. Some farmers find that plastic tubes are more efficient because they allow precise watering and reduce water wastage. Image 8 shows a plastic tube used in vegetable farming. Farmers need to move the tube every 20 minutes; one watering can cover four vegetable beds. They say this method is effective because it keeps the soil moist for longer. They usually water once every two to three days.

Regarding sprinklers, some farmers say they are costly, and the sprinklers often break down. As shown in image 9, some farmers use sprinklers for farm irrigation. The expenses for irrigation include pumps, pipes, and electricity; drilling groundwater costs more than 769 NZD (10,000,000 LAK); these costs are part of the initial setup expenses.

Image 6: A manual watering

Source: Paliphon Bounlu (2025)



Image 7: A manual watering

Source: Paliphon Bounlu (2025)



Image 8: Using the plastic tube for watering

Source: Paliphon Bounlu (2025)



Image 9: Using sprinklers

Source: Paliphon Bounlu (2025)



6.8.5 Fertiliser application

Participating farmers described fertilisers as essential for crop production. According to the research information, farmers applied fertiliser at a rate of 0.5 to 1 kilogram per bed per application, and various methods of applying fertiliser were used. A method involves mixing fertilisers with water before applying them to each plant, as shown in images 10 and 11. Images 12 and 13 show how a farmer sows fertiliser by hand, which is common for leaf vegetables such as coriander, choy sum, dill, and others. Few farmers preferred to dig holes around each plant to apply fertilisers. This method is believed to help fertilisers last longer for the crops. However, spraying is necessary for plant supplements or fertiliser applied through leaves. Farmers often use mixtures of fertilisers, for example, a mixture of (NPK) 46-0-0 and 16-20-0 for coriander. The common types of fertilisers used among participating farmers are listed in Appendix 1. According to participating farmers, vegetable prices influence the use of fertiliser. Most farmers indicate that they increase fertiliser application when vegetable prices are high. in addition, farmers' crop evaluations often determine the rate of usage; if the crop performs poorly, the usage rate increases. Fertiliser usage rate among participating farmers is based on their experience rather than recommendations.

Image 10: applying method by combining fertilisers with water

Source: Paliphon Bounlu (2025)



Image 11: The farmer applies fertilisers to each plant

Source: Paliphon Bounlu (2025)



Image 12 and Image 13: Show how a farmer applies fertilisers by hand sowing.

Source: Paliphon Bounlu (2025)





6.8.6 Insecticide

Most farmers apply insecticide on a weekly basis. Farmers apply insecticides to prevent pests from affecting their productivity in the dry season. The primary method of application involves mixing insecticides with 20 litres of water and spraying it with a spraying machine. Some farmers describe that they mix insecticides with plant supplements or fertilisers, which help prevent pests and also provide essential nutrients to crops. However, some farmers choose not to use chemical-type insecticides and prefer organic alternatives. For example, a few farmers utilise neem powder mixed with water for spraying. Some farmers spray a mixture of rice water combined with 20 litres of water and a blend made from ash, alcohol, dish soap, tobacco, and vinegar. Farmers who use organic products have found them somewhat effective; however, if pest populations are high, they must resort to chemical insecticides to protect their productivity.

Based on the research information, the frequency and quantity of insecticide application are influenced by crop types, vegetable prices, input costs, seasons, and pest intensity. One farmer provided an example of insecticide application per crop cycle: for growing broccoli, apply it two to three times; for growing corn, apply it weekly; and for growing cauliflower, apply it every other day. Some farmers have found that applying insecticide twice within a two-day period is effective when pest intensity is particularly high.

6.8.7 Fungicide

Fungicides are commonly applied during the rainy season to prevent leaf spot disease, root rot, and leaf rot. Most farmers consider fungicides essential for their vegetable farming. Some farmers describe the application of fungicide as being based on the actual situation and crop performance. The frequency of fungicide application is once or twice a week.

6.8.8 Chemical application protection

Some farmers prefer to apply chemicals themselves, while others hire someone to do the job. The head of Thakhek village expressed concern about how farmers apply fertilisers and chemicals. Some farmers follow the label instructions for usage rates, while others do not. For instance, when spraying a supplement, herbicide, or insecticide without proper safety measures, some individuals neglect to protect themselves with masks or gloves, leading to peeling hands and swelling. Some farmers who applied chemicals report wearing gloves and a face mask, but others do not. As images 14 and 15 show, the person who sprays wears a hat, a surgical face mask, long clothes and rubber gloves. Image 16 shows how farmers mix the chemicals for spraying, as we can see, there is no protection when interacting with chemicals.

Image 14: How a person sprays chemicals without wearing gloves and wearing surgical facemask

Source: Paliphon Bounlu (2025)



Image 15: The method of spraying chemicals

Source: Paliphon Bounlu (2025)



6.9 Agricultural inputs

The Lao PDR cannot produce fertiliser and chemicals, relying instead on imported products. In areas where the research was conducted, fertilisers and chemicals were available, giving farmers access to essential agricultural inputs. Farmers sourced fertilisers and chemicals from local general stores. These shops also sold agricultural products, along with a variety of household items like packaged foods, snacks, cooking oil, soap, laundry detergent, and basic cleaning supplies. As image 16 illustrates, the local shop supplied agricultural inputs to the farmers in the research area. The shops offered both wholesale and retail fertilisers and many types of chemicals, as shown in image 17. The local shop provided input delivery directly to farms. Farmers could buy fertilisers and chemicals in advance and pay after harvesting. Some farmers also purchase their inputs from online markets in Thailand.

Image 16: A local fertiliser and chemical shop.

Source: Paliphon Bounlu (2025)



Image 17: Variety chemical inputs at the local shop

Source: Paliphon Bounlu (2025)



6.9.1 Price

Farmers commonly purchase fertilisers and chemicals in small quantities. Many farmers have found that the cost of these inputs is high and unreasonable compared to the prices of vegetables. They noticed a significant increase in input costs over the last two years, as the country faced high inflation. Farmers interviewed stated that the fertiliser price rose from pre-COVID $NZ 23 to $NZ 69 during COVID (300,000 LAK to 900,000 LAK) per 50 kg bag. The elevated cost of inputs influences farmers to change their farming practices and the application of fertilisers and chemicals.

6.9.2 Agricultural input inspection

According to the district officer interviewed, the district office is responsible for shops that sell agricultural inputs, which must be certified by the agriculture and forestry sector. The district office stated that officials conduct shop inspections once or twice a year to identify and remove illegal or prohibited products. The officer indicated that some shops still sell banned products, such as paraquat, a herbicide that is banned, yet is still available in these local shops. The officer expressed that enforcing compliance is challenging because shops are uncooperative and try to hide forbidden products during inspections. The district officer also noted that farmers continue to use this product, which comes from Thailand, despite it being illegal there.

According to the provincial officer, the inspection of unregistered and forbidden products is being conducted. The officer explained the inspection process: If any prohibited items are found, the first incident results in a warning, the second leads to a report, and the

third prompts action under the law. There are 55 types of chemicals on the banned list for agricultural production in the Lao PDR. Refer to notification No. 1776/MAF, Department of Agriculture, Ministry of Agriculture and Forestry. The officer states that the fertiliser and chemicals are sufficient for domestic agricultural production. Most of the inputs are imported from China, Thailand, or Vietnam, and he views the price of these inputs as still high compared to the purchasing power of farmers.

6.9.3 Fertiliser and chemical storage

Farmers store their fertiliser and chemicals in bags or buckets, keeping them in a shady place away from direct sunlight. As images 18, 19, and 20 show the spray machine is stored in a shaded area that is insecurely covered. The circle in image 19 shows how a farmer stores the chemical products, and the circle below indicates where the spray machine is kept. These images illustrate the different methods farmers use to store their agricultural inputs and equipment. The storage of fertiliser among interviewed farmers is often insecure, with it being bagged and placed as shown in images 21 and 22.

Image 18, Image 19, and Image 20: The ways of agricultural tools and inputs in the research area.

Source: Paliphon Bounlu (2025)







Image 21 and Image 22: fertiliser and chemical storage in the plastic bag.

Source: Paliphon Bounlu (2025)





6.10 Harvest

Vegetable prices are crucial factors influencing the pre-harvest period and labour hiring. Most farmers apply fertiliser and chemicals three to seven days before harvesting their crops. Some farmers think that if they harvest after five days, the crops will reduce weight. However, some farmers state that applying fertiliser one or two days before harvest accelerates crop production, causing it to rot faster. If too much fertiliser is used, the vegetables may die. However, when vegetable prices are high, farmers tend to harvest more quickly than usual. Most farmers are aware of chemical residue in vegetable products, and they think harvesting after one week can reduce the contamination rate. They believe that applying fertiliser and chemicals enhances the appearance and weight of the vegetables. A farmer interview described the experience from interacting with chemical use during the harvest, causing peeling hands and other health effects, which they think were caused by the chemical use in vegetable production.

6.11 Productivity

Most of the participating farmers reported satisfactory productivity, indicating that they have no issues with production. In general, their vegetable yields have been good and meet expectations, with productivity varying between dry and rainy seasons. According to information from the provincial officer, vegetable production is heavily reliant on seasonal and climatic conditions. When environmental conditions are favourable during the season, farmers achieve good yields. Conversely, during hot and rainy weather, production tends to decrease. To adapt to climate or seasonal changes, many farmers use greenhouses and sunshade sheets, which mitigate the effects of excessive heat, rainfall, and storms, according to the provincial officer. Some farmers report that coriander productivity with a bed size of 25 metres in length and 1.20 metres in width can yield 84 to 100 kilograms per bed in the dry season, while in the rainy season, it can

produce less than 32 kilograms per bed. Vegetable productivity is low in the rainy season and high in the dry season.

6.12 Vegetable price

Prices for vegetables in the rainy season are significantly higher than in the dry season and begin to rise in hot weather. According to the provincial official, during the dry season, farmers can produce high yields that exceed demand. In contrast, during the rainy season, the supply of agricultural products often falls short of meeting market demand, leading to higher prices. Some farmers report that the coriander price in the dry season is $NZ 4 (50,000 LAK) per 16 kilograms, while in the rainy season, it can increase to $NZ 254 (2,000,000 LAK) per 16 kilograms.

Vegetable prices present significant challenges to the participating farmers. They describe vegetable prices as unpredictable, unstable, and unreasonable, leading to uncertain profit impacts on farmers' livelihoods. The prices fluctuate daily, making it hard for farmers to plan their cultivation. As the head of the Hatkansa village comments, the agricultural production in this district is adequate, but the prices are unreasonable for the farmers. The village head added that the industry and trade sectors should assist farmers in stabilising the vegetable price.

The participating trader states that he determines the price for purchasing products from farmers, rather than the market dictating the price. The trader described setting prices by adding $NZ1.5 (20,000 LAK) to the amount he pays farmers per unit. For example, the trader buys at $NZ 3.8 (50,000 LAK) from farms, then he sells it at $NZ 5.3 (70,000 LAK). The trader mentions that during the dry season, the price is unpredictable, as to whether the cost of products will increase or decrease.

6.13 Market

Participating farmers sell their vegetable produce to local traders. The market preference for vegetable products favours visually appealing items. The trader imposes no requirements or standards for the production process, including farming practices. The only requirement is for aesthetically pleasing products, which influences farmers to focus on enhancing the appearance of their goods. Farmers can practice as they choose, and they will produce high-quality products with an attractive appearance. As the trader says, the trader does not know how farmers apply fertiliser and chemicals to their products. The trader only buys the products if they are visually appealing; farmers will receive a better price. Conversely, if the products lack aesthetic appeal, the price will decrease. A trader stated that the price is determined by both quality and quantity: if the products are in low supply, the price will be higher; however, if the supply quantity is large, the price will be lower.

The head of Thakhek village said that his town has 10 traders who purchase vegetable products from farmers. One farmer sells their products to various traders. Farmers must deliver to traders when vegetable prices are low; conversely, when prices are high, traders collect the products from farmers. Most farmers encounter no issues with market access, as they can sell any crops they grow to traders. The standard unit for trading vegetable products is 16 kilograms, which counts as one unit. Farmers have no

bargaining power with traders, as they cannot negotiate for a higher price and are only given the price by traders. In the past, supermarkets purchased products from farmers, but they did so in small quantities and irregularly, buying 32 kilograms of leafy vegetables and 160 kilograms of tomatoes every four days.

After collecting the vegetables from farmers, traders supply the products to the wholesale markets in Vientiane. The trader who participated in this research only buys fruit-type vegetables such as tomatoes, sponge gourd, chilli peppers, or eggplants. The amount that the trader purchases daily exceeds 1 ton. The reason he only buys fruit-type because he has fewer labourers. Fruit products are easier to manage and fetch better prices than leafy vegetables, as they do not require cleaning or refrigeration. Fruit-type products are typically bagged and do not require the same level of care as leafy products, as shown in images 23 and 24. If certain products are unavailable in the village, the trader purchases them from different locations. Currently, he buys products from Khammuan province; later in the season, he will buy from Vientiane province and Xiengkhuang province, as each province can grow crops during different timeframes.

Image 23 and Image 24: A trader packs and stores products in his car before going to the market.

Source: Paliphon Bounlu (2025)





Additionally, the trader explained that fruit products generally have more stable prices compared to leafy vegetables. The trader buys products from all the farmers in nearby villages and is willing to acquire as much product as they have. He mainly supplies the products to Odsy Market, one of the largest wholesale markets in Vientiane. If the trader

has a large quantity, he supplies it directly to the market sellers; when he has a low quantity, he sells it on the market.

The trader markets his products on social media and delivers them to customers in other provinces, enabling him to achieve higher profits. The trader typically earns a profit of about $NZ 154 (2,000,000 LAK) per round each day and generally supplies one round, though he sometimes supplies two rounds. For example, the price at the farm is $NZ 5.3 (70,000 LAK), while the selling price in another province is $NZ 11 (140,000 LAK). Customers bear the shipping costs. A tomato at the farm costs $NZ 1 per 16 kilograms (10,000 LAK), but he sells it to another province for $NZ 3.8 (50,000 LAK). The selling units differ between those sold in the market (16 kg) and those shipped to other provinces (12 kg). The price for sponges ranges from $NZ 3.8 to 6 (50,000 to 80,000 LAK), while eggplant costs $NZ 2.3 to 3.7 (30,000 to 40,000 LAK) per 16 kg, with prices fluctuating daily in response to market demand. For eggplant, a trader can make a profit from $NZ 0.4 to 1 (5,000 to 10,000 LAK) above the farm price. The price of chilli peppers ranges from $NZ 38 to 61.5 (500,000 to 800,000 LAK) per 16 Kg, while the price of tomatoes is $NZ 0.76 (10,000 LAK) per 16 kg.

The trading process primarily occurs throughout a relationship, where farmers contact traders by phone to sell their products. If the trader is unfamiliar with the farmers, he will engage with them to make a purchase. For most regular farmers, they deliver products to the trader's house; however, sometimes the trader travels to collect the products directly from the farms, as some farmers take a considerable amount of time to deliver.

6.14 Customers

The trader states that many customers come from different provinces, including Savannakhet, Lak Sao (the border between Bolikhamxay and Khammouane provinces), and Vientiane province, to buy products in the capital and then sell them in their respective provinces. Based on information from a trader interview, vegetable products in Vientiane capital also supply more to the southern provinces, as shown in Figure 9, which demonstrates the location of vegetable supply to the southern provinces. The standard products that these provincial customers tend to purchase include tomatoes, cucumbers, and leafy vegetables.

Figure 9: the Lao PDR provincial map.

Source: laos-guide-999.com



6.15 Product quality

6.15.1 Product safety

Defining the quality of vegetable products is challenging since there is no standardised testing from either the public or private sectors. According to the provincial officer, no safety measures are in place before vegetable products enter the market, and agricultural production is deemed to be of lower quality. The officer states that the products available on the market are not standardised and lack effective management in market systems. The provincial and district officers shared their experiences working with farmers, noting that the use of fertilisers and chemicals on vegetable products is excessive, while farmers have limited technical knowledge regarding the application of these substances. Each farmer has their own methods and follows different procedures, with no records of their farming practices.

The provincial official indicates that agricultural production in the country is gradually improving; however, consistently achieving high quality across all production remains a challenge. The officer says good quality requires effective production practices and proper packaging. A product label suitable for examination does not currently exist in the country's system. Agricultural production involves coordination with various sectors that can establish production standards before entering the markets.

The obtained information revealed that several farmers believe their vegetable production is unsafe for consumption due to chemical contamination, particularly during the rainy season. One farmer mentioned that a supermarket tested his products but found them to be unsafe. For those farmers who feel their production is unsafe, they maintain separate beds for selling and personal use. However, the district official adds

that the products do not have the good appearance as the ones they produce for the market. A farmer illustrates that if vegetables are grown for their own consumption, they will not spray chemicals. However, some farmers fear consuming their own products due to the intensive use of chemicals. An experience of a farmer about a case of high usage rate of chemicals that impact health: He saw that the farmer is sick and has developed cancer. Conversely, farmers who consider their production to be safe because they harvest after two weeks to a month of fertilising, which reduces chemical contamination in the products. Some farmers believe that they apply a low rate of fertilisers and chemicals. Certain farmers might harvest the vegetables early when they receive a reasonable price.

6.15.2 Vegetable products inspection

The Provincial Office of Agriculture and Forestry conducts random checks for chemical residues in Vientiane's vegetable products for product inspection. They examine both markets and farms. For organic vegetable products, the farmer’s product cannot be sold for months, as there is already a regulation regarding this matter. If inspectors find residue in general vegetable products, they report it to the market owner. The provincial office mandated that 28 markets be inspected for product residue and informed the markets about safe products, prompting them to warn traders about those that may be contaminated. However, implementing safe product regulations is not comprehensive and needs to be enforced seriously to penalise non-compliant people. Currently, the government is promoting production, which needs to adapt to safety policies and enhance farmers’ understanding gradually.

6.15.3 Product quality improvement

According to the district officer, improving product quality is very challenging. It is important to encourage people to participate, apply technical knowledge in farming, and adopt innovative techniques that follow current trends. However, most farmers still use traditional methods. To motivate farmers to get involved, it is essential to influence their attitudes. About 30% of the farmers in the village are part of agricultural groups, and only 10% follow the recommendations. The district officer described the difficulties in supporting farmers to grow crops using technical information. Farmers tend to rely on their personal beliefs and experiences. It is hard to persuade them to follow proper procedures.

6.15.4 Agricultural support projects

According to the provincial official, in the past, there were projects that supported the agricultural sector, such as the Japan International Cooperation Agency (JICA), which enhanced organic production. The World Bank supported rice and vegetable production and established agricultural groups in three districts: Hadxayfong, Xaythany, and Paknguem. The World Bank project supported farmers in the district by providing tractors to the villages and supports 10 agriculture groups in the district. A project provided seeds for farmers to grow and sell back to the project. However, while farmers grew the crops, the project did not come to purchase them after the farmers had produced them.

The Korean International Cooperation Agency (KOICA) supports agricultural production, including greenhouse cultivation and training on GAP. The project assisted ten villages in the Hatsayfon district and promoted agricultural techniques such as GAP and organic farming, with officials from the provincial department training farmers in line with the Department of Agriculture's standards under the Ministry of Agriculture and Forestry. This training enhanced farmers' understanding of how to produce goods that meet those standards. The sample project-supported greenhouses are shown in images 25 and 26.

Image 25: The KOICA project provides greenhouses to the farmers

Source: Paliphon Bounlu (2025)



Image 26: another perspective of the farmer's greenhouses supported by the KOICA project

Source: Paliphon Bounlu (2025)



6.15.5 Project effectiveness related to vegetable farming

Organic projects

Throughout the training, the provincial officer viewed some projects as effective and others as ineffective. The effective project focused on supporting organic production, which had 6 to 7 markets prior to the COVID-19 pandemic. After COVID, the market was reduced to just one that opens twice a week, on Wednesday and Saturday. This project was implemented from 2004 to 2006, and officers consider it successful because it began in a small community, which has since expanded. It now encompasses nine organic groups and two cooperatives across six districts.

GAP project

The project supporting GAP is still unsuccessful. According to the officer, the provincial department is collaborating with farmers to provide training on technical procedures related to production, aiming to reduce the use of fertilisers and chemicals while promoting information about agricultural inputs that harm people's health. The project was less successful than anticipated due to a misunderstanding of farmers about the GAP concept and the complexity of following its procedures. For GAP, each product can be examined, and every stage must be recorded or reported. It requires products to be labelled, which is used to assess the product and consumers' complaints regarding it. It is difficult for farmers to record and report the procedures in detail.
According to the provincial officer, there is no available market for GAP products. The markets do not categorise or differentiate between various types of agricultural products, such as GAP, organic, and others. There is no price difference across multiple types of vegetable growing, so farmers do not adopt GAP and lack incentives to follow it. For example, regarding the use of chemicals (herbicides, insecticides, and others), farmers still utilise prohibited products, especially in areas along the Mekong River, where they import them illegally. This poses a risk to production that affects both producers and consumers. The standard practice and GAP differ, as GAP requires a longer period. The project also provided markets for the farmers, but it did not succeed due to complicated pricing. Sometimes the market buys at lower prices than the general market and only purchases vegetables when prices are high. Even though farmers and buyers made a contract, it still did not work.

