The influence of soilanimals on the chemical properties of two well drained soils in Kenya.

Inge Aalders, 1987

Abstract

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An attempt is made to show the influences of biological activity on the chemical properties of two Nitosols in the Chuka area, Kenya.
Three different kind of samples were collected from two profile-pits:
- disturbed bulk samples
- granular elements only
- subangular blocky elements only

To study the influence of the type of vegetation additional composite samples are taken. All samples were subjected to (total) chemical analysis. A texture analysis was carried out on the profilepit samples only.

The landuse, soilanimal-activity and soilstructure were studied in detail.

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1.General

1.1.Introduction

Previous research has made it clear that soilanimals can be important in the development of soils (Wielemaker.1984). Soil-fauna has a great inpact on physical and chemical properties.
The aim of this research is to obtain a better insight in the role of soil animals (particularly termites) on chemical properties of the strongly weathered soils on the slopes of the Mount Kenya.

It was assumed that animal activity results in a granular structure which gradually will change into a subangular stucture.

For additional information is referred to the research on physical properties (Nobbe, 1987) to which this research is strongly linked.

1.2. General information on the research area.

1.2.1. Location.

The research took place in the Embu district of Kenya(mapsheet 122/3; 1:50.000). The two pits (P24 and P18, see fig 1) used for the research were located near Kathageri and the village Kigumo respectively at an altitude of approx. 1600 m on the footslope of the Mount Kenya. A detailled site description is to be found on page 4.
For additional information is referred to Aalders and Noppe, 1985.

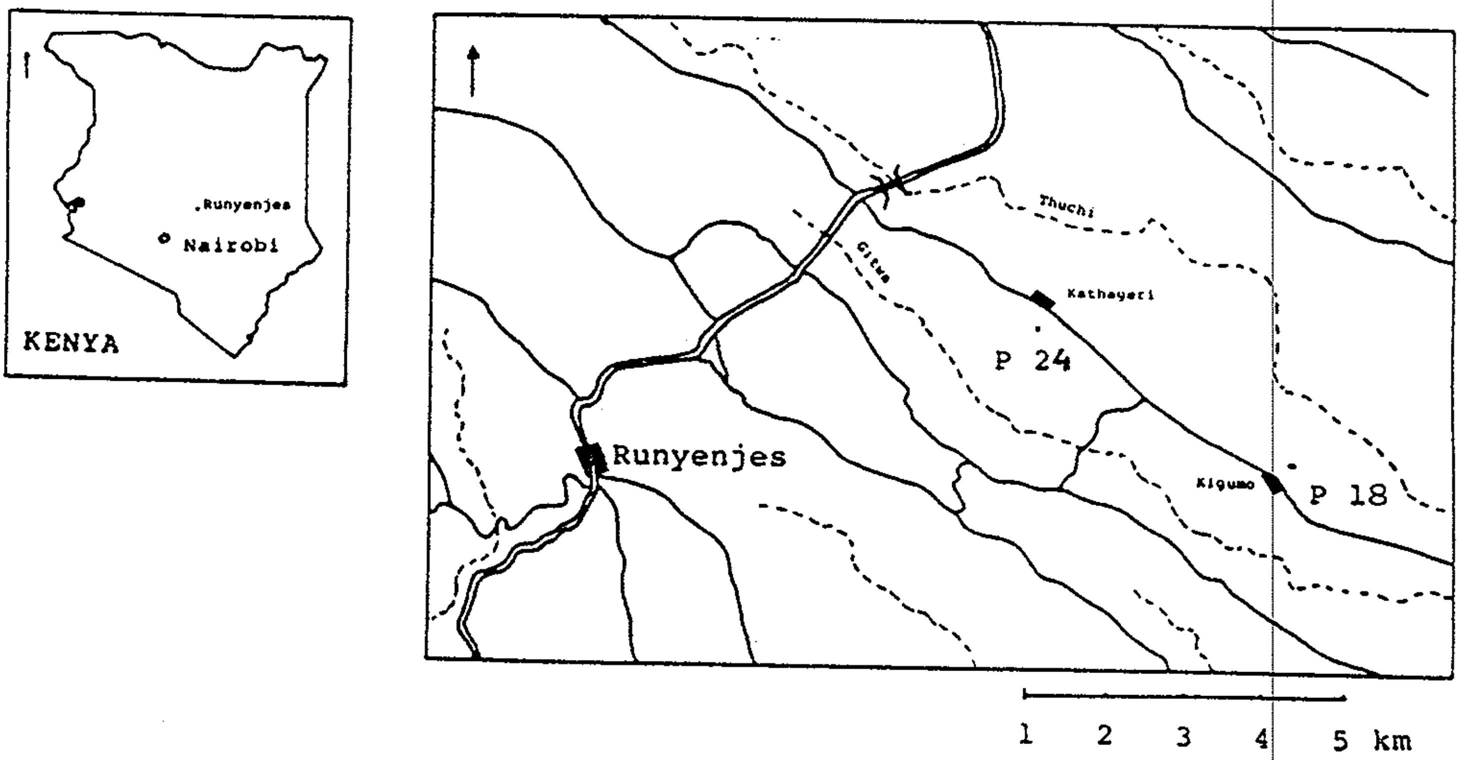


Fig. 1 Location of the research area

1.2.2. Climate.

The climate of the research area is classified as sub-humid to semi-humid.
The average rainfall varies from 1050 to 1400 mm. There are two rainy seasons in April-May and October-November. Most of the rain falls in those two periods.
The mean annual temperature is 20-22oC (Jaetzhold.1983).

1.2.3. Geology.

A complex of lava- & laharflows from eruptions of the Mount Kenya cover the research area. During the eruptions porphyric phonolites, Kenyte lavas and nepheline syenite were ejected.
These three kinds of material are only found in the higher regions of the Mount Kenya. They are chemical identic, but differ in texture. On the lower slopes mainly porphyric phonolites are found.
A general description of the chemical composition of phonolite is given in table 1. (Campbell Smith,1931).

Table 1 Chemical composition of porphyric phonolite (in %) (Campell Smith,1931)

SiO_2	52.10	K_2O	4.66
Al_2O_3	22.29	H_2O+	0.75
Fe_2O_3	1.73	H_2O-	1.00
FeO	4.10	TiO_2	0.30
MgO	1.17	P_2O_5	0.46
CaO	2.42	MnO	0.23
Na_2O	8.60		

1.2.4. Soils.

The soils are classified according to the USDA Soil Taxonomy (Soil Conserv. Serv.,1975) & the FAO legend of the soil map of the world (1:5,000,000; FAO/UNESCO,1974).
The FAO-classification is used in Kenya with some adjustments to the Kenyan situation. The soils of the research area are deep & well drained. They consist mainly of kaolinitic clays (> 90 %).
The soils are classified as Nitosols (Nobbe, 1986).

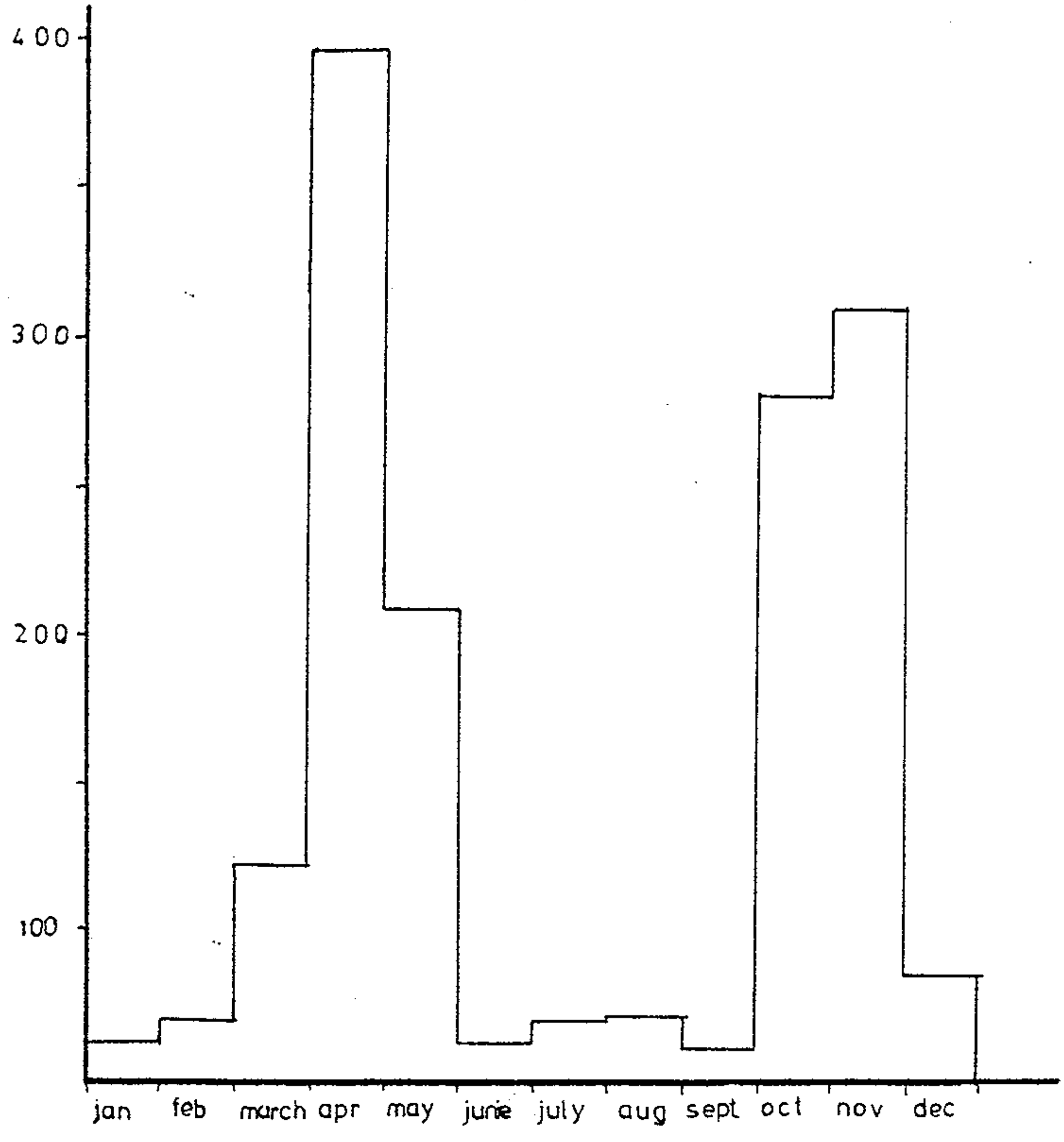


FIG 2: MEAN MONTHLY RAINFALL in mm (Runyenjes 1478 m)

source: Jaetzhold, 1983

1.2.5. Human influence.

In earlier years the area was covered with a rainforest vegetation. It has changed ever since and is now cultivated with food- & cashcrops.

The main foodcrops are maize, beans and bananas. They are grown on small fields, shambas, either as a monoculture or in mixed cropping.

The main cashcrop is coffee. This crop is grown according to the instructions of the coffeefactory. The farmers are instructed in the use of fertilizers, terracing and soil management in general.

