Perspective and Research Concept note to Asia Hub Collaboration

Land Development Department, Thailand

Date : 7 September 2023

Assessment of some land degradation indicator impact to balance of food and energy sources of Cassava production in Thailand

Concept Note : Land Development Department

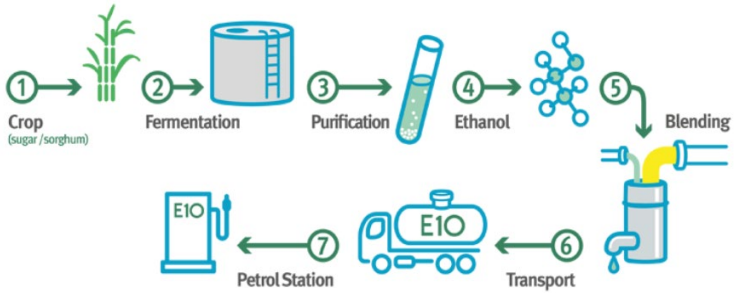
Presenter : Dr. Sasirin Srisomkiew
Agricultural Research Officer, Professional Level
Research and Development for Land Management Division

Dr. Nuanjun Chaba
Expert of Soil Biotechnology
Soil Biotechnology Division

Background

Cassava is one of the crops that is suggested as the best raw material for ethanol production, simply turned into dried chips. The chips with extended shelf life can be stored and distributed to the ethanol industry when required (*Fathima et al., 2022*).

Thailand is the **3rd largest** cassava growing area in the world after **Nigeria** and **Brazil**. In addition, Thailand is the **world's number one exporter** of cassava products. Therefore, domestic demand for cassava tends to increase both in the food industry and demand to produce ethanol.

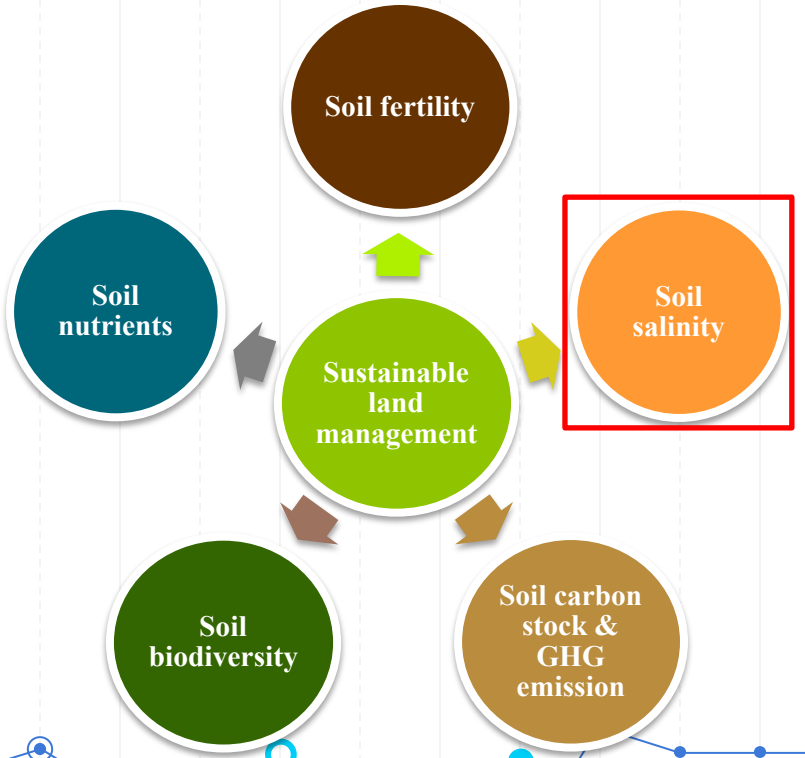


Problem Statement

Several published papers showed that long-term cassava cultivation leads to soil erosion & land degradation because cassava in Thailand is always grown on low fertility sandy soils without any soil improvement or soil and water conservation.

Cassava uptakes large amounts of soil nutrients such as nitrogen (N), phosphorus (P), and potassium (K) from the soil (*Howeler, 1991, Sumithra et al., 2013*).

Therefore, **soil fertility information** and **soil nutrient statuses** are essential for increasing cassava production and achieving **sustainable land management (SLM).**



Sub Project: 1 The application of deep learning and RS data to assess soil salinity distribution and suitable land management approaches for increasing cassava production in Maha Sarakham Province

Researchers:
1. Dr. Sasirin Srisomkiew, Land Use Planning and Policy Division, LDD
2. Ms. Raviya Thongyon, Soil Resources Survey and Research Division, LDD
3. Mr. Wilailak Sunsangjaroen, Soil Resources Survey and Research Division, LDD

Remote sensing (RS) data have been widely used for **digital mapping** of both physical and chemical soil properties that provide new opportunities to improve soil information systems. **The satellite images** can quickly and accurately extract **soil environmental factors**, which reduce the laboratory work and field surveys that can solve the problems of time and cost-consuming processes.

