

Developing the potential of agricultural areas caused by climate change Ban Pla Bu, Nong Saeng Subdistrict, Wapi Pathum District Maha Sarakham province

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Abstract - The objective of this research is to: 1) study the impact of climate change on water and soil salinity in agricultural areas, 2) develop risk maps for water and soil salinity in agricultural areas and propose a corresponding mobile application, and 3) enhance soil quality using biotechnological products derived from bacteria to support crop growth in areas with limited water resources. The research is conducted through a participatory action research approach, with the target community being the residents of Plabu Village, Group 14, Nong Saeng Sub-district, Waeng Pa Thum District, Maha Sarakham province. This small village, with approximately 250 residents in 80 households, relies on agriculture, including rice cultivation, animal husbandry, and vegetable gardening, covering an average of 22 acres per family. The project findings include: 1) climate change impacts, such as 1.1) increased flood risks in the southern part of the village, and 1.2) drought risks affecting agricultural areas heavily dependent on natural water sources for rice cultivation, 2) the development of risk maps for water and soil salinity revealed natural limitations in soil salinity and water quantity and quality. Local policies promoting shared water resource management are crucial for addressing these challenges, and 3) the creation of the “Water and Soil Salinity in Agricultural Area: WSSA” app, utilizing data from meteorological radar, rainfall, river water levels, soil salinity, and presenting risk maps through community forums. Furthermore, the research explored the use of biotechnological products from bacteria, specifically the collaboration with the Department of Land Development’s Super PD 2 formula, to improve soil quality. Initial feedback from

collaborating farmers, Thanyarat Suriyakant and Siwakarn Khongsri, indicated satisfaction with reduced production costs and a shift towards organic farming. Crop yields from fields using biotechnological products were notably higher, with a 15% increase in rice production compared to non-treated fields. Despite positive outcomes, the target group still seeks continuous support from government or other agencies to address agricultural challenges arising from climate change, ensuring sustainable livelihoods and resilience in the face of environmental changes.

Keywords: Climate change, saline agriculture, saline soils

1. Background

Drought refers to the disaster resulting from prolonged water scarcity in a specific area, leading to dryness and adversely affecting the livelihoods of people in the community. Regions facing drought issues in Thailand often stem from periods of reduced rainfall and seasonal dry spells, causing insufficient water for agriculture and daily living. The northeastern part of the country has long experienced drought problems, primarily due to extended periods of reduced rainfall, typically from July to September each year (Meteorological Department, Ministry of Agriculture and Cooperatives). According to the Land Management Planning group's report in 2014, the Nong Saeng Sub-district in Waeng Pa Thum District, Maha Sarakham province, is an area repeatedly affected by severe drought, occurring 4-5 times within a 10-year period. This problematic drought area covers approximately 7,566 acres (Land Development Department, Ministry of Agriculture and Cooperatives). Presently, global climate change intensifies the severity and expands the coverage of drought-affected areas. Thailand is experiencing a rising trend in temperatures, estimated at 1.04-1.80 degrees Celsius over the next 100 years, along with a consistent decrease in rainfall over the past 30 years (Tan & Pereira, 2011). In addition to causing water shortages for both consumption and agriculture, drought exacerbates soil salinity issues. The problem often arises from excessive digging of groundwater wells beyond established limits for domestic water use. This, in turn, leads to the rapid spread of saline soil to adjacent areas, adversely impacting a wide agricultural region (Faculty of Humanities and Social Sciences, Mahasarakham University, 2020).

The area in Nong Saeng sub-district, Waipipat district, Maha Sarakham province, is the sub-district with the highest number of villages in Thailand, totaling 28 villages. The agricultural area covers 30,708 acres, with rice cultivation spanning 29,854 acres, accounting for 97% of the total agricultural area. The topography of Nong Saeng sub-district is generally characterized by low hills with flooded areas. The soil is predominantly loamy with some sand, and the soil quality has deteriorated due to a lack of maintenance and proper adjustments. During the dry season, the sandy soil causes water retention issues, while in the rainy season, flooding occurs. The rice cultivation areas are divided into highly suitable areas covering 20,671 acres (46.79%), moderately suitable areas covering 6,620 acres (14.99%), and unsuitable areas covering 2,754 acres (6.23%). Additionally, there is a risk of salinity in the target areas, with more than