Economically less important crops are cassavas, sweet potatoes, pigeon peas, napier grass, mangoes, lemons, oranges and firewood.

2. Methods.

2.1. Field methods.

Two pits with a different landuse (history) were selected and described according to FAO guidelines (FAO,'65). In addition the profiles have been described in detail on features related to biological activity such as fungi-chambres and channels (Nobbe, 1987).

From each distinguished soilhorizon the following three samples were taken for laboratory analyses:

1. disturbed bulk sample
2. granular structure elements only
3. subangular blocky structure elements only

The granular and subangular blocky structure elements were only sampled if they could be recognized.

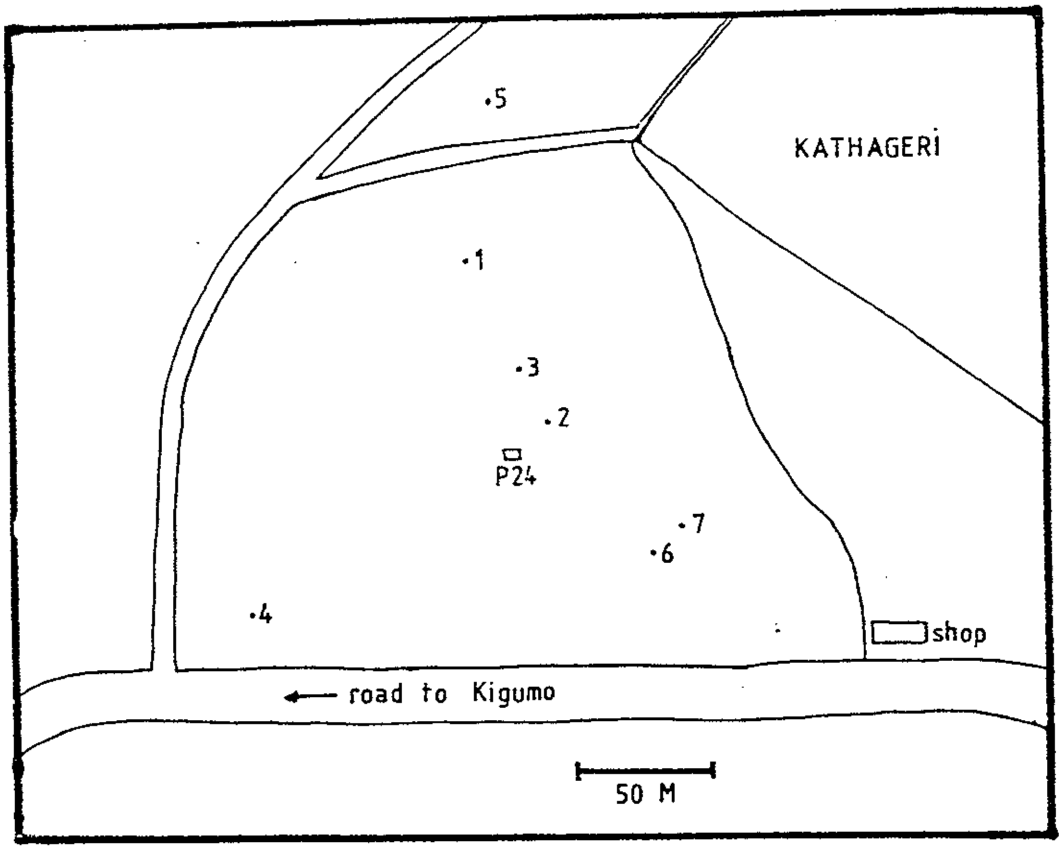


Fig. 3: Detailled map of the location of the rondom samples

Additional information was gained by site observations (FAO,'67) and interviews of farmers.
To study the relation between soilanimal-activity chemical properties and vegetationtype so called "random" samples of profiles of the same soilunit and with the same topography and hydrology, but with a different vegetation/landuse as P24 were collected (see figure 3).

For this purpose holes about 40 cm deep were dug and disturbed bulksamples of 0-10 cm, 10-20 cm and 30-40 cm were taken for laboratory analyses. In the field all samples were compared with those of P24 on features as colour, structure and biological activity.

2.2. Laboratory methods.

Total FeO, Fe2O3, MgO and Na2O were obtained by a wet destruction method. H2O+ was obtained by heating to 900oC.
Rontgen fluorescention was used for the total concentration of all other elements.
All these analyses were carried out by the staff of the laboratory of the department of Soil Scence and Geology, Agric. Univ. of Wageningen.

The moisture content (H2O-) was obtained by drying the samples during 24 hours in an oven at 105 oC.
The organic carbon content of the samples was analysed by the method of wet combustion. Nitrogen was analysed according to the method of Kjeldahl.
In solutions of H2O and CaCl2 (0.01 M) the pH was measured with an electronic pH-meter.
The CEC and exchangeable cations were analysed by the Li EDTA-method, but because of unusual high values, the Ca2+ was analysed by using the Li EDTA-Na4 EDTA method, which yielded more reasonable results.

The samples of profiles P24 and P18 were determined on the clay-mineralogy and texture.

2.3.Office work

In order to come to conclusions about the research results of the field and laboratry work are carefully studies.
Results of the analyses are compared and the mean values of the soil profiles are calculated.

Together with the additional information available the final conclusions are made about the differences between the samples.
The computerprogramm LOTUS 123 is used to make grafics to give a better view on the differences.

3. The influence of soil animals on the chemical properties of the soil.

3.1. Site description.

The sites are located on almost flat parts of the footslopes of the Mount Kenya on deep weathered, well-drained soils. The soilfauna-activity is high-very high. The general groundwater-level and the effective soildepth are very deep.

3.1.1. P24 Kathageri

The pit is situated in a shamba with coffeetrees. This shamba has been intensely cultivated for about 30-40 years.
Young weeds are mixed with the topsoil by using a fork jembe.
The owner applies fertilizer once a year in april. He also uses pesticedes against insects that attack the treeleaves and berries.

3.1.2. P18 Kigumo

The pit is situated at the corner of a shamba. This shamba makes a desserted impression with some nice looking maize, but mainly napier grass, cassavas and weeds.
At the moment the human activity on this shamba is low. This is only temporarely, because this shamba is for sale. The field has been fallow only since the last growing season.

3.1.3. The random samples

The area, where the random samples were collected, consisted of a number of small shambas near P24. They are all intensively cultivated with mainly foodcrops, but some give the impression that they are left fallow for one growingseason.
At places with the following vegetation the topsoil was sampled:

sample no.	vegetationtype
1.	under a large mangotree
2.	under a firewoodtree
3.	in a coffeefield
4.	in a field with intercropping of maize & beans
5.	healthy maize
6.	unhealthy maize
7.	healthy maize

3.2. Description & sampling of the soils.

In addition to the disturbed samples granules and subangular blocky structure elements were collected separately. The granular structure elements were taken from biogenic channels & holes.

The soilanimal activity in these soils is high considering the number of biogenic channels & holes in both pits.
The random samples were taken from small pits at depths of 0-10 cm, 10-20 cm and 30-40 cm. Only disturbed samples were taken. They are compared to P24 Kathageri in the field on structure & colour (ch. 3.4.).
The samples were brought to the laboratory of the Soil Science dep. of the Agric. Univ. of Wageningen for chemical & elemental analyses.

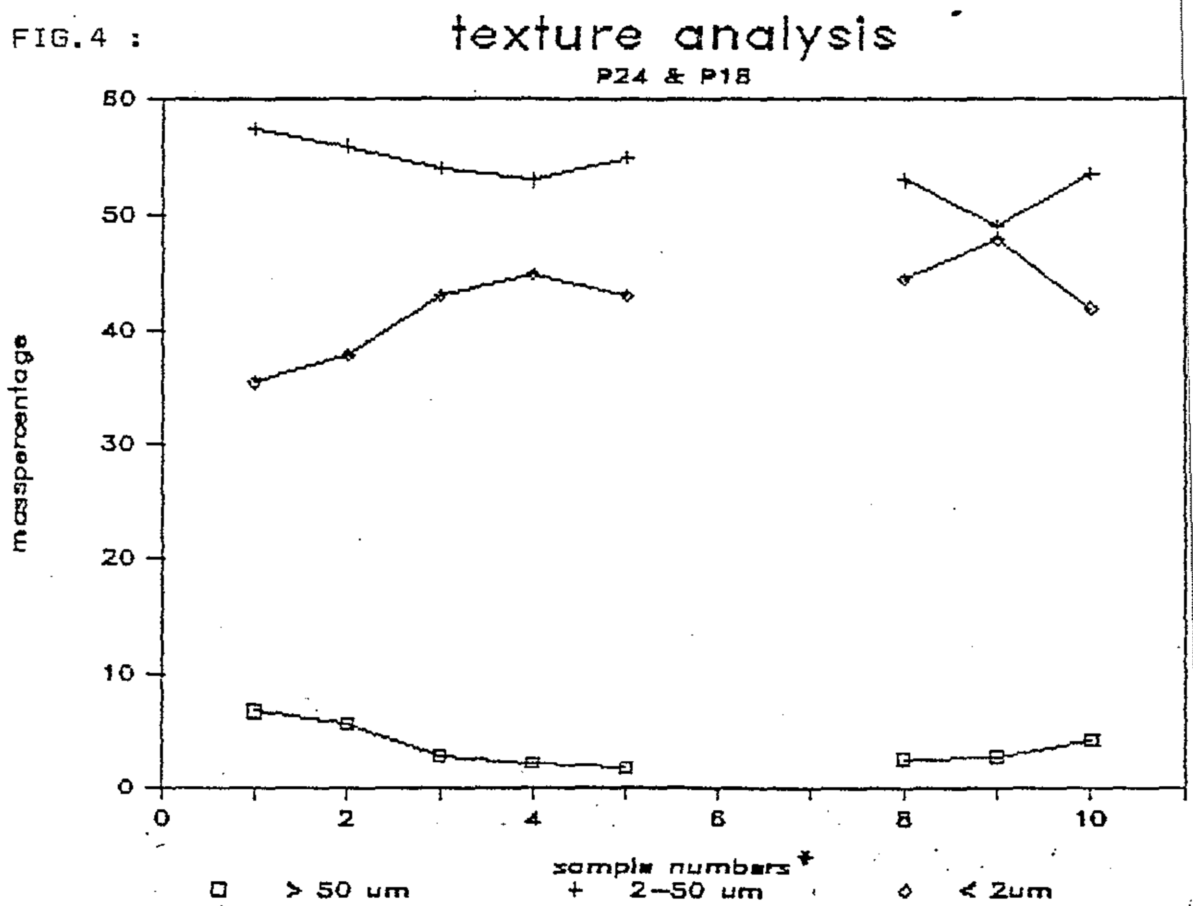
Throughout the profile detailled drawings of patches of 10 x 10 cm were made. From these drawnings the amount of granules and subangular blocky structure elements could be counted (ch. 3.4.). The intermediate between a granular and a subangular blocky structure is called massive.

