THESIS

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Introduction to Eggplant Production in Laos

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1 Introduction and objectives

1.1 Introduction

Eggplant (*Solanum melongena*) belongs to the nightshade family, which also includes tomatoes, peppers, and potatoes (Sarker et al., 2023). This plant group contains around 1,400 species and has long been valued for both culinary and medicinal uses. It ranks as the fifth most economically important Solanaceous after potato, tomato, pepper, and tobacco (Taher et al., 2017). Eggplant is believed to have originated in South and Southeast Asia (Mainali, 2014). Currently, it is widely grown in tropical, subtropical, and some temperate countries. The main eggplant producing countries are China, India, Turkey, etc (Oladosu et al., 2021). Today, many vegetables in the nightshade family, including eggplants, are grown commercially and exported to other countries (Srisat, 2013).

Eggplants (Mak-khua in Lao) are not mere vegetables in the Lao setting, but their daily lives, culture, and food habits revolve around them. Home kitchen gardens usually grow eggplants with herbs and a few other crops. Despite its value to the culture and economy of the country, eggplant growing remains unrecorded in Laos, neither in the FAOSTAT database nor elsewhere in another database. Because published data in Laos on eggplant production are scarce, information pertaining to Laos from neighboring countries with similar climatic conditions has also been cited and clearly indicated as external references.

Eggplant is eaten in many ways in much of Laos from grilling and boiling to roasting or even fermenting out anywhere in a village or town market. There is an esteemed place for the fermented eggplant in many Lao dishes, thus proving the ingenuity and viability of the local cuisine. Apart from being culinary, the eggplant functions in a more cultural way. For example, the Lao Post Office issued postal stamps featuring the eggplant (Figure 1), a very rare opportunity for such vegetable crops to be portrayed on postage. The Lao people appreciate eggplant's economic importance and its cultural significance, which permeates their everyday lives.

Figure 1. Eggplant stamp from Lao post

(Source: Postbeeld)

In terms of income and food security for others, eggplant cultivation is important; grown throughout the year with some management, it offers a steady option for smallholder farming households who generally cannot afford costly farming inputs. Eggplant sells well in local markets, particularly in off-season times, thereby giving an added income to farmers.

The thesis focuses on describing the current eggplant cultivation practices in Laos, the identification of problems, and the possible ways to improve both productivity and quality while ensuring safety and sustainability of production. Field observations, literature study, and small-scale experiments are combined in this work to give practical implementation recommendations for local farmers. In the treatments that were studied, fertilizer, compost, and straw mulching were central topics; these represent traditional and modern farming techniques available to Laos farmers.

The project examines eggplant production methods in Vientiane, Laos, with a focus on their economic contributions and cultural significance. Cultivation methods tested in the experiment include application of fertilizers, composts, and straw mulching so that sustainable ones could be recommended for yield improvement in support of smallholders. In Laos, eggplants are often planted in soils of medium fertility. So, producers usually treat the soil with locally available amendments, in particular compost or manure, and rarely resort to applying chemical fertilizers to enhance productivity. For this eggplant experiment, land was taken to test production of eggplant on soil that was previously under rice and grass from the standpoints of quantity and quality. It is thus highly relevant to explore how these fertility practices affect yields for the improvement of smallholder production.

1.2 Objectives

The literature analyzed shows that soil fertility management, irrigation, and climate conditions are the main factors that have a big effect on eggplant production. Much research work has been done in foreign countries about the effects of fertilizers, organic amendments, and mulching, but the information is not enough to cover smallholder farming systems in Laos. Particularly, the influence of different management practices on the growth and yield of local eggplant varieties under the agroecological conditions of Vientiane is a poorly understood area. Hence, the aim of this research was to analyze the impact of different cultivation methods synthetic fertilizer, compost, rice straw mulch applications, and a control on the development and yield of eggplant. Moreover, a market survey was carried out to determine consumer preferences and seasonal price changes of eggplant in local markets. The combination of these results intends to deliver not only feasible recommendations to the farmers but also a deeper understanding for the future studies related to sustainable eggplant production in Laos.

2 Literature Review

Although significant efforts were made to collect literature specifically from Laos, the availability of published information is limited. Therefore, the review relies on the accessible materials gathered during this study, supplemented where necessary with references from neighboring countries that share similar climatic and agricultural conditions

2.1 General overview

2.1.1 Geographic and Climate Background of Laos

The Lao People's Democratic Republic is among the landlocked countries in the Northeast-Central parts of Mainland Southeast Asia, having an area of 236,800 km^2 (Phimphanthavong, 2012). The country has around 80% of its terrain as mountainous, while the other 20% is plain land (JICA, 1999). The terrain just extends in a long, narrow configuration from north to south; it is quite wide around the northern border, but it tends to taper down toward the southeast (Figure 2). In general, from the northwestern edge to the southeasternmost tip, the country measures roughly 1,050 km in length (Arthur, 2022). By 2025, Laos is estimated to have a population of around 7,861,459, give or take, depending on the projection (Worlddometers, 2025).

Laos has 17 provinces and a capital with the following: Phongsali, Louang Namtha, Bokeo, Oudomxai, Louangphrabang, Houaphan, Saiyabuli, Vientiane Province, Xiangkhoang, Bolikhamxai, Khammouan, Savannakhet, Xekong, Salavan, and Champasak. Vientiane (Lao: Viangchan) is the capital that washes along the eastern stretch of the country all the way along the Mekong River (JICA, 1999). There are five countries around Laos. China is to its north; from the northeast to the east lies Vietnam; in the south is Cambodia; in the west is Thailand; and to the northwest, Myanmar (Burma) (Figure 2)(Arthur, 2022). The geological environment of Laos offers beautiful variations that include lowland plains, upland plateaus, and forested mountains. These regions are chiefly utilized in agricultural pursuits, including rice farming and the farming of coffee, bananas, and cassava (FAO, 2011; JICA, 1999). They also serve as the abode to ethnically, linguistically, and traditionally variedly intermixed populations.

Laos has a tropical monsoon climate, which brings distinct wet and dry seasons. The rainy season lasts from May to October, with average rainfall in the Bolovens Plateau ranging from 1,400 mm to 2,500 mm, and in some areas up to 3,500 mm (FAO, 2011; Unisdr, 2012). This season is mainly influenced by the southwest monsoon. From November to April, the country experiences a dry season, affected by the northeast monsoon. Temperatures during December to February can drop close to 0°C in the highlands. In contrast, temperatures in the lowlands can reach over 40°C in March and April, just before the rainy season starts. The average daytime temperature in the rainy season is about 27°C (Arthur, 2022).

Figure 2. A map of Laos and its provinces and major cities (Source: Maps of India, 2023)

2.1.2 Soil

Soil is essential to agriculture and ecosystem health in Laos. Agriculture continues to be a significant source of income, with over 986,000 hectares under cultivation. Improved land management and sustainable farming depend on an understanding of soil properties. Acrisols are the most prevalent type of soil in Laos, accounting for roughly 73% of the country's total land area (Figure 3) (Chaplot et al., 2010). These soils are less fertile and more likely to erode because they frequently contain more aluminum and fewer nutrients. They are still frequently employed in shifting cultivation, a conventional farming technique, though. Cambisols (12%), Luvisols (4%), and lesser amounts of Arenosols, Ferralsols, and Gleysols (roughly 2% each) are other soil types that can be found in Laos. About 4.64 billion tons of soil organic carbon (SOC) are found in the top 1 m of Lao soil, with the top 30 cm storing 65% of this total. The average SOC level is 129 Mg C/ha, with regional variations ranging from 1.8 to 771 Mg C/ha. Forested areas have the highest SOC, whereas heavily farmed lands have the lowest (Chaplot et al., 2010).

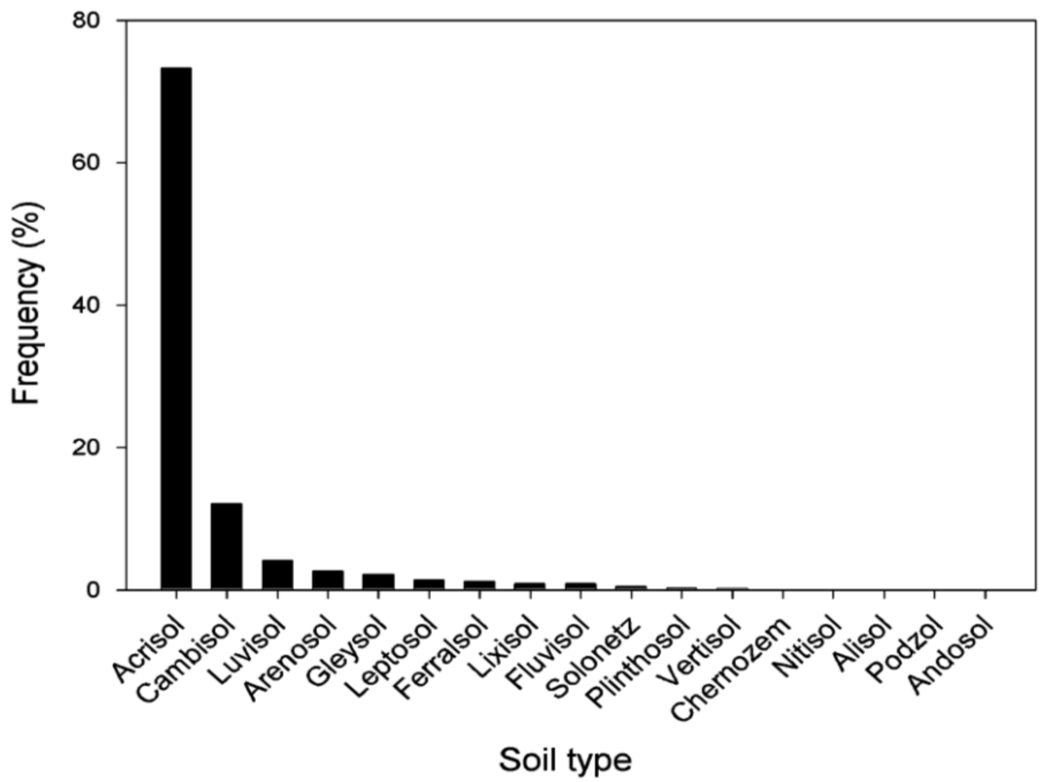

Figure 3. Distribution of soil types in Lao (Source: Chaplot et al., 2010)

2.1.3 Economic background

According to the World Bank reports of 2023, the agricultural sector was providing employment for over 69.64% of the Laotian population, on the whole (Lao Statistical Bureau, 2025). Agriculture is of paramount importance to the economy of Laos. The key export items are coffee, cassava, rice, bananas, cattle, buffalo, maize, fruits, and rubber (FAO, 2022). The largest export markets include China, Thailand, Vietnam, Australia, and Singapore, with almost 90% of exports being agricultural products. Subsequently, Laos witnessed a rise in agricultural GDP from 899 million USD in 2022 to 932 million USD in 2023. Going by the records of the last 10 years, agricultural GDP averaged 814.6 million USD, reaching its nadir in 2012, 698.6 million USD and peaking in 2023, 997 million USD (Lao Statistical Bureau, 2025).

