OPEN ACCESS Freely available online

Journal of Plant Biochemistry & Physiology

Research Article

Research and Development of Soil Salinity with Local Different Organic Materials for Agriculture

Somsanguan Passago1[*], Sapphasit Kaewhaob[1], Chedchai Sombatyotac[1], Wannapa Leamsingkornd[1], Jurairat Kurukode[1]

[1]*Department of Environmental Science, Faculty of Science and Technology, Rajabhat Maha Sarakham University, Maha Sarakham, Thailand*

ABSTRACT

Solving problems with the true soil differentiated variables for improvement at local organic materials; rice husk, cow hung, rice straw and mixed of four soil conversions as experimental variables, and the 1st controlling variable with original soil. Using the Africa Sesbania Rostrata, fresh fertilizer growth plant was randomized, and suitability parameters; pH, EC, soil salinity, organic matter, nitrogen, phosphorous, and potassium mineral qualities in before and after 60 days. The four material treatments indicated that the plants grew suitability color like dark brown; the rice husks are improved on pH value was near the most neutral (6.57); the EC has 544.00 μs/cm; soil salinity as 5.44 ds/m; organic matter (2.09%); and nitrogen mineral (0.68%). The cow dung has the most beneficial phosphorus (37.89 ppm) and potassium (754.05 ppm). The consistent soil properties relevant and protection suitability with research and development of soil salinity for agriculture in Nongbor reservoir area, differently.

Keywords: Research and development, soil salinity, soil suitable agriculture, soil parameters, soil improvement, fresh plant fertilization, experimental research method

INTRODUCTION

Thailand location, a comprising an area of 514,000 km2 in Southeast Asia, Thailand extends almost two-thirds down the Malay Peninsula. It is bordered on the North East and East by Laos, on the South East by Cambodia and the Gulf of Thailand (formerly the Gulf of Siam), on the South by Malaysia, on the South West by the Andaman Sea, and on the West and North West by Myanmar, with a total boundary length of 8,082 km. Thailand has a tropical climate. For much of the country there are three distinct seasons: the summer season, from March through May; the rainy or wet monsoon, June to October; and the winter season, November through February (International Trade Center, 2012). As organic agriculture becomes more popular in Thailand, several organizations working on organic production have emerged. GreenNet and Earth Net Foundation were founded in 1993 and is now one of the leading organizations with an instrumental role in organic conversion. A national private certification body, the Organic Agriculture Certification Thailand (ACT) founded in 1995 was also set up to provide professional organic certification services for all farm production as well as processing and handling operations (Poapongsakorn & Chokesomritpol, 2017). Agriculture in Thailand is highly competitive, diversified and specialized and its exports are very successful internationally. Agricultural production as a whole accounts for an estimated 9-10.5 percent of Thai GDP. Forty percent of the populations work in agriculture-related jobs. The farmland they work was valued at US$2,945 per rai (0.395 acre; 0.16 ha) in 2013. Most Thai farmers own fewer than eight hectares (50 rai) of land (Piesse, 2017).

Rice is the country's most important crop, with some 60 percent of Thailand's 13 million farmers growing it is on fully half of Thailand's cultivated land. Thailand is a major exporter in the world rice market. Rice exports in 2014 amounted to 1.3 percent of GDP (Bangkok Post, 2017). Rice is the major crop grown and Thailand is the world's biggest rice exporter. Other crops grown in the country include: rubber, sugarcane, cassava, fruit, cashew nuts, corn, tobacco, cotton, cocoa, peanuts, soybeans, medical

[*]**Corresponding to:** Passago S, Department of Environmental Science, Faculty of Science and Technology, Rajabhat Maha Sarakham University, Maha Sarakham, Thailand; Tel: 66892773645; Email: somsanguan_c@yahoo.com

Received date: Aug 12, 2019; **Accepted date:** September 16, 2021; **Published date:** September25, 2021

Citation: Passago S, Kaewhaob S, Sombatyotac C, Leamsingkornd W, Kurukode J (2021) Research and Development of Soil Salinity with Local Different Organic Materials for Agriculture. J Plant Biochem Physiol 9:p773.

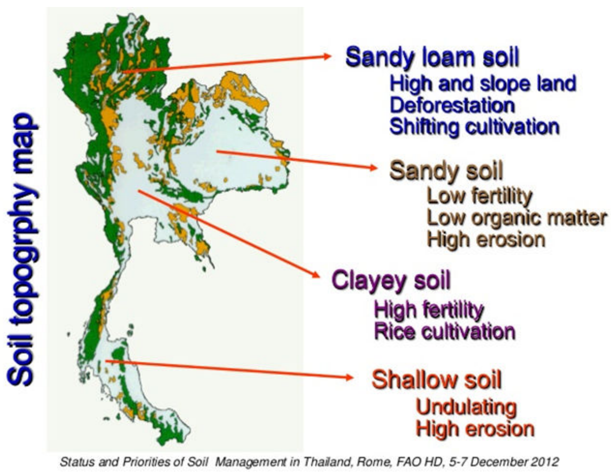
plants, dairy, and fishery products. Fresh flowers, especially orchids, are important exports. The land use is divided as follows: arable land 27%, permanent crops 7%, other 65% (Food and Agriculture Organization of the United State, 2011). Soils throughout most of the country are of low fertility, largely as a result of leaching by heavy rainfall. Differences between the various soil types are the result of differences in parent rock material, variations in the amount of rainfall, length of wet and dry seasons, type of vegetable cover, and other natural factors. In general, stony and shallow soils characterize the hill and mountain terrain of the North. Large portions of this mountainous area were traditionally used by hill peoples for shifting cultivation. The Lua (also called Lawa) and Karen cultivated for short periods, and then permitted the land to lie fallow for long periods, which allowed forest re-growth and restoration of soil fertility.

Soil is one of the most important natural resources for human life. Because most people use soil for agriculture whereas agriculture in Thailand is highly competitive, diversified and specialized and its exports are very successful internationally (Yuwaniyom, 2003). Soil consists of a solid phase of minerals and organic matter (the soil matrix), as well as a porous phase that holds gases (the soil atmosphere) and water (the soil solution) (Chesworth, 2008). Accordingly, soils are often treated as a three-state system of solids, liquids, and gases. Therefore, if the soil is lost, decay until the soil lacks the abundance of essential minerals for plant growth inevitably affects agriculture; the deterioration of the soil is caused by several reasons, such as caused by direct human actions, planting only one plant in the same area, lack of soil maintenance, deforestation in order to obtain a plantation area that causes soil erosion (McCarthy, 2006). In addition, it is caused by the nature itself that causes soil deterioration, such as the action of wind, rain water, temperature or deteriorated soil itself, with the internal elements of the soil itself, such as acid soil, saline soil etc. Saline soil is one of the causes that affect agriculture causing the soil in that area to not be able to grow crops or can grow plants, but the yield may be low until not cost-effective in production (Passage et al., 2012). Soil has four important functions: it is a medium for plant growth; a means of water storage, supply and purification; a modifier of Earth's atmosphere; a habitat for organisms; all of which, in turn, modify the soil. (Danoff-Burg, 2017).

In Thailand, we can found this kind of soil in wide vicinity, both in lowland and highland, especially in not frequent rainy zone that the humidity between the rainy and dry seasons is concisely different. The soil feature is brown or brownish red but it is possibly to be found in yellow, red dark or gray. The soil mass texture appears in many types but the important feature, it must show the nature of accumulation of clay particles in the criteria being Argillic sub-layer in the soil sub-base layer. The order or suborder classification is hardly used; the mostly used classification is the great soil group and downward (Thai Land Development Department, 2013). Northeast Thailand is a square shaped plateau almost completely surrounded by mountain ranges and divided into two basins (Khorat Basin, Sakon Nakon Basin) by a relatively small mountain range. Most of the arable soils in Northeast Thailand are sandy, acidic and infertile. Their primary and secondary minerals are mainly quartz and kaolinite. This is because their parent materials are highly weathered. These infertile soils are liable to be degraded by human activities. In this sense, these soils can be said to be typical tropical sandy soils (Wada, 2011).

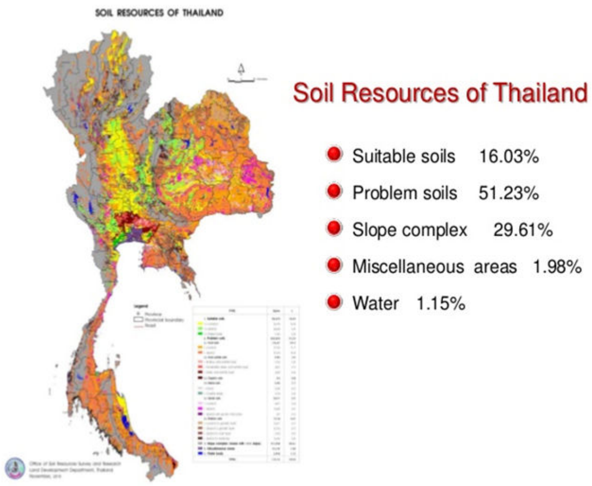
The destruction of natural vegetation to make room for cultivation, the soil organic matter is low resulting in low Cation Exchange Capacity (CEC) and low pH value. Amelioration of these soils requires liming, fertilization and application of organic matter and 2:1 type clay minerals. Each of these ameliorating techniques encounters respective problems. Rather many farmers are using animal dung as an organic fertilizer for cash crops and/or rice seedlings. Traditionally, they transplant rice seedlings when the paddy field is sufficiently flooded without fear of drought. Under these circumstances, most of the farmers are very poor, eager to get cash income by working away from home and have not enough experience and knowledge to utilize high technologies (Figure 1).

