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Effect of Burning and Cultivation on Soil Properties and Microbial Population of Four Different Land Use Systems in Abakaliki.

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Abstract: Measurement of the effect of burning and cultivation on soil prosperities and microbial population of four different land use systems – forest land, bush fallow systems, continuous cropping land and alley cropping system in Abakaliki was carried out in a complete randomized design (CRD). Burning improved soil pH from strongly acid to moderately acid in the bush fallow system and slightly acid (pH 6.1) in the alley cropping system but reduced organic C by 36% in the forest land, 44% in both the bush fallow and continuous copping land 34% in the alley cropping system. Also total soil N declined in all the land use systems. Available P, exchangeable Ca, Mg and K increased after burning. Cultivation inversely depleted nutrient level with the lowest soil nutrient content occurring in the continuous cropping land. Burning did not have lasting effect on the microbial populations. At 5 days post-burn, the population of micro organisms were very low compared to the pre-burn populations. But at 25 days post-burn there was a surge in microbial population. In the bush fallow and alley cropping systems, both bacteria and the cellulolytic groups increased in numbers but in the strongly acid forest and continuous cropping land the population of fungi dominated. Continuous cultivation led to a decrease in the population of bacteria, actinomycetes and algae. The general decline in the population of microorganisms under cultivation was associated with the over all fertility decline of cultivated soil.

Key words: Burning, forest, bush fallow, continuous cropping, alley cropping system.

INTRODUCTION

Soils beneath the tropical rainforest vary widely in chemical and micrological characteristics. In the drier forest zone of West Africa with mean annual precipitation between 1400 to 1800mm, the relatively high base status (Ca, Mg and K), Alfisols and associated Inceptisols and Entisols are dominant. Under forest ecology, these soils are moderately fertile because of the accumulation of Ca- saturated soil organic matter and high activity and population of soil macro-and microorganisms in the surface layers[5]. But in the vast area of high rainfall, low altitude tropics with annual rainfall between 1800 and 2000mm, the strongly acid and leached Ultisols and Oxisols are the dominant soils. The luxurious rain forest are supported by extremely poor soils beneath them. Such soils generally contain very low levels of exchangeable Ca and Mg. soil organic matter is often saturated with Al ions and possesses little cation exchange capacity[14]. Most of the plant nutrients, if not all are held and recycled within the forest vegetation. Thus, once the nutrient cycle is broken by forest removal, soluble nutrients released from decomposing organic materials are rapidly lost by leaching and run-off because these highly weakened Ultisols and Oxisols have little nutrients and water-holding capacities.

In Ebonyi State (Southeast Nigeria), the area under forest vegetation is gradually diminishing because of increasing human activities. Clearing forest, for cultivation often results in a rapid decline in soil fertility due to decline in the physical, chemical and biological properties of the soil[5]. The numbers of and distribution of microorganisms present in forest soils are often influenced by soil environment, particularly soil pH, the amount and quantity of huimified and non-himified soil organic matter, levels of available phosphorus and nutrient cations. Clearing and cultivation of tropical forest is usually accompanied by a decline in both amount of organic matter in the underlying growth[19,25].

The main objective of this work was to study the soil properties and the microbial population of soils of different land use Management systems and to investigate changes in soil properties by burning and cultivation.

MATERIALS AND METHODS

The study was conducted in four different use systems within Abakaliki ($06^{0}25^{1}$N and $08^{0}65^{1}$E) with an elevation of about 400m above sea level. Mean

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annual rainfall ranges from 1600 – 1800mm, distributed bimodal with four dry months. The mean annual daily temperature ranges between 27-31^{0}C. Abakaliki agricultural zone lies within the Asu river group and consists of olive – brown sandy shales, fine-grained sand stones and mudstones. The soils are shallow, with unconsolidated parent materials (shale residuum) within 1m of the soil surface. It belongs to the ultisol within Ezzamgbo soil association and classified as typic Haplustult.