Since the late 20th century, Laos has come to depend much on foreign investment and external economic assistance. The early years of the new Lao People's Democratic Republic focused on collectivized agriculture and hence led to stagnation. Economic growth was also interrupted during the civil war years from the 1950s to 1975. Then in 1980 came a wave of reforms where the government embraced pragmatic development along with market liberalization. These reforms continued until 1986 (Phimphanthavong, 2012), after which the country began encouraging private sector growth and foreign direct investment.

Until recently, global volatility has continued to adversely affect the Laotian economy. Inflation, devaluation of the Laotian kip currency, and subsequent reduction of purchasing power have contributed to increased prices. In 2024 alone, the parallel market rate plummeted by 28%, whereas the official rates of the kip declined by 19% against the US dollar and by 24% versus the Thai baht (Davading et al., 2024).

2.1.4 Climate and Geography of Vientiane

The study region was Vientiane Capital, with an estimated population of 755,941 in 2025 (Worldpopulation, 2025). This region experiences a savanna climate with a wet and dry season. Generally, the wet season lasts from April to September and is hot and humid, with an average temperature of 28.39°C. Average monthly rainfall ranges from 70 to 210 mm, according to WorldClim data (WC, 2019). During the dry season (October to March) the weather is cooler and less humid than that in the wet season. Temperature-wise, Vientiane varies during the year, dropping to a low of 17.21°C in December and rising to a temperature maximum of 42.6°C in

April. It lies at an elevation of 171 meters above sea level and extends 3,920 km² as an administration. Out of this, a 210 km² stretch along the left bank of the Mekong River is slated for city development (JICA, 1999).

On the basis of this, Table 1 and Figure 4. summarizes climate conditions in Vientiane, Including temperature, precipitation, humidity, and sunshine hours.

Table 1. Monthly temperature, precipitation, humidity, and sunshine hours in Vientiane (Source: WC, 2019)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Nov	Oct	Dec	Year
Record high °C (°F)	36.0 (96.8)	42.0 (107.6)	43.0 (109.4)	44.0 (111.2)	43.0 (109.4)	39.0 (102.2)	38.0 (100.4)	36.0 (96.8)	35.0 (95.0)	35.0 (95.0)	35.0 (95.0)	34.0 (93.2)	44.0 (111.2)
Average high °C (°F)	29.06 (84.31)	33.04 (91.47)	35.81 (96.46)	37.48 (99.46)	35.33 (95.59)	32.43 (90.37)	30.9 (87.62)	30.63 (87.13)	31.25 (88.25)	30.66 (87.19)	30.55 (86.99)	28.56 (83.41)	32.14 (89.85)
Daily mean °C (°F)	24.38 (75.88)	27.84 (82.11)	31.26 (88.27)	33.31 (91.96)	32.08 (89.74)	29.7 (85.46)	28.27 (82.89)	27.86 (82.15)	28.2 (82.76)	27.32 (81.18)	26.54 (79.77)	23.91 (75.04)	28.39 (83.1)
Average low °C (°F)	17.6 (63.68)	20.19 (68.34)	24.1 (75.38)	26.45 (79.61)	26.48 (79.66)	25.28 (77.5)	24.34 (75.81)	23.97 (75.15)	23.53 (74.35)	21.78 (71.2)	20.24 (68.43)	17.21 (62.98)	22.6 (72.68)
Record low °C (°F)	9.0 (48.2)	11.0 (51.8)	14.0 (57.2)	18.0 (64.4)	22.0 (71.6)	22.0 (71.6)	22.0 (71.6)	17.0 (62.6)	20.0 (68.0)	13.0 (55.4)	12.0 (53.6)	9.0 (48.2)	9.0 (48.2)
Average precipitation mm (inches)	7.97 (0.31)	3.44 (0.14)	16.85 (0.66)	35.46 (1.4)	108.39 (4.27)	152.02 (5.99)	213.45 (8.4)	281.61 (11.09)	186.64 (7.35)	76.85 (3.03)	13.42 (0.53)	4.65 (0.18)	91.73 (3.61)
Average precipitation days (≥ 1.0 mm)	1.73	1.27	4.45	7.73	16.45	18.36	22.82	22.0	21.64	9.91	2.45	0.73	10.79
Average relative humidity (%)	59.35	46.67	42.81	48.24	63.28	75.43	81.79	83.66	82.49	77.6	70.41	63.67	66.28
Mean monthly sunshine hours	8.9	11.47	11.21	12.29	12.41	11.84	11.33	11.18	11.48	8.16	8.5	8.4	10.6

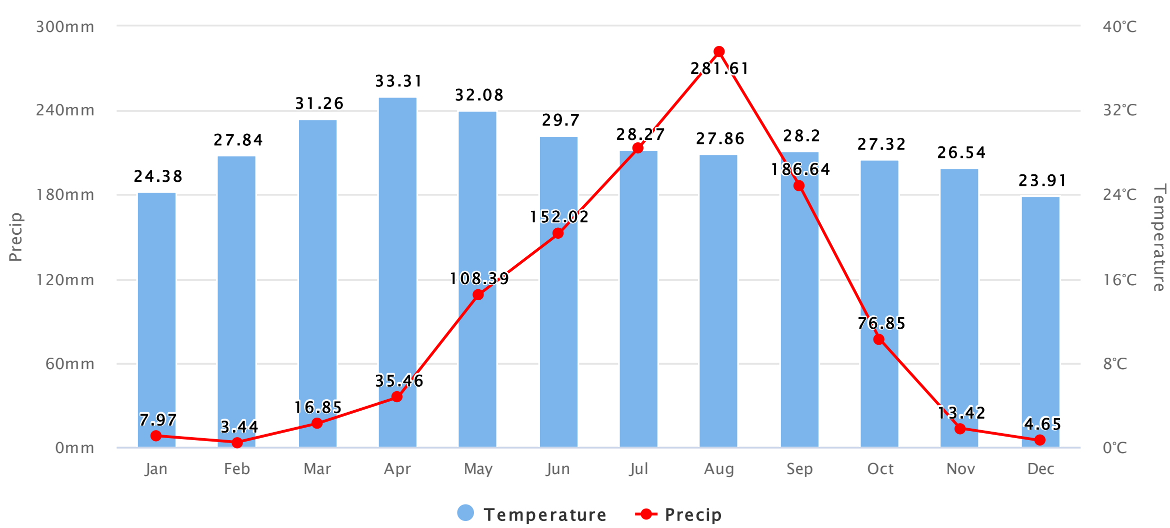

Figure 4. The chart of monthly temperature and precipitation of Vientiane (Source:(WC, 2019)

2.2 Introduction of Eggplant

2.2.1 Morphological characteristics

Generally, eggplants carry broad, oval, or somewhat lobed leaves with a rough texture (Shaul, 1986). The leaves are normally 10-20 cm long and 5-15 cm broad, although numerous studies have noted variations from 3-25 cm in length due to environmental conditions (Figure 5) (Lagat, 2016). Leaf stalks are about 10 cm long, with the leaf being typically green but showing purplish veins that may vary from one variety to another (Figure 6). The leaves can go yellow and then drop off in later growth stages, which is an often-cited symptom of nitrogen deficiency. The prickles commonly arise under the stalk or in the midrib of the leaves (Dash et al., 2019).

The stem usually remains erect and attains an intermediate height. The fruit is commonly covered with stellate trichomes (star-shaped hairs), which, depending on the variety and growing environment, frequently also increase in size to become prickles. Eggplants grow from a minimum height of about 20-81 cm to a maximum of approximately 120 cm, with a spread of 91-122 cm depending on environmental and varietal factors (Chieriell et al., 2021).

Figure 5. Eggplant leaves showing typical shape and venation (source: NCSU 2023; Garden eco 2023)

The inflorescence of eggplant is an asymmetrical cyme that may occur singly or in branches on the stem. Usually, flower colors range from deep violet to light purple, and white kinds often exist. They are perfect flowers, having both male and female reproductive organs (Figure 7). The star-shaped corolla consists of five to six joined petals, with persistent green sepals of the calyx that remain attached through the development of fruit. Short yellow filaments surround a single ovary bearing yellow pollen. Cross pollination, enhanced greatly under good conditions by wind or insect pollinators like honeybees, aids greatly in fruit set (Kowalska, 2008).