Figure1: Map of the status and properties of soil management in Thailand **Source:** Potichan (2013)



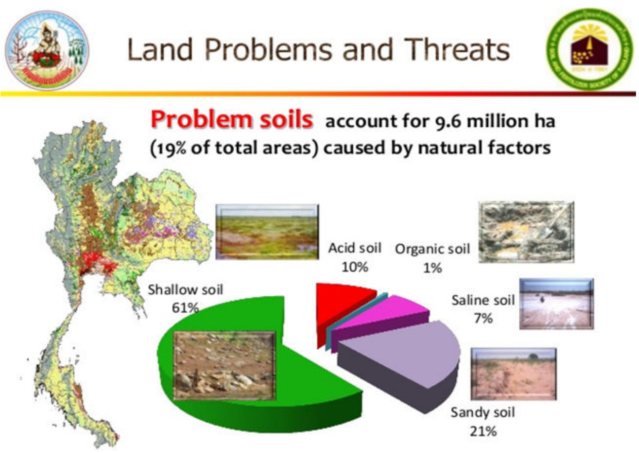
Accordingly, ameliorating technologies acceptable to the farmers must be cheap, simple and profitable. If technologies are really appealing to farmers they will adopt them without any effort of extension. Elevations inside the undulating region are conventionally classified into high, middle and low terraces according to their relative height (Moorman et al. 1964). Inside the salt-affected area, these terraces are differently affected with salt. Salt affects only the foot of high terrace, from the top to the foot of middle terrace and from the top till the foot of the low terrace. In addition, narrow low ground amongst these terraces is often salt-affected. Small salty mounds called Nam Dun in Thai are distributed mainly at the top of the middle terrace. Salt of Nam Dun appears to move downward along the slope (Wada, 2011). Based on these facts and other information, the following tentative theory was proposed for salinization in Northeast Thailand (Khoyama & Subhasaram, 1993), especially in the plateau reservoir area, Borabue District, Maha Sarakham Province (Figure 2).

Figure 2: Map of soil resources of Thailand **Source:** Limtong (2012)



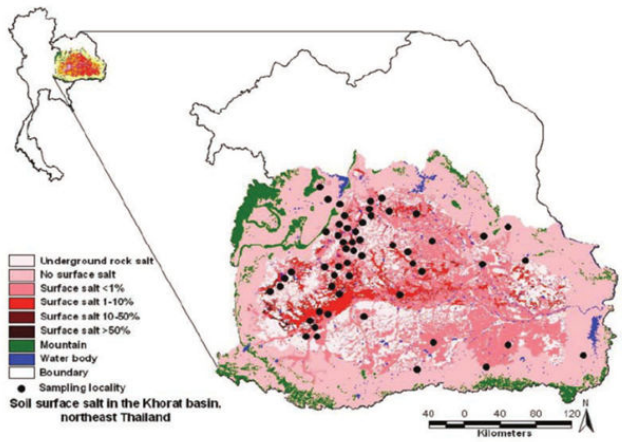
Salinity is one of the most brutal environmental factors limiting the productivity of crop plants because most of the crop plants are sensitive to salinity caused by high concentrations of salts in the soil, and the area of land affected by it is increasing day by day. For all important crops, average yields are only a fraction – somewhere between 20% and 50% of record yields; these losses are mostly due to drought and high soil salinity, environmental conditions which will worsen in many regions because of global climate change. A wide range of adaptations and mitigation strategies are required to cope with such impacts. Efficient resource management and crop/livestock improvement for evolving better breeds can help to overcome salinity stress (Shrivastava & Kumar, 2015). However, Soil salinity problems are common in Thailand, which is found as saline soil in the seashore area, central region, and northeast region but these found that the most problem is in the northeastern, which has soil salinity area, representing 17 percent of the total area. Therefore, saline soil problems are a major obstacle to the development of the northeastern region with a soil salinity area of approximately 17.81 million rai and the soil that has the opportunity to become soil salinity for approximately 19.40 million rai (Passago et al., 2012) (Figure 3).

Figure 3: Graphic of problem soils in Thailand **Sources:** Hongprayoon et al (2015)



Low soil fertility, poor soil materials, uncertainty of climate and natural disasters are the main factors reported to reduce agricultural productivity. One prevalent natural disaster in this region is salinity. Saline land is usually barren, for crops cannot tolerate the high salt content of the sub-soil or, sometimes, the surface soil. Certain weeds are tolerant to salinity and are used as salt-indicators: these include the small water sources, branches of the river of Chi-Mun basins. Every year the acreage of saline soils is increasing and causing major problems for farmers in managing the land. During April and May, saline areas in the central and northern part of Northeast Thailand were investigated. These were classified into three major types on the basis of their topographic and geologic settings: hill, valley, and basin. A major source of salt wherever it is exposed or lies close to the surface is the Rock Salt Member of the Maha Sarakham Formation, which consists mainly of rock salts. There are, however, other potential salt-sources that were formerly classified as salt-free strata (Figure 4).

Figure 4: Map of the Northeast Thailand showing 56 sampling localities **Source:** Suwannatrai et al (2011)



These are the Upper Classic Member of the Maha Sarakham Formation and the Plio-Pleistocene Formation, which have recently been reported to contain traces of salts such as gypsum, sulfate, and carbonate, which replace halite. The mechanism of salinization in this region is short-distance interflow of brine in source layers together with capillary rise. Interflow is of short distance because many of the scattered hillocks of the region are underlain by the Maha Sarakham Formation, while the Plio-Pleistocene Formation is also found in small sub-basins. Furthermore, broad, flat, low-lying topographies like the Phimai Plain and the Thung Kula Ronghai (large poor land field at the Central of Northeastern Region) are still wrongly classified as alluvial plains, whereas in fact they are Plio-Pleistocene surfaces with alluvial patches and scattered patches of Maha Sarakham Formation. Salt that is weathered and eroded from salt-sources is transported either by surface water or by groundwater to low-lying lands. Whenever the ground surface is dry enough, salt precipitates from saturated brined surface water or rises from saturated brined groundwater (Wongsomsak, 2010).

Solving the problem of saline soil is therefore urgently needed and should continue saline soil is considered to be a soil that has low abundance to have the bad physical properties, not suitable for agriculture to allow saline soil areas that have problems that have returned to the area for food production and other uses It is necessary to continue to improve the soil. There are many agencies trying to find solutions to saline soil problems, such as improving soil by using various organic substances to improve saline soil choosing to grow salt tolerant plants, which various methods; it helps to alleviate saline soil problems in some parts only but still experiencing saline soil problems and distribution of saline soil areas in the present.. Research and development of saline soil improvement at this time, the research team hoped that the improvement of saline soil, especially the Nong Bo Reservoir, Borabue District, Maha Sarakham Province and saline soil development, which was a top priority problem of Maha Sarakham Province must hurry to improve in order to be able to use the salinity area again. In addition, the knowledge gained from the research would be published to the local community. The community can use the knowledge gained from research to solve problems in concrete and economical guidelines.

METHODOLOGY AND MATERIALS

This research was therefore a research and development method to integrate for the improvement of the saline soil area to be able to bring that area back to maximum utilization, which has been considered the production cost of the farmers, to help farmers can increase agricultural productivity for good living as well as contributing to solving the poverty problem of the people in another way that would result in strength and sustainability for the community. The research team hoped that the improvement of saline soil, especially, the Nong Bor Reservoir, Borabue District, Mahasarakham Province, and saline soil development, which was a top priority problem must hurry to improve in order to be able to use the said area again In addition, the knowledge gained from the research will be published to the local community.

The Land Development Department (DLD), Ministry of Ministry of Agriculture and Cooperatives was commissioned to design and build spatial databases for their published soil group maps with other data layers such as administrative boundaries, main roads and streams. This project is to develop DLD Soil Information System (DLDSIS) that allow a user to select an area of interest, retrieve the above spatial information and to be able to retrieve information on soil types and their suitability level for selected crops. Spatial Database was created by digitizing 1:50,000 soil group maps, administrative boundary sub-district level, main roads and streams. The database covers north, central, and northeastern regions of Thailand (Land Development Department, 2009) [18].