The land use systems studied included:

- a planted forest of over 33 years dominated by Gmelina arborea, located within the Faculty of Agriculture and Natural Resources Management of Ebonyi State University, Abakaliki and occupying over 10 hectares of land. Predominant activities taken place in the forest includes illegal fallen of economic trees in quest for fire wood, with stumps regrowing without defined management. The outskirts of the forest has been modified by man resulting in secondary scrubby bushes dominated by herbaceous weeds such as *Eupatorium ordoratum*, *panicum maximum*, *Andropogon tectorum*, *Aspilia Africana* etc. This vegetation occupied 20m into the forest.
- a three-year bush fallow with dominant and abundant vegetative species consisting of *Imperata cyclindrica*, *Panicum maximum*, *Pteridum* equilibrium, inter-spaced with stunted *Acacia sp*. The bush fallow land occupies 2 hectares of land.
- a continuous cropping land measuring 2.5 hectares. Cultivation was preceded through clearing by slash – and – burn system. Cultivation was done manually with hoes. The crop combination include yam as maize crop, inter-cropped with maize, okoro and pumpkin. Cultivation has been going on for three years.
- The fourth land use system was an eleven-year alley cropping system planted with *Gliricidia sepium*, *Leucaena leucocephala* and *Cajanus cajan* forming the hedgerow trees.

The study started in early May, 2007. the area under study in each site was 20m x 20m replicated four times in a complete randomized design (CRD). Soil samples were taken before land clearing in the four sites at 0-15cm and sieved with a 2mm sieve. Burning of the cleared vegetation was done within the 20m x 20m study sites and in the alley cropping system. Care was taken to ensure that the hedgerow trees were not affected. At 5 and 25 days post burn soil samples were taken. These samples were collected at 0 – 30cm into two sub-samples, each of which contained 20 cores. One sub-sample was used to assess the microbial population at 5 and 25 days post-burn, while the second sample at 25 days post-burn was homogenized and sieved with a 2mm aperture sieve and used for the determination of soil chemical prosperities. At 50 days after cultivation, another soil samples were collected at 0-30cm to determine the effect of cultivation on soil properties. Ten undistributed core samples were collected from each land use system for the analysis of dry bulk density and available water capacity.

Analytical Methods: Soil separates were determined by the procedure described by Bouyoucos[9]. Dry bulk density was determined by the core method[8]. Total porosity was calculated from bulk density data as the fraction of total volume not occupied by soil assuming a particle density of 2.65gcm^{-1}. Available water capacity was determined using a pressure plate apparatus at 10kPa field capacity[27].

Soil pH was determined in a 1:2.5 soil – water suspension. Organic C was determined by the dry combustion[15]. Total soil N and available P were measured in moist – ground – sieved soil. Total soil N was determined by the modified Kjeldahl method[7]; available soil P was determined using Bray 2 solution as outlined by Page *et al*[24]. Exchangeable cation (Ca, Mg and K) and total acidity were determined by the procedure described by Tel and Hgarty[28].

Total numbers (log No. g^{-1} soil) of bacteria were determined by the most probable number (MPN) method[1], fungi was estimated on Martin agar (1975); Cellulolytic organisms were enumerated as described by Voets *et al*, while the Kuzents or and Yangulova[16] medium containing chltin was used to enumerate actinomycetes. Algae populations were quantified by the most probable number method and further enumerated by Gunnison and Alexander[12] methodology.

Data colleted from this study were analyzed using complete randomized design (CRD) as described by Steel and Torrie[26].

RESULTS AND DISCUSSION

Soil Prosperities: The textual class of the soils of the different land use management systems were sandy loam (Table 1). The soil bulk density varied in all the land use systems. Soil bulk density was considerably highest in the continuous cropping land with the highest value of 1.76gcm^{-1} occurring at the 15 – 30cm soil depth. It was observed in this study, that soil bulk density increased with increasing soil depth. The high bulk density in the continuous cropping land over the other land use systems could be attributed to the level of organic matter and tillage. Anikwe[2] deserved that trafficking during field operation could increase soil bulk density as these tillage operations could to

Table 1: Soil properties at the different land use management systems before clearing.