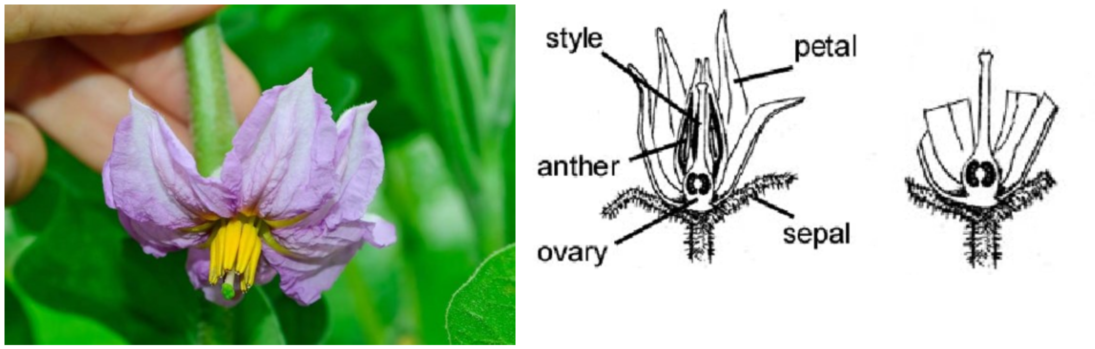

Figure 6. Eggplant flowers structure and color variations

(Source: Melchor, 2021; "Eggplant Seed Production", 2020)

The edible fruit is the most economically significant part of the eggplant. It is composed of three very important parts: skin, flesh, and seeds (Figure 8) (Torun et al., 2015). The skin is smooth and glossy in appearance and comes in deep purple, faint violet, green, white, and striped, depending on the cultivar. This skin is hard while immature and softens as soon as the fruit ripens. The flesh is normally white or greenish, and when raw, it has a mild, somewhat bitter taste, while on cooking, it develops an intense flavor. Seeds are minuscule and brown and are lodged into fleshy flesh. A single fruit may grow up to 40 cm in length, and the seeds are edible but may taste bitter if the fruit is too ripe. Maturity is crucial for eggplant marketability. Young fruits are firmer and milder in flavor, whereas overripe fruits are soft and bitter and not desirable for marketing. From the time of ripening onward, fruits must have appropriate firmness to achieve satisfactory shelf life, market acceptance, and quality at the market level (University of Florida, 2024).

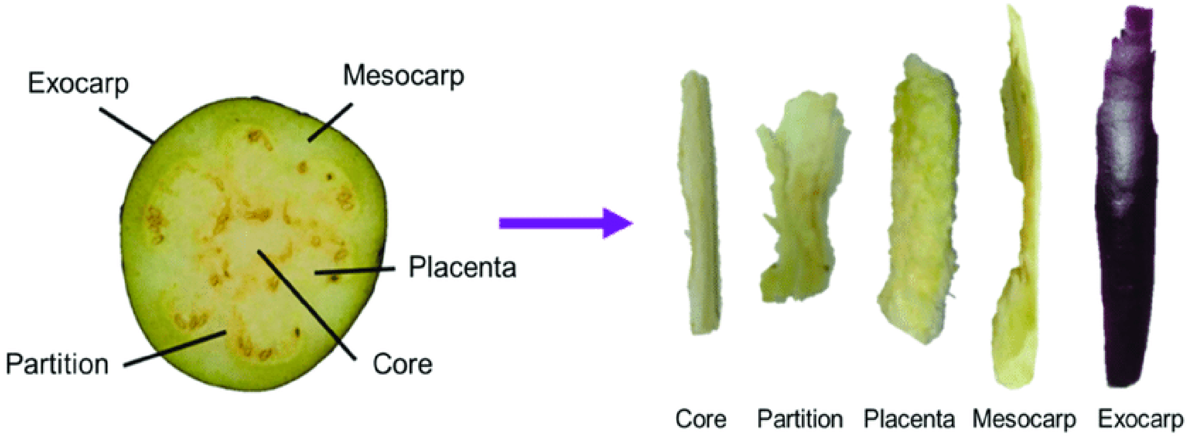

Figure 7. Significant parts of the eggplant fruits (Source: Wang et al., 2021)

2.2.2 Nutritional Value of Eggplant

Eggplants are highly valued as a nutritious vegetable with a variety of health advantages. They are low in calories and rich in crude fibers (1.01-2.48%), vitamins, and minerals of human health concern (Sonmez et al., 2020). The fruit consists of about 92% water, has a 1% protein content (Mansurat, 2023), and ranges from 19.59 to 32.1 kcal per 100 g (Quamruzzaman, 2020). This high water content makes eggplant an excellent hydrating food.

Besides fiber for digestive health (Naeem & Ugur, 2019), eggplants carry beneficial vitamin C content for immunity and the rest: vitamins K (blood clotting), D, E, A, B1, B6, and B12 (Nadeeshani et al., 2021). The purple skin of many cultivars contains anthocyanins, mostly nasunin, a potent antioxidant that prevents cell damage from free radicals. Eggplants also contain chlorogenic acid (antimicrobial and anti-inflammatory) (Quamruzzaman, 2020).

Phenolic compounds were formerly considered to be the antioxidative agents (Niño-Medina et al., 2017); in contrast, nowadays, flavonoids are also closely related to antioxidative potential (Akanitapichat et al., 2010). From cultivar to maturity stage and growing environment, qualitative and quantitative differences are observed. Young and immature eggplants are tender, well-appreciated, and nutritionally rich, while over-aged fruits are considered to be of less nutritive value. Eggplant has been classified as a non-climacteric fruit (non-ripening fruit) (Sharma, 2021), with an impeded shelf life.

2.2.3 Cultivars of Eggplant

Worldwide, it is generally classified into two major groups comprising cultivated eggplants: common varieties and specialty cultivars. Common varieties are those widely found in markets, like Brinjal, Scarlet, and Gboma eggplants. Specialty cultivars, or Indian, Chinese, Sicilian, and Italian types, come in different sizes, colors, shapes, and tastes (Keinath, 2024).

The World Vegetable Center (WorldVeg) lately maintains a large germplasm collection of eggplants, with more than 3,200 accessions from 90 countries representing both cultivated species (mainly *Solanum melongena*) and more than 30 wild relatives (Taher et al., 2017). These accessions are co-shared with breeding programs public and private for yield, fruit quality, and pest and disease resistance. Further research is underway for enabling wild relatives in breeding for abiotic stress tolerance (Saini, 2019).

Increased interest in gene technology in recent years has led to its application to eggplant improvement. These include genome editing, tissue culture, genetic transformation, somatic hybridization, and somaclonal variation (Collonnier et al., 2001). These technologies were aimed at improving productivity, disease and pest resistance, nutritional quality, and adaptability to climate change. Conventional breeding methods are also used to develop superior cultivars with desired traits for fruit size, shape, and color (Dennis et al., 2008).

In Laos, cultivar selection is determined chiefly by the agroclimatic factors of a particular region. Local cultivars are appreciated for their distinct taste and cooperation toward the local environment, while hybrids are appreciated more for their high yields. Cultivars common to traditional muter carrying include Mak Khua Muang (Lao Purple Stripe) and Mak Khua Khuen (Lao Green Stripe). These cultivars are chosen because of their aptness to local tastes and growing environments they require little chemical-based product input, and they are relatively resistant to some pests and diseases that afflict hybrids; for yields and uniform fruits, however, hybrids are favored. Eggplants are mainly grown in the lowlands and home gardens in central and southern Laos, where they are a staple in the local market for their cultural and culinary significance. Nevertheless, many farmers use imported seeds from Thailand and Vietnam, becoming dependent on outside suppliers. Due to limited published data on this subject in Laos, the above description relies on local knowledge and practical experience.

2.2.4 Soil and climate requirements

Eggplants thrive best in soils that are well-drained, loamy, and fertile, rich in organic matter, and slightly acidic with a pH of 5.5–6.8 for optimum plant growth (Agri.PG, 2012; Caruso et al., 2017). Eggplant can also tolerate a variety of soil types, with the best yield in fertile lowland soil near rivers, like those along the Mekong Basin. Fertility can be ameliorated with the use of organic fertilizers such as compost and manure, which aid in improving soil structure and nutrient availability (Mekuria et al., 2014).

Eggplants are warm season crops and said to grow best within a temperature range of 22°C to 30°C (Caruso et al., 2017). They require constant soil moisture and tolerate mild waterlogging, but if excess water stays around during flowering and fruiting stages, they become highly susceptible to root rot and fungal attacks (Fraikue, 2016). If the temperature rises above 35 °C, flowers tend to be dropped, whereas fruit setting is greatly reduced if temperatures go below 15 °C, especially at higher altitudes. The optimum temperature for fruit setting is 22–24 °C at night and 33–35 °C during the day (Fraikue, 2016) .

The tropical monsoon climate of Laos grants distinct wet and dry seasons, which considerably affect planting schedules. The wet season, lasting from May to October, does indeed bring heavy rains. Hence, there is a need for soil that yields good surface drainage, or else one will have to form raised beds to avoid waterlogging. In contrast, in the dry season, November to April, water shortage might limit growth, though drip irrigation has been shown to be an effective practice to provide soil with optimum moisture levels, the marginal cost of which discourages a wider adoption. Now, with these challenges to the climatic regimes coupled with an increase in temperature, there are greater risks of pest outbreaks as well as yield losses, particularly in the lowland farming systems (Annabell, 2021).

2.2.5 Pest, disease and weeds

The pests and diseases that infest eggplant cultivation also include weeds, which can severely diminish yields. The most harmful insect pest is the eggplant shoot and fruit borer (*Leucinodes orbonalis*) (Figure 9), which can cause a yield loss of 90% (Siam et al., 2024). Other pests are the sweet potato whitefly (*Bemisia tabaci*), the two-spotted spider mite (*Tetranychus urticae*) (Figure 9), and leaf rollers (*Eublemma olivacea*) (Degri, 2021; Taher et al., 2020).