Objectives

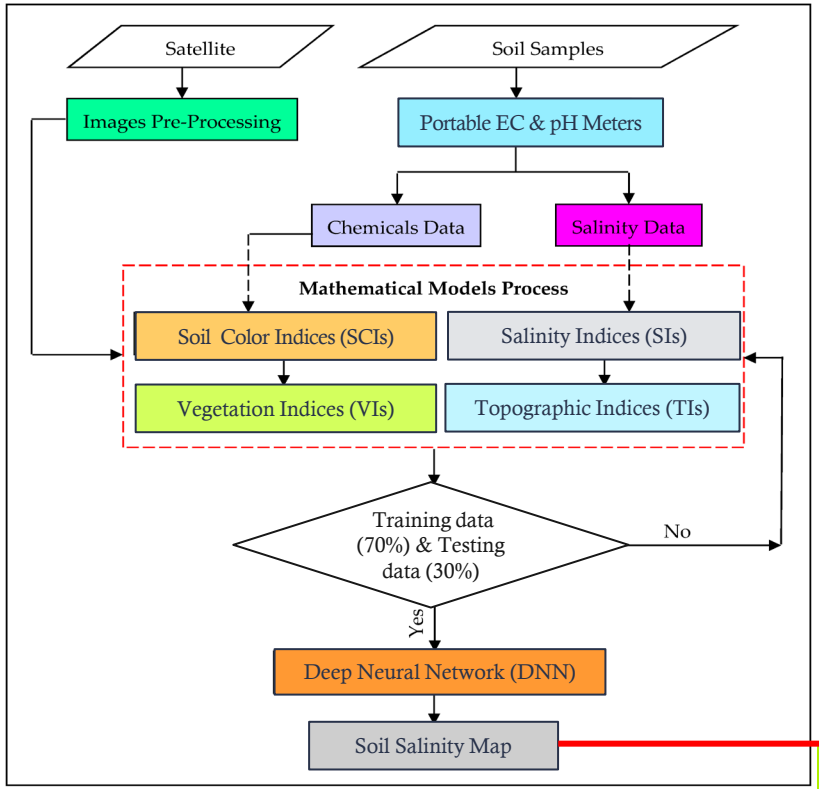
1. To apply **digital soil mapping (DSM) technique** to assess **soil salinity distribution** in Maha Sarakham Province by using related soil & environmental factors.

2. To determine the relationship between **soil salinity** and **plant health status** and **yield of cassava**.

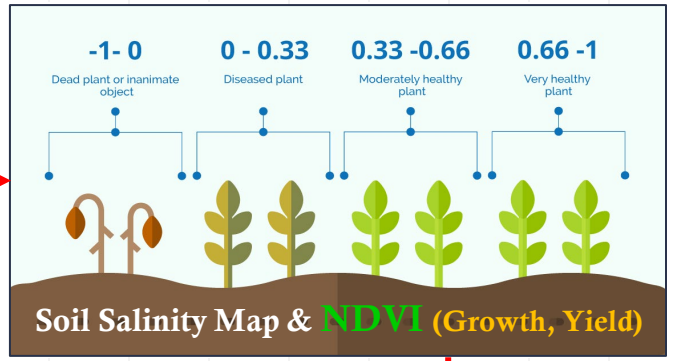
3. To determine **suitable land management approaches** to increase cassava productivity and reduce **land degradation** in the future.

Methodology

Step 1



Step 2



Step 3

Materials

Soil Direct EC/ ℃ Tester

Horiba Laquatwin pH-22

Horiba Laquatwin EC 33

Soil pH – Moisture Meter

Soil Sampling

Measuring Plant Growth

Interview Farmers








Expected outputs

1. The digital map of soil salinity in this research was developed using soil indicators and environmental variables derived from spectral indices and topographical indices at the **provincial level**. This allows for a more accurate determination of the soil salinity distribution which is an agricultural constraint.

2. The relationship between **plant health information** (at an appropriate time) and **yield of cassava** with **soil salinity**. It can be used as basic information to find suitable soil/land management approaches in each area to increase the yield of cassava in the future.

3. This information is important for **sustainable land management** and helps **reduce land degradation** in Maha Sarakham Province, helping farmers increase the potential of their land for cassava production.

