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# A PRELIMINARY STUDY ON SOIL CONDITION OF DIFFERENT TYPES OF AGRICULTURAL FIELD IN PAPUA NEW GUINEA

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## Introduction

Agriculture is the main industry in Papua New Guinea (PNG). Although modernized agriculture systems have been practiced throughout the country, a great part of the agriculture is still primitive and of low crop productivity. Agriculture in PNG is roughly classified into plantation and subsistance agriculture. Coconut, cacao, coffee, and so on are produced in plantations. Their production are for export. Most of the staple foods, such as tuber crops, sago, and banana are produced in small scale for self consumption. Shifting cultivation still occupies a high percentage of crop production as farm gardens and extends all around to the country.

Shifting cultivation (slash and burn system) refers commonly to the burning of forest land and making them cultivation fields for sweet potato (*Ipomoea batatas*), taro (*Colocasia esculenta*), yams (*Dioscorea* spp.), cassava (*Manihot esculenta*), pit-pit (*Saccharum spontaneum*); sugar cane (*Saccharum officinarum*), padanous palm (*Pandanus* sp.), and so on (SINNETT 1977). After few times of cropping, the field plot is left fallow (abandonment) while another plot, usually adjacent to the first on and within the same garden site, is burned and cleared. Abandonment of field plots is seen as a response to declining crop productivity, associated with either nutrient loss or weed competition (EDEN 1987).

We are interested in the agricultural soils with different cultivation systems in tropical zones, in PNG. For estimating its differences, we pay attention to the biological and chemical soil conditions. In this study, we try to get primary data of soil microflora and the amount of soil nitrogen and carbon. We analyzed soil samples from different types of agricultural fields of PNG. For example, plantation field, grass land, paddy field, and shifting cultivation field. In addition, on shifting cultivation fields, just after burning the forest and after a few times of cropping, we tried to observe what differences existed in the soils which differ in number of cropping times.

## Materials and Methods

*Soil sampling*

Fourteen soil samples were collected from agricultural fields which have different cultivation systems. Surface soil was taken by planting shovel from three points of each sampling site and packed in vinyl bag. The locations of soil sampling sites is shown in Fig. 1. Table 1 describes the field condition, associated with the kind of planted crops, its growth condition, and number of cropping times of each site. Soil sample Nos. 1, 2,

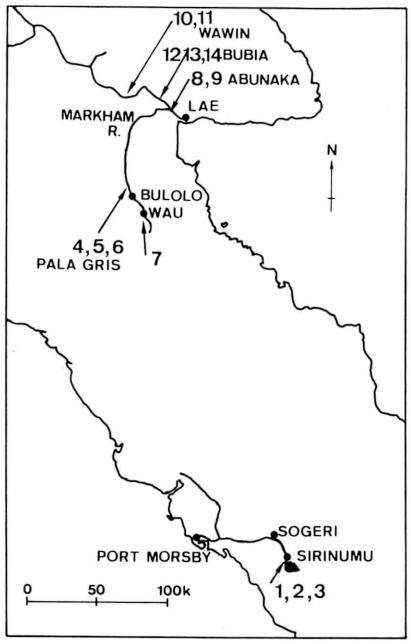


Fig. 1 Location of soil sampling site in PNG.

Table 1. Location of soil sampling site and description of its field condition in PNG, 1990

| Sample No. | Locality | Kind of fields | Crops | Remark |
|---|---|---|---|---|
| 1 | Sirinumu | Shifting field | Sweet potato, Maize | Just after burning the forest (1st year) |
| 2 | do. | do. | Sweet potato | 2nd year after burning, adjacent field to No. 1 |
| 3 | do. | do. | Pineapple | 3rd or 4th year after burning, adjacent field to Nos. 1 and 2, poor growth |
| 4 | Pala Gris | do. | | Just after burning the bush |
| 5 | do. | do. | Vegetable | Adjacent field to No. 4, poor growth |
| 6 | do. | do. | | Just after abandonment, adjacent field to Nos. 4 and 5 |
| 7 | Wau | Grass land in the forest | | |
| 8 | Abunaka | Paddy field | Rice | Low seed set |
| 9 | do. | Upland field | Maize | Good growth |
| 10 | Wawin | Upland field | Groundnut | Plantation, good growth |
| 11 | do. | Grass land | | Adjacent to No. 10 |
| 12 | Bubia | Upland field | Sweet potato Vegetable | Just after cutting the forest |
| 13 | do. | do. | do. | Just after cutting the forest, adjacent field to No. 12 |
| 14 | do. | do. | Banana | 2nd year after cutting, adjacent field to Nos. 12 and 13 |

and 3 are collected from shifting cultivation fields. They are adjacent to each other at Sirinumu, but the number of cropping times are different. These samples were used for comparing what differences existed in the soils which differ in number of cropping times. Soil sample Nos. 4, 5, and 6 at Pala Gris, and Nos. 12, 13, and 14 at Bubia were used for the same comparison as soil sample Nos. 1, 2, and 3.

