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Soil and Agricultural Capability of UiTM Sarawak Campus Farm, Malaysia

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Abstract

An area of 40.5 ha at UiTM Sarawak, Samarahan Campus farm was surveyed at a detailed level. There are three soil major groups, three soil families and six soil series identified in UiTM Sarawak, Samarahan campus. The three soil major groups are Red Yellow Podzolic (RYP), Gley and Organic. The three soil families are BEKENU and MERIT Family of RYP Group, BIJAT and TATAU Family of Gley Group and ANDERSON Family of Organic group. The soil series identified are Bekenu of BEKENU Family, Merit and Jakar of MERIT Family, Daro of BIJAT Family, Tatau of TATAU Family and Gadong of ANDERSON Family. The majority of the area is classified as having agriculture capability of Class 2t, 3te and 4te. Class 2t, 3te, 4te consist of Jakar, Merit and Bekenu series and which are restricted for agriculture due to the steepness of the slope. Class 3wi consists of Daro series soil where wetness and inundation hazard is a moderate limitation for agriculture use. Class 4fw consists of Tatau series soil which is not suitable for agriculture used due to serious fertility and serious wetness. Class 04go consists of Gadong series which is also not suitable for agricultural use due to high groundwater table and undecomposed organic surface layer.

Keywords: Soils, Agriculture, Soil capability, Soil classification, Campus farm, UiTM Sarawak

1. Introduction

The Soil Classification System of Sarawak was updated in 1982 (Tie, 1982). The nomenculture of this Classification System was strongly influenced by the earlier soil classification system (Soil Survey Staff, 1966, Andriesse, 1972; Scott, 1973; and Lim, 1975); Soil Taxonomy (USDA, 1975} and by new finding on soils of Sarawak (Andriesse, 1975; Eilers and Loi, 1978; Loi, 1980; Lah 1980 and Teng 1981).

UiTM Sarawak Samarahan campus is divided into three major physiographic types i.e. hilly areas, undulating areas and low lying areas such as alluvium and waterlogged peat swamp. About 60% of the survey area, UiTM farm, is undulating with a slope ranging from 2-20 degrees. The remaining 40% is flat and low lying, consisting of alluvium plain and basin swamp. Soils occurring in the area are classified based on the current soil classification developed by Teng (2004) and Tie (1982). According to the Sarawak Soil Classification System (Teng, 2004), the diagnostic horizons/characteristics are used for classifying the soils of the Sarawak at the Group level. The diagnostic horizons are adopted as defined in soil taxonomy, 1988. The diagnostic horizons are generally subsurface horizons underlying an epipedon or a leaf litter or at the surface of a partially truncated soil. They are mostly B horizons but may also include part of the A horizons.

The purpose of classifying land according to its capability for agriculture is to provide one of a series of inventories for rational land use planning. The land capability class indicates the severity or degree of limitation in land use while the subclass indicates the specific kind of limitation encountered. Complex technical information contained in soil survey maps and reports, as well as crop yields and fertilizer response data gleaned from research station and statistical reports are presented in simple terms of how suitable the land is for agriculture. Since few figures are available on the crop yield potential of the various soils in Sarawak, the main sources of reliable information are the soil surveys. By means of descriptions, classification and mapping, these provide the basic information on which soils can be rated and grouped into broad capability classes from good to poor. The kind of terrain and the observable soil profile characteristics such as soil depth, color, structure, texture, wetness and parent material are examined and evaluated in agronomic terms of rooting volume, tilth, moisture-holding capacity, drainage, fertility, slope and suitability for mechanization that enhance or limit their potential use. In a land capability map for agriculture, these factors will determine the kinds of limitations to be encountered while the severity of limitation will determine the class rating. Matching the class rating and the kinds of limitations expressed as subclass with the stated requirements of each crop can show the user the types of agricultural crops suitable for each area, the problems likely to be encountered and feasibility of making improvements.

The main objective of this study is therefore to identify the various soil types of the UiTM Sarawak, Samarahan campus farm and to develop recommendations and guidelines for soil management, as reference for land utilization for crop suitability and agricultural potential in the farm.