Duration and budget

Research duration: **2566 (1 years)**

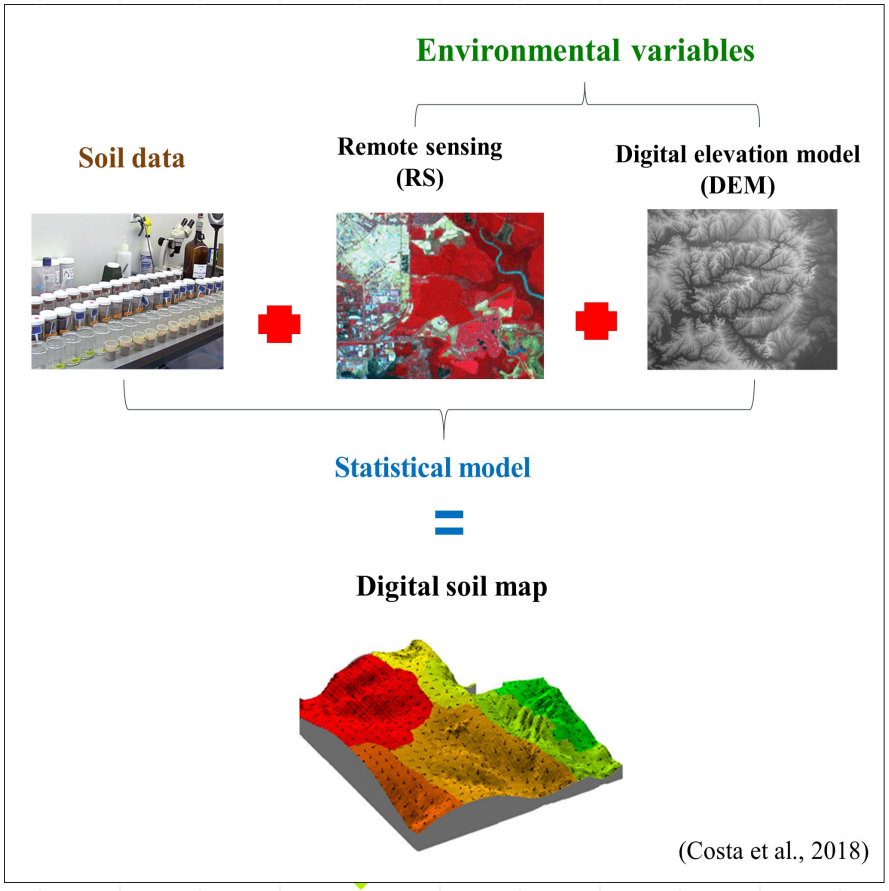
Sub Project : Assessment and monitoring changes of soil nutrients in Cassava plantation in the Maha Sarakham province

2

Researchers:

1. Dr. Sasirin Srisomkiew, Land Use Planning and Policy Division, LDD
2. Ms. Somjit Lertdisayawan, Land Use Planning and Policy Division, LDD
3. Ms. Tanomkwan Tipwong, Research and Development for Land Management Division, LDD

Presently, many countries have adopted **digital soil mapping (DSM) techniques** to estimate soil properties and create high-resolution soil maps. The DSM was designed to overcome the limitations found in the conventional soil mapping (CSM) approach, where soil data were rarely revised because of the **costly and time-consuming processes** involved in generating the soil maps (*Fathololoumi et al., 2020*).



Digital Soil Mapping (DSM)

DSM technique can predict spatial soil information using **statistical models** built on the interrelationship between **soil properties** and **environmental variables** derived mostly from digital elevation models (DEM) and remote sensing (RS) data (*Song et al., 2020*).

Digital soil maps will be useful information for effective soil management in the area. This will save a lot of time, budget and human resources for creating the **soil nutrient map**.

Objectives

1. To identify the important **spectral & topographic** indices for predicting various soil properties.

2. To create the digital soil maps of various soil properties using the **machine learning (ML) model**.

3. To assess the **soil nutrient level** in the Maha Sarakham province of Thailand.

Expected outputs

1. **The digital soil maps** can provide important information for indicating the soil nutrients level in the Maha Sarakham province.

2. **Soil information** for decision-making support to improve soil nutrients and monitor soil conditions for long-term trends.

3. **Soil information** from these digital maps can assist land users to determine the extent of crop nutrient deficiencies in their farmlands and use suitable soil management to improve the soil nutrients.