Insecticides are usually applied; however, the downside has been the emergence of resistant strains of these pests and damage caused to the environment due to these unregulated pesticides application (Ghosh & Senapati, 2009; Siam et al., 2024). Other sustainable methods could be used within Integrated Pest Management (IPM) framework. It includes resistant cultivars, pheromone traps, biopesticides, biological control agents, and mechanical weeding. Wild relatives of eggplant have demonstrated natural resistance to several of the significant pests and can therefore be useful in breeding (Taher et al., 2020).

Among several important diseases, bacterial wilt (*Ralstonia solanacearum*), Phomopsis fruit rot (*Phomopsis vexans*), Fusarium wilt, root-knot nematodes, and phytoplasma disorders cause huge losses (Khadka et al., 2020; Nahar et al., 2019; Rao & Kumar, 2017). Preventive and integrated approaches toward disease management are hot water or fungicidal seed treatments, improved nursery hygiene, anaerobic soil disinfestation (ASD), and vector control.

Figure 8. Eggplant fruit and shoot borer, Leucinodes orbonalis

(Source: Rahman et all., 2021)

Weeds compete with eggplants for light, water, and nutrients and may reduce yields by as much as 78 percent (Marques et al., 2017). Common species are *Eleusine indica*, *Portulaca oleracea*, and *Cyperus rotundus*. The best weed control starts with soil preparation, take out weed debris, dry soil before planting, and applying mulch such as rice straw or plastic. Hoeing early after planting and adjusting plant density will also suppress weeds. Considered alongside physical and cultural techniques, herbicide application can be used before planting to curtail enormous weed infestations and facilitate soil preparation (Srisat, 2013). A spray of chemicals should be followed by an additional drying period, upon which plowing, turning, and bed making can commence. These chemicals commonly contain:

- Paraquat: This one works on green aerial parts of narrow- and broad-leaved weeds during the early stage of growth but does not affect underground propagating structures (Srisat, 2013).
- Glyphosate: It gets absorbed through the leaves and goes throughout the plant, killing it completely (Srisat, 2013).

One or two weeks after spraying will mark the symptoms of the weed. Most drying of the sprayed weeds requires a good 4-6 hours of rain-free weather. Herbicides do not work well on certain perennial weeds, such as water chestnuts, which may have to be removed manually (Srisat, 2013).

In growing eggplants in Laos, the main challenges comprise limited access to resources such as affordable biological control agents and Integrated Pest and Disease Management training programs (Frederike, 2003). Resistance has burgeoned against chemical pesticides from overuse, thus damaging the environment. Furthermore, extension services that are inadequate in fundraising find themselves stricken by knowledge gaps, leaving farmers poorly equipped in acquiring adequate knowledge for sustainable farming practices (Keochansy, 2024). Traditional farming in Laos employs cheap inputs and predominantly manual labor. Mulching, intercropping, and staking are applied methods that increase yield and reduce pests, all handed down through generations (Keochansy, 2024). Though not formally documented, these methods have maintained the sustainability of small-holder farm practices.

2.2.6 Water Management and Irrigation Techniques

When growing eggplant, good soil humidity is one that affects the eggplant crop (Sbirciog, 2017). There should be a reserve water source for use during the dry season, and to drain extra water from the eggplant planting plot during the rainy season, the plot should be elevated higher than usual. Water stagnation in the planting plot should be avoided, particularly near the base of the eggplant plants, since this can lead to the spread of some eggplant diseases. A lack of soil moisture restricts eggplant growth and has an impact on yield and quality as mentioned. Finding a suitable deficit irrigation plan to increase irrigation water output is a pressing issue (Li et al., 2024). Consequently, determining appropriate irrigation thresholds is essential for reducing water waste and enabling the production of eggplants with exceptional quality and yield (Abd-Elrahman et al., 2022).

Water is supplied using tiny, parallel ditches or furrows between crop rows in a technique known as furrow irrigation. Using it along with the fertilizer application is one of the elements that can affect how effective furrow irrigation is. According to certain research on using different quantities of nitrogen and water supplied, eggplant fruit yield can be considerably increased by using alternative furrow irrigation techniques and raising nitrogen levels, as they used four treatments. 90, 120, 150, and 180 kg N/ha in each furrow, with water at 100%, 75%, and 50%, turned out to be the best result: 150 kg N/ha for furrow types (Aujla et al., 2007) and 120 kg N/ha for the dripping type. By delivering water straight to the root zone, drip irrigation minimizes evaporation and lowers the risk of diseases linked to moist foliage.

Another important method is like a sprinkler. By spreading water through a network of pipes and spray heads, sprinkler irrigation effectively covers enormous areas while simulating natural rainfall. Studies have demonstrated that deficit irrigation strategies, which involve applying water below full crop water requirements, can increase eggplant fruit yield and improve plant characteristics such as shoot height and stem diameter (Bello et al., 2024). An experiment about the effect of soil water content on eggplant cultivation, utilizing three treatments (60%, 90%, and non-irrigation control), was also cited in another study (Sbirciog, 2017). The findings indicate that the eggplant crop likes a balanced soil humidity regime, with the water content not falling below 60% of the range and not higher than 90% (Sbirciog, 2017). Eggplant has moderate water requirements, with the critical stages being germination, flowering, and fruit development. Inconsistent water supply during these stages can lead to reduced yields and poor fruit quality. On average, eggplants require 1-2 inches per week (Drost, 2020). This implies that the key to increasing agricultural output is optimum fertilizer management in combination with suitable irrigation techniques (Aujla et al., 2007), because overwatering leads to waterlogging, increasing the risk of root rot and bacterial wilt, and underwatering causes stress, leading to flower and fruit drops, especially in the dry season.

In the case of vegetable gardening, water can be provided using a boat or small engine placed on a rubber ring, and water pumped from watering the ditch on the plot. Utilizing a boat or small engine mounted on a flotation device, such as a rubber ring, to pump water from an on-site ditch for vegetable garden irrigation is an innovative approach that can be particularly effective in areas with accessible surface water sources (Srisat, 2013). This method allows for the efficient distribution of water directly from the source to the garden, reducing the need for extensive infrastructure.

Traditional irrigation patterns still exist in the Laotian countryside. Most smallholder farms irrigate manually with buckets or small pumps during the drying period. Although very laborious, the method sometimes can be inefficient during long dry spells. Other crops, such as rice, cassava, and maize, bore heavy dependence on monsoon rains. This means that plants are dependent on irregular climatic patterns and remain greatly affected by droughts or erratic rains. Information in this paragraph are based on personal observations and field experience in Laos.

Flood irrigation is generally practiced in relatively flat areas where it could be implemented easily. However, water wasting, water erosion, and water-use efficiency considerations are not ideally addressed to this method; while soil erosion acts against water-use efficiency, it also harms soil structure. In certain large-scale farms in Laos, modern irrigation systems increasingly find use, since their adoption further improves production efficiency, reduces labor costs, conserves water, and saves time. For instance, drip irrigation provides water to plants from a network of pipes and emitters directly in the root zone and thus may prevent a 50% loss of water. It also reduces the weed growth and waterlogging possibility while facilitating nutrient absorption through fertigation. Despite all of these benefits, adoption is limited by installation cost and poor technical knowledge of farmers (Aujla et al., 2007).

2.2.7 Fertilization

Eggplant is considered a demanding crop that requires nutrients, and proper fertilization is indispensable for optimal growth and yield. Considering the primary macronutrients, nitrogen is for vegetative growth; phosphorus is for root development and flowering; next, potassium is for fruit quality and resistance to stress. Research in Florida demonstrated a yield response to nitrogen levels following a quadratic mode, where optimal yields are attained and remain level above certain levels of N application (Hochmuth & Hanlon, 1999).

Chemical fertilizers are widely applied. The application of NPK fertilizers proved to be very effective in improving plant height, number of fruits, and wet weight in purple eggplants, using a pretreatment control comparison (Hariyadi et al., 2020). A similar study found that a balanced application of NPK fertilizers brought about improved yield and better fruit characteristics in eggplant (Abrham & Shumbulo, 2024).

The integrated nutrient management (INM) method uses a combination of chemical fertilizers, organic sources, and biofertilizers. INM was demonstrated to have a positive impact on yield, nutrient efficiency, soil health, and economic returns in eggplant and other Solanaceae crops (Kumar et al., 2024; Maghfoer et al., 2022). For example, with the application of 75% of the recommended fertilizer dose, plus manure and microbial inoculants, eggplant yield increased as compared to conventional fertilization (Maghfoer et al., 2022). It has been described in a review paper as an efficient approach for combining organic, inorganic, and biological sources of nutrients to sustain production and fertility of the soils (Saravaiya et al., 2010).

Comparative studies addressing NPK vs composted organic sources have often shown that NPK fertilizer raises fruit weight by 100% compared to only compost treatments, albeit organic sources contributed to longer-term soil benefits (Smeage et al., 2020).

Published literature on fertilization practices for eggplant cultivation in Laos is very scant. Farmers commonly use compost organic materials or small doses of chemical fertilizer, if any are available. The gap therefore points to the significance of researching fertilization strategies adapted to local resource constraints and sustainable practices.

3 Methods used

This research consists of two complementary parts. The first part is a small-plot field experiment to evaluate fertilization and mulching effects on eggplant growth and yield. The second part is a market survey in local markets in Vientiane Capital (Song Pueay, Nongsa, and Nanga), investigating consumer preferences and demand, as well as the seasonal fluctuation of eggplant prices. These two approaches thus complement each other, giving perspectives on the agronomic and socio-economic dimensions of eggplant production in Laos.

3.1 Conditions of the experiment

The experiment was conducted in Nanga Village, Naxaythong District, Vientiane Capital, Laos, with the purpose of evaluating the impact of various nutrient supplementation treatments on eggplant growth and yield under local smallscale farming conditions. The trial was carried out during the dry season of 2025 so as favorably to exclude the environmental fluctuations, which are usually introduced due to heavy rainfall or disease outbreaks during the wet season.

