Research Title	**Assessment of Soil Quality and Microplastic Contamination in Paddy Fields of Na Muen Sri and Khok Saba Subdistricts, Nayong District, Trang Province, Thailand**

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Abstract

This study aimed to assess soil quality and microplastic contamination in paddy soils of Na Muen Sri Subdistrict and Khok Saba Subdistrict. Soil samples were collected from rice fields and analyzed for chemical and physical properties, including macronutrient contents (nitrogen, phosphorus, and potassium), soil pH, moisture content, and light availability in soil. Microplastic contamination in the soil was also examined using particle separation and screening methods.

The results showed that paddy soils in both study areas contained low to very low levels of nitrogen and phosphorus, while potassium levels differed between the two sites. Soils from Khok Saba Subdistrict exhibited higher potassium levels than those from Nam Muen Sri Subdistrict. Soil pH values ranged from 6 to 8 and varied between the study areas. Microplastics were detected in paddy soils from both subdistricts, with a higher number of microplastic particles observed in Khok Saba Subdistrict. In contrast, no microplastic contamination was detected in some plots in Na Muen Sri Subdistrict. The microplastics identified were predominantly fibers and irregularly shaped fragments.

These findings highlight spatial variations in soil quality and microplastic contamination in paddy fields. The results provide baseline information for future monitoring of soil quality changes and for the development of sustainable agricultural land management strategies.

Keywords: Microplastics, Soil quality

Introduction

Paddy fields play a crucial role in food security and the livelihoods of communities in Thailand, particularly in rural areas where rice farming remains a primary source of income. Paddy soil is a fundamental resource that directly influences rice growth, as it serves as a reservoir of nutrients and water and provides a habitat for soil microorganisms that play key roles in nutrient cycling processes. Suitable soil quality enhances nutrient uptake by plants, improves growth efficiency, and ultimately affects rice yield in the long term (FAO, 2017; Brady & Weil, 2016). However, continuous land use combined with intensive agricultural practices may lead to soil degradation in both physical and chemical properties. Therefore, assessing soil quality in paddy fields is essential to provide baseline information for appropriate and sustainable soil management.

Soil quality assessment reflects soil fertility and suitability for plant growth. The primary macronutrients—nitrogen (N), phosphorus (P), and potassium (K)—are essential for plant growth processes, including stem and root development and yield formation in rice. Deficiencies or excesses of these nutrients can result in reduced yields and soil quality deterioration (FAO, 2008). In addition, soil pH is a key factor controlling nutrient solubility and availability for plant uptake, while soil moisture is directly related to water absorption, root respiration, and soil microbial activity (Brady & Weil, 2016). Although light reaching the soil surface is not a direct soil property, it influences soil surface temperature, water evaporation, and environmental conditions that affect soil biota activity. Evaluating these variables collectively provides a systematic reflection of paddy soil quality and aligns with principles of agricultural soil resource assessment.

In addition to soil quality assessment, which is a fundamental factor for agricultural production, soils are increasingly facing contamination by emerging pollutants, particularly microplastics. Microplastics are plastic particles smaller than 5 millimeters that can persist and accumulate in the environment over long periods. Scientific studies have reported the presence of microplastics in agricultural soils, where they may alter soil physical properties such as structure, porosity, and water-holding capacity, as well as potentially disrupt soil microbial activity and nutrient cycling processes (Rillig, 2017; de Souza Machado et al., 2019). Paddy soils, which form the foundation of national food production, may therefore be vulnerable to microplastic accumulation from agricultural activities and surrounding environmental sources. However, information on microplastic contamination in paddy soils at the local scale in Thailand remains limited. This study is thus important for assessing microplastic contamination alongside soil quality evaluation, providing baseline data to support sustainable soil management and rice production in the future.

Research Question

What are the soil quality characteristics of paddy soils in Na Muen Sri Subdistrict and Khok Saba Subdistrict in terms of macronutrient contents, soil pH, moisture, and the extent of microplastic contamination.

Research Hypothesis

Paddy soils in Na Muen Sri Subdistrict and Khok Saba Subdistrict differ in soil quality and levels of microplastic contamination.

Materials and Methods

1. Soil Property Analysis in the Study Areas

1.1 Materials and Equipment

1.Test tubes
2.Soil test kit for NPK and soil pH (HI3895 Quick Soil Test Kit)
3.Glass stirring rods
4.Beakers
5.Needle-type soil meter (Richmot brand)

1.2 Methods

1. Selection of study sites: The study sites were identified in Khok Saba Subdistrict and Na Muen Sri Subdistrict. Two sampling areas were selected in each subdistrict.




2.Preparation of soil–water suspension: A soil–water suspension was prepared by mixing 1.5 measuring cups of soil with 8 measuring cups of distilled water. The mixture was gently stirred or shaken for at least 1 minute and then allowed to stand until the soil particles settled.

