12. MANAGING AREAS WITH SALINE SOIL FOR PLANTING EXPORTED HOM MALI RICE AT THUNG KULA RONGHAI

1. General Information and description of best practice/technology

Information

Located in the southeast of the Korat Plateau, "Thung Kula Ronghai" is a large-scale plain. The terrain is characterized by being a large pan basin with gradient less than 2%. There are highlands around the edge of field which is gradually aslope to the middle region of the area. The area stretches crosswise along the Moon river with the maximum length measured by 150 kilometers and the maximum width measured by 50 kilometers. There are several main rivers, namely Lam Nam Siew, Lam Plub Pla and Lam Tao. The territory covers the areas of 51 sub-districts, 12 districts in 5 provinces, namely Roi Et, Surin, Si Sa Ket, Yasothon and Maha Sarakham accounting for 0.34 million ha. The area has physical, chemical and biological environments which are not suitable for doing paddy farming. As a result, products of rice and agricultural crops are very low. Therefore, Land Development Department entered the area to make a survey to classify the soil, make plans for land use and study how to solve the problems of soil, water and communication. The objectives for this are to develop the agricultural areas of Thung Kula Ronghai to be suitable with doing paddy farming and other agricultures of other aspects. It has been doing this since 1981 by initially establishing a pilot project in the area of 704 ha. This has been done by making a survey and designing the engineering infrastructure to be the water-controlling canal system in the paddy field or so-called "land remodeling" in order to mitigate flooding conditions. Water is drained from the area to reduce damages occurring to the rice tree. Moreover, water in the water drainage canal can also be used sufficiently in production. Ponds have been dug to store water to be used during the spell of rainy period. The soil and water conservation system has been constructed and maintained, and distribution of areas with saline soil has been reduced as follows:

1) The water-controlling system has been built to drain water at the soil surface and release salt together with the water harvesting system -water from rainwater and water from canals;

2) The communication system in the paddy field or roads in the paddy field have been built to be the economic route or roads connecting between communities with agricultural areas;

3) Water storing ponds or fish ponds each with the capacity of 400 cubic meters have been built to be reserved water sources for farmers;

4) Bridges or crosswalks of the water-distribution canal at each distance of 500 meters have been built;

5) Growing perennial plants has been promoted and conducted along the road in the paddy field throughout so that this can function as a windbreak to reduce problems of soil erosion due to whirlwind.

Moreover, Land Development Department has established the program of increasing standard Hom Mali rice products for export in the area of Thung Kula Ronghai. The objective is to support rice varieties and methods suitable for increasing Hom Mali rice products to alleviate troubles of target farmers for 87,400 households consisting of 400,000 lives living in Thung Kula Ronghai. Other objectives are to develop the production infrastructure, to build the transport route system for convenience in maintenance and product harvesting including transportation to the market. After that, there has been expansion of the operation area continuously to the present time. The achievement of land remodeling for the Thung Kula Ronghai development project from 1983 to 2018 can be categorized according to individual provinces as follows: 1) Roi Et accounting for 78,203.2 ha; 2) Surin accounting for 57,542.4 ha; 3) Maha Sarakham accounting for 13,840 ha; 4) Yasothon accounting for 1,766.4 ha with a total area accounting for 151,352 ha.

2. Problem conditions of the area before taking actions

1) Soil problems: The soil lacks fertility. It is very sandy and part of it is saline soil.

2) Water problems: Water cannot be controlled. There is shortage of water at the beginning of the cultivation season and there is flooding at the end of the cultivation season. There is also drought in the dry season.

3) Rice variety problems: The rice varieties used are not suitable with soil characteristics resulting in low average yields per hectare.

4) Land tenure problems: There has been freehand land tenure without ownership in the land.

Operating facility House No. 19, Moo 2, Ban Kho, E-ngong sub-district, Chaturaphak Phiman district, Roi Et province.