According to the head of Hatkansa village and a leader of the GAP group, 20 families participate in the GAP group, which was established in 2013. He considers the project unsustainable because, after it concludes, there are no training sessions or workshops for the farmers. His view on the project's implementation is that the information on agricultural practices is not suitable for real farming. Fertiliser and chemical recommendations from officials are noted as not being used in actual farming. There is no price difference between clean and normal products, and there is a lack of market and strong support. The challenge is that people do not show interest in participating in the projects. According to the head of Hatkansa village, the village's agricultural groups

include the GAP group with 30 members and the organic group, comprising more than 10 members (with two villages, Sayfong and Thakhek, each having 2-3 members). The district officer describes the challenges that arise when they attempt to support farmers in growing crops based on the technical information. Farmers tend to rely on their personal beliefs and experiences, making it difficult to persuade them to adhere to the proper procedures.

6.16 Conclusion

The descriptive information outlined the vegetable farming environment and characteristics in which the study was conducted. This chapter provides an overview of vegetable farming, a vital sector for supplying vegetables to markets. It also provides details on vegetable farming, from planting to harvesting and productivity, helping to improve understanding of how vegetable farming is generally carried out in the Lao PDR, which primarily follows traditional methods. The chapter presents a variety of techniques used by farmers, notably the use of fertiliser and chemicals. The next chapter presents the results analysis, which provides information on the use of fertilisers and chemicals, based on various practices and methods.

Chapter 7 Result Analysis

7.1 Fertiliser and chemical usage analysis

The aim of this research is to enhance understanding of how fertilisers and chemicals are used in vegetable farming in Laos by analysing data from the interviews to examine practices of fertiliser and chemical application. The data collected was categorised to identify standard practices among the farmers interviewed, such as crop types, fertilisers, chemicals, application methods, and the reasons influencing their use. The results analysis provides information on farmers' use of fertilisers and chemicals, as well as the factors that affect their application, filling a gap in the limited information about how farmers practice, the quantity of fertilisers, and chemical use in vegetable farming.

7.1.1 Vegetable bed size

The size of vegetable beds is crucial information for studies on fertiliser and chemical use among vegetable farmers, as it serves as a key unit of measurement for analysis. Additionally, it helps the study to define the usage rate of the farmers accurately. Vegetable bed size data can aid in understanding the usage rate of fertiliser and chemicals in specific areas of the farm. The study obtained bed size data from fifteen farmers who provided the width and length in meters of their beds, as shown in Table 3 below.

Table 3: The vegetable bed size found among interviewed farmers.

Interviewed farmers (n:15)		
Vegetable bed's width (m)		
1	1	
12	1.2	
1	1.5	
1	2.5	
Vegetable bed's length (m)		
1	13	
3	20	
5	25	
6	30	
Total bed area of farmer (m^2)		**Common Bed dimension**
4	Less than 25	≤1.2 m x ≤20 m
5	30	1.2 m x 25 m
4	36	1.2 x 30 m
1	40	
1	75	

Table 3 displays the variation in vegetable bed sizes observed. Twelve farmers had beds measuring 1.2 m in width, while three farmers had different widths of 1, 1.2, and 2.5 m. Concerning the length of the beds, about six farmers reported 30 m long beds, around

five farmers had 25 m beds, and three farmers had 20 m beds. The average bed size among the surveyed farmers showed that five out of fifteen had beds of 30 m^2. Four farmers each had a bed area of 25 m^2 and 36 m^2, while two farmers had beds of 40 m^2 and 70 m^2.

7.1.2 Soil test information

None of the participating farmers has ever tested their soil. Soil test information could help farmers understand the soil composition in these areas. Soil information data could help determine the optimal rates for applying fertilisers and chemicals to specific crops for farmers. According to the Australia Centre for International Agricultural Research (ACIAR) study in 2020 on integrating soil and water management in vegetable production in Laos and Cambodia, research was conducted in Huaha village, Hadxayfong district, where the soil was characterised as a soil class of silty loam, which combined with clay 24%, silt 57% and sand 20%. Silt loam soils had a higher available water-holding capacity than sand, loamy sand, sandy loam, and loam soil textures (Amsili et al., 2021). Available water-holding capacity (AWHC) refers to the quantity of water stored in a soil that is accessible to plants through their root systems (Libohova et al., 2018). The soil test in Huaha village at a depth of 15 cm, the soil had a pH of 7.9 (alkaline soil) and contained the following nutrients: nitrogen 1.37 kg/ha; phosphorus, 0.14 kg/ha; and potassium, 0.21 kg/ha (ACIAR, 2020). The depth of 15-30 cm tested soil contains N: 1.37 kg/ha, P: 0.16 kg/ha, and K: 0.16 kg/ha, respectively.

Huaha village was one of the study areas where this research was conducted. The ACIAR (2020) findings recommended applying agricultural lime in coordination with NPK fertilisers to help increase soil pH in areas with low pH (less than 5.5). The ACIAR study indicates that the lime application rate of 2,000 kg per hectare helps improve the pH level by 0.5, and 4,000 kg per hectare increases the pH level by 1 unit. Findings showed that applying lime with fertiliser at the recommended rate in low-pH areas enhances productivity and plant development, leading to increased vegetable growth, including density, weight, and height. However, the ACIAR (2020) had no information on the farmer usage rate of fertiliser in vegetable farming and did not specify or recommend a soil type for Huaha village.

7.2 Fertiliser application

Farmers involved in the research define fertilisers as vital for their vegetable production. Table 4 shows the common types of artificial fertiliser NPK ratios used by interviewed farmers in the research area, including 46:0:0 (urea), 16:20:0, 16:8:8, 15:15:15, 27:7:7, and some farmers also use organic fertiliser. Some farmers were found to mix different NPK ratios of fertiliser in their vegetable farming. Based on the data, most farmers apply fertiliser based on their experience and learn from more experienced growers. Farmers growing the same crops, such as coriander and tomatoes, each apply different NPK ratios, whether mixed or unmixed, along with spray plant supplements or chemicals. They have their own methods regarding the frequency, rate of use, and preferred products for vegetable farming. The data showed a wide variety of farming practices among coriander farmers. The farmers' assessment of crops and crop prices significantly

influences how much fertiliser they apply. The research data indicated that the typical frequency of fertiliser application among farmers across all crops was every seven to ten days. Methods used include broadcasting, foliar application, spot application, and liquid fertiliser application (hand-watering). Spot and liquid fertiliser applications are mainly used for fruit-type vegetables, while broadcasting is used for leafy vegetables. Foliar application is common across all vegetable types. Additionally, most farmers mix plant supplements (liquid fertilisers), insecticides, or fungicides with 20 litres of water and spray directly onto the plants.

Table 4: Fertiliser types found among farmers interviewed

Farmer (n:20)	NPK ratio
5	16:20:0
5	15:15:15
4	16:8:8
4	46:0:0
2	25:7:7

7.3 Chemical application

Vegetable production in the study areas relies heavily on chemical products. Chemical application plays a crucial role in vegetable commercial production, as it helps farmers improve productivity, farm management, and pest and disease control. Agricultural chemical products are readily available through local shops, which farmers can access sufficiently. These shops offer a wide range of different brands of chemical products. Most of the farmers interviewed indicated that they choose products based on the type and brand they have been using for a long time, and some farmers reported that they use products recommended by other farmers.

Based on the study information in Table 5, it shows that insecticides and liquid fertilisers (plant supplements) are most commonly used by farmers interviewed. Different types of chemical products are needed each season to grow vegetables. However, the use of chemicals in vegetable farming, especially in commercial settings that favour products with a good appearance, drives increased use of chemicals to boost productivity and meet market demands. The information from the interviewed farmers indicated that insecticides and plant supplements (liquid fertiliser) are the common chemical types most farmers use. Farmers reported that insecticide is important for preventing pests during warm climate months, which can damage vegetables. The plant supplement or liquid fertiliser is widely applied in commercial vegetable farming through spraying, often mixed with other chemicals. Farmers who applied plant supplements said they provide nutrients to the plants, which improves crop appearance, weight, and overall productivity. Regarding herbicides, about two-thirds of the farmers interviewed applied them to control weeds before sowing seeds, while around one-third preferred not to. Fungicides are used for root and leaf rot during the rainy season.

Table 5: Identification of chemical use among farmers interviewed

	Herbicide	Insecticide	Fungicide	Plant supplement
	Number of farmers (n:21)			
Apply	13	17	12	17
Not apply	6	1	2	1
Less likely to use	1	3	N/A	1
Absent	1	N/A	7	2

Those farmers who use a relatively small volume of chemicals do so because of the low prices they receive for vegetables. However, instead of applying chemical products, they used compost tea or rice water to prevent insects. Additionally, those farmers who try to avoid using chemicals do not use herbicides, and hand weed their vegetable beds. Also, in the rainy season, rather than using fungicides, they harvest vegetables before they get infected Some farmers indicated that they do not want to use chemicals due to the impact on farmers' health. When it is necessary to prevent loss from insects, some farmers hire someone to spray chemicals on the farm. One farmer indicated that she did not use insecticide because they are growing crops (Vietnamese coriander, mint, and e.g.) that have less threat from pests.

7.4 Coriander production

Coriander is one of the fastest-growing crop types in the study areas, due to its consistent demand in local markets, where it is used in local dishes and daily consumption in Lao PDR. The observation in the study area identified that most farmers grow coriander as one of their main crop types. Farmers interviewed reported that growing coriander is challenging, as its price can vary and fluctuate, with most indicating that coriander prices are higher in the rainy season. This is because growing coriander during the rainy season is difficult, as productivity is low and it is more sensitive to disease compared to the dry season. The importance of studying coriander cultivation in vegetable farming in Laos is highlighted, as it is considered a significant crop for farmers and a characteristic of local consumption and markets.

The research data showed that fourteen out of twenty-one farmers interviewed grow coriander on their farms. In vegetable farming, farmers apply different types of NPK ratios. According to the information gathered from questioning farmers about the fertiliser types they use for growing coriander, they reported using 16:20:0, 15:15:15, 46:0:0, 16:8:8, and 25:7:7. This indicates a wide range of NPK ratios being used for coriander cultivation. The data revealed an inconsistency in fertiliser application, with each farmer using different nutrient levels that are not necessarily based on crop nutrient requirements, soil conditions, or scientific advice. Instead, most farmers rely on their own experience when choosing fertilisers. Detailed information about farmers' fertiliser use in coriander farming is provided in Table 7.

The crop cycle for coriander lasts 45 days from seeding to harvest. The frequency of fertiliser application for coriander, as shown by the interviewed farmers, ranged from 2 to 4 applications per cycle, with some farmers mentioning a weekly fertilisation schedule. An outline of a typical coriander growing and management cycle is depicted in Appendix 1.

Table 6 shows data from coriander farmers about how often they apply fertiliser when growing coriander. Most farmers applied fertiliser three times each growing cycle. Some mentioned they applied four times, while others only applied twice. From the researched information, it showed the frequency of fertiliser application in the table below, which most interviewed farmers apply fertiliser 4 times for growing coriander.

Table 6: Frequency of fertilisers application in growing coriander

Farmer (n:14)	Frequency (times)
9	3
2	4
2	2
1	weekly

7.4.1 Fertiliser types use in coriander production

Farmers used different types of fertilisers with various NPK ratios to grow coriander. Data shows that coriander production involves two application methods: mixed and non-mixed, as both methods had a significant number of farmers. Mixed fertilisers mean applying more than one type, while non-mixed fertiliser involves using only one type throughout the crop cycle. The most common ratio among non-mixed farmers was 15:15:15, used by three out of all coriander growers. Ratios like 16:20:0 and 16:8:8 were also used by non-mixed farmers, with one farmer applying a 46:0:0 ratio. Six of the fourteen farmers used mixed fertilisers for their coriander crops, each with a different combination; as shown in Table 10, these varied mixes indicate inconsistent practices in crop production. Farmers employed a range of NPK ratios, suggesting limited knowledge of ideal plant nutrient needs. The most used fertiliser types in coriander farming were 16:20:0 and 15:15:15, each utilised by five farmers. Four farmers applied 16:8:8, and another four used 46:0:0. The two farmers who applied a 25:7:7 mix also used 16:8:8 and 16:20:0, as shown in Table 7.

Table 7: Fertiliser types use in coriander farming

Participation number (n:14)	NPK
Non-mixed fertiliser (n:8)	
3	15:15:15
2	16:20:0
2	16:8:8
1	46:0:0
Mixed fertilizer (n:6)	
1	46:0:0, 16:8:8
1	46:0:0, 16:20:0
1	46:0:0, 15:15:15
1	16:8:8, 25:7:7
1	16:20:0, 25:7:7
1	16:20:0, 15:15:15

7.4.2 Fertiliser usage rate

Farmers articulate their use of fertilizer in the main in terms of rate per bed with bed sizes varying on farms and across farms.

Table 8 below shows information from 13 coriander farmers regarding the amount of fertiliser they apply. The data reveal that most farmers use between 0.5 to 1 kilogram per bed. Some farmers reported using less than 0.5 kilograms per bed, while one farmer was found to use more than 1 kilogram per bed. However, each farmer's bed sizes vary, as shown in Table 8, which also includes the amount of fertiliser applied relative to bed size. Farmers applying 0.5 to 1 kg per bed generally have beds measuring 30 to 36 square metres. About three farmers reported using less than 0.5 kilograms, with bed areas ranging from 24 to 75 square metres. Additionally, one farmer used more than 1 kg per bed, with a bed size of 36 square metres.

Table 8: Fertiliser usage rate per bed area

Farmers (n:13)	Bed areas (m^2)
Farmers with usage rate 0.5 – 1 kg (n:9)	
3	36
3	30
2	20-24
1	39.6
Farmers with usage rate <0.5 kg (n:3)	
1	75
1	30
1	24
Farmers with usage rate >1 kg (n:1)	
1	36

The information on frequency, usage rate, NPK ratios, and bed areas enhances and supports analysis. The research can explore and study fertiliser and chemical use by estimating cases with different farming practice scenarios based on the obtained information, to identify the effects of fertiliser and chemical use on vegetable farming in Lao PDR. Table 9 below demonstrates the combined information of usage rate and frequency of fertiliser application in growing coriander.

Table 9: Fertiliser usage rate and frequency

Farmers (n:12)	Frequency (time)
Farmers with usage rate 0.5 – 1 kg (n:8)	
2	4
4	3
2	2
Farmers with usage rate <0.5 kg (n:3)	
3	3
Farmer with usage rate >1 kg (n:1)	
1	3

Table 9 shows that among coriander farmers who applied 0.5 to 1 kg/bed, most apply it three times, while some report applying it four or two times. For farmers using less than 0.5 kg/bed or more than 1 kg/bed, approximately three applications were made. This information reflects the variation in usage rate, frequency, and bed areas, which have a significant effect on the total amount of fertilizer applied by farmers.

To explore the range of amounts being applied by farmers a number of case study scenarios are outlined.

7.4.3 How much fertiliser farmers apply in growing coriander

A case study:

The application patterns of fertiliser varied in terms of quality, type, and frequency. The preferred method involved both mixed and unmixed forms of different NPK ratio fertilisers in coriander cultivation. To estimate the amount of fertiliser used in vegetable farming, this research focused on the identified fertiliser types to determine the quantity applied in growing coriander. Table 13 below shows the estimated scenario based on information about fertiliser types, amounts, frequency, and vegetable bed size, which calculates the fertiliser quantities used over approximately 45 days until harvest. The amounts and types of fertiliser applied by farmers helped the study to identify the NPK application rate per crop cycle.

The frequency of fertiliser application per crop cycle for growing coriander is three times, although some farmers apply it four times and others apply it twice, as shown in Table 9. Additionally, the research data reveals that farmers use fertiliser in different ways. About 8 out of 14 farmers use only one type of fertiliser, while 6 farmers use a mix of two types, with some variation among them, as shown in Table 10. Using this information, the amount of fertiliser was calculated by estimating the vegetable-based area of 40 m^2 bed which helps to demonstrate the amount of fertiliser used per hectare for a crop cycle.

Application rates range from a low of around 250 kg/ha to a high of 1500 kg/ha over the 45 day growing season of coriander. These rates may include 37 to 690 kg/ha Nitrogen, 0 through to 300 kg/ha phosphate and from 0 through to 225 kg/ha potassium.

Table 10: The amount of fertiliser used in growing coriander, based on various types, quantities and frequencies of application in a 40 m² bed size.

Coriander bed size 40 m²

Quantity/bed (kg)	**N-P-K kg/ha (Total quantity kg/ha)**		
Frequency	**2 times**	**3 times**	**4 times**
15:15:15			
0.5 kg/bed	37-37-37 (250)	56-56-56 (375)	75-75-75 (500)
1 kg/bed	75-75-75 (500)	112-112-112 (750)	150-150-150 (1,000)
1.5 kg/bed	112-112-112 (750)	169- 169-169 (1,125)	225-225-225 (1,500)
16:20:0			
0.5 kg/bed	40-50-0 (250)	60-75-0 (375)	80-100-0 (500)
1 kg/bed	80-100-0 (500)	120-150-0 (750)	160-200-0 (1,000)
1.5 kg/bed	120-150-0 (750)	180-300-0 (1,125)	240-300-0 (1,500)
16:8:8			
0.5 kg/bed	40-20-20 (250)	60-30-30 (375)	80-40-40 (500)
1 kg/bed	80-40-40 (500)	120-60-60 (750)	160-80-80 (1,000)
1.5 kg/bed	120-60-60 (750)	180-90-90 (1,125)	240-120-120 (1,500)
46:0:0			
0.5 kg/bed	115-0-0 (250)	172.5-0-0 (375)	230-0-0 (500)
1 kg/bed	230-0-0 (500)	345-0-0 (750)	460-0-0 (1,000)
1.5 kg/bed	345-0-0 (750)	517-0-0 (1,125)	690-0-0 (1,500)

A case study:

Growing coriander in a single crop cycle on a 40 m² bed. This scenario is based on research data on non-mixed fertiliser application collected from coriander growers, including types, application rates, and frequency, to estimate the fertiliser amount used during a crop cycle.

- A coriander farmer applies 16:8:8 fertiliser at a rate of 1 kg per bed (40 m²), with four applications. Referring to Table 10 above, it shows that over a growing area of one hectare, the farmer would use a total of 1,000 kg of 16:8:8 fertiliser for one crop cycle. In this calculation, the NPK ratio for one crop cycle is 160 kg/ha of nitrogen, 80 kg/ha of phosphorus, and 80 kg/ha of potassium.
- Another farmer applies 16:20:0 at a rate of 0.5 kg per (40 m²) bed, and the fertiliser is applied three times per coriander cycle. Based on this information, in one hectare of growing coriander, a farmer applies a total of 375 kg/ha of fertiliser, equating to 60 kg/ha of nitrogen and 75 kg/ha of phosphorus.

- Research data indicate that applying 15:15:15 fertiliser is common in growing coriander. In this scenario, with a usage rate of 0.5 to 1 kg per bed and three fertiliser applications, farmers who use 0.5 kg per bed in one hectare apply a total of 375 kg/ha of 15:15:15 fertiliser. This provides a total of 56 kg/ha each of nitrogen, phosphorus, and potassium. For a crop cycle with 1 kg per bed, farmers apply a total of 750 kg/ha, which includes 112 kg/ha of NPK combined.

Table 11: The amount of mixed fertilisers used in growing coriander, based on various quantities and frequencies of application in a 36 m² bed size.

Coriander bed size 36 m²
Fertilisers information:
NPK mixed ratio 8.5/1.5: 16:8:8 (20kg) and 25-7-7 (3 kg)

Quantity/bed (kg)	**NPK kg/ha (Total quantity kg/ha)**		
Frequency	**2 times**	**3 times**	**4 times**
0.5 kg/bed	48-22-22 (278)	72-33-33 (417)	95-44-44 (556)
1 kg/bed	95-44-44 (556)	143-66-66 (833)	191-87-87 (1,111)
1.5 kg/bed	143-66-66 (833)	215-98-98 (1,250)	286-131-131 (1,667)

A case study:

Mixed fertiliser application in growing coriander for one crop cycle. The estimated data is based on information obtained from an interview with the farmer. The details on bed size, fertilisers, usage rate, and application frequency are used to estimate the amount of fertiliser applied during one coriander crop cycle over an area of one hectare.

A farmer applied a mixture of fertilisers, in the ratio of 16:8:8 at 20 kg and 25-7-7 at 3 kg for growing coriander. The farmer provided information on his fertiliser application, applying 23 kg of fertiliser to 15 beds, each measuring 36 m^2. Based on the data, the fertiliser quantity per bed is calculated to be 1.53 kg. The application frequency per crop cycle is three times. From the data, we can determine, as shown in Table 11, that with a fertiliser amount of 1.5 kg per bed of 36 m^2 and three applications, the farmer's total application exceeds 1,250 kg/ha, comprising about 1,089 kg/ha of 16:8:8 and 163 kg/ha of 25-7-7 for one crop cycle. The total NPK applied per hectare for one coriander cycle, with three fertiliser applications, is approximately 215 kg/ha of nitrogen, 98 kg/ha of phosphorus, and 98 kg/ha of potassium.

Table 12: Details of the amounts of different fertilisers used in one of the mixed methods a farmer employs to grow coriander on a 30 m^2 bed.