2. Methods and materials

2.1 Soil survey

The project was a detailed soil survey which comprises preliminary studies of the area, actual field work, laboratory analysis, mapping and assessment of land capability for agricultural crops. In the preliminary studies, previous semi detailed reports and maps of the Samarahan area provided useful information for compiling tentative soil maps on a scale of 1:25,000.A detailed soil survey was carried out at a scale of 1:4,000. The cut lines (rentises) were planned in grid system as shown in Fig 1 so as to cut across as many as soil boundaries as possible.

A grid system of transect lines (rentises) spaced at 100 m interval was used. The field work involved cutting traverses along fixed compass bearings. Along each rentis the soils were examined at 125m intervals to a depth of 125cm using an Edelman auger for mineral soil and for peat soil the soils were examined at a depth of 200cm by using a peat auger. The soil samples were taken along each rentis at every 125 m interval. The slope, vegetation and other land features were also recorded along the rentis. Geostatistical Positioning System Trimble (GPS) was used to locate and identify the soil pit profiles and also for the land use mapping of the survey area. The information from the GPS was transfer to the Geographic Information System (GIS) for mapping.

2.2 Soil sampling

There were 51 soil samples from auger profiles and 3 water samples collected for the determination of chemical and physical soil properties such as pH, moisture content, CEC, etc. General description of the soil such as color, mottle, texture, consistency, stone, depth and others were also taken during the soil sampling,. The soil samples were collected at the sampling point by using an auger at a depth of 0-25 cm, 25-50 cm and 50-75 cm. The soil samples were collected every 125m along the rentis plan, while some soil samples were taken randomly due to no rentises have been cut in the area.. Groundwater samples were taken randomly for lowland soil classification based on the electrical conductivity measurement. A total of seven soil profiles or pit were dug in the farm for a detailed soil description. The soil profiles were described from the surface until a depth of 100 cm except for the organic soil which were described until 150 cm depth.

2.3 Soil analyses

Soil samples were analyzed by the Chemistry Laboratory, Agriculture Research Center Sarawak and also by a private accredited science laboratory. The analyses involved mineral content, particle size distribution, soil pH, moisture content, total organic carbon, total nitrogen, exchangeable cation, cation exchange capacity, reserved element, total P, available P, reserve P and total S. Soil pH was analysed in 1:1 soil to water by using pH meter; moisture content and

mineral content was automated using Thermogravimetric Analyzer; total organic carbon and total nitrogen were analysed by Dumas method and total organic carbon was measured by Multiphase Carbon Determinator LECO RC-412; exchangeable cation and cation exchange capacity reserved element such as Ca and Mg extraction were by hydrochloric acid method and measured by Inductive Coupled Plasma (ICP-AES); total P was determined by perchloric acid and digestion method; available P was determined by Bray II extracting solution, both using UV spectrophotometer; reserve P by using HCl extractable and measured by ICP-AES; and total S by Dumas method and measured by CNS analyzer.

3. Results and discussion

3.1 Soils Series Classification

Soils occurring in the survey area are classified based on the current soil classification (Teng, 2004).The three soil major groups are Red Yellow Podzolic (RYP), Gley and Organic. The three soil families are BEKENU and MERIT Family of RYP Group, BIJAT and TATAU Family of Gley Group and ANDERSON Family of Organic group. The three soil major groups are Red Yellow Podzolic (RYP), Gley and Organic. The three soil families are BEKENU and MERIT Family of RYP Group, BIJAT and TATAU Family of Gley Group and ANDERSON Family of Organic group.