Focused on soil salinity in Northeastern Region of Thailand, A model of salinity development was formulated upon the interaction of the factors as earlier identified by Mongkolsawat et al. (1990). As a result to determine the spatial soil salinity potential for the northeast it can formulate by coupling a GIS to additional model relating the interaction of four thematic layers: geologic formation, ground water quality and its yield, landform and land cover. The buildup of salt in the soil surface is basically found on the land which is underlain by the Maha Sarakham Formation (Mitsuchi et al., 1983; Kohyama et al., 1993). The ground water quality and its yield greatly enhance the salinization of soil. The "low terrace" land form in the Northeast is characterized by light textured soil flat to gently sloping topography. As a result, the soil salinization model in the northeast is then based on the interaction of geology, ground water and its yield, land form and land cover. This involved the development of a spatial database of geo-referenced data and its associated attribute for the Northeast. The spatial database consisted of the four thematic layers as shown in Figure 4.

These two basins, Khorat and Sakon Nakhon are underlain by the Maha Sarakham geologic Formation. Mean annual rainfall ranges 1200 in the south east and 1800 in the Northeast of the region. Land use is restricted to rice, field crops (cassava & sugar cane) and forest. The scattered trees and isolated patches of remnant forest can be found on the undulation topography of the alluvial plains. The dense forest, mainly Dipterocarp sp and Evergreen sp covers extensively on the mountainous area and sloping land mostly the National Parks and Wildlife Sanctuaries. Soils are inherently low in fertility and have light texture with low cation exchange capacity. Using the identified by Moncharoen & Wiensil (2001) of Soil Analysis Division, Land Development Department, Ministry of Agriculture and Cooperative to integrate the experimental research method was improving the development and improvement of saline soil would be a form of ongoing research in order to improve the solution of saline soil and maximize benefits in two phases in two years 2010-2012 was the research schedule limitations (Figure 5).

Figure 5: Effect of salinity soil (a) and plant producing growth (b) **Source:** Land Development Department (LDD) (2009)

a) Salinity soil environment   b) Property of plant producing growth

Maha Sarakham (also spelled Mahasarakham) is one of the 76 provinces of Thailand. It is in the northeastern (Isan) region of Thailand. Neighboring provinces are (from north clockwise) Kalasin, Roi Et, Surin, Buriram, and Khon Kaen. The Maha Sarakham Formation composes of five cycles of depositions in descending order, upper rock salt middle, mudstone-middle rock, and salt-lower mudstone-lower rock salt, thickness ranges 610-1,000 m aged Lower Upper Cretaceous. Rock contact of the seven rock formations is conformably underlain and overlain except the the Maha Sarakham Formation is thickness of the high terrace gravels yields between 40-60 m. The gravels are hypothesized to be contacted between the Maha Sarakham Formation. Improving the salinity area to be able to bring that area back to maximum utilization, which was considered the production cost of the farmers, to help farmers can increase agricultural productivity for good living as well as contributing to solving the poverty problem of the people in another way, which would result in strength and sustainability for the community at Nong Bor Reservoir, Borabue District, Maha Sarakham Province (Figure 6).

Figure 6: Locations of soil salinity surrounding the Nong Bor Reservoir **Source:** Photos by research team (2015)

a) Map of Nong Bor Reservoir b) Capacity of water in the reservoir c) Plant growth surrounding the reservoir

d) Fishing in the reservoir e) Soil land surrounding the reservoir f) Agricultural crop on soil land

Research objectives

The research objectives in the 1st year research project methodology

- To integrate of the efficiency of cow manure; rice husk; and the mixture of cow manure, rice husk, and rice straw to improve saline soil at Nong Bor Reservoir, Borabue District, Maha Sarakham Province.
- To compare the efficiency of cow manure; rice husk; and the mixture of cow manure, rice husk, and rice straw to improve saline soil Nong Bor Reservoir, Borabue District, Maha Sarakham Province.

Objectives in the 2nd year research project methodology of the 2nd phase

- To investigate of the improvement of saline soil quality by using Sesbania Rostrata as a green manure in the area, it was improved with cow chaff; rice straw; and a mixture of chaff, cow dung, and rice straw at Nong Bor Reservoir, Borabue District, Maha Sarakham Province.
- To compare the efficacy of Sesbania Rostrata in saline soil quality improvement in areas that have been improved with cow chaff; rice straw; and a mixture of cow manure, rice husk, and rice straw.

Research procedures

In the area of Rajabhat Maha Sarakham University requested to use the saline soil area in the Nong Bo Reservoir, an area of 43 rai from the Royal Irrigation Department, Mahasarakham in the new theoretical agricultural demonstration project in saline soil, which was an area that had salt problem and was left empty.

Saline soil quality improvement with organic matter materials in the 1st year

The organic materials including rice husk, cow dung, and straw were prepared. The pre-trial preparation of plots to adjust soil structure, the plot of land used in the study is 10 meters long and 2 meters wide, with 15 plots.

- Soil conversion 1-3 (Form 1) is a control soil conversion, no soil quality improvement
- Soil conversion 4-6 (Form 2) is a soil conversion that improves saline soil quality with rice husk.
- Soil conversion 7-9 (Form 3) is a soil conversion that improves saline soil quality with cow dung.
- Soil conversion 10-12 (Form 4) is a soil conversion that improves saline soil quality with rice straw.
- Soil conversion 13-15 (Form 5) is a soil conversion to improve the saline soil structure with a mixture of cow manure and rice straw.

How to proceed

- Conducting experiments as follows; collected all soil samples for analysis of physical and chemical properties before experimenting, and experiment in each formula, repeat 3 experiments (Replication) as follows from Form 1 was controlled set; adding 30 kilograms of rice husk (dry weight) in Form 2; putting cow dung (dry weight) in Form 3; chopped rice straw to a length of about 5 centimeters, number of 30 kilograms / plot into Form 4; adding 30 kilograms of rice straw (dry weight) into the formula, and adding 10 kilograms of mixture between cow chaff and rice straw per plot into the Form 5.
- Removed each type of material in the experimental plot designed for 60 days.
- Collected the soil samples from the experimental plots to analyze the physical and chemical properties defined in all parameters.

Soil sample collection

Soil sample collection for analysis of physical and chemical properties would analyze on soil properties before and after soil amendments with rice husk; cow straw; and mixture between cow manure, rice husk, and rice straw and mixture between cow manure, rice husk, and rice straw.

Collecting soil samples

Soil samples were collected to be represented by Zig Zag (Land Development Department, 2009)[18], each of soil conversion composed of 7 points per plot. Each point collected 20 grams of soil and mixed together to represent each plot, the experiment would be repeated in the three times in order to analyze of soil properties in each parameter. Each soil sampling conversion dried in the shade without dust, and the soil is dried, then make a fine by using mortar to crush the soil, and glide through the 2 mm diameter basket, collected the specimen in a plastic bag with a closed seal, these samples were collected for soil quality analysis.

Methods of measuring and analyzing soil properties

Soil color comparison by Munsell Code Book

Clay tablets into 2 parts. If the soil is dry, use a water sprayer to moisten the soil. Stand to let the sunlight shine through the shoulder to the soil color book and soil samples that are measuring soil color. Compare the color of the soil as any color in the earth color book Record the readable value.

pH analysis of soil

- Soil: Water ratio 1: 1, Equipment and tools;, 50ml beaker, Glass rods, 10 ml measuring cup, and pH meter was compared.
- Chemical solution and preparation method: Distilled water, Standard buffer solution, and Standard pH 4 buffer solution and standard pH 7 buffer solution for adjusting pH meter.
- Analysis method: weighing 10 grams of soil sample into a 50 ml beaker, adding 10 ml of distilled water, use a glass stick, stirring well several times, and taking the soil solution to measure pH using standard buffer solution pH 7 and pH 4, adjust the pH first.

Electrical conductivity (EC)

- Analysis of electrical conductivity methods: water ratio 1: 5 with the equipment and tools, which composed of; 125 ml Erlenmeyer flask, Cone, Filter paper number 5, Filtering flask 500 ml., 50ml beaker, Thermometer, and Conductivity meter (Conductivity meter).
- Chemical solution and preparation method: Standard Potassium Chloride (KCl) 0.01 N solution, dissolving potassium chloride (KCl) 0.7456 grams that is dried in distilled water, resulting in a volume of 1 liter, adjusting conductivity meter or using standard calibration solution 12.9 mS / cm 7230ppm NaCl , 0.1000 M ± 0.005 M KCl in machine adjustment (applies only to Orion Conductivity Cell), and Distilled water.
- Conductivity measurement method: Warm up the electrical conductivity meter for 15 minutes at 25 ° C. Adjust the machine using Standard Calibration 12.9 mS / cm 7230 ppm NaCl, 0.1000 M. 0.005 M KCl. Measuring the electrical conductivity of the solution with a conductivity meter. The value that can be read from the machine is in milliseconds per cm (mS / cm) at 25 °C = dS / m.

Soil salinity measurement

In the laboratory, soil salinity is usually assessed by determining either the total soluble salts by evaporation of soil water extract (TSS), or by determining the electrical conductivity (EC) of either a 1:5 distilled water: soil dilution, or a saturated paste extract. Soil salinity was measured by passing an electric current between the two electrodes of a salinity meter in a sample of soil. The electrical conductivity or EC of a soil sample is influenced by the concentration and composition of dissolved salts.