3.Nitrogen (NO_2) analysis Using a pipette, 2.5 mL of the clear supernatant soil extract was transferred into a clean test tube. One sachet of HI3895N-0 reagent for nitrogen testing was added. The tube was capped and shaken for approximately 30 seconds to dissolve the reagent. After standing for 30 seconds, the resulting pink color was compared with the nitrogen color chart to determine nitrogen concentration.

4.Phosphorus (P_2O_3) analysis: A volume of 2.5 mL of the clear supernatant soil extract was pipetted into a clean test tube. One sachet of HI3895P-0 reagent was added, and the tube was capped and shaken for approximately 30 seconds until the reagent dissolved. The blue color developed was compared with the phosphorus color chart to determine phosphorus concentration.

5.Potassium (K_2O) analysis: A volume of 0.5 mL of the clear supernatant soil extract was added to a clean test tube. Distilled water was then added up to the lower volume mark (2.5 mL). One sachet of HI3895K-0 potassium reagent was added, and the tube was capped and shaken for approximately 30 seconds. A blue color developed, and turbidity was compared with the K_2O reading chart to determine potassium concentration.

6.Measurement of soil pH, moisture, and light intensity: A needle-type soil meter (Richmot brand) was inserted vertically into the soil to a depth of 10 cm. Soil pH, moisture content, and light intensity at the soil surface were recorded.

2. Microplastic Analysis in Soil Samples

2.1 Materials and Equipment

1.Aluminum foil

2.Stainless steel trays

3.Analytical balance

4.Beakers

5.Sodium chloride (NaCl)

6.GF/C glass fiber filter paper (47 μm pore size)

7.Hydrogen peroxide (H_2O_2)

8.Hot air oven

9.Stereo microscope

2.2 Methods

Microplastic analysis was conducted following a modified protocol based on Khrismas Phatthanasirinanon and Jariyavadee Suriyaphan (2021), as described below.

1.Sample collection: Soil samples (1 kg each) were collected and wrapped tightly in aluminum foil. Sampling locations were clearly labeled. Three replicates were collected per sampling point, resulting in a total of 12 samples.

2.Sample preparation: The collected soil samples were spread evenly on stainless steel trays and dried in a hot air oven until completely dry. The dried soil was then sieved through a 0.425 mm mesh sieve.

3.Density separation and organic matter digestion: A total of 300 g of the sieved soil was weighed and transferred into a 1,000 mL beaker. Subsequently, 300 mL of 5 M sodium chloride (NaCl) solution was added. The mixture was stirred thoroughly, covered with aluminum foil, and allowed to settle. The supernatant was filtered, and the retained material was transferred into a 250 mL Erlenmeyer flask. Hydrogen peroxide (H_2O_2, 30%) was then added in 20 mL increments until organic matter in the sample was completely digested.

4.Filtration and microscopic analysis: The treated sample solution was filtered through pre-weighed GF/C glass fiber filter paper (47 μm pore size) using a vacuum filtration system. The filter papers were subsequently dried in a hot air oven at 60 °C for 24 hours. After drying, the filters were examined under a stereo microscope to identify and count microplastic particles. Microplastics were photographed, and all observations were recorded.

Results

1. Soil Quality in the Study Areas

The results of soil quality analysis revealed variations in macronutrient levels and physical properties among the four study sites. Nitrogen was predominantly detected at trace levels in almost all areas, except for Na Muen Sri Subdistrict 1, where nitrogen was found at a low level. Phosphorus (P) was generally present at trace levels, with only Khok Saba Subdistrict 2 showing a low level. Potassium (K) exhibited greater variability, ranging from low to high levels. The highest potassium level was observed in Khok Saba Subdistrict 2, whereas Na Muen Sri Subdistrict 1 showed the lowest potassium level.

Soil pH values ranged from 6 to 8, indicating neutral to slightly alkaline conditions. Khok Saba Subdistrict 1 exhibited the highest pH value, while Na Muen Sri Subdistrict 2 showed the lowest pH value, reflecting differences in soil chemical conditions among the study areas.

Regarding physical properties, soil moisture content varied markedly across the sites. Khok Saba Subdistrict 1 exhibited the lowest soil moisture, whereas Na Muen Sri Subdistrict 1 and Na Muen Sri Subdistrict 2 showed relatively higher moisture levels. In addition, soil light intensity ranged from 200 to 2,000 units, with the highest values recorded in Khok Saba Subdistrict 2 and Na Muen Sri Subdistrict 1. These findings reflect spatial differences in the physical environmental conditions of the soils across the study areas, as summarized in Table 1.

