A Study of the Correlations of Soil Properties with Growth and Yield of Sudan Roselle (Hibiscus sabdariffa L.) in Post-Harvest Rice Fields in Phak Mai Subdistrict, Huai Thap Than District, Sisaket Province, Thailand

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Abstract

This research investigates the correlations of soil properties with growth and yield of Sudan-variety roselle in post-harvest paddy fields at Ban Khok Samrong, Si Sa Ket Province. The study employed three soil management models—organic, control, and chemical fertilizer plots—each measuring 20×20 meters with 1-meter buffer dikes. Following GLOBE Protocols, soil physical and chemical properties, including texture, color, structure, temperature, moisture, pH, and NPK levels, were analyzed pre- and post-cultivation alongside plant growth and yield parameters. The results revealed that the dry and cool climate during harvest, characterized by 40% relative humidity and 20°C, served as a key stimulant, increasing calyx thickness to 0.2 mm across all treatments. Notably, the organic plot maintained a neutral soil pH of 7.12 and a topsoil temperature of 31°C, which was cooler than the control and chemical plots. In terms of productivity, organic management yielded the best structural growth with an average plant height of 81 cm, a stem diameter of 1.4 mm, and the highest yield of 15 pods per plant. Although the control plot exhibited the highest leaf count (63 leaves) and calyx length (4.1 cm), the economic analysis for a 400-square-meter area showed that the organic plot provided the highest net profit of 2,450 Baht and superior market value. This study demonstrates that organic soil management in post-harvest paddy fields is a sustainable approach that enhances both crop quality and farmer income.

Keywords: Soil properties, Sudan-variety roselle, Soil management, Post-harvest paddy fields, Organic farming, GLOBE Protocols

Introduction

Phakmai Subdistrict in Huai Thap Than District, Si Sa Ket Province, is a prominent agricultural area where farmers utilize post-harvest rice fields to grow economic crops for supplemental income. Among these, the Sudan strain of Roselle (*Hibiscus sabdariffa L.*) is highly popular due to market demand and its suitability for the post-harvest season. However, farmers face significant challenges regarding inconsistent yield quantity and quality. This variation is primarily driven by differences in physical and chemical soil properties resulting from divergent management practices: organic versus chemical farming.

According to the Department of Agriculture (2014), Roselle thrives in moderately fertile, well-drained soil with a pH range of 6.6 – 6.8. Deviations from these optimal conditions directly impact anthocyanin accumulation and calyx thickness. These soil properties are the fundamental factors controlling nutrient cycling and plant development. This is consistent with the research of Arkom Kanchanaprachot (2015), which emphasizes that appropriate soil management ensures efficient nutrient release to plants. Furthermore, Kulthida Thammarat (2020) found that the use of organic fertilizers improves soil structure and fosters long-term plant growth.

Despite existing studies on soil management and economic crops, there is a lack of scientific data specifically linking soil properties to the growth and quality of Roselle in the context of post-harvest rice fields at the community level. Therefore, this research aims to investigate these relationships in Ban Khok Samrong, Phakmai Subdistrict, Si Sa Ket. By employing the GLOBE Protocols for systematic measurement, this study ensures data consistency that can be compared with national and global databases. The findings will provide farmers with a deeper understanding of how soil properties influence Roselle production, serving as a guideline for soil improvement, post-harvest land-use planning, and the promotion of sustainable agriculture within the community.

Research Questions

1. How do the physical and chemical properties of soil in post-harvest paddy fields differ under various soil management practices during the pre-planting and post-harvest periods of Sudanese Roselle?
2. What is the Correlations between soil properties and the growth of Sudanese Roselle?
3. What is the Correlations between soil properties and the yield quality of Sudanese Roselle?

Research Hypotheses

1. Physical and chemical soil properties in post-harvest rice fields are different under different soil management practices, both before planting and after harvesting Sudan Roselle.
2. Soil properties are related to the growth of Sudan Roselle.
3. Soil properties are related to the yield quality of Sudan Roselle.

Research Objectives

1. To study the physical and chemical properties of soil in post-harvest paddy fields under different soil management practices, including organic, control, and chemical fertilizer plots.
2. To evaluate the growth of Sudan-variety roselle in the study area under different soil management practices, including organic, control, and chemical fertilizer plots.
3. To investigate the relationship between soil properties and the growth and yield of Sudan-variety roselle.

4. To utilize the findings as a guideline for appropriate soil management and land-use planning in post-harvest paddy fields at the community level.

Research Variables

Independent Variables: Soil properties in organic, control, and chemical fertilizer plots.

Dependent Variables: The growth and yield of Sudan-variety roselle.

Controlled Variables: Sudan roselle variety, planting period, planting area and plot size, data collection timing, and study area coordinates.

Expected Benefits

1. Acquisition of baseline data regarding soil characteristics and nutrient changes in organic, control, and chemical fertilizer plots within Ban Khok Samrong, Phak Mai Subdistrict, Si Sa Ket Province.
2. Understanding of the relationship between soil properties and the growth and yield of Sudan-variety roselle, providing a basis for future soil improvement.
3. Identification of the most suitable soil management practices to enhance the quality and quantity of Sudan-variety roselle yields during the post-harvest season.
4. Empowerment of local farmers to apply knowledge of soil-plant relationships to reduce production costs and increase crop value sustainably.

Research Methodology

1. Materials and Equipment


shovel


ziploc bags


smartphone


digital scale

Wash Bottle

pH meter


test tube

Mesh drawstring bag


Soil Temperature Tester


munsell soil color chart


Microwave


N,P,K tester kit


Dropper


Tape measure

Globe observer app


Vernier Caliper

Color Grab app

2. Scope of the Study

1. Site Selection and Experimental Design

The study was conducted in a post-harvest paddy field at Ban Khok Samrong, Si Sa Ket (14.931124 ,104.011235). The area was divided into three 20 \times 20$ meter plots: organic, control (no fertilizer), and chemical fertilizer. To prevent cross-contamination, each plot was enclosed by a 1-meter-wide buffer dike and separated by a 3-meter isolation gap.

2. Content Scope

2.1 Soil Physical Properties: Investigation and measurement of soil physical properties following **GLOBE Protocols**, including soil structure, consistence, texture, color, temperature, and moisture, conducted both before planting and after harvesting.