The soil found throughout this area tends to be sandy loam to silty loam, well-drained, moderately fertile, and good for the production of vegetables provided the soil is improved either with organic or fertilizer input. The pH condition of the soil ranges between 5.5 and 6.5, a bit acidic—the ideal range for the growth of eggplant. While soil fertility is generally considered moderate, the addition of compost, organic manure, or fertilizer can boost yield potential considerably.

The cultivated land is presently utilized for adhesive rice farming. It experiences two cropping cycles per year. After a harvest, livestock are pastured in the field, which helps get rid of rice stubble and adds organic matter into the soil by way of manure. For two years prior to conducting this experiment, one portion of the land was cumbered with grass for feeding livestock or for sale. The irrigation water was pumped from a nearby river and has been adequate for both irrigation of rice and grass. Part of this land was renovated as an Integrated Farming System at the beginning of 2025, an endorsement that is gaining wider acceptance in Laos.

3.2 Applied cultivation method

3.2.1 Seed Preparation and Nursery Stage

The seeds of the long purple eggplant were raised as per the standard local method. On 20 February 2025, seeds were purchased from a certified seed supplier (from Thailand: เมล็ดพันธุ์ตราสามเอ or Ma-led phan sam-ta) and were put into water for 24 hours to identify viable seeds, floaters were discarded as they are generally considered poor-quality seeds. During 21st to 27th February the seeds were wrapped in soaked tissue paper and kept in the shaded environment for pre-germination until radicle emergence was visible, after which they were sown on 28 February 2025 in small plastic bags (10 cm × 15 cm), half-filled with planting soil (Figure 9). Planting soil is prepared with topsoil, compost, and sand in equal proportions of 2:1:1.

Figure 9. Eggplant seed germination and early seedling growth under nursery conditions.

(Photo by the author, 2025)

From the seeds, seedlings emerged after seven days and further developed in the nursery until they attained the stage of 3–4 true leaves, approximately 20 days after sowing, on 20th March. At this stage, field transplantation in prepared pots was executed.

3.2.2 Field Preparation and Transplanting

After the field was plowed and leveled, it was devoted to planting. The area of the experiment was 10 meters in length and 2.8 meters in width (28 m²), with 20 plants in each plot. Spacing between plants in the row was 50 cm, while between rows, it was 70 cm, sufficient for the development of canopy and root. Thus, yielding a planting density of around 2.9 plants/m². The plants were watered manually, with approximately 6 L/m^2 every day. A weeding session was done by hand every fortnight, whereas pest control was through manual removal of visible pests.

3.3 Experimental Design

The entire experiment was conducted with four treatments or four rows. One treatment was applied to one plot containing 20 plants, divided further into four groups rows of five plants for observation and data collection (Figure 10). One five-plant row was considered as a replication. The treatments were as follows:

1st Plot – Fertilizer Treatment

Treatment was applied to study the effect of synthetic fertilizer on eggplant growth and yield: balanced NPK fertilizer (15-15-15), total used 370 g or 53.6 g/m2 or approximately 18.8 g/plant (Figure 11). Fertilizers were applied in split doses equally. Three times, first at transplanting on 20^{th} March and then during flowering and fruiting on 15^{th} May and finally on 23^{rd} June. The procedure was meant to determine the influence of readily available nutrients on plant height, fruit yield, and plant health condition. It was expected that these nutrients would promote rapid growth and high yields, yet nutrient leaching and soil degradational effects were taken into consideration.

2nd Plot – Organic Manure Treatment

In this treatment, dried chicken manure combined with rice husks was studied as a sustainable soil amendment. The organic manure was incorporated on top of the soil, using 10 kg or 357 g/m^2 or approximately 123 g/plant (Figure 11). Also, three times on the same date as fertilizers were applied. Improvement of soil structure, promotion of microbial activities, and gradual nutrient release were all included in the processes. It is expected that organic manure would improve plant health, provide pest and disease resistance, and enhance longer soil fertility. This cheap and environmentally safe technique hopefully could be a model for smallholder farmers in Lao PDR.

Figure 10. Eggplant’s experiment field (Photo by author, 2025)

3rd Plot – Rice Straw Mulch Treatment

Here, a 5-to-8 cm layer of dry rice straw was applied evenly around each plant immediately after transplanting (Figure 11). No additional compost or fertilizer was applied. It was expected that mulching would conserve soil moisture, maintain soil temperature, and suppress weed growth. Rice straw was also applied three times, on the same dates as fertilizer and compost. As time passed, partial decomposition of the straw could add to the soil's organic matter. Rice straw mulching is an age-old and inexpensive practice in Laos, and this experiment sought to quantify its effect on the yield of eggplant, using 6 bags (2 bags for one time) and the size of one bag is 50x90 cm.

4th Plot – Control Treatment

The control plot was not fertilized, not composted, or not mulched (Figure 11). Plants grew in soil that was untreated but watered as per the other amendments. In this way, the treatment was provided for purposes of comparison and, essentially, for allowing the low-input traditional farming methods to dominate agricultural systems. Data collected from this plot would provide insight into how fertile and productive the native soil of the locality is without any sort of external stimulus.

Figure 11. Eggplant plants under the four treatments: fertilizer (left), compost (second), straw mulching (third), and control (right)

(Photo by author, 2025)

3.4 Measured Characteristics

Plant height was measured from the soil surface to the highest leaf starting on 20th March 2025, that is, 20 days after transplanting, and continued until 14th August 2025 by using simple plastic measuring tape. Twenty plants were measured in each treatment and were recorded as four subgroups of five plants for considering within-treatment variation.

Fruits were harvested regularly when they reached marketable maturity, Yield components were recorded, including the number of fruits per plant. Total fruit weight were measured by a digital kitchen scale with the maximum capacity of 30 kg and the sensitivity of ±5 g. The average fruit weight was calculated as the total fruit weight divided by the number of fruits. Harvesting were conducted manually by hand picking, which is the common practice in smallholder farming in Laos. Fruits were harvested regulary at intervals of 8 to 10 days in total 9 times from 2nd June until 14th August. During the initial harvests (first and second rounds), the yields were low compared to late harvests, averaging between 1.5 and 2.2 kilograms from the 80 plants combined, for the plants had just begun fruiting.

Besides the quantitative measurements, visual assessments were also conducted throughout the growing period. Observations included pest and disease symptoms, flowering times, and the general vigor of the plants. After observation, notes were taken onto field record sheets. These observations were generally based on visible symptoms, since no laboratory diagnostic tools could be utilized at the site.

3.5 Statistical Analysis

The experiment was designed as a field layout with four treatments. There were twenty plants for every treatment that were categorized into four groups of five plants. For statistical evaluation, these subgroups were considered replications.

Data were handled in Microsoft Excel (Version 2021) and expressed in average ± deviation. One-way ANOVA was conducted by Analysis Toolpak of Microsoft Excel with the aim of testing whether treatments affected plant height, number of fruits, total fruit weight, and average fruit weight. If the p-value was lower than 0.05 than it was considered that the treatment significantly effected the value of the characteristic under analysis. As a post-hoc test Fisher's least significant difference test was used to detect significant differences among treatment averages.

Results were presented as:

Tables: showing raw data together with averages and deviations calculated.

Bar charts: comparing treatments for each characteristic measured.

Line graphs: depicting plant height trends over time.

3.6 Market survey

Market surveys on a smaller scale were held at the markets of Song-Pueay, Nongsa, and Nanga in Vientiane Capital. The purpose of these surveys was to understand the consumer preferences, their demand, and the fluctuation of eggplant prices on a seasonal basis in this particular local market so as to correlate the findings in production with the market reality.

In every market, three vendors (sellers) and three buyers were surveyed, which amounts to a total of 18 respondents. The traders were inquired about the sources of their eggplants proximately (local production or imports), their views on seasonal availability, and the usual changes in wholesale and retail prices during a year. The consumers were interrogated about their preferences for buying, how often they buy, and they were also asked to express their opinion on the quality of the products (e.g., size, color, freshness).

The interviews were performed with easily structured questions, and the process was verbal in the Lao language on 16th July (two markets) and 28th July (one market). Answers were written down in notes, and no formal questionnaires were given out since the survey was informal to mirror real market conditions. Alongside the interviews, the eggplant stalls were observed directly with regard to price, available quantity, and product variety.

The Appendix market survey questions that used to interview traders and customers included:

For traders:

- Where do you usually source to buy eggplants?
- Which type/variety of eggplant do your customers prefer most?
- How do eggplant prices change across the year?

For customers:

- How often do you buy eggplant?
- Which characteristics of eggplants are most important to you when you buying?
- Do you notice that the eggplant prices change across the year?

Market Characteristics

The three markets that were surveyed are different in size and clientele. Song-Pueay Market is among the larger district-level markets, attracting both wholesalers and retailers (Figure 12). Nongsa Market caters to mostly semi-urban household customers and has a steady daily turnover of fresh vegetables (Figure 13), while Nanga Market is more rural and mostly caters to village residents and petty traders (Figure 14). Across all three markets, eggplant is a staple vegetable with a steady presence throughout the year, though its supply and price fluctuate due to the seasons.

Figure 12. Photos of Song-Pueay Market (Photo by author, 2025)

Figure 13. Photos of Nong-sa Market (Photo by author, 2025)

Figure 14. Photos of Nanga Market (Photo by author, 2025)

3.7 Note on Research Conditions and Data Collection

The experiment in Nanga village, Vientiane Capital, was designed by the author and run with the help of one of the local farmers (a family member), while the author was away abroad. All field operations and observations were done locally, but the experimental design, treatment structure, and methodological framework were conceptualized by the author; data analysis and interpretation were done after collection. During the data collection, some modification was made with regard to, for example, more frequent measurements or technically detailed photographic documentation, making them more limited than in fully supervised field trials. Most relevant parameters were measured thoroughly, but some data may not have been collected as systematically as possible, and some photographic documentation may be less clear.