50% salt crust found in some locations. The region also faces recurring drought issues, further complicating agricultural activities. As a result, agriculture in areas with soil salinity problems tends to yield lower productivity, and farmers may struggle to fully utilize the land. It is essential for the local authorities and farmers to implement soil management practices to address the salinity and drought issues, thereby improving agricultural productivity and ensuring sustainable land use. The natural occurrence of soil salinity combined with the escalating drought conditions can directly impact agricultural productivity, particularly in terms of low yields and suboptimal crop quality. This issue directly affects the income of farmers and poses a challenge to meet market demands. Therefore, there is a need to develop agriculture, specifically rice cultivation, in saline soil areas with limited water, aiming to achieve standards comparable to normal rice cultivation conditions. The use of beneficial microorganisms, particularly those supporting plant growth, has gained attention as a potential solution. Studies have reported that the application of these microorganisms plays a role in improving soil quality and promoting the growth of crops under drought and saline conditions (Delshadi *et al.*, 2017; Numan *et al.*, 2018). In this study, the focus is on producing bioproducts from the *Streptomyces* sp. bacteria, which is a genus of bacteria known for its benefits in supporting continuous plant growth. Specifically, the *Streptomyces* sp. strains, namely *Streptomyces* sp. isolates SEF11, SEF28, and SEF37, have demonstrated the ability to produce indole-3-acetic acid under conditions with a sodium chloride concentration of 2.55%. The use of cell culture extracts from all three *Streptomyces* sp. isolates shows a tendency to stimulate the germination of rice (*Oryza sativa*) seeds, particularly those of the Khao Dawk Mali 105 variety. The cell culture extracts from *Streptomyces* sp. isolates SEF4 and SEF11 also exhibit a tendency to promote shoot growth in Khao Dawk Mali 105 rice plants (Somtrakul *et al.*, 2019). Furthermore, *Streptomyces* sp. isolate SEF11 has been found to stimulate the growth of the roots of glutinous rice (Khao Niew, variety Kao 6) under slightly saline and moderately saline conditions (Somtrakul *et al.*, 2020). It is anticipated that the bioproducts developed by the research team from *Streptomyces* sp. will contribute to enhancing plant growth and assisting rice cultivation in conditions with salinity and limited water, resulting in growth and yields that closely resemble those of normal rice cultivation.

The analysis of the targeted area has provided the research team with insights into the pressing issues. Consequently, this research aims to focus on studying the impacts of climate change on water and soil salinity in agricultural areas. The goal is to develop a risk map for water and soil salinity in agricultural areas. Additionally, the research team will introduce the “Water and Soil Salinity in Agricultural Area: WSSA” application, designed for monitoring and early warning for the general public and relevant organizations. The research team anticipates that the results obtained from this study can be applied by farmers in the target area to mitigate the damage to agricultural yields caused by disasters such as droughts, floods, and soil salinity. This application aims to enhance the income and sustainability of farmers by providing timely information and strategies to cope with agricultural challenges. Moreover, the findings from this research can be utilized by relevant organizations to plan and promote agriculture or alternative

livelihoods that are suitable for the agricultural context in the target area. This strategic planning can contribute to the overall development of the agricultural sector and other related professions, ensuring efficiency and sustainability in the target region.

2. Objectives

To analyze the impact of changes in climate on water and soil salinity in the agricultural area of Nong Saeng Sub-district, Wapi Pathum District, Maha Sarakham province.

To develop a risk map for water and soil salinity in the agricultural area of Nong Saeng Sub-district, Wapi Pathum District, Maha Sarakham province.

To improve soil conditions for crop cultivation in agriculture by using bio-products derived from bacteria that support plant growth, particularly in situations with limited water resources.

To present the “Water and Soil Salinity in Agricultural Area: WSSA” application for public and relevant organizations to check agricultural areas.

3. Operating period

From October 1, 2020 to September 30, 2021

4. Target group

The people residing in Pla Bu Village, located in Moo 14, Nong Saeng Sub-district, Wapi Pathum District, Maha Sarakham province, as depicted in Images 1-2, live in a small rural community. The village has an approximate population of 250 individuals distributed among 80 households. The primary occupations of the villagers are agriculture, rice cultivation, livestock farming, and vegetable gardening. The average landholding per family is around 22 rai, utilized for agricultural purposes. The villagers heavily depend on natural water sources, mainly rainwater and the Siew River, which serves as the main river for agricultural activities and animal husbandry. Additionally, some residents engage in daily-wage work within Wapi Pathum District. There is a seasonal migration of laborers to Bangkok for income generation, with a return to their homes during the rice cultivation season. Moreover, there is a permanent migration of some individuals.