3.3. Results of physical properties.

For a detailled description of the physical properties is referred to Nobbe 1987. Some of the properties are mentioned here for their importance in the results of this research.

The disturbed samples of the pits P24 and P18 are analyzed on texture (fig 4). Strong forces between the clay particles, resulting in the formation of pseudo-silt, could be an explanation for the unusual high silt/clat ratios found.

FIG.4 :



* sample numbers:

P24	1. 0-15 cm	4. 60-120 cm	P18	8. 0- 35 cm
	2. 15-30 cm	5. 120-200 cm		9. 35-100 cm
	3. 30-60 cm			10. 100-160 cm

The amount of structural elements counted from the detailled drawings (table 2) show an increase in the amount of granules in P24 followed by a strong decrease at 30 cm (fig 5a). In P18 the amount of granules gradually decreases (fig 5b). The amount of massive structures is higher in P18 than in P24, while the amount of granules in the topsoil of P24 is higher than in the topsoil of P18.

A comparison between the random samples and P24 (table 3) show that most differences occur in structure rather than biological activity or colour.

Table 2 Distribution of the structure elements.

sample no	depth in cm	P24 gran	P24 mass	P24 sub	P18 gran	P18 mass	P18 sub
1	0- 10	34%	66%	--	41%	59%	--
2	10- 20	38%	62%	--	33%	67%	--
3	20- 30	56%	--	44%	33%	67%	--
4	30- 40	17%	--	83%	28%	--	72%
5	40- 50	18%	--	82%	12%	--	88%
6	60- 70	23%	--	77%	21%	--	79%
7	80- 90	28%	--	72%	--	--	--
8	110-120	24%	--	76%	--	--	--

FIG 5A : Distribution of the structural elements

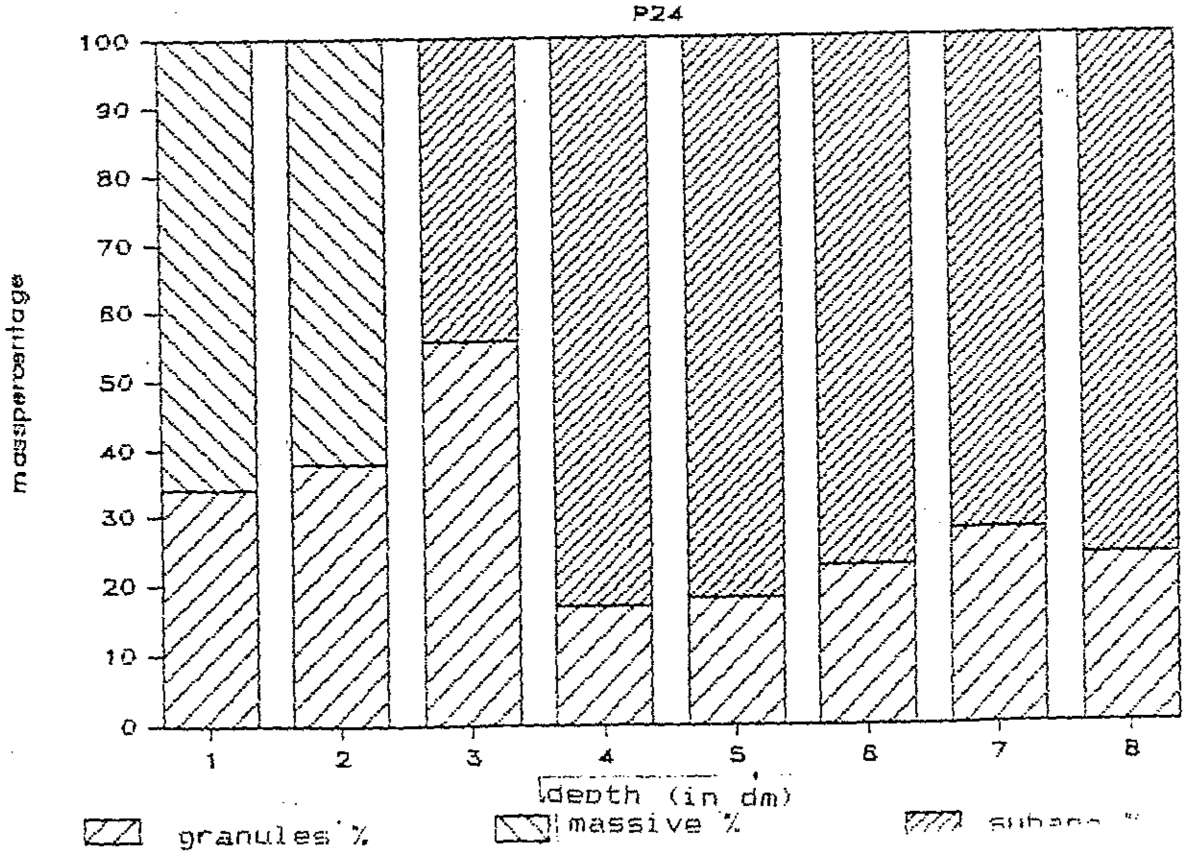


FIG 5B : Distribution of the structural elements

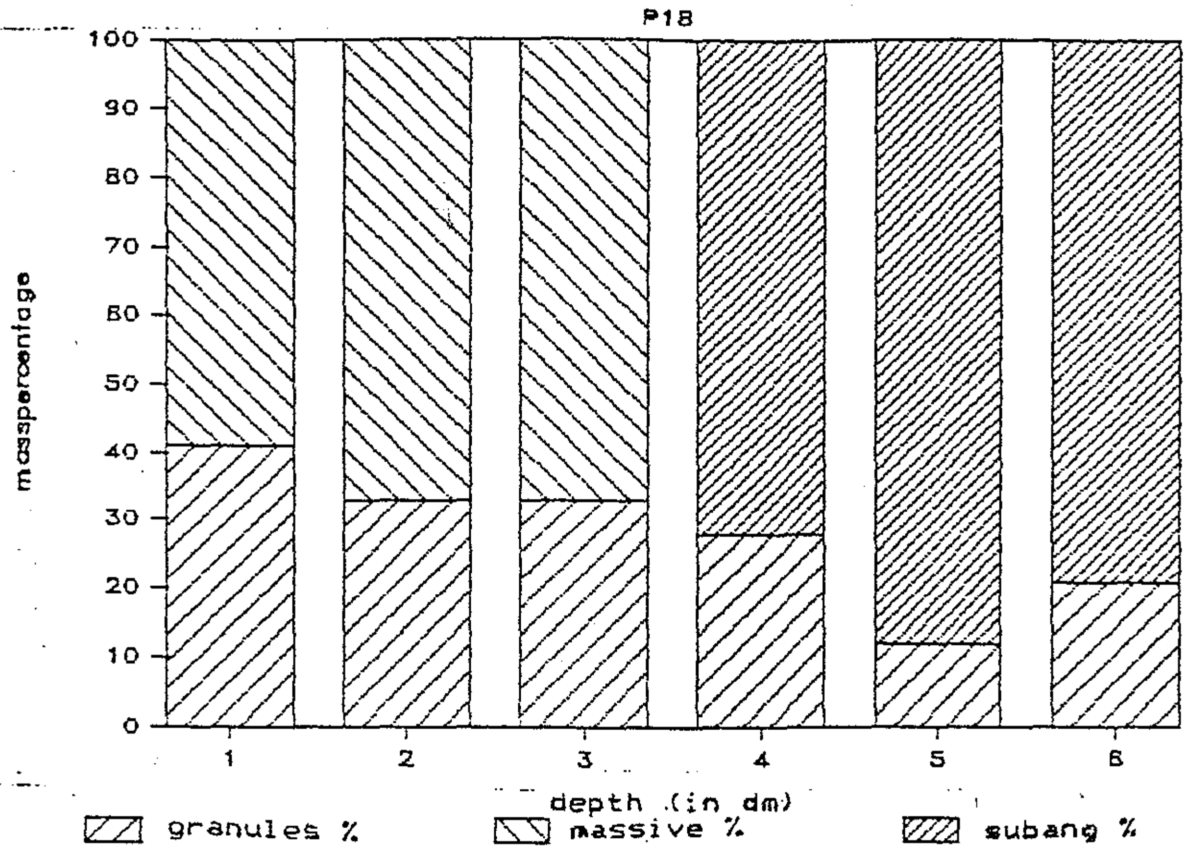


Table 3 The comparison of the random samples with P24

sample no	soilfauna activity	colour	structure	others
P24	very high	2.5YR3/4	see table 3	
1.	very high	darker	more granulars near surface	looser in topsoil
2.	high	darker	larger structure elements	looser consistence
3.	high	similar	more massive near surface	--
4.	high	similar	similar	stones at surface
5.	high	more red	near surface mass. & subang.blocky.	--
6.	very high	similar	crust, more gran. in subsoil	--
7.	very high	similar	massive & more gran structure	--

3.4. Results of the total analyses.

The fractions < 2mm & < 2 um of the samples of the pits (appendix 3) and the fracions , 2mm of the ranules and subangular blocky elements and af the random samples (appendix 4) were analysed.
The elements analyzed are SiO_2, Al_2O_3, Fe_2O_3, FeO, CaO, MgO, Na_2O, K_2O, TiO_2, P_2O_5, MnO, BaO in massfraction percentage.

3.4.1. P24 (Kathageri).

The mean elemental contents of granular & subangular blocky structures show hardly any differences (fig 6a, app.2).
The differences within the profile occur mainly in the subsoil (30-120 cm),where the values of subangular structures for SiO_2, Al_2O_3 are higher than those of the granular structures (app. 4a).
Differences in the topsoil occur only for Fe_2O_3. The granular structures have higher amount of Fe_2O_3 than the subangular blocky structures. The differences of all the other elements are very small.

The differences between silt- & clay fraction (app. 3a, fig 6) are far better pronounced than between subangular blocky & granular structures.In the clay fraction the amount of SiO_2, Al_2O_3 and BaO are much higher than in the silt fraction. All other elements have lower values, of which the differences in Fe_2O_3, CaO, TiO_2 and MnO are most pronounced.

3.4.2. P18 (Kigumo).

There are differences between the elementanalyses of granular & subangular blocky structure, but they are too small to be of any significance (app. 2 & 4b, fig 6).

Similar to P24 the differences between silt & clay fraction are far better pronounced. The main differences are found in the amounts of SiO_2, Al_2O_3, Fe_2O_3, CaO, TiO_2, MnO and BaO.