	Forest		Bush Fallow		Cont Cropping		Alley Cropping	
Soil parameters	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
Sand (gKg^{-1})	580	540	620	540	670	620	610	570
Silt (gKg^{-1})	220	200	200	260	200	200	200	240
Clay (gKg^{-1})	200	260	180	200	130	180	190	200
Texture	SL	SL	SL	SL	SL	SL	SL	SL
BD(gcm^{-3})	1.32	1.43	1.02	1.25	1.52	1.76	1.26	1.35
7B (%)	54	46	62	954	42	33	53	44
Mc (%)	54	40	56	47	38	31	67	52
pH (H20)	4.6	4.5	5.4	4.9	4.4	4.2	5.8	5.6
Org C. (gKg^{-1})	2.18	1.39	2.94	1.98	1.98	1.10	21.0	1.17
OM (gKg^{-1})	3.76	2.40	5.07	3.41	3.41	1.90	3.52	2.02
Total N.(gKg^{-1})	0.64	0.39	0.84	0.46	0.18	0.08	1.84	1.24
Avl. P(Mg Kg^{-1})	14.86	10.29	16.47	13.09	10.92	8.75	19.58	13.47
Ca (c mol Kg^{-1})	2.07	1.02	2.37	1.17	1.41	0.95	2.97	1.64
Mg (c mol Kg^{-1})	1.17	0.93	1.21	1.01	0.86	0.38	1.46	1.23
K (c mol Kg^{-1})	0.36	0.12	0.49	0.16	0.20	0.06	0.72	0.31
Al + H (c mol Kg^{-1})	2.69	3.72	2.04	2.89	3.06	4.12	1.98	2.17
CEC (c mol Kg^{-1})	3.6	2.07	4.07	2.34	2.47	1.39	5.15	3.18

Org C = Organic carbon, Om = Organic matter, N = Nitrogen, Avl.P = Available Phosphorus, Cont. = Continuous, SL = Sandy soil

compaction of soils. However, soil bulk density was lowest in the bush fallow system. The decrease in the soil bulk density in the bush fallow system was as a result of the level of organic matter. Charrau and Nicon[10] noted that a $0.1gcm^{-3}$ decreased in dry bulk density had a significant beneficial effect on root development because lowering of the compaction levels in soil. Soil bulk density is a soil physical property used extensively to quantify soil compactness and has great influence on root development. Total porosity was a reverse of the bulk density in the upper soil layer. The total porosity was highest in the 0-15cm soil depth (Table 1) relative to the lower soil depth 15 – 30cm in all the studied sites. Bush fallow with the lowest bulk density had the higher total porosity of 62% in the 0-15cm soil depth. The increase in the total porosity observed in the bush fallow was due to the organic matter content. Anikwe[2], Nnabude and Mbagwu[20] and Mbagwu[17] had made similar observation on influence of organic matter on aggregation and aggregate stability and its capacity to reduce bulk density and improve total porosity. The highest moisture content was obtained in the alley cropping system (67% and 52%) at the two soil depths. The high moisture content obtained in the alley cropping system could be due to continuous addition of prunings from the hedgerow trees.

The pH of the soil ranged between very strongly acid in the 0-15cm depth to extremely acid at the 15-30cam depth in the continuous cropping and forest lands. In the bush fallow system, the soil pH ranged between strongly acid in the 0-15cm to very strongly acid in the 15-30cm soil depth. However, in the alley cropping system, the soil pH was moderately acid at the two study depths (0-15cm and 15-30cm). The high acid level observed in the forest, bush fallow and continuous cropping lands would be responsible for the low exchangeable cations observed in this study (Table 1). In addition, the forest soils were prone to leaching as was observed by an increased clay level at the 15 – 30cm soil depth.

Under the bush fallow, organic matter was highest in the 0 – 15m soil depth (5.07g kg^{-1}) and 3.41g kg^{-1} in the 15 – 30cm depth. The organic matter in the bush fallow increased by 20% in the 0 – 15cm relative to the continuous cropping land and 28% in the 15-30cm depth in the same site. Similarly, organic matter was 14% in the 0-15cm and 18% in the 15 – 30cm over the forest soils; 18% in the 0-15cm and 26% in the 15-30cm over that of alley cropping system. Among the four land use management systems, the cultivated land had the lowest organic matter content at the two sampled depths.