5. Project implementation/activities/evaluation methods

Analyzing the impact of climate change on water and soil salinity in the agricultural area of Nong Saeng Sub-district, Wapi Pathum District, Maha Sarakham province, to

develop a risk map for water and soil salinity in the agricultural area of Nong Saeng Sub-district, Wapi Pathum District, Maha Sarakham province. The objectives in point 2 consist of two action plans, both successfully implemented. Each action plan has the following work processes:

1.1) Farmers reflect on lessons learned through two methods: online surveys and organizing reflection forums. Agriculture practices related to water resources in the area include surface water and groundwater. Constraints in utilizing water resources, both in terms of quality and quantity, are considered, along with the interconnection of soil, water, and weather conditions. This allows farmers to reflect on current agricultural challenges and adjust and develop businesses in alignment with their own resources. Understanding the community's agricultural costs and factors related to agricultural development, including cooperative development with the local development plan of the Nong Saeng Sub-district administration, aids in sustainable development. Image 1 illustrates activities reflecting the lessons learned by farmers, and Image 2 shows planning activities for soil sample collection with the participation of local residents.



Figure 1 Atmosphere of reflection on lessons learned by the Ban Pla Bu community (July 4, 2021)

2) The area survey involves measuring water quality and developing the potential of local researchers. This step is conducted within the study area, measuring 1.5 x 1.5 square kilometers (latitude from 15.810397 to 15.82406 oN and longitude from 103.317241 to 103.331131 oE). The survey includes walking through the area, measuring water quality with local researchers and youth, dividing it into 7 surface water

points (6 within the study area) and 4 groundwater points (1 within the study area). The measurement methods are outlined in Table 1, emphasizing collaborative learning for local researchers and youth to understand water quality values using scientific instruments. The goal is for them to explain phenomena such as water limitations for crop cultivation and efficiently plan water usage in the area. They can also communicate this information to other farmers in the region for adaptive measures. Image 3 depicts the atmosphere of water quality measurements with local researchers and youth, while Image 4 shows the condition of water sources, including the beneficial village river, Siew River, and Pla Bu Canal.

Table 1. Analysis methods and details of measuring instruments

Variable	Unit	Analytical method	Model	Country of manufacturing
pH	None	pH Meter	HACH HQ30D	USA
(Electrical Conductivity; EC	$\mu\text{S/cm}$	EC Meter	Yieryi C-600A	China
Temperature; Temp	$^{\circ}\text{C}$	Temperature Meter	EUTECH Instruments CD650 Serial No. 551685	Singapore
Dissolved Oxygen; DO	mg/l	DO Meter		
(Total Dissolved Solid; TDS)	ppm	TDS Meter		
NaCl	ppm	Salinity Meter		

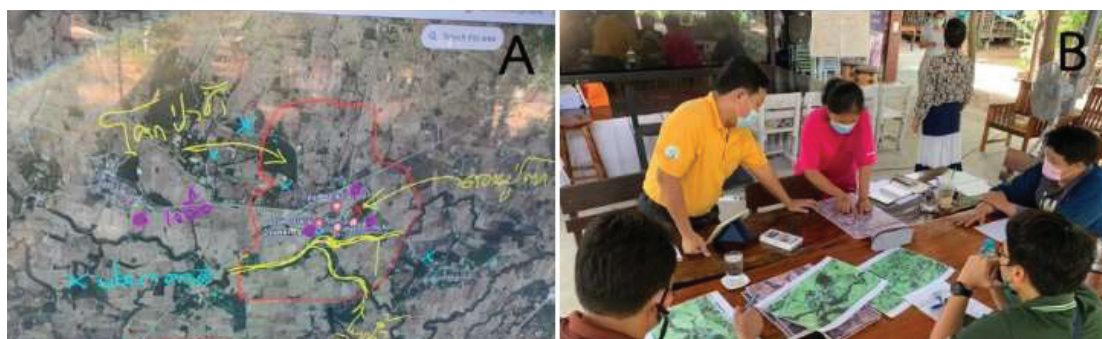


Figure 2. Activity to plan soil sample collection with villagers (26 June 2021)



Figure 3. Atmosphere of water quality measurement together with researchers, villagers and local youth

3) The analysis of water flow paths utilizes KU Modified STRM DEM data developed by Sutheerat with a spatial resolution of 90 meters. The reclassification technique is employed to enhance the spatial resolution to 12.5 meters. The analysis involves examining the flow direction of water, incorporating land use and land cover data from the year 2017 provided by the Department of Land Development in 2020. ArcMap software version 10.5 is utilized for this purpose.

