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Homegardens role in food security among Hmong and Lao households in mountainous areas of northern Laos

BACHELOR'S THESIS

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Declaration

I hereby declare that I have done this thesis entitled Homegardens role in food security among Hmong and Lao households in mountainous areas of northern Laos independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague, 16. April 2021

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Adéla Čermáková

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Abstract

Since the Vietnam War, the Hmong people have been facing problems with the Lao government that treat them as traitors and restrict them. Due to that and present commercialization tendencies, their agricultural system is going under changes that affect food security. The bachelor thesis aimed to identify the influence of commercialization of homegardens on food security of homegarden among Hmong and Lao gardens. A total number of 100 Lao and Hmong household respondents from six villages were surveyed based on a questionnaire survey. 133 species were identified as food species and connected with values of 26 essential nutrients. Differences in homegarden and household characteristics between Hmong and Lao households e.g. age, size and altitude of homegardens, household size, income etc. were observed. The dietary contribution of homegarden was observed as well. Hmong benefit from better access to fat, sodium, vitamin B3, choline and beta carotene. On the contrary Lao homegardens provided a higher amount of calcium, iron, vitamin C and vitamin K. Results indicate that the homegardens of both ethnic groups are from 78-84 % subject to commercialization which suggests a significant impact on loss of nutrition and fulfilment of daily dietary needs. For the final summary of the results, five essential nutrients (energy, sugars, fats, proteins, fibre) and three vitamins with frequent deficiencies in developing countries (vitamin A, C, and beta carotene) were selected for comparison to show how homegardens are involved in ensuring the daily dietary intakes of nutritions. The commercialization of homegardens negatively affected household food security. Data could be used to improving these traditional agricultural systems through the integration of micronutrient-rich crops and by offering nutrition information, however, further research is needed to cover the dietary habits of targeted households. This study leads to the conclusion that the commercialization of homegardens negatively affected household food security. Interventions are needed in different sectors, including agricultural production, knowledge on feeding and health services.

Keywords: agrobiodiversity; nutritional values; commercialization; resettlement; traditional farming

Consent of the thesis

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1. Introduction

Homegardens can be described as the oldest land-use system that contributes to household food security, local subsistence economy, and nutritional status all over the world, particularly in poor rural areas (see e.g. Soemarwoto 1987, Kumar & Nair 2004, Landon-Lane 2011, Galhena et al. 2013, Whitney et al. 2018, Abdoellah et. al 2020). Interesting is to watch the dynamic change of homegardens. Sometimes these changes are caused by forced resettlement, that is the case with the Hmong people from Laos. They dwelled in the mountains dispersed across hundreds of small villages, but currently, they live scattered around the globe due to their involuntary exodus caused by various struggles that started with the Vietnam War. Hmong people always lived a nomadic way of life and as Thao (1982) notes: „*The traditional Hmong have always moved from site to site in hope and expectation of bettering their living conditions*“ (Office of Refugee Resettlement 1985). This bachelor's thesis is however not an anthropological or cultural study, and the objective was not to describe the story of Hmong people however, their historical background is important for us if we are considering the development and changes of their homegardens. As Hmong farmers were moved from their homes in the higher altitudes to lowlands already settled by main ethnic majority, we do have limited information what homegardens mean to them now and how they contribute to the food security of the most famous ethnic minority of Laos. Laoyeng Saehang, a headman of Thantam village from Northern Thailand once said: "*It's possible to find knowledge from anyplace in the world when we humans learn from one another. Throughout the generations, we Hmong have learned from many diverse sources. To fulfil our lives, we young Hmong still learn from the whole world*" (Siriphon 2006). Hmong, similarly, to other minority groups in the tropics, tend to live in more remote areas with less access to services, sanitation, and infrastructure and thus they show higher rates of poverty and malnutrition (WFP 2017). In terms of public health, malnutrition among children in upland areas of Laos is a complicated problem that persists until these days (WFP 2017, Boloum et al. 2020). Homegardens may help to achieve a reduction in hunger and malnutrition in developing countries because of their remarkable sustainability. Their excellent ability, primarily, to feed households in poor rural areas and the possibility to occasionally sell some products grown on it could make it possible to supply the rural undernourished population with adequate food and nutrients. Consequently, if the attention towards homegardens as a strategy for increasing food security and nutrition rises, this small farming system with a long tradition could make a huge difference in world nutrition. (Galhena et al. 2013, Whitney et al. 2018). On the other hand, it should be considered that traditional homegardens are currently being transformed into commercial ones, due to the rapid development of market economics in rural areas. Their functions are changing, and plant structure is becoming simpler and dominated by commercial crops (Prihatini et al. 2018). This bachelor thesis is contributing to understanding the linkages between resettlement, traditions, food security, commercialization, and malnutrition among Hmong people living in northern mountainous areas in Laos.

2. Literature review

2.1. Hmong people: their history and farming systems

The Hmong or Miao (as the Hmong people are called in China) is an Asian ethnicity originally from Southern China that migrated to Laos at the beginning of the 19th century and they are the third-largest minority in the Lao's People Democratic Republic (Office of Refugee Resettlement 1985, Ireson 1995, Nibbs 2006, UNPO 2017). Hmong have two dialects in Laos. They are categorized into green and white Hmong and are generally known as Meo (Vidal & Lemoine 1970, Ireson 1995). Under this name, we can find them in the neighbouring countries of Southeast Asia such as north Vietnam, Myanmar, and Thailand (Vidal & Lemoine 1970, UNPO 2017).

a) b)

Figure 1. Hmong people in Laos:
a) young woman with the traditional basket, b) young girls in traditional dress.

Source: a) Carillet (2021), b) Hady (2021)

Hmong people, despite of rich history and culture, never had their own state in modern times. Moreover, their location/position in South-East Asia put them very often into various and numerous conflicts, such as the Indochina Wars in the second half of 20th century. This conflict is more famous as the "Vietnamese war for independence" or simply the "Vietnam War". During the Vietnam War (1961-1975) the Hmong population of Laos was divided into three factions – the first and second factions fought on both sides of the war and the third faction was neutral. However, the whole nation suffered from ongoing war (Yang 2003). Hmong were recruited by the Central Intelligence Agency (CIA) to fight against the communist regime that ruled in former North Vietnam (Corlett et al. 2003, Siriphon 2006, UNPO 2017). In this so-called „Secret War" (because Laos was engaged secretly), Hmong were supposed to help American soldiers who were unfamiliar with the mountainous terrain. In 1975 when American soldiers pulled out of Vietnam, the Hmong had to escape the revenge of the communist party that won and took over Laos (Office of Refugee Resettlement 1985, Xiong 2004, Nibbs 2006, Siriphon 2006). The Hmong were seen as an anti-government dangerous group due to their plotting against the authority in war and were targets of the systematic discrimination of the Laotian government. The ones who stayed in Laos had to hide in the jungle because of military violence and because they were constantly persecuted. The remaining Hmong, who did not flee to the jungle were dispatched to re-education camps in which many died (UNPO 2017). Other Hmong people succeed to cross the Thai border and waited in refugee camps for Americans to transport them from danger. Hmong refugees were accepted by the United States soon after they arrived in Thailand (Office of Refugee Resettlement 1985, Xiong 2004, Nibbs 2006, Siriphon 2006). After immigration to the United States, most of the Hmong people settled in the Central Valley of California, especially in Fresno County (Molinar et al. 2011). Others moved to Vietnam, Thailand, Australia, and France while approximately 300,000 Hmong remained in Laos (McGeown 2003). According to Yang (2003) in 2003 there were about 820 Hmong in Canada, 30 in Argentina, 3,000 in French Guyana, 10,000 in France, 77 in Germany, 2,000 in Australia, and 15,000 Hmong of Laos living legally or in an unauthorized situation in Thailand. A few Hmong refugees were resettled in southern China in the 1980s, but they were later repatriated back to Laos. Migration, resettlement, and exodus of Hmong people negatively affected their livelihoods. Hmong people in Laos have currently a poor standard of living, and, as Sunai Phasuk, a political analyst for the human rights group

Forum Asia, said, there is a kind of fault line that separates the Hmong from the rest of the population. He also noted that they are treated as traitors by the authorities, and they are blamed for siding with the foreign imperialists (McGeown 2003). Also, the government very often accuses them of problems associated with drug issues from the opium cultivation and deforestation from shifting cultivation practices (McGeown 2003) which is apart from political conflicts significant point in their history (McGeown 2003, Siriphon 2006). Due to persistent difficult government relations and fear, some 2,000-4,000 of Hmong people are believed to live in the remote Laotian jungle (UNPO 2017).

As already mentioned, Hmong are people who migrate from place to place. That's also because of the practice of fallow cultivation or slash-and-burn farming, as it is alternatively called, which requires moving back and forth between old and new lands. Farmers after some time leave their original dwellings and move to new places to establish villages and to settle new land due to larger size and/or higher fertility. It can be called pioneering when part of the village's households moves to a new area, to begin with land clearing, and if the yields are good enough set the base for the rest of the villagers (Ireson 1995, Lee 2005, Siriphon 2006). Crop cultivation on fields usually takes one to three years and then fields are left fallow. Interesting is that nobody owns these swidden fields, which means that families can occupy any unused field for as long as they want (Oparaocha 1998). Hmong livelihoods are mainly focused on a mixture of subsistence and commercial agriculture, with forest product use, such as hunting and plant collection. In addition of the occasional trade in forest products and agricultural products, such as cardamom, corn, and maize alcohol (Turner & Michaud 2008).

Figure 2. Hmong farmer burns the hillside to prepare for planting rice.