Organic Matter; OM Method

- Chemical solution and preparation method; Potassium dichromate solution 1 N Potassium Dichromate (K2Cr2O7) baked at 105.80C, 98.0 g, dissolved in distilled water resulting in a volume of 2 liters, Ferrous Ammonium Sulfate solution 0.5, Ferrous Ammonium Sulfate [Fe (NH4)2(SO4)2.6H2O] 400 grams, dissolved in sufficiently distilled water, add 50 ml of concentrated sulfuric acid to a volume of 2 liters. O-phenanthroline trole indicators solution (0.025 M), Ferrous Sulfate (FeSO4.7H2O) 0.7 g and O-phenanthroline 1.48 grams dissolved in distilled water, making it 100 ml volume, and Concentrated sulfuric acid (conc.H2SO4).
- Analysis methodว weighing 1 g of soil sample in a 250 ml flat bottom glass bottle, Pipette, 1 N10 ml potassium dichromate solution 15 ml of concentrated sulfuric acid Shake the glass lightly for 1-2 minutes. Set aside for 30 minutes add about 50 ml of distilled water leave to cool. Drop the indicator 5 drops of orthophonics, titrate with ferrous ammonia sulfate 0.5 to determine the amount of potassium dichromate left over from the reaction until the color of the soil solution changes from green to reddish brown at the end point. Record the amount of potassium dichromate and ferrous ammonium sulfate used, and made blank, same as soil analysis method.

% Organic carbon = % Organic carbon x 1.724

Total nitrogen determination in soil (Total N)

- Mixed indicator: Weighed methyl red 0.066 grams and green 0.099 grams, dissolved with 100 ml ethanol, stored in a sealed bottle, 2% H3BO3 - indicator solution; H3BO3 20 grams weighing 500 ml beaker, add about 300 distilled water on the hot plate. Let the H3BO3 completely dissolve (the person with a glass stick is periodically heated) and leave to cool; insert 1000 ml volumetric flask, add 500 ml of distilled water (by using the beaker to wash the H3BO3 in small increments), add mixed indicator 20 ml (use graduate pipette), shake well, adjust the color of this solution by 0.1 N NaOH by adding it in small increments (use graduate pipette) until dissolved into magenta (pH of solution approximately 5.0).
- Catalyst mixture: Mixing K2SO4 (or Na2SO4): CuSO4.5H2O: Se in the ratio of 100: 10: 1, and 40% NaOH 400 grams by weighing 400 grams of NaOH, put in a 1000-ml beaker, dissolved with distilled water (prepared in a fume hood), stirred with a glass rod to dissolve NaOH, adjust the volume to 1 liter, store the solution in a plastic bottle, and Std. 0.005 N H2SO4.
- Removing the distilled solution in the Erlenmeyer flask to titrate with std. 0.005 N H2SO4 at the end point. The solution would be purple-red. Note the volume of std. 0.005 N H2SO4 using titrate to calculate Total N.

Total N (%) = (ml std. H_2SO_4 Sample – ml std. H_2SO_4 Blank) x N std.H_2SO_4 x 0.014 x

Final volume (ml) x100

A liq. (ml) x wt. of soil (g)

Beneficial amounting Phosphorous (P) mineral in soils (BPM)

Prepare a series of standard solutions and banks (Use distilled water instead) to measure light absorption, same as the extract, calculation

Phosphorus content in soil = (B × C × X)/A ppm

When soil sample weight = A gram

Bray no. = B grams

Values read from the standard graph = X ppm

Dilution ratio = C

Beneficial amounting Potassium (K) mineral in soils (BKM)

Useful Potassium = (DxCxB)/A ppm

When

A = weight of soil sample (g)

B = volume of ammonium acetate solution used for extraction (ml)

C = Dilution factor (times)

D = potassium concentration compared to standard concentration (ppm)

Selected experimental materials

The African Sesbania Rostrata tree were selected, properties of the soil studied included physical properties; soil color; chemical properties included pH, salty, electrical conductivity, organic matter in the soil, and main nutrient.

Preparation before the experiment

Preparation of soil conversions before planting; the 1st-3rd soil conversions (Original 1) were the controlling experimental sample, which didn't crop. The 4th-15th soil conversions (Original No. 2-5) were a soil conversions were the experimental samples that were grown with African Sesbania.

Plant preparation

Prepare the Sesbania seeds by weighing 15 kilograms of African Sesbania seeds and leaving the seeds soaked for 1 night.

Cropping

The 1st-3rd soil conversions were the controlling soil conversions and wouldn't grow any crops at all. The 4th-15th, were grown with Sesbania Rostrata by planting African Sesbania. Into the experiment guideline in a row to thoroughly convert, using 1 kg of African Sesbania seeds, wet weight (about 10 minutes to remove the seeds before draining), which planting would begin to be planted in June 2012, which was the rainy season were planned.

Chopping

When the Sesbania Rostrata grows for 60 days, then chopping plant into the soil by giving the soil about 10 centimeters thick was selected. After that, let the decomposition of the plant for 60 days and collect soil samples for analysis of each parameter.

Soil sample collection

Soil sample collection for analysis of physical and chemical properties would analyze soil properties before planting and after soil quality improvement with green manure for the soil conversions in each plot of 7 points, each point collects 500 grams of soil and then mix together to represent each plot. The experiment would be repeated in 3 times, in order to analyze soil properties in each parameter.

Soil sample analysis

Soil sample analysis was collected at each time would be analyzed for the properties of the soil according to the parameters set, namely; soil color by the Munsell color code book, acidity – alkalinity with the pH meter, electrical conductivity and salinity of soil were measured by the with the Electrical Conductivity Meter, the organic matter and main nutrient was analyzed by the Walkley - Black Method, and the main nutrients, such as; totalized nitrogen, beneficial phosphorus and potassium was tested by the Atomic Absorption and Spectrophotometer, using the technique of Kjeldahl Distillation and Colorimetric Methods were analyzed. Statistically significant was analyzed with mean and standard deviation (Figure 7).

Figure 7: The 4-types of experimental materials **Source:** Photos by research team (2015)

a) The African Sesbania Rostrata b) Rice husk

c) Cow dung d) Rice straw

Figure 8: Preparing the into 5 original plots from the original soil to be improved **Source:** Photos by research team (2015)

a) Original soil salinity surrounding the Nong Bor reservoir (Plot 1) b) Preparation of experimental area (Plot 1)

c) Improving saline soil with rice husk (Plot 2) d) Improving saline soil with rice straw (Plot 3)

e) Improving saline soil with cow dung (Plot 4) f) Improving saline soil with rice straw (Plot 5)

Research limitations

Integrating the area was the saline soil area of Nong Bor Reservoir, Borabue District, Maha Sarakham Province in the empty space of the Siao Yai Basin Development Unit; the Royal Irrigation Department was responsible as 43 rai, approximately.

Indicating parameters consisted of physical properties with soil color; chemical properties with soil reaction, pH, and electrical conductivity (EC); and organic matter (Organic Matter, OM) were designed. The amount of qualities, such as; the total nitrogen content, available phosphorus quality, and available potassium that it was benefited.

Using the materials to improve saline soil include cow manure, rice straw, and plants that are grown as green manure include African Sesbania trees.

Research hypothesis

- 1. Efficiency in reducing salinity of cow manure; rice straw; and mixture of cow manure, rice husk, and rice straw on different saline soil.
- 2. Properties of saline soils improved with African Sesbania as green manure causing changes in the properties of saline soils of each experiment, differently.

Expected benefits

- To gain the knowledge about the improvement of saline soils both physically and chemistry from various materials until being able to bring the saline soil areas that cannot be used as agricultural benefits back into agricultural areas that can provide agricultural products again.
- Farmers can use the information obtained from this study as a guideline to improve the salinity problem in their area.
- The farmers can improve the saline soil that is a problem for agricultural production by themselves, considered to reduce production costs including being able to empty the previously used areas to return to being able to produce agricultural products. This is to increase income for farmers.
- Knowledge management that is beneficial to government agencies Local authorities Related to policy formulation would use the data from the research results to be useful in planning the improvement of saline soil that is a problem of local Maha Sarakham province and conserve soil resources for maximum and sustainable use.

RESULTS

To integrate of the conducting physical and chemical soil quality studies including soil color, pH value, electrical conductivity value, salinity value, organic matter, total nitrogen content, beneficial phosphorus and potassium content that were divided the experiment set into 5 original as follows:

Original 1: soil control unit

Original 2: soil, improved with the rice husk

Original 3: soil improved with the cow dung

Original 4: soil improved with the rice straw

Original 5: soil improved with the mixture of cow manure, rice husk, and rice straw

Soil colors

Table 2, and Table 3 show the soil colors' results that have compared between the experimental samples indicated that of timing experiments (before, and after past of 60 days were improved) in the 1st and 2nd year.