4) Statistical analysis in this study includes descriptive statistics such as mean and standard deviation. Additionally, correlation analysis is performed using the Pearson Product Moment Correlation Coefficient. The statistical software SPSS (Statistical Package for the Social Sciences) is utilized for these analyses.

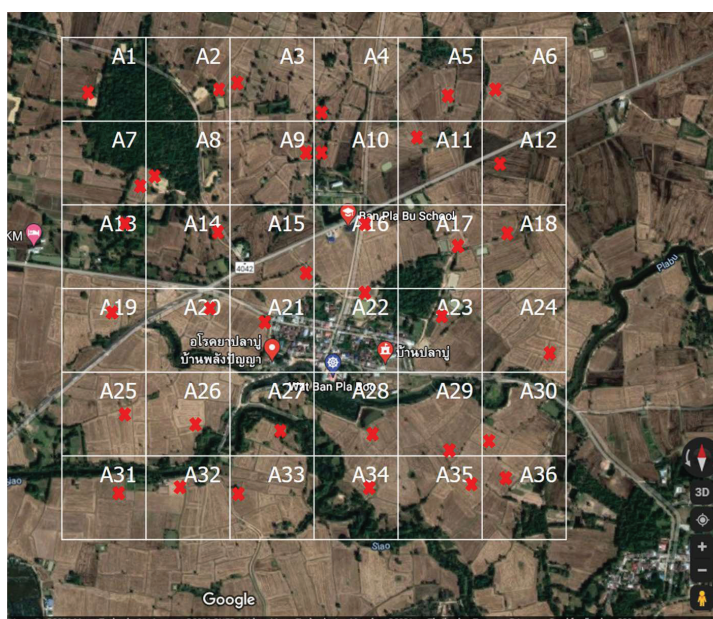


Figure 4. Soil sampling and preparation

5) Soil sampling and preparation were conducted by a team comprising professors, students, local residents, and youth. Soil samples were collected in Pla Bu Village during the early rice cultivation season (July 2021), a period when some areas already had standing water. The collection covered an area of approximately 1,400 acres, as indicated on the map in Image 6, with sampling points marked as shown in Image 5. A total of 36 soil samples were collected at depths of 0-30, 30-60, and 60-90 centimeters. The collected soil samples were air-dried in the shade for two weeks, then ground using a wooden mortar and pestle. Subsequently, the soil was sieved through a 2 x 2-millimeter mesh to remove impurities. The prepared soil samples were stored in plastic bags for further analysis. The process of soil sample preparation is illustrated in Image 7.



Figure 5. Sample collection team and pictures of Ban Pla Boo soil sampling



Picture 6. Map of Ban Pla Bu soil sample collection at 36 collection points (x shows the locations where soil samples were collected)

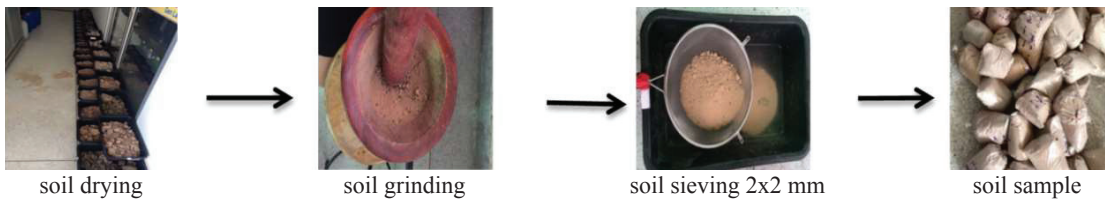


Figure 5. Soil preparation

6) The assessment of soil salinity involves the Matrix-matched extrapolation method and the measurement of soil acidity and alkalinity. To estimate salinity, the Matrix-matched extrapolation method is employed. This method involves weighing 10 grams of soil into three beakers, adding distilled water in volumes of 30, 50, and 100 milliliters, respectively. The mixture is then stirred and left to settle for 30 minutes to allow the soil to dissolve and form layers. The electrical conductivity of the water layer is measured using a FieldScout direct conductivity meter, calibrated with a 0.01 M KCl solution. A graph is created to establish a linear relationship between soil-to-water ratios of the three beakers and the measured electrical conductivity. The linear equation is then used to extrapolate salinity values for desired soil-to-water ratios. For soil acidity measurement, 10 grams of soil is mixed with water in a 1:5 ratio. The resulting solution is then tested using a Mettler Toledo pH meter. The concept of estimating soil salinity by extrapolating values using the Matrix-matched extrapolation method involves observing the behavior of the soil-water mixture, which forms a clay-like consistency that flows slightly but does not have excess water. For pH measurement, the pH of the water extracted from the beaker containing 10 grams of soil mixed with 50 milliliters of water is measured using a Mettler Toledo pH meter (pH 1:5).