2.2 Soil Chemical Properties and Fertility: Assessment of soil pH levels and essential macronutrients, specifically **Nitrogen (N), Phosphorus (P), and Potassium (K)**, to evaluate soil fertility changes before and after the cultivation period.

2.3 Growth and Yield of Sudan-variety Roselle: Monitoring of plant development, including plant height, leaf count, and stem diameter. Yield data is also collected, focusing on the number of pods per plant, average flower diameter, and the average length and thickness of the calyces.

2.4 Production Data Collection: Comprehensive collection of yield data from Sudan-variety roselle grown across all three experimental plots located at Ban Khok Samrong, Phak Mai Subdistrict, Huai Thap Than District, Si Sa Ket Province.

3. Research Methodology

1. Site Selection and Area Preparation

1.1 Study Site

Organic farming plot.

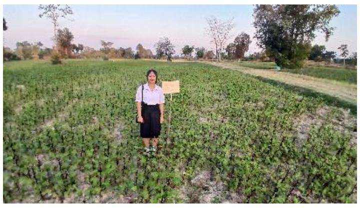
Control plot (no fertilizer application).

Chemical farming plot.

The study was conducted at Ban Khok Samrong, Phak Mai Subdistrict, Huai Thap Than District, Si Sa Ket Province. The specific geographical coordinates are Latitude 14.931124 and Longitude 104.011235

1.2 Experimental Plot Layout

The study area was divided into three 20x20 meter experimental plots, categorized as organic, chemical, and control treatments. The plots were categorized as follows:



1.Chemical farming plot.

2.Chemical farming plot.

3.Control plot

To ensure environmental control, each plot was enclosed by a 1-meter-wide paddy dike acting as a buffer zone, with a 3-meter isolation space maintained between each plot.

2. Soil Sampling Procedures

Soil samples were collected from the three experimental plots using a zigzag sampling method to ensure representative data across the area. At each plot, 15 sampling points were identified along the zigzag path. At each point, soil was extracted from three specific depths: 5 cm, 10 cm, and 30 cm.

The soil collected from each depth was thoroughly mixed to create a composite sample for that specific level. These composite samples were then placed into resealable plastic bags (Ziploc bags), sealed tightly to prevent moisture loss, and transported for physical and chemical analysis following GLOBE Protocols.


3. Soil Property Analysis

3.1 Physical Property Analysis The physical properties of the soil

It's including structure, consistence, moisture, temperature, texture, and color—were analyzed before and after the cultivation period according to the following procedures:

1) Soil Structure: Natural soil aggregates were observed by placing a soil clump on the palm and applying gentle pressure. The resulting fractures or cleavage patterns were analyzed to classify the structure shape, such as granular or platy.

2) Soil Consistence: The resistance of the soil to pressure was evaluated by squeezing a small soil clump (approximately 1.5–2 cm) between the thumb and index finger to determine whether the soil was friable or firm.



3) Soil Moisture: Soil samples were weighed before and after oven-drying. The moisture content was then calculated as a percentage relative to the dry soil weight.



4) Soil Temperature: A metal stem thermometer was inserted into the soil at depths of 5 cm, 10 cm, and 20 cm. The thermometer was left for at least 2 minutes until the reading stabilized before the data was recorded.


5) Soil Texture: Samples were moistened until they could be formed into a ball. The soil was then squeezed between the thumb and index finger to form a "ribbon." A ribbon longer than 5 cm indicated clay, while an inability to form a ribbon or the formation of only short pieces indicated sandy or sandy loam soil.




6) Soil Color: The color of both dry and moist soil samples was compared against the Munsell Soil Color Chart to accurately identify the specific hue and intensity.


3.2 Chemical Property and Soil Fertility Analysis

The chemical properties and primary nutrients (Nitrogen, Phosphorus, and Potassium) were analyzed before and after the cultivation period using the following methods:

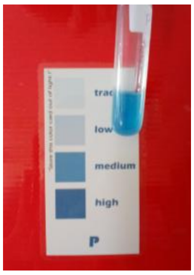
1) Soil pH Measurement: Soil and distilled water were mixed at a 1:1 ratio, shaken for 30 seconds, and allowed to settle for 30 minutes. The pH level of the supernatant (clear liquid above the soil) was then measured using a pH meter or pH indicator paper.

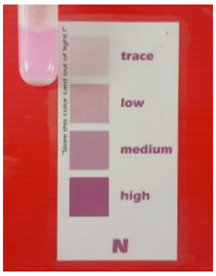



2) Nitrogen (N) Content: 2.5 ml of settled soil solution was transferred into a test tube using a pipette. One packet of HI 3895-N reagent was added. The tube was capped and shaken for 30 seconds. The resulting pink color was compared against a nitrate color chart to estimate the nitrogen levels.

3) Phosphorus (P) Content: 2.5 ml of settled soil solution was transferred into a test tube. One packet of HI 3895-P reagent was added. The tube was capped and shaken for 30 seconds. The resulting blue color was compared against a phosphorus color chart to estimate the phosphorus levels.

4) Potassium (K) Content: 2.5 ml of settled soil solution was transferred into a test tube. One packet of HI 3895-K reagent was added. The tube was capped and shaken for 30 seconds. The resulting turbidity (cloudiness) was compared against a potassium comparison chart to estimate the potassium levels.



3.3 Growth and Yield Analysis of Sudan-Variety Roselle

Growth and yield data were monitored through several parameters, including plant height, leaf count, stem diameter, number of pods, flower diameter, and calyx characteristics. The procedures were as follows:

1) Plant Selection and Labeling: In each of the three plots, 15 healthy representative plants were selected and labeled (K1–K15) for continuous monitoring until harvest. The selection was distributed as follows:

K1–K8: Two plants from each of the four corners.

K9–K12: Four plants from the center of the plot.

K13–K15: Three plants distributed between the corners and the center. Growth measurements were recorded every 14 days.


2) Growth and Physical Yield Measurements:

Plant Height: Measured from the soil surface to the highest tip using a measuring tape (cm).

Leaf Count: Total count of fully expanded, healthy leaves.

Stem Diameter: Measured 2-3 cm above the soil base using a Vernier Caliper (mm).

Number of Pods: Total count of mature, healthy pods per sample plant.

Flower Diameter: Width of the flower during full bloom (cm).

Calyx Length and Thickness: Measured from base to tip (cm) and at the mid-section (mm) using a Vernier Caliper.


