

6. "Green manure", an amazing crop for soil amendment and saline soil reduction of the Northeast of Thailand (I-san)

1. General Information and description of best practice/technology

Information

In the past, besides using *Sesbania rostrata* as a green manure for soil amendment in the area with saline soil, Land Development Department also promoted using *Crotalaria juncea* (sunn hemp) as a green manure plant with the objective to increase organic matter and improve soil. Moreover, planting and storing seeds can be done more easily than other green manure. This can also be planted and used as soil amendment together with various approaches, which has been accepted by farmers in every area. Due to problems of degraded soils used in cultivating industrial crops for a long time, the soils have been degraded chemically and physically with low fertility. Soil texture is characterized by being sandy clay loam. Flaky salt stain was found on the soil surface and the soil is saline with lack of water in the dry season. This also includes the fact that the area is outside the irrigation zone, making farmers unable to cultivate rice and obtain yields as needed. As a result, household incomes are low. Therefore, knowledge of using green manure plants has been implemented in the area with saline soils for growing rice together with using fermented bio-extracts from banana shoots and chemical fertilizers application according to advice.

Operating facility Moo 5, Ban Kok Phrom, Non Thai sub-district, Non Thai district, Nakhon Ratchasima province

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Geographical location

Latitude 102.03417 Longitude 15.23985

Operation Start Date

The operation started in 2004.

2. Classification of the best practice / technology

The Northeast of Thailand covers the area of 107 million rai. This region has the most area of rice farming in the country. However, the ratio of yields per rai is still low when compared with other regions. It must rely on rain water whereby the amount of rain distribution is not constant. Soil fertility is low. The soil loses organic matter easily. Another 17% of the area consists of saline soils. A method of keeping the fertility level of soil to the increase of crops in the area with saline soil is to increase organic matter and plant nutrients especially nitrogen added to soil. Due to the fact that nitrogen fertilizers currently costs a lot, Land Development Department, Ministry of Agriculture and cooperatives, has the project of soil amendment with green manure plants (*Crotalaria juncea*) and the campaign project of plowing up and over to cover straw stubble and green manure plants for soil amendment to reduce global warming in every area of Thailand from the area of farmers growing rice. This area also has limitations from land use which are having saline soil with a little salinity to moderate salinity, small amount of organic matter and low fertility and pH values with a little acidity and a little alkalinity. In the area of Non Thai district, Nakhon Ratchasima province, it face the problem of water shortage in the dry season. The area is also outside the irrigation zone. Agriculturists and officers of Land Development Department have transferred knowledge regarding increasing organic matter in the areas with degraded soils whereby volunteer soil doctors and farmers in the area implement the technology including applying it together with soil and water conservation in cultivation areas.

Mr. Mana Siangsunthia, volunteer soil doctor of Non Thai district, Nakhon Ratchasima province, is a farmer who understands, reaches and is ready to learn problem solving in his own area made use for occupation by having cooperated with officers of Area 3 Land Development Office, Land Development Department since 1997 in receiving supports such as production factors, PD microorganisms, green manure plants, vetiver and water resources in the paddy field. Moreover, guidelines obtained from learning are implemented to develop his own area where the Khaw Dawk mali 105 rice variety is grown accounting for 7 rai. Previously, any plants grown in the mentioned area could not produce any yields. Due to problems of degraded soils used in cultivating industrial crops for a long time, the soils have been degraded chemically and physically with low fertility. Soil texture is characterized by being sandy clay loam. Flaky salt stain was found on the soil surface and the soil is saline with lack of water in the dry season. As a result, a snag occurs. This also includes the fact that the area is outside the irrigation zone, making farmers unable to cultivate rice and obtain yields as needed. As a result,