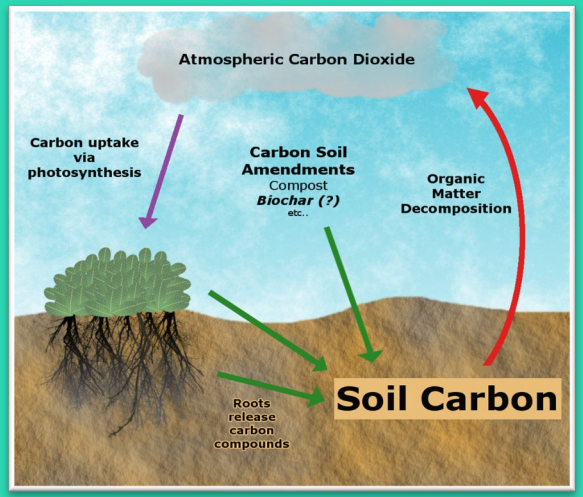
Duration and budget

Research duration: **2566 – 2568 (3 years)**

Sub Project : Assessment and monitoring changes of soil organic carbon sequestration and GHG emissions in the cassava plantations of Maha Sarakham province

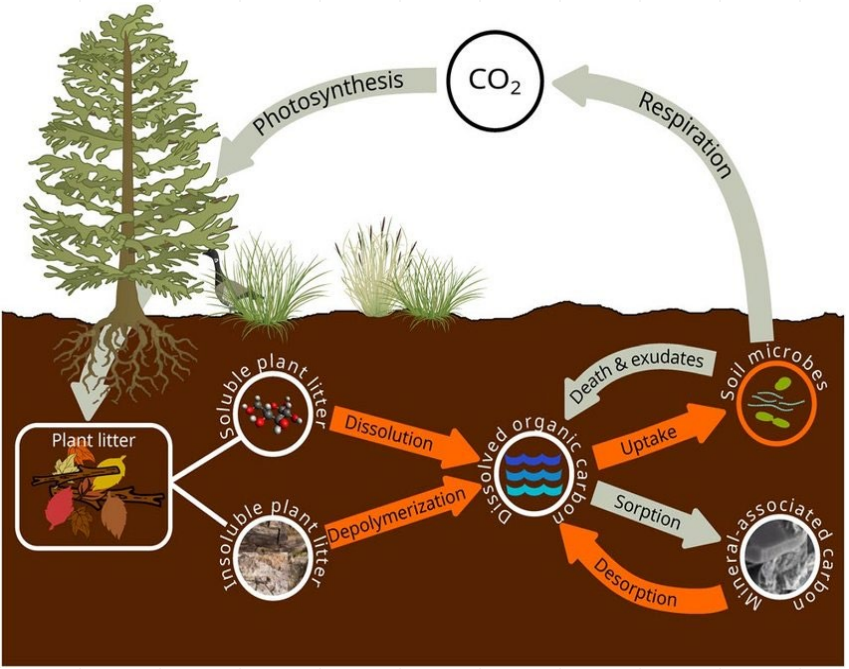
3

Researchers:
1. Mr. Wattana Phatthavorn, Soil Survey and Soil Resource Research Division, LDD
2. Ms. Preeyarat Chailangka, Policy and Land Use Planning Division, LDD



The cassava management practices including tillage practice, nitrogen fertilizer application, cassava harvesting and residue management are the **factors in controlling methane (CH_4) and nitrous oxide (N_2O) emissions** (*Sriphirom et al., 2020; Arunrat et al., 2021*). However, the agricultural land also has ability to remove the GHGs from the atmosphere if there are special management practices for the agricultural area.

Soil Organic Carbon (SOC)



SOC is the importance indicator to evaluate sustainable land management in the agricultural area. Therefore, the balance of sequestration and emission processes of carbon is necessary to determine and monitor to set the baseline and compare changes of **soil organic carbon stock** and **GHG emissions** in such area.