There are three (3) soils groups found in the area and are classified at family and series level as shown in Figure 2 below. Soils of the Merit series are derived from shale parent material. They are mature soils that show increase in clay content with depth and moderately well drained to well drained soils. The Merit soils have a yellowish brown (10YR or yellower), with an A horizon of approximately 20 cm with clay loam texture, weak fine crumbly structure and friable to firm consistence. This horizon is well rooted with few large roots, and fauna activity is high. The B horizon is colored brownish yellow, with clay texture, firm consistence and structure is moderately coarse sub angular blocky. Movement of material from the upper horizon is shown by the presence of organic material along root channels. In the lower part of this horizon, the soil becomes massive and faint mottles occur and there are many soft to hard iron concretions in the B horizon. The BC horizon comprises a mixture of weathered rock (shale) fragments. Meanwhile, soils of the Jakar series are similar to that of the Merit series but differ only in color. The Jakar soils are mainly colored strong brown or redder soil color, with hues of 7.5YR throughout the one meter control section. The Jakar soils have a yellowish brown A horizon but at few sites, the A1 horizon has a darker color of dark brown or dark yellowish brown. The B horizon is more variable. The predominant color is reddish yellow. This reddish yellow or strong brown color having a hue of 7.5YR must occur within 50 cm which is distinctive characteristic of this Jakar series, separating it from the Merit. The texture of the Jakar soils is invariably clay loam A horizon overlying clay B horizon. The soil consistence is friable in topsoil and firm in the subsoil. The weak fine angular blocky structure in the surface horizon is followed by moderate coarse sub angular blocky structure and many iron concretions and grit in the underlying horizons. The soils have low permeability and are normally well drained. Mottles are not common in the Jakar series. They are present only at a few sites and are often associated with the weathering shale fragments.

On the other hand, soils of Bekenu series are well drained soils and have formed in fine grained sandstones. The Bekenu soils profile has a yellowish brown fine sandy loam A horizon overlying brownish yellow fine sandy clay loam B horizon. In the lower part of the subsoil the texture is clay or sandy clay in places. The brownish yellow colour of the B horizon often grades to reddish yellow at depth. The consistence is friable in the upper half portion of the profile but firm in the lower portion. The structure is weak fine angular blocky in the topsoil and weak medium angular or subangular blocky in the subsoil. Weathered fine-grained sandstone and occasionally siltstones fragments are common in the subsoil. The amount of rock fragments is controlled mainly by the underlying rocks and topography. The Bekenu series in the UiTM farm occurred in association with Merit and Jakar series of MERIT Family on undulating to moderately dissected terrain. The Daro series soil in this farm is characterized by clayey texture (.35% clay) throughout the soil profile (100cm), presence of sulphidic materials at a depth of more than 75cm, non-saline groundwater salinity which is less than 1000 micromhos/cm, at 25 degrees C and poorly drained. The Daro series in this area has been reclaimed, where the sulphidic materials have oxidized to form a jarosite upon continued drainage. On the other hand, the Tatau series soil in this farm is characterized by a loamy sand texture. The soil has a light matrix colour of 10YR 6/2 or light brownish grey to 10YR 7/2 or light grey throughout the profile within 100cm. The Tatau series is differentiated from other series in the TATAU Family by the salinity of the groundwater. The soil is non saline soil with groundwater salinity is less than 1,000 micromhos/cm 25^{o}C and poorly drained. The Gadong series in this area consists of more than 150 - 200 cm of residual organic materials overlying a clayey mineral substratum, very poor drainage and a water table generally occurs near or above water surface. A Gadong series soil is an autochthonous organic soil material with a high ash content which is in between 10-35%.

3.2 Agriculture Capability Classification

In the agriculture capability classification, which rates land according to their limitations for agricultural development, there are five classes each for mineral soils and organic soils. The limitations of land characteristics to agricultural use are divided into five levels of severity ranging from none to very serious. The rating of capability classes are based on the number and intensity of the limitations imposed by various land characteristics such as topography, wetness,

physical soil conditions and soil fertility as shown in Agriculture Capability Classification (Figure 4) of the UiTM Sarawak Samarahan Campus farm.