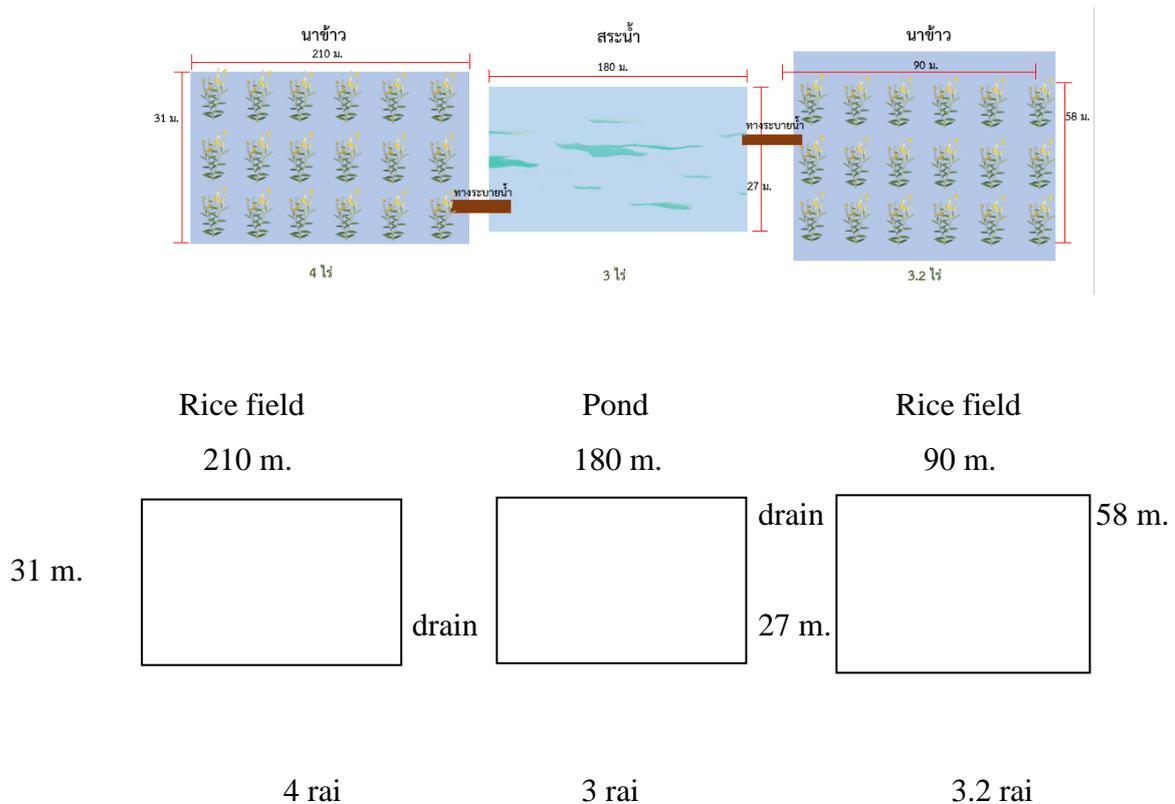
household incomes are low. Therefore, knowledge of using green manure plants has been implemented in the area with saline soils for growing rice together with using fermented bio-extracts from banana shoots and chemical fertilizers application according to advice. In 2004, average yields of 180-250 kilograms per rai were obtained. This had been practiced continuously until 2011. Rice yields increased to 400 kilograms per rai.

After having used *Crotalaria juncea* (Sunn hemp) for 16 years continuously, the soil has had better structures, becoming incoherent. Salinity of the soil has been reduced. This has brought about the origin of conducting farming based on natural agriculture restoring areas with saline soil without using chemical fertilizers from 2013 to the present time. Farmers also use the technique of observing weather conditions together with water management to be sufficient during having a dry spell due to climate variability. The green manure plant "*Crotalaria juncea* (Sunn hemp)" is used at the rate of 5 kilograms per rai for soil amendment for every 2 years together with selection of salt tolerance Kow Hom Thai rice varieties with outstanding characteristics of tolerating drought and pests well. As a result, yields of 500-600 kilograms per rai were obtained.