Nonetheless, it should be emphasized that the experiment took place under real smallholder field conditions, with the results being actual observations regarding growth and yield. The results account for the prevailing local soil characteristics, weather, and farmer practices during the period of March–August 2025. Acknowledging these limitations, the study outcome presents useful insights on eggplant production under smallholder conditions in Laos.

4 Results and their evaluation

4.1 Plant height development

Plant height has gradually increased since the first observation made on 20th March 2025 up to the first week of May (Figure 15), after which it has slowed down, probably as the plants started mobilizing their energy toward flowering and fruit production.

On May 10th, 2025, when the plants were about 40 days old, some clear treatment differences were recorded from photographs and field observations. In the Fertilizer treatment, plants averaged an height of 42.2 cm, while in the Compost treatment heights averaged 39.2 cm. Rice Straw Mulch recorded 28.2 cm, with Control trailing at 23.0 cm (Table 2). Early differences like this illustrate the strong influence of nutrient availability during the establishment phase of eggplant growth.

Table 2. Effect of the type of nutrient supplement material on the development of height (in cm, avg. ± dev.) of eggplant plants during the experiment (Source: Author's own experiment, 2025)

Treatment	20-Mar	18-Apr	10-May	20-Jun	23-Jul	14-Aug
Fertilizer	10.9 ± 0.5 ab*	25.7 ± 2.9 a	42.2 ± 0.7 a	80.5 ± 1.2 a	105.1 ± 2.9 a	115.3 ± 1.2 a
Compost	11.1 ± 0.7 ab	24.8 ± 0.5 a	39.0 ± 1.1 b	72.4 ± 1.4 b	95.0 ± 0.7 b	109.1 ± 2.4 b
Straw	10.3 ± 0.3 b	19.6 ± 1.3 b	28.2 ± 0.5 c	44.1 ± 1.7 c	61.4 ± 2.5 c	72.7 ± 0.8 c
Control	11.7 ± 0.7 a	18.4 ± 0.2 b	23.0 ± 0.8 d	34.2 ± 1.3 d	43.5 ± 1.1 d	54.3 ± 2.4 d
p-value	0.0286	$4{,}29 \cdot 10^{-5}$	$7{,}74 \cdot 10^{-13}$	$1{,}22 \cdot 10^{-14}$	$3{,}89 \cdot 10^{-14}$	$1{,}07 \cdot 10^{-14}$
LSD-5%	0.9	2.5	1.3	2.2	3.1	2.8

*Treatment averages marked by the same letter in a column are not statistically different from each other at 95% probability level based on Fisher's least significant difference post-hoc test

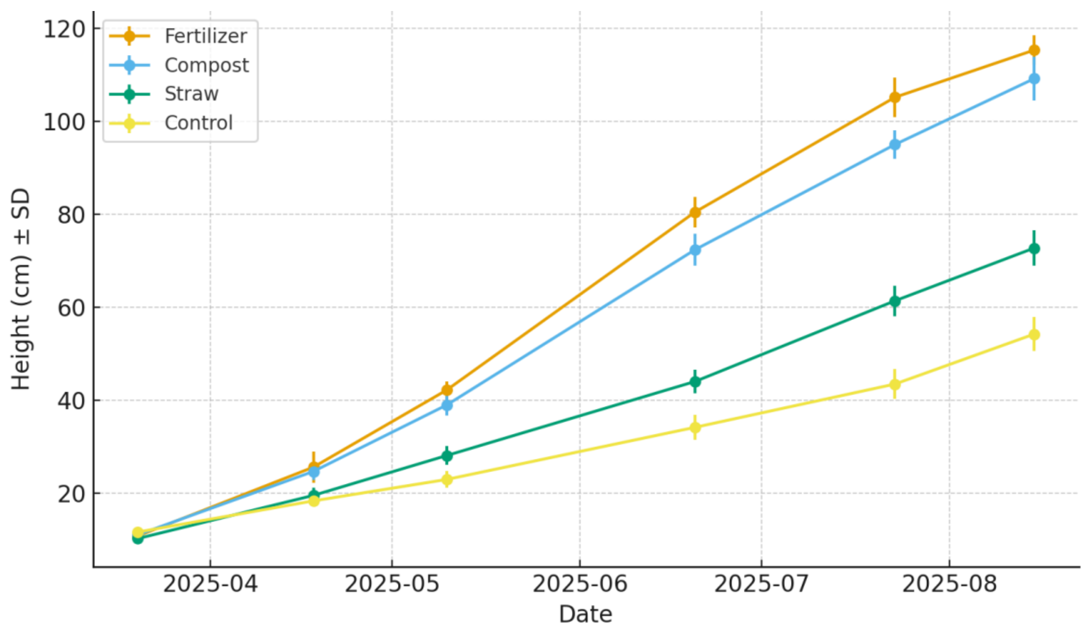

Figure 15. Lines of eggplant height growth over time by treatment (Source: Author's own experiment, 2025)

On the final measurement day of 14th August 2025, the fertilizer treatment held the highest plants with an average height of 115.3 cm, followed by compost treatment with 109.1 cm. The rice straw mulch treatment reached 72.7 cm, whereas the control measured the lowest plant heights at 55.3 cm (Figure 15). Every treatment average differed significantly from all the other ones at 95% probability level (Table 2). The relatively delayed growth in the control plot could probably be explained by the lack of any supplementation of nutrients and the absence of soil management practices. Overall, trends insinuate that nutrient availability was predominantly essential for vegetative growth, while soil covering provided moderate value in reducing moisture loss and controlling weeds.

4.2 Yield components

Fruit production began some 60 days after transplanting, on 25th May 2025. During the initial harvests, per-row yields were low (<2 kg combined 80 plants) (figure 16), reflecting that period of initial flowering. In late June and through July (fourth to sixth harvest), during the peak harvest, combined pickings from 80 plants sometimes hit 3.8-5 kilograms, with most fruits coming from the Fertilizer and Compost rows. The late harvest yields were impressive with yields going up to the highest production phase. That period of production saw the plants reaching their full capacity of fruiting under good growing conditions. From there, it started to decline from late July through August, with the last harvest yielding about 3 kilograms per plot.

Figure 16. Harvested eggplants from the experimental field (Photo by author, 2025)

4.2.1 Fruit number

According to the one-way ANOVA, it has been established that at the 95% confidence level, fertilization methods had an impact upon the number of fruits per square meter ($p = 2.20 * 10^{-5}$) (Appendix no.1). The control treatment produced significantly the lowest number of fruits, at 13.4 pieces m^{-2}, while the straw treatment gave 17.0 pieces m^{-2}, although still significantly lower than the fertilized treatments. Fertilizer (22.3 pieces m^{-2}) and compost (20.6 pieces m^{-2}) treatments yielded the highest number of fruits, with no significant difference found between them (Figure 17). To summarize, fertilizer and compost applications really promoted fruit set in relation to straw mulching and control plots.

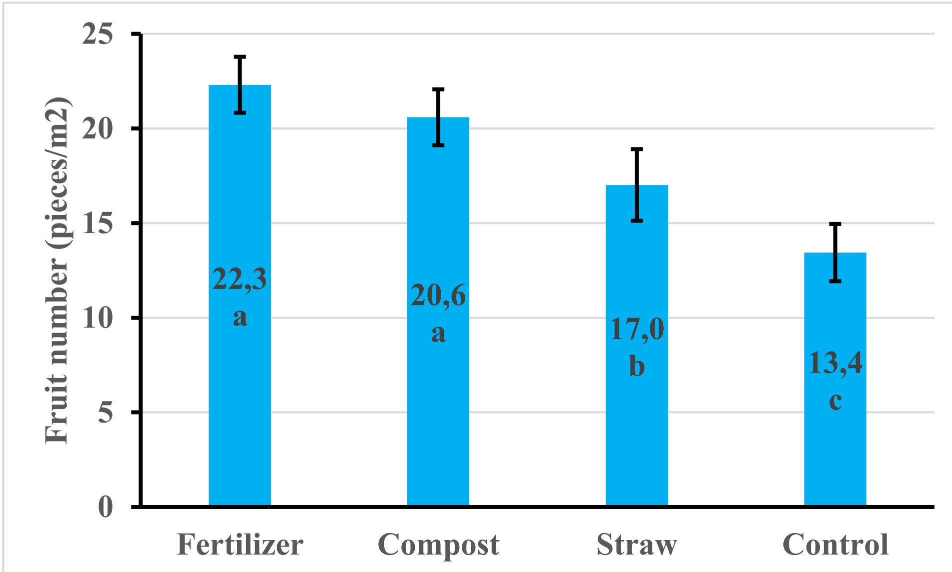

Figure 17. Effect of different management/fertilization practices on number of fruits of eggplant (Author's own experiment, 2025)

*Treatment averages marked by the same letter in a column are not statistically different from each other at 95% probability level based on Fisher's least significant difference post-hoc test

4.2.2 Average fruit weight

Average fruit weight had also been affected significantly by the treatments ($p = 1.35 * 10^{-4}$) (Appendix no.2). The smallest fruits were formed in control and straw treatments, measuring 68 g and 69 g, respectively, without any significant differences between them (Figure 18). Larger fruits were formed under fertilizer and compost treatments, measuring 81 g and 77 g, respectively, and these two treatments did not differ statistically. This observation emphasizes directly the role of nutrient supply through fertilizer or compost in improving fruit size, while straw mulching alone was not sufficient to increase fruit weight beyond that control.