Class 2t, 3te and 4te consists of Merit, Jakar and Bekenu series soils which occur on a wide variety of terrain. Steepness of slopes (c) and erosion hazard (e) are the major limitations to agriculture use. These soils are rated as Class 2t with slopes of 6-12 degrees, class 3te with slopes of 12-25 degrees and class 4te with slopes of 25-33 degrees. Meanwhile, the Class 3wi consists of Daro series soil where wetness (w) and inundation hazard (i) is a moderate limitation of the use of the land for agriculture. In addition, class 3wi is affected by other possible moderate limitations including dense massive clay subsoil (c) and depth of organic surface (o). Although few crops area adapted to poorly drained conditions of the Daro series, it is one of the best natural soils for wetland rice in Sarawak. On the other hand, Class 4fw consists of Tatau series soil where serious fertility (f) and wetness problem (w) which restrict the use of the land for agriculture. In addition, class 4fw is affected by other possible moderate limitations including moisture holding capacity (m), organic surface (o) and inundation hazard (i). The soil classified in this class has such limitations that they are only suitable for a few crops, the yield is low or the risk crop failure is high. However, Class 04go land consists of Gadong series which is very poorly drained peat deeper than 100cm. The most serious limitations include poor drainage due to high groundwater table (g) and undecomposed fibric surface layer. Deep peat is a serious limitation to rooting because it offers only a poor anchorage medium for plant roots. Peat subsides rapidly upon drainage which further increases the difficulty of drainage and the risk of flooding. Gadong series soils are suitable only for wetland rice and sago in their natural states. Major improvements in flood protection, drainage and water table control could change the rating of these soils from 04 to 03. With comprehensive fertilizer and production program a wide range of crops can be grown.

4. Conclusion

The distribution of the soil types in the farm is based on the terrain of the area. The RYP soil group occurred on undulating hill comprising of Merit and Jakar series of MERIT Family and Bekenu series of BEKENU family. The Gley soil group was developed on lowland area or at floodplain areas and are comprised of Daro and Tatau series of BIJAT Family, while Organic soil group can be found in basin swamps which are comprised of Gadong series of ANDERSON Family.

Agricultural capability of the area is predominantly classified in Class 2t-3te-4te and Class 3wi. Class 2t-3te-4te consists of Jakar, Merit and Bekenu series and it is restricted for agriculture due to the steepness of the slope. Jakar, Merit and Bekenu soils that are classified in Class 2t and 3te are suitable for agricultural activities and can be planted with various types of crops such as upland rice, banana, sugarcane, cocoa, oil palm, pepper, papaya, coffee, fruit trees, coconut, cashew and rubber. The 4te class of Jakar, Merit and Bekenu needs proper soil management due to the long term effects of potential soil erosion. It is suitable for only an infrequent crop of hill rice or for small-holder rubber with a permanent ground cover.

Class 3wi consists of Daro series soil and naturally is suitable for wet padi cultivation. However the area now is planted with oil palm, coconut, coffee and guava, because the area has been under continuous drainage. Class 4fw consists of Tatau series soil which is not suitable for agriculture use due to serious fertility and serious wetness, but with proper water and fertilization management the soil can be planted for coconut and cashew. Class 04go consists of Gadong series which is also not suitable for agriculture use but with good water management the area can be improved to Class 03o which can be planted with sago.

Soil analytical data of this area have been analysed for soil classification, but further investigation is needed on the soil fertility of the area. Experimental plots could be built for such a study. It is suggested and recommended that further research should be done on soil fertility or soil quality study in this area in the near future.