Table 1: Soil color before improvement and after soil improvement with organic matter for the 1st year

Soil conversion	**Soil color before improvement**		**Soil after improvement with organic matter**	
	Color	**Color code**	**Color**	**Color code**
No. 1 (controlled)	Light brown soil	7.5YR8/4	Light brown soil	7.5YR8/4
No. 2 (the rice husk)	Light brown soil	7.5YR8/4	Yellow-brown soil	7.5YR7/6
No. 3 (the cow dung)	Light brown soil	7.5YR8/4	Dark brown soil	7.5YR6/6
No.4 (the rice straw)	Light brown soil	7.5YR8/4	Yellow-brown soil	7.5YR7/6
No. 5 (the mixtures)	Light brown soil	7.5YR8/4	Yellow-brown soil	7.5YR7/6

Table 2 and 3 show the soil colors' results that have compared between the experimental sample indicated that of timing experiments (before, and after past of 60 days were improved).

Table 2: Soil color before improvement and after soil improvement with organic matter for the 2nd year

Soil conversion	**Soil color before improvement**		**Soil after improvement with organic matter**	
	Color	**Color code**	**Color**	**Color code**
No. 1 (controlled)	Light brown soil	7.5YR8/4	Light brown soil	7.5YR8/4
No. 2 (the rice husk)	Yellow-brown soil	7.5YR8/6	Dark brown soil	7.5YR5/6
No. 3 (the cow dung)	Yellow-brown soil	7.5YR8/6	Dark yellow-brown soil	7.5YR6/8
No.4 (the rice straw)	Yellow-brown soil	7.5YR8/6	Dark brown soil	7.5YR5/6

No. 5 (the mixtures)	Yellow-brown soil	7.5YR8/6	Dark brown soil	7.5YR5/6

PH values

Table 3 and Figure 9 report on the controlling and experimental samples of soils that their statuses as before improvement and after 60 days' improvements in the first and second year were compared.

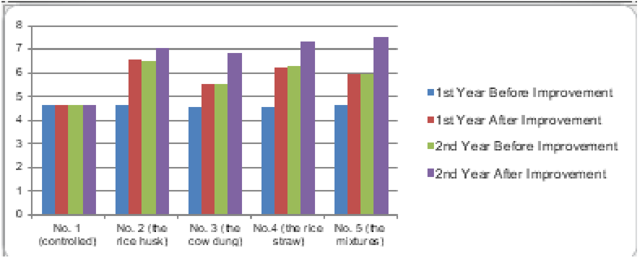
Table 3: Comparisons between the pH values of the five soil conversions in the 1st and the 2nd year with mean averages indicates of before and after of soil experimental improvement

Soil conversion	**Before soil improvement**		**After soil improvement in 60 days**	
	Mean average ($\overline{X}$)		**Mean average ($\overline{X}$)**	
	the 1st year	**the 2nd year**	**the 1st year**	**the 2nd year**
No. 1 (controlled)	4.64	4.62		4.62
No. 2 (the rice husk)	4.63	6.51	6.57	7.04
No. 3 (the cow dung)	4.59	5.53	5.53	6.81
No. 4 (the rice straw)	4.59	6.26	6.25	7.30
No. 5 (the mixtures)	4.62	5.92	5.91	7.51

Table 3 reported for the pH values on each soil conversions of the on the controlling and experimental samples of soils that their statuses as before improvement and after 60 days' improvements were compared. The controlled soil set (No.1) has an average pH value of 4.64 ± 0.05, and after 60 days of experimentation, the pH value still has an average of 4.65 ± 0.04. The rice **husk** soil conversion (No.2), the average pH value was 4.63 ± 0.04 and after 60 days of experiment, the average pH was 6.57 ± 0.04. Similarly, No.3 (the cow dung), No, 4 (the rice straw), and No. 5 (the mixtures of materials) were responded through before and after improvements (60 days) of the pH values as 4.59±0.02 and 5.53±0.03; 4.50 ± 0.01 and 6.25 ± 0.03; and 4.62±0.04 and 5.91±0.01, respectively for the 1st year.

In the 2nd year, Table 3 reported of the pH value indicated that of 4.62±0.01, 6.51±0.17, 5.53±0.04, 6.26±0.03, and 5.92±0.01 for the soil qualities before improvement; and indicated that of 4.62±0.00, 7.04±0.55, 6.81±0.01, 7.30±0.01, and 7.51±0.01 for the soil qualities after improvement of the five soil conversions, respectively (Figure 9).

Figure 9: Significant differences between the pH values of soils in five conversions in terms of before and after improvement in the 1st and 2nd years



Electrical conductivity values: EC

The electrical conductivity values in the control soil, the rice husk, the cow dung, the rice straw, and the mixture of material series before soil improvement were EC equal to 847 ± 1.73 µs / cm, 847±1.00 µs/cm, 850±1.73 µs/cm, 847±0.57 µs/cm, and 848± 1.100 µs/cm; and after 60 days of experimentation, the EC values were 815.50 ± 4.41 µs/cm, 544.00±2.39 µs/cm, 737.11±2.42 µs/cm, 692.11±1.36 µs/cm, and 848± 1.100 µs/cm, respectively as details in Table 4.

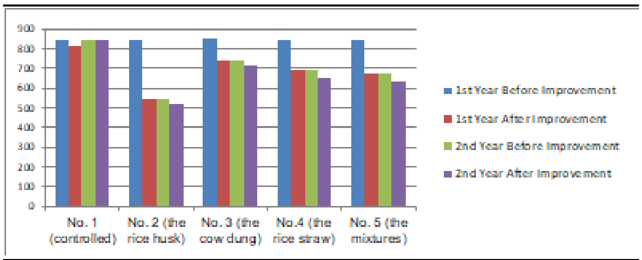
Table 4: Comparisons between the EC values of the five soil conversions in the 1st and the 2nd year with mean averages indicates of before and after of soil experimental improvement

Soil conversion	**Before soil improvement**		**Before soil improvement**		
	Mean average ($\overline{X}$)		**Mean average ($\overline{X}$)**		
	the 1st year		**the 1st year**		**the 1st year**
	847	No. 1 (controlled)	847	No. 1 (controlled)	847
No. 2 (the rice husk)		No. 2 (the rice husk)	847	No. 2 (the rice husk)	847
No. 3 (the cow dung)	850			No. 3 (the cow dung)	850
No. 4 (the rice straw)	847			No. 4 (the rice straw)	847
				No. 5 (the mixtures)	

In the 2nd year, the EC values indicated that of 846.22±1.20, 547.33±1.73, 740.44±-3.08, 693±1.65, and 693±1.65 µs/cm for the soil qualities before improvement; and indicated that of 847.66±3.35, 520.22±1.30, 711.88±2.08, 647.77±2.63, and

636.66± 1.11µs/cm for the soil qualities after improvement of the five soil conversions, respectively (Figure 10).

Figure 10: Significant differences between the EC values of soils in five conversions in terms of before and after improvement in the 1st and 2nd years



Soil salinity values (SS)

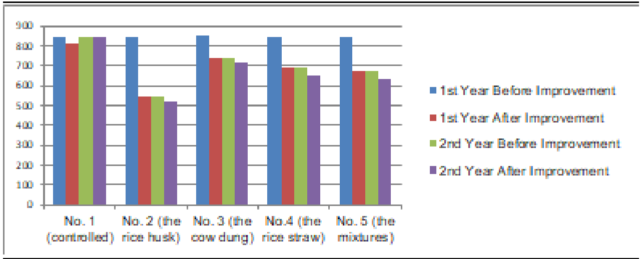
The soil salinity results were measured on the soil conversion number as 1st, 2nd, 3rd, 4th, and 5th indicated that of the soil salinity values before the soil improvement as 8.47 ± 0.01, 8.47±0.01, 8.50±0.01, 8.47±0.00, and 8.48±0.01 dS/m, and on after 60 days of experiment for improving the soils, the average salinity was 8.45 ± 0.01, 5.44±0.02, 7.37±0.02, 6.92±0.01, and 6.84±0.33 dS/m, respectively for the firth year. These results were reported in Table 5.

Table 5: Comparisons between the SS values of the five soil conversions in the 1st and the 2nd year with mean averages indicates of before and after of soil experimental improvement

Soil conversion	Before soil improvement		After soil improvement in 60 days	
	Mean average ($\bar{X}$)		Mean average ($\bar{X}$)	
	the 1st year	the 2nd year	the 1st year	the 2nd year
No. 1 (controlled)	8.47	8.46	8.45	8.47
No. 2 (the rice husk)	8.47	5.47	5.44	5.21
No. 3 (the cow dung)	8.50	7.39	7.37	7.11
No. 4 (the rice straw)	8.47	6.93	6.92	6.47
No. 5 (the mixtures)	8.48	6.47	6.84	6.36

Table 5 reported the soil salinity values in the 2nd year, the SS values indicated that of 8.46±0.01, 5.47±0.01, 7.39±0.01, 6.93±0.01, and 6.74±0.02 dS/m for the soil qualities before improvement; and indicated that of 8.47±0.03, 5.21±0.02, 7.11±0.02, 6.47±0.02, and 6.36±0.01 dS/m for the soil qualities after improvement of the five soil conversions, respectively (Figure 11).

