ON THE CLASSIFICATION AND UTILIZATION OF RED SOILS IN TROPICAL AND SUBTROPICAL CHINA

ZHAO Qi-Guo*

Red soils are widely distributed in the tropical and subtropical regions of southern China where rainfall exceeds 1200 mm. Average temperature of the coldest month exceeds 5°C and that of the hottest month exceeds 28°C. Pedologists generally accept the viewpoint that large areas of Red soils in tropical and subtropical China were developed under the Tertiary and Quaternary geological ages, and they still preserve the essential characteristics affected by the soil forming process of laterization under the present environmental conditions.

Red soils in tropical and subtropical China are derived from various parent materials including basalt, granite, limestone and quaternary red clay. Although the weathering products of laterization show great differences in chemical, mechanical and mineralogical characteristics from their parent materials, the effect of the latter, more or less, is still reflected in present soil profiles.

The present system of soil classification of Red soils adopted in China is based upon the following three factors: 1. Natural conditions and human activities which affected soil formation. 2. The soil forming process. 3. Soil properties. According to the above-mentioned factors, five categories have been adopted in the system, i.e., great soil group, soil subgroup, soil genus, soil species and soil variety. Recently, a tentative scheme of soil classification of Red soils in tropical and subtropical China has been suggested (Table 1).

As illustrated in Table 1, it includes 4 great soil groups and 16 subgroups, followed by 19 corresponding soil genus. However, as far as the agricultural utilization is concerned, a more detailed soil classification system is needed, where emphasis would be laid on the species and soil variety. In this case, soil fertility becomes a more important criterion for the distinction of the local types of Red soils in tropical and subtropical China.

Regional distribution of the great soil groups, from south to north, that is from the tropical to the subtropical area gives the following succession: Latosols – Lateritic Red Earths – Red Earths. Another succession occurring in southern China from east to west is as follows: Lateritic Red Earths, Red Earths, Yellow Earths and Tableland Red Earths.

Vertical zonality of Red soil distribution differs in various geographical regions. It shows the following sequence within the region of Latosols: Latosols (50 – 50 m above sea level) – Yellow Earths (500 – 1,000m) – Podzolized Yellow Earths (1,000 – 1,500m) – Shrub Meadow soils (> 1,500m). Another sequence occurring in the region of Lateritic Red Earths is found as follows: Lateritic Red Earths (20 – 30m) – Red Earths (300 – 600m) – Yellow Earths (600 – 1,100m) – Shrub Meadow soils (> 1,000m). However, as for the sequence distributed in the region of Red Earths, the arrangement can be found as follows: Red Earths (50 – 500m) – Yellow Earths (500 – 1,000m) – Shrub Meadow soils (> 1,000m).

Present article also gives a brief introduction on the characteristics and utilization of the main soil groups of Red soils in tropical and subtropical China.

1 Latosols

They are distributed in the tropical region of southern China. These soils are usually acid in reaction. The content of organic matter is around 2 to 4%. They contain a very low amount of alkaline earths and alkali metals. The silica-alumina ratio of clay fraction (less than 1 micron) is

* Prof. and Associate Chief of the Department of Soil Geography, Institute of Soil Science, Academia Sinica, Nanjing, China.

Table 1 A tentative system of red soils classification in tropical and subtropical China

Great soil group	Soil subgroup	Soil genus
Latosols	Latosols	Ferruginous Latosols
		Siferric Latosols
	Red Latosols	Siallitic Red Latosols
	Yellow Latosols	Siallitic Yellow Latosols
		Ferruginous Yellow Latosols
	Drab Latosols	Ferruginous Drab Latosols
		Siallitic Drab Latosols
	Cultivated Latosols	
Lateritic Red Earths	Lateritic Red Earths	Siallitic Lateritic Red Earths
		Ferruginous Lateritic Red Earths
	Yellow Lateritic Red Earths	Ferruginous Yellow Lateritic Red Earths
	Drab Lateritic Red Earths	Ferruginous Drab Lateritic Red Earths
		Siallitic Drab Lateritic Red Earths
	Cultivated Lateritic Red Earths	
Red Earths	Red Earths	Siallitic Red Earths
		Ferruginous Red Earths
		Siferric Red Earths
	Yellow Red Earths	Siferric Yellow Red Earths
	Cultivated Red Earths	
Yellow Earths	Yellow Earths	Siallitic Yellow Earths
		Siferric Yellow Earths
		Ferralitic Yellow Earths
	Gleyed Yellow Earths	
	Podzolic Yellow Earths	
	Cultivated Yellow Earths	

usually 1.3 – 1.5, and that of the soils derived from basalt and limestone is even lower. The clay minerals of Latosols are mainly composed of kaolinite and gibbsite. These soils can be used for tropical crops, namely, rubber tree, coffee, sisal hemp, etc. They are also used for rice plantation.

2 Lateritic Red Earths

They are distributed in the southern subtropical region. The solum is low in content of alkali and alkali-earth metals. The silica-alumina ratio in the clay fraction is 1.7 – 2.0. The clay minerals are chiefly composed of kaolinite. These soils are suitable for growing some tropical crops such as tea-oil tree, tung oil tree, oranges, sugar cane, etc.

3 Red Earths

They are spread all over the rolling hills of the northern subtropical region. The silica-alumina ratio in the clay fraction is around 2. Organic matter of the surface soil is from 1% in the eroded soil up to about 2.5% under vegetation. These soils can be used for upland crops and for rice plantation.

4 Yellow Earths

They are widely distributed over the mountains of the tropical and subtropical region. The upper solum of these soils is eluviated, appearing yellowish in color. They are characterized by a brownish red B horizon of heavier texture. The silica-alumina ratio in the clay fraction resembles that of Red Earths. These soils also contain primary minerals of low weatherability. They can only be used for forests.