Source: Berger (2013)

Historically, the Hmong farming system has been based on rainfed swidden agriculture with a wide range of species that provides sufficient amount for subsistence purposes (Oparaocha 1998, Lee 2005). We know from older publications that rice fields were not irrigated and were supplemented by the cultivation of chilli, cucumber, ginger, watermelon, taro, and yam. Bananas, papaya, and pumpkin were grown among cornfields, while vegetables, especially Chinese cabbage, and coriander, were grown in opium fields. More recent studies state that Hmong farmers, besides the cultivation of larger fields of crops, have homegardens that are planted near their villages. Such gardens included a wide variety of useful medicinal, fibre, and food plants (Corlett et al. 2003). Nowadays Hmong livelihood involves a mix of permanent terraced rice paddy or maize fields, depending on locality and rainfalls, rotating swidden plots, which is officially banned already, small homegardens, and the collection of forest products including fuel wood, herbal medicines, and honey (Turner 2011). The main crops are rice and maize when maize is usually used as cattle feed. Besides that, another very important and popular crop is opium, which can be sold at markets or used by Hmong themselves as medication. Opium is a dry season crop so it does not compete with other crops, moreover, it is easy to transport, and it can be stored for several years after harvesting (Oparaocha 1998, Corlett et al. 2003). For most rural Hmong households in Laos, growing and producing opium is one of the main sources of income and Hmong farmers are accused of damaging the environment, forest, and timber resources because of opium plantations (Ireson 1995, Siriphon 2006). The cropping system is complemented by a homegarden where green vegetables, legumes, root tubers, sugar cane, herbs, and fruit trees are grown. Crops from gardens are used are grown for household consumption, while surpluses became a subject of commercialization at local markets (Oparaocha 1998).

Figure 3. Mother and son bundling water spinach.

Source: Walter (2018)

Another important component of Hmong farming is livestock. The most common animals are pigs, Asian yellow cattle along with buffalos, and poultry especially chicken rather than ducks but selection may vary. Hmong also own horses as packed animals and occasionally goats for sale. This diversity stems from the uncertain mountain environment and animals have to be adapted to the natural conditions (Oparaocha 1998). Their agriculture practices seem to be relatively sustainable with a positive impact on food security. A specific role in Hmong farming systems belongs to their homegardens.

2.2. Hmong homegardens: Culture, food security and well-being

Generally, homegardens are recognized as agricultural land-use systems that are used to provide subsistence for gardeners and their families. Besides that, they can be used for the production of cash crops. Most of the homegardens usually consist of crops and multipurpose trees and shrubs in close association with livestock (see e.g. Fernandest & Nair 1986, Kumar & Nair 2004, Landon-Lane 2011, Galhena et al. 2013, Whitney et al. 2018, Abdoellah et al. 2020). Soemarwoto (1987) also reported that homegardens are characterized by a mixture of several or many annual or perennial species grown in association, and commonly exhibiting a layered vertical structure of trees, shrubs, and ground-cover plants, which recreates some of the properties of nutrient recycling, soil protection, and effective use of space above and below the soil surface to be found in forests. Homegardens are usually situated close to family houses and can generally be found in all ecological regions in tropical areas and even in continental climate. Their main advantage lies in the multipurpose character, as they contribute to (Galhena et al. 2013):

- food security,
- nutrition availability and food diversity,
- rural employment and additional income generation through off-season labour opportunities and production,
- production and/or market risk reduction through high level of agrobiodiversity,
- wide range of environmental, often non-tangible and non-commercial, services.

Homegardens have many fundamental social benefits, the most important would be their contributions to household food security by increasing availability, accessibility, and utilization of food products. Homegardens provide easy day to day access to fresh plant and animal food sources and both in rural and urban areas (Galhena et al. 2013). They have always played an important role in the domestication, especially of wild plants used for consumption or medical purposes (Fernandest & Nair 1986, Corlett et al. 2003, Landon-Lane 2011, Srithi 2012, Whitney et al. 2018). Plant diversity is influenced by many factors such as the geographical location of homegarden, social conditions, cultural affiliation, a sociodemographic profile of owners, as well as the current status of socio-economic development in the country or region (Kumar & Nair 2004, Srithi 2012). Animal food products are expensive and poor families cannot afford them, on the other hand, homegardens can offer nutritive food that is cheap and that fulfil nutritional needs. Also, gardening provides a greater diversity of species which overall increases nutritional intake. Previous studies have confirmed that households obtained more than 50% of the vegetables, fruits, tubers, and yams from their homegardens. This means that gardens are important for the enrichment and balance of food, especially for growing children and mothers (Landon-Lane 2011, Galhena et al. 2013, Abdoellah et al. 2020). The role of homegarden is even increasing nowadays as people are returning to traditional farming methods and low-input sustainable systems to run more environmental-friendly farming systems. (Landon-Lane 2011, Galhena et. al 2013). However, the Lao government is introducing practices to intensify agricultural systems, which affects Hmong households that had been pulled into the monetary economy and nowadays grow government-sponsored hybrid rice and maize seeds instead of their traditional crops. These commodities require cash income, and although this remains comparatively small in relation to the subsistence core of Hmong livelihoods, it is becoming an increasing part of Hmong livelihood equations. (Turner 2012). Existing literature shows that the Hmong farming system produces or were able to produce sufficient amount of food for families along with additional cash income from surpluses sold on local markets. However, we should ask ourselves a question whether their farming and particularly traditional homegardens, is sustainable regarding current rapid population growth and increased restrictions by the government of swidden fields. Also, as market economics is rapidly developing in rural areas, homegardens are being transformed from traditional ones to commercial ones and their structure and functions have changed. For instance, plant structure has become simpler and dominated by commercial crops. Simply put, gardens began to perform a predominantly economic function instead of providing various ecological, socio-economic, and cultural functions (Oparaocha 1998, Prihatini et al. 2018).

2.3. Food security and nutrition in Laos

As stated above, homegardens are important in the context of food security and as they are a source of essential nutrients, vitamins, and minerals to human health. If the attention towards homegardens as a strategy for increasing food security and nutrition rises, this small farming system could make a huge difference in world nutrition (Galhena et al. 2013, Whitney et al. 2018). It has to be also stated at the outset that safe and healthy diet contributes to an optimal state of health and protects against all forms of malnutrition. Generally, malnutrition is a condition when people consume an inadequate, unbalanced, or excessive amount of macro- and micronutrients. It includes undernutrition – child stunting, wasting and vitamin and mineral deficiencies, and overweight among obesity (FAO 2020). Poor developing countries have mostly faced undernutrition including stunting, wasting, and underweight on the contrary overweight and obesity have been the main problem of developed countries. In spite of this fact many developing countries suffer from double burden of malnutrition where prevails both – undernutrition and overweight (Boloum et al. 2020). According to FAO (2020), undernutrition is defined as the outcome of poor nutritional intake in terms of quantity and/or quality, and/or poor absorption and/or poor biological use of nutrients consumed as a result of repeated instances of disease. It includes being underweight for one's age, too short for one's age (stunted), dangerously thin for one's height (suffering from wasting), and deficient in vitamins and minerals (micronutrient deficiency).

Generally, proper nutrition allows children to survive, grow, develop, learn, play, participate and contribute to daily life, unfortunately the numbers of malnourished children in the world are still very high. Child malnutrition is a major public health problem in regions with low and middle income around the world. Despite estimated amelioration that stunting globally decreased from the year 2000 to 2017 by 10.3% in poor Asian and African countries stunting continue to prevail (Wali et al. 2020). In the case of our study in our case, it is appropriate to focus on the total numbers in Southeast Asia (see Figure 4).

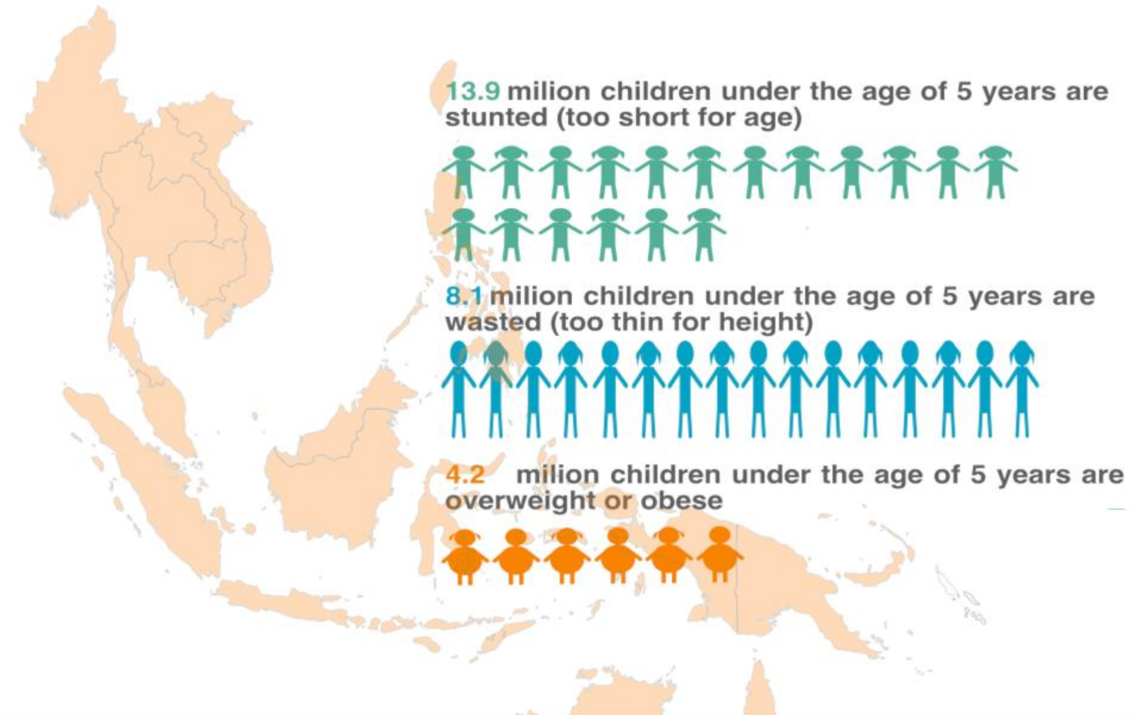


Figure 4. State of malnutrition among children under 5 in Southeast Asia.