Figure 11: Significant differences between the SS values of soils in five conversions in terms of before and after improvement in the 1st and 2nd years



Organic matter in the soil (OMS)

The organic matter in the soil results were measured on the soil conversion number as 1st, 2nd, 3rd, 4th, and 5th indicated that of the organic matter in the soil before the soil improvement as 0.54±0.01%, 0.54±0.01%, 0.54±0.01%, 0.54±0.01%, and 0.54±0.01%, and after 60 days of experiment for improving the soils, the mean average of the organic matter in soils revealed that of 0.54±0.01%, 2.09±0.01%, 1.21±0.02%, 1.39±0.01%, and 1.25±0.01%, respectively. These results were reported in Table 6.

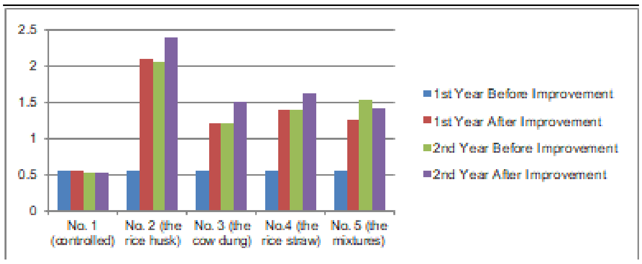
Table 6: Comparisons between the OMS values of the five soil conversions in the 1st and the 2nd year with mean averages indicates of before and after of soil experimental improvement

Soil conversion	Before soil improvement		After soil improvement in 60 days	
	Mean average ($\bar{X}$)		Mean average ($\bar{X}$)	
	the 1st year	the 2nd year	the 1st year	the 2nd year
No. 1 (controlled)	0.54	0.53	0.54	0.52
No. 2 (the rice husk)	0.54	2.05	2.09	2.38
No. 3 (the cow dung)	0.54	1.21	1.21	1.50
No. 4 (the rice straw)	0.54	1.39	1.39	1.62
No. 5 (the mixtures)	0.54	1.52	1.25	1.42

Table 6 reported the organic matter in the soil values in the 2nd year, the OMS values indicated that of 0.53±0.00%, 2.05±0.00%, 1.21±0.01%, 1.39±0.01%, and 1.25±0.01% for the soil qualities before improvement; and indicated that of 0.52±0.04%, 2.38±0.01%, 1.50±0.00%, 1.62±0.00%, and

1.42±0.01% for the soil qualities after improvement of the five soil conversions, respectively Figure 12).

Figure 12: Significant differences between the OM values of soils in five conversions in terms of before and after improvement in the 1st and 2nd years



Amount of Nitrogen mineral (N) in soils (NM)

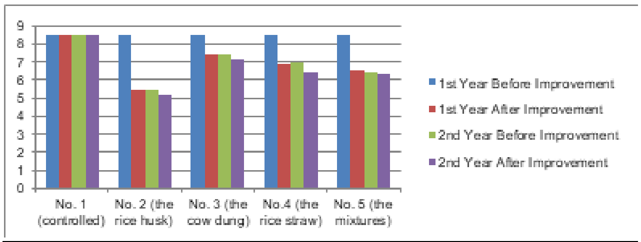
The results of the amount of Nitrogen mineral in soils were measured on the soil conversion number as 1st, 2nd, 3rd, 4th, and 5th indicated that of the amount of Nitrogen mineral in soils before the soil improvement with the mean averages as 0.01±0.00%, 0.01±0.00%, 0.01±0.00%, 0.01±0.00%, and 0.01±0.00%, and after 60 days of experiment for improving the soils, the mean average of 0.01±0.00%, 0.68±0.00%, 0.13±0.00%, 0.04±0.00%, and 0.22±0.01%, respectively. These results were reported in Table 7.

Table 7: Comparisons between the NM values of the five soil conversions in the 1st and the 2nd year with mean averages indicates of before and after of soil experimental improvement.

Soil conversion	Before soil improvement		After soil improvement in 60 days	
	Mean average ($\bar{X}$)		Mean average ($\bar{X}$)	
	the 1st year	the 2nd year	the 1st year	the 2nd year
No. 1 (controlled)	0.01	0.11	0.01	0.11
No. 2 (the rice husk)	0.01	0.68	0.68	0.71
No. 3 (the cow dung)	0.01	0.42	0.13	0.62
No. 4 (the rice straw)	0.01	0.43	0.04	0.60
No. 5 (the mixtures)	0.01	0.23	0.22	0.46

Table 7 reported the NM in the soil values in the 2nd year, the NM values indicated that of 0.11±0.01%, 0.68±0.00%, 0.42±0.01%, 0.43±0.01%, and 0.23±0.00% for the soil qualities before improvement; and indicated that of 0.11±0.01%, 0.71±0.01%, 0.62±0.01%, 0.60±0.01%, and 0.23±0.00% for the soil qualities after improvement of the five soil conversions, respectively (Figure 13).

Figure 13: Significant differences between the Nitrogen mineral (N) in soils in five conversions in terms of before and after improvement in the 1st and 2nd years



Beneficial amounting Phosphorous (P) mineral in soils (BPM)

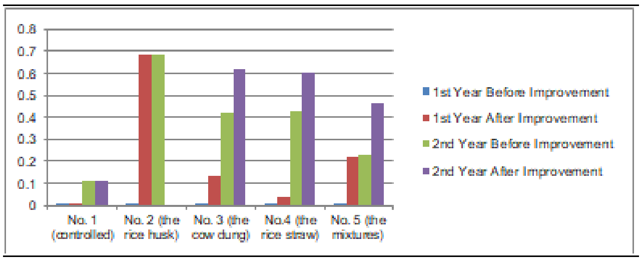
The results of the beneficial amounting Phosphorous mineral in soils were measured on the soil conversion number as 1st, 2nd, 3rd, 4th, and 5th indicated that of the beneficial amounting Phosphorous mineral in soils before the soil improvement with the mean averages as 1.10±0.01, 1.10±0.01, 1.10±0.01, 1.10±0.01, and 1.10±0.01 ppm, and after 60 days of experiment for improving the soils, the mean average of 1.16±0.01, 22.19±0.00, 37.89±0.01, 15.49±0.01, and 28.21±0.02 ppm, respectively. These results were reported in Table 8.

Table 8: Comparisons between the BPM values of the five soil conversions in the 1st and the 2nd year with mean averages indicates of before and after of soil experimental improvement.

Soil conversion	Before soil improvement		After soil improvement in 60 days	
	Mean average ($\bar{X}$)		Mean average ($\bar{X}$)	
	the 1st year	the 2nd year	the 1st year	the 2nd year
No. 1 (controlled)	1.10	2.09	1.16	2.10
No. 2 (the rice husk)	1.10	22.32	22.18	26.49
No. 3 (the cow dung)	1.10	38.11	37.89	46.12
No. 4 (the rice straw)	1.10	15.49	15.49	18.68
No. 5 (the mixtures)	1.10	28.21	28.21	32.75

Table 8 reported the BPM in the soil values in the 2nd year, the NM values indicated that of 2.09±0.01, 22.32±0.02, 38.11±0.10, 15.49±0.00, and 28.21±0.01 ppm for the soil qualities before improvement; and indicated that of 2.10±0.02, 26.49±0.03, 46.12±0.02, 18.68±0.05, and 32.75±0.11 ppm for the soil qualities after improvement of the five soil conversions, respectively (Figure 14).

Figure 14: Significant differences between the Phosphorous (P) mineral in soils in five conversions in terms of before and after improvement in the 1st and 2nd years



Beneficial amounting Potassium (K) mineral in soils (BKM)

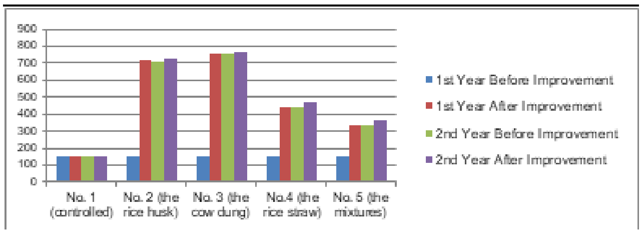
The results of the beneficial amounting Potassium mineral in soils were measured on the soil conversion number as 1st, 2nd, 3rd, 4th, and 5th indicated that of the beneficial amounting Potassium mineral in soils before the soil improvement with the mean averages as 155.72±0.11, 155.72±0.11, 155.72±0.11, 155.72±0.11, and 155.72±0.11 ppm; and after 60 days of experiment for improving the soils, the mean average of 155.67±0.09, 714.61±0.49, 754.05±0.63, 444.22±0.83, and 334.11±1.61 ppm, respectively. These results were reported in Table 9.