The total soil N contents of 1.84g N kg^{-1} and 1.28g N kg^{-1} were obtained in the 0-15cm and 15-30cm soil depths in the alley cropping system respectively. The differences in the total soil N between alley cropping system and the other land use managements were 44% at 0-15cm and 54% at 15-30cm soil depths relative to the bush fallow; 76% at 0-15cm and 88% in the 15-30cm over the continuous cropping land and 38% in the 0-15cm and 22% in the 15-30cm relative to the soil N in forest land. The results obtained in this study showed that continuous cropping land had the lowest soil N among the four land use systems. The implication of this result was that the level of soil N observed in any of the land use systems depended on the kind of vegetation growing there and the cultural practices used. More soil N was obtained in the alley cropping system because the hedgerow trees were legumes and the impropriation of the prunings together with the capacity of the hedgerow trees to fix atmospheric N improved the total soil N obtained in the system. Available soil P was also highest in the soils of alley cropping system. The observable link between total soil N and available soil P (Table 1) was that land management system with the highest total soil N also had the highest available soil P. Thus, alley cropping system with the highest total soil N had available soil P ranging from 19.58 mg P kg^{-1} in the 0-15cm and 13.47 mg P kg^{-1} in 15 – 30cm soil depth. Available soil P was also lowest in the continuous cropping land. The cation exchange capacity values were in the order: alley cropping system > bush fallow > forest land > continuous cropping land. The low CEC values obtained in the forest and continuous cropping land was responsible for the low pH values observed in these sites. In all, the continuous cropping land had low nutrient reserve. This could be attributed to either plant utilization and the decline in the soil organic matter content.

Post-burn soil Properties: Table 2, shows the chemical properties of soils of the different land use management system after burning. The soil pH of both the forest and continuous cropping changed from extremely acid to strongly acid. However, in the bush allow, the soil pH improved to moderately acid (pH 5.8), while the alley cropping became slightly acid (pH 6.1). The change in the soil pH could be due to increase in the exchangeable cations resulting from the incorporation of ash into the soil after burning. In addition, the available soil P and exchangeable Ca, Mg, and K all increased after burning. Owolabi *et al*[23] and Odedina *et al*[22] had found that ash enhanced soil pH and nutrient availability in soils of the Southwest Nigeria. The increase in the soil pH and exchangeable cations associated with ash affirms that ash had liming effect. Other workers[21] have successfully seen ash as a liming material. The total organic C within the 0-30cm declined in all the land use management systems where burning took place. The percent decline in the forest land was 36%, bush fallow system 44%, continuous cropping land 44% and alley cropping 34%, relative to the pre-burn soil organic C. The result obtained in this work differed from that of Odedina *et al*.[22] who observed that application of wood ash increased organic matter of soils. This was not so in this work as organic matter is a function of organic C, and low organic C were obtained in this study in the post-burn soil analysis. Similarly, total soil N declined in the different land use management systems after burning, particularly in the continuous cropping land where N decreased by 58% of the original total soil N (Table 1). In the forest, bush fallow and alley cropping system the total soil N decreased by 40%, 24% and 6% respectively. The decrease in total soil N may be due to volatilization during burning or utilization by the growing crop. So if ash from burning is to be used a nutrient source, nitrogen would need to be supplied from another source. Voundi Nkana *et al*[29] reported that wood ash contained virtually no N and their application will normally not affect the total N in the soil. Available soil P, exchangeable Ca, Mg and K increased after burning in the different land management systems. The values of these elemental nutrients tended to increase with the incorporation of ash. The alley cropping system was significantly different (<0.05) to the other land use management system in the available soil P. Also alley cropping system showed significant difference ($p<0.05$) in the CEC relative to the forest and continuous cropping land. The CEC of the alley cropping was 38% relative to the pre-burn (Table 1). Similarly, the forest land had an increased CEC of 13% relative to the pre-burn, and bush fallow and continuous cropping had 11% and 4% respectively over the initial CEC levels. The result of this study tended to agree with the work of Awodon[6]. The total acidity (Al +H) decreased as a result of burning. The increased soil pH resulting from the addition of ash contributed to the reduction of total acidity.