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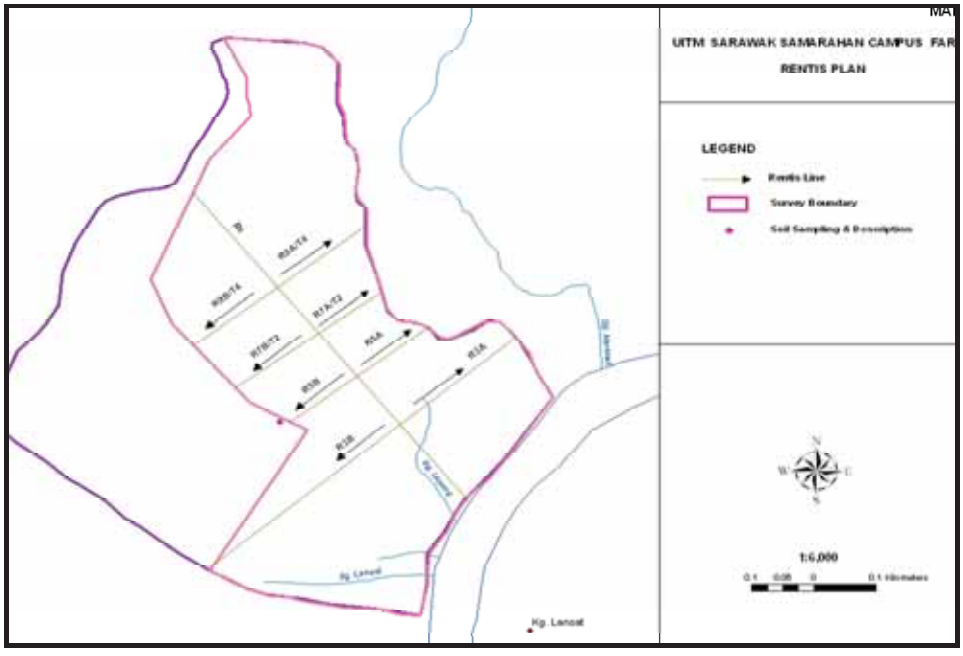

Figure 1. A Rentis Plan for the detailed soil survey at UiTM Sarawak Samarahan Campus Farm

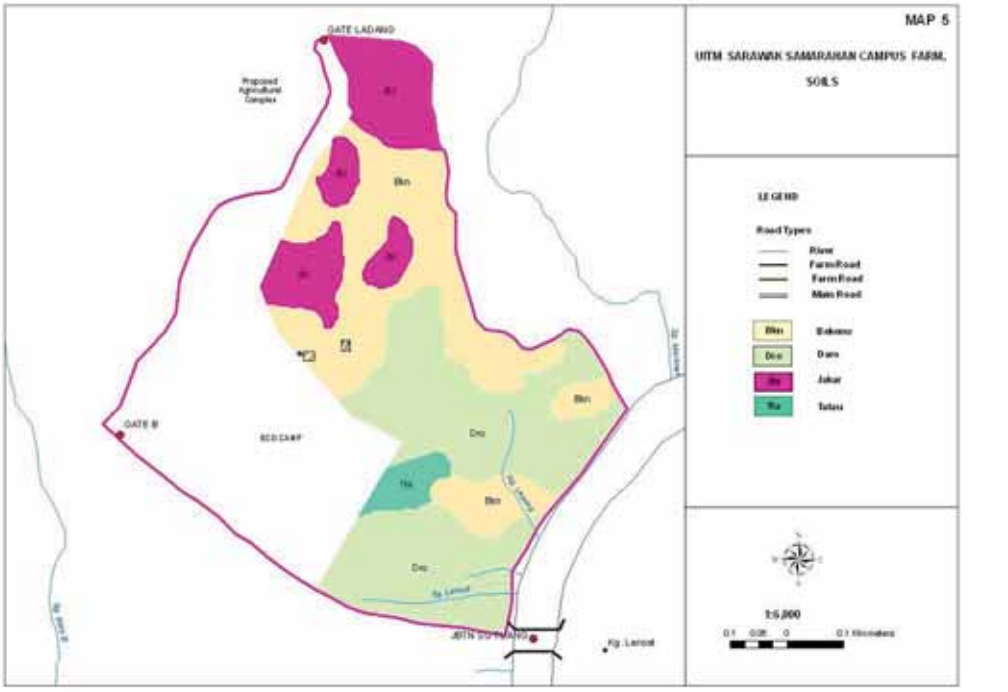

Figure 2. Soil Map of UiTM Sarawak Samarahan Campus Farm according to soil series