Objectives

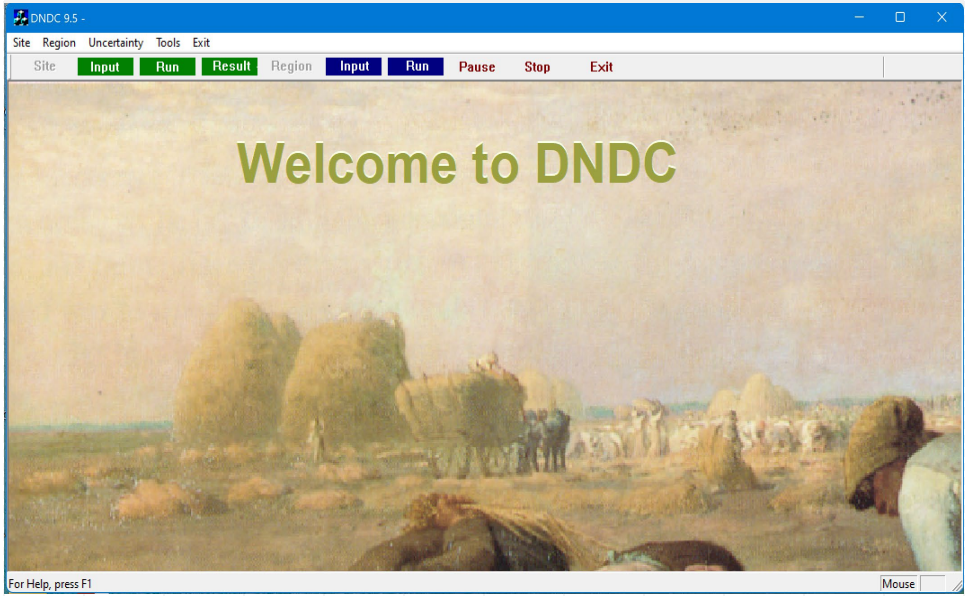
1. Studying and monitoring changes of **carbon sequestration and GHG** emissions in the cassava cultivation area.

2. Compare content of **carbon sequestration** and **GHG emissions** in different field management practices in the cassava cultivation area.

3. Simulate the long-term (2023-2050) of different scenarios of cassava field management to find the optimal mitigation way to **reduce GHG emissions** and increase **soil organic carbon stock**.

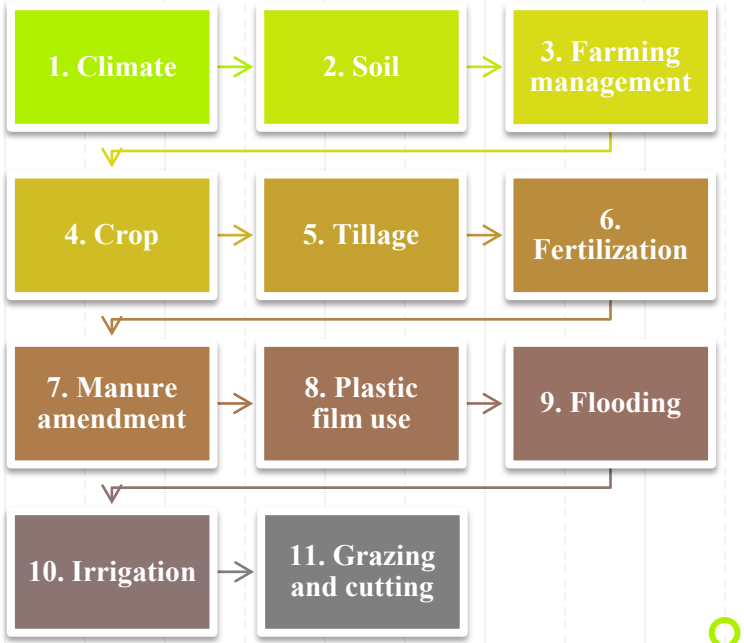
Methodology

Denitrification-Decomposition (DNDC) model



DNDC model is a computer simulation that has been developed for carbon and nitrogen cycling prediction in agroecosystems (*Li et al., 1994*).

Input Parameters



Expected outputs

1. **Baseline business** as usual of soil carbon stock and GHG emissions 2023-2050 in the cassava cultivation area.
2. **The soil carbon stock** and **GHG emissions 2023-2050 model** simulations of different cassava field management practices.
3. **The optimal cassava field management option** of the sustainable agricultural land management practice.

Duration and budget

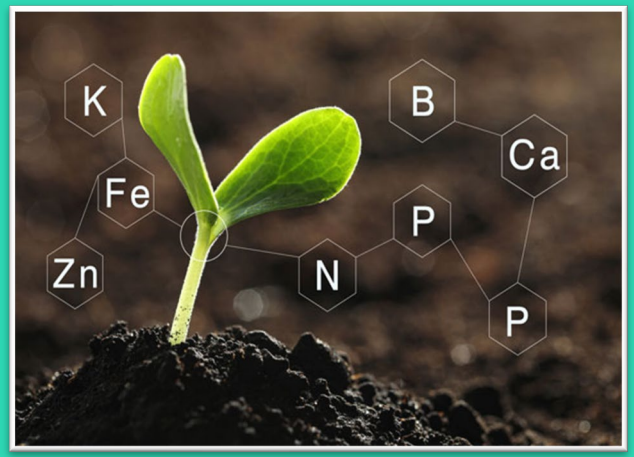
Research duration: **2566 – 2568 (3 years)**

Sub Project : Assessment and monitoring changes of soil fertility by digital soil mapping for Cassava plantations in the Maha Sarakham province

4

Researchers:

1. Dr. Sasirin Srisomkiew, Land Use Planning and Policy Division, LDD
2. Dr. Raviya Thongyon, Soil Resources Survey and Research Division, LDD
3. Ms. Kanokwan Chearphan, Research and Development of Biotechnology, Soil and Water Pollution Management Division, LDD



The spatial distribution of **soil fertility** using DSM is the key element for sustainable land management. However, the prediction of soil fertility is not easy because of its complex soil properties and requires soil datasets that are collected by soil surveys to estimate soil fertility indicators (Arrouays et al., 2020).