*Microflora*

The microflora was observed by the dilution plate method. Albumin agar medium was prepared for the growth of bacteria and actinomycetes, and rose bengal agar media, containing chloromphenicol, for the growth of fungi. Soil suspension obtained after several repeating orders at 10 times dilution, usually 6 to 7 orders for bacteria and actinomycetes and 3 to 4 orders for fungi, was transfered in the plates. They were incubated at 30℃ for 5 days for fungal, and 7 to 10 days for bacterial growth. After incubation, the number of colonies developed in the plate were counted. Classification of fungi was tried in fungi colonies under microscope.

*Total nitrogen*

Total nitrogen was determined by kjeldahl digestion method.

*Inorganic nitrogen*

$NO_3$-N was extracted with $H_2O$ (Soil : $H_2O$ is 1 : 2.5) and then determined by ion chromatography with a Toso 8000 CM chromatographer.

$NH_3$-N was extracted with 2N KCl (Soil : KCl is 1 : 2.5) and determined by micro diffusion analysis using Coway's unit.

*Total carbon*

Total carbon (organic carbon) was determined by Tyurin's method ; a suitable amount of soil (100～500mg) was taken to decompose its organic matter by oxidation with 0.4N $K_2Cr_2O_7$ (Potassium dichromate) -$H_2SO_4$ solution. From the reducing capability of oxidation, which was measured by titration with 0.2N ferrous ammonium sulphate ($FeSO_4(NH_4)_2SO_4 \cdot H_2O$), the amount of carbon was estimated.

## Results and Discussion

The numbers of colonies of fungi, bacteria and actinomycetes in each sample are shown in Fig. 2. The number of colonies of microorganisms varies considerably among samples. In general, it is said that soils having large number of fungi have poor growth potential. As shown in Table 1, sample Nos. 3 and 5 have poor growth, and sample No. 6 is an abandoned field. These three samples have high level of fungal colonies. The amount of fungi in sample No. 8, collected from a paddy field, is less than in other samples. Sample Nos. 12, 13,and 14 were collected at adjacent sites at Bubia, but differ in cropping times. As cropping times increased, the number of fungi colonies increased, but the number of bacteria and actinomycetes decreased. If this tendency is related to the declining of crop productivity in shifting cultivation, this phenomenon is interesting.

Classification of fungi in each samples is shown in Table 3. The kind of fungi varies among samples. Its variation arises from difference in cultivation system in each field. In sample Nos. 1, 2, and 3, and 4, 5, and 6, as the number of cropping times increase, the fungal density increases. The kind of fungi found in sample Nos. 1, 2, and 3 changes according to the number of cropping times, being different every year, while in sample Nos. 4, 5, and 6, the number of fungi kinds increases as every year pass. The amount of nitrogen and

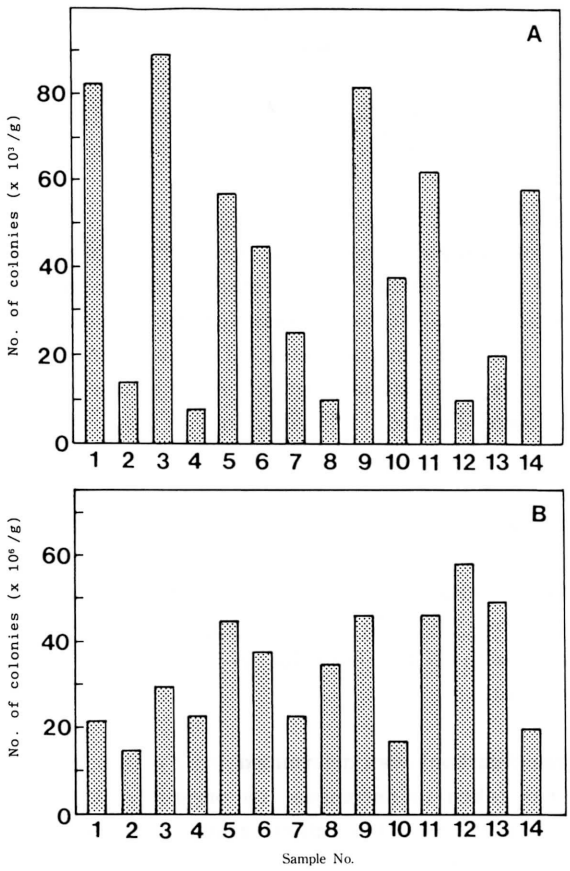


Fig. 2 The number of colonies of fungi (A), bacteria and actinomycetes (B) of soil collected in PNG.