3.4 Data Collection and Harvest

The final harvest and comprehensive yield data collection for the Sudan-variety roselle across all three plots in Phak Mai Subdistrict, Si Sa Ket, were completed in January 2026.

3.5 Data Reporting

All collected environmental and soil data were uploaded to the GLOBE Program database via the Data Entry system at https://www.globe.gov.

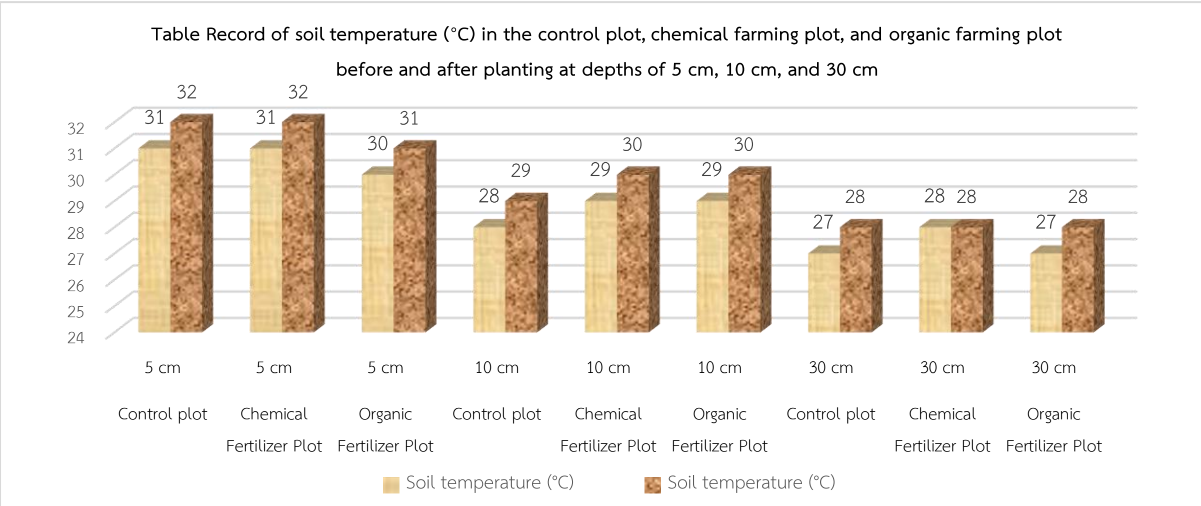
Research Results

Table 1 Physical soil property data record of the control plot, chemical farming plot, and organic farming plot at depths of 5 cm, 10 cm, and 30 cm.

Agricultural Plot	Depth	Period	Soil Structure	Soil Compaction	Soil Texture	Soil Color
Control plot	5 cm	Before sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/4 olive brown
		After sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/1 dark gray
	10 cm	Before sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/3 olive brown
		After sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/2 dark grayish brown
	30 cm	Before sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/4 olive brown
		After sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/2 dark grayish brown
Chemical Fertilizer Plot	5 cm	Before sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/4 olive brown
		After sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/1 dark gray
	10 cm	Before sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/3 olive brown
		After sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/2 dark grayish brown
	30 cm	Before sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/3 olive brown
		After sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/2 dark grayish brown
Organic Fertilizer Plot	5 cm	Before sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/3 olive brown
		After sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/2 dark grayish brown
	10 cm	Before sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/3 olive brown
		After sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/2 dark grayish brown
	30 cm	Before sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/3 olive brown
		After sowing	Granular	Friable	SANDY CLAY LOAM	2.5Y 4/2 dark grayish brown

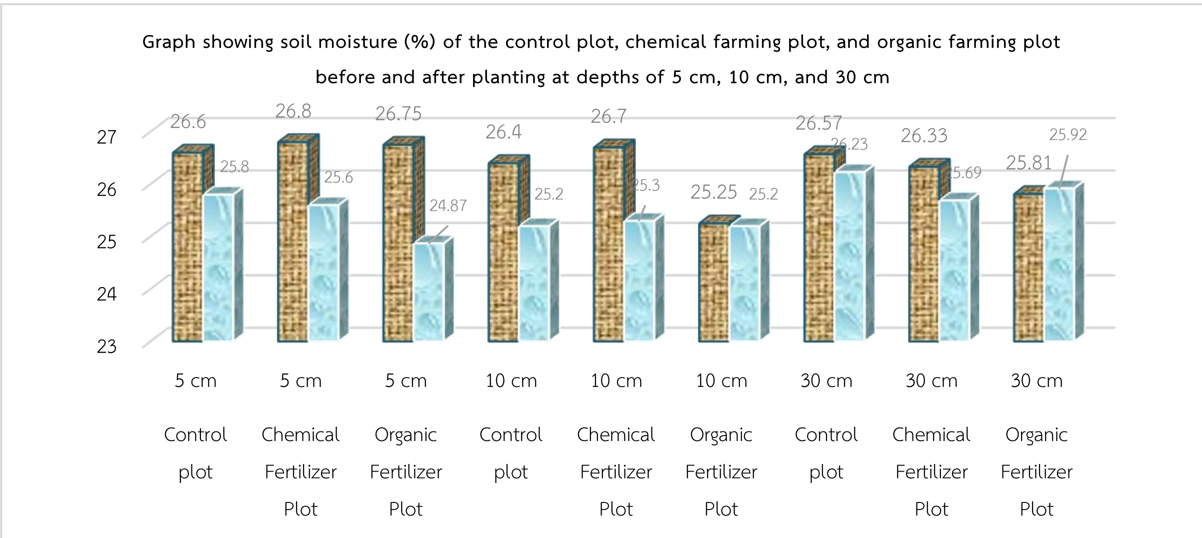
From Table 1, it was found that the soil texture and soil structure of the control plot, the chemical farming plot, and the organic farming plot at all soil depths (5, 10, and 30 cm) were classified as sandy clay loam, with a granular structure and a friable consistency. These characteristics are suitable for water drainage and nutrient uptake by roselle (Hibiscus sabdariffa L.) roots. In addition, changes in soil color were observed in all plots, with soils becoming darker after cultivation; for example, from 2.5Y 4/4 (olive brown) to 2.5Y 4/2 (dark grayish brown). The darker soil color reflects an increase in soil moisture and organic matter following land management practices, which are important supporting factors for plant growth and the quality of crop yield.