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Geographical location

Latitude 100.808868 Longitude 103.523083

Operation Start Date

The operation started in 2011

2. Approach, aims, and enabling environment

Objectives of the operation

1. To solve the problems by reducing the salinity level and preventing distribution of saline soils in agricultural areas

2 . To solve areas with saline soils to be used agriculturally with diversities and sustainability

Activities and details of the operation

1. Mr. Somporn Hitaphon has owned the land for farming accounting for 2.88 ha. The soil texture in farm is sandy clay. It is in soil classification Soil Series group 20, Kula Ronghai soil sries (Ki). The problems of saline soil are found mostly on the surface soil. Previously, rice farming had been conducted for a long time, resulting in rice yields for only 625-937.5 kg/ha. This is considered very low. Therefore, the technology of saline soil management has been used to replace the traditional method by conducting integrated farming. The rice variety of Dok Mali 105 is planted together with acacia or *Acacia ampliceps* on the levee. After the rice is harvested, vetiver grass, watermelon and corn are planted as plants after rice harvesting. Currently, the mentioned

areas have been stored. When the soil in the paddy field was examined again, it was found that soil salinity reduced. In the past, the water in this areas had the salinity of 4.0 ppt considered to be at a high level of salinity. After using the technology, the salinity of the water in the pond is at the level of 1.5 ppt considered to be a medium level of salinity. This condition has enabled various plants to be grown more. As a result, products of rice and other plant have increased so many that they can be harvested and sold to be incomes throughout the year. This farmer is considered to be the primary prototype farmer who is able to solve saline soil problems in Thung Kula Ronghai.

2. Regarding rice cultivation, soil amendment is enhanced with organic matter continuously in the area of 2.88 ha. Rice variety of Kao Dok Mali 105 is grown in the area of 2.08 ha for distribution. Sticky rice variety Gor. Kor. 6 is grown in the area of 0.8 ha for consumption. The procedure starts with plowing up and over rice stubble after doing rice farming. Dolomite is used at the rated of 625 kg/ha. Plowing and incorporating it for 7 days are conducted. Cultivation is conducted by sowing dry rice in the rainwater field in May. Chemical fertilizers are applied for the first time according to the advice from the soil analysis value after the rice germinates for 7-10 days. The formula 16-16-8 at the rate of 156.25 per ha. Top-dressing urea fertilizers are applied at the rate of 31.25-62.5 kg/ha during rice pregnancy for the second time. The amount of nitrogen (N) accounts for 39.38-53.75 kg/ha. The amount of phosphorus (P_2O_5) accounts for 31.25kg/ha. The amount of nitrogen (K_2O) accounts for 12.63 kg/ha. For protection, fermented bio-extracts are used to prevent the plant from pests and get rid of them. The water is left to be dry within 7 days before harvesting at the end of November. As a result, the rice builds and secret the aromatic substance called 2AP. Rice products account for 2500 kg/ha. The average selling price is 0.59 USD/kg, making farmers have the income of 3,529.41USD annually.

3. For planting crops after doing rice farming, the area is divided into planting corn and watermelon accounting for 0.32 ha. The products obtained are used as food in households and for distribution. There is circulation of reusing agricultural scrap remainders. For example, leaves of vetiver grass are cut to cover soil in order to keep moisture and prevent salt accumulation at the soil surface. Plots of vetiver grass propagation are made for 0.48 ha. Regarding planting vetiver grass, its shoots separating from the clump are cut to remain for 20 centimeters and the root is also cut to become short. After that, the cut root is soaked in water with the level of 5 centimeters for 5-7 days. The root will branch out again. Then, it is grown in the field with spacing of 50x50 centimeters. After planting it, watering must be done regularly. When it reaches the age of 1 month,

the 15-15-15 fertilizer is applied for 1 teaspoon per tree. When it reaches the age of 4-6 months, it is dug to be cultivated in plastic bags or it is prepared to be seedling with naked roots for being utilized further. For the area of 0.16 ha, 100,000 vetiver seedlings are obtained on average. This bring about the income of propagating vetiver grass accounting for 882.35 USD ~~30,000 baht~~ annually. This is due to the fact that the vetiver variety of Songkhla 3 can grow in the soil with a slight to medium salinity and it is in much demand of the market. Therefore, this is an important place of producing vetiver grass seedlings of Thung Kula Ronghai.

