GENERALIZED KEY TO THE SOILS OF SIAM

By

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Temperate Zone points of view and methods of studying soils have long since proven an inadequate background for studying the soils and plant nutrient relationships of the soils of humid equatorial regions. Having in my early years been trained as a soil surveyor, I have always taken every opportunity to collect and assemble information about the soils and particularly about what were believed to be the potential agricultural soils of a region. Thus from the time in 1935 that I first arrived in Siam by train from Singapore, I kept notes upon soils and land use practices wherever and whenever I travelled in the Kingdom. Extensive use of a camera effectively supplemented written notes.

In 1946, during a 4 months' assignment to Bangkok, it was found that difficulties of travel, and security problems in rural regions made field work practically impossible, or at least unwise; much of the time of that assignment was used in the preparation of a reconnaissance soils map. Soils data of the Kingdom were compiled into a formal soil group map. Through the much-appreciated assistance of Phya Salwitan Nides, head of the Cadastral Survey Office, Bangkok, this map was lithographed in 21 colors and published.[2] Later the Chao Khun was head of the Aerial Photo Mapping Department of the Thai Govornment which is making commendable progress in preparing railway surveys; and in the greatly needed additional topographic quadrangles of the Kingdom. In the meantime the Fairchild Aerial Surveying Company has photographed all the Kingdom north of about Chumporn on the Kra Isthmus. The U.S. Army's 29th Engineers have been working on the triangulation needed

1. Soil Scientist of the Ministry of Agriculture, Bangkok. December 29, 1956.
2. Robert L.Pendleton, 1949. Provisional Map of the Soils and Surface Rocks of the Kingdom of Thailand. Scale 1: 2,500,000. 50 x 75 cm. Lithographed at the Cadastral Survey Office, Bangkok.

to control the preparation of the base map. But we cannot wait for the new and better base maps which will ultimately appear.

Meanwhile, my assistant, Achan Sarot Montrakun, then attached to the Thai Department of Science, was from time to time making local, detailed soil surveys; and spending much time in the Soils Laboratory, with the staff making chemical and physical analysis of the hundreds of soil samples which we had been collecting in the field. Thus we were accumulating data which gave us at least some additional understanding of characteristics of Siamese soils. We were amazed by the very small amounts of "available" plant nutrients found in most of the soils. Sarot is now attached to the Rice Department of the Ministry and has been devoting much of his time and energies to the fertilizer experiments on rice, in order to establish the quantities and proportions of the principal plant nutrients needed for padi on the main soils groups of Siam.

Subsequently, when Point 4 and other projects were being planned and developed, these data and particularly the provisional edition of our soils map proved of great value. While on duty in Bangkok in 1950-52 more data were assembled concerning the soils of the Kingdom. These were summarized by Pendleton in a report to the Mutual Security Agency.[3] Many detailed observations on Siamese soils will be found in the several publications listed in the bibliography of more recent publications of Siamese Soils.[4] Now has come a time when more of the scattered data on Thai soils can be assembled.

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3. Robert L. Pendleton, 1953. Report to Accompany the Provisional Map of the Soils and Surface Rocks of the Kingdom of Siam. Mutual Security Agency. U.S. Special Technical & Economic Mission to Thailand. 290 pp. January, Bangkok, mimeographed.

4. Pendleton, Robert L. 1947. The Formation, Development, and Utilization of the Soils of the Bangkok Plain. The Siam Society. The Natural History Bulletin 14, No. 2, pp. 1-40, illus., Bangkok.

   Pendleton, Robert L. 1949. Soils and Land Use in Peninsular Siam. pp. 178 + 33 illus. Technical Bulletin 3, Thai Dept. Agric., Bangkok.

   Pendleton, Robert L. 1950. Notes on Soils and Land Use in Southeastern Siam. pp. 123 + 31 illus. Thai Dept. Agric., Tech. Bull. 4, Bangkok.

A soil sample collection was commenced in 1935. Only after more than 10 years was the provisional soils map prepared, and the soil groupings set up: So after 21 years a start has been made in correlating the soil samples. Grouping them, and compiling the other data, the attempt will be made to correlate all pertinent data which can be of value.

While the reasons are good for such large proportion of the soils of Siam being only mediocre in plant producing capacity, little can be done about it. Some of the deficiencies can be made good by the use of commercial fertilizer. But whether or not the increased productive capacity will pay, can only be learned by trying the measures and means suggested, to find out how much the crop is increased, and how much the increase costs. Annually we are conducting as many different widely scattered field plot test experiments as we have funds and staff for. So our knowledge of the potentialities of our soils, and the degree of response of our padi varieties is growing.