The Red soils in tropical and subtropical China have a great potential for farming, forestry and pasture production. They cover an area of 120 million hectares, of which 36 million hectares are under cultivation amounting to 36% of the total cultivated area of the whole country. Ten million hectares of such cultivated lands are used for rice cultivation and 26 million hectares are utilized for upland crops. The low yielding paddy fields account for 15%, and their single cropping of rice only yields 2.2 – 4 ton of grain per hectare. Besides, about 24 million hectare of mountainous and hilly lands are suitable for afforestation and farming.

There are four problems in the utilization of Red soils which should be considered.

1) Protection of the soil resources from soil erosion

In this region, the area suffering from soil erosion is about 390,000 km^2, accounting for 19% of the total area of Red soils, of which about 100,000 km^2 are severely eroded. Although soil erosion is the result of the influence of natural conditions combined with human activities, it is mainly brought about by unreasonable utilization such as deforestation, and land reclamation on steep slopes or shifting cultivation. Therefore, we must protect the existing forest and prohibit land reclamation on the steep slopes in the whole area.

Soil and water conservation in the hilly areas of granite, purplish sandstone and on the south-western plateau region should be made according to the nature of the soils themselves and the related natural conditions respectively.

2) Improvement of water supply and promotion of soil fertility

The deficiency of soil moisture during the dry season is a well known limiting factor to the productivity of Red soils. In this case, in order to improve the water supply and soil water-holding capacity, integration of hydraulic engineering measures such as building reservoirs and irrigation system with soil improvement measures such as increasing organic matter in soil should be the effective ways to overcome the drought disaster. Owing to the lack of organic matter in the cultivated horizon of the Red soils and the acidity (soil pH is about 4.5 – 5.0), it is necessary to apply organic manure or crop residues and to plant green manure crops for the soils. In addition, the need of NPK fertilizer should be evaluated according to the soil properties and the different nutrient requirements of cultivated crops.

3) Rational reclamation and utilization of land

There exists a large area of arable lands with greater potential in this region. Generally, all-round development of farming, forestry and animal husbandry is suitable for mountainous and hilly regions. In the eastern hilly region, it is desirable to grow fruit, tea, mulberry, bast-fibre plants and perennial pasture and to interplant crops between the mulberry trees or fruits. In the western mountainous districts, it is suitable to develop forestry and pasture. In order to facilitate afforestation, closing the hills with steep slope to livestock grazing and fuel gathering is necessary. In the tropical region of Red soils, tropical and subtropical crops such as rubber tree, coffee and tea can be planted on the waste lands.

4) Plantation and allocation of crops and trees according to soil type and natural conditions

Due to the complexity and diversity of soil types and natural conditions in this region, it is necessary to plant and allocate crops or trees on the soil that is best suited to them. Generally,

the policy of land utilization should be integration of farming, forestry and animal husbandry. For instance, in the central part, oil-forest crops such as tea-oil trees (*Camellia oleosa)* and tung-oil tree (*Aleurites fordii*) may be planted, whereas in the southern part, tropical crops such as rubber tree and coffee, etc. can be planted. Finally, the China fir, pine and bamboo may be planted in the northern part of this region to set up a base of timber production.

Discussion

Nagatsuka, S. (Japan): In what respect do the Lateritic Red Earths differ from the Latosols and especially from the Red Earths?

Answer: The Lateritic Red Earths are a form of transition between the Red Earths and the Latosols. This classification is the reflection of utilization as well as of characteristics and pedogenesis of the soils. For example the weathering process of the Lateritic Red Earths is not as advanced as that of the Latosols. The main differential characteristics are as follows: 1) Soil clay minerals in clay fraction ($< 1\mu$): L (Latosols) kaolinite 64%, gibbsite 13% and small amount of hematite 3 – 5%; L.R. (Lateritic Red Earths), kaolinite 80% and small amount of gibbsite 7% and ilmenite 1%; R. (Red Earths), kaolinite predominant with small amount of montmorillonite. 2) SiO_2/Al_2O_3 (in soil clay fraction), L: 1.3 – 1.5; L.R.: 1.7 - 2.0; R.: 2.0 3) Soil texture, L: heavy clay ($<$ 0.00 mm 55%, wilting moisture content $<$ 26%); L.R.: loamy clay; R: loam and sand chiefly 4) pH value, L: $<$4.5; L.R.: 4.5 – 5.0; R.: 5 – 6.0 5) O.M., L: 2 – 4% (0 – 15 cm); L.R.: 2 – 3% (0 – 15 cm); R: 1 – 2% (0 – 15 cm) 6) Iron oxide content in profile, L: hard iron concretions; L.R.: mottlings and iron concretions; R: mottlings only 7) Parent materials, L: basalt and paleo-weathering crust; L.R.: granite mostly; R: quaternary red clay mainly 8) Utilization, L: tropical crops; L.R.: tropical and subtropical crops; R: subtropical crops.

Hew, C.K. (Malaysia): 1) What are the soils considered most suitable for the cultivation of oil palm in tropical China? 2) Could leguminous crops or leguminous cover crops be grown on the severely eroded hilly soils?

Answer: 1) In southern tropical China only the Latosols with 3 – 4% of organic matter, a loamy clay texture and a deep profile which cover plains or rolling hills are considered most suitable for oil palm cultivation. The temperature is very critical and cultivation is restricted at temperatures below 22°C. 2) Yes. Leguminous cover crops such as *Astragalus,* etc. are the best crops for preventing erosion of the Red Earths soils in China. On the hills afforestation is possible as well as the development of cultivation of economic and fruit trees such as tea-oil tree, etc.