4. Regarding planting *Acacia ampliceps* on the levee, it is a salt-tolerant (high salinity) plant which can be propagated by seeds. This can be done by collecting seeds from the tree at the age of 2 years up. Flowers start to bloom in October and seeds are collected in succession from March to May because pods are not ripe together at the same time. Before planting the seeds, they are soaked in hot water with the temperature of 90 °C in order to destroy dormancy. Sandy loam and rice hull ash are mixed with compost or manure with the ration of 2:2:1 to be planting materials. Then, the young plants are transferred to a pierced plastic bag. After 7 days of germination, the height is about 5 centimeters. In the third month, the young plant is allowed to be fully exposed to light to increase strength. Then, the young plant at the age of not more than 3 months is transferred to be planted in the soil at the beginning of the rainy season from July to August. The planting distance of 2 meters along the levee is used. The size of a hole is 30x30x30 centimeters. Compost and manure incorporated with soil is put at the bottom of the hole. After the planting hole is covered up, rice hulls are used to cover it. Mr. Somporn can produce *Acacia ampliceps* seedlings to be sold in the amount of 1,176.47 USD per year. Planting *ampliceps* is an alternative which farmers in areas with saline soil can manage by themselves in order to restore degraded soil to have better qualities.

5. The achievement from using the technology in managing water perfectly with soil meeting the needs of rice and managing the integrated planting system is the environment which other areas do not have. Therefore, Thung Kula Ronghai is the source of producing top-grade hpm Mali rice suitable with the rice variety Kao Dok Mali 105 in building an aromatic substance called 2-Acetyl-1-Pyrroline or 2AP which is the same substance found in pandanus leaves. This substance smells like jasmine. The ability to build this kind of substance is determined by genes in DNA. This substance originates when rice is in stress from drought, water shortage in some periods especially during the harvesting period in which rice builds and secretes this aromatic

substance at the most. Moreover, it was also found that the sandy paddy field with a little salinity has an effect on making rice build the aromatic substance. 2AP more. This kind of rice has good cooking qualities which are rising well with cooking of rice. In other words, the rice becomes fluffy rice (flagrant, long, white and soft). Therefore, Hom Mali rice of Tthung Kula Ronghai has high prices, demanded by consumer's markets domestically and it is also exported internationally. It was registered for geographical indication on 21 April 2006. The applicant requested for registration of 5 provinces situated in the area of Thung Kula Ronghai.

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

3.1 Revenues and expenses in using the technology

1. Initial costs and expenses in using the technology

Inputs	Unit	Quantity	Expenses per unit (USD)	All expenses per inputs (USD)	Percent (%) of expenses incurred by land users
Labor					
Rice	hectare	13	367.63	4779.74	100.0
Equipment, fertilizers and substances killing/ inhibiting growth of living things (Biocide)					
Water pump	Machine	1	147.06	147.06	100.0
Manure	Sack	100	1.47	147.06	100.0
16-16-8 chemical fertilizer	Sack	2	44.12	88.34	100.0
Plant materials and construction materials					
Rice seed	Kilograms	100	0.74	58.82	100.0
Land rent	ha	13	36.75	477.94	100.0
Tractors + oil costs	Time	4	29.41	117.65	100.0
Others					
Expenses of vetiver grass propagation plots	ha	3	367.63	1102.94	100.0

Expenses of watermelon and corn planting plots	Kilograms	2	117.65	235.29	100.0
Total expenses of establishing the technology				**1,811.76**	

Calculation of costs and expenses

Expenses are calculated to technology-based areas (Unit of size and area: 2.4 ha)

(1 hectare = 1 ha = 6.25 rai)

The currency used to calculate expenses has the unit as Baht

Exchange rate (to US. dollars) 1 US. Dollars = 34.0 Baht

Average wage in hiring labor per day is 8.52 USD

Most important factors having effects on expenses

1. Costs of agricultural materials, increasing prices of chemical fertilizers
   - In the past (2017), each sack cost 29.41 USD.
   - Currently, each sack costs 47.06 USD

   As a result, the cost of expenses has increased 294.12 USD annually.
2. Labor costs account for 211.77 USD.
3. Rice seed costs account for 58.82 USD .

2.Maintenance costs

Inputs	Unit	Quantity	Expenses per unit (USD)	All expenses per inputs (USD)	% of expenses incurred by land users
Labor					
Weed removal/fertilizer application/rice harvesting/ rice threshing	ha	13	183.81	2389.69	100.0
Equipment, fertilizers and substances killing/ inhibiting growth of living things (Biocide)					
Price of 16-16-8 chemical fertilizers	Sack	3.0	44.12	132.35	100.0

Equipment, plant materials and others					
Fuels (tractors/ water pump) once a month, 10 liters per time (1 year = 2 months)	Time	12	11.77	141.18	100.0
Costs of materials used for planting seedlings of *Acacia ampliceps*	Bag	10,000	0.03	294.12	100.0
Water melon variety costs	Can	300	0.06	17.65	100.0
Corn variety costs	Kilograms	50	0.24	11.76	100.0
Total expenses of maintaining the technology				**979.41**	

3.2 Incomes from selling products and net incomes

Before using the technology Incomes came from doing rice farming only. However, obtained products were very low due to saline soil and water shortage. In the area of 0.16 ha, rice products accounting for 100 kilograms were obtained (2.88 ha resulted in products about 1,800 kilograms). The selling price was 0.15 USD /kilograms. The total income from rice cultivation accounted for 264.71USD /year.