Source: author, based on estimation of UNICEF (2020)

Stunting seems to be the biggest problem in the case of world malnutrition. Stunting (low height for age) also called poor linear growth, is the result of multiple circumstances and determinants, including antenatal, intrauterine, and postnatal malnutrition (Onis et al. 2011). FAO (2020) define stunting as height-for-age below the WHO Child Growth Standards median. The fact that a child will suffer from stunting is threatened from conception to the age of two when the growth is most sensitive for lack of nutrition, so the diet is crucial. It depends on the nutritional intake of mothers before and during pregnancy together with the breastfeeding period (Aguayo & Menon 2016, Wali et al. 2020). Besides that, Wali et al. (2020) also mentioned maternal factors like education and short stature, then child factors like illness, age, inappropriate feeding practices including poor diet during the 1000 days of life as well as household factors like household wealth index, family size, place of residence and last but not least access and utilization of services like health service utilization, and water and sanitation. Another form of undernutrition is wasting which is according to FAO (2020) defined as low weight-for-height, generally the result of weight loss associated with a recent period of inadequate dietary energy intake and/or disease especially diarrhoea. In children under five years of age, wasting is defined as weight-for-height less than -2 standard deviations below the WHO Child Growth Standards median.

Laos made significant improvements in various nutritional issues during the last decade. The country was able to reduce stunting rates from 44 to 33%, reach improvements in exclusive breastfeeding from 40 to almost 45%, improve in daily dietary per capita energy supply from 2,407 to 2,722 kcal, and reduce poverty headcount from 23 to 18%. However, despite these great achievements, disparities still exist between and within provinces, wealth quintiles, and ethnic groups. As a result, some areas in the country’s nutrition landscape even saw a deterioration. For instance, the situation in wasting in the country increased from 5.9 to 9% (UN Lao PDR 2021). Additionally, mountainous regions of Laos are expected to be much more malnutritional than the averages provided by national statistics. Undernutrition among children from upland ethnic minorities is still very high as approximately ≈75% are stunted, ≈50% underweight, and ≈10% wasted. Apart from the already mentioned reasons, national policies, which target nutrition in Laos, are not very effective in the case of upland communities and ethnic minorities (Boloum et al. 2020). In Laos, food availability improved significantly from 2000 to 2017. Total dietary energy supply increased by 21%, protein supply increased by 31%, and the protein of animal origin increased by 43% (FAOSTAT 2020). Therefore, vegetal-origin products remain the major dietary energy supply source (see Figure 5).

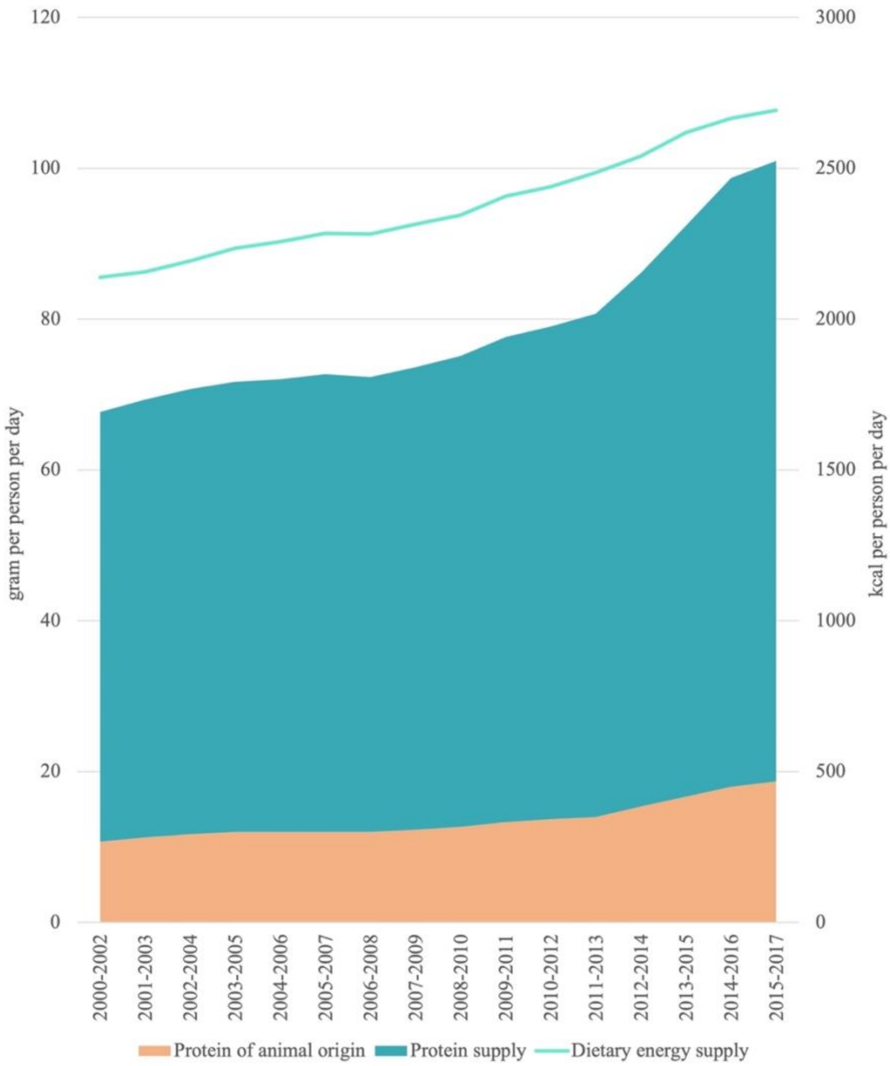
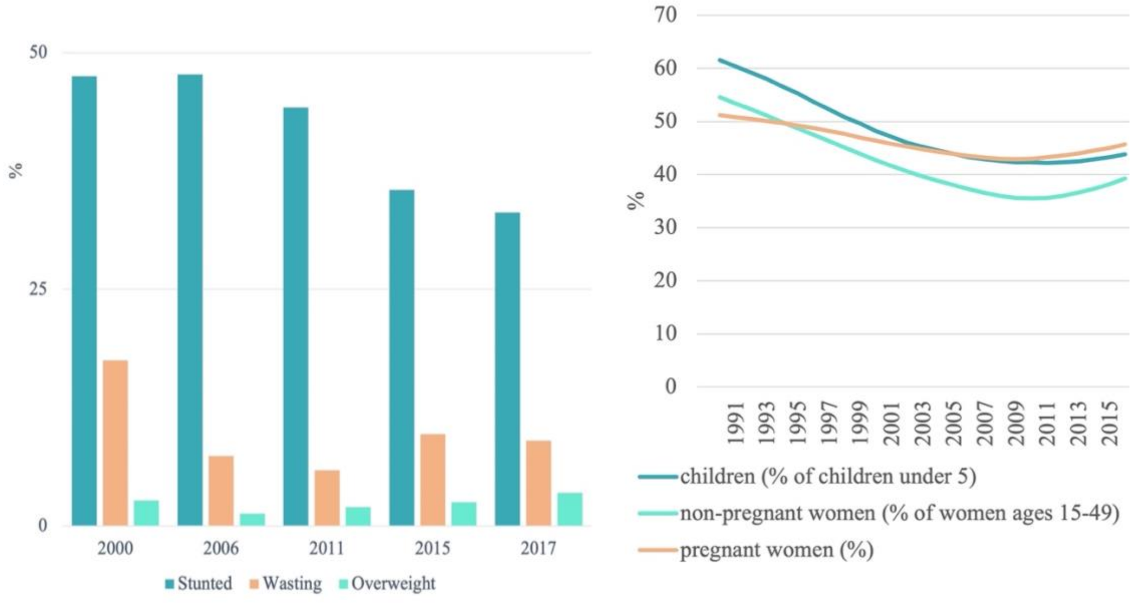


Figure 5. Food availability of Laos between 2000-2017.

Source: author, based on FAOSTAT (2020)

As shown in Figure 6, stunting over past years declined but is still very high at 33.1%. Wasting was at 17.5% in 2000 and it also declined to 9% in 2017 while overweight increased from 2.7% in 2000 to 3.5% in 2017 (FAOSTAT 2020). Figure 3 shows anaemia in Laos among children under 5 years, pregnant and non-pregnant women. Generally, since 1991 values had declined but recently numbers began to rise again. Deworming and iron supplementation can be effective for reducing anaemia (WHO 2018).



a) b)

Figure 6. a) Percentage of child malnutrition in Laos between 2000-2017, b) Anaemia in Laos between 1990-2016.
Source: author, a) based on Faostat (2020), b) based on WHO (2018)

Everyone should have a basic overview of nutrition to be able to prevent malnutrition in the world. Generally, dietary needs are different for every individual, they usually vary with gender, age, lifestyle, and scale of physical activity. Nevertheless, WHO (2018) lists some common characteristics of a healthy diet for adults. Calorie consumption, or energy intake, should balance with energy expenditure and diet should emphasize a healthy balance of nutrients:

- Protein is needed in good quality and adequate amounts to meet individual needs according to factors such as age, gender, and body weight. Protein quality depends on the mix of amino acids (protein building blocks), as well as how easily the protein is digested and used by the body
- Carbohydrates provide much of the dietary energy, and these should be mainly as unrefined complex carbohydrates in foods that are rich in fibre, vitamins, and minerals. Fruits, vegetables, and whole grains should provide at least 25 grams of dietary fibre every day

- Fats should be consumed in moderation (accounting for no more than 30% of all calories consumed) and primarily be unsaturated fats (e.g., from fish, avocado, nuts, sunflower, rapeseed, and olive oils).

