Soil Degradation Due to Shrimp Farming and Preventive Measures

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Abstract: Salt-affected soils occur naturally, extending along the coastal area and the northeastern part of Thailand. Besides that the activities such as brackish water shrimp farming have caused soil salinization due to the addition of concentrated brine and salt granules into the ponds to create suitable salinity for the growth of shrimp. Shrimp farming area has rapidly increased just over a decade ago. It is estimated that the total area of shrimp farming is approximately 72,000 ha in the coastal area, while 22,400 ha are located in 23 Central Plain provinces.

This activity has caused severe anthropogenic soil salinization. Discharge of sludge, excess feeds and saline water into nearby irrigation canals, including seepage of saline water to adjacent cultivated areas and under the ground has led to a significant built-up of toxicity and salinity. It is estimated that the total area of salt-affected arable land caused by shrimp farming extended to an area of 90,650 ha.

The government had been concerned about these problems, so it decided to ban shrimp farming in freshwater areas in July 1998. At the same time it introduced the plan to reclaim the land affected by shrimp farming to use for agricultural purposes.

Keywords: salinity, anthropogenic saline soils, shrimp farming, government policy, rehabilitation

1 Introduction

Soil and land problems have occurred from various reasons, resulting in the degradation of land resources, eventually causing the decline in crop yields. Soil salinity is one of the oldest problems for mankind that has affected agricultural production since ancient time. It is a major factor that has turned high quality lands to be low quality ones.

Salt-affected soils in Thailand are found along coastal area and in the northeastern part of the country. Beside that, some other activities such as brackish water shrimp farming have also caused soil salinization due to the addition of concentrated brine and salt granules into the ponds to create suitable salinity level for the growth of shrimp.

Brackish water shrimp farming in Thailand has been operated along the coastal zone and estuaries for the last 70 years. As a lucrative business, the number of farms has been rapidly increased in recent years. However, because of improper farming practices, soil and water pollution and shrimp disease outbreak occurred in many areas. The shrimp farming was then introduced to freshwater areas of arable land in the Central Plain, which is considered the rice bowl of the country. It is estimated that the total area of shrimp farms is approximately 72,000 ha in the coastal area, while 22,400 ha are located in 23 provinces of the Central Plain.

Thailand is an agrarian country; its economy depends very much on agriculture. The land resource is an important factor and is the foundation for agricultural production. Agriculture sector has contributed significantly to economic growth especially to the Gross Domestic Product (GDP). Therefore, the aims of land use at present are considered on the sustainable use of land. The diverse use of land for many purposes without care resulted in the adverse effect to the land for future generations. The activity on shrimp farming is a good example to show that soil and water resources could become degraded as a result of anthropogenic soil salinization. This is a major cause for production constraint that would eventually affect the National Action Plan for Food Security.

2 Materials and methods

The study was carried out in five provinces, i.e. Suphan Buri, Prachin Buri, Nokhon Si Thammarat, Nakhon Nayok and Chacheongsao Provinces, from November 1998 to December 2001.

The determination methods for the extent of the salinity problems and assessment of the severity of its adverse effect including estimation of the total affected arable land area of the country were adopted. The criteria for defining salt-affected area are based on the EC value of 2 dS/m. In each province a selection of 20 shrimp ponds was made. Locations chosen were the representative ponds that shrimp farming had been practiced for at least three years. For each representative pond, four transects were made perpendicular to the pond. Electromagnetic terrain conductivity (EM–38) method was employed in both horizontal and vertical directions, with the instrument placed on the soil surface. Measurement was made at the distances of 0, 10, 20, 30, 40, 50, 100 and 200 m from the pond. GPS reading was recorded in each measurement. Calibration of EM reading to soil salinity was made. Besides that, in each province sets of piezometer have been installed at the distances of 10, 20, 50, 100 and 200 m away from an active shrimp pond, with two piezometers at each spot at the depths of 3 m and 7 m.

Demonstration on rehabilitation of salt-affected areas and abandoned shrimp ponds was conducted in three provinces, i.e. Suphan Buri, Prachin Buri and Nakhon Si Thammarat. At each farm there were two dominant treatments. The traditional practice compared the Best Management Practices (BMP). The BMP included drainage and additions of organic matter and gypsum/lime. Other small plots were used to quantitatively compare treatments and designed to assess the incremental value of individual best practices, which are BMP, BMP minus organic matter, BMP minus gypsum/lime, BMP minus drainage, and control.

