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Chapter 5. Puddling and its Effects on Rice

One striking feature of most of the world's wetland rice is that it is grown on soils whose structure is deliberately destroyed and the soil dispersed by plowing and harrowing the soil in a flooded or saturated state. The operation is an important management practice in wetland rice culture and is called puddling. Ghildyal (1978) defined puddling as mixing soil and water to render it impervious.

The steps involved in puddling are:

1. saturating and flooding the soil;
2. plowing the supersaturated soil;
3. plowing or harrowing at progressively lower water contents

The two phases of puddling are increase in the soil moisture content and the mechanical work done on it. When the soil moisture content increases, soil aggregates swell, soften, and weaken. Cohesion between aggregates increases, reaches a peak at field capacity, and decreases. When such a soil is plowed or harrowed the aggregates are destroyed.

Effects of puddling on soil properties (Ghildyal 1978):

1. coarse aggregates are broken down;
2. noncapillary pore space is destroyed;
3. apparent specific volume decreases;
4. water-holding capacity increases;
5. hydraulic conductivity and permeability decreases;
6. evaporation decreases;
7. soil reduction is favored

Ghildyal (1978) defines a puddled soil as follows:

"A puddled soil is one whose structure has been destroyed, whose aggregates have lost their identity, and which has been converted into a structurally homogeneous mass of fine aggregates and textural separates."

The degree of puddling depends on the soil and cultural practices. A clay content exceeding 20% favors puddling (De Datta 1981). Smectitic clays puddle more readily than kaolinitic or oxidic. Sodium clays puddle easier than calcium clays. As the content of organic matter or that of iron and aluminum oxides increases, soils are less readily puddled (Sanchez 1976).

The changes brought about by puddling are not static. The soil particles settle and undergo stratification into clayey, silty, and sandy layers (Moormann and van Breemen 1978), the bulk density increases, the moisture content decreases in spite of the soil being flooded, and gases are trapped in the puddled layer. The thickness of the oxidized surface layer increases during the season and reddish-brown streaks and mottles are visible in the reduced puddled soil. When the soil is drained and dried, it cracks. Alternate drying and wetting and tillage regenerate aggregates. Soils high in organic matter or iron and aluminum oxides are easier to regenerate than others (Sanchez 1976).

Effects of puddling on rice.

The benefits of puddling for rice listed by De Datta (1981) include:

1. reduced draft requirements for tillage
2. weed control
3. easy transplanting
4. conservation of rain and irrigation water
5. increase in nutrient availability

Of these, weed control and water conservation are the most important.

Weed control. Puddling buries weeds and weed seeds in the soft mud where anaerobic conditions kill the weeds and retard germination of the seeds. According to De Datta (1981), tillage is the most important weed control factor in transplanted rice.

Water conservation. This is perhaps the most important benefit of puddling. Puddling significantly decreases water loss by percolation. In a drum study of six Philippine soils whose clay content ranged from 9 – 64% and clay composition included montmorillonite, kaolinite, and allophone, Sanchez (1976) observed that puddling decreased percolation by 1000 times. Field measurements indicate that the reduction by puddling reduces percolation losses to about one third of those in nonpuddled soils (Wickham and Singh 1978). But the long-term effects of puddling lead to plow pan or traffic pan formation that may reduce percolation drastically.

The main disadvantages of puddling are excessive water use, low trafficability, and difficulty of regenerating soil structure for the dryland crop following wetland rice.

SUMMARY

Most of the world's rice is grown on puddled soils. Puddling is wet cultivation of land that mixes soil and water to produce an impervious layer. It is achieved by plowing the flooded soil and harrowing it at progressively lower water contents.

A clay content exceeding 20%, dominance of smectitic clays, and sodium saturation facilitate puddling. Soils with a high content of organic matter, oxides of aluminum and iron, 1:1 clays or exchangeable calcium puddle less readily.

Puddling benefits rice by controlling weeds and conserving water.

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