Objectives

1. To perform a principal component analysis (PCA) to extract an appropriate **soil indicator** of soil fertility.

2. To create a **digital soil map of soil fertility** using machine learning (ML) model.

3. To verify the **soil fertility map** by comparing it with the ground truth data.

Expected outputs

1. **The information** on the spatial distribution of soil fertility can be applied for the high yield and healthy growth of cassava in the future.

2. **The government and related agencies** can utilize the information of soil fertility and cassava productivity to set policy and standard farm management practices for the farmers and improve soil fertility.

3. **The DSM technique and knowledge** in this study can transfer to other region to make the digital soil maps of entire Thailand.

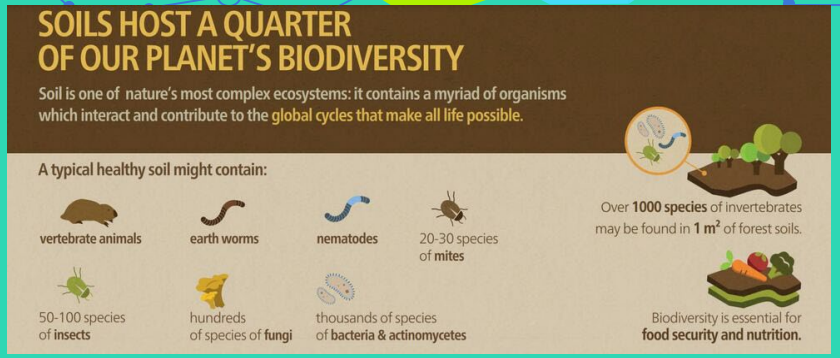
Duration and budget

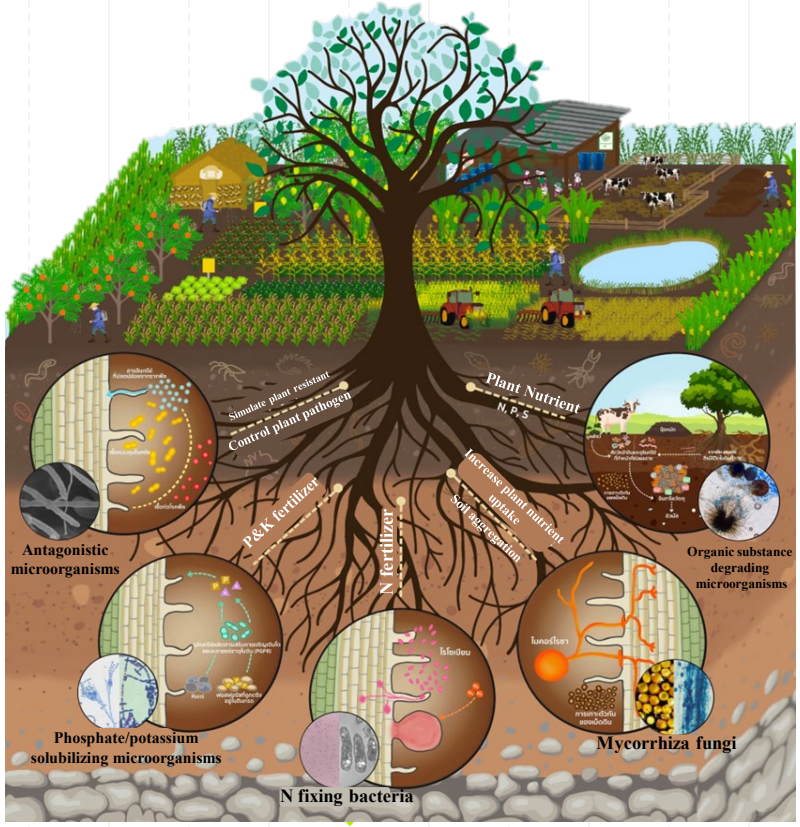
Research duration: **2566 – 2568 (3 years)**

Sub Project : Study on changes of soil biodiversity at above and under ground of different soil management in Cassava plantations in the Maha Sarakham province

5

Researchers:
1. Dr. Nuanjun Chaba, Soil Biotechnology Division
2. Ms. Panida Preepremmot, Soil Biotechnology Division
3. Dr. Dararat Hotaka, Soil Biotechnology Division





Biodiversity properties of the aboveground and underground soils are essentially involved in the cycle of plant nutrient transformation in the soil, which is the process of decomposition and degradation and as a source of both nutrients and energy of microorganisms and it is also a **source of plant nutrients** in that area.

