SOIL NUTRIENTS FROM DIFFERENT SUCCESSIONAL STAGES IN LAKE BALINSASAYAO

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Introduction

Soil maintenance is very important for the life of most green plants. The need for fertile soil increases as the demand for human livestock food increases. The capacity of the soil to hold water and nutrients, in addition to air circulation capacity, is crucial for this need. Such capacities are critical to the growth and development of green plants. The maintenance of the nutrients in the soil is also dependent on the vegetation factor as demonstrated by the fact that when tropical forests are cleared and planted with annual crops, soil fertility declines rapidly unless fertilizers are applied (Jurion and Henry, 1969). The study by Cadeliña, (1987) on soil nutrient changes from various cropping systems in Lake Balinsasayao indicated an accumulation of acidity as cropping activities continue. The study also showed the nutrient levels in the soil in various cropping systems. However, it did not indicate the degree of diminishing returns the soil experiences from the time the primary forest is first opened for agricultural purposes to the time the various plots are abandoned.

It is the purpose of this study to determine the pH, nitrogen, phosphorus and potassium contents present in the soil from various successional stages. Nitrogen (N), phosphorus (P) and potassium (K), known as NPK, are involved in this study because these macronutrients are usually limiting in the growth of food crops. The percentage of organic matter content of the soil is dependent on its nitrogen availability. The best of all agricultural soils are the organic soils, those with the highest percentage of organic matter.

STUDY AREA AND METHODS

The primary forest, abandoned croplands of various ages and actively farmed plots at Lake Balinsasayao are the subjects of the study. Lake Balinsasayao is situated within the boundaries

of the municipalities of Sibulan and San Jose, Negros Oriental. The topography of the area is generally mountainous with slopes ranging from 35 to 66 degrees.

The soil is of the Guimbalon series which was formed from the older alluvial and washout materials from Canlaon Volcano and other venta in the island. The soil surface (0-36 cm depth) is reddish brown to dark brown when wet, brown to dark brown when dry, clay with fine granular structure. The subsoil (30-70 cm) is also clayey and the substrate (70-100 cm death) is weathered rock andesite (Antone. 1983).

Field work and sampling were carried out from March to May 1988. Six soil samples (1 kg/sample) were taken from each study plots and were analyzed to determine the pH and NPK.

RESULTS AND DISCUSSION

Tables I, II and III show the pH, amount of nitrogen (N), phosphorus (P) and potassium (K) present in the soil of a primary forest, abandoned croplands and actively farmed plots.

pH

The primary forest has a higher pH, 6.3 which is near neutral: in abandoned croplands the pH ranges from 4.9 to 5.5 while in actively farmed plots, the pH ranges from 5.0 to 6.1. The result of the study by R. Cadeliña, (1987) shows a pH value for all continuously farmed plots to range from 5.0 to 5.5, which is still lower compared to that in the primary forest soil. This shows that continuous farming activity can result to accumulation of acidity which cannot be restored even after several years of abandonment. The plots with trees (plot sample F) however, has a higher pH which is almost similar to that of a primary forest.

Nitrogen (N)

For the total available nitrogen content, the farm plot (plot sample pH), which is newly opened by fire and recently planted to agricultural crops together with reforestation activity, has the highest nitrogen content — 52.4 mg/kg compared to the primary

forest — 45.8 mg/kg and abandoned croplands which range from 21.4 mg/kg to 44 mg/kg. The high nitrogen content can be attributed to the fact that fire which destroyed the vegetation releases the nutrient from plant tissues in the form of soluble mineral ash (Mutch, 1970). However, as cropping activities continue, the amount diminishes and is restored after long years of abandonment (see Table II and III). Most farm plots in Lake Balinsasayao were opened through slash and burn method and and the farmers in the area when asked, revealed that as the length of cropping activity increases, their farm becomes less productive and the soil becomes poor. The slash and burn method enhances the nutrient regimen in the soil only temporarily. The fire destroys mychorrhizae within the soil and thus its recycling mechanisms. The nutrients are released in a single large dose and their availablility probably exceeds the exchange capacity of the soil. thus nutrients are quickly leached out of the root zone (Jordan and Kline, 1972) making plant uptake difficult.