Table 2. Create an application “Water and Soil Salinity in Agricultural Area : WSSA” that is used to inspect agricultural areas for citizens and related agencies. Details of the display within WSSA are as shown in the table.

Icon	Details of WSSA application
climate	Weather map in Nong Saeng Subdistrict area using data from the weather radar of Meteorological Department
Rainfall	Shows rainfall data for Nong Saeng Subdistrict, Wapi Pathum District, Maha Sarakham Province.
River water level	Criteria showing the water level in the river
Salinity of water	Shows the salinity of water in the area of Nong Saeng Subdistrict, Wapi Pathum District, Maha Sarakham Province.
Soil information	Show information about soil series in the area
Land use	Data showing land use in the area
Soil analysis	Show information about soil series in the area
Soil salinity	Displays the salinity of the soil in the area.
risk map	Flood risk map

4) To develop and improve soil using bioproducts from a group of bacteria that support plant growth in agriculture under limited water conditions, activities in this phase were carried out under two plans: Development of cultivation of Jasmine rice 105 in conditions with limited water using *Streptomyces* sp. in experimental pots. Development and creation of an experimental plot for cultivating Jasmine rice 105 using bacteria-derived bioproducts in the Pla Bu Village area. The work steps started with selecting the suitable type of bacteria for producing plant growth-promoting substances. Three isolates of *Streptomyces* sp. were studied: PB5, PNR29, and PNR30. Preliminary screening showed that all three *Streptomyces* sp. isolates had the ability to produce plant growth-promoting substances. Further analysis revealed the production of indole-3-acetic acid, exopolysaccharides, phosphate solubilization, and the ability to decompose cellulose. Additionally, *Streptomyces* sp. isolate PNR30 demonstrated the production of acid protease and acetyl xylan esterase. Testing the use of these bacteria on the growth of Jasmine rice 105 seedlings in experimental pots was followed by sending the bacteria for genetic analysis to identify the species at MacroGen Company, South Korea. The results showed that the species of *Streptomyces* sp. used could not be determined. Therefore, the bacteria tested in experimental pots could not be prepared as inoculants and bioproducts for farmers to use due to legal restrictions on the use of bacteria that cannot be identified in the environment. As a result, the promotion of knowledge to farmers about the benefits of using plant growth-promoting bacteria must consider alternative methods. The use of the biostimulant “Super PD 2” from the Department of Agriculture’s inventory, which has growth-promoting properties similar to the tested bacteria, is recommended for farmers. Farmers participating in the project provided their land as demonstration fields, and two farmers, Thanrada Suriyakhan and Siwakarn Khongsri, have been involved. However, as of the conclusion of the project, the application of bioproducts from the recommended bacteria has not been implemented due to the ongoing growing season. Further monitoring will be carried out after the harvest season.

6. Summary of operational results and important points obtained from project/activity implementation

The area in Nong Saeng Sub-district, Wapi Pathum District, Maha Sarakham province, is the sub-district with the highest number of villages in Thailand, totaling 28 villages. The agricultural area spans 30,708 acres, with rice cultivation covering 29,854 acres, accounting for 97% of the total agricultural area. The topography of Nong Saeng Sub-district is generally characterized as undulating hills prone to flooding. The soil is loamy with sandy components, and the soil quality has deteriorated due to a lack of maintenance and proper soil management practices. The sandy soil, combined with inadequate water management during both the rainy and dry seasons, contributes to waterlogging and salinity issues. The area faces recurring drought problems, further exacerbating the challenges for agriculture. Consequently, farmers in this region experience low crop yields and are unable to fully utilize the land. In summary, the

agricultural practices in the area are constrained by soil salinity, waterlogging, and frequent droughts, leading to suboptimal utilization of the land and reduced crop yields.