Biological properties is an indicators of soil quality in plant production. (Riches *et al*., 2013).

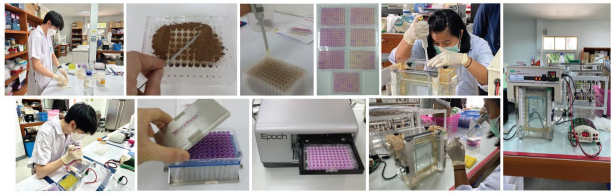
This information will be very useful in identifying the **ecosystem services availability** and **guidelines for soil management** for sustainability in the future.

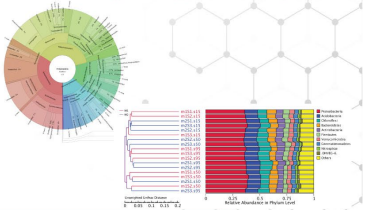
Study on soil biodiversity in Thailand

Research on soil biodiversity

- Soil microbial diversity in forest, agricultural area and organic farm.

- Soil fauna diversity in forest, agricultural area and organic farm.
- Soil microbial activities, biomass and community for plant production in good agricultural practice





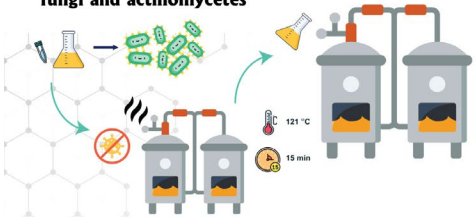
Utilization of soil biodiversity to : microbial product development

- Research on isolation and selection of beneficial microorganisms for agriculture and environment.

- Research and development on microbial formulation

LDD microbial product development

1. Cultivation of yeast, bacteria, fungi and actinomycetes



2. Inoculants mixing with carrier

3. Packaging

LDD microbial product

1. Microbial products for soil improvement, increasing plant nutrients and plant growth hormones

2. Microbial products for biocontrol

3. Microbial for environment

Objectives

1. Study and monitoring **changes of soil biodiversity** at above and under soil surface in Cassava plantation areas.

2. Identify and analyze **kind & number** of soil biodiversity at above and under soil surface of Cassava plantation areas.

3. Compare kind and number of living organisms and microorganism at above and under soil with **different soil management**.

4. Evaluate sustainable soil management to **preserve & conserve** soil biodiversity in such research area.

Methodology

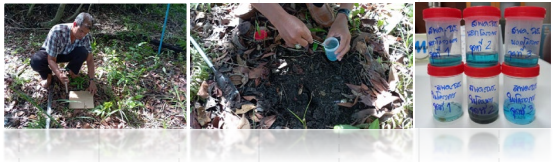
Select some of effective microorganisms

Select some of effective microorganisms in saline soil for utilization in **soil improvement, restoration or increase soil productivity** & **plant growth**.

Estimate soil fauna biodiversity

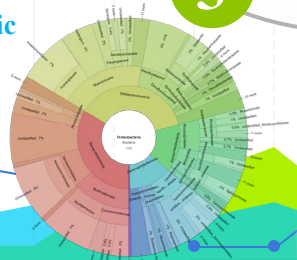
soil fauna on aboveground and **in soil surface layer** :

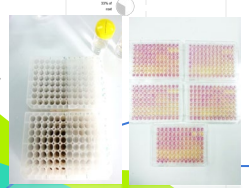
- Phylum Arthropoda (articular invertebrates)
- Phylum Nematoda (round worms)
- Phylum Annelida (segmented worms)



Estimate soil microbial diversity and activities

- **Soil microbial diversity** using **metagenomic pyrosequencing technique** by Novogene Bioinformatics Technology Co., Ltd., China.
- **Microbial activities** using **MicroRespTM technique** (Campbell *et al*., 2003).



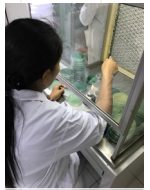


Soil sampling

- **Soil samples** will collected at a depth of **0 - 15 cm** with **different soil management**.
- **The samples** will collected for **3 time periods** (preparing the plot, growing season, and after harvesting).