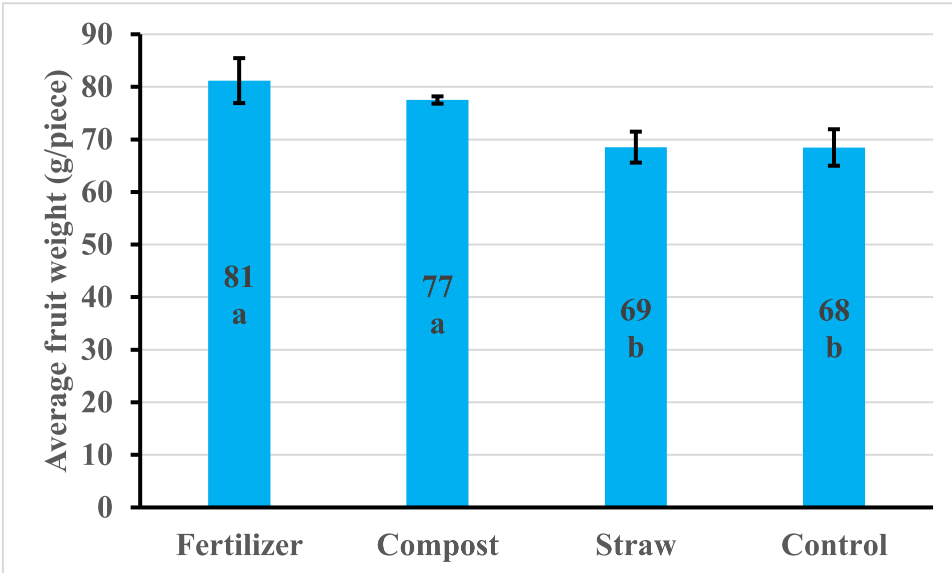

Figure 18. Effect of different management/fertilization practices on average fruit weight of eggplant (Author's own experiment, 2025)

*Treatment averages marked by the same letter in a column are not statistically different from each other at 95% probability level based on Fisher's least significant difference post-hoc test

4.2.3 Marketable yield

The total fruit yield per square meter showed the same trend as fruit number and fruit weight (Figure 19). The control treatment gave the least yield of 0.92 kg m^{-2}, followed by straw, which had a yield of 1.17 kg m^{-2}, moderately higher but still statistically lower than that of the fertilized treatments. Compost, meanwhile, produced 1.60 kg m^{-2}, and fertilizer, 1.81 kg m^{-2} (Appendix no. 3). The fertilizer and compost yields were not significantly different, but they were both significantly higher than straw and control. This, therefore, emphasizes that eggplant productivity is greatly dependent on nutrient supply, and the two materials are equally efficient in sustaining higher yields.

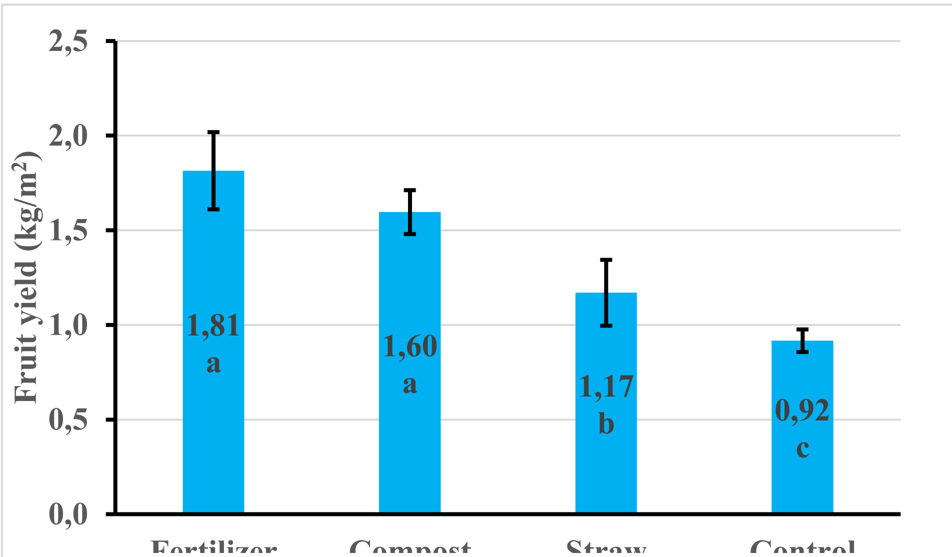

Figure 19. Effect of different management/fertilization practices on fruit yield of eggplant

(Source: Author's own experiment, 2025)

*Treatment averages marked by the same letter in a column are not statistically different from each other at 95% probability level based on Fisher's least significant difference post-hoc test

4.3 Market survey

Table 3: Survey responses of traders (n=9) and customers (n=9) on eggplant supply, preferences, characteristics, and price fluctuations in Vientiane Capital (Source: Author's own experiment)

Questions	Traders (n-9)	Customers (n-9)
Source of eggplants / Frequency of purchase	Mainly from the northern part of Laos, import from Thailand when local supply is slow	Buy 2-3 times a week depends on what they will cook, considered the household's stability
Preferred type/variety	Thai eggplant most demanded, following by long purple eggplant	Prefer thai eggplant for taste and cooking versatility
Important charecteristics	Demand based on consumer preference, freshness and size are key	Freshness, size, color, and prices
Price fluctuations	Higher during the rainy season (May-October) Lower during the dry season (Nov-April)	Noticed the price change during the peak rainfall in the rainy season

Consumer preferences

Customers prefer fruits that are:

- Medium-sized (18-22 cm long, ~50–90 g)
- Glossy and fresh-looking with deep purple skin
- Uniform in shape without deformities and pest damage

Seasonal Price Trends

Now, the vendors assert that eggplants are seasonally changing in prices (Table 6). The supply is relatively stable during the dry season (Nov–April) but declines as the rainy season (May–Oct) begins, since many farmers reduce planting eggplant under heavy rains. The following reasons have been cited: Increased pest and disease pressure (fungal rots, fruit borers), poor field access due to flooding, and yield loss risk from prolonged waterlogging.

Eggplant prices usually shoot up in the peak period during July and August (Figure 19). For instance, average prices ranged from 8,000 to 10,000 LAK/kg (0.37 to 0.46 USD) during the dry season, while they rose during rainy months to 12,000–15,000 LAK/kg (0.55 to 0.69 USD). Customers say that even if prices rise, customers still shop for eggplants; hence, the demand is relatively inelastic for this staple crop. Source here collected directly from traders during the market survey conducted in Jul-August 2025 across the three local markets.

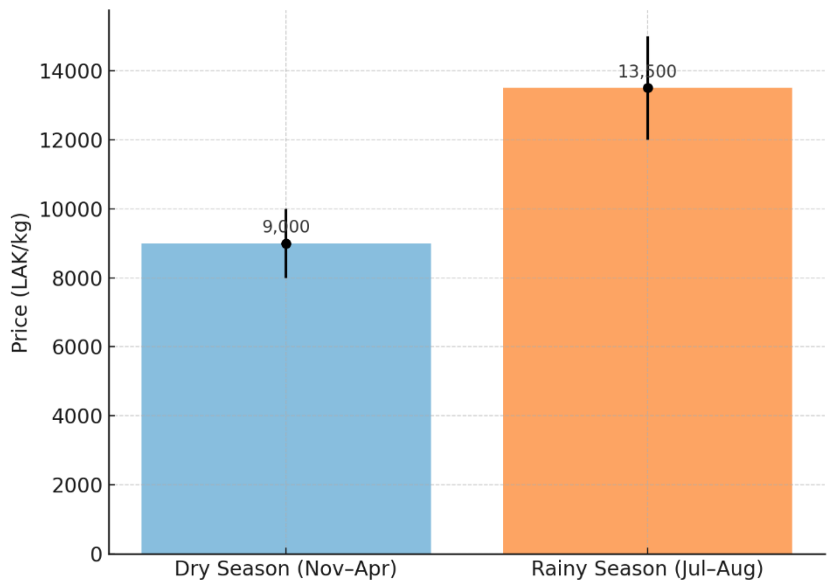

Figure 20. Bar chart of average eggplant prices in Laos market

(Source: Primary data collected from trader and customer surveys, Jul–Aug 2025, across three markets in Vientiane)

5 Conclusion and proposals

5.1 Conclusions

The experiment showed clear differences in the growth and yield of eggplants under the four management practices tested. Being fertilizer treatment, it yielded the highest production, validating the strong response of eggplant to nutrient availability. This, however, also raised the issue of farmer dependence on external inputs. Chemical fertilizer will improve productivity in the short term but might increase cost of production and degrade soil health if applied perpetually without organic amendments. In the Lao context, where many smallholders operate with limited capital, this raise concerns in terms of sustainability and access to inputs.

The composting treatment produced adequate growth and yield while enhancing soil quality. Compost and other organic amendments increase microbial activity, improve soil structure, and contribute to long-term soil fertility. Although the yield increase was not as high as with chemical fertilizer, this method is more in line with sustainable agriculture. It lessens dependence on external inputs and makes use of local resources that are generally available to the farmers in rural Laos. Therefore, the compost method should be considered a pragmatic and environmentally friendly choice for promotion in smallholder production systems.

The straw mulching treatment compromised a moderate yield as compared to fertilizer or compost applications. But its usefulness was not limited to yield alone. During growth, mulching conserved soil moisture, limited weed competition, and soil temperature, balancing especially well into the hot, dry periods that punctuate the growing season. Add to that the organic matter contributes to the soil system from the subsequent decomposition of rice straw. With rice straw being plentiful as a by-product of rice farming in Laos, this practice is quite an inexpensive way of improving soils and, at the same time, reducing labor required for weeding. Given moderate yields, mulching may perform better alongside fertilizer or compost in all future trials.

The control or untreated plot was considered the baseline for comparison. Yield-wise, it was the lowest, further underscoring the limitation of relying on the natural fertility of the soil. It could, however, be an important treatment because this scenario exactly depicts some smallholder farmers in Laos that do not access fertilizer, compost, or mulching material. The poor response to this control elevates the necessity of seeking appropriate interventions to improve productivity while simultaneously highlighting that, without inputs or some form of soil management, eggplant yields remain limited.