Coriander bed size 30 m^2
Fertilisers information:
NPK mixed ratio 1/1: 46:0:0 and 16:20:0

Quantity/bed (kg)	**NPK kg/ha (Total quantity kg/ha)**		
Frequency	**2 times**	**3 times**	**4 times**
0.5 kg/bed	103-33-0 (333)	155-50-0 (500)	207-67-0 (667)
1 kg/bed	207-67-0 (667)	310-100-0 (1,000)	413-133-0 (1,333)
1.5 kg/bed	310-100-0 (1,000)	465-150-0 (1,500)	620-200-0 (2,000)

One of the coriander farmers provided details about a 30 m^2 bed that received fertiliser in amounts of 0.5 kg with mixed ratios of 46:0:0 and 16:20:0. The fertiliser was applied three times. Based on the given scenario and the analysis of fertiliser quantity per hectare, the total fertiliser use rate is 500 kg/ha, divided into 155 kg/ha of nitrogen, 50 kg/ha of phosphorus, and no potassium for one cycle, as shown in Table 12.

7.4.4 Chemicals used in coriander farming

In commercial vegetable farming, chemicals play a vital role for farmers growing coriander. The types of chemicals commonly used by coriander farmers include herbicides, insecticides, fungicides, and plant supplements. Most farmers see chemicals as important for boosting productivity, preventing losses, and meeting market demands. Many coriander farmers use chemicals in their farming, which is explained in detail below.

Table 13: Information on coriander farmers' chemical use

	Herbicide	**Insecticide**	**Fungicide**	**Plant supplement**
	Number of farmer (n:14)			
Apply	9	11	8	11
Not apply	4	0	2	1
Less likely to use	1	3	4	1
Absent	N/A	N/A	N/A	1

Table 13 displays data on the number of farmer respondents who use chemicals in growing coriander. The farmers were asked about the types of chemicals they apply while growing coriander. According to the data, most farmers use all kinds of chemicals. Herbicide use in coriander farming is reported by nine farmers, compared to four who do not use it. Only one farmer indicated they try to not use chemicals. Insecticide use is reported by eleven of the fourteen farmers, while three farmers are considering using organic insecticides. Eight farmers used fungicides in vegetable farming, whereas two farmers do not consider fungicides. Four coriander farmers said they are less likely to use

chemical fungicides preferring organic options. Eleven farmers applied plant supplements (liquid fertiliser), whereas only two farmers did not use liquid fertiliser preferring organic plant supplements.

7.4.5 Chemical usage rate

Based on this research's data, farmers used a variety of brands and types of chemical products, including insecticides, fungicides, and herbicides. Farmers in the study areas found access to these chemicals to be sufficient, as they can buy small quantities, although they often have to purchase the whole bottle. However, the products are available under various brands, most of which are imported. The way farmers measure chemical products, such as insecticides, varies; some use spoons, bottles, and cans without standard measurements, making it difficult for researchers to estimate the amount of chemicals used. Based on the sites visited and information gathered, farmers employed a wide range of chemical products in their vegetable production. Refer to Appendix 3 – 6. The frequency of chemical application was 2 to 4 times per crop cycle, with many farmers applying chemicals three times. When spraying, most farmers mix different chemicals, such as insecticides with other liquid fertilisers. Some farmers appear to use more chemicals than recommended on the label to boost effectiveness. The estimated chemical usage will be detailed in a case study on tomato growing.

7.5 Tomato farming and production

Tomatoes are another type of vegetable with high local demand, and they were found to be widely cultivated by farmers in the study area. Based on the research data, tomatoes rank among the most common fruit-type vegetable grown. Tomato farming requires different practices compared to coriander farming, as there are differences in planting techniques and the application of fertilisers and chemicals. Therefore, to analyse the information on fertiliser and chemical use in tomato cultivation, the analysis is based on the longer crop cycle, described by farmers as one month for vegetative growth and four to five months for the harvesting period. The amount of fertiliser applied will be calculated based on the quantity applied per month. The results will be presented as fertiliser quantity per hectare per month. A detailed explanation of the analysis will follow in the section below.

7.5.1 Fertiliser use in growing tomatoes

The fertilisers used for growing tomatoes included 15:15:15, 46:0:0, and 16:20:00. According to information from tomato farmers, different application methods are used, including both spot and liquid fertilising. One method involves mixing 15:15:15 with water and pouring a cup into each plant every 7 to 10 days. Another farmer applied 46:0:0 during the vegetative stage and 15:15:15 before flowering, with weekly applications. The farmer reported using 100 kg of fertiliser, including 16:20:0 and 15:15:15, for his 2,000 m^2 tomato patch during the vegetative stage (one month). Spot fertiliser applications were made every two weeks, while water-mixed fertiliser was applied weekly.

A case study:

Since tomato production differs from coriander, it can take between 6 and 8 weeks to see results. Tomato plants typically produce for 5 to 6 months with most farmers planting during the dry season (when is the dry season between which months). Based on the information, farmers apply 46-0-0 and 15-15-15 fertiliser mixes. The estimated amount of fertiliser used was demonstrated by two farmers, who applied 50 kg for 1,600 m^2 and 100 kg for 2,000 m^2.

Table 14: Fertiliser quantity used for tomato production with a usage rate of 50 kg per month for 1,600 m² growing areas.

Tomato plantation areas 1,600 m^2
Fertiliser information: NPK 46:0:0, 15:15:15
Fertiliser quantity apply: 50 kg/months

Fertiliser application patterns for tomato	1st month	Apply rate per month	5 months of applying	Total fertiliser quantity applies
Fertilsier type	46:0:0	15:15:15	15:15:15	
N-P-K kg/ha (Total quantity kg/ha)	144-0-0 (312.5)	47-47-47 (312.5)	235-235-235 (1,562.5)	379-235-235 (1,875)

A case study:

Based on the information obtained from a tomato farmer, who applies 50 kg of fertiliser per month for 1,600 m^2 areas. The frequency of fertiliser application is weekly, which is approximately 12.5 kg per week. As the growing pattern of the tomato, in the first month of the vegetative stage, 46:0:0 is applied for the first month after planting. According to the farmer, the tomato plants can produce fruit after one month from planting and can continue to produce for up to 5 months. Table 14 illustrates the calculation of the fertiliser quantity used for growing tomatoes. It can be estimated that with one hectare of tomato plantation, the total amount of 46:0:0 used for growing tomatoes is 312.5 kg per month, 144 kg of nitrogen. In the producing stage, the 15:15:15 is applied at 312.5 kg/month, providing about 47 kg of N-P-K. The tomato crop cycle, which is estimated to be about 6 months of cultivation, the total quantity of fertiliser applied in a hectare is 1,875 kg, supporting 379 kg of nitrogen, 235 kg of phosphorus and potassium.

Table 15: Fertiliser quantity used for tomato production with a usage rate of 100 kg per month for 2,000 m² growing areas.

Tomato plantation areas 2,000 m^2
Fertiliser information: NPK 15:15:15
Fertiliser quantity apply: 100 kg/months

Fertiliser application for tomato	a month	6 months
N-P-K kg/ha (Total quantity kg/ha)	75-75-75 (500)	450-450-450 (3,000)

Table 15 presents information on the fertiliser quantity used by one farmer, who applies 15:15:15 at 100 kg per month across a 2,000 m^2 growing area. The fertiliser is applied every two weeks. The farmer described the application method: digging a hole and applying fertiliser to each plant. It can last up to two weeks; if mixed with water and applied, it lasts for about a week. Based on this information, it can be estimated and calculated, as shown in Table 18, that if farmers apply fertiliser at a rate of 100 kg per 2,000 m^2, then for a hectare, a farmer would apply approximately 500 kg of fertiliser per month, containing 75 kg/ha of NPK combined. Since the crop cycle for tomatoes is around 6 months, the total amount of fertiliser applied over one hectare would be 3,000 kg of 15:15:15, providing 450 kg of NPK.

7.5.2 Chemicals used in growing tomatoes

Chemicals contribute significantly for tomato production. The application of herbicides by tomato farmers shows that some farmers use herbicides, while others do not. All tomato farmers use insecticides during the vegetative stage to deter worms. One farmer explains that he mixes 30 ml of chemical with 20 litres of water and sprays it along with two other plant supplements. Farmers describe the method of applying insecticide. Using fungicide data helps farmers prevent aphids during the rainy season for tomato production. Two farmers use plant supplements, such as liquid fertiliser, for tomato cultivation.

Table 16: Chemical quantity used for tomato production, with a usage rate of 150 ml for 1,600 m^2 growing areas.

Tomato plantation areas 1,600 m^2
Chemicals information: plant supplement and insecticide
Fertiliser quantity apply: 150 ml/week

Chemical application for tomato	week	month	6 months
Chemical quantity (ml/ha) Plant supplements and insecticides	937.5	3,750	22,500

A case study:

A tomato farmer provides information on chemical application. The frequency of chemical use is weekly, with a rate of 1 capsule of “super green” and 50 ml of “Lasakatai” mixed in 20 litres of water, then sprayed. For a planting area of 1,600 m^2, farmers use 60 litres of three different mixes. From this, it is estimated that about 937.5 ml of chemical is applied per hectare each week, as shown in Table 16. It shows that for growing tomatoes on one hectare, chemicals are applied at 3,750 ml monthly. Over a 6-month growing period, the total estimated chemical use is 22,500 ml. However, this figure is an estimate; farmers often mix several chemical types in one spray, which can increase the amount used. Additionally, the quantities are not measured with scales or precise tools; farmers tend to use spoons, bottles, or caps for measurements, which can affect the actual amount applied. However, based on the recommendation of quantity use, it varies

based on chemical type, as mentioned in the earlier chapter, as some chemical products do not contain labels and instructions, it would be challenging to indicate the recommended rate.

7.6 Annual fertilisers and chemicals are applied to grow coriander and tomatoes

Case studies:

Assuming a one-hectare vegetable farming operation, tomatoes are planted over six months, from August to February. The estimated tomato fertiliser usage is analysed using 15:15:15 at 100 kg per month for 2,000 m^2 areas, as shown in Table 16. After harvesting the tomato in February, from March to July, coriander is grown for three crop cycles. Based on information from Table 10, the estimated fertiliser application for coriander was 1 kg of 16:8:8, with three applications per 40 m^2 bed. Based on this, the annual fertiliser application for growing tomato and coriander is estimated at 5,250 kg/ha, supplying 690 kg/ha of nitrogen, 570 kg/ha of phosphorus, and potassium. This amount is divided into 3,000 kg/ha of 15:15:15 for tomatoes and 2,250 kg/ha of 16:8:8 for coriander.

The estimated chemical rate including crystal fertilisers, insecticides and fungicides is based on information that farmers applied around 150 ml for an area of 1,600 m^2. As most of the interviewed farmers purchased chemicals in the small amount not the whole bottle or packages, which was difficult to identified the brand or type of chemicals and recommendation rate for the chemical. The chemical is applied three times during a coriander cycle and four times per month for tomatoes. The chemical that farmers applied for coriander at a rate 150 ml/1,600 m^2, can be estimated to be 8,437.5 ml (8.4 litres) for growing coriander three crop cycles. On the other hand, for growing tomatoes for six months, the chemical usage can be 22,500 ml (22.5 litres). The total annual chemical application (plant supplements and insecticides) is roughly 30,937.5 ml or 31 litres per hectare. However, the identified application of the chemical quantity did not include herbicide and fungicide quantities, and the information was insufficient. For tomatoes, this totals about 22.5 litres over six months, whereas for three coriander crop cycles with three applications each, approximately 8.4 litres are used per hectare.

Another estimate considers a scenario where only coriander is cultivated annually. The yearly planting of coriander is estimated at six cropping cycles. Under this scenario, fertiliser application with mixed ratios of 1/1 fertilisers, specifically 46:0:0 and 16:20:0, indicates a usage rate of 0.5 kg per 30 m^2 bed. The fertiliser is applied three times per crop cycle. Over the course of six cropping cycles, the annual fertiliser requirement is estimated at 3,000 kg/ha, delivering 930 kg/ha of nitrogen, 300 kg/ha of phosphorus, and other non-potassium nutrients. The chemical application, based on a frequency of three, is 150 ml for 1,600 m^2, resulting in an estimated total chemical use of nearly 17 litres per hectare annually for growing coriander.

7.7 Factors that influence the use of fertilisers and chemicals

According to the research data, the frequency and amount of insecticide use depend on crop types, vegetable prices, input costs, seasons, and pest levels. As crop types contribute significantly to chemical applications in vegetable farming, farmers apply insecticide two to three times for broccoli, weekly for corn, and every other day for cauliflower. Some farmers also find that applying insecticide twice within two days is effective when pest pressure is very high.

Vegetable prices can be important factors that influence the use of fertiliser. Most farmers indicated that they increase fertiliser application when vegetable prices are high. The increased rate of fertilisers to enhance crop development, such as appearance, weight, and fast growth. Seasons are also another factor that contributes to the use of fertiliser and chemicals by farmers.

Seasonal insects required farmers to apply chemicals at higher rates in certain months, while during months with fewer insects, farmers applied lower rates of insecticides. During the rainy season, farmers apply fungicides to protect crops from rot and other diseases. The differences in seasons significantly impact farming practices as described in the descriptive chapter. The various seasons can be defined as the cool weather from September to February, which is favourable for vegetable farming. During this cool period, farmers apply low levels of fertilisers and chemicals since there is a lack of pests, allowing crops to develop well and leading to high productivity. Conversely, vegetable prices during this season remain low. The hot weather, lasting from March to May, presents intense pest problems, and crops do not develop well, prompting farmers to increase their use of fertilisers and chemicals. This intense application of fertilisers and chemicals is necessary this season for crop protection, enhancing yield and appearance. Vegetable prices rise during this period. The rainy season, from June to August, poses challenges for vegetable farming due to seasonal floods and crop diseases. Wet conditions can cause crops to rot, preventing the growth of many types of vegetables and making them more susceptible to disease. This issue caused the crop to produce low productivity. Crops grow during the rainy season, farmers apply fertilisers and chemicals at notably high rates, especially fungicides and plant supplements to prevent leaf rot, disease, and prevent crop loss, which results in high vegetable prices. One of the farmers interviewed stated that, to prevent leaf rot of coriander in the rainy season, he applied a chemical twice over three days, as crop yield in the rainy season is lower than in the dry season. Vegetable prices soar and low productivity in the rainy season, leading to increased use of fertiliser and chemicals.

Fertiliser use among farmers is usually based on their experience rather than official recommendations, as they have been practising and trying different types and methods. Most farmers prefer to use their own methods; for example, some farmers prefer the type of fertiliser they are familiar with, and the frequency of fertiliser and chemical applications varies for each farmer. Some farmers believe that applying fertiliser four times can lead to a better yield and a good appearance, while others who apply three times think it is enough for the plants' needs and also helps save costs. Farmers' crop assessments are another factor that can help determine the fertiliser and chemical

application rates. If the crop performs poorly, the application of fertiliser and the use rate of supplements increase to enhance crop development and prevent loss.

7.8 Conclusion

Based on the results presented above, it is clear that the use of fertilisers and chemicals among vegetable farmers varies. The data shows that farmers employ a wide range of fertiliser types, using different rates, methods, and practices to grow the same crops, especially coriander and tomato. The analysed information on fertiliser and chemical use among vegetable farmers can be inconsistent with the actual application rates, as there are limitations in precise measurement. Since most usage rates are based on farmers' estimates, this leads to inconsistent application of these substances. The findings on the application of fertiliser and chemicals in growing coriander and tomato illustrate this. The estimated information, which reflects the nature and characteristics of vegetable farming practices in Lao PDR, helps enhance understanding of how much fertiliser and chemicals are used in vegetable farming in Lao PDR, as well as the factors that influence farmers' use of these substances.

Chapter 8 Discussion

8.1 Introduction

This section presents information from this research study, along with existing studies in the Lao PDR. The discussion focuses on studies regarding the use of fertilisers and chemicals in vegetable farming and explores related factors that influence farmers' use of these substances. Additionally, this section provides comparison and contrast information, which can reflect both on and off-farm factors.

8.2 Fertilisers used in vegetable farming

Following analysis of how farmers who grow commercial vegetables use fertilisers and chemicals, the research found that for farmers these inputs are crucial for vegetable production. The farming methods for growing vegetables varied among farmers, including the types of fertilisers and chemicals used, their application rates, frequencies, and methods, as well as farm sizes. This variation in farming practices was reflected in the study's analysis, which drew on information and scenarios provided by farmers who grow vegetables, specifically coriander and tomatoes.

8.3 Fertiliser types

The information from the research study identified the common fertiliser types in vegetable farming, which were urea,16:20:0, 15:15:15, 16:8:8, and 25:7:7, with each farm using more than one type in their vegetable production. The analysis reveals a range of fertiliser and chemical products used, reflecting individual farmers' practices and preferences. This study supports the information regarding different fertilisers in vegetable farming, which is strongly backed by the results based on farmers' characteristics and practices. However, the study by the ACAIR (2020) indicated that most farm practices rely on 46:0:0 (urea) as the primary fertiliser, mainly due to cost reasons and reported that the most common use fertiliser types are urea, 16:20:0 and 15:15:15. Another study demonstrates that the fertiliser types used in vegetable farming in Lao PDR were primarily (urea) 46:0:0, 15:15:15, (diammonium phosphate) (18:46:0), (ammonium sulphate) 21:0:0, and (solophos)17:44:0 (Potutan et al., 1998). However, the study also identifies the significant use of liquid types of fertiliser or plant supplement accused by spraying and mixing with other chemicals. This suggests that the types of fertilisers farmers use is more diverse than recorded to date and the estimated rates of applications are also diverse.

8.4 Fertiliser usage rate

The annual fertiliser application for growing coriander and tomato on one hectare is estimated at 4,500 kg, supplying 690 kg of nitrogen, 570 kg of phosphorus, and 570 kg of potassium. However, based on the Lao government's recommended annual fertiliser rates (16:16:16 and 46:0:0) for rice on one hectare, which is 415 kg, providing 116 kg of

nitrogen, 40 kg of phosphorus, and potassium, the recommendation for maize is 500 kg, or 184-48-48 kg of NPK (FAO, 2025). As shown, the application of fertiliser in vegetable farming, in a scenario of annually growing one tomato and two coriander cropping cycles, is more than ten times higher than the government fertiliser recommendation rate for rice and maize. The estimated fertiliser use in vegetable farming, reported a huge range from 1,500 – 6,000 kg annually, which did not indicate the farming size (ACIAR, 2020). In different scenario, which involves growing only coriander over six cropping cycles, the total fertiliser use (16:20:0 and 46:0:0) is 3,000 kg/ha, supplying 930 kg/ha of nitrogen, 300 kg/ha of phosphorus, and other non-potassium nutrients. Compared to the ACIAR (2020) study on fertiliser application for broccoli farming, which estimated three crop cycles a year, the amount of fertiliser used is N: 780 kg/ha, P: 324 kg/ha, and K: 966 kg/ha. The fertiliser quantities used for broccoli in that study are similar to those observed in our coriander and tomato farming and confirm farmers are tending to apply much more than is recommended.

8.5 Characteristic of fertiliser use

The findings indicate that the processes in vegetable farming practices are inconsistent in terms of types, application, usage rate, frequency, and planting areas. These differences in farming practice are crucial for analysing the fertiliser and chemical application. Most farming practices are based on farmers' long-term experience. The farming practices reflected individual application of fertiliser quantity and frequency from the farmer's crop evaluation, price, and seasons. The preferred fertiliser application is based on farming experiences through real farming and examination. Most farmers indicate that they seek information from experienced farmers when facing farm issues. The experienced farmers indicated are those who grow vegetables well, seeking advice on the type of fertiliser to use in the crop, including frequency and quantity, which they adapt to their usual farm practices. In line with the ACIAR study, farmers rely on personal experience, family, and experienced farmers for their farming information (ACIAR, 2020).

The research data indicate that farmers' strategic use of fertilisers primarily relates to types of vegetable farming. Fertiliser applications are used differently across crop types, including variations in frequency and usage rates. The farmers interviewed indicated that fertiliser application varies for different crops, as each crop requires specific nutrients; farmers use various types of fertilisers for different crops. The fertiliser use was different across farmers. Farmers may recognise that different crops require different nutrients; however, there appears to be no consistency in fertiliser use across farmers for similar crops. The study also shows that fertiliser strategies among farmers are unrelated to soil type, crops, or yield as was also identified by ACIAR (2020). The research reveals a variety of methods for applying fertiliser in vegetable farming, including digging a hole, mixing fertiliser with water, or hand sowing, with each method suited to different kinds of vegetables. Farmers favour certain methods that they find effective and suitable. Most interviewed farmers reported that fertiliser use contributes to increased productivity and improves crop appearance and weight, thereby increasing yield and meeting market preferences. The rate of NPK fertiliser application in vegetable production shows a strong response, as higher usage has a positive impact on productivity, including quantity and weight (ACIAR, 2020). Despite limited information on proper fertiliser application, many

studies highlight a lack of knowledge on their use in vegetable production. According to the study data, fertiliser application among farmers often ignores soil and crop nutrient needs, farmers did not incorporate this information in their farming. The actual amount of fertiliser used, influenced by crop evaluation and market prices, can fluctuate according to season, leading to increases or decreases in quantity of fertiliser used. Insufficient fertiliser and chemical use information can be another challenge for local farmers as there is missing knowledge on what fertilisers or chemicals are appropriate, inappropriate and what works and does not work.