Abandoned croplands vary in their nitrogen content, lower at early years of abandonment and on plots without trees while higher on plots with trees. After 8 years of abandonment, the nitrogen content of the soil is only 21.4 mg/kg compared to 40.5 mg/kg after 20 years of abandonment. The two plots have different vegetational status, a grassland without trees results after 8 years of abandonment whereas shrubs and small trees dominate a plot of 20 years of abandonment. The low nitrogen content in the soil after 8 years of abandonment can be explained by the existing vegetation itself which is a grassland. Grasses and decomposers use up soil nitrates and ammonium ions so rapidly (Ricklefs, 1979).

Phosphorus

Although continued cropping activities can result to lower phosphorus content in the soil (Cadeliña, R. 1987), this study shows that the actively farmed plots have higher values which range from 600 to 1300 mg/kg. The high value can be attributed to the contouring method practiced. Contours help hold the top soil and the subsoil, this soil nutrient run-off can be checked.

Potassium

The primary forest has the highest total potassium content, 970 mg/kg, while actively farmed plots have the lower values. However, those with trees regardless of being abandoned or farmed have high values too. These values are lower than that of the primary forest soil. These results parallel that of R. Cadeliña, (1987) wherein continuously farmed plots with trees regardless of cropping system ave the highest content. These results would indicate that trees help in retaining potassium in the soil, preventing against the leaching effect of rainfall. And in the tropical soils, fertility is maintained by vegetation, it traps and retains nutrients imported by rainfall (Ricklefs, 1979).

Table I

Soil Nutrients From A Primary Forest

Plot Sample	pH	Total Available nitrogen (N) mg/kg	Total phosphorus (P) mg/g	Total potassium (K) mg/kg
A	6.3	45.8	320	970

Table II

Soil Nutrients From Abandoned Croplands

Plot	No. of yrs. abandonment	Vegetation type	pH	Total available nutrients (mg/kg)		
				N	P	K
B	8	grassland with-cut trees	5.0	21.4	760	250
C	10	grassland with trees and shrubs	4.9	44.0	1085	195
D	14	grassland with shrubs at farm's edge only	5.5	28.1	265	650
E	20	tall shrubs and small trees w/o layering	5.0	40.5	510	240

Table III

Nutrients from Actively Farmed Plots

Plot Sample	No. of years of farming	Types of cropping	pH	Available Nutrients		
				N	P	K
F	20, contoured 2 yrs. ago	mixed with trees	6.1	31.8	600	485
G	20, contoured 2 yrs. ago	mixed w/o trees	5.0	19.4	1300	180
H	2, newly opened by fire	mixed with reforestation activity	5.6	52.4	870	250

Summary

It is shown in this study that farmers need not expand their clearings. Cutting additional primary forest is not necessary. Maintenance of soil fertility can be done even without application of fertilizer. Proper upland soil management as tree planting on hilly edges, hedgerows and contouring are simple but fruitful practices that may result in increasing the amount of available soil nutrients, as shown in this study.

As an adjunct to this study, plant responses and soil performance could be tested by growing experimentally various species of plants on the different study plots.

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EFFECTS OF CONTOURED ROCKWALLS ON SOILS: THE ATA EXPERIENCE

Rowe V. Cadeliña and Rodrigo Puracan

Introduction

As mentioned elsewhere in the other paper in this volume the farms of the Ata are undergoing rapid deterioration. Top soils are virtually gone and those that have remained are no longer fertile. Through our Silliman University Research Action Development Program in the Uplands, an intervention project had been introduced to the Ata during the last three years. This intervention project is generally known as farming systems development.

The farming systems development project of the Ata has two major components. One is on cropping system and the other is on soil conservation and development. While soil conservation and development is essentially introduced to protect the remaining soils on the farms of the natives, cropping system also indirectly addresses the improvement of the fertility and the restoration of organic composition of the soil. Hence, the two related activities as implemented are designed to improve the soil condition of the farms of the Ata.

Having been introduced to the community around three years ago, the Ata project is expected to have brought in some positive effects on the soils of the farms. This paper, therefore, attempts to asess the present conditions of the soils of the Ata farms.

ISSUES AND PROBLEMS

Considering the limitation of the laboratory services available to us, we decided to limit our analysis of the soil condition on two major indicators. One is on the level of acidity and the other is on the macronutrient counts of the soil. Nitrogen, potassium and phosphorous were three macronutrients considered.