Figure 1 Comparison of soil temperature (°C) in the control plot, chemical farming plot, and organic farming plot before and after planting at depths of 5 cm, 10 cm and30 cm.



From Figure 1, it was found that the highest soil temperature occurred at the soil surface depth of 5 cm, with an average of 30–32 °C, and gradually decreased with increasing depth. The lowest temperature was observed at the 30 cm depth, at approximately 27–28 °C. In addition, soil temperature after planting tended to be about 1 °C higher than before planting at nearly all experimental sites. This trend is consistent with the darker soil color, which enhances heat absorption.

Figure 2 Presents a comparison of soil moisture content (%) in the control plot, the chemical farming plot, and the organic farming plot before and after planting at soild depths of 5,10, and 30cm.



From Figure 2, soil moisture content showed a slight decreasing trend with increasing soil depth. The organic farming plot exhibited slightly lower soil moisture at the 5 cm and 10 cm depths compared to the other plots during the measurement period, whereas the chemical farming plot recorded the highest soil moisture at the 5 cm depth, with a value of 26.8%.

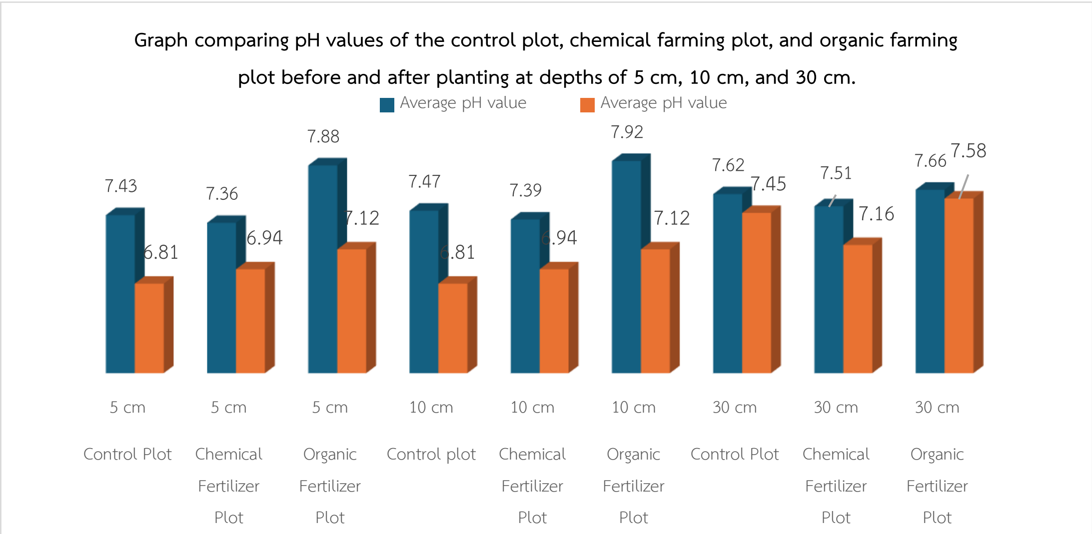
Table 2 Chemical properties and soil fertility of the control plot, chemical farming plot, and organic farming plot before and after planting at depths of 5 cm, 10 cm, and 30 cm.

Depth	agricultural plot	period	pH	Soil fertility		
				Nitrogen (N)	Phosphorus (P)	Potassium (K)
5 cm	Control plot	Before sowing	Neutral	Low	Moderate	Low
		After sowing	Slightly acidic	Very low	Low	Very low
	Chemical Fertilizer Plot	Before sowing	Neutral	Moderate	Moderate	Moderate
		After sowing	Slightly acidic	Low	Low	Very low
	Organic Fertilizer Plot	Before sowing	Neutral	Low	Moderate	Low
		After sowing	Neutral	Very low	Low	Very low
10 cm	Control plot	Before sowing	Neutral	Low	Moderate	Low
		After sowing	Neutral	Very low	Low	Very low
	Chemical Fertilizer Plot	Before sowing	Neutral	Moderate	Moderate	Low
		After sowing	Neutral	Low	Low	Very low
	Organic Fertilizer Plot	Before sowing	Neutral	Low	Moderate	Moderate
		After sowing	Neutral	Very low	Low	Very low
30 cm	Control plot	Before sowing	Neutral	Low	Moderate	Low
		After sowing	Neutral	Very low	Low	Low
	Chemical Fertilizer Plot	Before sowing	Neutral	Moderate	Moderate	Low
		After sowing	Neutral	Low	Low	Very low
	Organic Fertilizer Plot	Before sowing	Neutral	Low	Moderate	Moderate
		After sowing	Neutral	Very low	Low	Very low

From Table 2, it was found that after planting, soil pH at the 5 cm depth in the control and chemical farming plots shifted from neutral to slightly acidic, whereas the organic farming plot was able to maintain a neutral pH at all soil depths. Regarding macronutrients, nitrogen (N) levels in all plots decreased to a very low level after harvest, even in the chemical farming plot where nitrogen had previously been at a moderate level before planting. Phosphorus (P) levels under all management practices declined from moderate to low after the cultivation period. Potassium (K) at the 30 cm depth in the chemical and organic farming plots remained at moderate and low levels, respectively, while the other plots decreased to a very low level.

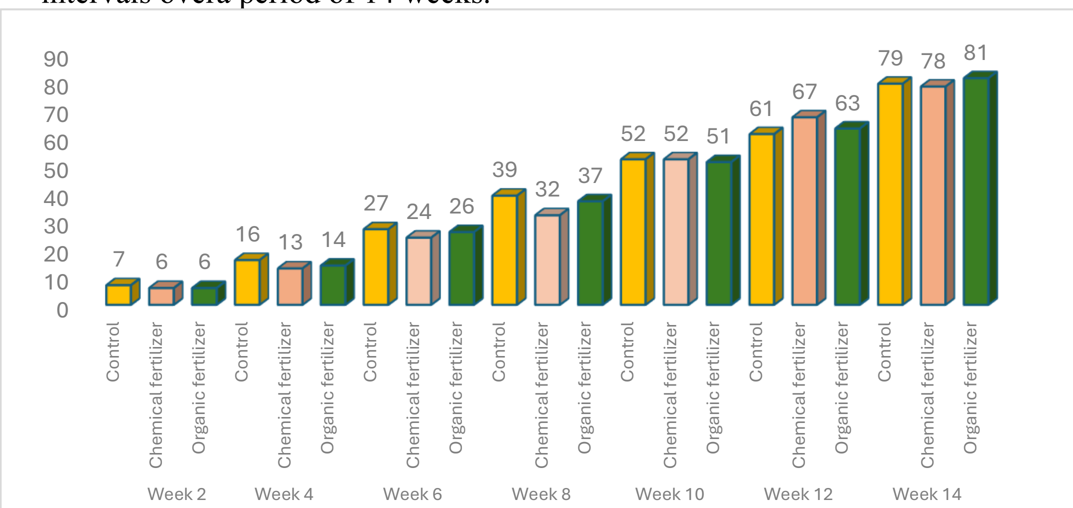
These results indicate that organic farming management is particularly effective in maintaining soil pH balance. Although macronutrient levels declined in accordance with the plant growth cycle, the resulting chemical stability is an important factor supporting the yield quality of roselle (Hibiscus sabdariffa L.).

