5. Manila tamarind planting in combination with integrated farming for saline soil management in Nakhon Ratchasima Province, Thailand.

1. General Information and description of best practice/technology

Information

Nakhon Ratchasima Province has a total saline soil area of 3,005,990 million rai, which is approximately the most saline soil area in the northeastern part of Thailand. More than 50% of the area of 69,974 rai has salt stains on the soil surface. The purpose of this technology, Manila tamarind planting in combination with integrated farming for saline soil management in Nakhon Ratchasima Province, Thailand, was to reduce the level of salinity in the soil and to improve saline soil areas to be able to grow a variety of plants and also to enhance sustainable integrated farming for farmers who live in saline soil areas for higher productivity, income, and a better quality of life. In terms of land use adaptation, Manila Tamarind was used in conjunction with integrated farming (tilapia and cow farming) in areas such as water restoration, maintenance, harvest, and transportation.

Mr. Niphon Plianklang is a volunteer soil doctor in Makha Sub-district, Non Thai District, Nakhon Ratchasima Province. He was a role model farmer who pioneered the application of this method in his area, which was formerly utilized for rice production but is now used to cultivate Manila tamarind using integrated farming. The land of the Manila tamarind plantation has been rehabilitated at this time. Previously, the salinity of the soil in this area had a negative impact on rice harvests. However, after implementing this technology, Manila Tamarind may thrive in saline soil environments. The taste, as well as the size and color, were excellent, and the market demand was met. Aside from tamarind production, there was also a section set aside for tilapia and cow rearing. As a result, there are goods that may be gathered and sold throughout the year as a source of revenue.

The objectives of this technology are to address the problem of saline soil in agricultural land and to prevent the spread of salinity and to minimize salinity in saline soil areas to be able to used for more diverse and sustainable agriculture..

Location where best practice / technology is being implemented/Country

No. 117, Village No. 3, Ban Maklua, Makha Subdistrict, Non Thai District, Nakhon Ratchasima Province.

Geo-reference of selected site

Latitude 102.11202, Longitude 15.24495

Year of implementation started

The operation started in 2017

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Reviewer Dr.Bunjirtluk Jintaridth

2. Classification of the best practice / technology

Activities and details

1. Manila tamarind cultivation. Prepare for Manila Tamarind planting by digging a trench on the land with a width of 4 meters and a depth of 2 meters. The ditch was used for water restoration and tilapia which is a fish that can grow well in saline soil areas because it can generate income while Manila Tamarind is not yet ready to harvest. The excavated soil was raised to the plot at 1.00 meters height and 6.00 meters width for planting Phetch Non Thai Manila Tamarind. The distance recommendation for the Manila Tamarind plantation was 8-10 meters, but there were 350 Manila Tamarind seedlings were planted in an area of 15 rai with a distance of 5 meters each. The reason was for grafting every other plants. One seedling was sold for 25 baht. Beginning in March, add 1 sack of manure per plant (manure obtained from cow dung on the farm). After 8 months, apply bio-extract to nourish the tree after reproductive stage. During this period, *Bactrocera dorsalis* (Hendel), a major pest Manila Tamarind, will attack and destroy the pods. This caused the bent pods and lowered the price of the products. Applying fumigation and insect traps by burning straws to produce smoke to disturb them. When they fly up above, they will be eaten by birds. After 2 weeks, the sheath bark will be thickened and safe from pests. In the first year, products from Manila Tamarind weighed 1,500 kilograms total, and the average selling price was 80 baht per kilogram. It gave farmers an annual income of 120,000 baht. In the second year, after the harvesting period, pruning will be done by grafting the branches and cutting them for propagation. It takes about a month for grafting to form strong roots within the rootstock. Rootstock could be sold at 60 baht each, but if applied in a pot for 15 days, the price will be sold at 35 baht per pot. Presently, main income comes from the sale of Manila Tamarind propagation. Once, he sold 50,000 pots

at a cost of 5 baht per pot. This brought his income from only selling Manila Tamarind seedlings up to 1,750,000 baht in that year.

2. Tilapia farming in Manila tamarind orchards. In brackish waters, tilapia can live. Phytoplankton and moths, which were created by manure and hay placed in the garden grooves, fed the fish in the ponds. They come from the farm's cow waste. The Nakhon Ratchasima Provincial Fisheries Office sold 1 baht baby tilapia, and 15,000 transgender tilapia were released. Before they can sell, they need 5 months. The selling price per kilogram was 60 baht. After costs were deducted, the total profit per fish was 20 baht. Due to a lack of water, tilapia fish farming can only be done once a year, despite the fact that the income from fish farming is 300,000 baht per year.The fish had a lower disease-causing potential. In comparison to saline water, germs and parasites were reduced. This resulted in high-quality fish in terms of texture, flavor, and odor, which is why they fulfill market demand.