8.6 Agro-chemicals use in vegetable farming

Chemicals have become increasingly important in commercial vegetable farming in Lao PDR. Research found that among 21 farmers interviewed, 17 reported using insecticides, 17 using liquid fertiliser, 13 using herbicides, and 12 using fungicides. The farmers noted that these chemicals help with farm management by controlling weeds, pests, and diseases. The use of chemicals helped prevent production losses and improved the appearance of crops. The chemical products contributed significantly to commercial vegetable farming, as crop yield and appearance are crucial for farmers' benefits and marketability. The application of chemicals is widely used in vegetable farming to enhance these factors.

8.6.1 Chemical types

The chemical types found in this study include herbicides, insecticides, fungicides, and plant supplements. These chemical products, available in various forms and brands, whether liquid or powder, are widely used in vegetable farming. The study of chemical use in crop production in the northern province revealed that the most common chemical types are mainly herbicides, insecticides, fungicides, rodenticides, and molluscicides (CCL, 2024). However, the chemical types identified in this study focus on crops such as rice, corn, pumpkin, watermelon, and others that are predominantly cultivated for farming in the northern province of Lao PDR. The types of chemicals farmers apply reflects the growing conditions and crops grown in different parts of the country.

8.6.2 Chemical usage rate

Based on the recommendation rate on some fungicide product (metalaxyl) 40 ml per 20 liters of water, and insecticide product is 8 – 10 ml per 20 liters of water. Most interviewed farmers applied chemical product different based on personal preferent, the application rate of chemical for vegetable can be difficult to estimate as farmers mixed several chemical products, which cannot identify as it contain in different container for buying in small amount. The frequency of chemical application for coriander is three times per crop cycle, and for tomatoes, it is four times per month. Based on the study by CCL (2024), which indicates the average volume of herbicide use in growing corn is 3.73 to 6.04 L/ha per crop cycle, the estimated annual use for three crop cycles of corn could range from 11.28 to 18.12 L/ha. The study found the application of herbicides among farmers who grow corn more than 1.5 to 1.2 times the average (CCL, 2024). Another study in another northern province found the use of herbicide at 18.6 to 19.2 L/ha/year, with a

significant use of paraquat products ranging from 17.4 to 19.5 L/ha/year (Bartlett, 2016; Rassapong, 2016). According to the New Zealand Environmental Protection Authority (EPA), the recommended application rate for Paraquat application is a maximum of 600 grams per hectare for single and annual applications. Comparing the paraquat application in Lao PDR, it showed that farmers in Lao PDR use a high rate of paraquat application. The study on chemical application on growing yard-long beans, indicated the application of chemicals such as fungicide and insecticide from the conventional farming, indicating that the mixing of six fungicide products and an insecticide product, stated the moderate overuse of chemical products mainly fungicides at the label-recommended rate. Most of the existing studies in Lao on using chemical in growing crops mostly relate to the application of herbicide. This study presents information on the chemical use of plant supplements and insecticides in the commercial cultivation of vegetables. Plant supplements and insecticides were considered important for vegetable farming as they help crops to get stronger and prevent insects, which is high in the dry season. The presented information can be additional knowledge and information in agricultural production in Lao PDR. m^2

8.6.3 Chemical application

The research data shows that intensive chemical use occurs during hot weather and rainy seasons, which challenges vegetable farming since crops grow less during these climates. The study indicated that in vegetable farming, farmers mix more than two types of chemicals in one spray. The mixing rate of each chemical ranges from about 30 to 50 ml mixed with 20 litres of water. The frequency of chemical application is every seven days or once a week. As indicated in the CCL (2024) study, the frequency of chemical application for growing yard-long beans is weekly, when farmers mix six fungicide products and insecticide in their sprays. The study on pesticide overuse in Southeast Asian vegetable production (Vietnam, Cambodia, and Laos) found that Laos accounted for 59 percent of overused pesticides, which is lower than in Vietnam and Cambodia, based on the profit-maximising optimum method (Schreinemachers et al., 2020a). This study adds to the information on the amount of chemical use, based on the data collected and the characteristics of the farmers.

8.6.4 Banned chemical products

The banned chemical substances are available for use in vegetable farming in the researched area; the district official stated that farmers have applied paraquat. The existence of prohibited products in the market and use among farmers, about 10 percent of herbicide products in Laos contained paraquat. In addition, this research's findings indicate that numerous types of chemical products have been used without labels or specified chemical ingredients. The study on understanding agrichemical use in Southeast Asian agriculture – Vietnam and Laos reported on the prohibited product "folidol," the active ingredient of which is Prathion-methyl, an insecticide, which was widely used among vegetable farmers in Hadxayfong district (Carter et al., 2022).

8.6.5 Chemical storage

The study found that chemical storage is insecure among the interviewed farmers, as some purchase chemicals in small quantities, often contained in various bottles, including energy drink and water bottles. Most of the farmers interviewed store chemicals in plastic bags, hanging them off the ground in shaded, dry areas, as shown in pictures 17 to 21 in the descriptive chapter. This aligns with international guidelines for pesticide storage, which require that chemicals be stored in a secure, separate area away from living spaces, especially from food, and that exposure to people be prevented (World Health Organization, 2020). The storage of chemicals used in vegetable farming, in which the farmers participated in the research, was identified as a high-risk area for chemical exposure due to insufficient protection and a lack of awareness regarding hazardous and safety issues. The evidence shows that farmers store chemical products in open and unprotected spaces, such as on walls, tables, and in areas close to living spaces. The chemical waste cans or bags were seen around the farm, which increases the risk of chemical exposure to people.

8.6.6 Protection of chemical application

Personal protective equipment (PPE) is recognised as essential for reducing risks associated with the use of chemicals in agricultural activities. The evidence from this research found the chemical use in vegetable farming, for instance, spraying without adequate protection. As shown in Picture 15 from the descriptive chapter, it was observed that a person wore a head covering, a surgical mask, a long-sleeved shirt, long pants, and long boots, but no gloves, while handling chemicals for mixing. An interesting study by Sapbamrer et al. (2021) investigated the effectiveness of respiratory equipment against insecticides used among Thai farmers. The study examined 10 different types of masks, including surgical masks, cotton masks, woven masks, fabric masks, and various types of respirators, testing them with six different insecticides. The results indicated that the surgical mask had the lowest filtration efficiency among all types tested against insecticides. Its efficiency was significantly lower than that of cotton, woven, and fabric masks, highlighting that surgical masks lack adequate protection against the chemicals contained in insecticides (Sapbamrer et al., 2021). Based on FAO and WHO recommendations, insecticide sprayers must wear a respirator at a minimum during application. Furthermore, in the US, the protection standard states that individuals handling insecticides in agricultural activities are required to wear respiratory protective equipment, as they define the use of insecticides as extremely and highly hazardous, necessitating a specific respirator filter (Fults, 2017; World Health Organization, 2020). Based on the international standard for chemical use protection, it was found that farmers have high exposure to chemical use in their vegetable farming, especially to surgical face masks, which are found to be the most dangerous to wear for protection during chemical use in vegetable farming. By observing from this study, it becomes apparent that the appropriate protection equipment is not readily available for farmers, and the available equipment is expensive, which prevents farmers from accessing it. Most of the farmers are aware of the effects of chemical use on health, with evidence presented by some farmers of cases affected by chemical use.

8.7 Vegetable product safety

Several farmers involved in this research reported growing vegetables separately for their own consumption and commercial purposes. It appears that farmers have an awareness of the risk associated with high chemical use. They explained that, for personal use, they cultivate crops in various areas or beds using fewer chemicals, resulting in lower yields and less visually appealing produce, though with less chemical contamination. However, for commercial vegetables, they apply more potent chemicals and fertilisers to improve quantity and appearance, thus meeting market demands and preferences. The widespread use of unidentified chemical products in vegetable farming is a concern. The interviewed farmers typically apply chemicals during the harvest period, 4 to 7 days before harvest, with one notable case of applying them only one day prior to harvest to capitalise on rising vegetable prices. Food safety concerns associated with agricultural products include heavy metal contamination, insecticides, mycotoxins, preservatives, and other hazardous ingredients, which pose food safety and health risks in the Lao PDR among ASEAN countries (Kasza et al., 2024). As vegetables are the basis of food consumption in the Lao PDR, the vegetable production should be prioritised for improvement. Based on this research's data, some interviewed farmers have demonstrated that their products are unsafe due to the intensive use of fertilisers and chemicals, and they are aware of hazardous vegetable products on the market.

The data gathered from officials regarding chemical use in vegetable production, which they identified as heavy use of fertilisers and chemicals, highlights issues of chemical contamination in vegetables sold in local markets and across Vientiane. A district official reported that farmers are using banned chemical products. Officials stated that agricultural input inspections occur twice yearly, with warnings issued when banned products are found for sale. They were also aware of unsafe vegetables in the markets showing high levels of chemical residues. Provincial officials mentioned that addressing this problem would take considerable time and require a gradual approach. The frequency of inspections was considered infrequent. There are no clear guidelines or standards for vegetable farming, and vegetables entering the market do not need to meet specific safety criteria. The officials acknowledged that improving food safety in Laos is very challenging; it demands significant effort to enhance production practices, as many Lao farmers are smallholders who have long used traditional methods. Transitioning to new practices and regulations will take a considerable amount of time for farmers to adopt. The insufficient enforcement of roles and rules is inconsistent and lacks funding to regulate or provide advice to farmers, which largely relies on international aid projects.

8.8 Vegetable market

The vegetable market significantly impacts fertilisers and chemicals use in vegetable farming. According to this study, the vegetable markets in Lao PDR have uncertain prices that fluctuate significantly. For some farmers and traders, the vegetable price varies throughout the day or from day to day, as farmers state it fluctuates by about $NZ 0.76 (10,000 LAK) to $NZ 1.50 (20,000 LAK). For instance, the price of 16 kg of coriander can range from as low as $NZ 3.8 (50,000 LAK) to as high as $NZ 153 (2,000,000 LAK) during the rainy season. The information received from a trader interviewed suggests that

vegetable price fluctuations can be attributed to supply and demand; however, this study insists that a substantial price gap within a short timeframe creates uncertainty and unfairness in agricultural production and the overall system, alongside concerns regarding food supply insecurity and the uncertainty of vegetable pricing. The volatile market prices of vegetables can influence policy stabilisation, place farmers at high risk, alter land use, create unpredictable future supply and demand, and incite speculative activity (Qiao et al., 2023).

Vegetable production has limited market channels; the organic vegetable market is lacking, with availability restricted to once a week at specific times, which is insufficient for serving consumers in general and in their daily lives. However, enhancing and facilitating the distribution of clean products in regular markets and in people's routines, it could boost market demand for clean products, encouraging farmers to adjust their production to meet these standards. Expanding markets involves exploring high-quality demand sectors like restaurants, hotels, and supermarkets that have a strong need for quality products. These can help stabilise vegetable prices, create diverse market channels, ensure safe product quality, and most importantly, encourage improvements in farming practices to produce safer vegetable products that meet standard requirements.

8.9 Vegetable price

This study found that traders set vegetable prices based on the interviews with traders and farmers, leaving farmers with limited power in price negotiations. From the interview with local traders, the vegetable price can be based on the available vegetables in the areas and the prices that other traders give to farmers for the same vegetables. Similarly, the characteristics of vegetable markets in rural China concerning the formation of fresh vegetable price mechanisms indicate that unstable prices affect farmers and their supply chains. This suggests that providing farmers with technological information and communication, connecting them to the final market, and improving the price formation mechanism can enhance their bargaining power (Cao & Mohiuddin, 2019). As vegetable farming is meant to serve the market, which directly influences the production process, the price and cost of farming are important factors in the use of fertilisers and chemicals. Consistent with these findings, the use of chemicals, including fertilisers, can be influenced by vegetable prices; when vegetable prices are high, farmers tend to increase fertiliser and chemical usage. In line with the trader's demand or market preference for visually appealing vegetables, this is a key factor affecting chemical application in farming. The use of chemicals for pest and disease management can influence the overall chemical usage rate in vegetable farming to meet customer expectations and demand (Carter et al., 2022).

8.10 Conclusion

The chapter includes the important component of using fertilisers and chemicals in the agriculture sector, specifically in vegetable farming in the Lao PDR. As discussed above, the farmers who participated in this research practised differently, growing the same crops, but farmers applied different fertilisers and chemicals. This variation is difficult to

estimate and makes the data inconsistent, as different farmers prefer different methods and practices. However, there is very limited information on vegetable farming studies in Laos, which would make it more difficult to analyse, compare and contrast information specifically on vegetable crops. This research study provides information on fertiliser and chemical use in vegetable farming in the Lao PDR, identifying important findings and data that are highlighted in the next chapter.

Chapter 9 Conclusion

9.1 Introduction

Agriculture plays a vital role in the Lao PDR, where the majority of the population is primarily engaged in agricultural activities. These activities range from subsistence to commercial farming, contributing to the country's food security. In the pursuit of sustainable development, with agriculture as the main sector for growth in Lao PDR, there is a strong focus on rural areas, which are often economically disadvantaged, since they provide a crucial food source for local livelihoods. In cities that have experienced significant economic and social development alongside high population densities, a greater food supply is required to meet demand, increasing the importance of commercial farming. Vegetable products play a key role in daily life, primarily for consumption, and demand remains consistently high.

This study aimed to examine farming practices related to commercial vegetable production. The practices, particularly the use of fertilisers and chemicals, are crucial in vegetable farming. The goal is to present findings on commercial vegetable farming practices that involve fertilisers and chemicals, as well as to explore the factors influencing farmers' decisions to use them. The study also seeks to improve understanding of vegetable farming, including farming characteristics and how farmers apply chemicals in their vegetable production.

The purpose of this chapter is to conclude the study results and findings to conclude the study's results, drawing together the key findings from this research. The results present the analysed information related to fertiliser and chemical use in vegetable farming in Lao PDR. The chapter also examines the factors affecting fertilisers and chemicals use in vegetable farming, identifying challenges and limitations. This chapter also provides practical recommendations for moving forward to sustainable agriculture in the Lao PDR.

9.2 Fertilisers

The research underscores the significance of fertiliser use in vegetable farming. Access to fertilisers in the study area is found to be adequate and convenient for farmers. The types of fertilisers used in vegetable farming are quite similar: 16:20:0, 15:15:15, 16:8:8, 46:0:0, and 25:7:7, with several brands mainly imported from Thailand. For annual vegetable farming on a one-hectare plot, the fertiliser amount applied is estimated at 4,500 kg, providing N: 690 kg, P: 570 kg, and K: 570 kg—about ten times the amount recommended by the government for rice. In another scenario, where farmers grow only coriander throughout the year, covering six crop cycles, the estimated application is 3,000 kg/ha/year, with N: 930 kg, P: 300 kg, and K: 0, using a mixture of 46:0:0 and 16:20:0.

Key findings:

- Limited information: The fertiliser application in vegetable farming does not correlate with soil information and the amount of nutrients that the crop needs. This information is limited and presents a challenge for farmers to assess.
- Various fertiliser practices: A variety of fertiliser types, quantities, and mix ratios of fertiliser are used in growing coriander. The farming practices are based on farmers' own experiences, which also revealed the differences in how they use fertilisers and chemicals, such as how often and in what amounts they apply them. Farmers explained that they make their decisions based on personal preference. Additionally, the research found that mixed and unmixed fertiliser applications are used on the same crop, as most farmers stated this is based on personal experience and in a way that they feel satisfies and works for their farming.
- Increase and decrease in fertiliser use: Farmers' crop evaluation can influence the increase or decrease in fertiliser quantity in vegetable farming; if crops grow slowly, the application amount will be increased. Another factor is crop price; when the price is high, farmers tend to apply more fertiliser to enhance crop growth and meet the desired price. Vegetable farming in different seasons can affect the quantity used.

9.3 Chemicals

Chemicals are another resource that contributes significantly to vegetable farming, including chemicals that enhance farm management such as weed control, pest and disease management, and productivity improvement. The quantity of chemicals used in this study is estimated at 28 l/ha annually, based on the use rate of 150 ml per 1,600 m^2. As there is no official recommendation rate, the appropriate quantity cannot be identified.

Key findings:

- The characteristics of chemical use, which most farmers mix chemical products for each spray, might affect the actual quantity.
- The amount of chemicals applied: similar to the fertiliser factor, the application depends on individual farmer characteristics and crop assessment. Each farmer has a preferred quantity and mix of products, which can influence the amount of chemicals used. The crop price also affects the amount of chemicals in vegetable farming, aiming to improve the crop's appearance and prevent productivity loss from pests and diseases, aligned with market preferences. If market prices for vegetables are favourable, farmers tend to use more chemicals, promote quick and healthy growth, and keep vegetables in good condition to meet market expectations.
- The study found that none of the participating farmers were using agricultural information on chemical practices. The information appears to be inaccessible to small farmers, as the information on the appropriate use of chemicals in vegetable farming is limited.
- The handling of chemicals in vegetable farming is found to be inadequate compared to international standards. The way chemicals are applied on farms is considered high risk for health effects, as handlers wear surgical face masks, which are identified as the most dangerous mask protection for chemical use in farming.

- Wide use of banned chemical (paraquat) and unregistered products in vegetable farming.

9.3.1 What is found to be challenging on fertiliser and chemical use in vegetable farming in the Lao PDR?

Fertiliser and chemicals are vital in vegetable farming in the Lao PDR. The vegetable farming system seems to be unstructured, as farmers tend to grow crops independently. The use of fertilisers and chemicals is mostly based on personal experience, which farmers highly trust. Furthermore, there are limited guidelines for small farmers on how to use fertilisers and chemicals. Additionally, there are no basic requirements in farming practices regarding fertilisers and chemicals in Lao PDR, which affects to the concern of vegetable products safety. Market preferences for vegetable products are driven by visual appeal, leading to high use of fertilisers and chemicals and limited market channels for farmers. This situation hinders the improvement of farming practices. The amount of fertiliser used is ten times higher than recommended rates, indicating excessive fertiliser application among vegetable farmers. From this, it is clear that vegetable farming in Lao PDR faces uncertainties, and the way fertilisers and chemicals are applied does not support sustainable agriculture, as the country aims for. The instability of fluctuating vegetable prices in the market demonstrates uncertainty and unpredictability, resulting in farmers having no strategic planning. Farmers also have limited bargaining power due to the restricted market channels.

The study on vegetable farming practice related to the use of fertiliser and chemicals increases attention on practice standards, which are connected to safety consumption for people. The evidence from some farmers' interviews indicated that they grow vegetables separately for their own consumption and for sale, as they use more fertiliser and chemicals for selling vegetables. The report demonstrates the information on fertiliser and chemical use in vegetable farming, as characteristic of farming practices, and considers the safety concerns of farmers and consumers. There is a need to improve vegetable farming, as it is a vital food source for the country, requiring a sustainable and secure approach.

9.4 Contribute to knowledge

The research findings on fertiliser and chemical use in vegetable farming showed the estimated amounts used, which are limited in Lao PDR. The information on how much fertiliser and chemicals farmers apply can help fill the existing knowledge gap and improve data for future research. The variety and differences in farming practices reported in this study also contribute to understanding and reflect different perspectives on actual vegetable farming in Lao PDR. The diversity of practices, including types, brands, usage rates, frequencies, and plantation sizes in growing coriander, demonstrated practical variations among farmers. The study provides useful information on the fertiliser and chemical products used in vegetable farming, which helps to enhance knowledge in this area. In addition, most farmers interviewed appeared to use other chemicals, such as plant supplements. This study offers insights based on farmers' perspectives that are linked to the characteristics of the study areas.

9.5 Future research

The study reveals that vegetable farming practices in the Lao PDR are traditionally rooted. Farmers rely on experience, routine, and tradition without integrating scientific and advanced technology or information into vegetable production. The characteristics of the farmers show that they are less likely to attend the local workshops on vegetable farming provided by the government because it conflicts with their farming schedules. The socioeconomic status of farmers can also limit their focus to farming, rather than focusing on improving farm practices. However, vegetable farming in Lao PDR, the future can be exploring these challenges and limitations in vegetable farming. The research on improving vegetable farming in the Lao PDR tries to incorporate information on crop nutrient needs, soil, climate and season. Research on the optimal level of fertiliser and chemicals for specific crops would enhance vegetable farming practices and improve the effective use of fertiliser and chemicals, thereby enhancing product safety. This requires research and analysis of farming practices over extended periods and across specific seasons. The study can explore the best approach to inform farmers and help improve farming practices, as based on the natural and social principles in Lao vegetable farming, supporting the development of more sustainable practice that respect local characteristics. Historically, international aid organisations have offered training to promote sustainable agriculture and improve farming practices, but participation has been low. Our data highlight the difficulties in encouraging farmers to attend training, as it may conflict with their priorities. It can be demonstrated that there is a need for study on exploring different approach that are suitable to the local farmers, which are essential parts for the improvement in vegetable farming in the Lao PDR.