Figure 3 Illustrates a comparison of soil pH values in the control plot, the chemical farming plot, and the organic farming plot before and after planting at soil depths of 5, 10, and 30 cm.



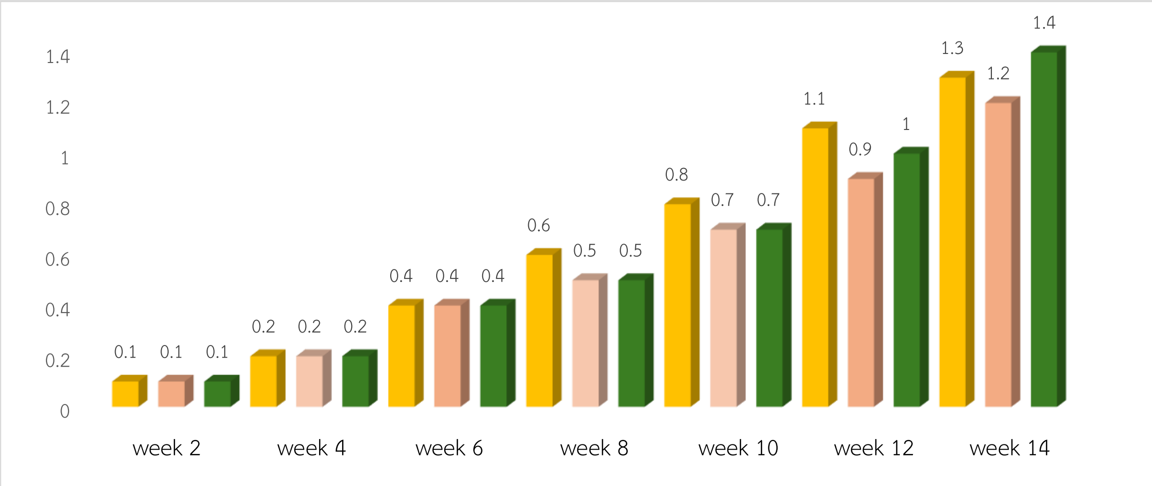
From Figure 3, it was found that before planting, soils in all plots had pH values ranging from 7.36 to 7.92. After planting, soil pH tended to decrease toward neutrality, with values ranging from 6.81 to 7.58. This trend was particularly evident at the 5 cm depth in the control and chemical farming plots, where soils became slightly acidic after planting, whereas the organic farming plot was able to maintain neutral pH values at all soil depths.

Figure 4 shows a comparison of the plant height of Sudan roselle among the control plot, the chemical farming plot, and the organic farming plot, measured at 14-day intervals overa period of 14 weeks.



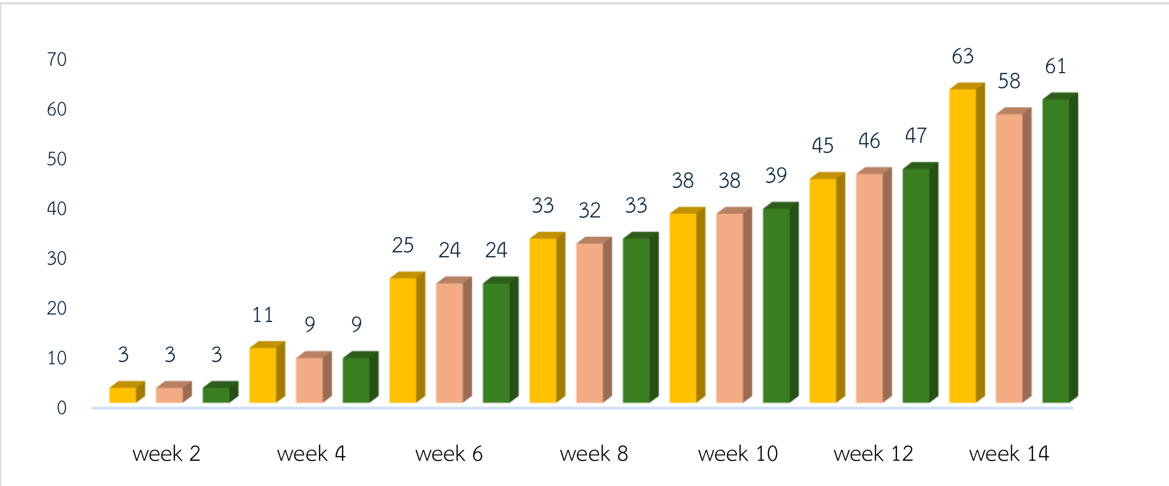
From Figure 4, roselle plants in all plots showed a continuous increase in height from week 2 to week 14. The organic farming plot exhibited the best growth performance, with the highest average plant height of 81 cm at week 14. This was followed by the control plot, with an average height of 79 cm, while the chemical fertilizer plot recorded the lowest average plant height at 78 cm.

Figure 5 presents a comparison of stem diameter (mm) of Sudan roselle in the control plot, the chemical farming plot, and the organic farming plot, measured at 14-day intervals over a period of 14 weeks.