3.4.3. The random samples.

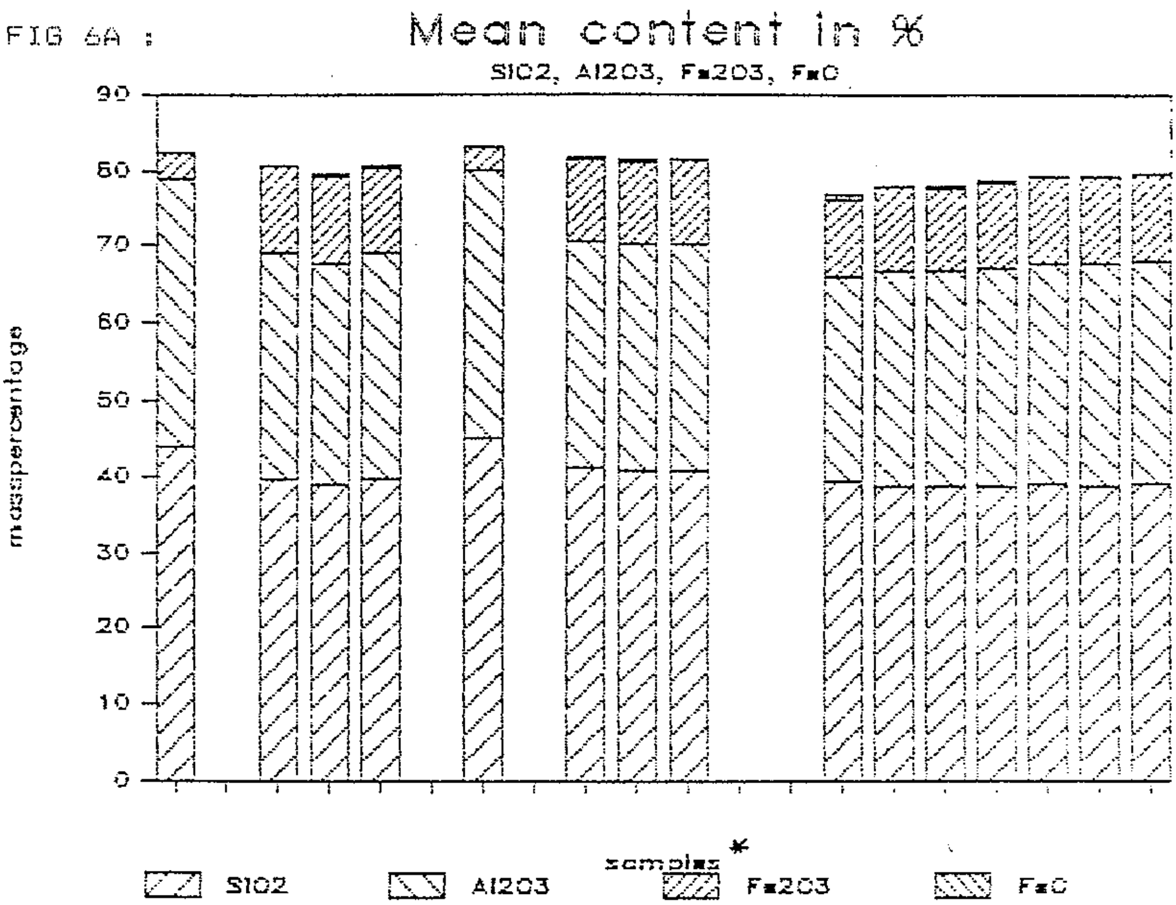
These analyses of the random samples can be divided into three groups:

a. mangotree
b. maize samples
c. coffee,firewood,maize & beans

The largest differences with P24 Kathageri occur in groups a & b. The mangotree has got higher amounts of FeO, MgO, CaO, P_2O_5 and lower amounts of Al_2O_3, Fe_2O_3 and MnO.

The maize samples contain much lower amounts of CaO and MnO and a higher amount of SiO2 & Al2O3.
The remaining samples are very similar to P24 Kathageri. These three samples have only one element that differs much with the pitsamples. Sample 2 has a lower CaO and sample 3 a higher MgO content.
The differences again are rather small.

FIG 6A :



* Samples:

P24	P18	Random
clay dist gran sub	clay dist gran sub	1 2 3 4 5 6 7

FIG 6B :

Mean content in %

MgO, CaO, Na2O, K2O

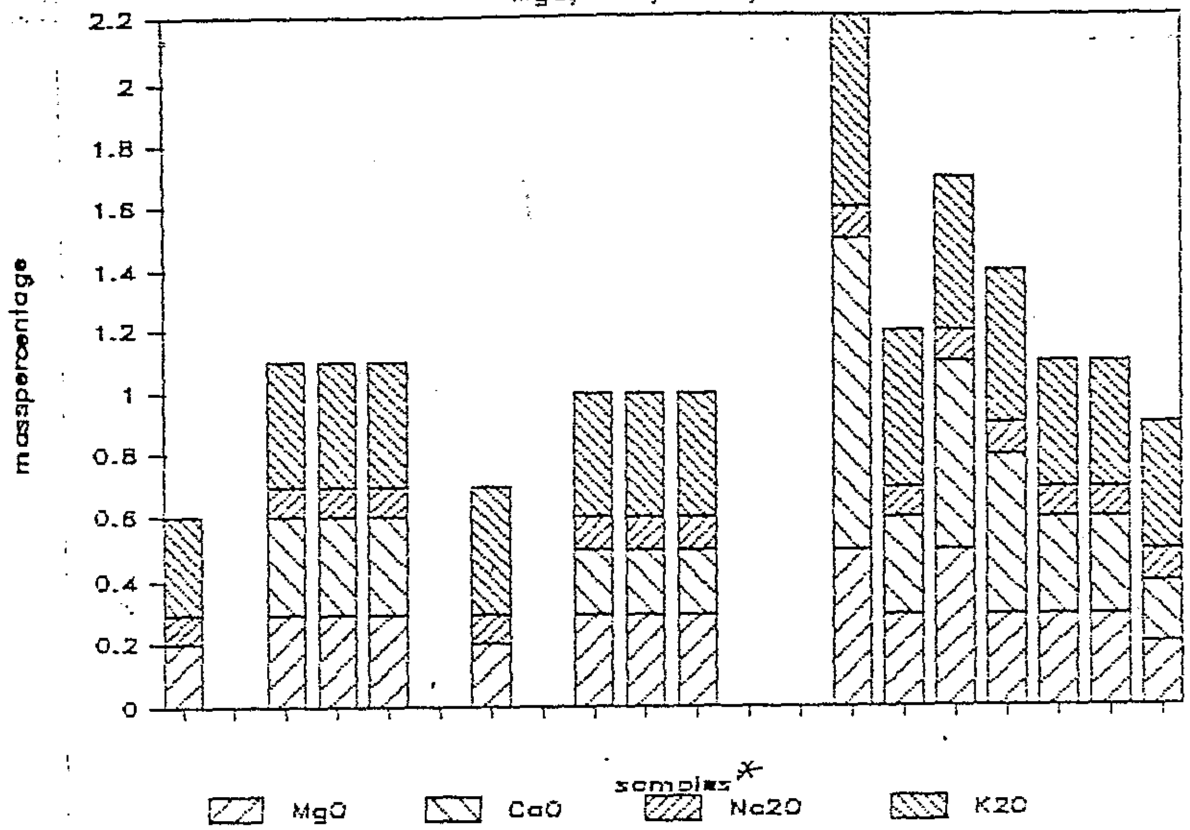
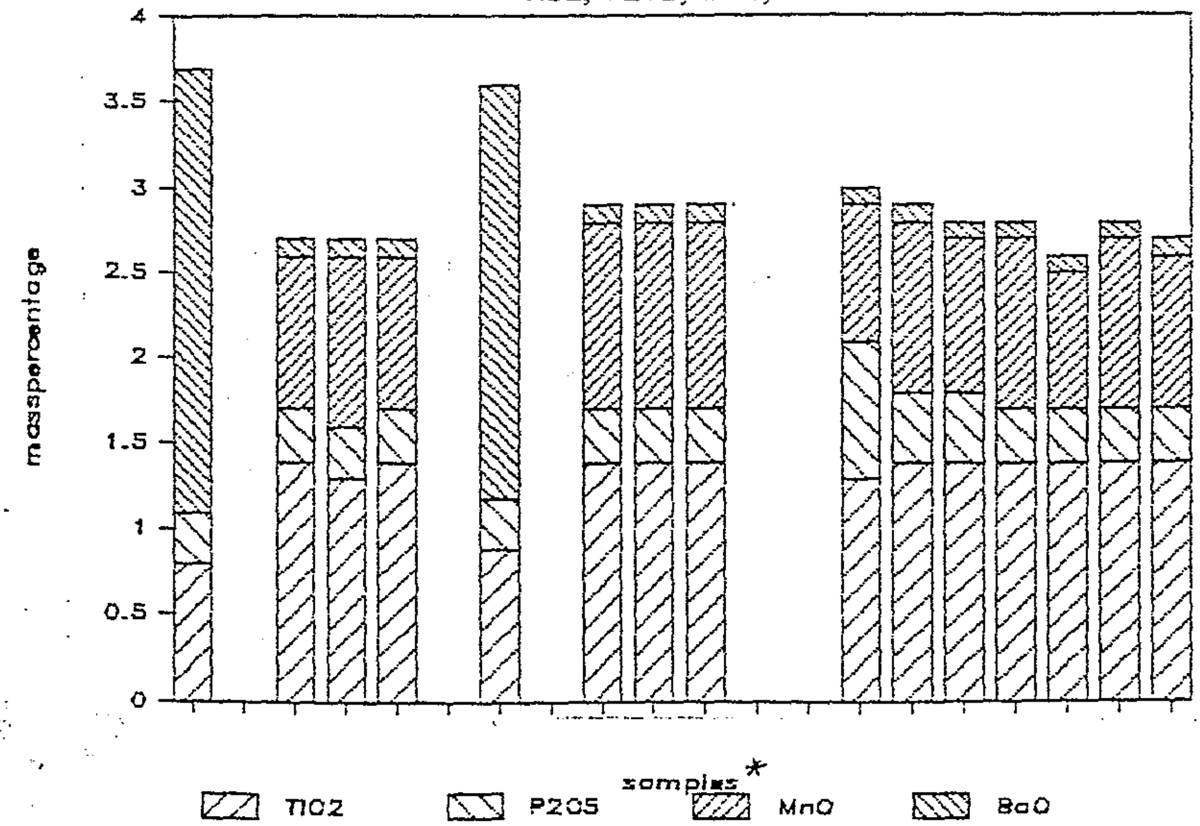


FIG 6C :

Mean content in %

TiO2, P2O5, MnO, BaO



---* Samples:

P24 clay dist gran sub   P18 clay dist gran sub   Random 1 2 3 4 5 6 7

3.5. Results of the chemical analyses.

The mixed & structure samples were analyzed on organic matter, nitrogen, pH (H_2O & $CaCl_2$), exchangeable bases and CEC (App. 5 & 6).

3.5.1. P24 (Kathageri)

The pH of P24 decreases with the depth. The mean pH of the granules is higher than of the subangular blockies (fig 7).
The mean organic carbon and nitrogen data show hardly any differences between the disturbed, granular and subangular blocky samples (fig 8), but they decrease strongly with depth.

The amount of Ca^{2+} is much higher than that of the other bases (fig 9). The mean values of P24 do not change much except for those of K^+. The topsoil has a higher CEC and Ca^{2+} content than the subsoil (fig.10).

3.5.2. P18 (Kigumo)

In general the chemical properties of P18 are the same or little less than tose of P24 (fig. 7-10). Unusual is the increase in pH with depth. The amounts of organic matter , Ca^{2+} & K^+, basesaturation and CEC are lower than those of P24.
At greater depth both pits become more similar.
There are no differences between the data of granules and of subangular blocky structure elements.