The combination of natural soil salinity and the increasing severity of drought poses significant challenges to agriculture in the region. These factors lead to low crop yields and poor-quality produce, impacting the income of farmers and affecting market demands. The objectives of this research are to study the impact of climate change on water and soil salinity in agricultural areas, develop a risk map for water and soil salinity, and introduce the “Water and Soil Salinity in Agricultural Area: WSSA” application. The WSSA app serves as a tool for monitoring and early warning for the general public and relevant organizations. Additionally, the research aims to address the challenges by developing and improving soil quality through the use of bioproducts derived from bacteria that support plant growth. This initiative targets agricultural practices in areas facing water limitations. The overall goal is to create sustainable agricultural practices that mitigate the adverse effects of soil salinity and water scarcity, ultimately enhancing crop productivity and the livelihoods of local farmers. In this research, the navigational study area focuses on one village that has been significantly impacted by changes in climatic conditions, specifically related to “soil and water.” The selected village is Baan Pla Boo, located in Moo 14, Tambon Nong Saeng, Amphoe Waeng Pa Pao, Maha Sarakham province. It is a small rural village with approximately 250 residents and 80 households. The primary livelihoods of the villagers include agriculture, rice cultivation, livestock farming, and vegetable gardening. On average, each family owns agricultural land covering about 22 rai. The agricultural activities in the village heavily rely on natural water sources. The research aims to assess the consequences of climate change on soil and water in this specific village, considering the agricultural practices and livelihoods of the local community.

From a study of the effects of climate change on water and soil salinity in agricultural areas, it was found that the effects of natural disasters on communities include:

- 1.1) Flooding: Areas in any direction that can be flooded. will be more affected than other areas and migrate to the area where Ban Plabu School Which is currently an abandoned school. Some people in the community sold flooded land to move elsewhere. Because the produce from farming is not enough. There was an exodus of workers to find income elsewhere. Families, father, mother and children did not live together,
- 1.2) Drought: If there is no rain in the farming area, there will be no water to grow rice. Some years we have to farm more than usual. There are some years when farming is not possible. and people in the community who have only Nakhon farming land, there was no rice to eat in that year. What happened is labor migration, go to work in construction or other jobs outside the community. The family, father, mother and children do not live together,
- 1.3) Impacts during a disaster: when flooding occurs, the affected area must be evacuated to school and home property was damaged, fish disease outbreak and many died. The rice that was planted rotted and died. Unable to produce full production, there was a food shortage and labor migration occurred,
- 1.4) Impacts during drought: The arable land has no water, unable to cultivate. There was a food shortage. Unable to produce full results. There was a food shortage and labor migration occurred.

The possibility that a disaster will occur in the future. The chance of another disaster occurring in the Ban Pla Bu community is very high. Both flood and drought threats due to the dry rain, Naton area has no water because there is no natural water source, there is a danger of flooding because the area in the direction is a lowland area as well as there is no drainage.

1. From the development of water and soil salinity risk maps in agricultural areas. The research team has surveyed the effects of climate change on water and soil salinity in agricultural areas in the target area. To be used to create a water and soil salinity risk map in agricultural areas, Nong Saeng Subdistrict, Wapi Pathum District, Maha Sarakham province. This is from mapping water and soil salinity risks in the Ban Pla Bu prototype area. It was found that this area has limitations in terms of natural soil salinity, including the quantity and quality of water that farmers in the area need to create a plan for joint use of water resources in the form of local policy options, especially for use in farming, which requires a large amount of water. And there may be a situation of competition for water by all water users. It is necessary to develop a cropping calendar and reduce the area size. If there is a limited amount of water, in addition, the potential to be a tourist attraction that is not an agricultural dimension may be seen. Because the survey found that there were some measurement points which has water resources that have unique and beautiful characteristics. Even though it cannot be used in agriculture. But it may be possible to create a landscape in terms of tourism.

2. Creating an application “Water and Soil Salinity in agricultural Area : WSSA” used for inspection or early warning. By the form of the application, functionality in the form of an application can be used via mobile phones. The WSSA application can display weather maps in the Nong Saeng Subdistrict area. Using data from the weather radar of the Meteorological Department, rainfall data for Nong Saeng Subdistrict, Wapi Pathum District, Maha Sarakham province, showing water levels in the river. Shows the salinity of water in the area of Nong Saeng Subdistrict, Wapi Pathum District, Maha Sarakham province. Shows soil data in the area. Show land use information in the area. Displays the salinity of the soil in the area and show a map of the risk of flooding.