It should be of interest to know why the soils of the Kingdom are not more fertile. Siam is in one of the older and more stable parts of the earth's surface. Many of the rocks and soils of the Kingdom have long been exposed to the weather ("long exposure" means for a geologically long time). Not only have the parent rocks been seriously attacked by the weathering agents - rain water, soil water which also contains weak acids, decaying organic matter, and dissolved gases. And their effects are more intense in a tropical region. Most of Siam is of low or slight relief and has been so for a long time, so that erosion in its various forms has *not* played an important part in removing the weathered-out minerals and residues. Thus fresh portions of the parent rocks have not been exposed. The Korat region, especially, is "suffering from too little erosion".[5] While a mountainous region inevitably sloughs off

5. Pendleton, Robert L. 1943. Land Use in Northeastern Thailand. Geographical Review. 33. 15. - 41. illus.

much of its weathered-out soil and decayed surface rocks, in a region of only moderate or low relief, such as the Korat, this process is retarded. Rather, in these senile soils secondary products such as laterite and pisolitic iron concretions develop. Such iron compounds are not only a poor source of fertility, but they lock up in insoluble form even traces of phosphorus and other important elements, so they can't be absorbed by plant roots.

Such weathered-out, senile, soils can support a heavy stand of forest trees, providing they are watered by *an adequate rainfall.* Such a forest must have started when the soil was virile, when it was better supplied by plant foods. Then, providing the land was not cleared, that the plant food in the forest trees was not liberated by wholesale burning and clear-in, the plant food was being used over and over by the forest standing on the land. But once the land be cleared, and the plant nutrients in the plant cover liberated by fire; the ashes are soon washed by the heavy rains into the deeper subsoils or into low lying depressions. Once this plant food cycle: rock-soil-tropical high forest-ashes is broken, the system cannot be put back together.

Unfortunately, a large proportion of the soils of Siam are only mediocre, or really very poorly supplied with plant nutrients. But the low demands of padi for nutrients, combined with the natural lay of much of the land of the Bangkok plain and the Chieng Mai and other valleys; the favorable rainfall and water relationships, plus the industry and ability of the Thai peasants, make it possible for more than 80% of the population to live by agriculture;[6] and has enabled the Kingdom to gain a well-deserved reputation for the quality of certain of her agricultural and forest products.

6. Kassebaum, John C. 1953. Thailand Economic Farm Survey, Divn. of Agricultural Economics, Ministry of Agriculture; Bangkok, Thailand.

Now, if there were an active volcano to spread "ash" (fine rock powder) over the country side, the weathering of this rock powder would soon liberate many elements, some of which would be plant nutrients. These would increase the plant food content of the soil; they would rejuvenate the soil for plant growth.

Silt, separating out from muddy river water would have a similar, though lesser effect, for much of the silt carried by Siamese streams is from already more or less weathered minerals, which have lost a considerable portion of their total bases to the weathering solutions. A portion of the silt in the rivers and streams will still be able to weather and so release minerals which rejuvenate the soil, because some of the silt will be mechanically produced by rock fragments ground up in the streams. This silt will further weather, liberating nutrients.

Sarot Montrakun, who has made many quick-tests of dry season well water in the Korat region, calls attention to the fact that while the surface soil in that region is very thoroughly leached out and senile, the subsoil drainage is so inadequate, largely due to the low relief and the low total annual rainfall, that the deeper subsoil and well-waters contain considerable amounts of nutrients. This emphasizes the importance of deep rooting shrubs and trees. More reason for the farmers considering trees "manure". And quantities of the heavier clay deeper subsoils, which must inevitably have absorbed many soluble ions, have been brought to the surface by termites. These are some reasons why termite mounds are prefered spots for many crops which will not thrive on the flat land.[7]

7. Pendleton, Robert L. 1940. Some results of Termite Activity in Thailand Soils. Thai Science Bulletin. vol. 3 pp. - 29 - 53. Dept. Science, Ministry of Economic Affairs, Bangkok.
Pendleton, Robert L. 1942. Importance of Termites in Modifying Certain Thailand Soils. Jour. American Society Agronomy 34, 340 - 344. illus.

Now the termite heaps are generally used in the Korat region for growing the more demanding upland crops. Providing the rainfall is at all adequate, short season padi can be grown on the lower portions of the terrain, which can be kept flooded at least most of the time during the padi growing season. Sarot emphasizes[8] that the ground water is relatively rich in nutrients. The termites are evidently an effective means also of reversing, to a modest extent, at least, the downward leaching of plant nutrients.