9.6 Practical implication

Vegetable farming practices in the Lao PDR still need to be improved in terms of quality and safety to ensure that the products meet standards. Many of the farming practices are not aligned with recommendations, as some farmers apply more than the label suggests. Improving farming practices and the efficient use of fertiliser and chemicals in vegetable production requires the cooperation of the public sector, the private sector, and farmers to work together. To enhance farming practices and the effective use of fertiliser and chemicals, it is essential to work closely with farmers because they depend on their personal beliefs and experiences, which can make it difficult to adopt new methods, as these beliefs may be biased. Working closely with farmers will facilitate sharing information on the characteristics of farming practices and help identify suitable approaches for improvement. As noted, in the study areas, there are no agricultural extensionists. The public sector can play a key role in actively implementing policies, enforcing rules and regulations, and supporting agricultural policies, especially for farmers with limited socioeconomic opportunities.

The private sector can support this by expanding market channels and influencing production to meet standards, as markets can influence and encourage change in farming practices. This would help improve vegetable farming practices in the Lao PDR. The GAP and organic markets are limited and unavailable, which restricts consumers' choices. Having more market channels can stabilise vegetable prices and market

conditions. Increasing awareness of food safety and healthy habits among consumers can help boost demand for clean and safe products, as this can be a key driver for vegetable farming to improve and meet standards. Some consumers demand safe vegetable products but have limited access.

9.7 Concluding thought

Vegetable production is crucial for the Lao people and their dishes. As a result, vegetable farming has become an important source of food supply in Lao society, providing enough food for a large portion of the population. However, as the research indicated, Lao vegetable farming is conducted individually or independently. This can be explained by the lack of organisation in crop type production, which leads to oversupply of certain crops in some seasons and causes their prices to be low. There is no system to assist farmers in planning the types of crops they should grow across different seasons, which would ensure a sufficient supply of various crops. This information is valuable for farmers in planning and making better predictions about vegetable prices. Access to strategic crop information could help farmers optimise their planting, improve vegetable quality, and stabilise prices.

Improving vegetable farming practices is crucial for farmers and consumers in Lao PDR. To boost these practices and ensure the proper use of fertilisers and chemicals in vegetable cultivation, farmers need information on crop nutrient requirements, as well as climate, weather, water, and soil data to determine correct application amounts. However, the study could involve different quantities of fertilisers and chemicals used and their effects on plant growth, as current information on this in Laos is limited. This knowledge will significantly help farmers improve fertiliser and chemical efficiency, reducing overapplication beyond what crops need, which saves costs. It will also enable more precise application, as farmers sometimes use more chemicals than necessary. The public sector plays a key role in enforcing policies, rules, and regulations, especially regarding banned chemical products, as well as promoting and supporting local farmers to operate according to established standards. Since sustainable agriculture has been a major part of Lao national socioeconomic development plans since 2016, and the idea was introduced to the country in the 1990s, vegetable farming has seen little progress in terms of sustainability. Alongside the participation of the private sector, which helps generate vegetable products and implement safety standards, this will encourage farmers to improve their farming practices. Consequently, all these factors can help make vegetable farming more sustainable and stable, ensuring a consistent vegetable supply and enhancing food security for the people, as vegetable farming becomes more efficient, safer, and compliant with standards for consumption.

References

ACIAR. (2020). *Intergrated resource management for vegetable production in Lao PDR and Cambodia*. Australian Centre for International Agricultural Research (ACIAR).

ADB. (2018). *Lao People's Democratic Republic: Agriculture, natural resources, and rural development sector assessment, strategy, and road map*.

ADB. (2021). *Developing agriculture and tourism for inclusive growth in Lao People's Democratic Republic*.

Amsili, J. P., Es, H. M. van, & Schindelbeck, R. R. (2021). Cropping system and soil texture shape soil health outcomes and scoring functions. *Soil Security*, *4*, 100012. https://doi.org/10.1016/j.soisec.2021.100012

Barriball, K. L., & While, A. (1994). Collecting data using a semi-structured interview: A discussion paper. *Journal of Advanced Nursing-Institutional Subscription*, *19*(2), 328–335.

Bartlett, A. (2016). The toxic landscape. *LURAS Project*.

BOL. (2024). *Annual Economic Report 2023*.

Busetto, L., Wick, W., & Gumbinger, C. (2020). How to use and assess qualitative research methods. *Neurological Research and Practice*, *2*(1), 14.

Cao, Y., & Mohiuddin, M. (2019). Sustainable emerging country agro-food supply chains: Fresh vegetable price formation mechanisms in rural China. *Sustainability*, *11*(10), 2814.

Carter, L., Williams, L., Wensveen, M., Liem, N., Hoan, D., Tuat, N., Hien, P., My, C., Nga, N., Duong, N. H., Duc, N., Hung, P.-V., Bouphakaly, M., Sinavong, P.,

Xangsayasane, P., Phommalath, S., & Sisaphaithong, T. (2022). *Understanding Agrichemical Use in Southeast Asian Agriculture—Vietnam and Laos*. https://doi.org/10.13140/RG.2.2.23300.33921

CCL. (2024). *How much pesticide do Lao farmers use? A quantitative assessment in northern Lao PDR*.

Douangboupha, B., & Sommany, X. (2012). *Food security and Agricultural sustainability: The wild vegetables and the role play of production vegetables for rural livelihood nutrition in Northern of the Lao PDR*. Thailand Science Research and Innovation.

FAO. (2021a). *Food system profile Lao People's Democratic Republic*.

FAO. (2021b). *National agricultural innovation system assessment in Lao PDR*.

FAO. (2023). *Special report – 2022 FAO/WFP Crop and Food Security Assessment Mission (CFSAM) to the Lao People's Democratic Republic*.

FAO. (2025). *Special report: 2024 FAO/WFP Crop and Food Security Assessment Mission (CFSAM) to the Lao People's Democratic Republic*. FAO; WFP; https://doi.org/10.4060/cd4991en

Fults, J. (2017). *How to Comply With the 2015 Revised Worker Protection Standard For Agricultural Pesticides What Owners and Employers Need To Know.* US Environmental Protection Agency.

Goto, K., & Douangngeune, B. (2014). *Agricultural Modernization and Rural Livelihoods in Rice Farming Villages of Laos*. https://doi.org/10.13140/RG.2.2.15997.56806

Gueneau, S., Cirad, & Xiong, M. (2022). *The Institutionalisation of agroecology in Lao PDR*.

Hamid, F., Yazdanpanah, M., Masoud, B., Bijan, K., & Hossein, A. (2021). *Factors affecting farmers' behavior in using nitrogen fertilizers: Society vs. Farmers' valuation in southwest Iran*.

Holton, E. F., & Burnett, M. F. (2005). The basics of quantitative research. *Research in Organizations: Foundations and Methods of Inquiry*, 29–44.

Ikeguchi, A., & Onsy, S. (2011). Marketing channels for wild food resources and their role in sustainable rural development in the Vientiane Plain, Lao PDR. *横浜国立大学教育人間科学部紀要 III (社会科学)*, *13*, 1–26.

JICA. (2011). *Vientiane Capital Urban Development Master Plan*. JICA.

Kassam, S., & Dhehibi, B. (2016). *Mechanization to Drive A Process for Fertilizer Subsidy Reform in Egypt*.

Kasza, G., Izsó, T., Kunszabó, A., Szakos, D., Lénárt, I., Békefi, E. B., Vongxay, K., Popp, J., Oláh, J., & Lakner, Z. (2024). Consumer knowledge, attitudes, and behaviour regarding food safety–A perspective from Laos. *Heliyon*, *10*(9).

Kethongsa, S., Thadavong, K., & Moustier, P. (2004). *Vegetable marketing in Vientiane (Lao PDR)*.

KPL. (2024). Vientiane Capital. *Khaosan Pathet Lao*.

Libohova, Z., Seybold, C., Wysocki, D., Wills, S., Schoeneberger, P., Williams, C., Lindbo, D., Stott, D., & Owens, P. R. (2018). Reevaluating the effects of soil organic matter and other properties on available water-holding capacity using the National Cooperative Soil Survey Characterization Database. *Journal of Soil and Water Conservation*, *73*(4), 411–421.

LSB. (2021). *The 3rd Lao census of agriculture 2019/2020*.

LSB. (2024). *Lao Economic Performance in 2023 and Trends for 2024*.

LSB. (2025). *Lao Economic Performance in 2024 and Trends for 2025*.

MAF. (2015). *Agriculture Development Strategy to 2025 and Vision to the Year 2030*.

MAF. (2021). *Green and sustainable agriculture framework for Lao PDR to 2030*.

Makino, T., & Inthalangsee, B. (2023). A Comparative Study Between Organic Agriculture for Vegetables and Fruits Production in Lao PDR and the MRL Approach Used by Other Countries in the Mekong Region. *JAS (Journal of ASEAN Studies)*, *11*(2).

MPI. (2021). *9th five-year national scio-economic development plan 2021-2025*.

NAFRI. (2007). *Report on Fruit and Vegetable Production and Marketing in Vientiane Capital*.

Panyakul, V. (2012). *Lao's organic agriculture: 2012 update*.

Potutan, G. E., Holmer, R. J., & Schnitzler, W. H. (1998). *Peri-urban Commercial Vegetable Production in Vientiane, Lao PDR*.

Qiao, Y., Kang, M., & Ahn, B. (2023). Analysis of factors affecting vegetable price fluctuation: A case study of South Korea. *Agriculture*, *13*(3), 577.

Rassapong, S. (2016). *Pesticides: A Cause for Concern*.

Ritchie, J., Lewis, J., Nicholls, C. M., & Ormston, R. (2003). *Qualitative research practice* (Vol. 757). sage London.

Ruslin, R., Mashuri, S., Rasak, M. S. A., Alhabsyi, F., & Syam, H. (2022). Semi-structured Interview: A methodological reflection on the development of a qualitative research instrument in educational studies. *IOSR Journal of Research & Method in Education (IOSR-JRME)*, *12*(1), 22–29.

Sapbamrer, R., Hongsibsong, S., Naksata, M., & Naksata, W. (2021). Insecticide Filtration Efficiency of Respiratory Protective Equipment Commonly Worn by

Farmers in Thailand. *International Journal of Environmental Research and Public Health*, *18*(5). https://doi.org/10.3390/ijerph18052624

Schreinemachers, P., Chen, H., Nguyen, T. T. L., Buntong, B., Bouapao, L., Gautam, S., Le, N. T., Pinn, T., Vilaysone, P., & Srinivasan, R. (2017). Too much to handle? Pesticide dependence of smallholder vegetable farmers in Southeast Asia. *Science of The Total Environment*, *593–594*, 470–477. https://doi.org/10.1016/j.scitotenv.2017.03.181

Schreinemachers, P., Grovermann, C., Praneetvatakul, S., Heng, P., Nguyen, T. T. L., Buntong, B., Le, N. T., & Pinn, T. (2020a). How much is too much? Quantifying pesticide overuse in vegetable production in Southeast Asia. *Journal of Cleaner Production*, *244*, 118738. https://doi.org/10.1016/j.jclepro.2019.118738

Schreinemachers, P., Grovermann, C., Praneetvatakul, S., Heng, P., Nguyen, T. T. L., Buntong, B., Le, N. T., & Pinn, T. (2020b). How much is too much? Quantifying pesticide overuse in vegetable production in Southeast Asia. *Journal of Cleaner Production*, *244*, 118738.

Shattuck, A. (2021). Toxic uncertainties and epistemic emergence: Understanding pesticides and health in Lao PDR. *Annals of the American Association of Geographers*, *111*(1), 216–230.

United Nations Lao PDR. (2024). *Flood Needs and Early Recovery Assessment Report*. UN Lao PDR.

Van Nguyen, T., Ha, T. M., Boulom, S., Voe, P., Heang, C., Ha, D. A., Chialue, L., Bor, B., Phommaluesa, S., & Pham, D. H. (2020). Consumers' risk perception of vegetables in Southeast Asia: Evidence from Laos, Cambodia, and Viet Nam. *APN Science Bulletin*.

World Bank. (2021). *Managing Pesticides for Greener Growth in Lao PDR*.

World Bank. (2021). *Climate Risk Country Profile Lao PDR*. the World Bank Group.

World Health Organization. (2020). *Guidelines for personal protection when handling and applying pesticides: International Code of Conduct on Pesticide Management*. Food & Agriculture Org.

World Bank. (2018). *Commercialization of rice and vegetables value chains in Lao PDR: Status and prospects*.

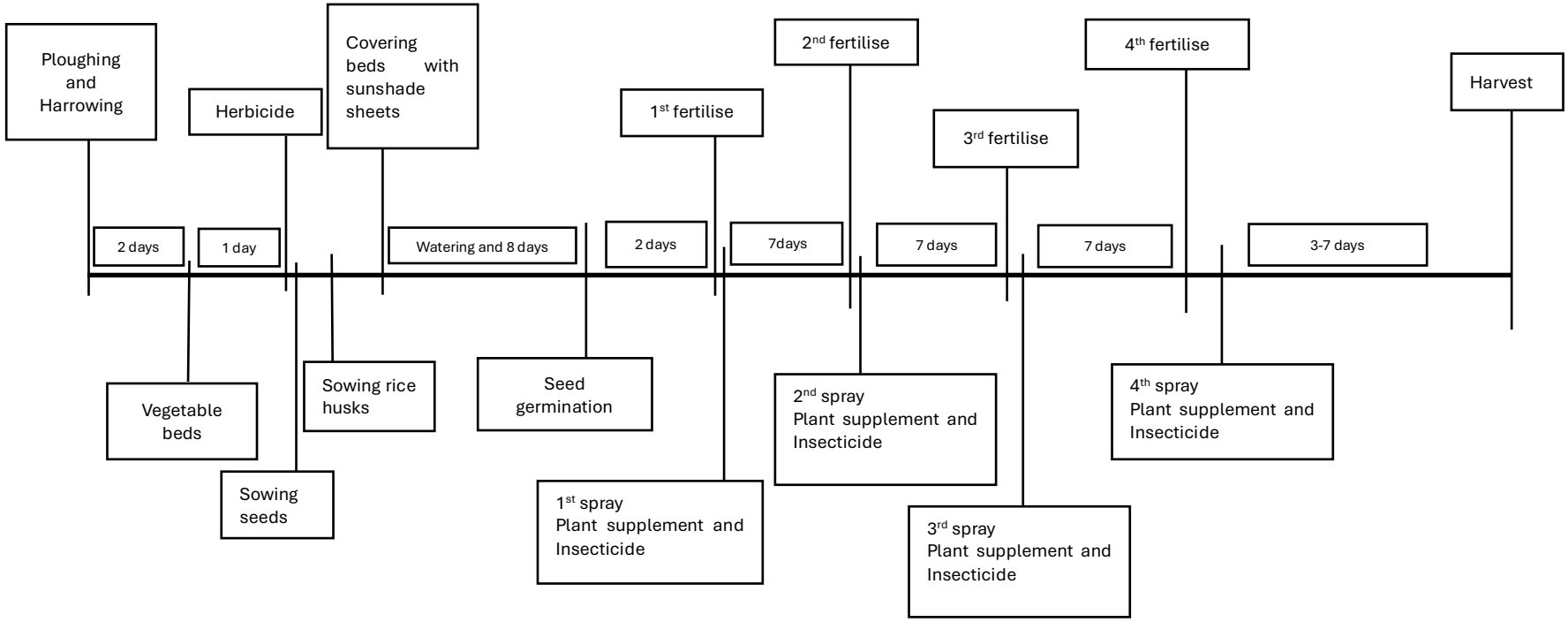
World Bank. (2022). *Developing agribusiness potential in the Laos-China railway corridor*.

World Bank. (2022). *Lao Rural Livelihoods in Times of Crisis*.

World Bank. (2024). *Lao PDR economic monitor*.

Zhou, Y., Yang, H., Mosler, H.-J., & Abbaspour, K. C. (2010). Factors affecting farmers' decisions on fertilizer use. *Consilience*, (4), 80–102. JSTOR. http://www.jstor.org/stable/26167133

Appendix 1: Coriander growing pattern



Appendix 2: Fertilisers type use among interviewed farmers

Fertiliser		
N-P-K Ratio	**Farm's usage information**	**Sample image**
46-0- 0	• Farmers apply this pertiliser to the leaf vegetable • Some farmers mix this fertiliser with other fertilizer before applying to the crops.	 
16-20-0	• Commonly apply for coriander caltivation. • Some farmers believes that greenery benefits crops also helps the corps look good.	
16-8-8	• Some farmers apply this fertilisers in coriander	
15-15-15	Farmer mainly use this fertiliser for fruit vegetablea (tomato, chilli pepper, sponge gourd) and some apply for leaf vegetables (lemon balm, choy sum, cauliflower, corainder).	 

27-7-7	• Farmers consider it as intense fertiliser. • Farmers mix it with plant supplement or insecticide and 20 litres of water before spraying.	
Name: Fresh green	The fertiliser is a quality organic fertilizer product with over 24.5% organic matter (OM) and complete NPK nutrients, secondary and supplementary nutrients. Plants can use or eat it right away.	

Appendix 3: Plant supplements use among farmers interviewed

Plant supplement			
Name	Ingredients	Utilisation	Sample image
Super green	N/A	• farmers believe this product is organic • apply by spraying for leaf vegetables • 1 capsule with20 litres of water	
Super Fruit	N/A	• farmers believe this product is organic • apply by spraying for fruit vegetable • 1 capsule with 20 litres of water	
Pop-up	7% Magnesium (MgO) 0.4% Iron (Fe) 3% Manganese (Mn) 1% Copper(Cu) 0.4% Boron (B)	• This product is produced by Appliedchem (Thailand) Co., Ltd. • This product enhances plant growth. • Farmers apply by mixing it with 20 litres of water and spraying the plants.	
Rasakatai	N/A	• Plant enhancer liquid type • Farmer use 1 cap per 20 litres of water and spray	

Appendix 4: Insecticides use among farmers interviewed

Insecticide			
Name	Ingredient	Utilisation	Sample image
Prevathon	Chlorantraniliprole 51.7 g/l (anthranilic diamide)	Some farmers apply this product to prevent insects. Mix one pack with 20 litres of water and spray.	 
Poseidon	Cypermethrin 10% W/W Chemical group: Pyrethroid		
Polydon	Cypermethrin 3% W/W Chemical group: Pyrethroid	Farmers apply this product to the soil to eliminate soil worms.	
Tawee 5	Emamectin benzoate 5% WG Chemical group: Avermectin (group 6)	Lebel: Package of 20 g. Instruct to use 10 g for 20 liters of water. Use 20 g for 40 l for 1,600 m^2	 
VU ema	Emamectin benzoate 5% SG Chemical group: Avermectin (group 6)		

	The product is a systemic insecticide that works through ingestion and contact. It can be rapidly absorbed by the plant leaves and acts immediately after being sprayed on the plant. It disrupts the nervous system and muscle function, causing the insects to cease eating upon contact. It can control Lepidopterous insects (butterflies) at all life stages, including eggs, larvae, pupae, and even adults (flying ones). It can eliminate a wide variety of insects, such as cutworms, armyworms, ball borers, leaf miners, thrips, mites in chili, and flea beetles. Lebal: 10 millilitres per 20 litres of water.		

Appendix 5: Fungicides used among farmers interviewed

Fungicide			
Name	**Ingredients and product information**	**Utilisation**	**Sample image**
Bentas	Common name : Carbendazim.....50% SC Substance group : Benzimidazole [Group 1] Product information • Systemic fungicides that act both as preventive and elimination agents for plant diseases. They are absorbed into the green parts of the plant and can move to eliminate plant pathogenic fungi. • Prevent and eliminate leaf spot, anthracnose, leaf burn, sheath blight, powdery mildew, scab, and melanose. Lebel: 30 cc per 20 liters of water, spray twice: first when a disease outbreak is detected, and second 10 days after the first application. - Do not harvest rice within 14 days after the last spray - Do not harvest mangoes within 3 days after the last spray - Do not mix Bentas SC with lime, sulfur and bordomixer		
Syngenta Score	Difenoconazole (23.3% w/w)	This product is widely used by farmers, particularly during the rainy season, to prevent root and leaf rot.	

Appendix 6: Herbicides use among farmers interviewed

Herbicide			
Name	**Ingredients**	**Utilisation**	**Sample image**
Zizane	Clethodim. 24 % W/V EC.	This herbicide for grasses and general narrow-leaved weeds, the type that is absorbed and kills weeds after seed germination Instruction: Spray 15 - 25 days after planting or when the weeds have 3 - 6 leaves. Usage rate: 20-30 ml/20 l 50 ml/20 l	
Round up	Glyphosate-isopropylammonim 48% W/v SL		

Appendix 7: Soil amendment product used by a farmer interviewed

Soil amendment			
Name	**Ingredients and product information**	**Utilisation**	**Sample image**
Din Nao	N/A This product solves issues like soil rot, compacted soil, and fungus. It is a natural organic substance, free from chemicals, that helps adjust the soil's acidity and alkalinity to neutral levels. Additionally, it promotes the growth of microorganisms, which are vital nutrients that help adjust, fix, and enhance the soil's nutrient content.	Farmer use it to improve soil quality	

Appendix 8: Research informants

Informant	Number
Provincial Official Department of Agriculture and Forestry, Vientiane Capital.	1
District Official and farmer Office of Agriculture and Forestry, Hadxayfong District.	1
Head of the village Thakhek Village, Hadxayfong District.	1
Community, agriculture lead and Farmer Hadkansa Village, Hadxayfong District.	1
Middle Saler	1
Farmers	20 (Total: 21)
Total	25

Number	Age	Gender	Education	Farming experience	Farm size m^2	Land ownership
1	36	Male	Bachelor	>5	12,800	own
2	65	Male	Bachelor	< 20	6,400	own
3	47	Male	Elementary	<20	4,800	rent
4	70	Female	N/A	<30	4,800	own
5	55	Female	N/A	<30	4,800	own
6	56	Male	N/A	<30	24,000	rent
7	54	Female	N/A	<30	2,000	own
8	56	Male	N/A	<20	3,200	rent
9	27	Male	N/A	<15	5,600	rent
10	36	Male	N/A	>4	3,200	rent

11	50	Male	N/A	<20	8,000	rent
12	48	Male	Bachelor	<15	3,200	rent
13	48	Male	elementary	<10	14,400	N/A
14	55	Male	elementary	<10	11,200	N/A
15	46	Male	elementary	<30	4,800	rent
16	65	Male	elementary	<10	4,800	own
17	60	Male	N/A	<40	4,800	own
18	47	Male	N/A	<20	3,200	own
19	54	Male	N/A	<35	6,400	rent
20	55	Male	N/A	<30	4,800	own
21	29	Male	Bachelor	>5	3,200	own

Appendix 9: Information Sheet in English

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TE WĀHANGA PŪTAIAO

Chemical and fertiliser use on Lao PDR vegetable farms

INFORMATION SHEET

Researcher(s) Introduction

I am Paliphon Bounlu, and I am pursuing a master's in Agribusiness at the School of Agriculture and Environment, Massey University, New Zealand. This research study is a requirement of the master's degree programme.