3.5.3. Random samples

The mixed samples of the random samples have been compared with the values of both pits.
The mean values of the random samples differ, but the differences are neither large nor regular except for sample number 1 (fig 7,8,11,12).

The most important differences of sample 1 (mango) are found in the organic matter, nitrogen, Ca^{2+} and Na^+ content.

Compared to P24 sample 2 (firewood) has a lower amount of Ca^{2+}, Mg^{2+}, Na^+, sum of bases, CEC, while the amount of nitrogen is higher. The amount of K^+ at 30-40 cm is remarkebly high as is the basesaturation.

Sample 3 (coffee) has a smaller amount of bases & CEC compared to the values of P24.

Sample 4 (maize & beans) is more like P18, except for a higher amount of organic matter, nitrogen, Ca^{2+} and K^+.

Compared to P18 Kigumo sample 5 (maize) has a higher amount of organic matter and nitrogen.The CEC & sum of bases are lower while the basesaturation is similar.

Sample 6 (maize) has a remarkable high amount of K+. The amount of organic matter, nitrogen, pH, K+, basesaturation are higher than in P18.

Sample 7 (maize) was also compared to P18 and has a higher amount of organic matter,nitrogen, K+ and basesaturation. For CEC ,C/N-ratio, pH and Mg2+ the values are lower.

FIG 7 :

Mean pH

H2O & CaCl2

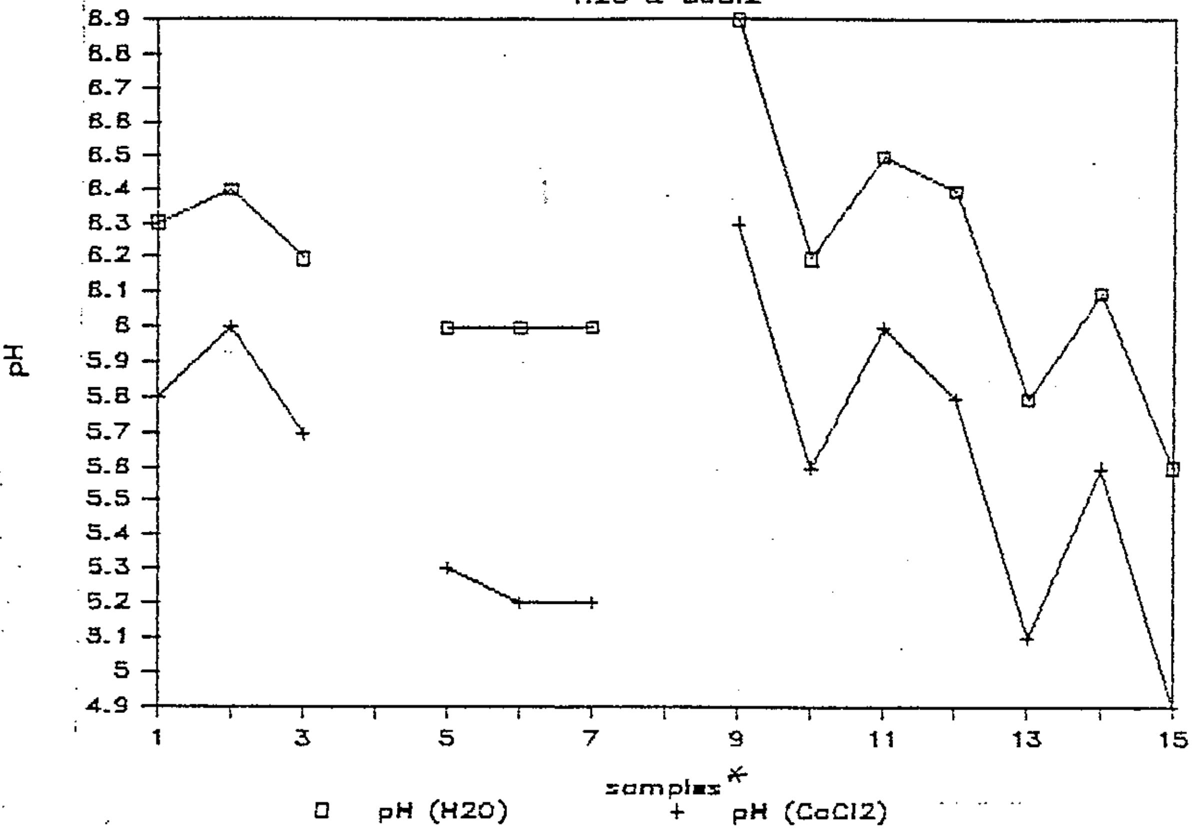
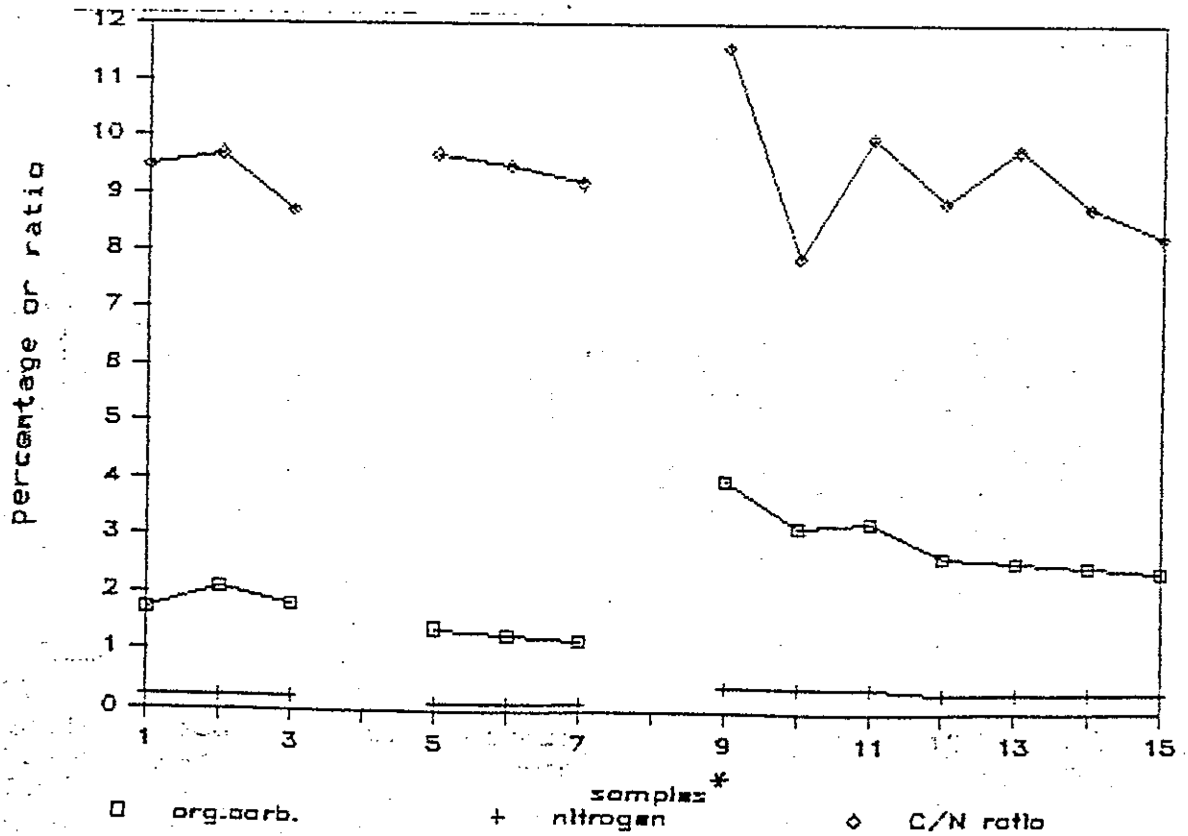


FIG 8 :

Mean C & N & C/N



* Samples:

P24
1. disturbed
2. granular
3. subang.blocky

P18
5. disturbed
6. granular
7. subang.blocky

Random
9. no 1
10. no 2
12. no 4
13. no 5
15. no 7

FIG 9 : Basic cations of P24 & P18

(disturbed samples)