In addition to consuming these basic components of the diet, vitamins and minerals are also an integral part. If we accept only a small amount of these elements, or even almost none, sooner or later their deficiency will overtake us, we can become seriously ill, and in the extreme case, a long-term deficiency can end in death (recommended daily intakes of vitamins are shown in Table 1). The most relevant nutrients with respect to our study are provided here (WHO 2018, NIH 2020, Webb 2020):

- Vitamins are essential organic compounds provided in the human diet. The human body cannot synthesize them, but they are required in only small amounts (mg or μg) for proper body functioning. Vitamins are subdivided into vitamins that are fat-soluble like A, D, E, K, and water-soluble like C and a group of B vitamins. In general, fat-soluble vitamins that are stored in body tissues can overdose on the contrary water-soluble vitamins are easily urinary excreted. In the absence of vitamins, so-called avitaminosis, disorders of the body's functions, or even serious diseases can occur. Every vitamin and its by-products have a specific role in helping the body.
- Vitamin A has several forms, the most common in the human diet are retinol and beta-carotene, which have an important function in the human body and affect, for example, growth, vision, immunity, reproduction, and cellular communication. Retinol is contained in food of animal origin for example in meat, dairy products, and fish. On the contrary, provitamin A carotenoid beta-carotene is a form of plant pigment and occurs in dark green, orange, and yellow fruits and vegetables and some vegetable oils. Both have to be metabolized intracellularly into the active forms of vitamin A. Lack of vitamin N causes xerophthalmia leading from night blindness to permanent blindness and poor growth especially in developing countries.
- The E group of vitamins is involved in immune function and participates in antioxidant activities. There is a variety of food that contains vitamin E but for example seeds, nuts among dark green leaves of vegetables, and cereals provide the highest amount. Digestion of vitamin E requires fat so it can be absorbed

therefore deficiency is almost always associated with specific diseases in which fat is not properly digested or absorbed - Crohn's disease, cystic fibrosis, etc.

- Vitamin K family contains phylloquinone (K_1) from plants and menaquinone (K_2) produced by intestinal bacteria. Vitamin K is required for blood clotting and healthy bone metabolism. It is found in green vegetables like spinach, broccoli, kale, some vegetable oils, fruits such as blueberries, and in food of animal origin. People with a deficiency of vitamin K have bleeding problems among bruising and the risk of getting osteoporosis is often increased.
- The B group of vitamins consists of eight vitamins: thiamine, riboflavin, niacin, vitamin B6, vitamin B12, folate, pantothenic acid, and biotin. Thiamine, also known as vitamin B_1, is crucial in energy metabolism and growth and development of cells. Vitamin B is found in all food of plant and animal origin, but rich sources are seeds, nuts, and whole cereals. Thiamine deficiency causes a disease called beriberi that affects the nervous system. Riboflavin, so-called vitamin B_2 is a component of flavin nucleotides, coenzymes, which are important in energy production. The richest sources of vitamin B2 are milk, eggs, liver, and broccoli. Generally, pregnant and breastfeeding women, vegetarians, and vegans have trouble getting enough riboflavin. Effects of deficiency are raw red lips, cracking at the corner of the mouth, weakness, fatigue, and liver disorders. Severe deficiency leads to anaemia. Niacin, vitamin B_3, is an important component of NAD and NADP coenzymes involved in numerous oxidation-reduction reactions. It is contained in a variety of food, but a significant amount is in meat, fish, nuts, grains, and wholemeal cereals. Severe Niacin deficiency causes the disease pellagra and symptoms are dermatitis, diarrhoea, and dementia. Vitamin B_6, present in food as pyridoxine, pyridoxal, or pyridoxamine is involved in many key enzyme reactions in the human body. Vitamin B_6 occurs in the food of animal and vegetable origin, mostly in liver, potatoes, and cereals. The deficiency its effects are similar to the already mentioned Riboflavin. Folate or folic acid or vitamin B_9 is involved in reactions necessary for DNA and RNA synthesis and metabolism of amino acids. Good dietary sources are livers, fruits, green vegetables such as broccoli and spinach, nuts, and whole-grain cereals. Deficiency of folate is rare, and it is usually associated with deficiency of other nutrients and the frequent effect is megaloblastic anaemia which also is a symptom of B_{12} deficiency.

- Vitamin C, also known as ascorbic acid, is an antioxidant that has an important role in immune function. The best sources of vitamin C are fruits and vegetables such as oranges, grapefruits, broccoli, peppers, or tomatoes. Content of vitamin C in food may be reduced by cooking and lack of vitamin C leads to scurvy.

Table 1. Recommended daily intakes of vitamins

Vitamin	Recommended daily amount
Vitamin A	M: 900 mcg (3,000 IU) W: 700 mcg (2,333 IU)
Thiamine (vitamin B_1)	M: 1.2 mg, W: 1.1 mg
Riboflavin (vitamin B_2)	M: 1.3 mg, W: 1.1 mg
Niacin (vitamin B_3,	M: 16 mg, W: 14 mg
Vitamin B_5	M: 5 mg, W: 5 mg
Pyridoxine (vitamin B_6)	31–50 years old: M: 1.3 mg, W: 1.3 mg;
	51+ years old: M: 1.7 mg, W: 1.5 mg
Vitamin C	M: 90 mg, W: 75 mg
Vitamin E	M: 15 mg, W: 15 mg
Folate (vitamin B_9)	M: 400 mcg, W: 400 mcg
Vitamin K	M: 120 mcg, W: 90 mcg

Source: Harvard Health Publishing (2020)

Following Table 2 shows the list of minerals, their different functions in the human body, how much of each nutrient is needed every day, and what are the best sources to gain an adequate supply.

Table 2. List of minerals – functions, daily intakes, food sources

Mineral	Benefits	Recommended daily amount	Food sources
Calcium, Ca	Builds and protects bones and teeth. Helps with muscle contractions, relaxation, blood clotting, nerve impulse transmission. Hormone secretion and enzyme activation, healthy blood pressure	31–50: M: 1,000 mg, W: 1,000 mg 51-70: M: 1,000 mg, W: 1,200 mg, 71+: M: 1,200 mg, W: 1,200 mg	Yoghurt, cheese, milk, tofu, sardines, salmon, fortified juices, leafy green vegetables, such as broccoli and kale (but not spinach or Swiss chard, which have binders that lessen absorption)
Copper, Cu	Plays an important role in iron metabolism and the immune system. Helps make red blood cells	M: 900 mcg, W: 900 mcg	Liver, shellfish, nuts, seeds, whole-grain products, beans, prunes, cocoa, black pepper
Iron, Fe	Helps haemoglobin and myoglobin ferry oxygen throughout the body. Needed for chemical reactions in the body and for making amino acids, collagen, neurotransmitters, and hormones	19–50: M: 8 mg, W: 18 mg 51+: M: 8 mg, W: 8 mg	Red meat, poultry, eggs, fruits, green vegetables, fortified bread, and grain products
Magnesium, Mg	Needed for many chemical reactions in the body, muscle contraction, blood clotting, and regulation of blood pressure. Helps build bones and teeth	18+: M: 420 mg, W: 320 mg	Green vegetables such as spinach and broccoli, legumes, cashews, sunflower seeds and other seeds, halibut, whole-wheat bread, milk
Manganese, Mn	Helps form bones, metabolize amino acids, cholesterol, and carbohydrates	M: 2.3 mg, W: 1.8 mg	Fish, nuts, legumes, whole grains, tea
Phosphorus, P	Part of DNA and RNA. Helps build and protects bones and teeth, converts food into energy. Part of phospholipids, which carry lipids in blood and help shuttle nutrients into and out of cells	M: 700 mg, W: 700 mg	Wide variety of foods, including milk and dairy products, meat, fish, poultry, eggs, liver, green peas, broccoli, potatoes, almonds
Potassium, K	Balances fluids in the body. Helps maintain n steady heartbeat and send nerve impulses. Needed for muscle contractions.	M: 4.7 g, W: 4.7 g	Meat, milk, fruits, vegetables, grains, legumes
Selenium, Se	Acts as an antioxidant, neutralizing unstable molecules that can damage cells. Helps regulate thyroid hormone activity	M: 55 mcg, W: 55 mcg	Organ meats, seafood, walnuts, sometimes plants (depends on soil content), grain products
Sodium, Na	Balances fluids in the body. Helps send nerve impulses. Needed for muscle contractions. Impacts blood pressure; even modest reductions in salt consumption can lower blood pressure	M: 2,300 mg, W: 2,300 mg	Salt, soy sauce, processed foods, vegetables
Zinc, Zn	Helps form many enzymes and proteins and creates new cells. Frees vitamin A from storage in the liver. Needed for immune system, taste, smell, and wound healing. When taken with certain antioxidants, zinc may delay the progression of age-related macular degeneration	M: 11 mg, W: 8 mg	Red meat, poultry, oysters and some other seafood, fortified cereals, beans, nuts

Source: Harvard Health Publishing (2020)

3. Aims of the thesis

As the literature review suggests, households in the Laotian mountains are facing problem with malnutrition. Even though homegardens contribute to household food security, local subsistence economy, various conservation efforts, and nutritional status, their role and characteristics have been changed due to current social, political, economic or climate dynamics.

Build on the aforementioned issues and the literature review, the main aim of the thesis was to estimate the nutritional value of homegardens, found out how it supplies dietary needs of local households, and what would be the potential effect of homegardens commercialization. In order to meet this aim, three specific objectives were set:

1. Document characteristics of Lao and Hmong households and homegardens and identify potential differences.
2. Document how homegarden may contribute to household dietary needs and how it is affected by commercialization.
3. Find out associations between household and homegarden characteristics and nutrition.

4. Methodology

4.1. Study site description

The survey was conducted in Khoune, one of the mountainous districts, located in the Xiangkhoang province in the northeast of Lao PDR (see Figure 7). The actual territory of Xiengkoung province is 15,880 km^2. The area is characterized by a mountainous topography with an average altitude of 1,300 m. The climate in this area is mostly tropical savannah with an average temperature range between 22.2-27.4 °C, annual relative humidity around 73 % and an average annual rainfall of 1,232.2 mm. The total population of the province is 244,648 people and most of them depend on agriculture production. Crop production produces mainly rice, maize, vegetables, cassava, fruit trees and numbers of livestock are e.g. cattle 174,000 units, pig 107,000 units, poultry 1,388,000 units. In the focused area - Khoune district there are two seasons distinguished: a dry season from April to October and a rainy season from May to September. The average temperature is around 24 °C, annual humidity is around 73 % and the total rainfall range is between 1,500-1,900 mm per year. About 35,332 people live in the Khoune district and there are four main ethnic groups – Lao, Hmong, Khamu and Erdu. The focused area is located in the Namngiew river watershed which constitutes the most important water source for agricultural irrigation systems in the area and the river can supply water for agriculture during the whole year. According to the good condition of natural resources and environment, most families in the Khoune district are depended on agriculture activities as the main source of household income. Most of the farmers sell surpluses of products on markets in the local area or the other cities especially Vientiane capital. Khoune district was selected as a representative study area for examination of household cash security and the effect of homegarden on plants diversity (Sian 2018).

