RICE CULTIVATION ON ACID SULPHATE SOILS IN THE VIETNAMESE MEKONG DELTA

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1 Summary

In the Mekong Delta of Vietnam an estimated 60% of the land is affected by acid sulphate soil conditions. By trial and error local rice farmers have developed various management systems that overcome or minimize the adverse soil conditions.
Two popular and successful practices applied for rainfed rice are described: (1) the intensive shallow drainage system, yielding up to 4 t/ha of paddy on shallow-developed and potential acid sulphate soils, and (2) the acid avoidance practice yielding up to 6 t/ha on well-developed acid sulphate soils.

2 Introduction

Although a complete and comprehensive inventory of the distribution of acid sulphate soils in the Vietnamese part of the Mekong Delta has not been realized yet, an estimated 2.6 million ha of potential and actual acid sulphate soils have been recognized in various areas in southern Vietnam (Soils Survey Division, Ministry of Agriculture, 1978, unpublished data). The well-developed acid sulphate soils are found on large areas in the Plain of Reeds, the Plain of Hatien, and on scattered spots throughout the Delta with a total area of about 870,000 ha. The potential acid sulphate soils in tidal marshes and underneath mangrove forests total to about 704,000 ha. Shallow-developed acid sulphate soils

are found in empoldered backswamps subject to salt water intrusion with a total of about 1,015,000 ha. Another estimated area of 27,000 ha of potential acid sulphate soils can be found underneath 0.5-2.0 meters of peat soil found mostly in *Melaleuca, Avicenia* and *Rhizophora* forests in Min-hai province. Despite the fact that about 60 per cent of the total land areas of the Vietnamese Mekong Delta is affected with acid soils, the subsistent farmers have long been using part of that land quite satisfactorily. By trial and error, they have found various ways to overcome the acidity of their soils to produce food crops for subsistence. This paper describes some of the popular methods of management of acid sulphate soils by South Vietnamese farmers.

3 Rice cultivation on shallow-developed and potential acid sulphate soils

In the various districts of the former Ca-mau region, now belonging to Minh-hai province, where annual rainfalls reach 2,200 to 2,400 mm, a method of rice cultivation gaining increasing popularity is called 'intensive shallow drainage system'. Up to the main crop season of 1980, thousands of individual intensive shallow drainage systems have been installed on an estimated 90,000 ha of acid sulphate soils. This represents about 52 per cent of the rice land of Ca-mau region.
The drainage system comprises an intensive network of shallow ditches (Figure 1). As the ditches are excavated, the land between two ditches becomes a slightly raised bed on which rice is grown. Since land ownership is still by individual farmers, each farmer makes his own system. At present, therefore, sometimes the networks are not connected together by a common drainage canal. Thus, drained acid or saline acid water may run off the raised beds but remains stagnant in the ditches. Rice yields usually double in the first year after installment of the shallow drainage system, and from the second year on, a yield increase of two to four times is reported by most farmers.

Figure 1. Rice cultivation with intensive shallow drainage systems

It is not known exactly who came up first with the idea for such a system. According to our investigations, sometime in 1957 during a meeting attended by some 100 of the more successful traditional rice farmers in this region, one farmer reported that when he considered abandoning the land on which he had obtained almost no yields during the previous years, he constructed a seedbed to prepare seedlings for his last effort and he discovered that those seedlings left on the raised seedbed became the best rice plants he had ever seen. In the following year, he turned all his land into several raised beds, and got good yields. Another idea came from the observation that as farmers pulled their sampan boats through muddy fields to transport their newly harvested rice to threshing pads, several ditches were incidentally formed. During the following year's rice crop, they observed that rice plants along those ditches grew much better than those away from the ditches. From then on, ditches were excavated intentionally.

We made several investigations to identify soil types in these areas. Mostly the intensive shallow drainage system is practiced in empoldered areas with dikes running along waterways to prevent salt water overflow,

and with gates made from hollow coconut trunks to permit simple regulations at high and low tides. We found that in almost all cases, the soils are typical young acid sulphate soils with jarosite present at 30 to 50 cm below the surface. The practice is being gradually extended to areas of newly cleared mangrove and *Melaleuca* forests where potential acid sulphate soils are found at 30 to 60 cm below a thick peaty topsoil of various depths.

3.1 Land and drainage system preparation

Excavations of ditches usually starts after harvesting the previous crop of rice, when the soil is just dry enough for earth work. The common land area unit used by Vietnamese farmers in the Mekong Delta is the '*công*' measuring 36 × 36 m^2 (1/7 ha). For new construction, one side of the field is divided into four strips of 9 × 36 m^2. Between each strip a ditch of about 1 m width and 0.3 to 0.6 m depth is excavated by hand. The more depressed the field is, the wider and deeper the ditches are. The excavated soil is spread evenly on the strip between the two ditches thus forming a moderately raised bed (see Figure 2). In this operation the soil is not broken into granular form, but deposited carefully as unaltered thin slices of spade-shaped soil. For two- and three-year old systems, repairing the ditches by dredging is carried out soon after harvesting the previous rice crop. The dredging is timed to allow the soil on the ridges to dry thoroughly.