carbon was estimated in connection to variation of microorganism and shown in Table 3. Generally, poor growth sites have low inorganic-N level. Sample No. 8 derived from a paddy field has also low inorganic-N and rice plants planted in the whole paddy field showed low seed set. Sample No. 10 was collected from a plantation field of groundnut. The sample has high inorganic-N level, low carbon level, high fungi colonies, and low bacteria colonies, showing that artificial action was done. The soil was chemically fertilized.

We tried to identify the differences of the biological and chemical soil condition of different cultivation fields in PNG. Concerning to microorganism, it was estimated that variation in microorganism density arises not only from different cultivation systems but also from the number of cropping times. Moreover, differences in fungi variation was observed in not only just the number of individuals but also the kind of it. Generally, the soil which have bad plant growth increase the number of fungi. However, due to the importance of the soil in the agriculture production, we highly recommend to continue and expand the presented topic.

Table 2 Classification of fungi of soil samples collected in PNG

| Sample No. | *Asp. g.g* | *Asp. d.y.g* | *Asp. g.y.g* | *Asp. niger* | Albino mutant | *Trico. g.o.g* | *Trico. p.y.g* | *Trico. g.g* | Mucor | *Penicillium* | M1 | M2 | M3 | M4 | M5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | + | | | + | + | | | | | | + | | | | |
| 2 | | | | | ++ | | | | | | | + | | | |
| 3 | | + | | | | | | | | | + | | | | |
| 4 | | | | | | + | | | | | + | | + | | |
| 5 | + | | | | | + | | | | + | + | | | | |
| 6 | + | | | | | + | | | + | + | + | | ++ | | |
| 7 | | | | | | | + | | | | | + | | + | |
| 8 | | | + | | | | | + | | + | | | | | |
| 9 | | + | | | | | | | | + | | | | | + |
| 10 | | + | | | + | | | | | | | | | | + |
| 11 | | ++ | | | + | | | | | | | | | | |
| 12 | ++ | | | | | | + | | | | | | | | |
| 13 | + | | | | | | + | | | | | | | | |
| 14 | ++ | | | | | | + | | | | | | | | |

Table 3 The amount of inorganic-N, the ratio of total-C, and C/N of collected soil in Papua New Guinia

| Sample No. | $NH_4$-N mg/100g* | $NO_3$-N mg/100g* | Inorganic-N mg/100g* | Total-C (%) | Total-N (%) | C/N |
|---|---|---|---|---|---|---|
| 1 | 3.0 | 7.6 | 10.6 | 3.0 | 0.43 | 6.98 |
| 2 | 6.3 | 4.4 | 10.7 | 3.6 | 0.52 | 6.92 |
| 3 | 3.1 | 0.9 | 4.0 | 2.7 | 0.23 | 11.74 |
| 4 | 0.9 | 10.0 | 10.9 | 3.2 | 0.48 | 6.67 |
| 5 | — | — | — | 3.8 | 0.72 | 5.28 |
| 6 | 0.6 | 5.9 | 6.5 | 3.4 | 0.34 | 10.00 |
| 7 | 0.6 | 9.2 | 9.8 | 2.6 | 0.21 | 12.38 |
| 8 | 1.7 | — | 1.7 | 3.5 | 0.55 | 6.36 |
| 9 | 0.4 | 9.8 | 10.2 | 2.7 | 0.29 | 9.31 |
| 10 | 0.6 | 31.5 | 32.1 | 1.2 | 0.11 | 10.91 |
| 11 | 0.6 | 10.6 | 11.2 | 2.3 | 0.35 | 6.57 |
| 12 | 0.3 | 16.5 | 16.8 | 2.0 | 0.21 | 9.52 |
| 13 | 0.3 | 11.7 | 12.0 | 3.3 | 0.43 | 7.67 |
| 14 | 0.6 | 10.4 | 11.0 | 1.8 | 0.32 | 5.63 |

* Oven-dry soil

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