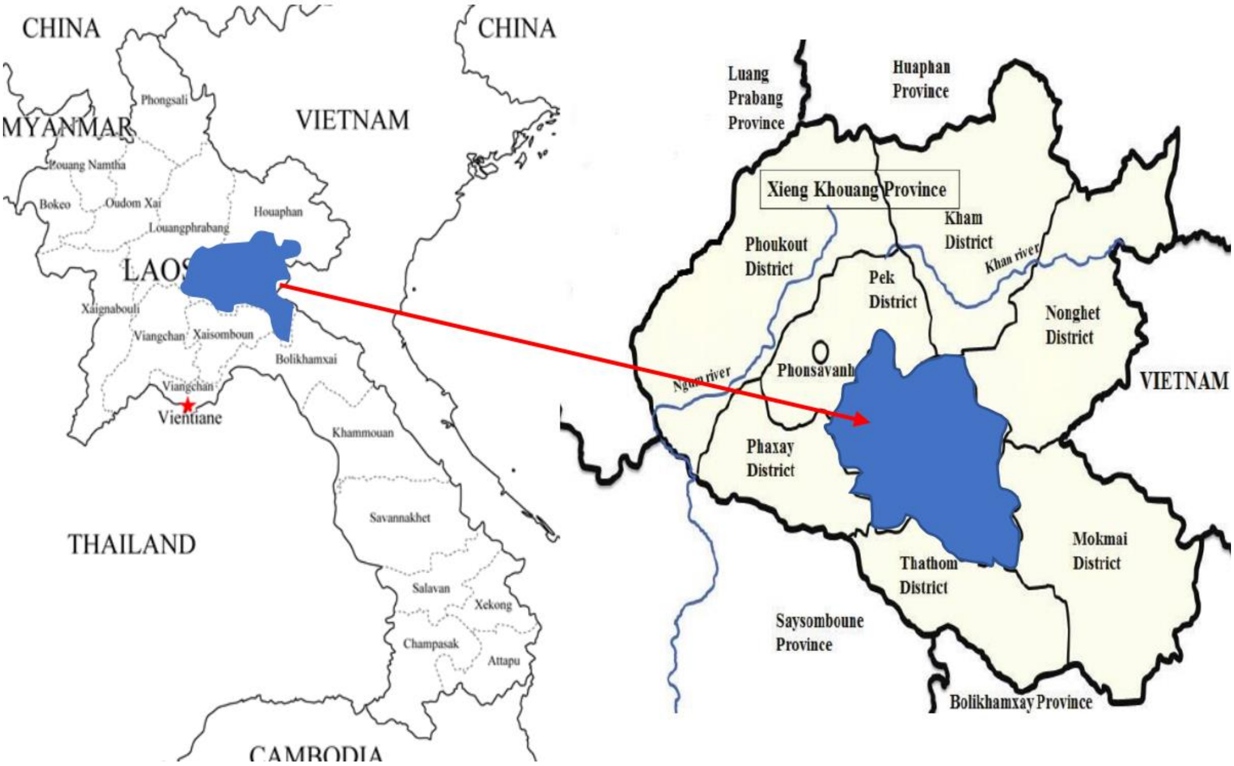


Figure 7. Map of the Xiangkhoang province and Khoune district.

Source: Sian (2018)

4.2. Data collection

The data was collected in multiple ways. All 100 homegardens were selected using the snowball method from six different villages which varied in topography situation and access road. In total, 60 homegardens were owned by Lao households and 40 were run by Hmong families. Household and homegarden data were collected for the purpose of master thesis compilation in summer 2018. Data on the nutritional composition of plant species grown in focused homegardens were gathered from the USDA FoodData Central database, Web of Science database, ResearchGate, WHO, and Harvard Health Publishing.

For the survey of planted crops in homegardens of Lao and Hmong, a structured questionnaire was used for an interview with farmers from Khoune district. It recorded 133 species names by local names, the number of individuals of each species per homegarden, annual production estimation, and market-oriented annual production. A questionnaire also obtained information about households and homegarden sizes.

Information about the nutrition of particular crops planted in the homegardens was obtained mainly from the USDA FoodData Central database and also searched in articles focused on nutritional analysis available on Web of Science and ResearchGate. Primarily, we focused on energy, sugar, fat, protein, some essential minerals, and vitamins. A total of 26 different nutrients were recorded. Data for recommended daily intakes were searched on the website of WHO and Harvard Health Publishing. The following Table 3 shows plant species that have been excluded or modified according to related species (last three of the table) due to lack of data. It must be said that these species occurred only rarely in homegardens.

Table 3. Excluded or modified plant species

Scientific name	English name	Local names	
		Lao Loum	Hmong
Colocasia gigantea	Elephant's ear plant	*Lumtoon*	*Qos yaj ywm*
Livistona saribus	Palm	*Mak khore*	*Txiv kuj*
Tagetes erecta L.	African marigold	*Dork dowhieang*	*Pai hau sam*
Mayodendron igneum (Kurz) Kurz	Tree jasmine	*Dork leav*	*Paj liv*
Oroxylum indicum (L.) Kurz	Broken bones tree	*Mak linhmai*	*Txiv nplai zaj*
Tradescantia spathacea Sw.	Boat-lily	*Wan zonh*	*Txiv vab xuon*
Euphorbia splendens Bojer ex Hook.f.	Christ Thorn	*Dork sethtea*	*Paj xev thij*
Ricinus communis L.	Castor	*Mak hongdeng*	*Tob ntoo liab*
Caesalpinia sappan	Sappanwood	*Fang deng*	*Paj liab*
Leucaena leucocephala (Lam.) de Wit	Ipil-ipil	*Mak katinh*	*Txiv kab thij*
Gossypium herbaceum L.	Cotton	*Fay*	*Paj khi te*
Dendrobium sp.	Orchid	*Dork fueng*	*Paj ntoo tawb*
Piper sarmentosum Roxb.	Wildbetal Leafbush	*Phak ealert*	*Zaub ilwv*
Limnophila aromatica (Lam.) Merr.	Rice paddy herb	*Phak kayeng*	*Zaub qhab nye*
Aquilaria malaccensis	Agarwood	*Mai ketsana*	*Ntoo kov xaij naj*
Unknown	Unknown	*Mak lord*	*Txiv nyuj me*
Unknown	Unknown	*Mak mard*	*Txiv phab las*
Unknown	Unknown	*Yalaosoung*	*Tshuaj hmoob*
Prunus domestica ssp. *italica*	Green Plum	*Mak katanh*	*Txiv kab than*

Table 3. Continues

Ocimum × africanum Lour.	Lamon basil	*Phak eatou*	*Zaub tswv xya*
Ocimum citriodorum	Holy basil	*Phak kapout*	*Zaub txig taum paj*

4.3. Data analysis

Data analysis was conducted in three steps. Initially, data were summarized for each homegarden in MS Office Excel. A total of 133 plant species were recorded. To every plant grown in Hmong and Lao homegardens were assigned 26 selected nutritional values per 100 grams published on USDA FoodData central database or Web of Science. Then the individual nutritional values were multiplied by the average annual production of each homegarden, which gave us the nutritional values achieved by cultivation throughout the year. After that, annual market-oriented production had to be also considered, so it was necessary to find out how much available nutrition will be left to the homegardens after the sale of these crops on market. The resulting numbers of available nutrition were in the next step put in a table where the size of the households and the recommended daily intakes of the nutrition according to WHO and Harvard Health Publishing were considered. As the age of the family members was not known from the questionnaire, the recommended daily intakes were averaged according to the number of females or males in the household. After calculating the available nutrition among the individual family members and daily intakes in MS Office Excel it has reached the final percentage of nutrition. It was found if particular homegardens have the potential to fulfil the nutritional needs of individual households.

Then data were statistically analyzed in Jamovi version 0.9.1.6 to find out if there is a difference between Lao and Hmong ethnic. First, it was necessary to determine whether the data could be considered as normally distributed so the Shapiro–Wilk test was used. Comparative tests were used, nepametric Mann-Whitney U-test was used as not all variables were normally distributed. Descriptive statistics and Mann-Whitney U-test were applied to investigate the household and homegarden characteristics. Likewise, Mann-Whitney U-test was used to determine differences between the contribution of Lao and Hmong homegardens to household dietary needs. Simple bar graphs in MS Office Excel showed how amounts of nutrition are affected by commercialization. Lastly, correlation and simple regression were used.

5. Results

5.1. Households and homegardens characteristics

Table 4 shows significant differences between Lao and Hmong were documented in nine out of thirteen variables. Hmong homegardens were significantly larger (p=0.001) and were located in higher altitudes (p=0.091) compare to Lao. On the opposite, Lao homegardens were older (p=0.001) and more of them were inherited (p=0.011). In the case of household characteristics, Lao had older household head (p=0.091) who studied longer than Hmong one (p=0.000) and a higher number of household female labour (p=0.000). Hmong had bigger households (p=0.042) with a higher number of household labour (p=0.012).