Description of the study and invitation to participate in this study

The purpose of this study is to explore how and why vegetable farmers in Lao PDR apply chemicals and fertilisers and what the on-farm and off-farm factors are associated with the usage. Vegetable production is important in Lao PDR as a food source for local daily consumption and income for smallholder vegetable farmers. Most of the vegetable production available in the markets depends on domestic small producers. There is limited information on how farmers produce vegetables in Lao PDR. This research will enhance the understanding of vegetable production and provide valuable information for agricultural development and sustainability in Lao PDR.

As vegetable production increasingly faces challenges from pests and diseases, it becomes essential to explore how farmers manage these issues and the factors that shape their coping strategies. Understanding these influences is critical to identifying the methods farmers implement to sustain their crop yields, and secure sufficient income to support their livelihoods. Additionally, exploring these dynamics can provide insights into the decision-making processes behind agricultural practices, including the use of chemicals and fertilisers, and highlight areas where targeted interventions or support may be needed to enhance their resilience and ensure sustainable farming.

In this study, the researcher will interview key informants and vegetable farmers who grow vegetables for business purposes, around a total of 30 participants in Vientiane. The key informants include community leaders, agricultural officials, agricultural extensionists, input sellers, middle sellers.

With your consent an interview will be completed at a time and place suitable for you. The interview is likely to take 1 to 1.5 hours and I will seek your permission to digitally record the interview.

Data Management

The data obtained will be solely used for academic purposes. The collected data will be stored on a portable hard drive and backed up in Google Drive securely. The recorded information will be transcribed and used for analysis. The final thesis will be accessible at Massey University.

Te Kunenga ki Pūrehuroa
School of Agriculture and Environment (PN 433)
Private Bag 11222, Palmerston North 4442, New Zealand T +64 356 9099 F +64 6 350 5680; www.massey.ac.nz/science

Appendix 10: Information sheet in Lao.

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ການນຳໃຊ້ເຄມີ ແລະ ປຸ໋ຍໃນການປູກຜັກຂອງ ສປປ ລາວ
ຂໍ້ມູນການສຶກສາຄົ້ນຄ້ວາ

ກ່ຽວກັບຜູ້ຄົ້ນຄ້ວາ

ຂ້າພະເຈົ້າຊື່ວ່າ ທ. ປະລິພົນ ບຸນລື ເປັນນັກສຶກສາລະດັບປະລິຍາໂທ ສາຂາການຄ້ານາະສິກຳ, ພາກວິຊານາະສິກຳ ແລະ ສິ່ງແວດລ້ອມ, ມະຫາວິທະຍາໄລແມັສຊີ (Massey University), ປະເທດນິວຊີແລນ. ການສຶກສາຄົ້ນຄ້ວາດັ່ງກ່າວນີ້ແມ່ນເພື່ອນຳໃຊ້ເຂົ້າໃນຫຼັກສູດລະດັບປະລິນຍາໂທ.

ລາຍລະອຽດ ແລະ ການມີສ່ວນຮ່ວມໃນການສຶກສານີ້

ຈຸດປະສົງແມ່ນເພື່ອ ຄົ້ນຄວ້າວິທີການ ແລະ ສາເຫດທີ່ຊາວນາະສິກອນຜູ້ປູກຜັກໃນ ສປປ ລາວ ນຳໃຊ້ສານເຄມີ ແລະ ປຸ໋ຍ ແລະ ປັດໃຈທີ່ມີສ່ວນກ່ຽວຂ້ອງກັບການນຳໃຊ້. ຜັກແມ່ນສິນຄ້ານາະສິກຳທີ່ມີຄວາມສຳຄັນຂອງປະເທດລາວ ເປັນແຫຼ່ງອາຫານໃນການດຳລົງຊີວິດ ແລະ ບ່ອນສ້າງລາຍໄດ້ໃຫ້ແກ່ຊາວນາະສິກອນຂະໜາດນ້ອຍ. ເນື່ອງຈາກສິນຄ້າຜັກທີ່ມີຂາຍຕາມທ້ອງຕະຫຼາດສ່ວນໃຫຍ່ແມ່ນຂຶ້ນກັບການຜະລິດພາຍໃນ ເຊິ່ງຂໍ້ມູນໃນການຜະລິດຜັກໃນ ສປປ ລາວ ຍັງມີຄວາມຈຳກັດ. ສະນັ້ນ, ການສຶກສາດັ່ງກ່າວນີ້ ຈະຊ່ວຍສ້າງຄວາມເຂົ້າໃຈກ່ຽວກັບການຜະລິດຜັກເປັນສິນຄ້າ ແລະ ເປັນຂໍ້ມູນທີ່ສຳຄັນໃນການພັດທະນາ ດ້ານນາະສິກຳ ໃຫ້ມີຄວາມຍືນຍົງຂອງ ສປປ ລາວ.

ການຜະລິດຜັກໃນປະຈຸບັນ ກຳລັງປະເຊີນກັບສິ່ງທ້າທາຍຈາກສັດຕູພືດ ແລະ ພະຍາດເພີ່ມຫຼາຍຂຶ້ນ, ຈຶ່ງເຮັດໃຫ້ການຄົ້ນຄ້ວາມີຄວາມສຳຄັນ ກ່ຽວກັບວິທີການຂອງຊາວນາະສິກອນ ໃນການບໍລິຫານຈັດການບັນຫາ ແລະ ປັດໃຈທີ່ມີຜົນນາະທິບຕໍ່ການກຳນົດຍຸດທະສາດເພື່ອປ້ອງກັນສິ່ງທ້າທາຍຕ່າງໆ. ການສ້າງຄວາມເຂົ້າໃຈກ່ຽວກັບປັດໃຈທີ່ນາະທິບຕໍ່ການປະຕິບັດຂອງຊາວນາະສິກອນ ແມ່ນມີຄວາມສຳຄັນ ເພື່ອພັດທະນາການປູກຜັກຂອງຊາວນາະສິກອນໃຫ້ມີຜົນຜະລິດທີ່ຍັ່ງຍືນ ແລະ ຮັກສາລາຍໄດ້ໃຫ້ຄົງທີ່ ເພື່ອສົ່ງເສີມການດຳລົງຊີວິດຂອງຊາວນາະສິກອນ. ນອກຈາກນີ້, ການສຶກສາຄົ້ນຄ້ວາ ບັນດາວິທີການ ແລະ ປັດໃຈຕ່າງໆ ແມ່ນຈະຊ່ວຍສະໜອງຄວາມເຂົ້າໃຈ ໃນຂະບວນການຕັດສິນໃຈເບື້ອງຫຼັງ ການຜະລິດສິນຄ້ານາະສິກຳ ລວມທັ້ງການນຳໃຊ້ເຄມີ, ປຸ໋ຍ ແລະ ຂົງເຂດເປົ້າໝາຍທີ່ມີຄວາມຕ້ອງການ ການສະໜັບສະໜູນເພື່ອສົ່ງເສີມຄວາມຍືດຢຸ່ນ ແລະ ຮັບປະກັນການນາະສິກຳແບບຍືນຍົງ.

ການສຶກສາຄົ້ນຄ້ວານີ້ ຜູ້ຄົ້ນຄ້ວາຈະສຳພາດຜູ້ທີ່ມີສ່ວນກ່ຽວຂ້ອງ ແລະ ຊາວນາະສິກອນຜູ້ປູກຜັກເພື່ອເປັນສິນຄ້າ ປະມານ 30 ທ່ານ ໃນຂົງເຂດນະຄອນຫຼວງວຽງຈັນ. ພາກສ່ວນທີ່ກ່ຽວຂ້ອງແມ່ນ ນາຍບ້ານ, ພະນັກງານ ຂະແໜງນາະສິກຳ, ນັກວິຊາການ ນາະສິກຳ, ຜູ້ຂາຍສິນຄ້ານາະສິກຳ ແລະ ຜູ້ຂາຍຄົນກາງ.

ການເຫັນດີເຂົ້າຮ່ວມສຳພາດຂອງທ່ານ ໃນການສຶກສາດັ່ງກ່າວນີ້ ແມ່ນຈະໃຊ້ເວລາ ແລະ ສະຖານທີ່ ທີ່ເໝາະສົມສຳລັບທ່ານ ເຊິ່ງຈະໃຊ້ເວລາປະມານ 1 ຫາ 1.5 ຊົ່ວໂມງ ແລະ ຂ້າພະເຈົ້າ ຈະຂໍອະນຸຍາດຜູ້ເຂົ້າຮ່ວມເພື່ອບັນທຶກການສຳພາດ.

ການບໍລິຫານຂໍ້ມູນ

ຂໍ້ມູນທີ່ຖືກເກັບກຳແມ່ນຈະຖືກນຳໃຊ້ສະເພາະຈຸດປະສົງໃນດ້ານວິຊາການ. ຂໍ້ມູນຈະຖືກຈັດເກັບໄວ້ໃນຮາດດິດ ແລະ ກູໂກດຣາຍຟ (google drive) ຢ່າງປອດໄພ. ຂໍ້ມູນທີ່ບັນທຶກແມ່ນຈະຖືກຖອດຄວາມ ເພື່ອໃຊ້ໃນການວິເຄາະ. ບົດວິທະຍານິພົນ ແມ່ນ ສາມາດເຂົ້າເຖິງໄດ້ທີ່ ມະຫາວິທະຍາໄລແມສຊີ, ປະເທດນິວຊີແລນ.

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ຂໍ້ມູນຂອງຜູ້ເຂົ້າຮ່ວມຈະຖືກຮັກສາໄດຍການບໍ່ເປີດເຜີຍໃຕ້ດິນ ແລະ ຂໍ້ມູນສ່ວນໃຕ້ຂອງຜູ້ເຂົ້າຮ່ວມ. ໂດຍອີງຕາມ ຈຸດປະສົງຂອງການສຶກສາ, ບາງຂໍ້ມູນຂອງບາງຜູ້ເຂົ້າຮ່ວມ ໂດຍສະເພາະຜູ້ທີ່ຢູ່ໃນຂົງເຂດວຽກງານບໍລິຫານລັດ ແຕ່ຈະບໍ່ມີການອ້າງ ອີງ ຫຼື ລະບຸ ໂດຍກົງເຖິງບຸກຄົນໃດໜຶ່ງ ແຕ່ອາດຈະລະບຸເຖິງໜ້າທີ່ເປັນທາງການ.

ສິດຂອງຜູ້ເຂົ້າຮ່ວມ

ທ່ານບໍ່ມີພັນທະທີ່ຕ້ອງຕອບຮັບການເຊີນເຂົ້າຮ່ວມ. ຖ້າທ່ານເລືອກທີ່ຈະເຂົ້າຮ່ວມ ທ່ານມີສິດດັ່ງນີ້:

- ຖາມກ່ຽວກັບການສຶກສາຄົ້ນຄ້ວາໃນໄລຍະ ແລະ ຫຼັງການເຂົ້າຮ່ວມ.
- ປະຕິເສດການຕອບບາງຄຳຖາມ.
- ຖອນ ຫຼື ຍົກເລີກ ການເຂົ້າຮ່ວມ.
- ຂໍໃຫ້ປິດການບັນທຶກສຽງໃນໄລຍະການສຳພາດ.
- ຮັກສາຂໍ້ມູນສ່ວນບຸກຄົນ ລວມທັງ ຊື່, ຕຳແໜ່ງ, ທີ່ຢູ່, ແລະ ເບີໂທ ຈະບໍ່ຖືກເປີດເຜີຍໃຫ້ແກ່ບຸກຄົນພາຍນອກ ກ່ອນໄດ້ຮັບ ການອະນຸຍາດຈາກທ່ານ.
- ເຂົ້າເຖິງຂໍ້ມູນຂອງການສຶກສາ ພາຍຫຼັງການສະຫຼຸບ.

ຂໍ້ມູນຕິດຕໍ່ກ່ຽວກັບການສຶກສາ

ຖ້າທ່ານຕ້ອງການຂໍ້ມູນໃນດ້ານຕ່າງໆກ່ຽວການສຶກສາ ກະລຸນາຕິດຕໍ່ຜູ້ທີ່ມີສ່ວນຮ່ວມໃນການສຶກສາ ດັ່ງຂໍ້ມູນຂ້າງລຸ່ມນີ້:

ນັກຄົ້ນຄ້ວາ: ທ. ປະລິພົນ ບຸນລື

ຄະນະກະສິກຳ ແລະ ສິ່ງແວດລ້ອມ, ມະຫາວິທະຍາໄລແມັສຊີ, ປະເທດນິວຊີແລນ.

ເບີໂທ: [redacted] (ນິວຊີແລນ) or [redacted] (ລາວ)

ອີເມວ: [redacted] OR [redacted]@massey.ac.nz

ຄະນະອາຈານທີ່ປຶກສາ ຈາກ ຄະນະກະສິກຳ ແລະ ສິ່ງແວດລ້ອມ, ພາກວິຊາວິທະຍາສາດ, ມະຫາວິທະຍາໄລແມັສຊີ, ປະເທດນິວຊີ ແລນ.

ປອ. ປີເຕີ ໄທສເຊີ, ອາຈານທີ່ປຶກສາຫຼັກ, ອາຈານໃນສາຂາວິຊາ ການບໍລິຫານຄຸ້ມຄອງໝາມ.

ເບີໂທ: +6469517795 - ອີເມວ: P.Tozer@massey.ac.nz

ປອ. ເຈນເນັດ ຣີດ, ອາຈານທີ່ປຶກສາຮ່ວມ, ຫົວໜ້າກຸ່ມ ແລະ ອາຈານອາວຸດໂສດ້ານລະບົບການກະສິກຳ.

ເບີໂທ: ++6469517812 - ອີເມວ: J.I.Reid@massey.ac.nz

ການຄົ້ນຄ້ວາມີຄວາມສ່ຽງຕ່ຳ

ໂຄງການຄົ້ນຄ້ວາແມ່ນມີຄວາມສ່ຽງຕ່ຳໂດຍການປະເມີນຈາກຜູ້ຊ່ຽວຊານ. ດັ່ງນັ້ນ, ຈຶ່ງບໍ່ໄດ້ຮັບການປະເມີນຈາກຄະນະກຳມະການ ດ້ານຈັນຍາບັນຂອງມະນຸດຂອງມະຫາວິທະຍາໄລ. ເຊິ່ງນັກຄົ້ນຄ້ວາທີ່ມີຊື່ຂ້າງເທິງແມ່ນມີຄວາມຮັບຜິດຊອບຕໍ່ຈັນຍາບັນຂອງການ ຄົ້ນຄ້ວານີ້.

ຖ້າທ່ານຕ້ອງການສະແດງຄວາມຄິດເຫັນກ່ຽວກັບການສຶກສາຄົ້ນຄ້ວາ ສາມາດປະສານຫາ ທ່ານ ເຫຼົ່ກ ຈອນຊັນ, ຜູ້ອຳນວຍການ,ຈັນ ຍາບັນການຄົ້ນຄ້ວາ, ໂທລະສັບ +646 356 9099 x 85271, ອີເມວ humanethics@massey.ac.nz.

Appendix 11: Consent form in English

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Chemical and fertiliser use on Lao PDR vegetable farms

PARTICIPANT CONSENT FORM - INDIVIDUAL

I have read, or have had read to me in my first language, and I understand the Information Sheet. I have had the details of the study explained to me, any questions I had have been answered to my satisfaction, and I understand that I may ask further questions at any time. I have been given sufficient time to consider whether to participate in this study and I understand participation is voluntary and that I may withdraw from the study at any time.

1. I agree/do not agree to the interview being sound recorded
2. I agree to participate in this study under the conditions set out in the Information Sheet.

Declaration by Participant:

I _____hereby consent to take part in this study.

Signature: _____ Date: _____

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Appendix 12: Consent form in Lao.

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TE WĀHANGA PŪTAIAO

ການນຳໃຊ້ເຄມີ ແລະ ປຸ໋ຍໃນການປູກຜັກຂອງ ສປປ ລາວ

ແບບຟອມການຍິນຍອມຂອງຜູ້ເຂົ້າຮ່ວມ - ສ່ວນບຸກຄົນ

ຂ້າພະເຈົ້າ ໄດ້ອ່ານ ແລະ ຮັບຮູ້ໃນພາສາຫຼັກຂອງຂ້າພະເຈົ້າ ແລະ ຂ້າພະເຈົ້າເຂົ້າໃຈເອກະສານຂໍ້ມູນ ຂອງການສຶກສາຄົ້ນຄ້ວາ. ຂ້າພະເຈົ້າ ໄດ້ຮັບການອະທິບາຍກ່ຽວກັບລາຍລະອຽດຂອງການສຶກສາຄົ້ນ ຄ້ວາ, ຄຳຖາມຕ່າງໆທີ່ຂ້າພະເຈົ້າມີແມ່ນໄດ້ຮັບຄຳຕອບທີ່ເພິ່ງພໍໃຈ, ແລະ ເຂົ້າໃຈວ່າຂ້າພະເຈົ້າອາດຈະ ຖາມຄຳຖາມຕື່ມອີກໄດ້ທຸກເວລາ. ຂ້າພະເຈົ້າໄດ້ຮັບເວລາທີ່ພຽງພໍໃນການພິຈາລະນາ ເພື່ອເຂົ້າຮ່ວມ ການສຶກສານີ້ ແລະ ຂ້າພະເຈົ້າເຂົ້າໃຈວ່າການເຂົ້າຮ່ວມແມ່ນຄວາມສະໝັກໃຈ ແລະ ສາມາດຢຸດຕິການ ເຂົ້າຮ່ວມໄດ້ທຸກເວລາ.

1. ຂ້າພະເຈົ້າ ຍິນຍອມ/ບໍ່ຍິນຍອມ ການສຳພາດທີ່ບັນທຶກສຽງ.
2. ຂ້າພະເຈົ້າຍິນຍອມເຂົ້າຮ່ວມໃນການສຶກສາພາຍໃຕ້ເງື່ອນໄຂທີ່ກຳນົດໄວ້ໃນເອກະສານຂໍ້ມູນ.

ການເຫັນດີຂອງຜູ້ເຂົ້າຮ່ວມ:

ຂ້າພະເຈົ້າ _____ຍິນຍອມມີສ່ວນຮ່ວມໃນການສຶກສານີ້.

ລາຍເຊັນ: _____ ວັນທີ: _____

Appendix 13: Photograph consent form in English

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Chemical and fertiliser use on Lao PDR vegetable farms

CONSENT FORM – COLLECTING PHOTOGRAPHS

The purpose of collecting photographs in this study is to visually document and support the research findings related to vegetable farming practices in Lao PDR. The photographs will provide valuable insights into the daily practices of farmers and their environments, serving as a complement to the data collected during the study. The photographs collected will only be used strictly for educational and academic purposes and respect the dignity and privacy of participants.

Declaration by Participant:

I agree / do not agree to photographs being taken of myself and/ or family and used for the purposes described above.

.

I _____hereby consent to the taking of photographs as indicated above.

Signature: _____ Date: _____

Appendix 14: Photograph consent form in Lao.

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ການນຳໃຊ້ເຄມີ ແລະ ປຸ໋ຍໃນການປູກຜັກຂອງ ສປປ ລາວ

ແບບຟອມການເຫັນດີ - ການເກັບກຳຮູບພາບ

ຈຸດປະສົງຂອງການເກັບກຳຮູບຖ່າຍໃນການສຶກສາຄັ້ງນີ້ ແມ່ນເພື່ອບັນທຶກເປັນເອກະສານ ແລະ ສະໜັບ ສະໜູນຜົນການຄົ້ນຄວ້າທີ່ກ່ຽວຂ້ອງກັບການປູກຜັກໃນ ສປປ ລາວ. ການເກັບກຳຮູບພາບດັ່ງກ່າວຈະໃຫ້ ຄວາມເຂົ້າໃຈທີ່ມີຄຸນຄ່າ ກ່ຽວກັບການປະຕິບັດປະຈຳວັນຂອງຊາວກະສິກອນ ແລະ ສະພາບແວດລ້ອມ ຂອງພວກເຂົາ, ເປັນການເສີມໃຫ້ກັບຂໍ້ມູນທີ່ເກັບກຳໃນລະຫວ່າງການສຶກສາ. ຮູບພາບທີ່ເກັບໄດ້ຈະ ຖືກນຳໃຊ້ຢ່າງເຂັ້ມງວດເພື່ອຈຸດປະສົງທາງດ້ານ ການສຶກສາ ແລະ ວິຊາການ ໂດຍເຄົາລົບກຽດສັກສີ ແລະ ຄວາມເປັນສ່ວນຕົວຂອງຜູ້ເຂົ້າຮ່ວມ.