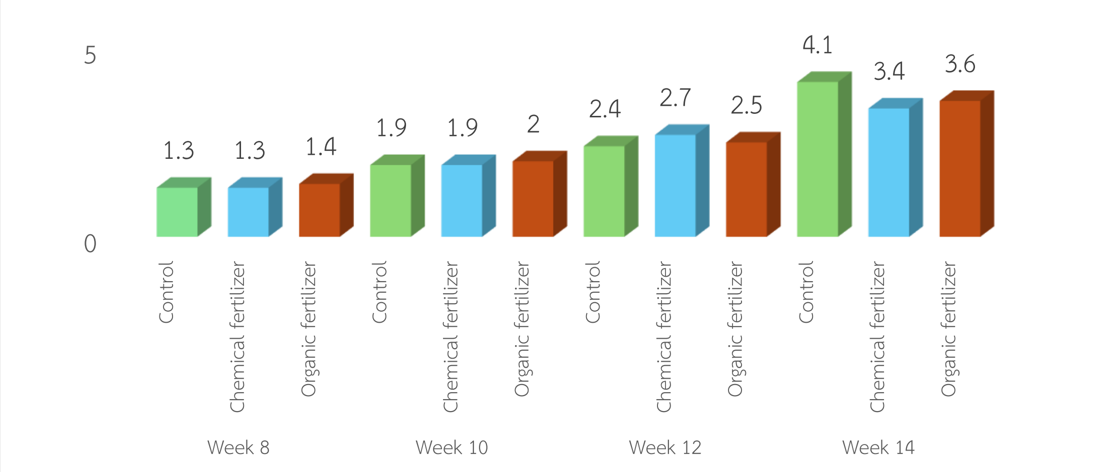
From Figure 5, the organic farming plot exhibited the largest average stem diameter, reaching 1.4 mm at week 14. This result indicates greater structural strength of the plants, which is associated with organic soil management practices.

Figure 6 presents a comparison of the average number of leaves (leaves per plant) of Sudan roselle in the control plot, the chemical farming plot, and the organic farming plot, measured at 14-day intervals over a period of 14 weeks.



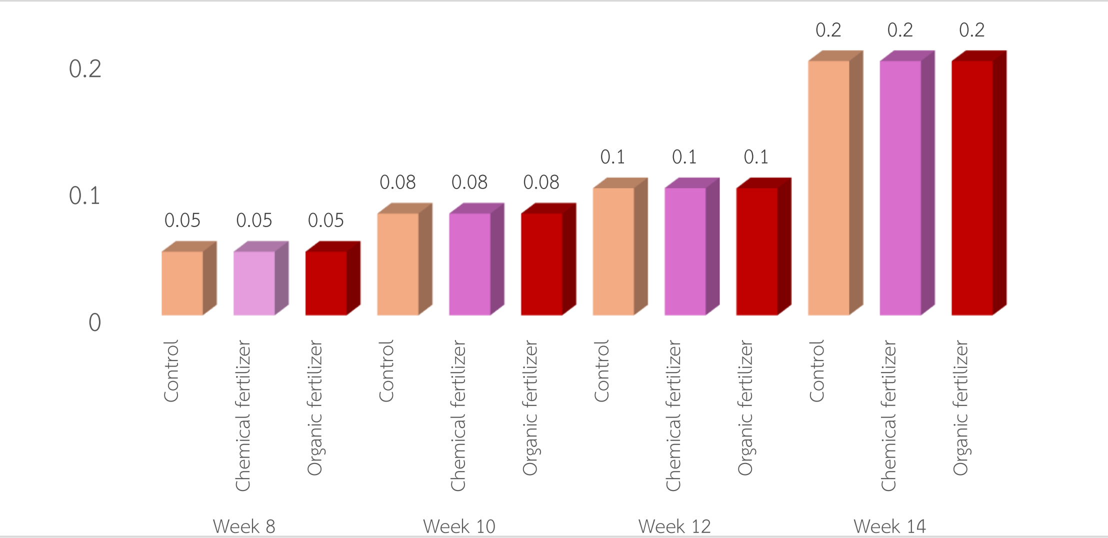
From Figure 6, roselle plants in all plots showed a rapid increase in leaf number from week 6 onward. During weeks 2–4, plants had similar average numbers of leaves, ranging from 3 to 11 leaves, which corresponds to the initial stage of plant height and stem development. The control plot recorded the highest average number of leaves (63 leaves), followed by the organic farming plot (61 leaves), while the chemical farming plot had the lowest average number (58 leaves).

Figure 7 presents a comparison of calyx length (cm) of Sudan roselle from the initial pod-setting stage to the harvest stage, with data collected at 14-day intervals (from week 8 to week 14).



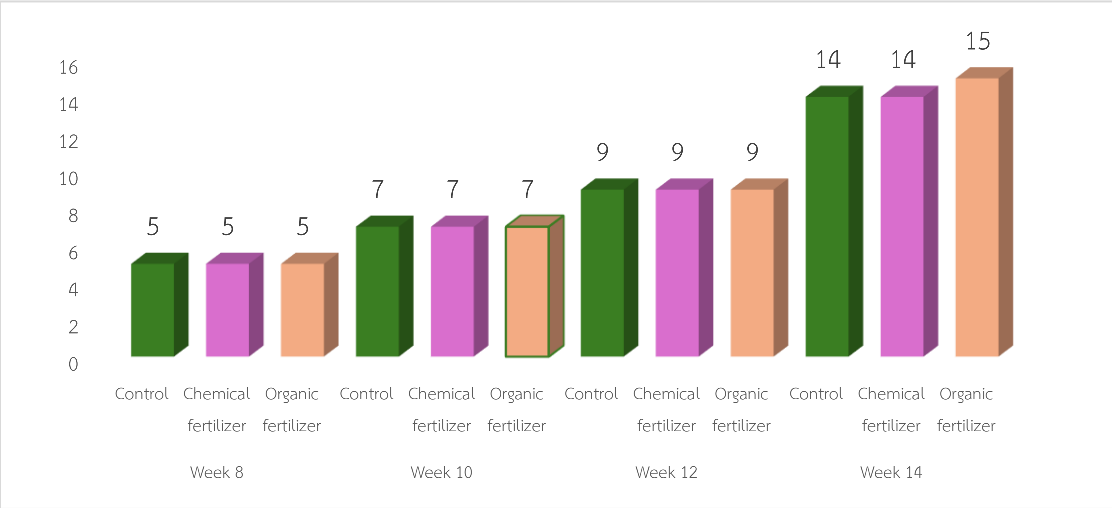
From Figure 7, during weeks 8–10, plants in all plots exhibited similar calyx lengths, ranging from 1.3 to 2.0 cm. However, clear differences emerged during weeks 12–14, which correspond to the nutrient accumulation stage for yield formation. The control plot recorded the highest average calyx length, reaching 4.1 cm, which was markedly higher than that of the organic farming plot (3.6 cm) and the chemical fertilizer plot (3.4 cm).