Post-Cultivation Soil Properties: The results of the soil properties at 50 days after cultivation are shown in Table 3. There were rapid decline in most of the soil properties. However, the soil bulk density increased due to cultivation. The soil bulk density of forest soils

Table 2: Soil chemical properties at 25 days post – burn (0 – 30cm)

Sites	pH (H20)	Org C. (gKg^{-1})	OM (gKg^{-1})	Total N.(gKg^{-1})	AVl. P (Mg Kg^{-1})	Ca (c mol Kg^{-1})	Mg (c mol Kg^{-1})	K(c mol Kg^{-1})	AI + H (c mol Kg^{-1})	CEC (c mol Kg^{-1})
Forest	5.2	1.68	2.89	0.46	28.66	4.37	2.44	0.55	1.27	7.36
Bush fallow	5.8	1.91	3.29	0.80	32.09	5.08	2.65	0.89	1.01	8.62
Cont. cropping	5.4	2.21	2.08	0.07	24.79	2.79	1.17	0.21	2.13	4.17
Alley cropping	6.1	1.56	2.69	2.75	37.22	5.56	2.89	0.97	0.98	9.42
LSD (0.05)	NS	0.07	0.68	1.12	3.07	1.56	0.08	NS	NS	1.41

Cont. = Continuous, Org C = Organic, Om = Organic matter, Avl. P = Available Phosphorus,

Table 3: Soil chemical properties at 50 days post – burn (0 – 15cm)

Sites	BD g cm^{-3}	Tp%	Mc%	pH (H_2O)	Org Cg kg^{-1}	Omg kg^{-1}	Total Nmg kg^{-1}	Avl.Pmg Kg^{-1}	Cac mol kg^{-1}	Mgc mol kg^{-1}	Kc mol kg^{-1}	(AL+H)c mol kg^{-1}	CECc mol kg^{-1}
Forest	1.45	45	50	4.8	1.36	2.85	1.24	16.32	1.41	0.32	0.19	1.31	1.92
Bush fallow	1.28	52	52	5.0	1.22	2.10	1.89	19.06	1.62	0.94	0.14	0.92	2.70
Cont. cropping	1.67	37	41	4.3	0.77	1.34	0.56	10.48	1.18	0.10	0.07	1.97	1.35
Alley cropping	1.19	55	61	5.6	1.08	1.86	2.97	21.74	2.49	1.06	0.99	0.76	4.54

BD = Bulk density, Tp = Total porosity, Mc = Moisture content

and continuous cropping lands which were 1.32g cm^{-3} and 1.52g cm^{-3} respectively in the pre-cultivated period (Table 1) increased to 1.45g cm^{-3} and 1.67g cm^{-3} respectively after cultivation. The general increase in the soil bulk density in the 0-15cm soil depth was due mainly to tillage operations. Soil bulk density is known to increase with time after cultivation as a result of trafficking during field activities and other natural factors. The incorporation of prunings reduced significantly (p.<0.05) soil bulk density. This suggests that prunings might have reduced the degree of erodobility, which are factors that increase soil bulk density. Both total porosity and moisture content were also reduced. The soil pH which increased as a result of burning decreased with cultivation. The soil pH of the continuous cropping land became extremely acid, whereas that of the forest and bush fallow reverted to very strongly acid. However, the soil of the alley cropping system remained moderately acid. Similarly, the elemental nutrients – organic C, total N, available P, and exchangeable cations declined. The reasons for this situation might include: crop utilization of these nutrients; the available ash which brought an improved condition in the soil had no lasting effect; leaching may have occurred resulting in the removal of nutrients beyond the sampled depth. The total soil N, available P and the CEC were significantly different (p<0.05) in the alley cropping system soils to the forest, bush fallow and the continuous cropping soils. The lowest nutrient level occurred in the continuous cropping soils. Similar results were obtained by Ayanaba *et al*[5] and Juo and Lal[13] working with a continuous cultivated Alfisol after clearing from a secondary forest in Southwest Nigeria.