Table 4. Comparison of household/homegardens characteristics among Lao and Hmong

Variable [unit]	Lao		Hmong		U-test
	Mean	SD	Mean	SD	p-value
Homegarden size [sq. m]	1,287.780	1,096.370	2,195.030	1,644.550	0.001
Homegarden age [years]	20.200	13.324	12.875	9.664	0.005
Distance to market [km]	21.883	4.438	20.825	2.037	0.539
Altitude [m asl]	1,148.300	54.934	1,231.850	165.633	0.091
Homegarden inherited [yes=1]	0.983	0.129	0.850	0.362	0.011
Household size [number]	5.250	1.558	6.950	6.280	0.042
Household head age [years]	46.683	10.333	43.150	11.233	0.091
HH born in village [yes=1]	0.850	0.360	0.750	0.439	0.216
Household head schooling [years]	8.767	3.099	5.000	4.320	0.000
Household labour [number]	3.333	1.217	4.300	1.814	0.012
Household male labour [number]	1.750	0.751	1.900	0.982	0.596
Household female labour [number]	1.583	0.850	2.400	1.257	0.000
Household dependent members [number]	1.917	1.418	2.200	1.588	0.387

5.2. Contribution of homegardens on household dietary needs and commercialization

When commercialization of Lao and Hmong was compared, the data were significantly different and the numbers of Lao were generally higher (see Table 5). Lao households had higher income (p=0.000) associated with higher income from homegardens (p=0.015) with higher commercialization of homegardens (p=0.033) and household cash per capita income (p=0.000).

Table 5. Comparison of economic characteristics of Lao and Hmong

Variable [unit]	Lao		Hmong		U-test
	Mean	SD	Mean	SD	p-value
Household income diversity [activities]	4.317	1.017	4.375	1.170	0.549
Household cash income [ths Kip]	67,120.167	33,295.679	34,280.500	18,960.366	0.000
Household income from homegarden [ths Kip]	20,487.500	18,508.804	12,647.500	12,815.795	0.015
Homegarden contribution to household income [%]	30.795	21.119	39.563	26.628	0.115
Commercialization of homegardens [%]	0.842	0.140	0.784	0.153	0.033
Household cash per capita income [ths Kip]	13,666.183	7,633.552	6,095.800	3,851.775	0.000

Table 6 below shows that there were few significant differences between Lao and Hmong in term of the contribution of homegardens to household dietary needs. Hmong from their homegardens had better access to fat (p=0.008), sodium (p=0.064), vitamin B3 (p=0.029), choline (p=0.001) and beta carotene (p=0,061). In contrary Lao homegardens provided higher amount of calcium (p=0.000), iron (p=0.005), vitamin C (p=0.000) and vitamin K (p=0.000).

Table 6. Comparison of nutrition provided by homegardens between Lao and Hmong (% per capita daily requirement)

Variable [unit]	Lao		Hmong		U-test
	Mean	SD	Mean	SD	p-value
Energy	6.567	5.756	6.967	5.438	0.683
Protein	10.913	9.066	11.806	8.892	0.517
Fat	2.017	3.066	5.383	7.995	0.008
Carbs	20.124	18.891	19.982	13.814	0.454
Fibre	23.741	19.909	16.828	9.438	0.178
Ca	13.912	12.184	7.650	5.610	0.000
Fe	165.596	262.170	76.376	73.469	0.005
Mg	32.925	34.573	24.360	15.644	0.299
P	16.524	13.458	18.951	13.954	0.232
K	0.149	0.115	0.127	0.0707	0.632
Na	1.592	1.641	3.021	3.509	0.064
Zn	13.776	18.604	9.511	6.443	0.508
Cu	24.686	21.592	19.969	11.118	0.522
Mn	37.091	38.705	26.619	18.093	0.309
Se	3.657	3.111	3.188	2.469	0.709
Vitamin A	38.853	55.176	34.998	29.172	0.678
Vitamin C	79.426	78.652	42.532	36.262	0.000
Vitamin B1	17.008	15.461	18.073	12.673	0.269
Vitamin B2	13.736	11.587	10.727	6.212	0.379
Vitamin B3	10.638	11.033	16.384	15.919	0.029
Vitamin B6	23.808	18.972	19.934	11.986	0.569
Folate	20.355	17.191	19.614	13,970	0.902
Choline	3.544	3.955	5.849	4.679	0.001
Vitamin E	8.790	11.895	7.820	6.563	0.858
Vitamin K	141.834	207.449	78.198	96.914	0.000
Beta carotene	0.247	0.286	0.356	0.345	0.061

After comparison of selected essential nutrients in Figure 8 it was found that Lao homegardens produced a higher amount of energy but after commercialization amount of available energy was lower than in Hmong homegardens (see Figure 8). In term of protein, fat etc. Lao homegardens produced a higher amount of protein, carbs and fibre, Hmong homegardens produced a higher amount of fat. Although Laotian homegardens had higher production in total, remained amounts of nutrition after commercialization were higher in Hmong homegardens (see Figure 9).

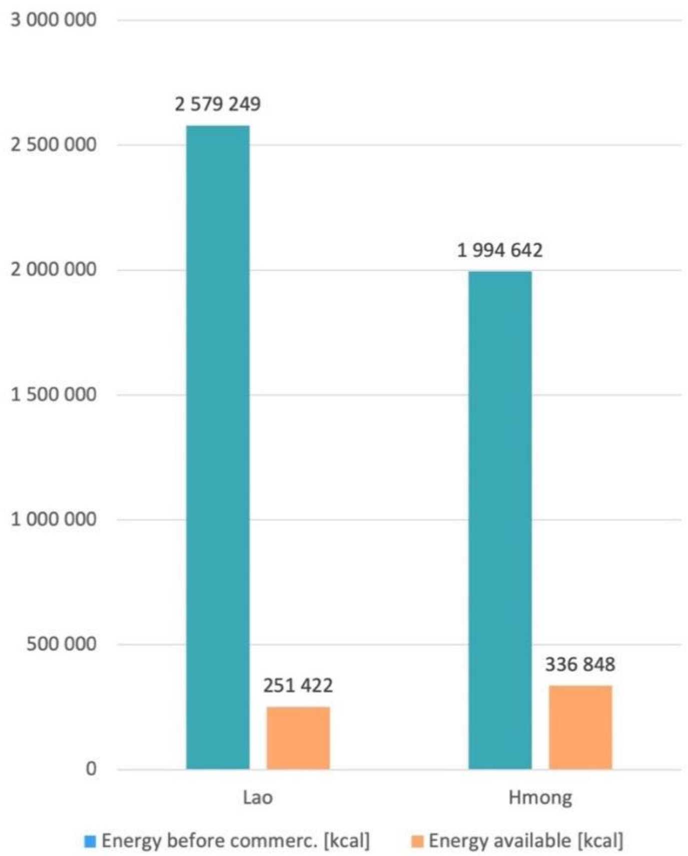
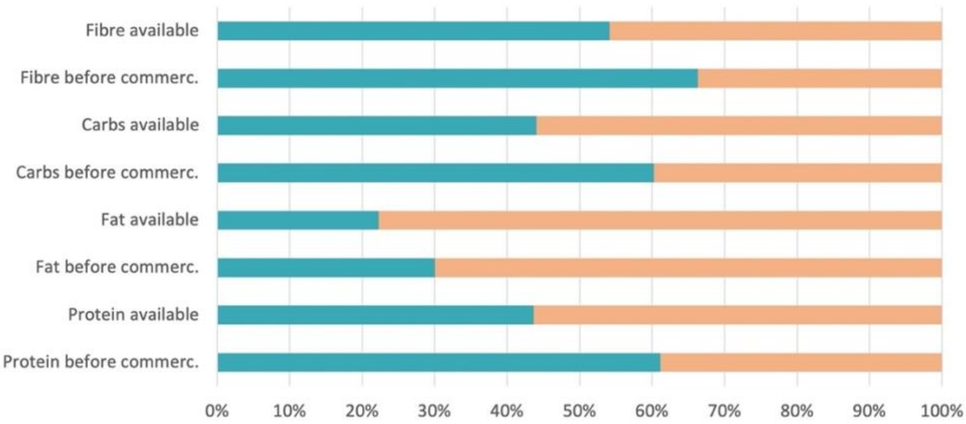


Figure 8. Average energy [kcal] per homegarden before and after commercialization

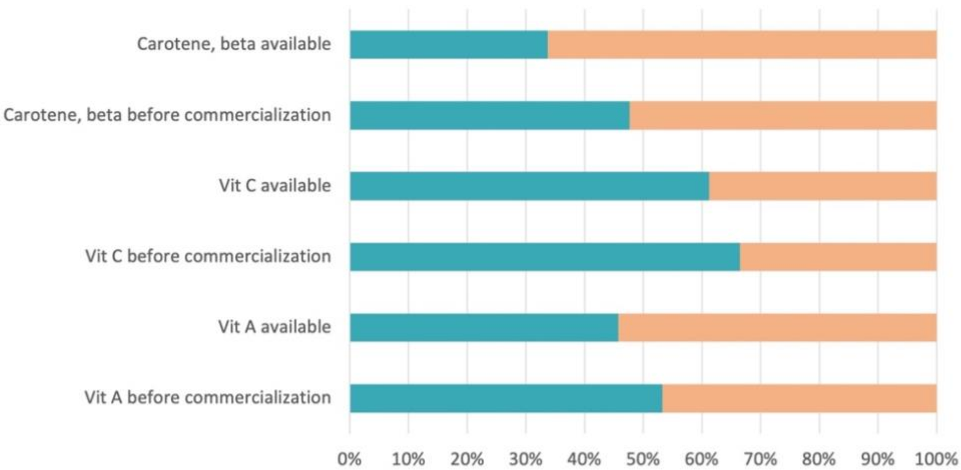


	Protein before commerc.	Protein available	Fat before commerc.	Fat available	Carbs before commerc.	Carbs available	Fibre before commerc.	Fibre available
Lao	157 787	9 780	26 060	2 685	473 976	43 758	188 765	13 349
Hmong	100 193	12 629	60 579	9 337	312 652	55 531	95 819	11 306

Lao Hmong

Figure 9. Averages of selected essential nutrients per homegarden before and after commercialization - protein, fat, carbs, fibre [grams]

Figure 9 summarises averages of selected vitamins in µg per homegarden. Lao homegardens produced a higher amount of vitamin A, C and after commercialization higher amount of vitamin C was left in their homegardens. On the contrary Hmong homegardens provided a higher amount of beta carotene and higher numbers of vitamin A and beta carotene after commercialization.