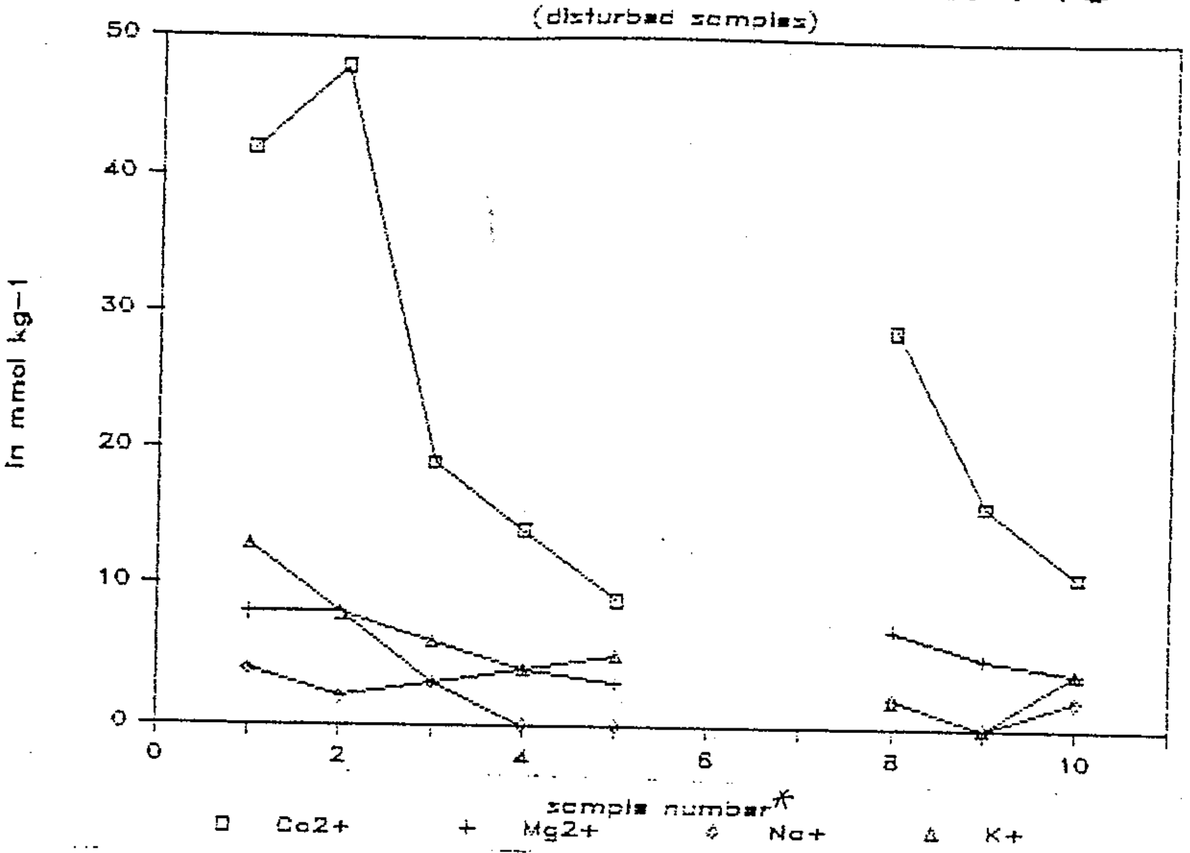
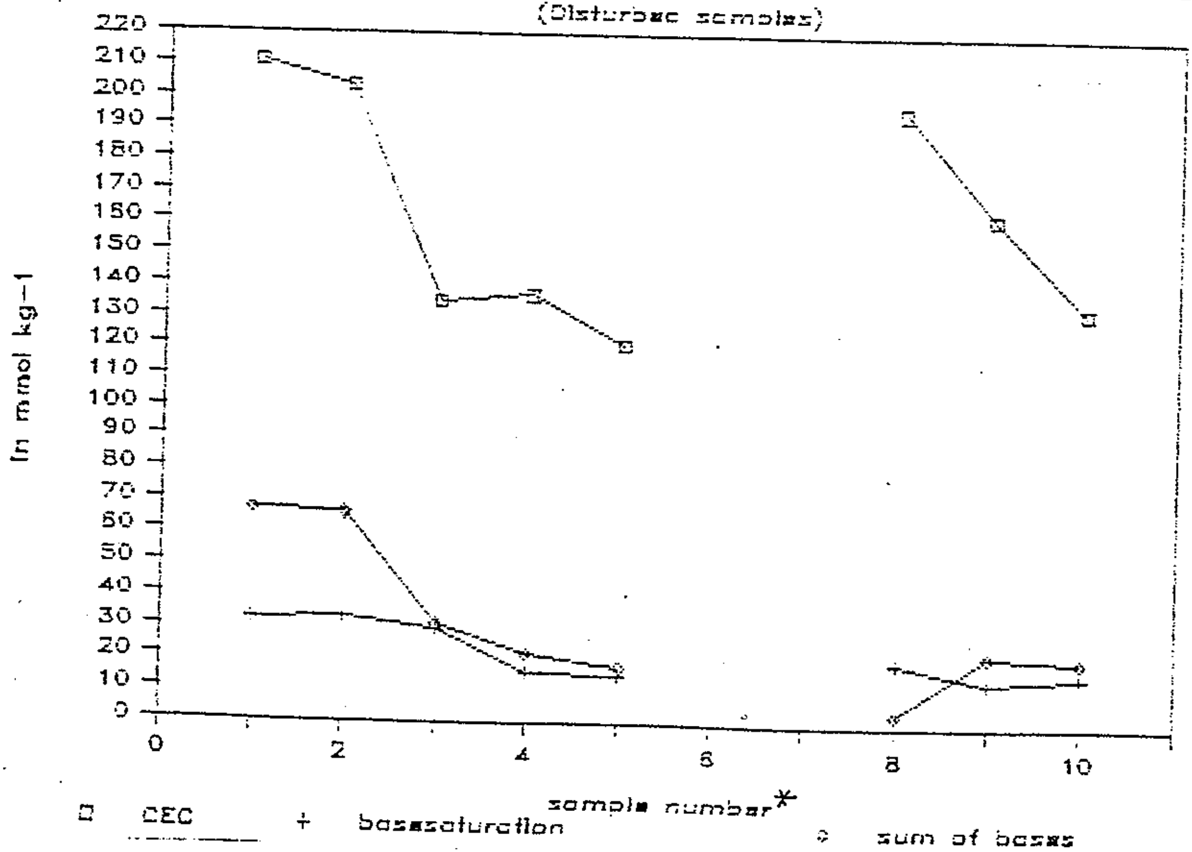


FIG-10 : CEC & basesaturation in P24 & P18

(Disturbed samples)



* Samplenumbers:

P24	1. 0-15 cm	4. 60-120 cm	P18 8. 0- 35 cm
	2. 15-30 cm	5. 120-200 cm	9. 35-100 cm
	3. 30-60 cm		10. 100-160 cm

FIG 11 :

Mean Basic cation content

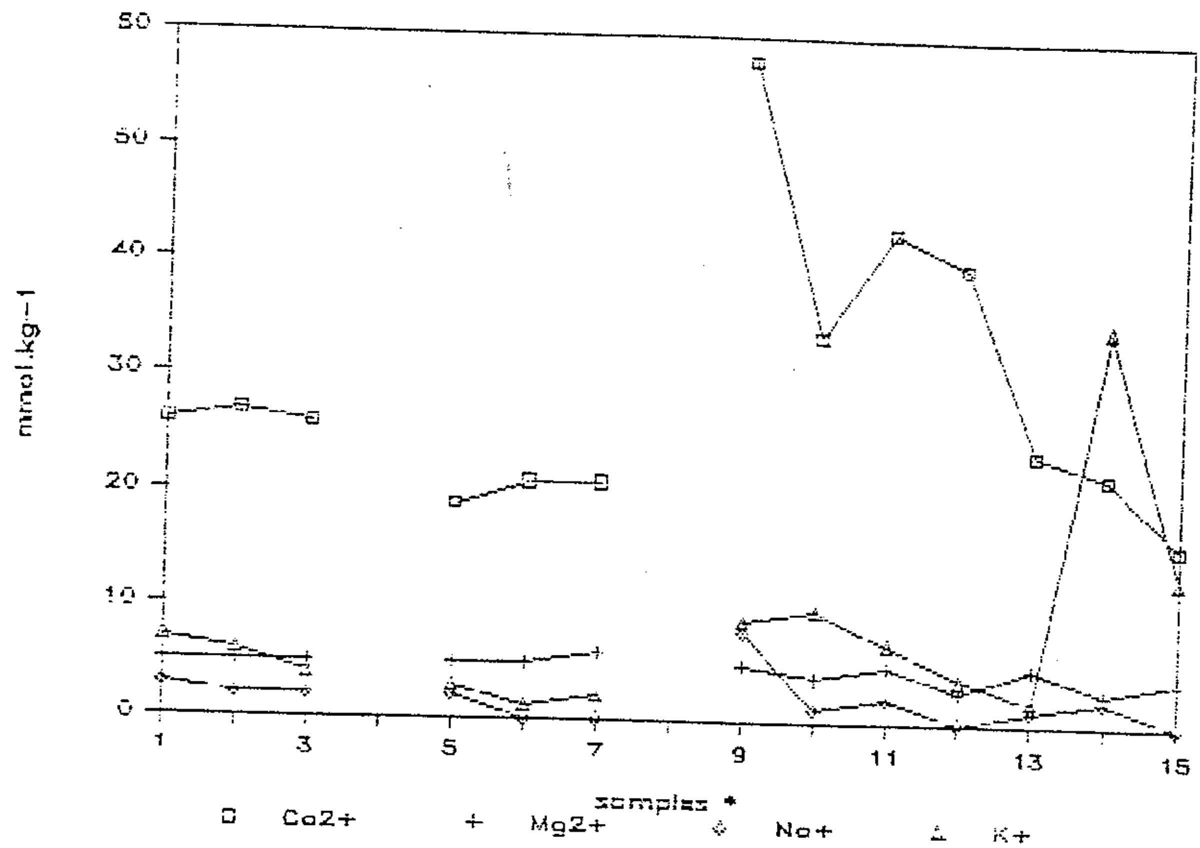
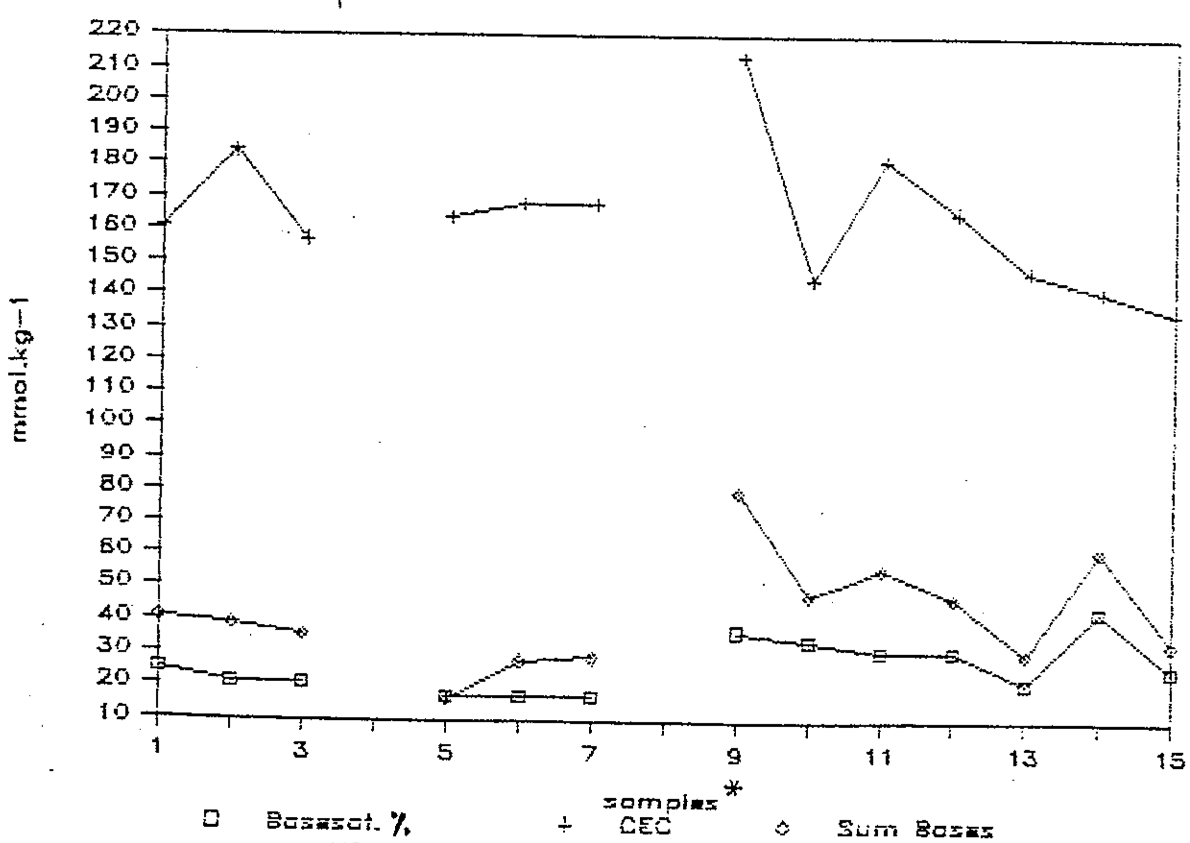


FIG 12 :

Mean CEC & basesaturation



* samples:

P24	P18	Random		
1. disturbed	5. disturbed	9. no 1	12. no 4	15. no 7
2. granular	6. granular	10. no 2	13. no 5	-
3. subang.blocky	7. subang.blocky	11. no 3	14. no 6	

4. Discussion & Conclusion

The results of this research come from a relatively small number of samples. Therefore mistakes made in different stages of the research can have a strong influence on the results.