In sum, the results suggest that there is no single “best” solution for all farmers. To entice farmers into fertilizer use, there must be immediate benefits yield; fertilizer-based agriculture is defined by long-term dependence; composting guarantees sustainable soil fertility but samples fungi beyond labor and the availability of organic material; mulching permits soil and water management and modest yield benefits; and the control data confirms that productivity is grossly limited by doing nothing. For Laos, where farming conditions are scattered and resources are always scarce, they need an integrated approach that will carry organic manure, mulching, and balanced application of fertilizer.

These findings, on a bigger scale, will have implications beyond farm-level impacts. The key policy implication and extension-service possibility would be emphasizing the promotion of low-cost and sustainable methods such as composting and mulching alongside the balanced use of fertilizers. From the research perspective, the study enunciates a greater need for larger multi-season experiments with proper replications, as anything less would cast doubt on the reliability of the outcome. Lastly, for the farmers, it provides strong practical evidence that resources in their locality substantially contribute to sustaining yields and maintaining soil fertility while reducing costs.

5.2 Proposals

Based on the results of this study, the following recommendations are made for farmers and future research:

For farmers:

- The application of compost should be promoted as a green practice that not only improves soil structure but also increases fertility and at the same time keeps reasonable yields all through the use of natural resources instead of costly external inputs.
- It is highly recommended that rice straw mulching be utilized during the dry season, and its moisture conservation, weed suppression, and heat stress reduction characteristics will be more pronounced. The application of compost or moderate fertilizer will yield the best results in conjunction with this practice.

For future research:

- To enhance the dependability of findings, future experiments must consist of additional replications and be performed in various locations and at different times of the year.
- Treatment economic analyses should be performed to determine the cost-benefit ratios because profitability is one of the major factors that attract farmers to use the new technologies.
- Moreover, a study has to be conducted to test the integrated combinations of fertilizer, compost, and mulching to find the best and the most suitable management strategies for eggplant production in Laos.

6 Summary

Eggplant (*Solanum melongena L.*) is one of the most popular vegetable crops in Laos. It is widely cultivated for both household consumption and sale in the market. Despite the importance of this vegetable in the culture and economy, there is little available information on its cultivation practices in the country.

This thesis has three main objectives. The first objective was to conduct a literature review and give a comprehensive account of the situation that regards eggplant farming in Laos, encompassing the whole discussion of its significance, different methods that are employed, and the difficulties that are encountered by peasants. The second goal was to set up a small-scale field trial to compare production management practices of different sorts (chemical fertilizer, organic compost, straw mulching, and control) and to measure their effects on the growth and eggplant yield performance under local conditions. Third came the market survey in the selected localities of Vientiane, where the consumption patterns, the changes in price over the seasons, and the overall market for eggplant were explored.

The research was conducted in Nanga Village, Naxaythong District, Vientiane Capital, with the aim of studying different cultivation methods and their effects on growth and yield performance. The four treatments studied were chemical fertilizers, organic compost, mulching with rice straw, plus a control with no inputs. In parallel with the experiment, a small market survey was carried out in local markets of Vientiane to determine consumer demand and seasonal price fluctuations.

Differences appeared to be obvious when comparing the treatments. Fertilizer use guaranteed the best results and proved eggplant to be a sensitive crop to nutrient supplies. Compost improved soil structure and fertility, while by its nature, it is a sustainable and locally available option for smallholder farmers in returning reasonable yields, although the yield was somewhat lower than in the fertilizer treatment, but the difference was not statistically significant. Rice straw mulching behaved moderately in yields but added additional points in moisture conservation, weed control, and temperature regulation. The control performed the least because nature differentiated soil fertility inadequately sustains yield.

The market survey conducted in three local markets in Vientiane finds eggplant consistently demanded throughout the year. Traders reported that generally, the supply decreases in the rainy season; thus, the prices rise in the dry months, July-August. Both traders and consumers emphasized medium-sized glossy purple fruits as preferred and easy to sell and handle. These findings further emphasized that a steady supply maintained through good management practices and proper use of compost and mulch should be one of the means to stabilize the market and farmers' income in Laos.

It is concluded that no single method fits all conditions. Whereas fertilizer grants a quick output gain but also creates dependence, compost provides for long-term soil fertility, mulching gives inexpensive soil and water benefits, and the control shows the necessity of using inputs. It is proposed that an integrated approach, using compost and mulching with a slight amount of fertilizer, offers the best solution for smallholder farmers in Laos.

7 Bibliography

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List of figures and tables

Appendices

Appendix no. 1. One-way ANOVA performed on fruit number data

Egytényezős varianciaanalízis **LSD5%** **2.5**

ÖSSZESÍTÉS

Csoportok	*Darabszám*	*Összeg*	*Átlag*	*Variancia*	
Fertilizer	4	89.232	**22.3**	2.181227	**a**
Compost	4	82.368	**20.6**	2.181227	**a**
Straw	4	68.068	**17.0**	3.571759	**b**
Control	4	53.768	**13.4**	2.290288	**c**

VARIANCIAANALÍZIS

Tényezők	*SS*	*df*	*MS*	*F*	*p-érték*	*F krit.*
Csoportok	186.229	3	62.07635	24.28533	**2.20E-05**	3.490295
Csoporton	30.6735	12	2.556125			
Összesen	216.9025	15				

Appendix no. 2. One-way ANOVA performed on average fruit weight data

Egytényezős varianciaanalízis **LSD5%** **5**

ÖSSZESÍTÉS

Csoportok	*Darabszám*	*Összeg*	*Átlag*	*Variancia*	
Fertilizer	4	324.7615	**81**	18.26285	**a**
Compost	4	309.9854	**77**	0.477158	**a**
Straw	4	274.1532	**69**	8.658697	**b**
Control	4	273.869	**68**	12.04265	**b**

VARIANCIAANALÍZIS

Tényezők	*SS*	*df*	*MS*	*F*	*p-érték*	*F krit.*
Csoportok	497.375	3	165.7917	16.81399	**1.35E-04**	3.490295
Csoporton	118.3241	12	9.860339			
Összesen	615.699	15				

Appendix no. 3. One-way ANOVA performed on fruit yield data

Egytényezős varianciaanalízis **LSD5%** **0.23**

ÖSSZESÍTÉS

Csoportok	*Darabszám*	*Összeg*	*Átlag*	*Variancia*	
Fertilizer	4	7.25868	**1.81**	0.041582	**a**
Compost	4	6.38352	**1.60**	0.01348	**a**
Straw	4	4.67896	**1.17**	0.030286	**b**
Control	4	3.66652	**0.92**	0.003564	**c**

VARIANCIAANALÍZIS

Tényezők	*SS*	*df*	*MS*	*F*	*p-érték*	*F krit.*
Csoportok	1.97732	3	0.659107	29.65201	**7.84E-06**	3.490295
Csoporton	0.266737	12	0.022228			
Összesen	2.244057	15				

Declaration of Students and Doctoral Candidates on the Use of Artificial Intelligence (AI)”

1. general information:

Name of the student:	**Thipaksone Xaphouvong**
Neptun ID:	**FFI0OS**
Level of program (mark with X):	☒ BSc/BA ☐ MSc/MA ☐ Doctoral School (PhD) ☐ Other: ………………………
6Name and code of the subject*:	
Title of the work:	

* Not required to be completed in the case of a doctoral dissertation.

2. Declaration on the Use of AI

I, the undersigned, fully aware of my ethical responsibility, make the following declaration:

(Please choose one of the options below!)

☐ A) I have not used any artificial intelligence system or service.

(If you selected this option, completing the subsequent tables is not required.)

☒ B) I have used an artificial intelligence system or service.

(Please fill in the relevant tables!)

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TABLE I: Assistant or Minor Usage (e.g., translation, language proofreading, brainstorming, etc.)

(For these uses, attaching the specific prompts and responses is not required.)

Purpose of Use	Name and Version of the AI Tool Used	Affected Section (if not applicable to the entire text)

Language proofreading and translation	Chat GPT 5	Introduction, Literature Review, Methodology, Results and Discussion, Conclusion.
Brainstorming	Chat GPT 5	Introduction, Literature Review, Methodology, Results and Discussion, Conclusion.

Purpose of Use	**Name, Version, and Access Information of the Al Tool Used**	**Exact Number of the Affected Chapter / Figure / Table**	**Entry Number of the Appendix Containing the Prompt Log**

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Rules Prescribed by the Lecturer or Supervisor

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I declare that I have critically reviewed, edited, and incorporated any content potentially generated by Al in all cases. I take full responsibility for every element of the submitted work, including its originality and scientific validity. I acknowledge that the Hungarian University of Agriculture and Life Sciences may check the submitted work with an artificial intelligence detector and may initiate proceedings if my declaration is found to be false or incomplete.

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……………………………………………… ………………………………………………

Signature of the Student

DECLARATION

Ombódi Attila (V25HSZ) as a consultant, I declare that I have reviewed the final thesis and that I have informed the student of the requirements, legal and ethical rules for the correct handling of literary sources.

I recommend the final thesis to be defended in the final examination.

The thesis contains a state or official secret: yes <u>no</u>*[1]

Date: 2025. year November month 03. day

Ombódi Attila

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Appendix 4 – Declaration

STUDENT DECLARATION

Signed below, Thipaksone Xaphouvong, student of the Szent István Campus of the Hungarian University of Agriculture and Life Science, at the BSc/MSc Course of Agricultural engineering declare that the present Thesis is my own work and I have used the cited and quoted literature in accordance with the relevant legal and ethical rules. I understand that the one-page-summary of my thesis will be uploaded on the website of the Campus/Institute/Course and my Thesis will be available at the Host Department/Institute and in the repository of the University in accordance with the relevant legal and ethical rules.

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Student

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