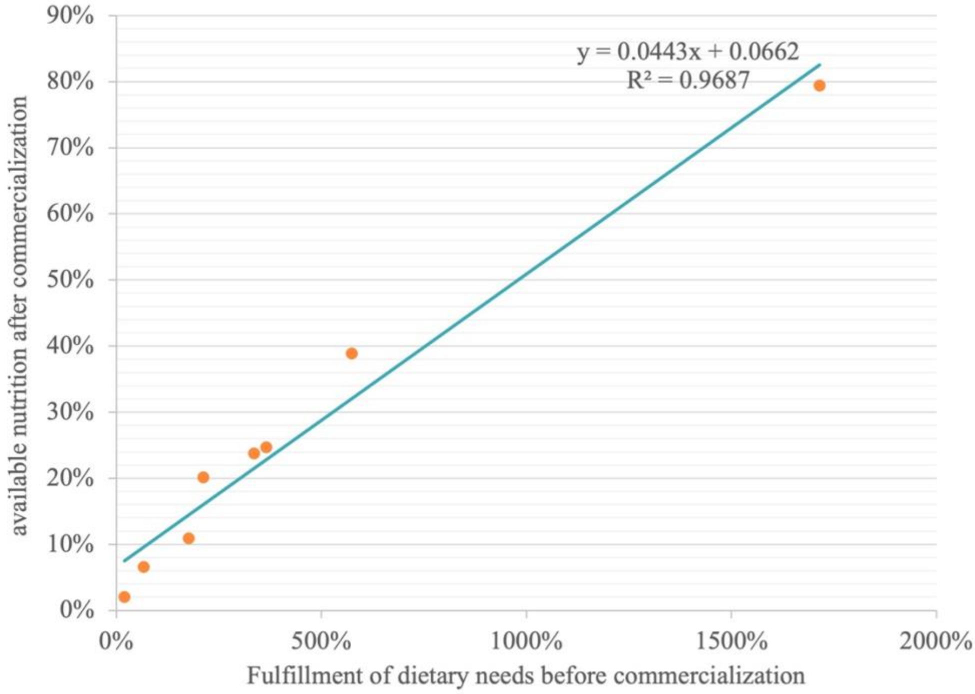


	Vit A before commercialization	Vit A available	Vit C before commercialization	Vit C available	Carotene, beta before commercialization	Carotene, beta available
Lao	8 343 817	529 929	2 473 732	115 317	38 266 336	2 535 944
Hmong	7 315 539	627 262	1 244 940	72 927	41 949 146	4 988 031

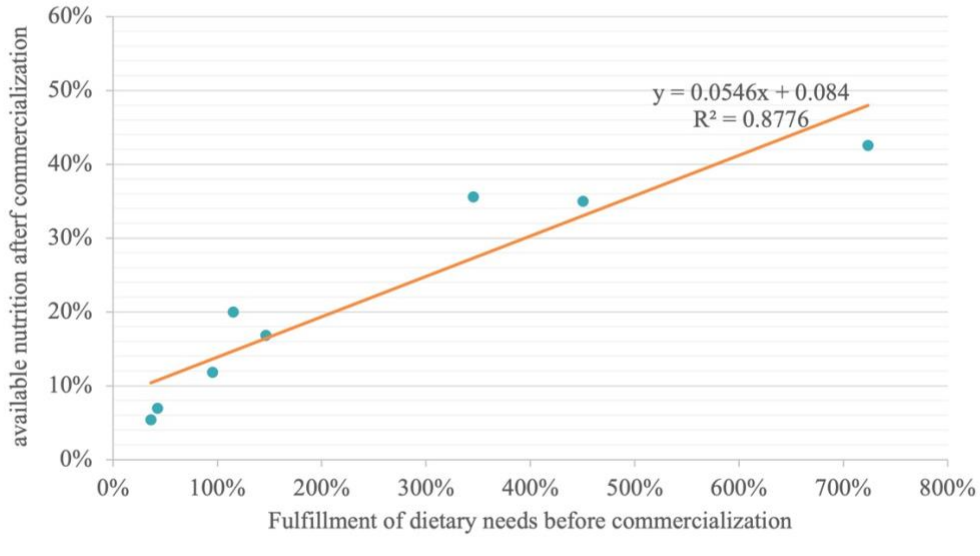
Lao Hmong

Figure 10. Averages of selected vitamins [µg] per homegarden

Correlation between commercialization and nutrition among both ethnicities was tested and results show that loss of nutrients is associated with commercialization (see Figure 11).



a)



b)

Figure 11. Linear regression: Fulfilment of dietary needs before and after commercialization a) Lao ethnic b) Hmong ethnic

5.3. Associations between household and homegarden characteristics and commercialization

Several correlation tests between household/homegarden characteristics and commercialization were tested but no correlations were found.

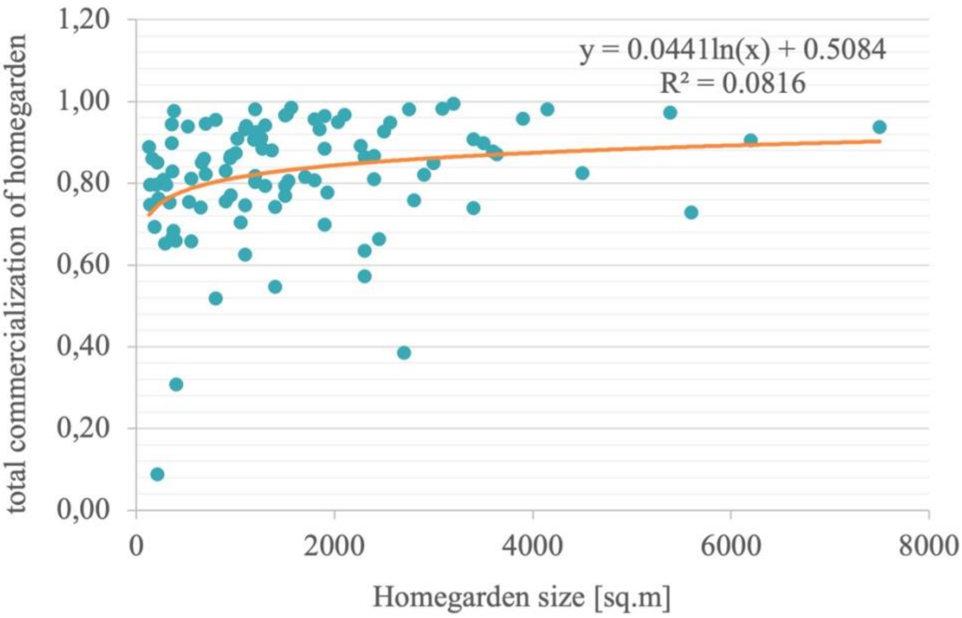


Figure 12. Association between homegarden size and total commercialization of homegarden production

6. Discussion

The literature shows that homegardens fulfil social, cultural and economic needs and contribute to household food security and nutritional status in association with providing several ecosystem services (Soemarwoto 1987, Kumar & Nair 2004, Landon-Lane 2011, Galhena et al. 2013, Whitney et al. 2018, Abdoellah et. al 2020). With the global population growth, there is a continuous need to increase food production. Consequently, the attention towards homegardens rises. The results show that the commercialization of homegardens among Lao and Hmong ethics is significant. As shown in different studies (Abdoellah et al. 2006) commercialization of homegardens has a significant impact on the change of functions and structural patterns of this agricultural system. Plant diversity is decreasing with increased use of monocultures in commercialized homegardens. Also, commercial farming reduces social equitability and requires higher external inputs such as fertilizers and pesticides.

The low association between the level of commercialization and the size of the homegardens in the present study suggest that homegarden size is probably not the main factor that governs the rate of commercialized production. Hmong homegardens had a bigger size and the commercialization rate was lower than at Lao homegardens. Homegardens did not resemble, but commercialization was high in both cases.

As pointed out by Abdoellah et al. (2006) and Whitney et al. (2018) there is the risk of neglecting or losing the dietary role of homegardens in providing protein, vitamins and minerals. The first aim was found out if there is any relationship between commercialization and food availability. We assumed that homegardens whose commercialized production is higher will face a more pronounced nutrient deficiency. The resulting numbers showed that Lao homegardens were more commercialized and their households had lower intakes of nutrition compared to Hmong. This difference suggests that the nutritional intakes were strongly influenced by the commercialization of homegardens (Figure 10). It coincides with the results of the study of Abdoellah et al. (2020) and it means that the commercialization of homegardens negatively affected household food security. In the most basic sense, there is less food available to households as they turn their homegardens into commercial.

However, if we look at the numbers of nutrients it is clear that even if households kept the entire production, this amount would still not be enough to cover daily nutritional requirements. Perhaps, for this reason, it may be advantageous for households to sell such a large part of the production and then buy other nutritionally rich foods for the money earned. Because it's just an assumption there is a space for further research. Moreover, diets and health outcomes are problematic in the Laotian mountainous regions and both short and long-term nutrition interventions are required to mitigate food insecurity and malnutrition. Furthermore agricultural developments focus on increasing production for sale to markets which is not very sustainable in remote mountainous areas as northern Laos with little market access. Governments should promote nutrition-sensitive agriculture as a potential solution to increase food and nutrition security (Bouloum et al. 2020). The Laotian government seeks to improve these conditions and is on track to reduce poverty and malnutrition (Sekkenes 2021). As previously mentioned, the promotion and development of homegardens, which ensure a variety of nutritious foods throughout the year may help meet these goals.

6.1. Limitations and suggestion for further research

There were few limits of the study which could lead to inaccurate data. Data were collected using a questionnaire and no individual species were specifically weighed. The form of examined crops was not recorded, so it was not known whether they are eaten fresh, dry, or cooked which may lead to errors in nutritional values. Also, we did not know the main purposes of use and parts of use of individual plants. No nutritional analysis of the crop species was performed, we tried to find everything through the USDA database and scientific articles focused on nutritional analysis.