The results of the disturbed, granular and subangular samples do not show a significant difference. The differences are rather small and the methods used are too inaccurate to give significant results.

Eventhough the results are limited, something can be said. Soil management especially the use of fertilizers can greatly influence the found differences.
Also the distribution of granular and subangular blocky structures and the differences in texture between these structure elements might have something to do with it. These characteristics can be influenced by soilanimals, but the soilstructure is a result of a complex of external influences. From this research it can not be concluded that only soilanimals are responsible for the differences in structure distribution between both pits. It is more likely that the stability of the structure elements differ and that the activity of animals in both pits are rougly the same.

The large differences in results between land that is left fallow for one growing season and that being supplied with fertilizer give an indication of the fast chemical changes under these climatic circumstances. The speed of chemical changes makes the results of this small scale research on chemical properties over a sort period less reliable.

Compared to the differences between granules and subangular blocky structure elements the differences between the silt and clayfraction are very small. It is therefore important to know if there are any differences in texture between the structure elements.
May be those results are of greater importance to the chemical properties than the activity of soilanimals.

The random samples seem to differ only because of the difference in landuse for the results are rather similar with the exception of the mangotree. The mangotree-profile is a relatively rich one.

If soilanimals are responsible for the quantity of granules in a soilprofile, the final conclusion of this research is that they hardly influence the fertility of the soil.

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Appendix 1a: Soil description P24 Kathageri

Observation no	:122/3-24
Agro-Ecological zone	:Main coffee zone
Mapping unit	:FV 1
Soil Classification	:humic Nitosol (Vermic Argiudoll)
Parent material	:Pyroclastica/phonolit flow
Physiography	:Volcanic Footridge
Relief	:Flat
Vegetation/landuse	:Coffee
Erosion	:non to verh slight splash erosion
Rockiness	:nil
Surface stoniness	:nil
Overwash/overblow	:nil
Slope gradient	:0 %
Surface sealing/crusting	:cracks, width 5 mm, spacing 15 cm
Effective soil depth	:120 cm
Drainage class	:well drained

Horizons:

Ap 0-15 cm	Dark reddish brown (5YR 3/2, moist); silty clay to clay; moderate very fine to fine granular structure; very friable when moist, slightly sticky and slightly plastic when wet; many biopores; very frequent very fine roots ;abrupt and wavy transition to:
A 15-30/35 cm	Dusky red (2.5YR 3/2, moist); silty clay to clay; moderate very fine to subangular blocky structure; very friable when moist, slightly sticky and slightly plastic when wet; many biopores; very frequent very fine and very frequent fine roots; clear and wavy transition to:
]:i 30/35-65 cm	Dusky red (2.5YR 3/2, moist); silty clay to clay; moderate very fine angular and subangular blocky structure; broken thin clay skins; very friable when moist, slightly sticky and slightly plastic when wet; many biopores;common very fine and common fine roots; gradual and smooth transition to:
B 65-90 cm	Dark reddish brown (2.5YR 3/4, moist) and dark red (2.5YR3/6, moist); silty clay to clay; moderate very fine angular and subangular blocky structure; broken thin clay skins; friable when moist, slightly sticky and slightly plastic when wet; many biopores; common very fine and fine roots; gradual and smooth transition to:
B2 90-130 cm	Dark red (2.5YR 3/6, moist); silty clay to clay; moderate very fine angylar and subangular blocky structure; broken thin clay skins; friable when moist, slightly sticky and slightly platsic when wet; manu biopores; common very fine and fine roots; gradual and smooth transition to:
130-200+ cm	Dark red (2.5YR 3/6, moist) silty clay to clay; moderate very fine angular blocky stucture; patchy thin clay skins; very friable when moist, slightly sticky and slightly plastic when wet; many biopores; common very fine and fine roots.

Appendix 1b : Soil descibtion P18 Kigumo

Observation no	:122/3-18
Agro ecological zone	:Main coffee zone
Mapping unit	:RV2
Soil Classification	:humic Nitosol (vermic Argiudoll)
Parent material	:Pyroclastic material/Phonolite
Physiography	:Top of Volcanic Footridge
Relief	:Flat to very gently undulating
Vegetation/landuse	:Annual crop cultivation
Erosion	:very slight sheet and splash erosion
Rockiness	:nil
Surface stoniness	:nil
Overwash/overblow	:nil
Slope gradient	:1 %
Surface stoniness	:nil
Effective soil depth	:160 cm
Drainage class	:well drained

Horizons:

A	0-35 cm	Dark reddish brown (5YR 3/2, moist); silty loam; moderate, very fine, granular structure; friable when moist, sticky and slightly plastic when wet; many biopores; very frequent, very fine and common fine roots; gradual and wavy transition to:
Bu1	35-100 cm	Dark reddish brown (5YR 3/3, moist); silty clay; moderate very fine to fine subangular blocky structure; patchy, thin clay skins; friable when moist, slightly sticky and slightly plastic when wet; many biopores; few fine and common very fine roots; diffuse and smooth transition to:
Bu2	100-160 cm	Dark reddish brown (2.5YR 3/4, moist); silty clay; moderate very fine subangular blocky structure; friable when moist, slightly sticky and slightly plastic when wet; many biopores; few fine and common very fine roots.

Appendix 2: Mean elemental content (in %)

	SiO_2	Al_2O_3	Fe_2O_3	FeO	SiO_2/ Al_2O_3	SiO_2/ Fe_2O_3	Al_2O_3/ Fe_2O_3
P24							
< 2mm	39.6	29.4	11.6	0.2	1.3	3.4	2.6
< 2um	43.8	35.1	3.5	0.1	1.2	12.8	10.2
gran	39.0	28.9	11.5	0.2	1.3	3.4	2.5
subang.	39.7	29.3	11.5	0.2	1.3	3.4	2.6
P18							
< 2mm	41.2	29.2	11.1	0.1	1.4	3.7	2.6
< 2um	44.9	35.0	3.1	0.1	1.3	14.8	11.5
gran	40.9	29.1	11.1	0.1	1.4	9.8	2.6
subang	40.9	29.2	11.1	0.1	1.4	9.7	2.6
random							
1	39.4	26.7	10.2	0.4	1.5	3.9	2.6
2	38.8	27.8	11.1	0.3	1.4	3.5	2.5
3	38.8	27.8	11.0	0.3	1.4	3.5	2.5
4	38.6	28.5	11.3	0.2	1.4	3.4	2.5
5	39.2	28.7	11.2	0.2	1.4	3.5	2.6
6	38.8	29.0	11.4	0.2	1.3	3.4	2.6
7	39.0	29.0	11.6	0.2	1.3	3.4	2.5

	Fe_2O_3/ FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5
P24							
< 2mm	90.0	0.3	0.3	0.1	0.4	1.4	0.3
< 2um	35.4	0.2	tr	0.1	0.3	0.8	0.3
gran	90.2	0.3	0.3	0.1	0.4	1.3	0.3
subang	87.5	0.3	0.3	0.1	0.4	1.4	0.3
P18							
< 2mm	93.0	0.3	02	0.1	0.4	1.4	0.3
< 2um	30.7	0.2	tr	0.1	0.4	0.9	0.3
gran	111.3	0.3	0.2	0.1	0.4	1.4	0.3
subang	111.3	0.3	0.2	0.1	0.4	1.4	0.3
random							
1	26.9	0.5	1.0	0.1	0.6	1.3	0.8
2	43.5	0.3	0.3	0.1	0.5	1.4	0.4
3	39.9	0.5	0.6	0.1	0.5	1.4	0.4
4	56.3	0.3	0.5	0.1	0.5	1.4	0.3
5	49.9	0.3	0.3	0.1	0.4	1.4	0.3
6	56.8	0.3	0.3	0.1	0.4	1.4	0.3
7	51.4	0.2	0.2	0.1	0.4	1.4	0.3

	MnO	BaO
P24		
< 2mm	0.9	0.1
< 2um	tr	2.6
gran	1.0	0.1
subang	0.9	0.1
P18		
< 2mm	1.1	0.1
< 2um	tr	2.4
gran	1.1	0.1
subang	1.1	0.1
random		
1	0.8	0.1
2	1.0	0.1
3	0.9	0.1
4	1.0	0.1
5	0.8	0.1
6	1.0	0.1
7	0.9	0.1

Appendix 3 a: Elemental content of the disturbed samples P24

P24 Kathageri (disturbed & < 2mm) in %

depth	SiO2	Al2O3	Fe2O3	FeO	MgO	CaO	Na2O
0-15 cm	38.3	27.5	11.1	0.3	0.3	0.6	0.1
15-30 cm	39.4	28.6	11.6	0.2	0.3	0.5	0.1
30-60 cm	39.8	30.0	11.6	0.1	0.3	0.3	0.1
60-120cm	40.1	30.4	11.9	0.1	0.2	0.1	tr
120-200cm	40.4	30.6	12.0	0.1	0.2	0.2	0.1

	K2O	TiO2	P2O5	MnO	BaO	SiO2/ Al2O3	SiO2/ Fe2O3
0-15 cm	0.5	1.4	0.4	1.0	0.1	1.4	3.5
15-30 cm	0.5	1.4	0.4	1.0	0.1	1.4	3.4
30-60 cm	0.4	1.3	0.3	0.9	0.1	1.3	3.4
60-120cm	0.3	1.3	0.2	0.8	0.1	1.3	3.4
120-200cm	0.3	1.4	0.2	0.7	0.1	1.3	3.4

	Al2O3/ Fe2O3	Fe2O3/ FeO
0-15 cm	2.5	37.0
15-30 cm	2.5	58.0
30-60 cm	2.6	116.0
60-120cm	2.6	119.0
120-200cm	2.6	120.0

P24 Kathageri (disturbed & < 2 um) in %

depth	SiO2	Al2O3	Fe2O3	FeO	MgO	CaO	Na2O
0-15 cm	43.9	35.2	3.2	0.1	0.2	tr	0.1
15-30 cm	43.5	34.9	3.8	0.1	0.2	tr	0.2
30-60 cm	44.2	35.3	2.6	0.1	0.2	tr	0.1
60-120cm	43.8	35.3	3.7	0.1	0.2	tr	0.1
120-200cm	43.8	34.8	4.4	0.1	0.2	0.1	tr

	K2O	TiO2	P2O5	MnO	BaO	SiO2/ Al2O3	SiO2/ Fe2O3
0-15 cm	0.4	0.8	0.3	tr	2.1	1.2	13.7
15-30 cm	0.4	0.8	0.3	tr	2.6	1.2	11.4
30-60 cm	0.3	0.7	0.3	tr	2.9	1.3	17.0
60-120cm	0.3	0.8	0.3	0.1	2.4	1.2	11.8
120-200cm	0.3	0.8	0.3	0.1	3.0	1.3	10.0

	Al2O3/ Fe2O3	Fe2O3/ FeO
0-15 cm	11.0	32
15-30 cm	9.2	38
30-60 cm	13.6	26
60-120cm	9.5	37
120-200cm	7.9	44