ການເຫັນດີຂອງຜູ້ເຂົ້າຮ່ວມ:

ຂ້າພະເຈົ້າ ຍິນຍອມ / ບໍ່ຍິນຍອມ ເກັບກຳຮູບພາບຂອງຂ້າພະເຈົ້າ ແລະ/ຫຼື ຄອບຄົວ ແລະ ນຳໃຊ້ເຂົ້າ ໃນຈຸດປະສົງ ດັ່ງທີ່ກ່າວມາຂ້າງເທິງນັ້ນ.

ຂ້າພະເຈົ້າ _____ຍິນຍອມໃຫ້ເກັບກຳຮູບດັ່ງກ່າວຂ້າງເທິງ.

ລາຍເຊັນ: _____ ວັນທີ: _____

Appendix 15: Interview Topic guideline in English.

Interview Question Guidelines

Research Topic: Chemical and fertiliser application in Lao PDR vegetable farming: a study of usage pattern and consequences

Qualitative Interview Introduction

Length: 30 – 45 minutes

Objective: to study how vegetable farmers in Lao PDR apply chemicals and fertilisers and what factors are associated with their usage.

Verbal consent

The participants were informed of their right to withdraw at any point and assured that all data would be anonymised and kept confidential. The interview will be recorded with the participant's permission.

Farmers

Background Information and Farming

- Invite the interviewee to talk briefly about the general background (name, age, and education)
- Can you tell me about your experience as a vegetable farmer?
  - How long have you been farming?
  - Size of your farm
- What crops do you currently grow, and how do you decide which crop to plant?
- Can you describe a typical day on your farm?
- What are some of the main steps you take when growing your crops, from planting to harvest?
- How do you manage your farm's pests, weeds, and soil fertility?
- Do you test the soil for nutrient levels or pH? If so, how often?

General Use of Agricultural Inputs

- What types of fertilisers and pesticides do you use on your farm?
- How many kinds or types of chemicals and fertilisers do you use on your farm?
- How do you decide when and how much fertiliser or pesticide to use?
- How frequently do you use it?
- Why do you decide to use this brand? Or this type of fertiliser?
- Have you received any training on the safe use of chemicals or fertilisers?
- What benefit do you think you received?
- Does the pattern of your implementation provide satisfaction in your productivity?

Pest and Disease Management

- How do you control pests and diseases on your farm? Do you use pesticides, crop rotation, or other methods?
- If you use pesticides, how do you decide which ones to use and how much to apply?
- Do you have a system in place to prevent excessive pesticide use or manage resistance in pests?

Assess of Agricultural Inputs

- Where do you typically purchase your agricultural inputs? (e.g., local market, cooperatives, government programs)
- Do you find it easy or difficult to access high-quality agricultural inputs in your area?
- Are any barriers, such as distance or supply issues, affecting your ability to obtain inputs?
- How do the costs of agricultural inputs impact your farming practices?

Handling and Harvesting Practices

- Can you walk me through the steps you follow when harvesting your crops?
- How do you store or transport your vegetables after harvest?
- Do you use specific practices to keep your produce clean or fresh?
- Do you have experience with government checks for vegetable sanitary?

Observing factors that can affect chemical and fertiliser usage.

Challenges Faced in Farming

- What are some of the main challenges you face in growing and selling your crops?
- Are there any particular farming practices you find difficult or costly to implement?
- Do you have access to the necessary resources, like seeds, water, or farming tools?
- If you reduce the use of chemicals and fertilisers, will it impact your production?

Community and Market Influences

- Are there any practices that buyers or community leaders recommend for vegetable farming?
- Have buyers ever asked questions about how you grow your crops?
- Do you think other farmers in your community would be interested in learning more about safe farming practices?

Handling of Chemicals and Pesticides

- Where and how do you store pesticides, fertilizers, and other chemicals on the farm?
- Are there any precautions you take when handling or applying these chemicals?
- Do you follow any guidelines regarding how long to wait before harvesting crops after applying pesticides?

Food Safety Awareness

- How important do you think it is to produce vegetables that are safe and healthy for consumers?
- Do you take any specific steps to ensure that your vegetables are safe to eat?
- Are you familiar with any guidelines or standards for safe food production?

Observing on familiarity with Food Safety

- Are you familiar with any specific food safety standards or guidelines?
- What does food safety mean to you? Do you feel that food safety is important for your farm products?
- Have you heard of any specific practices that help make produce safer for people to eat?
- Do you take any steps to ensure your vegetables are safe for consumers?

Awareness of Agricultural Standards or Programs

- Have you ever heard of programs or guidelines to help farmers improve their production practices? (If applicable, mention local agriculture programs.)
- Have you participated in any training sessions or workshops related to farming practices?

For Community Leaders

Background Information and Farming characteristic

- Invite the interviewee to talk briefly about the general background (name, age, and education)
- Can you tell me about your experience with vegetable farming in your areas?
- How long have you been a village leader?
- Can you tell me about the history of people growing vegetables in this area? How long since people in this area began growing?
- Do you work or communicate with vegetable farmers? How often? And what kind of task have you been working on with them?
- What kind of vegetables do farmers like to grow in this area?
- What is the average vegetable farm?

Farming practices

- Can you help explain the way people grow vegetables in this village?
- How do people learn about the way of growing vegetables? From other farmers, family or their neighbours? Or is it heritage?
- How do farmers learn new techniques?
- Do people use tools in their farming? What kind of tools do they use?
- How do people prepare their farming for pre-farm?
- Do farmer test their soil?

Chemical and Fertilizer

- Do you think chemicals and fertilisers are essential for growing vegetables here? Why?
- How much do farmers here use chemicals and fertilisers?
- How do they apply in their farming?
- What kind of chemicals and fertilisers do most farmers use?
- Can you explain the patterns that farmers use in their farms?
- As you explain the use of the pattern, what are the impacts?
- Do you think farmers have a good understanding of using chemicals and fertilisers in their farms? If not, what can be improved?
- Do farmers receive any workshops or training from the government or organisations?

Access to chemicals and fertilisers

- Where do farmers get their agricultural inputs?
- How do farmers decide what products they use and buy?
- Do you think farmers have sufficient access to chemicals and fertilisers?

- Do the products available meet the needs of the farmers?
- Are there any challenges for farmers in accessing chemicals and fertilisers?

Economic perspective

- How important of vegetable farming to people in your community?
- How much do you think vegetable farming supports the community?
- Is it an essential part of people's income?
- Do vegetable farms provide people sufficient income?

Challenges

- What are the challenges in vegetable farming?
- Is there any impact on vegetable production in these areas?
- What do you think needs to be improved or addressed?
- Do farmers need help? What kind of help?
- Are there any cultural, economic, or logistical factors that challenge farmers?

Food safety and standards

- Are farmers in your community familiar with food safety standards?
- If yes, how do they practice?
- Do you think vegetables grown in your community are safe to consume?
- Are there any specific ways of growing vegetables that can improve product consumption safety?
- Are there any programs or guidelines to help farmers improve their production practices?
- How does your community support farmers in learning about improving practices?

For Provincial and District Officials in Department of Agriculture and Forestry

General information

- Briefly about the general background: What is your name and role?
- How long have you been working in the department?
- What are your responsibilities?
- What do you think about the vegetable farming in Vientiane?
- Do you think vegetable production meets the demand for consumption?
    - If not, what would be the constraints?
- Do you think farmers who grow vegetables meet the quality standard?
- What improvements do you think farmers can make to improve their productivity?
- Does your work relate to vegetable farming? How often do you work with farmers? What kind of work?
- How often do you visit vegetable farms?
- Can you explain what you do when you visit the vegetable farms?
- What are the roles of the DAF in supporting vegetable production in Vientiane?

Farming practice

- Based on your experience, can you help describe how most farmers practice on their vegetable farm in Vientiane?
- Does the DAF support improving farmers' practices or generating information on new skills and techniques?
- What are the things you identify as essential or unnecessary practices?
- How do farmers learn new practices or techniques for growing vegetables? From other farmers, their families, or their neighbours? Or is it heritage?
- Do you think farmers quickly adapt to new practices?
- Do farmers use tools in their farming? What kind of tools do they use?
- How do farmers prepare their farming for pre-farm?
- Do farmer test their soil?

Chemicals and Fertilisers

- What are the roles of DAF in the supply of chemicals and fertilisers?
- How do farmers access to agricultural inputs in Vientiane? Especially chemicals and fertilisers.
- How do farmers who live in remote areas get their inputs?
- Do you think chemicals and fertilisers are available and meet the demand for farmers?
- Do you think chemicals and fertilisers are necessary for vegetable production?
- Do you think vegetable farmers use proper chemicals and fertilisers in their farming?
    - What is the role of DAF in ensuring the proper use of chemicals and fertilisers?

- What would be the proper use of chemicals and fertilisers that DAF recommends on vegetable farms?

Challenges and Barriers:

- From your experience, what are the biggest challenges for farmers?
- What could be the barrier that prevents suitable productivity?
- What are the areas of development in improving farmers' production?

Monitoring and Enforcement:

- Are there any regulations or guidelines for applying chemicals and fertiliser?
- Are there any regulations on food safety products?
- How does the department monitor among farmers?
- What mechanisms are in place to ensure food safety in vegetable production?
- Are there any penalties or incentives associated with unsafety products?

Recommendations for Policy or Support:

- What policies or programs would you recommend to improve vegetable farming in Lao PDR?
- What policy can be implemented to help the sufficient use of chemicals and fertilisers in vegetable production?
- How can the department work with other stakeholders, like local leaders or input sellers, to support farmers?
- What possible solution is available to address challenges in vegetable farming?
- What can be improved to support vegetable production to be more safety and standards?
- What can be improved to support Lao vegetable production in the export market?

Appendix 16: Topic guideline for traders.

1. Background Information

- **Can you tell me about your business and your role in purchasing vegetables?**
- **How long have you been involved in buying vegetables?**
- **What types of vegetables do you purchase most frequently, and where do you source them from?**

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2. Purchasing Criteria and Preferences

- **What are the key factors you consider when purchasing vegetables (e.g., price, quality, freshness, appearance)?**
- **Do you prioritize vegetables grown using specific farming methods (e.g., organic, GAP-certified, conventional)? Why or why not?**
- **How important is food safety when selecting vegetable suppliers? What specific food safety standards do you require?**

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3. Knowledge and Perception of Chemical and Fertilizer Use

- **How aware are you of the use of chemicals and fertilizers in vegetable farming?**
- **Do you have any concerns about the use of pesticides, herbicides, or synthetic fertilizers in vegetable production? If so, what are they?**
- **Do you believe farmers follow proper guidelines when using chemicals and fertilizers? Why or why not?**

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4. Supplier Relationships and Communication

- **How do you choose the farmers or suppliers you work with? What criteria are most important?**
- **Do you discuss chemical and fertilizer use with your suppliers? If yes, what kind of information do you request?**
- **Do you provide any guidelines or requirements regarding the use of chemicals and fertilizers to your suppliers?**

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5. Quality Control and Food Safety Compliance

- **Do you conduct any inspections or testing to verify that vegetables meet safety and quality standards? If yes, how is this done?**

- **What actions do you take if you discover vegetables with chemical residues or other safety concerns?**
- **Are there any specific certifications (e.g., GAP) that you require from your vegetable suppliers? Why are these important to you?**

6. Market and Consumer Demand

- **Have you noticed any changes in consumer preferences regarding vegetable safety or production methods?**
- **Do your customers express concerns about chemical use in vegetable farming? If so, what are their main concerns?**
- **Is there increasing demand for organic or sustainably produced vegetables? How has this affected your purchasing decisions?**

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7. Challenges and Recommendations

- **What challenges do you face when ensuring that vegetables meet quality and food safety standards?**
- **What improvements would you like to see in the way farmers manage chemical and fertilizer use?**
- **How can collaboration between buyers, farmers, and agricultural authorities be improved to ensure safer and more sustainable vegetable production?**

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8. Future Trends and Expectations

- **Do you foresee any future changes in how vegetables are produced or how you will source them?**
- **What role do you think buyers like yourself can play in encouraging safer and more sustainable farming practices?**

Appendix 17: Interview guideline in Lao.

ແນວທາງຄຳຖາມສຳພາດ

ຫົວຂໍ້ການຄົ້ນຄ້ວາ ການນຳໃຊ້ເຄມີ ແລະ ປຸ໋ຍໃນການປູກຜັກໃນ ສປປ ລາວ

ແນະນຳກ່ຽວກັບການສຳພາດ

ເວລາ: 1 – 1.5 ຊົ່ວໂມງ

ຈຸດປະສົງ: ເພື່ອສຶກສາ ແລະ ຮຽນຮູ້ການນຳໃຊ້ເຄມີ ແລະ ປຸ໋ຍຂອງຊາວກະສິກອນຜູ້ປູກຜັກ ແລະ ບັນດາປັດໃຈທີ່ມີກະທົບຕໍ່ການນຳໃຊ້.

ການຍິນຍອມທາງວາຈາ

ຜູ້ເຂົ້າຮ່ວມໄດ້ຮັບຮູ້ກ່ຽວກັບສິດໃນການຖອນໂຕໃນທຸກເວລາ ແລະ ຮັບປະກັນວ່າຂໍ້ມູນທັງໝົດຈະບໍ່ຖືກເປີດເຜີຍ ແລະ ເກັບໃວ້ເປັນຄວາມລັບ. ການສຳພາດແມ່ນຈະຖືກບັນທຶກໂດຍໄດ້ຮັບການອະນຸຍາດຈາກຜູ້ເຂົ້າຮ່ວມ.

ຊາວກະສິກອນ

ຂໍ້ມູນພື້ນຖານ ແບະ ການເຮັດກະສິກຳ

- ເຊີນຜູ້ເຂົ້າຮ່ວມບັນລະຍາຍກ່ຽວກັບ ຂໍ້ມູນພື້ນຖານເຊັ່ນ ຊື່, ອາຍຸ, ແລະ ການສຶກສາ.
- ເລົ່າກ່ຽວກັບປະສົບການເຈົ້າກ່ຽວກັບການເຮັດສວນຜັກ?
    - ດົນປານໃດແລ້ວທີ່ເຈົ້າເຮັດສວນຜັກ?
    - ຂະໜາດສວນ?
- ພືດປະເພດໃດທີ່ເຈົ້າກຳລັງປູກ, ແລະ ເຈົ້າເລືອກພືດທີ່ເຈົ້າປູກແນວໃດ?
- ເລົ່າຊີວິດປະຈຳວັນໃນການເຮັດສວນຂອງເຈົ້າ?
- ເລົ່າກ່ຽວກັບຂັ້ນຕອນໃດແດ່ທີ່ເຈົ້າໃຊ້ໃນການຜູກພືດ, ຕັ້ງແຕ່ເລີ່ມປູກຈົນຮອດເກັບກ່ຽວ?
- ເຈົ້າມີວິທີບໍລິຫານແນວໃດ ກ່ຽວກັບ ສັດຕູພືດ, ຫຍ້າ, ແລະ ການໃຫ້ສານອາຫານທາງດິນ?
- ເຈົ້າໄດ້ມີການກວດລະດັບສານອາຫານໃນດິນ ຫຼື ຄວາມດ່າງຂອງດິນບໍ່? ເລື້ອຍປານໃດ?

ການນຳໃຊ້ທົ່ວສິນຄ້າກະສິກຳ

- ເຄມີ ແລະ ປຸ໋ຍປະເພດໃດທີ່ເຈົ້າໃຊ້ໃນສວນ?
- ເຄມີ ແລະ ປຸ໋ຍທີ່ປະເພດ ຫຼື ຊະນິດໃດ ທີ່ເຈົ້າໃຊ້ໃນສວນ?
- ເຈົ້າຕັດສິນໃຈແນວໃດ ວ່າຕອນໃດ ແລະ ຫຼາຍປານໃດ ທີ່ເຈົ້າໃຊ້ປຸ໋ຍ ແລະ ເຄມີ? ເລື້ອຍປານໃດ?
- ເປັນຫຍັງເຈົ້າຄືເລືອກໃຊ້ຍີ່ຫໍ້ນີ້?
- ເຈົ້າເຄີຍເຂົ້າຮ່ວມຝຶກອົບກ່ຽວກັບການນຳໃຊ້ ເຄມີ ແລະ ປຸ໋ຍ ບໍ?
- ເຈົ້າຄິດວ່າເຈົ້າໄດ້ຫຍັງແດ່ຈາກການຝຶກນີ້?
- ເຈົ້າມີຄວາມພໍໃຈຕໍ່ ວິທີການທີ່ເຈົ້າໃຊ້ ແລະ ຜົນຜະລິດຂອງເຈົ້າບໍ?

ການບໍລິຫານ ສັດຕູພືດ ແລະ ພະຍາດ

- ເຈົ້າມີວິທີການຄວບຄຸມ ສັດຕູພືດ ແລະ ພະຍາດ ແນວໃດໃນສວນຂອງເຈົ້າ? ເຈົ້າໃຊ້ຢາປາບສັດຕູພືດບໍ, ການໝູນວຽນພືດ ຫຼື ວິທີການໃດ?
- ຖ້າເຈົ້າໃຊ້ຢາປາບສັດຕູພືດ, ເຈົ້າເລືອກໃຊ້ໂຕໃດ ແລະ ໃຊ້ຫຼາຍປານໃດ?
- ເຈົ້າມີວິທີການໃດ ຫຼື ລະບົບໃດໃນການປ້ອງກັນເມື່ອມີການໃຊ້ຢາປາບສັດຕູພືດເກີນ ຫຼື ການປ້ອງກັນສັດຕູພືດ?

ການເຂົ້າເຖິງສິນຄ້າກະສິກຳ

- ເຈົ້າຊື້ສິນຄ້າກະສິກຳຢູ່ໃສ? ຕະຫຼາດ, ສະຫະກອນ, ໂຄງການຂອງລັດ.
- ເຈົ້າຄິດວ່າການເຂົ້າເຖິງສິນຄ້າທີ່ມີຄຸນນະພາບສຳລັບເຮັດກະສິກຳແມ່ນມີຄວາມຫຍຸ້ງຍາກບໍ່ໃນທ້ອງຖິ່ນຂອງທ່ານ?
- ຄວາມຫຍຸ້ງຍາກ ເຊັ່ນ ໄລຍະທາງ ຫຼື ບັນຫາດ້ານການສະໜອງສິນຄ້າ ສົ່ງຜົນກະທົບຕໍ່ການນຳໃຊ້ ສິນຄ້າກະສິກຳບໍ?
- ການໃຊ້ຈ່າຍສຳລັບສິນຄ້າກະສິກຳ ໄດ້ສົ່ງຜົນກະທົບຕໍ່ການເຮັດກະສິກຳຂອງເຈົ້າບໍ?

ການຊອກຫາປັດໃຈທີ່ກະທົບຕໍ່ການນຳໃຊ້ເຄມີ ແລະ ປຸ໋ຍ

ຂໍ້ຫຍຸ້ງຍາກໃນການເຮັດກະສິກຳ

- ມີຂໍ້ຫຍຸ້ງຍາກຫຍັງແດ່ທີ່ເຈົ້າພົບເຈີ ໃນການປູກ ແລະ ຂາຍ ຜົນລະປູກ?
- ມີການເຮັດກະສິກຳແບບອື່ນບໍ່ທີ່ເຈົ້າຄິດວ່າ ຍາກ ແລະ ມີຄ່າໃຊ້ຈ່າຍສູງ?
- ເຈົ້າສາມາດເຂົ້າເຖິງຊັບພະຍາກອນທີ່ສຳຄັນບໍ່ເຊັ່ນ ແກ່ນພັນ, ນ້ຳ ແລະ ອຸປະກອນ ໃນ ການເຮັດກະສິກຳ?
- ຖ້າເຈົ້າໃຊ້ ເຄມີ ແລະ ປຸ໋ຍ ໜ້ອຍລົງ, ຈະມີຜົນກະທົບຕໍ່ຜົນຜະລິດຂອງເຈົ້າບໍ່?

ຜົນກະທົບຈາກຊຸມຊົນ ແລະ ຕະຫຼາດ

- ມີວິທີການເຮັດກະສິກຳໃໝ່ ທີ ຜູ້ຊື້ ຫຼື ນາຍບ້ານແນະນຳໃຫ້ເຈົ້າປະຕິບັກໃນສວນຂອງເຈົ້າ ບໍ່?
- ຜູ້ຊື້ເຄີຍຖາມກ່ຽວກັບວິທີປູກຜັກນຳເຈົ້າບໍ່?
- ເຈົ້າຄິດວ່າຜູ້ປູກຢູ່ເຂດນີ້ ມີຄວາມສົນໃຈຮຽນຮູ້ກ່ຽວກັບການເຮັດກະສິກຳທີ່ປອດໄພບໍ່?