Developing and improving soil by using biological products from bacteria that support plant growth. From preliminary experiments, it was found that bacteria that have the potential to promote the growth of white jasmine rice 105 at the trial pot level cannot be used in demonstration plots. This is because the bacteria cannot be identified down to the species level. Therefore, the research team adjusted the use of biological products by using microorganisms from the Department of Land Development, Super P.D. 2 formula, developed together with nutrient formulas used for growing microorganisms in the laboratory instead. The farmers who cooperated in using biological products include Mrs. Thanrada Suriyakhan and Ms. Siwakarn Kongsi. In the initial use, farmers were satisfied with the use and cooperated well. This is because farmers want to reduce production costs and want to change their farming methods to organic farming. However, it is not yet possible to determine whether the applied microbial biopharmaceuticals can improve yield and soil quality at the trial pot level. Because at present the project has

to be closed, it is still in the trial phase, which is the beginning of the planting season. This requires repeated and continuous use of biologics. The planting and harvesting season is from the end of November - December 2021. During that time, farmers are happy to allow the research team to follow up on the use of biological products even after the project has closed so that the researchers can use the information to improve and develop biological products in the future.

7. Discuss performance results/concise synthesis and recommendations

Operations throughout the past period have been able to answer all of the project's objectives.

The objective number 1 is to analyze the impacts of climate change that affect water and soil salinity in agricultural areas, Nong Saeng Subdistrict, Wapi Pathum District. Maha Sarakham province.

Objective number 2 is to develop a water and soil salinity risk map in agricultural areas, Nong Saeng Subdistrict, Wapi Pathum District. Maha Sarakham province. In summary, this area has limitations in terms of natural soil salinity including the quantity and quality of water that farmers in the area need to create a plan for joint use of water resources in the form of local policy options, especially for use in farming, which requires a large amount of water and there may be a conflict over water by all water users. It is necessary to develop a cropping calendar and reduce the area size. If there is a limited amount of water and agriculture must be done in line with natural resource capital in the area, including water quantity, water quality, including soil quality, it must be a plant that tolerates salt and drought well, including consideration of purchasing sources, market demand and support mechanisms from the network or support that is the mission of government agencies in the existing area, so that farmers able to have continuous and sustainable income including having knowledge and skills in managing your own area to create value, and ready to adapt to the changes that will occur. In addition, the potential to be a tourist attraction that is not an agricultural dimension may be seen. Because the survey found that there were some measurement points which has water resources that have unique and beautiful characteristics. Even though it cannot be used in agriculture, it may be possible to create a landscape in terms of tourism. This is another potential of the area that needs to be studied further.

Objective number 3 is to present the application "Water and Soil Salinity in Agricultural Area : WSSA" used to inspect agricultural areas for citizens and related agencies.

Objective number 4 is to adjust soil conditions to be suitable for growing crops in farmers' agriculture in conditions of limited water by using biological products from plant growth support bacteria. It is carried out by recommending that farmers change their farming methods. By allowing farmers not to leave the land empty in seasons that

are not the growing season, they may plant cover crops or find mulching materials to reduce soil erosion from wind currents. Including preventing water from evaporating and bringing salt stains to the top layer of soil. As for the use of biological products from microorganisms to improve soil quality, two farmers joined the project and agreed to use their land as demonstration rice fields: Mrs. Thanrada Suriyakhan and Ms. Siwakarn Khongsi, which the farmers experimented with. Biological agents are already being used to improve soil quality and promote rice growth. This is because farmers are already trying to change their own farming methods. Receiving advice from the project increases farmers' confidence. Moreover, agriculture is pleased to have the research team from Mahasarakham University follow up on results throughout the growing season until the harvest season.

Most of the villagers who participated in the project were satisfied with the project at the highest level. Regarding activities, they are consistent with the problems and needs of the community/target group. Able to apply knowledge and experience from participating in activities in daily life/work operations for the agency. Able to apply knowledge and experience from participating in activities in daily life/work to society and the community. Participating in activities creates networks in the community/society. Gain useful knowledge and experience and be able to transfer knowledge and experience to the community/society. Knowledge and experience from participating in activities can be used to develop new knowledge or lead to expansion of results. As for the subject, knowledge and experience from participating in activities can be applied to daily life/work for oneself. Satisfaction with the project was at a high level and equally high. The villagers who participated gave suggestions that it was a good activity, involved in creating a sustainable system, very interesting, and wanted to find appropriate plants, with soil to teach and promote or it can be added to increase the value of what is in the community to be consistent with the surrounding weather conditions in the community. I want there to be experimentation and practice in agricultural areas forever until perfect soil conditions are obtained. I want to find various solutions to be tested in the community in order to actually solve the problem.