After using the technology Incomes comes from more various agricultural production, namely

Rice products account for 2,500 kg/ha. The most production is 5 tonnes. The selling price is 294.12 USD / ton. This gives a total of 1,470.59 USD.

The vetiver seedling variety is produced at the most accounting for 200,000 trees. The selling price is 0.0044 USD per tree. This gives a total of 0.88 USD.

The Acacia ampliceps seedling variety is produced at the most accounting for 10,000 trees. The selling price is 0.12 USD per tree. This gives a total of 1.18 USD.

Other product from the farm are watermelon, corn etc.

The total income is 3,529.41 USD.

3.3 Summary of expenses and net income

The income accounts for a total of 3,529.41 USD.

Expenses in conception and maintenance account for a total of 2,791.18 USD.

The net income accounts for 738.24 USD.

4. Environment

4.1 Property characteristics of the natural environment

The terrain is quite flat and 130-160 meters higher than the average sea level. Regarding the climate, there are 3 seasons. The average lowest and highest temperature are 21°C and 35°C respectively. It does not rain regularly. The average amount of rainwater is between 1,000-1,400 millimeters. The soil has rather poor water drainage and is more than 20 centimeters deep. It is grayish brown and has spot with colors. The soil texture on the top is sandy clay loam. The soil texture at the bottom is silt clay loam. The soil is Thung Kula Ronghai soil series (Ki) influenced by salt in the category of Maha Sarakham rock. The ground water cannot be used. The water at the soil surface is at a medium level. However, due to the water quality, the water can be used for agriculture only. However, water salinity is an important problem in conducting farming. As a result, only certain plants can be planted and low yields are obtained.

4.2 Impact in the on-site from using the technology

1. Economic and social impact

Aspect	Impact	Before	After
1. Crop production	**Increased at the most**	Products of 100 kilograms were obtained from crop production for 0.16 ha (2.08 ha = 1,300 kilograms) because the soil was very saline resulting in low production of rice.	Rice products of 5,000 kilograms per round of production are obtained.
2. Cultivation qualities	**Increased at the most**	Only a small quantity of the rice product was	When the planting system is changed to be suitable with soil conditions,

Aspect	Impact	Before	After
		obtained. The rice did not cover the whole seed.	products with better qualities are obtained.
3. Fodder production	**Greatly increased**	Due to the fact that the soil is very saline, there were not even grass or weeds growing.	Soil salinity has been reduced. As a result, farmers can use areas to conduct farming more variously.
4. Products which are sources of income has more diversities.	**Increased at the most**	The monoculture farming conducted was growing rice.	The integrated farming system is operated, namely rice, vetiver grass, watermelon, corn and Acacia ampliceps.
5. Variety of products	**Increased at the most**	Rice was grown only.	There are more products obtained from the farm, namely rice, vetiver grass seedlings, Acacia ampliceps seedlings.
6. Expenses of agricultural factors of production	**Much reduced**	-	Costs of chemical fertilizers can be reduced for 88.24 USD (costs of chemical fertilizers applied in the paddy field for 2 sacks) because there is crop rotation, reducing costs of production much.
7. Incomes	**Increased at the most**	Incomes came from selling rice. The average price of rice was 0.15-0.18USD /	Farmers have more incomes from rice production, propagation of

Aspect	Impact	Before	After
		kg. In the area of 2.08 ha, rice was produced for 1,800 kgs bringing about the income of about 264.71 USD.	vetiver grass variety seedlings, Acacia ampliceps variety seedlings. 1. Having incomes from selling rice up to 5 tonnes with the price of 294.12 USD/ton. The income accounts for 1,470.59 USD. 2. Having incomes from selling vetiver grass variety seedlings for 0.0044 USD/tree. The sale volume is 200,000 trees/year bringing about the income up to 882.35 USD 3. Having more incomes from selling Acacia ampliceps variety seedlings for 0.12USD/tree. The most sales account for 10,000 trees bringing about the income up to 1,176 USD