3 Results and discussion

The results of monitoring on impact of shrimp farming showed that the electric conductivity (EC) of soil in adjacent farms substantially decreased with the distances away from shrimp pond. Monitoring in Suphan Buri, Prachin Buri and Nakhon Si Thammarat was conducted at the distance of 0, 10, 20, 30,50, 100 and 200 m from shrimp pond. Due to topography, the EM reading was done at varying distances at Nakhon Nayok and Chachoengsao Provinces: the former at 0, 10, 20, 30, 50 and 100 m and the latter at 10, 20, 30, 50 m from shrimp ponds. In Suphan Buri Province, the EC of soil ranged 2.5 — 4.2, 2.7 — 4.3, 2.3 — 4.2, 1.9 — 4.2, 1.7 — 4.6, 1.5 —3.9 and 1.7 — 3.0 dS/m, repectively. At the site in Prachin Buri Province, the EC of soil ranged 2.1 — 5.4, 1.9 — 5.8, 1.8 — 3.7, 1.5 — 2.9, 1.0 — 2.7, 1.2 — 2.9 and 1.0 — 2.1 dS/m, and at Nakhon Si Thammarat site, it ranged 3.1 — 6.0, 2.1 — 5.9, 1.8 — 6.0, 1.7 — 5.6, 1.5 — 5.3, 1.4 — 3.5 and 1.6 — 5.2 dS/m, while at Nakhon Nayok site, it was 2.9 — 3.7, 2.2 — 5.8, 2.9 — 4.5, 2.1 — 4.5, 2.1 — 4.1, and 2.4 — 3.1 dS/m, respectively and at Chacheongsao site it was 2.2 — 3.8, 2.4 — 3.3, 3.3 — 5.3, 3.3 — 3.6 and 1.7 — 2.6 dS/m. In comparing the EC values of the five locations of shrimp farms it indicates that the salt-affected soil in Nakhon Si Thammarat had a higher level of EC than in those in other provinces. Nakhon Si Thammarat Province is located in the coastal zone. This may have resulted from using higher concentrations of brackish water for farming. The salinity of soil in each transects of shrimp ponds were varied which depended upon salt contents in brackish water, geographical characteristics, direction of water flow and amounts of precipitation. For water samples in Suphan Buri Province, the piezometer sets were installed at the distance of 10, 20, 50, 100 and 200m, while Prachin Buri, Chachoengsao and Nakhon Nayok Provinces the piezometers were installed at the distance of 10, 20, 50 and 100m away from shrimp pond. Water analyses also showed the same trend, decreasing in EC by the distances away shrimp pond. An average EC of water from piezometer at Suphan Buri province were 4.4, 4.1, 5.0, 4.7 and 2.1, while at Prachin Buri they were 4.6, 2.9, 1.6 and 1.8 dS/m, Chachoengsao Province were 4.4, 2.9, 1.8 and 1.7 dS/m and Nakhon Nayok Province were 3.9, 4.7, 4.0 and 2.8 dS/m (Figure 1).

The results from the demonstration plot in three locations, which focused on improvement and rehabilitation of salt-affected area and abandoned shrimp pond, showed that among the treatments, BMP gave the highest yield of 4.5 t/ha while the lowest was 0.78 t/ha in the control treatment (Figures 1 and 2).

The EC_e of soil on salt-affected area ranged from 2.1 to 4.2 dS/m and abandoned shrimp pond before planting ranged from 2.3 to 10.2 dS/m, depending on cultural practices and precipitation regime. The pH values ranged from 4.0 to 7.4. After rehabilitation, the EC of soil gradually decreased around 1.0 dS/m.