8. Partnership

The research team learned how to conduct community-based research projects. In doing this research, there was good cooperation with the community. This may be because it is an area where researchers from Maha Sarakham University regularly visit to conduct research. However, the research team is another team that has ties with the Ban Pla Bu community, and has carried out research in various projects continuously for the past 4 years, causing the villagers of Ban Pla Bu Build trust in activities in the area. And the villagers cooperated and participated in various activities very well and the villagers opened their minds. Have a positive mindset with the research team and are willing to work with the research team continuously for 3 years as planned.

Suggestions from the project implementation are the implementation of activities in the 2nd and 3rd years according to the plan in order to achieve concrete development in the area.

- Mutually beneficial to all involved parties (mutual benefits)

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- Learning happens together. and produced academic works (knowledge sharing)

From the project implementation plan the research team held a meeting to discuss the project's next step in the second year, "emphasizing biological cultivation in collaboration with local philosophers". The research team saw the benefits that would bring about sustainable development in community by raising the level of knowledge of "Youth group" Ban Pla Bu who came to join the project in the first year to continue "Youth group" and "Farmer group" who want to upgrade their knowledge and abilities. To gain knowledge and understand the use of academic principles of science to change the way of farming in the community. At the same time, the innovations from Year 1 were put to work.

And from visiting the area in the first year, it was found that the villagers of Ban Pla Bu, there is a need for the research team to provide knowledge on planting plants - herbs that are suitable for saline soil areas, such as beans and white sesame, etc. The research team will include them in the project proposal in the second year.

- Measurable of social impact

1) Success factors: Important things that make this project successful according to the set goals include: 1.1) Coordinating with the community in a concrete way. Participate in discussions with community leaders (formal/informal) to draft a framework

for the areas where villagers must participate in activities, 1.2) Defining the framework and a clear period of operation. Although affected by Covid-19, the team has changed the operating plan to comply with the measures of the province and the university, 1.3) The community understands the activities of the project. This is because the community will allocate resources to the people who join the project. The researcher received cooperation from the community. There are youth in the community who are interested in participating in data collection with researchers and student groups, 1.4) The research issue is a community pain point (community understanding) and requires assistance from researchers. Because this community is a community that is affected by climate change as mentioned above. As a result, villagers in the community are interested in joining the project and cooperate very well. 2) Factors of failure: Important things that prevent some parts of the project from being carried out include risks from unexpected events such as the Covid-19 epidemic, etc. The research team has adjusted the plan so that the work can be carried out, mainly based on the goals of the project.

9. Benefits

1) Organizing activities to go to the area to collect information, whether collecting data on “water”, “soil” and using microorganisms to improve soil for growing rice. The research team organized activities in the form of collaboration between researchers and students, and the villagers who own the area. And from the field visit, it was found that almost half of the villagers participating in the project are youth groups in the village, which shows their interest in learning how to do activities together, creating activities for their own hometown community. Therefore, the researcher hopes to create a work system in the community that can make villagers aware, know how to think, act, and solve problems on their own. Or there may be consultation between community groups themselves.

2) Because the goal of the project does not primarily focus on community health. However, the expected health benefits will be benefits that occur more indirectly, such as when villagers have their attitudes changed about “water,” “salted soil,” “use of microorganisms,” and weather forecasting. Make the villagers aware of and care about the natural resources that they have. When natural resources are abundant and of good quality, it will affect the quality of life and health. Make the villagers have good health and a clear mind as well.

3) Field visits for all 3 activities to conduct surveys and collect data. The research team also brought students to the area to learn about activities in the area. Provides students with knowledge and understanding in using theories outside the classroom. This is another learning that can actually happen and be effective. In addition, the study that took place with villagers who were volunteers in the area together with the research team created knowledge and understanding of the natural resources in their own land. Therefore, having the research team participate in activities with the community will definitely create quality “community scientists”. which has resulted in a change in

perspective on agriculture or the lifestyle of the villagers who will drive their way of life with science and technology.

4) Generate income, reduce expenses, save costs, and increase productivity. Carrying out research project activities in the first year, the research team focused on learning as much as possible about the Ban Pla Bu community. To analyze the community and store natural resource data systematically. To facilitate analysis/development/upgrading the community at the point. Therefore, this year the reflection of economic expectations is unclear. However, the research team hopes that the activities they have done with the community will make people think and analyze the issue of investing in their daily lives and finding their own economic balance.

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