For the Korat region it would be a *great* benefit *if* some of the muddy water of the Mekhong could be diverted onto those sandy soils. It is likely that the international character of the river, and the possible claims of Laos and Cambodia to their share of the water would make complications. But the relatively small amount of water which would be needed, and could be used in the Korat region, in comparison to the total amount of water in the Mekhong, make it seem fantastic that there could be any serious and valid objection which could not be quickly arbitrated. Certainly, if a low lift or gravity flow diversion from the Mekhong from above the rapids north of Loei could be managed, it could mean great benefits for the region.

A need has arisen for a smaller scale map of the soils of Siam, and one which can be published in black and white only. The provisional Map was in color, with 21 separations. Combining those soil groups in a more logical arrangement gives us the following rough key and groupings:

A GENERALIZED KEY TO THE SOILS OF SIAM

The soil group names or numbers which appear below are those used in the colored Provisional Map of the soils and surface rocks of the Kingdom.

8. Personal Communication.

A. Lowlands: Smooth topography; poorly drained alluvial plains:

1. Mainly for padi. Ridging, or raising the land (*rong*), is necessary for crops other than padi:

Heavy, low clays e.g. Bangkok clays. Transplanted padi.

Very acid, heavy clays, very poorly drained e.g. Ongkarak clays. Broadcast padi.

2. Clays too saline to grow field crops e.g. Tachin clays. Salt making; fish ponds and shrimp farms, mangroves for firewood, charcoal, and poles. Ridged for coconuts and fruits

3. Diversified cropping often possible - main crop of padi followed by soybeans, peanuts, garlic, or second crop of rice:

Recent alluvia e.g. Chieng Mai loams.

Undifferentiated alluvia in Central Valley e.g. Yom loams and clays.

Recent coastal ridges, coconuts and fruit trees on beach ridges, padi between. e.g. Pattani sandy loams and clays.

B. Flat to Gently Sloping: Old deltas; terrace lands; shallow soils on hill and mountain footslopes.

1. Deeply weathered; old, well drained formations:

a. Ferruginous concretions e.g. Krabin gravelly loams. Fruit trees; upland crops.

b. Friable, deep red clays, from mafec rocks e.g. Chantaburi clays. Pepper, rubber, fruits.

2. Deep soils with flat topography e.g. Gula Ronghai silt loams. Poor pasture; fishing during rains.

3. With irregular delta topography and variable textures e.g. Kampangsaen loams. Tobacco; cotton; sugar cane; padi in low portions.

4. Mountain footslopes from granitic rocks e.g. Sritamarat sandy and coarse sandy loams. Upland crops as *baw gaeo* (kenaf) and maize, peanuts, castor beans, bananas, and fruits. Clearings (kaingins) in rains: Rubber in S.E. Siam and in Peninsula.

5. Soils of moderate depth:

   a. Marl substratum e.g. Lopburi clays. Padi, and early cotton

   b. Residual soils of good depth to bedrock e.g. Pakchong loams. Peanuts, maize, fruits, oranges, *lamyai*, *jak*, sugar cane.

   c. Silt loams on outwash plains e.g. Bangkla silt loams. Padi.

   d. Sandy and fine sandy loams from sedimentary rocks e.g. Korat fine sandy loams. Pasture; open forest; when flooded for padi, becomes Roi Et fine sandy loams.

6. Soils shallow:

   a. Residual from mafec rocks e.g. Chaibadan clays: Upland crops, kapok, fruit trees, pasture, legumes.

   b. Residual from sandstones; laterite horizon in subsoil e.g. Sakon Nakorn loams. Forest, some padi.

   c. Loams residual from sandstones, underlain by variagated, dense clay loams e.g. Amnat Charoen loams. Padi, pasture, and open forest.

C. Uplands: Hilly to steep topography

1. Residual soils of shallow depth to bedrock

a. Intermediate elevations, from quartzitic sandstones e.g. Map Group 42. Forest; pasture; clearings for annual crops-cotton, maize, vegetables.

b. Higher forested hills e.g. Kuntan sandy loams. Forest and pasture.

c. Limestone outcrops and crags e.g. Soil Group 8. Forest.

d. Rough mountains not otherwise classified e.g. Soil Group 30. Forest; timber. Clearing culture (kaingining) for upland rice; opium poppies.

Unfortunately the smaller, illustrative regional sample maps of the Soil Survey of the Kingdom have not yet been completed, so they cannot at this time be included in this paper.