Analysis of beneficial microorganisms:

Quantitative analysis of 6 groups: Cellulolytic bacteria, cellulolytic fungi, cellulolytic actinomyces, nitrogen fixating bacteria, phosphate solubilizing bacteria, and phosphate solubilizing fungi



Expected outputs

1. **The database of soil biodiversity** is developed as the base line of each soil managements for further research activities to compare some changes of such data.

2. **This research** will use the guidelines for monitoring of soil biodiversity by **FAO 2021** & **other methods** to full fill the basis necessary data. This methodology should be useful for the future research work.

3. **Some of sustainable land management** of cassava plantation will identify by using such soil biodiversity as the one indicator for consideration.

4. Some of selected **effective microorganisms** will identify and study more for utilization in soil improvement and restoration in future especially in sandy and saline soil.

Duration

Research duration: **3 years**

Thank you

Future Research under the Collaboration between Land Development Department and Asia Hub

Concept Note : Land Development Department

Presenter : Dr. Sasirin Srisomkiew

Agricultural Research Officer (Professional Level)

Policy and Land Use Planning Division

Date : 7 September 2023

Development and Collaboration in the Future

Training/ Workshop

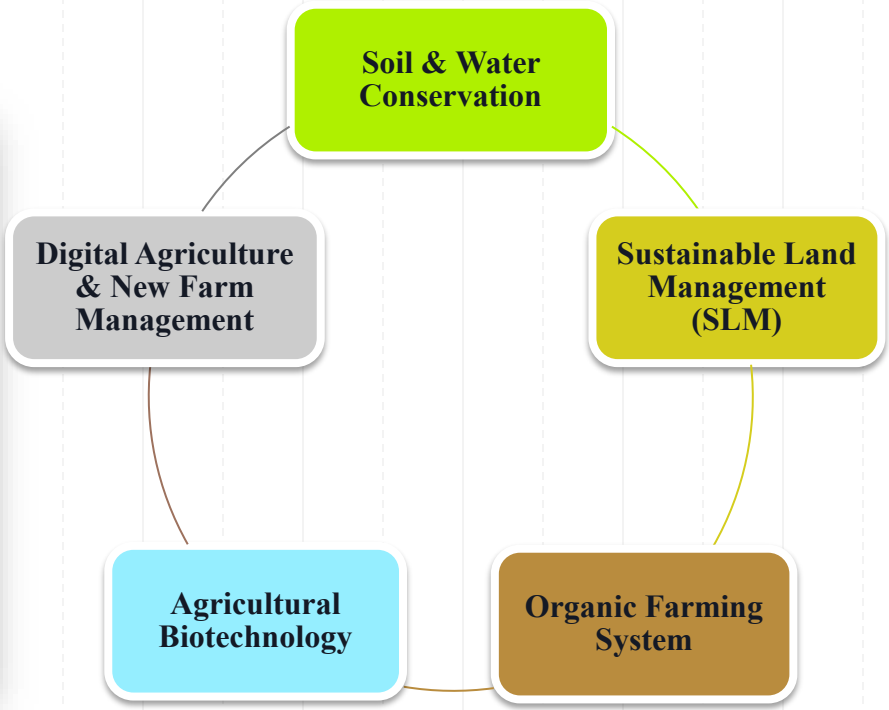
1. Artificial Intelligence & Machine Learning
2. Digital soil mapping (DSM)
3. Greenhouse gas emissions
4. Carbon stocks and changes maps
5. Biodiversity and Ecosystem in soil

Equipment & Technology

- High-resolution Satellite image
- Environmental weather station
- Laboratory Equipment
- Hardware & Software programs
- Machinery, Robots, Drones
- Applications

Study Tours


โครงการศึกษาดูงานและอบรมเชิงปฏิบัติการ
Yuxi Normal University
ณ ประเทศสาธารณรัฐประชาชนจีน
ระหว่างวันที่ 8 - 23 ตุลาคม 2561
โดย คณะครูโรงเรียนอนุบาลเชียงใหม่


Soil & Water Conservation
Sustainable Land Management (SLM)
Organic Farming System
Agricultural Biotechnology
Digital Agriculture & New Farm Management

Conferences

- Networking for future collaborations
- Presenting papers
- Skills Development
- Publication
- Added Research Value
- Opportunity
- Find out what's new

Research Collaboration & Networks

Scholarship

- Bachelor Degree
- Master Degree
- Doctoral Degree
- Postdoctoral
- Short Courses

Thank you

Any questions?

You can contact me at

sasirin.09ldd@gmail.com

sasirin@ldd.go.th

Tel. +66 612704977