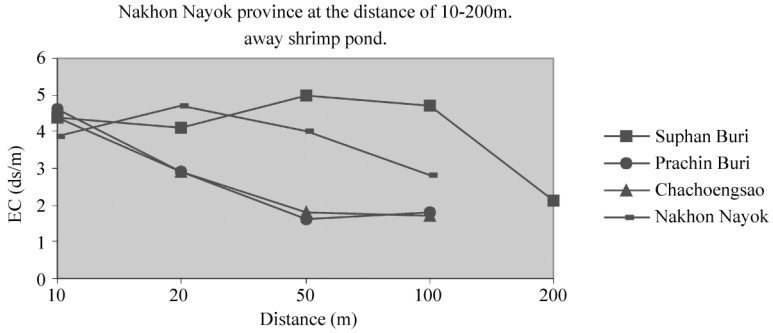

Fig.1 EC of ground water in Suphan Buri, Prachin Buri, Chachoengsao and Nakhon Nayok province at the distance of 10 — 200 m. away shrimp pond.

The results of water samples from adjacent area and surrounding irrigation canals close to shrimp pond showed that the EC_w was high, particularly in dry season. The average of EC_w was ranged 3 — 4 dS/m which depended on quality and quantity of discharge water from shrimp pond to its proximity. The effect was extended in a large area of agricultural land, particularly in the paddy field in the Central Plain of the country. Although rice is moderately tolerant to salinity but most plants are more sensitive to salinity particularly during germination. Besides that, discharge of sludge and excess feeds as well as seepage of saline water into adjacent area and underground has led to a significant built-up of toxicity and salinity.

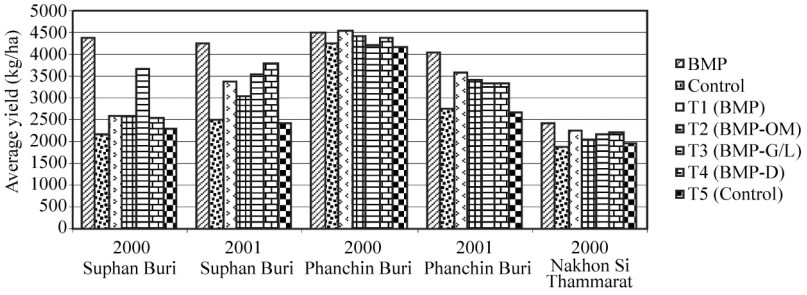

Fig. 2 Rice yield of improvement of salf-affected rice field plot (2000—2001)

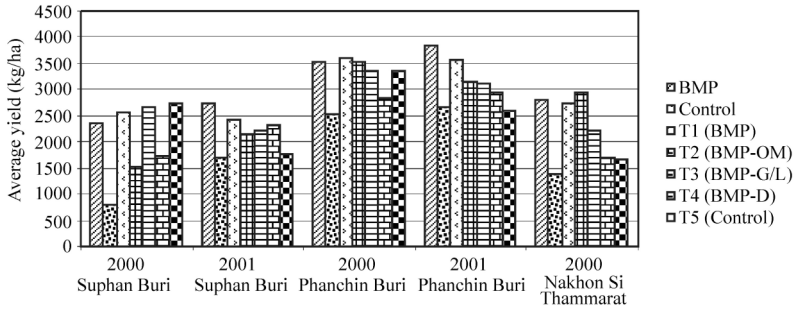

Fig. 3 Rice yield of rehabilitation of abandoned shrimp pond plot (2000—2001)

The impact of shrimp farming in freshwater arable land showed that most of affected area due to shrimp farming the level of salinity was severely affected in surrounding area within the distance of 50m away from shrimp pond. It could be estimated that the total extent of affected area including shrimp farms is approximately 90,650 ha. However, the Thai Government foresees the critical effect to land and water

resources due to the change of land use to shrimp farm which rapidly increased and extended to a large area of arable land, resulting in degraded quality of land and water, eventually to decline of crop yield. Moreover, the controversial issue was arisen nationwide, eventually, had become the confrontation issue between the farmers who use freshwater and shrimp farmers who use brackish water. In July 1998, it decided to ban shrimp farming in freshwater area throughout the country. At the same time it introduced the plan to reclaim the land affected by shrimp farming to use for agricultural purposes.

4 Conclusion

The conversion of land in large area, particularly on arable land to shrimp ponds had severe impact on land and water resources. Distribution of salinity from shrimp farm to adjacent area had severely affected with the distance of 50 m surrounding shrimp pond. It is estimated that the total area of arable land affected by shrimp farming was around 90,650 ha. The discharge of effluent from shrimp ponds into nearby irrigation canals, agricultural land, as well as underground water had led to a significant built-up of toxicity and salinity.

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