One of the anticipated effects of rockwalls is the accumulation of eroded soil from the hillside on the catchment areas along the sides of rockwalls. If the accumulation of erosion is effective, it is assumed that the thickness of "trapped" soil increases. This

increasing accumulation of top soil is expected to improve the pH level of the soil. In a highly eroded land area, the pH value is expected to decline tremendously making the soil highly acidic.

Since both the soil conservation and the cropping systems are designed to improve soil fertility, some macronutrients will be positively affected. The introduction of leguminous crops such as cajanus cajan along rockwalls is expected to improve nitrogen content of the soil. The growing of peanuts, mung beans and other legumes are also assumed to bring higher nitrogen reading on the soil.

The decomposition of organic matter will cause all those macronutrients trapped in the plant tissues to be pumped back into the soil. Assuming that the "nutrient pumping" into the soil is approximately positive for all macronutrients, an increase on most of the macronutrients can be expected in areas where rockwalls have been installed. Since erosion is prevented from taking place, "pumped-in" macronutrients from organic materials can also be trapped in the soils held by the rockwalls.

The following questions are raised in this paper:

(1) Are there soils trapped by rockwalls? Is there any indication of increase?

(2) What is the status of macronutients in farms where rockwalls have been installed?

FIELD PROCEDURE

For trapped soils, monitoring was done by ocular inspection of soil catchment areas of rockwalls. This ocular inspection was done regularly with occasional measurements of thickness of soil trapped especially after heavy rains.

To determine the effects of rockwalls on soil pH and macronutrient content, soil samples were taken from two sites. Soil samples were taken from areas where rockwalls are constructed and from areas where no rockwalls are established. Holes with a diameter of six inches were dug four inches deep into the ground

and around one-fourth of an inch of soil was scrapped from the side of the soils. Holes were randomly distributed within a specified area.

Ten trials were made for each area with rockwalls and those without. The soil samples were analyzed by the provincial soils laboratory in Negros Oriental.

RESULTS

It should be noted that cropping development has been only limited on area where soil conservation measures have been introduced. Hence, it must be assumed that whatever changes in soil macronutrients are taking place on the developed areas, those changes should be considered as the results of cropping and coil conservation measures.

Soils Trapped By Rockwalls

Field observation on soil catchment areas of rockwalls shows that a substantial amount of soil has been trapped. Trapped soils range from one inch to two inches in thickness with a width of around four to six inches. During a period of 12 months, observation showed an increasing thickness of the soil trapped by rockwalls. This suggests certain level of efficiency of rockwalls in preventing soil from erosion. Hence, the soil within the 18-hectare farm land which the Ata now cultivates is no longer threatened by erosion.

Soil pH

The higher the pH level of the soil, the more favorable the soil is for crops. Otherwise, the soil will have poor supporting capacity of plant life. This is expected since pH value usually results from extensive soil erosion and loss of nutrients either by leaching or by plant use.

The pH level can be improved by keeping soils from erosion and increasing organic materials on the ground. Since the new system of the Ata allows more biomass and tissues to decompose in the ground and the soil conservation measures protect the soil from erosion, an improvement on the pH reading can be expected on the developed farms of the Ata.

Table 1 shows the results of the laboratory analysis of two sample groups of soils. Soil samples for rockwalled areas yielded a higher pH reading compared to that yielded by the soil samples taken from those sites without rockwalls. The former is higher by around four percent compared to the latter.

Variation from the mean of the pH value for soil samples taken from areas with rockwalls is smaller compared to those found among soil samples from areas without rockwalls. This suggests that in the former category of samples, we tend to find a consistently high pH reading, although they may not be statistically significant. In those areas without rockwalls, pH reading tends to be on a lower level and more erratic. This implies that the cropping system and the soil conservation measures tend to have a positive uniform effect on the soil pH. Such effect is now taking place in the Ata farms.

Macronutrients

Three macronutrients are considered. These are nitrogen, potassium, and phosphorous.

Nitrogen: Measured by percentage of organic materials, soil samples were tested for nitrogen content.

Table 2 shows that the soil samples taken from sites with rockwalls have higher nitrogen contact compared to soils from areas without rockwalls.

The former is higher by around 72% than that of the latter Percentage of organic matter content in the soil tends to be consistently high in most of the soil samples from areas with rockwalls. This is suggested by the low coefficient of variation from the mean (33%) of soil samples from areas with rockwalls compared to that established (81%) for soil samples coming from areas without rockwalls. Nevertheless, the difference appears to be not statistically significant yet.