During the dry season after harvesting yields, in order to keep moisture in the soil, the method of plowing up and over to cover straw and stubble is used. They are not burned. The ground is covered with leaf debris. *Crotalaria juncea* (sunn hemp) is sowed during the harvesting season and it is allowed to fall naturally without plowing up and over during the flowering period. Fermented bio-extracts are used after harvesting. Soil and water conservation is focused in the cultivation area. During the rainy season, if rain water is at a high enough amount, it can be stored to be used in the dry season. Apart from this, farmers can also use the technique of washing off salt from the soil surface into water resources. There has been improvement of water quality with fermented bio-extracts at the rate of about 40 liters per cubic meters to be used for cultivation in the dry season.

3. Technical specifications, implementation activities, inputs, and costs

Technical plan of the technology



Methods of planting *Crotalaria juncea* (sunn hemp) to be used as a green manure plant in areas with saline soil are as follows:

1. The period of planting is during February to April whereby planting is conducted in between after harvesting rice yields so that *Crotalaria juncea* (Sunn hemp) can thrive and give out high biomass.

2. Plough and ferment rice stubble together with using PD 2 bio-extracts to create bacterial process in the soil accelerating decomposition taking about 2 weeks. Then, sunn hemp is sowed at the rate of 5 kilograms per rai in the soil with appropriate moisture throughout the plot in order to bring about regular germination.

3. Plowing up and over to cover sunn hemp stubble at the age of 120 days after collecting seeds of sunn hemp whereby the stem of sunn hemp is at the average of more than 1.2 meters resulting in obtaining more biomass. After that, during the period of preparing the area for planting rice, rice can be sowed in May or when there is enough amount of water.

4. When the seeds are kept to be used in the following season, the seed coat of sunn hemp is used as material incorporated with soil to make compost for soil amendment in growing vegetables.

3.1 Revenues and expenses in using the technology

1. Initial costs and expenses in using the technology

Inputs	Unit	Quantity	Expenses per unit (Baht)	All expenses per inputs (Baht)	% of expenses incurred by land users
Labor					
Plow to prepare plots	Time	1	500.00	500.00	
Sow rice	Time	1	600.00	600.00	
Pump water	Time	2	2000.00	4000.00	
Harvest yield	Time	1	6250.00	6250.00	
Plant materials					
Rice seeds	Kilogram	8	18.00	144.00	
Fertilizers and substances killing/ inhibiting growth of living things (Biocide)					
Weight	Liter	40	10.00	400.00	
Green manure	Kilogram	5	23.00	115.00	
Others					
Oil costs for farm truck	Time	1	2000.00	2000.00	
Total expenses of establishing the technology				14,135.00	
Total expenses of establishing the technology (US dollars)				428.33	

Calculation of costs and expenses

Expenses are calculated per areas using technology (Unit of size and area: 7 rai)

The currency used to calculate expenses with the unit as Baht

Exchange rate (to US. dollars) 1 US. dollars = 33.0 Baht

Average wage in hiring labor per day is 300 Baht

Most important factors having effects on expenses

1. Labor costs
2. Fuel costs

3.2. Incomes from selling products and net incomes

- In an area of 1 rai, yields can be harvested for 600 kilograms. Therefore, for the area of 7 rai, a total of products accounting for 4,200 kilograms/year will be obtained.

-The wholesale price of rice is 50 Baht per kilo Therefore, a quantity of rice accounting for 2,200 kilograms = 110,000 Baht.

(stored for consumption in the household accounting for 700 kilograms)

- The selling price for seeds is 23 Baht per kilograms. Therefore, the number of seeds accounting for 2,000 kilograms = 46,000 Baht.

- Total incomes = 156,000 Baht/year.

- The net income/year accounts for $156,000 - 14,135 = 141,865$ Baht.

4. Environment

4.1 Characteristics of the natural environment

The mentioned area has the average amount of rainwater between 1,001 - 1,500 milliliters. It is situated in the zone of semi-arid climate. The area is flat and 200 meter from the seal level. The soil depth is more than 120 centimeters. The soil texture on the top is sandy clay loam. The soil texture at the bottom is sandy clay. The level of organic matters is moderate (1-3%). The ground water cannot be used. The water at the soil surface is at a good level. The water can be used for agriculture only.