Microbial Population and Distribution: Table 4, showed the numbers and distribution of microorganisms present in the soils of different land use systems. The results showed that the numbers of microorganisms were influenced by soil depth, soil pH, and amount of organic matter, total N, available P and levels of exchangeable cations. As shown in Table 4, fungi populations increased in the forest and continuous cropping soils and were more in the top 0-15cm. Bacteria and actinomycetes were higher than the fungi, algae and the cellulolytic members at the lower depth (15 – 30cm). The abundance of fungi on the top soil (0 – 15cm) may be attributed to the fact that fungi as a group are strict aerobes and exhibit selection preference for various depths of the soil. Also more fungi occurred in the forest and continuous cropping soils than the other microbial groups. Soil properties played an important role in determining the distribution of the various microbial groups enumerated. In the forest and continuous cropping lands with very low pH, fungi dominated, reaching a population level of 66.01 x 10^4 and 49.89 x 10^4 respectively. The abundance of fungi group in the two land use systems could be attributed to their ability to proliferate at pH less than 3.0. The increase in soil acidity and cationic nutrient probably brought about changes in microbial population. Ayanaba and Omayuli[4] observed that microorganisms degrading cellulose and those involved in the mineralization, oxidation and reduction of nitrogen are few in acid soils of Nigeria. The bush fallow and alley cropping systems supported the growth of both bacteria and the cellulolytic members more than the other organisms. Both bacteria population and the cellulolytic organisms reached a population of 53.64 x 10^7 and 102.40 x 10^2 respectively. Alley cropping system tended to support the growth and proliferation of all the microbial population as follows: cellulolytic groups > bacteria > fungi > actionmycetes > algae. The increased microbial population in the alley

Table 4: Microbial population at different soil depths in the different land use management systems.

	Land management system							
	Forest		Bush fallow		Cont. Cropping		Alley Cropping	
Organisms	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15.30cm
Bacteria $x10^7$	5.93	21.12	53.64	26.08	31.36	20.88	77.85	56.48
Actinomycetes $x10^6$	12.26	2.99	39.34	14.85	19.24	10.01	62.39	26.61
Fungi $x10^4$	66.01	1.81	28.32	2.68	49.89	12.07	67.25	20.92
Algae $x10^4$	20.31	0.64	13.19	0.52	13.19	0.95	29.46	10.46
Cellulotytic $x10^2$ Members	25.01	13.80	102.40	43.36	21.04	11.33	119.44	93.36

cropping could be attributed to improved nutrients content of the soil, caused by the high quality prunings incorporated into the soil (Tables 1 and 3).

Effect of Burning: Clearing and burning did not cause any lasting effect on any of the five microbial group studied (Table 5). Within few weeks of burning, the microbial populations were very high, and even higher than the pre-burn population. There was partial sterilization observed from the low number of microorganisms at 5 days after burning. The highest population of microorganisms occurred in the alley cropping system at 5 days post-burn enumeration. These populations of microorganism were very low compared to the pre-burn populations (Table 4). In the 5 days post-burn, cellulolytic groups and fungi were higher than the bacteria in the forest land (35.0 x 10^2 and 21.7 x 10^4 respectively). In the continuous cropping system, fungi was highest in the 5 days post-burn (27.10 x10^4).

There was a surge of microbial population, particularly, bacteria and cellulolytic groups at 25 days post-burn count. The surge in the population of microorganism brought over 100% increases in the population of micro-organisms after burn relative to the pre-burn microbial number (Table 4). In the bush fallow and alley cropping systems, bacteria and cellulolytic group had the highest population increases. However, in the strongly acid soils of the forest and continuous cropping land burning led to increase in soil microbial populations, particularly bacteria at 25 days post-burn. Such increases in the number of microorganisms were attributed to the increase in soil pH and the level of available nutrients particularly phosphorus after burning. The increase in soil pH which came as a result of the addition of ash after burn could be responsible for the surge in population. Demeyer *et al*[11] reported that wood ash application stimulated microbial activity in soil through the amelioration of the physico – chemical characteristics of soils. Bacteria, fungi and the cellulolytic microbes increased over actinomycetes and algae in the different land use systems at 25 days post-burn. Mahmood *et al*[18] reported increase in the fungi/bacteria ratio that were related to increase in the wood ash. However, algae populations were most affected by burning as their numbers did not appreciate like the other four organisms.