3. Cattle farm. There are two mother cows being raised on the farm. They are used for breeding and producing calves for sale. The price for a male calf is 25,000 baht and for a female calf is 50,000–100,000 baht. One cow produces 200 sacks of manure every 6 months. Therefore, two cows will produce 800 sacks of manure in a year, which is enough to use in the area of Manila Tamarind and fish farming in the orchards. Moreover, the excess amount of manure can be sold at 40 baht per sack. It is a sustainable and self-reliant integrated farming system. There is a turnover of agricultural waste materials in the plots to be used in cattle farms, such as grass in tamarind plots used in feeding cattle. The cultivation of napia grass to be used as food for cows in order to reduce the production cost and the use of waste for soil improvement and as a foliar supplement to increase plant growth and productivity. In addition, manure can also be applied to the bottom of the fish pond or mixed alternately with a pile of straw to feed the fish in the pond as well.

Mr. Niphon Plianklang, of 117 Village No. 3, Ban Maklua, Makha Subdistrict, Non Thai District, Nakhon Ratchasima Province, has used this technology in his farming. A role model farmer who has successfully combined Manila tamarind with integrated agriculture to manage saline soil. This area used to have a salinity level of 10 ppt, which was quite high. The salinity of the soil was lowered after applying this approach. Until now, the soil in the area and the garden waterway had a salinity of 3.7-4.0 ppt, which is a moderate degree of salt. You can cultivate a wider range of crops

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

3.1 Income and expenditure on technology

1. Cost and initial costs of using technology

input	unit	amount	Cost per unit (Baht)	Total cost per input (Baht)	% of expenses incurred by land users
labor					
Raising the garden groove, planting Manila Tamarind, laying the water system (17 people, 20 days)	force	340	300	102,000	100.0
Equipment Fertilizers and disinfectants/inhibits the growth of organisms (biocides)					
pump	machine	2	5,000	10,000	100.0
manure	sack	350	40	14,000	100.0
Chemical fertilizer formula 15-15-15	sack	3	700	2,100	100.0
Plant materials and construction materials					
Manila Tamarind Tree	Tree	350	25	8,750	100.0
land rent	rai	15	5,000	75,000	100.0
house of animals	house	2	6,000	1,200	100.0
other					
The value of the transgender tilapia larvae	tilapia	15,000	1	15,000	100.0
fish feed	kilogram	50	280	14,000	100.0
Total cost of technology establishment				**242,850**	
Total cost of technology establishment				7,901.56	

(US dollar)					

Calculation of costs and expenses

The cost is calculated per area in which the technology is used. (Area and unit size: 15 rai. 6.25 rai = 1.25 hectares = 1.25 ha) The baht exchange rate (to US dollars) was used to calculate expenses. 1 US dollar equals 32.0 baht. The average wage for hiring workers per day is 300 baht.

The most significant determinant of cost is

Feed prices for fish are increasing.

- In the past (year 2017), it was at the price of 280 baht per sack.
- Currently, the price is 350 baht per sack.

As a result, the current cost of living has increased per year.

3.2 Maintenance costs

input	**unit**	**amount**	**Cost per unit (Baht)**	**Total cost per input (Baht)**	% of expenses causing by land users
labor					
Manila Tamarind Pruning and Propagation	branch	50,000	5	250,000	100.0
Equipment Fertilizers and disinfectants/inhibits the growth of organisms (biocides)					
Chemical fertilizer formula 15-15-15	sack	3.0	700	2,100	100.0
equipment, plant materials, etc.					
Fuel (mowing and pumping) 1 time per week, 2 liters each time, cost 60 baht (1 year = 52 weeks)	time	52	60	3,120	100.0

Material for grafting for propagation	set	50,000	5	250,000	100.0
Tilapia	Tilapia	15,000	1	15,000	100.0
Tilapia food cost	sack	50	350	17,500	100.0
The total cost of maintaining the technological condition				**537,720**	
The total cost of maintaining the technological condition (US dollar)				16,803.75	

3.3 Revenue from sales of produce and net income

Before using technology, most of the income came from rice cultivation, but the yield is very low due to saline soil and water shortages. In an area of 1 rai, rice yields 80 kilograms (15 rai yields 1,200 kilograms), sold at 5-6 baht/kg, including income from rice cultivation, about 6,000 baht/year.