4.2 Characteristics of land users implementing the technology

Land users settle down and implement the technology as individuals/ households. They have incomes from outside the farm accounting for 10-50% of all incomes. Regarding the wealth level, they have enough to get by. The land where the technology is implemented is small accounting for 25 rai. Land ownership is individual. They receive rights of land tenure.

Service access and infrastructures

Aspect	Access
Health	Good
Education	Medium
Technical aid	Medium
Employment (such as outside the agricultural sector)	Medium
Market	Good
Energy	Medium
Road and transportation	Good
Drinking water and sanitation	Good
Financial services	Medium

4.3. Impact in the on-site from using the technology

4.3.1 Economic and social impact

Aspect	Impact	Before	After
<i>Production</i>			
Crops production	Moderately positive	Being areas with saline soils with salt stain on the soil surface, yields per rai	Soil properties become better, the quantity of products increases
Quantity of crop products	Moderately positive	The rice plant stands and dies.	The plants receive nutrients and the soil quality improves

		Yields per rai are low.	resulting in better product quality.
Land management	Very positive	Factors and soil amendment materials are used continuously every year.	Good soil properties make soil management for cultivation become easier.
<i>Usefulness and water qualities</i>			
Water availability for irrigation	Very positive	Rain water is used for conducting agricultural farming.	Water resources in the paddy field
Water qualities for irrigation	Moderately positive	Affected by salt water	Water qualities are improved by using fermented bio-extracts.
<i>Incomes and expenses</i>			
Expenses of factors of agricultural production	Moderately reduced	A large quantity of factors and soil amendment materials were used	Materials easily found in the area such as fermented extracts, green manure are used.
Farm incomes	Greatly increased	Low productivity	Received more quantities of rice products

4.3.2 Other social and cultural impacts

Aspect	Impact	Before	After
Food security and being able to rely on oneself	Positive	Yields not enough for consumption in the household	Having the quantity of rice products for household consumption enough throughout the year accounting for 700 kg./year
Health situations	Positive	-	Conducting natural farming by avoiding fertilizer and chemical application
Institutes of the community	Moderately positive	Study how to solve problems by themselves	Building interaction of farmers groups in the area based on consulting and mutual problem solving
SLM or knowledge of land degradation management	Positive	There is no knowledge propagation.	Farmers in the adjacent plot accept the technology and implement methods of soil management in their own areas.

4.3.3 Ecological impact

Aspect	Impact	Before	After
<i>Soil</i>			
Moisture in the soil	Moderately increased	The soil is arid with flaky salt on the soil surface.	There has been accumulation of organic matter and mulch keeps moistures and reduces water evaporation in the soil.
Mulch	Moderately increased	-	Humus, straw, stubble cover soil surface.
Circulation and replenishment of nutrients	Greatly increased	-	Nutrients increase due to planting different crops such as sunn hemp and plowing up and over rice stubble.
Salinity	Moderately decreased	Moisture in the soil was low. The soil was characterized by having flaky salt appearing on the soil surface.	Salinity measured from the soil surface decreased. Organic matter and the number of microbes accumulating in the soil increased.
Organic matter in the soil/ lower than in the soil of C horizon	Moderately increased	-	Organic matter from plowing up and over to cover rice stubble, green manure plants
<i>Biodiversity of plants and animals</i>			
Biodiversity of plants	Positive	-	Plant varieties which can be planted and grow in the area more such as rice, sunn hemp

4.2. Off-site impact from using the technology

Aspect	Impact	Before	After
Water which can be utilized	Moderately positive	Small-scale water resources	Expansion of digging ponds resulting in more areas of water storage

Activities Pictures



Left picture Soil survey in the area of Non Thai district

Right picture Cross sectional Pratai soil series (Pt-sclA)



Left picture Sun hemp seed coat is used to make compost

Right picture Sow seeds of sun hemp before the cultivation season



Left picture Plow up and over to cover sun hemp

Right picture Harvest yields of salt tolerant Hom Mali rice