Table 9: Comparisons between the BKM values of the five soil conversions in the 1st and the 2nd year with mean averages indicates of before and after of soil experimental improvement

Soil conversion	Before soil improvement		After soil improvement in 60 days	
	Mean average ($\bar{X}$)		Mean average ($\bar{X}$)	
	the 1st year	the 2nd year	the 1st year	the 2nd year
No. 1 (controlled)	155.72	155.62	155.67	155.61
No. 2 (the rice husk)	155.72	713.53	714.61	724.74
No. 3 (the cow dung)	155.72	754.50	754.05	767.96
No. 4 (the rice straw)	155.72	445.02	444.22	472.04
No. 5 (the mixtures)	155.72	333.96	334.11	361.54

Table 9 reported the BKM in the soil values in the 2nd year, the BKM values indicated that of 155.2±0.06, 713.53±1.49, 754.50±0.32, 445.02±0.81, and 333.96±1.20 ppm for the soil qualities before improvement; and indicated that of 155.61±0.19, 724.74±0.84, 767.96±1.09, 472.04±0.97, and 361.54±0.70 ppm for the soil qualities after improvement of the five soil conversions, respectively (Figure 15).

Figure 15: Significant differences between the Potassium (K) mineral in soils in five conversions in terms of before and after improvement in the 1st and 2nd years



Comparison of saline soil quality before and after improvement with organic matter

The presence of more variation of the parameters were tested for the soil salinities at the sample area of 43 rai whereas it is surrounding the Nongbor Plateau reservoir area, Borabue District, Maha Sarakham Province, Thailand with the five soil conversions (No. 1: controlled soil, No. 2: the rice husk, No. 3: the cow dung, No. 4: the rice straw, No. 5: the mixtures with the rice husk, the cow dung, and the rice straw) in terms of soil improvements in before and after 60 days of experimental improvements of the soils with the mean average scores were compared in the 1st year.

Figure 16, 17 and 18 present a pictorial comparison of the parameters; pH, electrical conductivity, soil salinity, the organic matter in the soil, the amount of Nitrogen mineral (N) in soils, the beneficial amounting Phosphorous mineral (P) in soils, and the beneficial amounting Potassium mineral (P) in soils of the soil improvements between before and after 60 days of experimental improvements of the soils with the mean average scores and indicates that the after experimental improvements of the soils would prefer more pH, electrical conductivity, soil salinity, the organic matter in the soil, the amount of Nitrogen mineral (N) in soils, the beneficial amounting Phosphorous mineral (P) in soils, and the beneficial amounting Potassium mineral (P) in soils of the soil salinity properties than the original soil salinity properties for agriculture in the Nongbor Plateau reservoir area, Borabue District, Maha Sarakham Province, Thailand, for the 1st year were compared, differently.

The finding also further supports previous related research in that in that a variety of studies has indicated that soil salinity properties, which they are improved with the four material, namely; the rice husk, the cow dung, the rice straw, and the mixtures with the rice husk, the cow dung, and the rice straw are used and analyzed of this experimental research method.

Similarly, The presence of more variation of the parameters were tested for the soil salinities at the sample area of 43 rai with the five soil conversions (No. 1: controlled soil, No. 2: the rice husk, No. 3: the cow dung, No. 4: the rice straw, No. 5: the mixtures with the rice husk, the cow dung, and the rice straw) in terms of soil improvements in before and after 60 days of experimental improvements of the soils with the mean average scores in the 2nd year were compared.

Statistically significant to compare of the soil salinity qualities for each parameter in terms of before and after improvement with organic matter was analyzed with the sources of variation, comparative test of average pairs (Post Hoe test) with LSD (LSD: Least significant difference), and F-test. Table 10 reported of the analyzing results were differentiated (Table 10).

Table 10: Sources of variation, Mean average ($\bar{X}$), and F-test were compared of the five materials to improve the experimental soil salinity in two years

Parameter	Sources of variation		Mean average (($\bar{X}$)										F-test
	Between groups	Within Groups	Controlled		Rice husk		Cow dung		Rice straw		Mixed		
			B FY	A SY	B FY	A SY	B FY	A SY	B FY	A SY	B FY	A SY	
pH	26.42	0.07	4.64	4.62	4.63	7.04	4.59	6.81	4.59	7.3	4.62	7.51	4131***
EC (μs/cm)	3.98 x10^6	1.20 x10^5	847	848	847	520	850	712	847	648	848	637	35.6***
SS (dS/m)	48.48	0.93	8.47	8.47	8.47	5.21	8.5	7.11	8.47	6.47	8.48	6.36	560***
OMS (%)	12.68	0.006	0.54	0.52	0.54	2.38	0.54	1.5	2.54	1.62	0.54	1.42	2385***
NM (%)	2.79	0.002	0.01	0.11	0.01	0.71	0.01	0.62	0.01	0.6	0.01	0.46	1296***
BPM (ppm)	8.04 x10^3	0.003	1.1	2.1	1.1	26.5	1.1	46.1	1.1	18.7	1.1	32.8	2529***
BKM (ppm)	2.62 x10^5	31.73	156	157	156	725	156	768	156	472	156	362	8868***

The results as above indicated that of the comparisons between the efficiency of rice husk; cow hung; and mixed of the rice husk, cow hung, and rice straw mixture showed that the pH, electrical conductivity, salinity, organic material soil, total Nitrogen mineral quality, beneficial Phosphorus and Nitrogen mineral values were tested and measured with the experimental research method design. Conducting the five soil conversions at the soil salinity area of 43 Rai (1 Rai = 0.3592 Acre = 1,600 m2) into the target land whereas the land is empty and a public place around the Nongbor reservoir area in Maha Sarakham Province, Thailand. To provide the controlling variable with the 1st soil conversional plot, it called the Original 1: soil control unit, and experimental variables were set into four original soil conversion groups follows: as the Original 2: soil, improved with the rice husk; Original 3: soil improved with the cow dung; Original 4: soil improved with the rice straw; and Original 5: soil improved with the mixture of cow manure, rice husk, and rice straw were randomly assigned (Figure 16, 17, 18, and 19).

Figure 16: The growth of African Sesbania trees in the experimental improvement

with the rice husk

Source: Photos by research team (2015)

Figure 17: The growth of African Sesbania trees in the experimental improvement

with the cow dung

Source: Photos by research team (2015)

Figure 18: The growth of African Sesbania trees in the experimental improvement

with the cow dung

Source: Photos by research team (2015)

Figure 19: The growth of African Sesbania trees in experimental improvement with 3 ingredients (rice husk, cow dung, and rice straw)

Source: Photos by research team (2015

All of the originals showed the statistically significant differences at the level of .05. The values of the original electrical conductivity improved with cow dung and the original that is improved with rice straw has no significant difference at the level of .05 for the pH, electrical conductivity, salinity, organic material soil, total Nitrogen mineral quality, beneficial Phosphorus and Nitrogen mineral values. As for the electrical conductivity value that was improved with cow dung and the original that was improved with rice straw, there were no significant differences at the level of .05. Because the rice husk, when decomposed, will insert in the soil for a long time, and causing the soil to have high salt leaching and the decomposition of other soil improvement materials causing the soil to have more organic matter, resulting in better physical properties of the soil. Especially, plants can absorb nutrients in the soil to use and proper the pH reaction with suitability.

CONCLUSIONS AND DISCUSSIONS

This experimental research study was conducted with a scientific approach, where a set of variables are kept constant while the other set of variables are being measured as the soil salinity that it to improve with the controlling and experimental groups of experiment. Normally, the experimental research is one of the founding quantitative research methods into three basic types of experimental research designs. These include pre-experimental designs, true experimental designs, and quasi-experimental designs. The degree to which the researcher assigns soil salinities to conditions and five groups distinguishes the type of experimental design. This module would focus on the different types of true experimental designs. True experimental designs are characterized by the random selection of participants and the random assignment of the participants to groups in the study. The researcher also has complete control over the extraneous variables. To integrate of the conducting physical and chemical soil quality studies including soil color, pH value, electrical conductivity value, salinity value, organic matter, total nitrogen content, beneficial phosphorus and potassium mineral contents that were divided the controlling and experimental set into 5 original soil conversion groups follows: Original 1: soil control unit as the controlling group; Original 2: soil, improved with the rice husk, Original 3: soil improved with the cow dung, Original 4: soil improved with the rice straw, and Original 5: soil improved with the mixture of cow manure, rice husk, and rice straw are randomly assigned into one of four groups.

Agricultural area development in Nong Bo Reservoir, Borabue District, Maha Sarakham Province In the first year study, the improvement of saline soil by using organic materials, such as rice husk, cow dung, rice straw and a mixture of rice husk, cow dung and rice straw with the mean averages of quantitative data were compared in terms of before and after improvements of soil salinity, differently in the first year. In the second year, using the African Sesbania plant as a fresh fertilizer for soil salinity improvement that used to improve soil by using rice husk, cow dung or manure and rice husk and rice husk mixture. The 7-parameter, such as; pH, conductivity value (EC), salinity, organic matter, total nitrogen content, beneficial phosphorus and potassium mineral qualities also were found that summarized as followed:

Soil color: Soil color before soil improvement with various organic matters; the soil is brown. All on five soil conversion experiments after 60 days of soil improvement; it was found that the soil that was improved with cow dung was darker than the four original soil conversion experiments, which were improved with rice husk and a mixture of cow manure and rice straw.

PH value: Soil that was improved with organic matter in all authentic experiment would increase the value of the soil with all the pH values. The soil that was improved with rice husk has an increase in pH until near the most neutral (pH = 6.57).