ການນຳໃຊ້ ສານເຄມີ ແລະຢາປາບສັດຕູພືດ

- ເຈົ້າເກັບ ເຄມີ, ປຸ໋ຍ ແລະ ຢາປາບສັດຕູພືດ ທີ່ໃຊ້ຢູ່ໃນສວນເຈົ້າແນວໃດ?
- ເຈົ້າມີວິທີນຳໃຊ້ແນວໃດ?
- ເຈົ້າມີວິທີນຳໃຊ້ສະເພາະ ຫຼື ຕາມຂໍ້ແນະນຳໃດ ເຊັ່ນ ກ່ອນເກັບກ່ຽວດົນປານໃດຫຼັງຈາກ ໃຊ້ຢາປາບສັດຕູພືດ?

ການຮັບຮູ້ກ່ຽວກັບຄວາມປອດໄພທາງດ້ານອາຫານ

- ເຈົ້າຄິດວ່າການຜະລິດພືດຜັກທີ່ມີຄວາມປອດໄພ ແລະ ສະອາດ ມີຄວາມສຳຄັນຕໍ່ຜູ້ ຊົມໃຊ້ບໍ?
- ເຈົ້າໄດ້ໃຊ້ວິທີການໃດບໍ່ໃນການປູກຜັກເພື່ອໃຫ້ປອດໄພໃນການບໍລິໂພກ?
- ເຈົ້າເຄີຍນຳໃຊ້ວິທີການ ຫຼື ມາດຕະຖານໃດບໍ່ສຳລັບຄວາມປອດໄພໃນການຜະລິດ ອາຫານ?

ສຶກສາຄວາມລຶ້ງເຄີຍກ່ຽວກັບຄວາມປອດໄພທາງດ້ານອາຫານ

- ເຈົ້າເຄີຍຮູ້ກ່ຽວກັບມາດຕະການ ຫຼື ວິທີການກ່ຽວກັບ ຄວາມປອດໄພທາງດ້ານອາຫານບໍ?
- ເຈົ້າຄິດວ່າ ຄວາມປອດໄພທາງດ້ານອາຫານໝາຍເຖິງຫຍັງ? ເຈົ້າຄິດວ່າຄວາມປອດໄພທາງດ້ານອາຫານມີຄວາມສຳຄັນຕໍ່ການຜະລິດກະສິກຳຂອງເຈົ້າບໍ່?
- ເຈົ້າເຄີຍໄດ້ຍິນວິທີການທີ່ຈະຊ່ວຍໃຫ້ສິນຄ້າຂອງເຈົ້າມີຄວາມປອດໄພສຳລັບການບໍລິໂພກບໍ?
- ເຈົ້າມີວິທີການປູກແນວໃດ ເພື່ອໃຫ້ສິນຄ້າກະສິກຳຂອງເຈົ້າປອດໄພຕໍ່ຜູ້ຊື້?

ການຮັບຮູ້ກ່ຽວກັບມາດຕະຖານກະສິກຳ

- ເຈົ້າເຄີຍໄດ້ຍິນກ່ຽວກັບ ໂຄງການຫຼືວິທີການ ທີ່ຊ່ວຍໃຫ້ຊາວກະສິກຳພັດທະນາການວິທີການຜະລິດກະສິກຳ? ຖ້າສາມາດລະບຸໂຄງການ
- ເຈົ້າເຄີຍເຂົ້າຮ່ວມການຝຶກອົບຮົມ ກ່ຽວກັບການປູກພືດກະສິກຳ?

ນາຍບ້ານຫຼື ຜູ້ນຳຊຸມຊົນ

ຂໍ້ມູນພື້ນຖານ ແບະ ລັກສະນະການເຮັດກະສິກຳ

- ເຊີນຜູ້ເຂົ້າຮ່ວມບັນລະຍາຍກ່ຽວກັບ ຂໍ້ມູນພື້ນຖານເຊັ່ນ ຊື່, ອາຍຸ, ແລະ ການສຶກສາ.
- ຊ່ວຍເລົ່າກ່ຽວກັບປະສົບການກ່ຽວກັບການເຮັດກະສິກຳປູກຜັກໃນທ້ອງຖິ່ນຂອງ ທ່ານ?
- ເຈົ້າເປັນນາຍບ້ານໄດ້ດົນແລ້ວບໍ?
- ຂໍໃຫ້ ທ່ານຊ່ວຍເລົ່າປະຫວັດຄວາມເປັນມາ ກ່ຽວກັບການປູກພືດກະສິກຳໃນຂົງເຂດ ນີ້? ດົນປານໃດແລ້ວ ທີ່ ຊາວບ້ານເລີ່ມປູກພືດກະສິກຳ?
- ເຈົ້າໄດ້ເຮັດວຽກນຳ ຊາວກະສິກຳ ຢູ່ບໍ? ເລື້ອຍປານໃດ? ສ່ວນໃຫຍ່ ແມ່ນວຽກກ່ຽວ ກັບຫຍັງທີ່ເຈົ້າດເຮັດວຽກນຳ?
- ປະຊາຊົນຢູ່ນີ້ມັກປູກຜັກຊະນິດ? ປະເພດໃດ?
- ຂະໜາດສວນສະເລ່ຍຢູ່ເຂດນີ້ປະມານຫໍ່ໃດ?

ວິທີການເຮັດສວນ

- ປະຊາຊົນຢູ່ບ້ານນີ້ ເຂົາເຈົ້າມີວິທີການປູກຜັກແນວໃດ?
- ເຂົາເຈົ້າຮຽນວິທີການນີ້ມາຈາກໃສ? ຈາກ ຊາວສວນນຳກັນ, ຄອບຄົວ,ຫຼື ໄຫບ້ານດຽວ ກັນ? ສືບທອດ?
- ເຂົາເຈົ້າຮຽນວິທີການປູກໃໝ່ແນວໃດ?
- ເຂົາເຈົ້າໃຊ້ເຄື່ອງມືກະສິກຳປູກຜັກບໍ? ເຄື່ອງມືແບບໃດ?
- ເຂົາເຈົ້າກະກຽມສວນກ່ອນປູກຜັກຄືແນວໃດ?
- ປະຊາຊົນໄດ້ມີການກວດດິນບໍ?

ເຄມີ ແລະ ປຸ໋ຍ

- ເຈົ້າຄິດວ່າ ເຄມີ ແລະ ປຸ໋ຍ ມີຄວາມສຳຄັນຕໍ່ການປູກຜັກຢູ່ບ້ານນີ້ບໍ? ຍ້ອນຫຍັງ?
- ປະຊາຊົນຢູ່ເຂດນີ້ໃຊ້ ເຄມີ ແລະ ປຸ໋ຍ ຫຼາຍບໍ?

- ເຈົ້າພໍຮູ້ວິທີທີ່ເຂົາເຈົ້າໃຊ້ໃນສວນບໍ?
- ເຄມີ ແລະ ປຸ໋ຍ ປະເພດໃດ ທີ່ຊາວສວນຢູ່ນີ້ສ່ວນໃຫຍ່ນິຍົມໃຊ້?
- ອະທິບາຍວິທີ ຂັ້ນຕອນການໃຊ້ເຄມີ ແລະ ປຸ໋ຍ ຂອງຊາວສວນ?
- ຈາກການອະທິບາຍຂັ້ນຕອນການໃຊ້ ຈະສົ່ງຜົນກະທົບແນວໃດ?
- ເຈົ້າຄິດວ່າຊາວສວນຢູ່ບ້ານນີ້ເຂົ້າໃຈດີກ່ຽວກັບການນຳໃຊ້ ເຄມີ ແລະ ປຸ໋ຍ ໃນສວນຂອງເຂົາເຈົ້າ? ຖ້າບໍ່ ເຮົາຈະຊ່ວຍແນວໃດ?
- ປະຊາຊົນໃນຂົງເຂດນີ້ໄດ້ຮັບການຝຶກອົບຮົມໃນດ້ານກະສິກຳຈາກພາກລັດ ຫຼື ອົງກອນໃດບໍ?

ການເຂົ້າເຖິງ ເຄມີ ແລະ ປຸ໋ຍ

- ຊາວສວນຢູ່ນີ້ຊື້ສິນຄ້າສຳລັບການກະສິກຳຢູ່ໃສ?
- ເຂົາເຈົ້າເລືອກຊື້ ແລະ ໃຊ້ສິນຄ້າແນວໃດ?
- ເຈົ້າຄິດວ່າຊາວສວນມີຄວາມສະດວກໃນການເຂົ້າເຖິງ ເຄມີ ແລະ ປຸ໋ຍບໍ່?
- ເຈົ້າຄິດວ່າສິນຄ້າມີພຽງພໍສຳລັບຄວາມຕ້ອງການຂອງຊາວສວນບໍ່?
- ສິ່ງທ້າທາຍຕໍ່ການເຂົ້າເຖິງສິນຄ້າກະສິກຳມີຫຍັງແດ່?

ດ້ານເສດຖະກິດ

- ການເຮັດສວນຜັກມີຄວາມສຳຄັນຕໍ່ປະຊາຊົນໃນຂົງເຂດນີ້ບໍ່?
- ການເຮັດສວນຜັກສະໜັບສະໜຸນຕໍ່ຊຸມຊົນນີ້ບໍ?
- ມີຄວາມສຳຄັນຕໍ່ລາຍໄດ້ຂອງປະຊາຊົນບໍ?
- ເຈົ້າຄິດວ່າການເຮັດສວນເປັນແຫຼ່ງສ້າງລາຍໄດ້ຄົງທີ່ໃຫ້ປະຊາຊົນ ບໍ?

ສິ່ງທ້າທາຍ

- ເຈົ້າຄິດວ່າສິ່ງທ້າທາຍໃນການເຮັດສວນມີຫຍັງແດ່?
- ເຈົ້າຄິດວ່າມີຜົນກະທົບຫຍັງແດ່ ໃນການຜະລິດກະສິກຳ?
- ເຈົ້າຄິດວ່າມີຫຍັງບໍ ຄວນພັດທະນາ ຫຼື ແກ້ໄຂ ເພື່ອສົ່ງເສີມການຜະລິດກະສິກຳ?

- ເຈົ້າຄິດວ່າ ຊາວສອນຕ້ອງການຊ່ວຍເຫຼືອໃນດ້ານໃດ? ການຊ່ວຍເຫຼືອແບບໃດ?
- ເຈົ້າຄິດວ່າ ມີສິ່ງທ້າທາຍຈາກປັດໃຈ ທາງດ້ານ ວັດທະນະທຳ, ເສດຖະກິດ, ຫຼື ໂລຈິດຕິກ ຕໍ່ຊາວສອນບໍ່?

ຄວາມປອດໄພ ແລະ ມາດຕະຖານ ທາງດ້ານອາຫານ

- ຊາວສອນບ້ານນີ້ມີຄວາມລົ້ງເຄີຍກັບ ມາດຕະຖານຄວາມປອດໄພທາງດ້ານອາຫານບໍ?
- ຖ້າມີ, ເຂົາເຈົ້າປະຕິບັດບໍ?
- ເຈົ້າຄິດວ່າ ຜົນຜະລິດກະສິກຳຢູ່ເຂດນີ້ປອດໄພສຳລັບບໍລິໂພກບໍ?
- ເຈົ້າຄິດວ່າ ມີວິທີໃດບໍ່ທີ່ຈະຊ່ວຍພັດທະນາສິນຄ້າກະສິກຳທີ່ປອດໄພຕໍ່ການບໍລິໂພກ ໃນຂົງເຂດນີ້ບໍ?
- ມີໂຄງການ ເພື່ອຝຶກອົບຮົມຊ່ວຍເຫຼືອຊາວສອນພັດທະນາການຜະລິດກະສິກຳ?
- ຊຸມຊົນເຈົ້າໄດ້ມີການຊ່ວຍເຫຼືອຊາວສອນໃນການຮຽນຮູ້ພັດທະນາການເຮັດກະສິກຳ?

ພາກລັດ

ຂໍ້ມູນທົ່ວໄປ

- ຂໍໃຫ້ອ້າຍເລົ່າຂໍ້ມູນສ່ວນໂຕ ວ່າຊື່ ແລະ ຕຳແໜ່ງຮັບຜິດຊອບ?
- ອ້າຍເຮັດວຽກຢູ່ນີ້ໄດ້ດົນປານໃດແລ້ວ?
- ໜ້າທີ່ຮັບຜິດຊອບຫຼັກຂອງອ້າຍແມ່ນຫຍັງ?
- ເຈົ້າຄິດແນວໃດກ່ຽວກັບການກະສິກຳປູກຜັກໃນນະຄອນຫຼວງວຽງຈັນ?
- ເຈົ້າຄິດວ່າຊາວສວນປູກຜັກຜະລິດ ພຽງພໍສຳລັບຄວາມຕ້ອງການບໍ?
    - ຖ້າບໍ່, ແມ່ນຫຍັງແມ່ນຂໍ້ຈຳກັດ?
- ເຈົ້າຄິດວ່າ ການຜະລິດກະສິກຳ ຈາກຊາວກະສິກອນ ຜ່ານຄຸນນະພາບບໍ?
- ເຈົ້າຄິດວ່າ ຊາວກະສິກອນຄວນເຮັດແນວໃດເພື່ອຍົກສູງຄຸນນະພາບການຜົນຜະລິດກະສິກຳ?
- ວຽກເຈົ້າກໍໄດ້ພົວພັນນຳຊາວສວນຜູ້ປູກຜັກຢູ່ບໍ? ເລື້ອຍປານໃດ? ອ້າຍເຮັດວຽກຫຍັງນຳເຂົາເຈົ້າ?
- ອ້າຍໄດ້ໄປລົງຢ້ຽມຢາມສວນປູກຜັກເລື້ອຍຢູ່ບໍ? ອ້າຍລົງໄປອ້າຍໄດ້ເຮັດວຽກຫຍັງນຳເຂົາເຈົ້າ?
- ທາງພະແນກແຂວງ (ເມືອງ) ໄດ້ເຮັດວຽກສົ່ງເສີມໃນດ້ານແດ່ ໃຫ້ແກ່ການກະສິກຳປູກຜັກໃນນະຄອນຫຼວງວຽງຈັນ?

ການເຮັດກະສິກຳປູກຜັກ

- ໂດຍອີງຕາມປະສົບການຂອງເຈົ້າ ອ້າຍຊ່ວຍອະທິບາຍກ່ຽວກັບການເຮັດກະສິກຳປູກຜັກຂອງຊາວກະສິກຳສວນໃຫຍ່ແມ່ນເຮັດແນວໃດ?
- ທາງພະແນກ (ເມືອງ) ໄດ້ມີສວນຊ່ວຍເຜີຍແຜ່ ຫຼື ຝຶກອົບຮົມ ເຕັກນິກ ວິທີການໃໝ່ ໃຫ້ແກ່ຊາວສວນແນວໃດ?
- ອ້າຍຄິດວ່າ ອັນໃດສຳຄັນ ຫຼື ບໍ່ສຳຄັນສຳໃນການເຮັດກະສິກຳຂອງຊາວສວນ?
- ຊາວສວນເຂົາເຈົ້າມີວິທີການຮຽນຮູ້ ເຕັກນິກການປູກພືດໃໝ່ໆ ເພື່ອພັດທະນາຄຸນນະພາບການຜະລິດແນວໃດ? ຈາກໃ ຊາວສວນນຳກັນ, ຜູ້ຊື້, ຄອບຄົວ, ສືບທອດ?

- ເຈົ້າຄິດວ່າ ຊາວສອນສາມາດປັບໂຕເຂົ້າກັບເຕັກນິກໃໝ່ ໄດ້ໄວ ແລະ ງ່າຍບໍ?
- ຊາວສອນເຂົາເຈົ້າໃຊ້ເຄື່ອງມືປະເພດໃດໃນການເຮັດສວນ?
- ເຂົາເຈົ້າໄດ້ມີການກວດດິນບໍ?

ເຄມີ ແລະ ປຸ໋ຍ

- ພາລະໜ້າທີ່ຂອງພະແນກ (ເມືອງ) ມີຄືແນວໃດຕໍ່ກັບການສະໜອງ ເຄມີ ແລະ ປຸ໋ຍ
- ໃນການເຮັດກະສິກຳ?
- ຊາວສອນມີການເຂົ້າເຖິງສິນຄ້າກະສິກຳແນວໃດ? ໂດຍສະເພາະ ເຄມີ ແລະ ປຸ໋ຍ
- ຊາວສອນທີ່ຢູ່ເຂດຫ່າງໄກຊອກຫຼືກເຂົ້າເຖິງສິນຄ້າກະສິກຳແນວໃດ?
- ເຈົ້າຄິດວ່າ ເຄມີ ແລະ ປຸ໋ຍ ມີພຽງພໍສຳລັບຄວາມຕ້ອງການຂອງຊາວສອນບໍ?
- ເຈົ້າຄິດວ່າ ເຄມີ ແລະ ປຸ໋ຍ ມີສຳຄັນສຳລັບຄວາມຕ້ອງການຂອງຊາວສອນບໍ?
- ເຈົ້າຄິດວ່າ ຊາວສອນໃຊ້ ເຄມີ ແລະ ປຸ໋ຍ ໃນປະລິມານເໝາະສົມບໍ?
    - ໜ້າທີ່ຂອງຂອງພະແນກ (ເມືອງ) ມີຄືແນວໃດ ເພື່ອໃຫ້ຊາວສອນໃຊ້ ເຄມີ ແລະ ປຸ໋ຍ ໃນປະລິມານເໝາະສົມ?
- ການນຳໃຊ້ ເຄມີ ແລະ ປຸ໋ຍ ໃນປະລິມານເໝາະສົມ ທີ່ພະແນກ (ເມືອງ) ແນະນຳແມ່ນແນວໃດ?

ສິ່ງຫ້າຫາຍ ແລະ ຂໍ້ຈຳກັດ

- ໂດຍອີງຕາມປະສົບການຂອງເຈົ້າ ແມ່ນຫຍັງເປັນສິ່ງຫ້າຫາຍສຳລັບຊາວສອນ?
- ແມ່ນຫຍັງເປັນຂໍ້ຈຳກັດໃຫ້ແກ່ຊາວສອນໃຫ້ມີຜົນຜະລິດທີ່ສົມເຫດສົມຜົນ?
- ຂົງເຂດໃດທີ່ເຈົ້າຄິດວ່າຄວນຈະພັດທະນາ ເພື່ອເພີ່ມຜົນຜະລິດໃຫ້ແກ່ຊາວສອນ?

ການຕິດຕາມ ແລະ ການຈັດຕັ້ງປະຕິບັດ

- ມີກົດລະບຽບ ຫຼື ຂໍ້ແນະນຳໃຫ້ແກ່ຊາວສອນໃນການນຳໃຊ້ ເຄມີ ແລະ ປຸ໋ຍ ບໍ?
- ມີກົດລະບຽບກ່ຽວກັບຄວາມປອດໄພສິນຄ້າທາງດ້ານອາຫານບໍ?
- ທາງພະແນກ (ເມືອງ) ມີວິທີການໃນການຕິດຕາມຊາວສອນຄືແນວໃດ?

- ມີລະບົບໃນການຕິດຕາມ ຄວາມປອດໄພສິນຄ້າທາງດ້ານອາຫານຄືແນວໃດ?
- ມີການລົງໂທດ ຫຼື ປັບໃໝຫຍັງບໍຖ້າມີການພົບເຈີສິນຄ້າທີ່ບໍ່ຜ່ານຄວາມປອດໄພ?

ຂໍ້ສະເໜີແນະ ຕໍ່ນະໂຍບາຍ ຫຼື ການສະໜັບສະໜຸນ

- ມີນະໂຍບາຍ ຫຼື ໂຄງການໃດ ທີ່ອ້າຍຢາກສະເໜີ ເພື່ອສົ່ງເສີມການປູກຜັກໃນລາວ?
- ນະໂຍບາຍຫຍັງທີ່ຈະສາມາດຊ່ວຍສົ່ງເສີມການນຳໃຊ້ ເຄມີ ແລະ ປຸ໋ຍ ທີ່ເໝາະສົມໃນການປູກຜັກ?
- ພະແນກ ຈະຮ່ວມເຮັດວຽກກັບພາກສ່ວນທີ່ກ່ຽວຂ້ອງ, ຜູ້ນຳບ້ານ ຊຸມຊົນ ຫຼື ຜູ້ຂາຍສິນຄ້າກະສິກຳ ເພື່ອສົ່ງເສີມຊາວສວນ?
- ມີທາງອອກ ຫຼື ວິທີທາງແກ້ໄຂ ຕໍ່ສິ່ງທ້າທາຍ ໃນການເຮັດກະສິກຳປູກຜັກ?
- ເຮົາຄວນພັດທະນາຫຍັງທີ່ຈະຊ່ວຍສະໜັບສະໜຸນ ສິນຄ້າກະສິກຳໃຫ້ມີຄວາມປອດໄພ ແລະ ໄດ້ມາດຕະຖານ?
- ເຮົາຄວນພັດທະນາຫຍັງທີ່ຈະຊ່ວຍສະໜັບສະໜຸນ ສິນຄ້າກະສິກຳໃຫ້ສາມາດສົ່ງອອກໄດ້?