After using technology**,** they now have a more diverse agricultural production revenue, such as Manila Tamarind, which produces 1,500 kg, thanks to the use of technology. Sell it for 120,000 baht, or 80 baht per kilogram. The Manila Tamarind tree is utilized to sell the most seedlings, 50,000, for a total of 1,750,000 baht, at 35 baht per tree. Depending on the breed, the female calf is sold for 25,000 baht, and the female is sold for 50,000–100,000 baht. 15,000 tilapia for a total of 300,000 baht at a profit of 20 baht each. Other farm products, including as manure and lime, brought in a total of 2,245,000 baht.

3.4. Spending and net income

Total earnings: 2,245,000 baht

The total cost of setup and maintenance is 780,370 baht.

A total net income of 1,464,430 baht was generated.

4. Environment

The area is semi-arid, with an average rainfall of 1,001 to 1,500 millimeters. The yearly rainfall averaged 1,070.5 milliliters in 2021. (data from the Meteorological Station: Meteorological Department). The terrain is level. The elevation of the plateau ranges from 101 to 500 meters. The depth of the earth is greater than 20 cm. Fine-grained clay makes up the topsoil. Loam and silty clay make up the subsoil. Organic matter levels are moderate (1-3 percent). It is impossible to extract groundwater. The water quality is unpurified, yet the surface water is moderate. Because of the salinity of the water, it can only be used for agriculture. As a result, it is a significant issue in agriculture. Only a few types of crops can be produced as a result, and yields are minimal.

4.1 The effects of utilizing technology (Economic and Social)

Title	Effect	Before	After
1. crop production	the greatest increase	Because the soil is very saline, 1 rai of crop yields 80 kg (15 rai = 1,200 kg), resulting in less rice production; not worth the investment.	yield of Manila tamarind is 1,500 kg per production cycle, or 15000 tilapia.
2. Cultivation excellence	the greatest increase	less rice yield whole grain rice.	When changing plant types to suit the soil conditions, it results in better quality yields, good flavor yields, and large pods.
3. Production of animal feed	a significant increase	The soil was so salty that there was not even any grass or weeds growing.	The salinity of the soil was reduced, causing grass and weeds to grow, allowing farmers to mow the grass to feed

			the cows on their farms.
5. product variety	the greatest increase	only rice cultivation	More farm products were obtained, including Manila tamarind fruit, tamarind seedlings, manure, calf, tilapia, and animal feed.
6. cost of agricultural inputs	a significant reduction	-	Because of integrated farming, he can reduce the cost of manure by up to 8,750 baht (the cost of manure put in the Manila tamarind plot is 350 sacks) and thereby reduce production costs significantly. Both in terms of the cost of manure pet food and the cost of food for raising fish in the garden groove.
7. Income	the greatest increase	He makes money by selling rice; the typical price of rice is 5-6 baht per kilogram, and he can produce 1,200 kg of rice	This technology brings in more money for farmers. Manila trees, manure,

		in a 15-rai area, earning 6,000 baht.	calves, and tilapia for sale. 1. Revenue from the sale of 1,500 kg of Manila Tamarind pods every production cycle The price per kilogram is 80 baht, or 120,000 baht. 2. Income from the sale of Manila Tamarind trees for 35 baht each, which used to sell up to 50,000 trees per year, resulting in an annual income of up to 1,750,000 baht. 3. Increased revenue from the sale of calves Male calves cost 25,000 baht each, while female calves cost 50,000 to 100,000 baht each. 4. Annual profit from tilapia sales is 300,000 baht.

The effects of utilizing technology (Social and Cultural)

Title	Effect	Before	After
1. Food security and self-reliance	the greatest improvement	The price of 1,200 kilograms of rice is 5 baht per kilogram.	Produce 1,500 kg of Manila Tamarind at 80 baht per kilogram and 15,000 tilapia fish for domestic consumption.
2. community institution	Maximum strengthening	-	promoting community unity and sharing your thoughts in order to tackle the problem of saline agricultural land management
3. Knowledge about SLM (Land Degradation Management)	a significant improvement	There is still a scarcity of information.	As a result of the increased adoption of technology, knowledge began to circulate more widely.
4. The social and economic position of disadvantaged groups	greatly enhance	They are still unsure how to transition from monoculture to integrated farming.	They received knowledge transfer from the learning center that they may apply in their local area, as well as seeking counsel and guidance from model farmers.