Figure 8 presents a comparison of the average calyx thickness (mm) of Sudan roselle from the initial pod-setting stage to the harvest stage, with data collected at 14-day



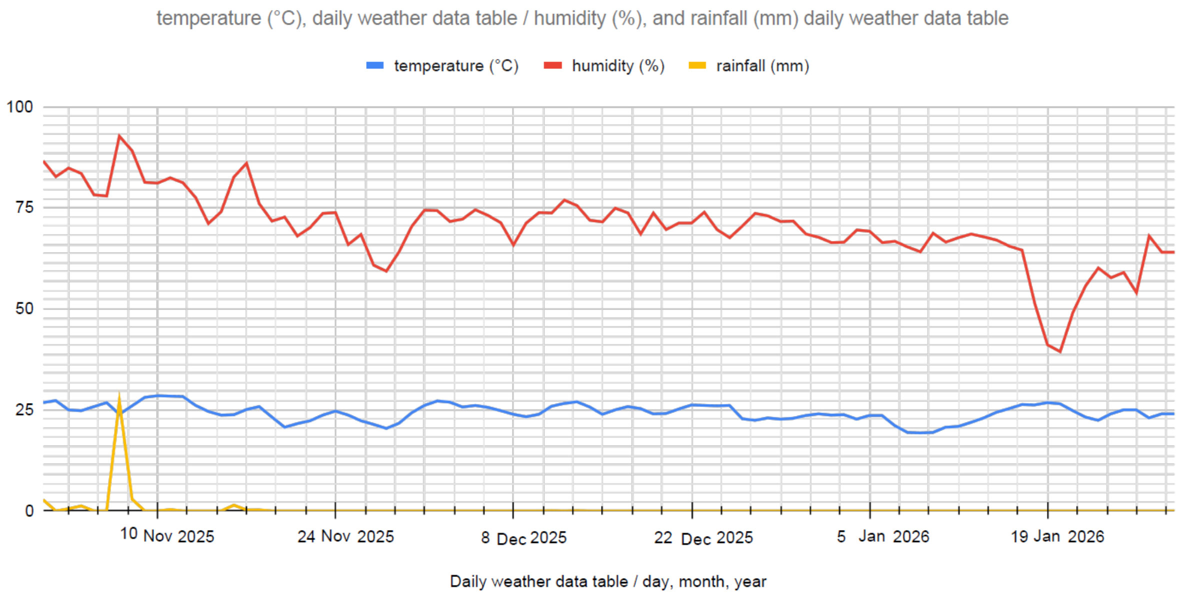
From Figure 8, during week 8, calyx thickness in all experimental plots started at the same initial value of 0.05 mm. The thickness then increased steadily, reaching an average of 0.1 mm by week 12. During weeks 12–14, calyx thickness further increased from 0.1 mm to 0.2 mm under all soil management practices. At week 14, which corresponds to the harvest stage, the control plot, the chemical fertilizer plot, and the organic farming plot all exhibited the same average calyx thickness of 0.2 mm.

Figure 9 presents a comparison of the average number of pods (pods per plant) of Sudan roselle from the initial pod-setting stage to the harvest stage, with data collected at 14-day intervals (from week 8 to week 14).



From Figure 9, during the first 12 weeks of growth, plants under all soil management practices showed a uniform and comparable increase in the average number of pods. Upon reaching the harvest stage, the organic farming plot produced the highest average number of pods, at 15 pods per plant, whereas both the control plot and the chemical fertilizer plot produced the same yield of 14 pods per plant.

Figure 10 presents a comparison of daily climatic conditions, including temperature (°C), relative humidity (%), and rainfall (mm), from 1 November 2025 to 28 January 2026.



From Figure 10, air temperature (°C) varied between 20 and 28 °C, with the lowest temperatures occurring in mid-January 2026 at approximately 20 °C. This period corresponded to the stage of full plant development (weeks 12–14). Relative humidity (%) showed a continuous decreasing trend, declining from 75–90% in November to 60–70% in December, and reaching a minimum of approximately 40% during 19–20 January 2026. Rainfall (mm) was largely absent throughout the study area, consistent with dry-season conditions. Only one heavy rainfall event was recorded in early November (8–9 November), with a maximum rainfall of 25–30 mm; thereafter, no rainfall occurred for the remainder of the study period.

Table 3 Summary of Sudan roselle yield per 1 rai

Study site	Fresh Pod weight (kg/rai)	Dry Pod weight (kg/rai)	Fresh-to-dry ratio	Production Cost	Fresh Pod sales value (THB/rai)	Dry Pod Sales Value (THB/rai)	Profit / Loss
Control plot	152	8	19/1	400	1,520	2,000	1,600
Chemical Fertilizer Plot	285	15	19/1	700	1,425	1,500	800
Organic Fertilizer Plot	228	12	19/1	500	2,280	3,000	2,450

From Table 3, the organic fertilizer plot generated the highest net profit, amounting to 2,550 THB per rai, primarily due to its higher dry yield of 12 kg per rai and the greater sales value of dried pods. In comparison, the control plot achieved a profit of 1,600 THB per rai, while the chemical fertilizer plot yielded the lowest profit at 800 THB per rai.

Research Summary

1. Physical and chemical properties of soil

1.1 Physical properties: Soils in the control, chemical farming, and organic farming plots were classified as sandy clay loam with a granular structure and friable consistency. Post-planting soil temperature was approximately 1 °C higher than pre-planting, corresponding with darker soil color, which enhanced heat absorption.

1.2 Chemical properties: The organic fertilizer plot showed the greatest capacity to maintain a neutral soil pH (7.12), whereas the control and chemical fertilizer plots tended to become slightly acidic in the surface soil layer.

1.3 Soil fertility: After harvest, macronutrients (N–P–K) in all plots declined to very low levels due to plant uptake for yield formation.