Each shallow drainage ditch is open on one end to a larger and deeper drainage canal, while the other end is kept closed. Each adjacent farmer may have a separate main drainage canal, or several farmers may pool efforts to construct a main drainage canal running to a river. All together, the area looks like an immense checkboard. Experienced farmers observed that even if drained water could not be evacuated to the river, it still did not appreciably harm the growth of the rice plant on the ridges.

Figure 2. Excavation of ditches and formation of raised beds

3.2 Drainage control practices

The Ca-mau region receives a higher rainfall than other regions in the Mekong Delta. With the first heavy rains, normally in April, rainwater washes off the oxidized sulphidic soil material on the ridges and removes toxic substances such as aluminum and salts. These substances concentrate in the shallow ditches and in drainage canals. The outlet gates remain closed until the drained water reaches the level of the surface of the raised beds. With the next rains, the accumulated water is allowed to run through the canals and out to the river at low tides. The cycle is repeated two or three times before the entire region is naturally flooded, and drainage is no longer possible.

3.3 Planting

Saline- and acid-tolerant, medium duration rice varieties are utilized extensively. Some of the most popular varieties are: Than Nong Do, Trang Mot Buoi, Trang Hoa Binh, Nang Tet, Trang Lun, Trang Tep Thai lan, etc. At the beginning of the rainy season in April, seedbeds are prepared. On some raised beds first weeds are chopped off, then the topsoil is hand-tilled to a granular structure with clod size around 3 to 4 cm in diameter. Sowing takes place in early June. Twenty days after sowing, the final land preparation of the other raised beds begins. By this time, the whole area may be flooded to about 10 to 40 cm. Weeds are chopped off with a large scyth and gathered into the shallow ditches the drainage capacity of which is not needed for the time being. Forty-five to 60-day-old seedlings (about 60 to 100 cm tall) are transplanted on the cleared raised beds which are submerged under 10 to 40 cm of water. Transplanting is facilitated by driving a round wooden dagger into the soil to make a hole into which 3 to 4 seedlings are pushed. Farmers seldom use chemical fertilizers under such conditions. Thus the rice plant grows under totally rainfed conditions. The maximum water level reaches usually 0.5 to 0.8 meter (Figures 3 and 4).

After first installation of the intensive shallow drainage system, rice yields increase every year up to the fourth year. In the first year, grain yields jump to 1.5 to 2.0 t/ha compared to the previous undrained yields of 0.2 to 0.5 t/ha on similar land without ditches. The fourth year yields maybe as high as 4.0 t/ha, but after that yields tend to decline unless the drainage capacity is restored again e.g. by dredging the ditches. As an alternative many farmers prefer to excavate a very narrow (0.25 meter) ditch right in the middle of each raised bed, running along its length. Others may refill the old ditches and excavate new ones.

Our actual field determinations of grain yields during November-December 1980 harvests gave a range from 3.20 to 3.85 t/ha with the rice variety Trang Mot Buoi under natural conditions, without applying any fertilizer. The huge amounts of decaying weeds spread on the fields, may contribute positively to the soil fertility.

Figure 3. Rice on raised beds at heading stage

Figure 4. Rice on raised beds at ripening stage

4 Rice cultivation on well-developed acid sulphate soils

In depressed backswamps, normally deep water or floating rices are being cultivated, as in Hatien Plain, and part of the Plain of Reeds. Rice seeds traditionally were broadcasted in dry conditions before the onset of monsoon rains. Along the fringes of the Plain of Reeds in Long-an and Tien-giang provinces with the introduction of high yielding rice varieties with short growth duration (90 to 100 days), farmers turned to transplanting the short duration rice near the end of the rainy season. As soon as water in the field started receding, rice seedlings were prepared on raised beds. Simultaneously, the fields for transplantation were rotovated to incorporate weeds into the soil. Phosphate fertilizers were used extensively, as the most important input to maximize grain yields. Occasionally, one or two additional sampan pump irrigations with fresh water still available in the canals were necessary if drought occurred toward the ripening period of the rice plant. Rice yields often reached as high as 4.5 to 6.0 t/ha with high yielding rice varieties such as IR36, IR2307-247-2-2-3, and IR2823-399-5-6.
This system is called 'acidity avoidance practice'. The farmers avoid toxic substances dissolved by rain water during the early part of the rainy season, and transplant only when the soil has been leached, and toxic substances were diluted to a safe limit. Some farmers even planted a first crop of short duration rice very early at the beginning of the rainy season in an attempt to forestall development of adverse conditions. The time of seeding is crucial in this case, and it should be early in order to enable the plants to reach the ripening stage before the build-up of acid substances in the flooding water to toxic concentrations. Grain yields with precocious transplanting seldom surpassed 4.0 t/ha.

5 Conclusion

The farmers in the rainfed areas with acid sulphate soils in the Mekong Delta are gaining more and more experience to better manage their soils for food production. The practices such as intensive shallow drainage

system and acid avoidance cultivation as described above are now adopted widely. Pending the realization of large scale irrigation schemes for efficient fresh water supply and production increase in acid sulphate areas, the popular methods now in use seem to be the most practical. They can serve as a basis for further agronomic studies aimed at more intensive and productive rice cropping on various acid sulphate soils under purely rainfed conditions.