The results obtained in this study have shown that burning could only cause temporal decrease in microbial population and that the improvement of the physico chemical properties could favour growth of microorganism.

Effect of Cultivation: Continuous cultivation generally led to a decrease in the population of actinomycetes and algae (Table 6). Fungi and cellulolytic groups, however, increased upon cultivation in the continuous cropping land. The decline in the number of microorganisms as a consequence of continuous cultivation could be attributed to the over-all fertility decline of the cultivated soil. Among the land use systems studied, forest, bush fallow and alley cropping system tended to support bacteria and cellulolytic groups on cultivation. A convenient and easily measured indicator in these land use systems is the organic C. Continuous cultivation led to a decrease in soil organic C as compared to soils under bush fallow Ayanaba *et al*[5] and Juo and Lal.[13] observed a decrease in soil organic C with continuous cropping. The decline in soil organic C is closely related with organic matter, total n as well as available nutrient statues of the different land use systems (Table 3).

Conclusion: The result obtained from this study showed that the different land use systems varied in their nutrient level. Burning and cultivation affected both the physical and chemical properties of the soil. While burning decreased soil bulk density, it increased the soil pH, available P and exchangeable K, Ca and Mg. Cultivation increased bulk density, and reduced the available nutrients. The results of this study have

Table 5: Effect of burning on the microbial population of the different study sites (0-30cm)

		Micro organism g-^{1} soil			
Organism	Sample Period	Forest	Bush fallow	Cont. Cropping	Alley Cropping
Bacteria	5 days post-burn	14.8 x 10 ^{7}	24.8 x 10^{7}	11.2 x 10^{7}	39.6 x 10 ^{7}
	25 days post-burn	89.3 x 10 ^{7}	108.6 x 10^{7}	72.7 x 10^{7}	161.9 x 10^{7}
Actinomycetes	5 days post-burn	11.4 x 10^{6}	18.5 x 10^{6}	13.2 x 10^{6}	20.6 x 10^{6}
	25 days post-burn	56.7 x 10^{6}	92.9 x 10^{6}	41.4 x 10^{6}	98.3 x x10^{6}
Fungi	5 days post-burn	21.7 x 10^{4}	17.8 x 10^{4}	27.8 x 10^{4}	29.2 x 10^{4}
	25 days post- burn	147.2 x 10^{4}	70 x 10^{4}	88.3 x 10^{4}	134.8 x 10^{4}
Algae	5 days post-burn	9.7 x 10^{2}	8.3 x 10^{2}	0.2 x 10^{2}	4.3 x 10^{2}
	25 days post-burn	7.2 x 10^{2}	14.7 x 10^{2}	10.8 x 10^{2}	14.7 x 10^{2}
Cellulolytic	5 days post-burn	35.0 x 10^{2}	18.6 x 10^{2}	13.5 x 10^{2}	41.1 x 10^{2}
Membus	25 days post-burn	102.3 x 102	14.2 x 10^{2}	98.6 x 10^{2}	192.3 x 10^{2}

Table 6: Number of microorganism in cultivated soils of the different land use system (0-30cm)

	BacteriaX 10^{7}	ActinomycetesX 10^{6}	FungiX 10^{4}	AlgaeX 10^{2}	CellulolyticX 10^{2}
Forest	26.55	10.60	22.71	2.64	33.61
Bush Fallow	18.49	14.27	11.28	2.93	45.90
Cont. Cropping	3.59	1.94	10.36	1.24	18.42
Alley Cropping	32.74	21.28	25.29	1.98	53.33
LSD (0.05)	2.76	2.37	2.52	0.98	4.14

shown that burning could only cause temporal decline in microbial number, but the improvement of the physico-chemical properties could favour proliferation of microorganisms.

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