2. Plant growth and yield at week 14

Vegetative growth: The organic fertilizer plot exhibited the best performance, with an average plant height of 81 cm and a stem diameter of 1.4 mm. The control plot recorded the highest average number of leaves (63 leaves), followed by the organic fertilizer plot (61 leaves), while the chemical fertilizer plot had the lowest (58 leaves). Average calyx thickness at harvest was identical across all soil management practices (0.2 mm), indicating that soil factors did not influence calyx tissue thickness at the final developmental stage.

3. Yield quantity and quality

The organic fertilizer plot produced the highest average number of pods (15 pods per plant). The control plot achieved the greatest average calyx length (4.1 cm) and the highest leaf number (63 leaves). Calyx thickness in all plots developed equally to 0.2 mm at harvest.

4. Climatic conditions: air temperature, relative humidity, and rainfall

4.1 Climatic effects on plant development: Throughout the study period (November 2025–January 2026), climatic conditions directly influenced plant development at different stages. During weeks 2–10, relatively stable air temperatures (20–28 °C) promoted continuous increases in plant height and stem size. During the pod-setting stage (weeks 12–14) in mid-January 2026, air temperature decreased to an average of 20 °C, accompanied by a decline in relative humidity to approximately 40%, creating dry conditions that stimulated accelerated assimilate accumulation for reproductive development. This resulted in an increase in calyx thickness from 0.1 mm to 0.2 mm across all plots and enhanced pod setting, particularly in the organic farming plot, which produced 15 pods per plant.

4.2 Rainfall and soil water management: Rainfall was a limiting natural factor, as the study area experienced almost no rainfall, with only one event in early November (25–30 mm). Consequently, plants relied on moisture retained in post-harvest paddy soils. The organic fertilizer plot maintained a cooler soil temperature at the 5 cm depth (31 °C) compared with other plots under extremely dry atmospheric conditions, supporting appropriate transpiration rates and maintaining plant vigor.

Overall, the successful cultivation of roselle in post-harvest paddy fields resulted from the interaction between cool, dry climatic conditions and effective soil management. Organic soil management proved to be the most suitable approach for coping with climatic variability, as it reduced heat stress and maintained neutral soil pH, thereby promoting healthy plant growth and achieving the highest pod production.

Discussion

From the study of the relationship between soil properties and the growth and yield quality of Sudan roselle cultivated in Phak Mai Subdistrict, Sisaket Province, the key discussion points can be summarized as follows.

1. Effects of soil management on plant growth and chemical properties

Organic soil management had the most positive effect on plant structural development, as evidenced by the greatest plant height (81 cm) and stem diameter (1.4 mm), which were clearly higher than those observed in the other plots. This can be attributed to the ability of organic fertilizers to maintain soil pH at a neutral level (pH 7.12) and to stabilize surface soil temperature, keeping it cooler than in other plots (31 °C). These conditions enhance nutrient uptake efficiency compared with chemical fertilizer plots, which tended to induce slight acidity in the surface soil layer.

2. Plant adaptation to climatic conditions

Climatic conditions during the final phase of the study, characterized by very low relative humidity (as low as 40%) and cool air temperatures (approximately 20 °C), acted as important natural stimuli. Under these conditions, plants in all plots exhibited increased calyx thickness, reaching 0.2 mm at harvest. This response is consistent with plant behavior that accelerates reproductive development to ensure species survival under dry conditions. In addition, the control plot developed the highest number of leaves (63 leaves), increasing leaf surface area for photosynthesis to compensate for very low soil nutrient availability. This adaptation contributed to the production of the longest calyx length, reaching up to 4.1 cm.

3. Economic relationships and sustainability

Organic management produced the most vigorous plants and the highest number of pods per plant (15 pods per plant), resulting in the highest net profit of 2,550 THB per rai. This outcome was primarily due to lower production costs and an appropriate proportion of dry yield. Furthermore, considering the chemical soil properties indicating acidification in the chemical fertilizer plot, organic management represents a more sustainable option for maintaining long-term soil health in post-harvest paddy fields. The organic fertilizer plot was therefore the most cost-effective management system, generating higher profits despite producing a lower total yield than the chemical fertilizer plot. In contrast, the chemical fertilizer plot incurred the highest production costs but yielded the lowest profit due to lower unit selling prices.

Recommendations

1. Recommendations for practical application

1. Farmer extension: Farmers in post-harvest paddy fields should be encouraged to adopt organic fertilizer management, as it provides the highest net profit while helping to maintain soil pH balance.

2. Moisture management: During January, when extremely dry conditions prevail, the use of mulching materials is recommended to conserve soil moisture and prevent excessive increases in surface soil temperature.

2. Recommendations for future research

3. Long-term monitoring of changes in soil structure and the abundance of beneficial soil microorganisms should be conducted following continuous application of organic fertilizers over multiple growing seasons.

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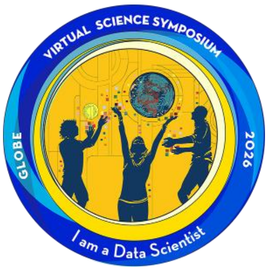
Badges

I AM AN EARTH SYSTEM SCIENTIST

This research reflects an Earth System Science approach by studying the relationship between the Lithosphere (soil) and the Biosphere (plant growth). Instead of only tracking how the Roselle plants grew, we used GLOBE Protocols to analyze physical and chemical soil properties in detail. We aimed to explain how different soil management styles—organic and chemical—affect the yield of Roselle. By connecting data from different systems, we gained a clear scientific understanding of how the ecosystem in post-harvest rice fields works as a whole.

I AM A DATA SCIENTIST



This research applied systematic data science skills, starting from standardized data collection using GLOBE Data Entry to the analysis of both quantitative and qualitative data. We managed a structured dataset by tracking the growth of individual plants, each identified with a unique code, every 14 days. Additionally, we converted physical harvest results into digital data by using the Color Grab application to compare color values between organic and chemical plots. By organizing the data step-by-step and presenting it through comparative graphs, this study provides clear conclusions backed by strong empirical evidence.

I AM A COLLABORATOR

This research succeeded through close collaboration between students from Phakmaiwittayanukul School and local farmers in Phakmai Subdistrict. We worked together to survey and conduct experiments in actual rice fields. Within our team, roles were clearly assigned based on individual strengths, including soil sampling, field maintenance, and yield analysis. This collaboration not only provided data that reflects real local conditions but also bridged the gap between school knowledge and the community. By working with the farmers, we helped promote sustainable agricultural development for post-harvest rice fields in our hometown.