Electrical conductivity (EC): Soil that was improved with organic matter in all of four soil salinity experiments with reduced conductivity values, the original soil that was improved with rice husk has the highest electrical conductivity value (EC = 544.00 µs / cm).

Soil salinity value: Soil that was improved with organic matter in all of four soil conversion experiments with decreasing salinity on all four soil experimental conversions. The soil that has been improved with rice husk has the highest decreasing soil salinity (Soil Salinity = 5.44 ds / m).

Organic material value in soil: Soil that was improved with organic matter in four experimental soil conversions with all the organic ingredients added, the soil that was improved with rice husk has the highest organic material value (Organic material = 2.09%)

Total Nitrogen mineral in soils: Soil that was improved with organic matter in all of four experimental soil conversions with increasing total nitrogen content. The soil that has been improved with rice husk has the highest total nitrogen content (N = 0.68%).

Beneficial Phosphate Mineral Quality: Soil salinity that was improved with organic matter in all experimental groups with all the added benefits of phosphorus, the soil that has been improved with cow dung has the most beneficial phosphorus quality (P = 37.89 ppm).

Beneficial Potassium Mineral Quality: Soil salinity that was improved with the organic matter in all four experimental conversions with all the added benefits of Potassium, the soil that has been improved with cow dung has the most beneficial potassium quality (K = 754.05 ppm)

Generally, a guide to standard recognizing soil properties relevant to plant growth and protection suitability, the color is black or sometimes very dark brown in color. The sub-soil beneath the peaty topsoil usually has dominant grey colors, or is dark grey or black. Soil pH may also affect the availability of plant nutrients. Nutrients are most available to plants in the optimum 5.5 to 7.5 range. Soil electrical conductivity (EC) ranges 450 to 700 µS/cm, the standard soil texture class is loamy, and the primary macronutrients, such as N, P, and K quantities as 0.2% to 4.0% by dry weight. The research results are consistent with the standardized recognizing soil properties relevant to plant growth and protection suitability with the Research and development of soil salinity for agriculture in the Nongbor Plateau reservoir area, Borabue District, Maha Sarakham Province in Thailand, significantly.

ABBREVIATION

EC: Electrical conductivity (μs/cm), SS: Soil salinity (dS/m), OMS: Organic matter in soil (%), NM: Total Nitrogen mineral in soil (%), BPM: Beneficial Phosphorous mineral in soil (ppm), BKM: Beneficial Potassium mineral in soil (ppm), BFY: Before the 1st year for soil improvement, and ASY: After 60 days in the 2nd year for soil improvement.

Competing interests

Environmental science, water resource, human resource, biological science, water pollution, biological environment, ecology, environmental pollution, energy and solving-problem on human in daily life.

Availability of data and materials

The data supporting the conclusions of this article are included within the article. Any queries regarding these data may be directed to the corresponding author.

Consent for publication

Authors have agreed to submit it in its current form for consideration for publication in the Journal

Ethics approval and consent to participate

Not applicable. No tests, measurements or experiments were performed on humans (research team) as part of this work only.

Funding

This work was supported by a Grant from the National Research Council of Thailand (NRCT) with the Thai National Budget Research Scholarship.

HIGHTLIGHT

- To improve the Mahasarakham Formation's source layers, Nong Bor reservoir area.
- The true soil differentiated variables for improvement with the local organic material
- Using the Africa Sesbania Rostrata, fresh fertilizer growth plant was randomized to improve soil salinity, and suitability with seven parameters
- To identify according to before and after 60 days soil improvement technique.
- Comparisons' efficiencies between the four material treatments indicated that the plants grew suitability after soil salinity improvement and protection suitability are provided, differences, significantly

REFERENCES

1. https://www.bangkokpost.com/business/1193633/thai-organic-foods-have-healthy-growth-potentialBangkok%20Post.%20(2017).%20Thai%20organic%20foods%20have%20healthy%20growth%20potential.%20Available%20%20from%20https:/www.bangkokpost.com/business/news/1193633/thai-organic-foods-have-healthy-growth-potential
2. Chesworth, W. (2008). Encyclopedia of soil science (PDF). Dordrecht, the Netherlands: Springer. ISBN 978-1402039942. Available on 17 December 2017.
3. Danoff-Burg, J.A. (2017). The terrestrial influence: geology and soils. Earth Institute Center for Environmental Sustainability. New York, New York: Columbia University Press. Available 17 December 2017.
4. http://www.fao.org/aquastat/en/countries-and-basins/country-profiles/country/THAFood%20and%20Agriculture%20Organization%20of%20the%20United%20State.%20(2011).%20Geography,%20climate%20and%20population%20of%20Thailand.%20Available%20from%20http:/www.fao.org/nr/water/aquastat/countries_regions/THA/
5. Hewitt, A. (2004). Soil properties relevant to plant growth: a guide to recognizing soil properties relevant to plant growth and protection. Lincoln, N.Z. : Manaaki Whenua Press. Landcare Research Science Series, ISSN 1172-269X ; No. 26).
6. https://www.intracen.org/exporters/organic-products/country-focus/Country-Profile-Thailand/International%20Trade%20Center.%20(2012).%20Country%20profile%20Thailand.%20Available%20%20from%20http:/www.intracen.org/exporters/organic-products/country-focus/Country-Profile-Thailand/
7. Kohyama, K., & Subhasaram, T., (1993). Salt-affected Soils in Northeast Thailand: Their Salinization and Amelioration. Technical Paper No.12. Agricultural Development Research Center in Northeast, Khon Kaen Province, Thailand.
8. Land Development Department. (2009). Provincial soil salinity map 1:100,000 scale. Soil Survey Division, Land Development Department, Ministry of Agriculture and Cooperatives.
9. McCarthy, D. F. (2006). Essentials of soil mechanics and foundations: basic geotechnics (7th ed.). Upper Saddle River, New Jersey: Prentice Hall. ISBN 978-0131145603.
10. Mitsuchi, M., Wichaidit, P., & Jeungnijnirund, S. (1986). Outline of soils of the Northeast plateau Thailand. Technical. Paper No. 1, ADRC.
11. Moncharoen, P., & Wiensil, T. (2001). Carbon in soils of Thailand. Soil Analysis Division, Land Development Department, Ministry of Agriculture and Cooperatives. Bangkok. Thailand.
12. Mongkolsawat C., &Thirangoon, P. (1990). A Practical application of remote sensing and GIS for soil salinity potential mapping in Korat Basin, Northeast Thailand. Khon Kaen University. (PDF) GIS Application to Spatial Distribution of Soil Salinity Potential in Northeast Thailand. Available from: https://www.researchgate.net/publication/266473819_GIS_Application_to_Spatial_Distribution_of_Soil_Salinity_Potential_in_Northeast_Thailand [accessed Dec 26 2018].
13. Moorman, F. R., Montrakun, S. & Panichapong, S. (1964). Soils of Northeastern Thailand, a key to their identification and survey. Land Development Department, Bangkok, Thailand.
14. Passage, S., Karukoat, J., Nuesri, C., Lhiumsingkorn, W., & Kanjuk, A. (2012). Saline soil improvement for glutinous rice (Oryza sativavar. glutinosa) planting. Available from https://programming.cpe.ku.ac.th/AgriInformatics/viewProject.php?itemID=4571
15. Piesse, M. (2017). Thai farmers oppose national water resources bill: Are rougher political conditions ahead? Future Directions International. Available on 2 November 2017.
16. Potichan, A. (2013). Soil maps and soil information of Thailand. Land Development Department, Ministry of Agriculture and Cooperatives, Bangkok, Thailand Available from http://library.wur.nl/isric/fulltext/isricu_i34282_001.pdf
17. Poapongsakorn, N., & Chokesomritpol, P. (2017). Agriculture 4.0: Obstacles and how to break through. Thailand Development Research Institute (TDRI). Available on 15 September 2017.

18. Shrivastava, P. & Kumar, R. (2015). Soil salinity: A serious environmental issue and plant growth promoting bacteria as one of the tools for its alleviation. Saudi Journal of Biological Science, 22(2): 123–131. doi: 10.1016/j.sjbs.2014.12.001
19. Thai Land Development Department. (2013). Classification and kind of soil. Available from http://www.ldd.go.th/ldd_en/en-US/classification-and-kinds-of-soil/
20. Wada, H. (2011). Managing sandy soils in northeast Thailand. Formally of CSIRO Land and Water, Davies Laboratory, Townsville Australia now with International Water Management Institute, Bangkok Thailand.
21. Wongsomsak, S. 2010. Salinization in Northeast Thailand (Problem soils in Southeast Asia). Research Gate. Available from https://www.researchgate.net/publication/32159844_Salinization_in_Northeast_Thailand_Problem_Soils_in_Southeast_Asia
22. Yuwaniyom, A. (2003). Soil salinity management in the Northeast of Thailand. Soil Salinity Research and Development Section. Institute to Prevent Desertification and Warning Land Development, Ministry of Agriculture and Cooperatives. Available from http://www.sri.cmu.ac.th/~environment/Download/050505.pdf