The data sugest that both the cropping system and the soil conservation development have improved the nitrogen supply in the soil. Obviously, the emphasis on leguminous crops as one of

the buffer plants against the rockwalls must have contributed to the increment of the reading on organic matter content. The level may still be low for both, but indications suggest an improvement in those areas where rockwalls have been introduced.

Potassium: For potassium, the treated areas yielded higher reading compared to those coming from the untreated sites. Soil samples from sites with rockwalls yielded 61 parts per million of potassium; while soil samples from sites without rockwalls yielded only 56 parts per million. The former is higher by around nine percent from the latter (see Table 3). This result, however, is not statistically significant.

Reading of potassium level for soil samples from sites with rockwalls tends to be consistently high and homogeneous. This suggests that the farming systems intervention program or the Ata must have a unifying effect on the condition of macronutients like the amount of potassium available in the soil for plant use. In areas where no such intervention is implemented, potassium content level tends to be generally low while its distribution on the ground is generally erratic and fluctuating. This is expected since the areas do not have any controlling machines on the supply and utilization of soil nutrients.

It is apparent from the data that the intervention package must have started to have its effect on the soil. The continuation of this effect will obviously have to depend on a sustained practice of the recommended appropriate cropping systems and soil development.

Phosphorous: Unlike other macronutrients, phosphorous yielded the highest margin of content from the sites with rockwalls compared to the sites without rockwalls. The difference is around 83%. For sites with rockwalls, the average parts per million of potassium is 174 in contrast to only 95 for sites without rockwalls (see Table 4).

Like the other two nutrients just discussed, phosphorous content tends to be uniformly high on sites that are developed toward appropriate farming systems. The opposite is taking place on sites where such development is not taking place.

Table 1

The pH Value of Soils From Two Samples

Samples Types of Soils	No. of Test Soil Samples	Average pH Value	Coefficient of Variation	
Soils from areas with rockwalls	10	7.2	44%	3.168
Soils from areas without rockwalls	10	6.9	57%	3.933
t = .1878 NS		.30		

Table 2

Nitrogen Content of Soil From Two Samples

Types of Soil Samples	No. of Test Samples	Average Percentage of Organic Matter	Coefficient of Variation	
Soil Samples taken from sites with rockwalls	10	4.5	33%	1.485
Soil Samples taken from sites without rockwalls	10	3.7%	81%	2.997
t = .7563 NS				

Table 3

Potassium Content Level From Two Soil Samples

Types of Soil Samples	No. of Soil Test Samples	Average Parts Per Million of Potassium	Coefficient of Variation	—
Soil samples from sites with rockwalls	10	61	51%	31.11
Soil samples from sites without rockwalls	10	56	71%	39.76

t = .3131 NS

Table 4

Phosphorous Content Level From Two Soil Samples

Types of Soil Samples	No. of Soil Test Samples	Average Parts Per Million of Phosphorous	Coefficient of Variation	
Soil samples from sites with rockwalls	10	174	57%	99.18
Soil samples from sites without rockwalls	10	95	65%	61.75

t = 2.138 Sign .05

SUMMARY AND CONCLUSIONS

Three issues were explored: (1) soil trapping capability of rockwall; (2) pH level, which suggests the general nutrient condition of the soil; (3) macronutrients. Because of the limitation of the laboratory facility, only the macronutrients were tested.

For the last two issues, a comparative approach was used. Soil samples from farms with and without rockwalls were taken and their average pH and macronutrient readings were recorded. The effects of rockwalls on these issues were measured by the difference of readings between the two samples.

On the basis of the data just presented, the following conclusions are drawn:

(1) Indications show that the contoured rockwal s on the Ata farms are effectively trapping eroded soils;

(2) The pH level of the soil has been improved by rockwalls since soils are prevented from erosion. The introduction of new cropping system into the rockwalled areas must have also helped improve the general nutrient condition of the soil;

(3) Contoured rockwalls and the appropriate cropping system introduced have collectively brought positive effects on the macronutrient condition of the soil. In all three types of macronutrient (nitrogen, potassium and phosphorous), indications for higher readings have been noted for samples taken from sites where rockwalls have been established;

(4) Improved farm productivity can be expected in the next ten years especially if there is a continuing practice of appropriate cropping system as well as maintenance and expansion of rockwalls.

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