Regarding further research, it would be good to link the data from this work with information about what people eat (food score). To make a simple questionnaire that would reveal, what households consume from what they grow and what they consume from what they buy on the markets. This would close the triangle about the local food system as similarly suggests Tumwebaze (2018).

The thesis provided an analysis of food species produced and consumed by households in ethnically mixed northern areas of Laos. Data suggest that despite the promise of commercialization improving farmers' lives and livelihoods, homegardens as traditional farming systems are managed at a high rate of commercialization and thus their nutritional potential is threatened (Aboellah et al. 2020). Relevant stakeholders thus have to consider this point as malnutrition and food security in Laos is still a challenge. We suggest that homegardens should be supported to serve as a source of fresh and nutritionally rich foods. Persistent high rates of malnourished people show that there is space to improving these systems through the integration of micronutrient-rich crops and by offering information about nutrition which would refer to the importance of frequently eating fruits and vegetables. It could solve many problems associated with poverty and food insecurity while maintaining traditional culture and agrobiodiversity (Whitney et al. 2018).

The most vulnerable to food insecurity are Hmong communities that live in remote rural areas of the Lao mountains. They have little access to safe drinking water and many of them suffer from undernutrition. Also, they do not have access to basic services such as health care facilities (UNPO 2017). And according to McGeown (2003), the question, therefore, remains as to whether state officials and food security practitioners can concede, in the face of these facts, that it has been already a long time since when Vietnam war ended and Hmong people should be treated as other groups living in Laos. Introduced practices by the Lao government to intensify agricultural systems in the uplands which affect Hmong livelihoods (Turner 2012) should be carefully considered by state officials and act upon local concerns to inform more appropriate and effective approaches to ensure their food security (Bonnin & Turner 2011).

7. Conclusions

This study documented the influence of commercialization on homegarden-based food systems and their dietary outcomes. Homegardens are the main source of food and income for households in northern Laos. They can offer a diverse range of plant diversity which may have a positive impact on the nutrient content of homegardens and thus improvement of food and nutrition security for smallholder farmers.

Both household and homegarden characteristics were compared among Lao and Hmong ethnics. It turned out that they are different in many ways – age, size and altitude of homegardens, household size, income etc. In terms of commercialization, results indicate that Hmong homegardens commercialization percentage proportion of 78% is lower than the percentage at Lao homegardens with 84%.

A total number of 133 species were identified as food species with 26 nutritional values. For the final summary of the results, 5 basic nutrients were selected - energy, sugars, fats, proteins, fibre and 3 vitamins with frequent deficiencies in developing countries – vitamin A, C and beta carotene. There were few significant differences between Lao and Hmong in term of the contribution of homegardens to household dietary needs. Hmong from their homegardens had better access to fat, sodium, vitamin B3, choline and beta carotene. On the contrary Lao homegardens provided a higher amount of calcium, iron, vitamin C and vitamin K.

Generally, commercialization of homegardens does not always have a positive effect on the living standard of households and as was found out homegarden commercialization may also negatively affect household food security. Furthermore, during the study of the fulfilment of nutritional requirements, it was found that both ethnic groups had a problem with meeting dietary needs regardless of commercialization. However, it must be noted that the study was carried out in limitation by not recorded form of examined crops which may have influenced the number of nutritions provided by homegardens.

As the thesis was focused mainly on Hmong ethnic group, the results showed that although the Hmong are still treated like traitors due to their involvement in the Vietnam War and the governments do not treat them very well, in terms of nutrition, they are doing nutritionally better than Lao people. That only refers to the overall poor nutritional situation in developing countries, and international organizations must try to improve this difficult situation in the world.

8. References

Abdoellah, O. et al. 2020. Homegarden commercialization: extent, household characteristics, and effect on food security and food sovereignty in Rural Indonesia. Sustainability Science. **15**(2):3.

Aguayo, V. M.; Menon, P. 2016. Stop stunting: improving child feeding, women's nutrition and household sanitation in South Asia. Maternal & Child Nutrition **12**:3–11.

Bonin, C.; Turner, S. 2011. Livelihood Vulnerability and Food Security among Upland Ethnic Minorities in Northern Vietnam. Kasarinlan: Philippine Journal of Third World Studies **26**(1-2):324-340.

Boulom, S. et al. 2020. Factors associated with child malnutrition in mountainous ethnic minority communities in Lao PDR. Global Health Action, 13:sup2, 1785736

Corlett, J. L. et al. 2003. Hmong gardens: Botanical diversity in an urban setting.

Corlett, J. L. et al. 2002. Mineral content of culinary and medicinal plants cultivated by Hmong refugees living in Sacramento, California. International Journal of Food Sciences and Nutrition **53**:117–128.

FAO, IFAD, UNICEF, WFP and WHO. 2020. The State of Food Security and Nutrition in the World 2020. Transforming food systems for affordable healthy diets. Rome, FAO.

Fernandest, E. C. M; Nair, P. K. R. 1986. An evaluation of the structure and function of tropical homegardens, Agricultural Systems **21**:279-310.

Galhena, D. H. et. al 2013. Home gardens: a promising approach to enhance household food security and wellbeing. Agriculture & Food Security **2**:8.

Ireson, W. R. 1995. Hmong demographic changes in Laos: Causes and ecological consequences. Sojourn: Journal of Social Issues in Southeast Asia **10**:198-232

Kumar, B. M.; Nair, P. K. R. 2004. The enigma of tropical home gardens. Agroforestry Systems **61**:135–152

Landon-Lane, C. 2011. Livelihoods Grow in Gardens - Diversifying Rural Income Through Home Garden. Food and Agriculture Organization of the United Nations volume 2.

L'Annunziata, E. 2010. Following the plant: The political ecology of a Hmong community garden. Humboldt Journal of Social Relations **33**:97-134.

Lee, G. Y. 2005. The Shaping of Traditions: Agriculture and Hmong Society. Hmong Studies Journal **6**:1-33.

McGeown, K. 2003. Laos' forgotten Hmong. BBC News Online. Available from: http://news.bbc.co.uk/2/hi/asia-pacific/3031116.stm (accessed November 2020).

Molinar, R et al. 2011. Hmong culinary and medicinal herbs grown in Fresno County, California.

Nibbs, F. 2006. The Texas Two-Step, Hmong Style: A delicate dance between culture and ethnicity. Hmong Studies Journal **7**:1-34.

National Institutes of Health, Office of Dietary Supplements 2020. Vitamin A: Fact Sheet for Health Professionals. Available from: https://ods.od.nih.gov/factsheets/VitaminA-HealthProfessional/#disc (accessed March 2021).

Office of Refugee Resettlement (DIMS), Washington, D.C. 1985. The Hmong Resettlement Study. Volume I: Final Report.

Onis, M. et. al 2011. Prevalence and trends of stunting among pre-school children, 1990–2020. Public Health Nutrition:1-7

Oparaocha, S. 1998. Hmong women, opium cultivation and livestock production in Lao PDR. Gender, Technology and Development **2**:373-394

Prihatini, J. et al. 2018. The impacts of traditional homegarden conversion into the commercial one: A case study in Sukapura Village of the Upstream Citarum Watershed, West Java, Indonesia. Biodiversitas **19**:1926-1940.

Sian, P. 2018. Agrobiodiversity and commercialization of food plant species in mountainous farming systems in northern Laos [MSc. Thesis]. Czech University of Life Sciences Prague, Prague. 64 p.

Siriphon, A. 2006. Local knowledge, dynamism, and the politics of struggle: A case study of Hmong in Northern Thailand. Journal of Southeast Asian Studies **37**:65-81.

Sekkenes, S. 2021. 6th Annual Nutrition Forum, 2021**.** Available from: https://laopdr.un.org/en/111642-6th-annual-nutrition-forum-2021 (accessed February 2021).

Soemarwoto, O. 1987. Home gardens: a traditional agroforestry system with a promising future. Institute of Ecology, Agroforestry a decade of development:157-170.

Tumwebaze, J. 2018. Effectiveness of Home Gardening in Reducing Food Insecurity and Improving Health in Chacraseca, Nicaragua: A Pilot Study [PhD]. Auburn University. 160 p.

Turner, S.; Michaud, J. 2008. Imaginative and adaptive economic strategies for Hmong livelihoods in Lào Cai Province, Northern Vietnam. Journal of Vietnamese Studies **3**:158-190.

Turner, S. 2011: Making a living the Hmong way: An actor-oriented livelihoods approach to everyday politics and resistance in upland Vietnam. Annals of the Association of American Geographers **102**:403-422.

Turner, S. 2012. “Forever Hmong”: Ethnic minority livelihoods and agrarian Transition in upland Northern Vietnam, The Professional Geographer **64**:540-553.

Vidal, J.-E.; Lemoine, J. 1970. Contribution à l'ethnobotanique des Hmong du Laos. Journal d'agriculture tropicale et de botanique appliquée **17**:1-59.

Xiong, K. 2004. Hmong in France: Assimilation and adaptation.

Yang, K. 2003. Hmong Diaspora of the Post-War Period.

UNPO: The Unrepresented Nations and Peoples Organization, 2017. Member profile: Hmong, Congress of World Hmong People (CWHP). Available from: https://unpo.org/members/7891 (accessed February 2021).

Wali, N. et. al 2020. Factors Associated with Stunting among Children under 5 Years in Five South Asian Countries (2014–2018): Analysis of Demographic Health Surveys. Nutrients **12**:3875.

Webb, G. P. 2020. Nutrition: Maintaining and Improving Health. ISBN 9780815362418.

Whitney, C. et al. 2018. The Role of Homegardens for Food and Nutrition Security in Uganda. Human Ecology. **46**(4):497-514

World Food Programme 2017. Fill the Nutrient Gap Lao PDR. Available from: https://www.wfp.org/publications/2020-fill-nutrient-gap (accessed February 2021).

World Health Organization 2018. Information sheet – A healthy diet sustainably produced. Available from: https://apps.who.int/iris/bitstream/handle/10665/278948/WHO-NMH-NHD-18.12-eng.pdf?ua=1 (accessed February 2021).