The effects of utilizing technology (ecology)

title	**effect**	**before**	**After**
1. Soil protection	greatly enhance	There will be no more grass or weeds.	Grass or weeds start to emerge.
2. Salinity	the most lowered	A salinity of more than ten parts per thousand (ppt) is present.	The salinity was decreased to 3.7-4.0 ppt till other crops could be grown.

The effects of utilizing technology (Outside of the area)

title	effect	before	After
1. The availability of water	a significant increase	-	They can deliver usable water from saline land sources. Because the Manila Tamarind is a salt tolerant plant, and tilapia can thrive in brackish, salty water.
2. Fields of neighbors have been harmed as a result of the destruction.	a significant reduction	Pesticides are applied in massive quantities and inappropriate way.	Pesticides should be used less often. To limit the use of insecticides, concentrate on employing bug traps.
3. Greenhouse gas's impact	reduction	Preparing the plot by burning rice fields	It is possible to reduce carbon dioxide emissions from burning by switching to tamarind cultivation. Contribute to the reduction of greenhouse gas emissions.

5. Conclusion

5.1 The adoption of the Technology

Approximately 1–10% of farmers have accepted and applied the technology without any material or financial incentives because the initial adjustments require a relatively high investment. There are local farmers who participated in the project and applied the technology in their own areas. By changing the area and type of crop grown from rice to a salt-tolerant crop, tamarind, in conjunction with fish and livestock farming, But adjustments must be carried out gradually and systematically planned.

5.2 Strengths/ advantages/ opportunities in the land user's view

1. Deteriorating soil conditions are more fertile.
2. improved earnings and productivity
3. Capable of pursuing a profession in agriculture in places with saline soil.

5.3 Strengths: The opinion of compilers

1. Farmers on saline terrain can adapt to sustainable farming. On the farm, diverse materials are rotated in order to lower input costs.

2. If certain farm goods are harmed, such as Manila Tamarinds that have been exposed to rain, they cannot be sold as food but can be used as cow feed. However, it has little impact on overall earnings. Because other farm goods, such as selling manure Manila Tamarind plants and tilapia, provide revenue.

5.4 Weaknesses/ disadvantages/ risks in the land user's view

Use the initial investment to acclimate the area and digging wells is quite high effect some farmers don't have the courage or don't have enough capital to start making changes.

5.5 Weakness: The opinion of compilers

The Manila Tamarind has a limited shelf life. If harvested during the rainy season, fungal is easy to grow. Farmers must be cautious as harvest season approaches. And keeping an eye on weather forecasts to determine when to harvest with the least amount of rain.

Activities Pictures

Figure 1 Land transformation from paddy fields to raising trenches for Manila Tamarind planting and digging ponds for raising tilapia and storing water for agriculture.

Figure 2 Phet Non Thai Manila Tamarind produced from the orchards of Niphon Plaeng Klang, Volunteer Soil Doctor of Makha Subdistrict, Non Thai District, Nakhon Ratchasima Province.

Figure 3-4 A field visit to interview and inquire about the details of the successful modification and use of technology in saline soil management at the Land Development Technology Transfer Center 2017 of Mr. Niphon Plianklang, a volunteer soil doctor at Makha Subdistrict, Makha District. Non Thai, Nakhon Ratchasima Province.

Figure 5 Phet Non Thai Manila Tamarind cultivar produced by Niphon Phenklang's tamarind plantation, which is currently considered the main product. Agriculture can produce and generate income for agriculture throughout the year.

Figure 6-7 Raising two broiler cows capable of artificial insemination and yielding calves which if a calf is a male, It can also be sold at 25,000 baht per cow, and if a female calf can be sold at up to 50,000 – 100,000 baht/head, it can also produce manure from cow dung, up to 800 baht per year, saving costs and reducing the cost of buying fertilizer to put in their own plots as well.

Figure 7-8 A ditch or ditch dug between the tamarind plots for raising transgender tilapia, releasing 15,000 birds per year, and because it is a saline areaThe water in the raceway has a higher concentration of salt than usual, but tilapia has characteristics that can grow well in salty, brackish water. Raised tilapia is relatively easy to raise and less disease-causing because pathogens and parasites are less able to grow in salty water. Get good quality fish meat, a firm texture, and a sweet and delicious taste. No smell of mud on the fish. Therefore, it is the demand of the market and consumers.