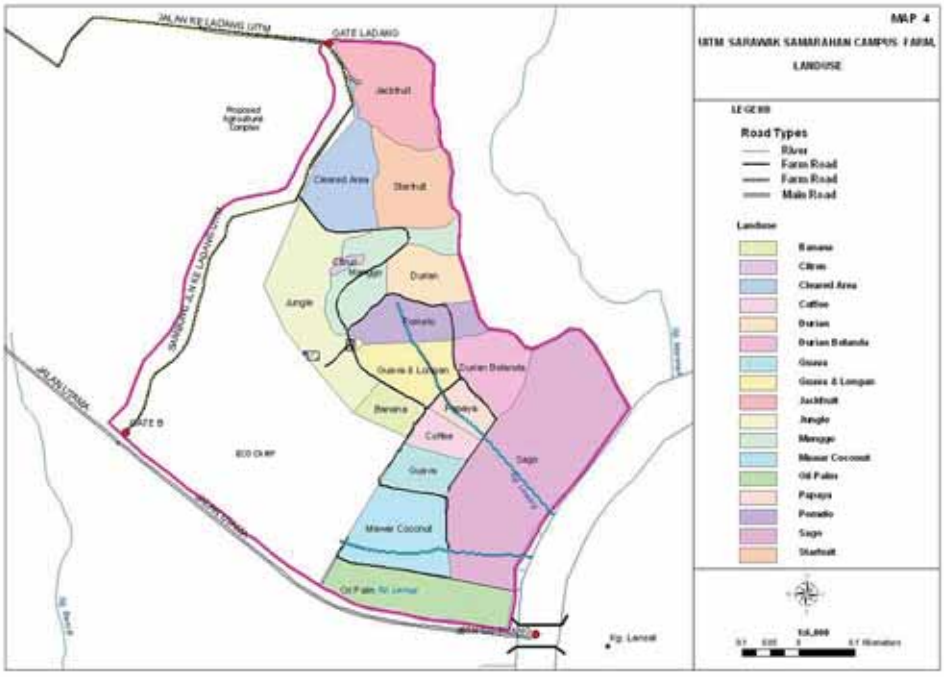

Figure 3. Present Crop plot of UiTM Sarawak Samarahan Campus Farm

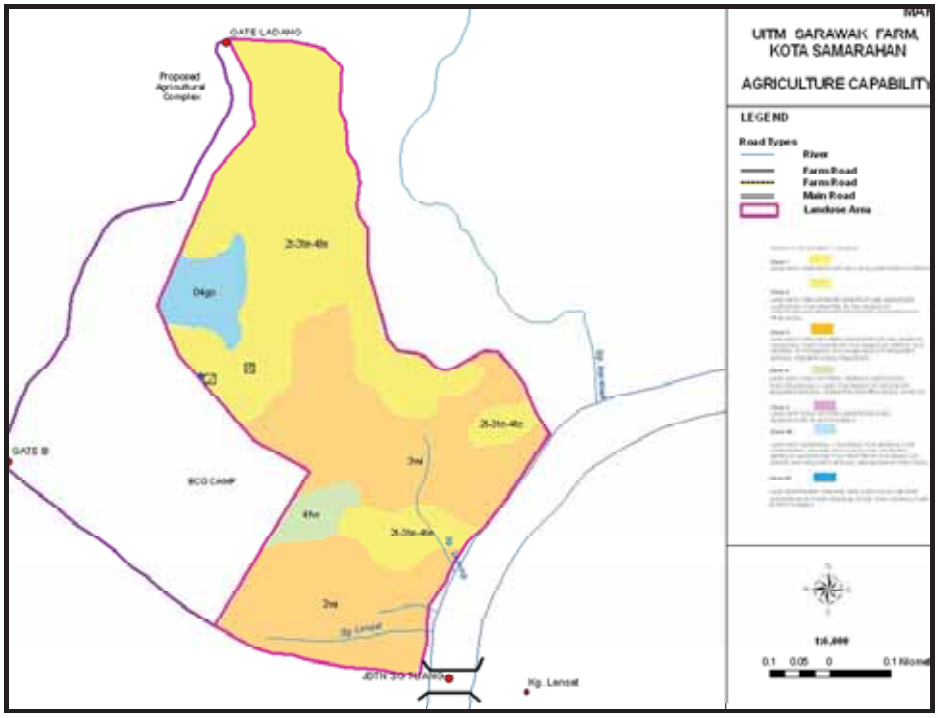

Figure 4. Agriculture Capability of the UiTM Sarawak Samarahan Campus farm.