2. Social and cultural impact

Aspect	Impact	Before	After
1. Food security and self-reliance	**Improved at the most**	Rice was produced for 1,800 kilograms. The selling price was 0.15 USD per kilo.	Rice is produced for 5,000 kilograms. The selling price is 0.29 USD per kilo. Vetiver grass seedlings and Acacia ampliceps seedlings are produced for sales to be supplementary incomes. Water melon and corn are grown to be consumed in households.
2. Community institutes	**Strengthened at the most**	-	Being a prototype plot for people in the community to come to see for study, exchanging knowledge and experiences, expressing opinions together and solving problems mutually regarding management of agricultural areas with saline soils
3. SLM or knowledge of land degradation management	**Improved**	There was not much propagation of knowledge.	The technology is accepted. There starts to be more propagation of knowledge and farmers start to follow the practice more.

Aspect	Impact	Before	After
4. Situations of the underprivileged	**Much improvement**	There was no knowledge of transforming monoculture farming into integrated farming.	Receiving knowledge transfer from the learning center and being able to implement the knowledge in one's own areas together with asking for advice from prototype farmers

3. Ecology impact

Aspect	Impact	Before	After
1. Things covering the soil	**Much improvement**	There was no grass or weeds growing.	Halophytes such as grass and salt-tolerant plants start to grow.
2. Level of soil salinity	**Reduced at the most**	The salinity level was more than 4 ppt.	The level of soil and water salinity is reduced to 1.5-2.0 ppt until other plants can be grown.

4.3 Off-site impact from using the technology

Aspect	Impact	Before	After
1. Usable water	**Greatly increased**	-	Water from areas with saline soil can be utilized because vetiver grass and Acacia ampliceps are salt-tolerant plants which can grow in salt water with medium salinity.

Aspect	Impact	Before	After
2. Damages done to neighbors ' cultivation areas	**Greatly reduced**	Pest-repelling substances were used in inappropriate amount.	Using pest-repelling substances has been reduced. Organic substances are focused on in order to reduce using chemicals.
3. Impact of greenhouse gas	**Reduced**	The area of paddy field was burned to prepare cultivation plots.	They turn to plant rotation crops after doing rice farming in order to help reduce carbon dioxide gas originating from burning rice stubbles and reduce greenhouse gas emission.

5. Acceptance of the technology and application

Farmers accept the principles by participating in the project of developing and preventing distribution of areas with saline soil based on integration. They apply the technology in their own areas. They adjust the farming system and change the cropping system by planting rice as the main plant, vetiver grass, corn, water melon as plant after doing rice farming and planting *Acacia ampliceps* as plants for use on the earthen dyke. There is saline soil management according to the principle. There are a lot of farmers who participate in the project due to the fact that changes at the beginning do not require high investment and they receive benefits from the project.

6. Conclusion

6.1 Strong points: Viewpoints of land users

1. Soil properties under the degradation factor have transformed into more fertility.
2. Having better products has brought about more incomes.
3. Being able to have agricultural occupations in areas with saline soil sustainably

6.2 Weak points: Viewpoints of land users

At the beginning of the project, making a survey for designing construction was required to adjust area conditions of conducting farming and water management. As a result, some farmers did not decide to start or they did not have enough land to start with adjustment.

6.3 Strong points: Viewpoints of the complier

1. Farmers can change the cropping system on areas with saline soils by themselves until there are more various kinds of products supported by the market. Occupations and sustainable incomes from conducting farming have been built.

2. If agricultural areas face problems such as flood, drought, damaged paddy fields, change can be done as follows: Changing to planting short-lived plants using a little water; or making plots to propagate halophytes or salt-tolerant perennial plants to be sold further

6.4 Weak points: Viewpoints of the complier

Making plots to propagate vetiver grass, halophytes or salt-tolerant perennial plants to be sold requires support from the market or demand on using a large quantity of products continuously because they are plants used in particular areas. Therefore, farmers must plan production to be in line with the market demand and the cropping season mainly.

Activities pictures

Fig.1 -2 Plough and incorporate rice stubble before sowing sunn hemp and sunn hemp plots during the flowering period

Fig.3-4 The plot of salt-tolerant Hom Mali rice variety for the period of 60 days and harvesting the Hom Mali rice to be used as a rice variety for reproduction