Table 1 Result of soil properties in the study area

Area	Nitrogen (N)	Phosphorus (P)	Potassium (K)	pH	Soil moisture	Soil light intensity
Khok Saba 1	trace	trace	medium	8	1	200
Khok Saba 2	trace	low	high	7	8	2000
Na Muen Sri 1	low	trace	Low	7	9	2000
Na Muen Sri 2	trace	trace	Medium	6	3	1000

2. Microplastic Contamination in Soil Samples

The results of microplastic analysis in paddy soils from the study areas revealed the presence of particles consistent with microplastics in both Khok Saba Subdistrict and Na Muen Sri Subdistrict when examined under a stereo microscope. Particles with morphologies distinct from typical soil particles were observed, including spherical particles and irregularly shaped fragments.

When analyzed by site, soil from Khok Saba Subdistrict 1 contained nine suspected microplastic particles, while Khok Saba Subdistrict 2 contained five particles. In the Na Muen Sri Subdistrict, microplastics were detected in both sampling plots; however, no microplastic particles were detected in Na Muen Sri Subdistrict 1, whereas four particles were detected in Na Muen Sri Subdistrict 2. Furthermore, microscopic images indicated that the detected particles varied in size, shape, and color among the study areas, reflecting the diversity of microplastics present in the paddy soils.

These findings demonstrate spatial variation in microplastic contamination across the study areas. While no contamination was detected in some sites, microplastic particles were clearly observed in others, as summarized in Table 2.

Table 2 Results of microplastic detection in soil in the study area

Area	Amount (pieces)	Example Images
Khok Saba 1	9	  

Area	Amount (pieces)	Example Images
Khok Saba 2	3	  
Na Muen Sri 1	0	-
Na Muen Sri 2	4	 

Conclusion and Discussion

The results of this study indicate that paddy soil quality in Khok Saba Subdistrict and Na Muen Sri Subdistrict differed in both chemical and physical properties. Soils in all study areas exhibited low to very low levels of nitrogen and phosphorus, which is consistent with the characteristics of paddy soils subjected to long-term and continuous cultivation. Such conditions often lead to nutrient depletion through plant uptake and nutrient loss from the soil system (Brady & Weil, 2016; FAO, 2008). In contrast, potassium levels varied among the study areas, with Khok Saba Subdistrict 2 exhibiting high potassium levels, while Na Muen Sri Subdistrict 1 showed low levels. This variation suggests that differences in soil management practices or inherent soil characteristics may influence nutrient accumulation in each area.

Soil pH values in the study areas ranged from 6 to 8, with soils in Khok Saba Subdistrict exhibiting higher pH values than those in Na Muen Sri Subdistrict. Such differences in soil pH may affect nutrient solubility and availability for plant uptake, as well as soil microbial activity (Brady & Weil, 2016). This interpretation is supported by the present findings, which showed that areas with different pH levels also exhibited variations in certain nutrient levels. Furthermore, differences in soil moisture content and light intensity among the study sites reflect variations in paddy field environments, such as water management and exposure to sunlight, both of which influence biological processes in soils (FAO, 2017).

Regarding microplastic contamination, particles consistent with microplastics were detected in paddy soils from both Khok Saba Subdistrict and Na Muen Sri Subdistrict, although the abundance varied across sites. Khok Saba Subdistrict exhibited a higher number of detected particles, whereas no contamination was observed in some sites within Na Muen Sri Subdistrict. These findings align with the concept that microplastic accumulation in agricultural soils is spatially heterogeneous and strongly influenced by local land-use practices and human activities (Rillig, 2017). The detected microplastics exhibited considerable variation in shape and size, consistent with the findings of de Souza Machado et al. (2019), who reported that soil microplastics originate from diverse sources and accumulate in multiple forms. Although the levels of microplastic contamination observed in this study were relatively low, their presence represents an early indication of pollutant accumulation in paddy soils, highlighting the need for continued monitoring and long-term studies.

Recommendations

1.Continuous and more extensive studies on microplastic contamination in paddy soils should be conducted to better assess spatial trends in microplastic accumulation and to enable clearer comparisons among different agricultural areas.

2.Appropriate paddy soil management practices should be promoted, such as the application of organic amendments and balanced fertilizer use, to restore soil quality and reduce the long-term risks associated with soil degradation.

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Globe Data Entry

Soil pH

Measured Date:	2026-01-21
Organization Name:	Sawat Rattanapimuk
Site ID:	409469
Site Name:	Na Muen Si
Country Name:	Thailand
Country Code:	THA
Latitude:	7.58372
Longitude:	99.66726
Elevation:	20.2m
Collected On:	2026-01-21T00:00:00
pH:	6
Horizon Top Depth:	0 cm
Horizon Bottom Depth:	10 cm
Horizon Number:	1
Reference Depth Level5cm:	true
Reference Depth Level10cm:	true
Ph Method:	meter
Comments:	