Appendix 3 b: Elemental content of the disturbed samples P18

P18 Kigumo (disturbed & < 2 mm) in %

depth	SiO2	Al2O3	Fe2O3	FeO	MgO	CaO	Na2O
0-35 cm	40.5	28.3	11.0	0.2	0.3	0.3	0.1
35-100cm	41.5	29.4	11.1	0.1	0.3	0.2	0.1
100-160cm	41.7	29.8	11.3	0.1	0.3	0.2	0.1

	K2O	TiO2	P2O5	MnO	BaO	SiO2/ Al2O3	SiO2/ Fe2O3
0-35 cm	0.5	1.4	0.3	1.1	0.1	1.4	3.7
35-100cm	0.4	1.5	0.3	1.2	0.1	1.4	3.7
100-160cm	0.4	1.4	0.3	1.0	0.1	1.4	3.7

	Al2O3/ Fe2O3	Fe2O3/ FeO
0-35 cm	2.6	55.0
35-100cm	2.6	111.0
100-160cm	2.6	113.0

P18 Kigumo (disturbed & < 2 mu) in %

depth	SiO2	Al2O3	Fe2O3	FeO	MgO	CaO	Na2O
0-35 cm	44.8	34.8	3.5	0.1	0.2	tr	tr
35-100cm	44.9	34.9	2.8	0.1	0.2	tr	0.1
100-160cm	45.1	35.2	2.9	0.1	0.2	tr	0.1

	K2O	TiO2	P2O5	MnO	BaO	SiO2/ Al2O3	SiO2/ Fe2O3
0-35 cm	0.4	0.9	0.3	tr	2.5	1.3	12.8
35-100cm	0.4	0.8	0.3	tr	2.2	1.3	16.0
100-160cm	0.4	0.9	0.3	tr	2.4	1.3	15.6

	Al2O3/ Fe2O3	Fe2O3/ FeO
0-35 cm	9.9	35.0
35-100cm	12.5	28.0
100-160cm	12.1	29.0

Appendix 4 a. Elemental content of the structure elements P24

P24 Kathageri (granular) in %

depth	SiO2	Al2O3	Fe2O3	FeO	MgO	CaO	Na2O
0-15 cm	38.4	27.6	11.3	0.3	0.3	0.6	0.1
30-60 cm	39.6	29.7	11.7	0.1	0.3	0.2	0.1
60-120cm	39.1	29.5	11.6	0.1	0.2	0.2	0.1

	K2O	TiO2	P2O5	MnO	BaO	SiO2/ Al2O3	SiO2/ Fe2O3
0-15 cm	0.5	1.4	0.4	1.1	0.1	1.4	3.4
30-60 cm	0.4	1.3	0.3	0.9	0.1	1.3	3.4
60-120 cm	0.4	1.3	0.3	0.9	0.1	1.3	3.4

	Al2O3/ Fe2O3	Fe2O3/ FeO
0-15 cm	2.4	37.7
30-60 cm	2.5	117.0
60-120cm	2.5	116.0

P24 Kathageri (subangular blocky) in %

depth	SiO2	Al2O3	Fe2O3	FeO	MgO	CaO	Na2O
0-15 cm	38.4	27.5	11.0	0.4	0.3	0.5	0.1
30-60 cm	40.2	30.0	11.7	0.1	0.3	0.2	0.1
60-120cm	40.4	30.4	11.8	0.1	0.2	0.1	0.1

	K2O	TiO2	P2O5	MnO	BaO	SiO2/ Al2O3	SiO2/ Fe2O3
0-15 cm	0.5	1.4	0.4	1.0	0.1	1.4	3.5
30-60 cm	0.4	1.4	0.3	0.9	0.1	1.3	3.4
60-120cm	0.4	1.3	0.3	0.9	0.1	1.3	3.4

	Al2O3/ Fe2O3	Fe2O3/ FeO
0-15 cm	2.5	27.5
30-60 cm	2.6	117.0
60-120cm	2.6	118.0

Appendix 4 b. Elemental content of the structure elements P18

P18 Kigumo (granular) in %

depth	SiO2	Al2O3	Fe2O3	FeO	MgO	CaO	Na2O
0-35 cm	40.6	28.6	11.0	0.1	0.3	0.3	0.2
35-100cm	41.0	29.3	11.2	0.1	0.3	0.2	0.1
100-160cm	41.0	29.5	11.2	0.1	0.3	0.2	0.1

	K2O	TiO2	P2O5	MnO	BaO	SiO2/ Al2O3	SiO2/ Fe2O3
0-35 cm	0.5	1.4	0.3	1.1	0.1	1.4	3.7
35-100cm	0.4	1.4	0.3	1.2	0.1	1.4	3.7
100-160cm	0.4	1.5	0.3	1.0	0.1	1.4	3.7

	Al2O3/ Fe2O3	Fe2O3/ FeO
0-35 cm	2.6	110.0
35-100cm	2.6	112.0
100-160cm	2.6	112.0

P18 Kigumo (subangular blocky) in %

	SiO2	Al2O3	Fe2O3	FeO	MgO	CaO	Na2O
0-35 cm	40.7	28.6	11.1	0.1	0.3	0.3	0.1
35-100cm	41.1	29.5	11.1	0.1	0.3	0.2	0.1
100-160cm	41.0	29.6	11.2	0.1	0.3	0.2	0.1

	K2O	TiO2	P2O5	MnO	BaO	SiO2/ Al2O3	SiO2/ Fe2O3
0-35 cm	0.4	1.4	0.3	1.1	0.1	1.4	3.7
35-100cm	0.4	1.4	0.3	1.2	0.1	1.4	3.7
100-160cm	0.4	1.4	0.3	1.0	0.1	1.4	3.7

	Al2O3/ Fe2O3	Fe2O3/ FeO
0-35 cm	2.6	111.0
35-100cm	2.7	111.0
100-160cm	2.6	112.0

Appendix 4 c. Elemental content of the random samples

Random samples in %

1.Mango

depth	SiO2	Al2O3	Fe2O3	FeO	MgO	CaO	Na2O
0-10 cm	39.2	26.3	10.0	0.5	0.5	1.0	0.2
10-20 cm	39.3	26.2	10.1	0.4	0.5	1.0	0.1
30-40 cm	39.8	27.6	10.6	0.3	0.4	0.9	0.1

	K2O	TiO2	P2O5	MnO	BaO	SiO2/ Al2O3	SiO2/ Fe2O3
0-10 cm	0.6	1.3	0.8	0.8	0.1	1.5	3.9
10-20 cm	0.6	1.3	0.8	0.8	0.1	1.4	3.9
30-40 cm	0.6	1.4	0.7	0.8	0.1	1.4	3.8

	Al2O3/ Fe2O3	Fe2O3/ FeO
0-10 cm	2.6	20.0
10-20 cm	2.6	25.3
30-40 cm	2.6	35.3

2.Firewood

depth	SiO2	Al2O3	Fe2O3	FeO	MgO	CaO	Na2O
0-10 cm	38.4	27.3	11.0	0.3	0.3	0.3	0.1
10-20 cm	38.7	27.6	11.0	0.3	0.3	0.3	0.1
30-40 cm	39.2	28.4	11.4	0.2	0.3	0.3	0.1

	K2O	TiO2	P2O5	MnO	BaO	SiO2/ Al2O3	SiO2/ Fe2O3
0-10 cm	0.5	1.4	0.4	1.0	0.1	1.4	3.5
10-20 cm	0.5	1.4	0.4	1.0	0.1	1.4	3.5
30-40 cm	0.5	1.4	0.3	1.0	0.1	1.4	3.4

	Al2O3/ Fe2O3	Fe2O3/ FeO
0-10 cm	2.5	36.7
10-20 cm	2.5	36.7
30-40 cm	2.5	57.0

3.Coffee

depth	SiO2	Al2O3	Fe2O3	FeO	MgO	CaO	Na2O
0-10 cm	38.3	27..	10.8	0.4	0.5	0.6	0.1
10-20 cm	38.7	27.6	11.0	0.3	0.5	0.6	0.1
30-40 cm	39.4	28.5	11.2	0.2	0.4	0.5	0.1

	K2O	TiO2	P2O5	MnO	BaO	SiO2/ Al2O3	SiO2/ Fe2O3
0-10 cm	0.5	1.4	0.5	0.9	0.1	1.4	3.5
10-20 cm	0.5	1.4	0.4	0.9	0.1	1.4	3.5
30-40 cm	0.5	1.4	0.4	0.9	0.1	1:4	3.5

	Al2O3/ Fe2O3	Fe2O3/ FeO
0-10 cm	2.5	27.0
10-20 cm	2.5	36.7
30-40 cm	2.5	56.0

4. Maize &Beans

depth	SiO2	Al2O3	Fe2O3	FeO	MgO	CaO	Na2O
0-10 cm	38.5	28.3	11.2	0.2	0.3	0.6	0.1
10-20 cm	38.6	28.6	11.3	0.2	0.3	0.5	0.1
30-40 cm	38.7	28.6	11.3	0.2	0.3	0.5	0.1

	K2O	TiO2	P2O5	MnO	BaO	SiO2/ Al2O3	SiO2/ Fe2O3
0-10 cm	0.5	1.4	0.4	1.0	0.1	1.4	3.4
10-20 cm	0.5	1.4	0.3	1.0	0.1	1.3	3.4
30-40 cm	0.4	1.4	0.3	1.0	0.1	1.4	3.4

	Al2O3/ Fe2O3	Fe2O3 FeO
0-10 cm	2.5	56.0
10-20 cm	2.5	56.5
30-40 cm	2.5	56.5

5. Maize

depth	SiO2	Al2O3	Fe2O3	FeO	MgO	CaO	Na2O
0-10 cm	39.0	28.6	11.2	0.3	0.3	0.3	0.1
10-20 cm	39.4	28.3	11.3	0.2	0.3	0.3	0.1
30-40 cm	39.3	29.3	11.2	0.2	0.2	0.2	0.1

	K2O	TiO2	P2O5	MnO	BaO	SiO2/ Al2O3	SiO2/ Fe2O
0-10 cm	0.4	1.4	0.3	0.8	0.1	1.4	3.5
10-20 cm	0.4	1.4	0.3	0.8	0.1	1.4	3.5
30-40 cm	0.4	1.4	0.3	0.8	0.1	1.3	3.5

	AL2O3/ Fe2O3	Fe2O3/ FeO
0-10 cm	2.6	37.3
10-20 cm	2.5	56.5
30-40 cm	2.6	56.0

6. Maize

depth	SiO2	Al2O3	Fe2O3	FeO	MgO	CaO	Na2O
0-10 cm	38.2	28.4	11.3	0.2	0.3	0.3	0.1
10-20 cm	39.0	29.2	11.4	0.2	0.3	0.4	0.1
30-40 cm	39.2	29.4	11.4	0.2	0.3	0.3	0.1

	K2O	TiO2	P2O5	MnO	BaO	SiO2/ Al2O3	SiO2/ Fe2O3
0-10 cm	0.4	1.4	0.3	1.0	0.1	1.3	3.4
10-20 cm	0.4	1.4	0.3	1.0	0.1	1.3	3.4
30-40 cm	0.4	1.4	0.3	1.0	0.1	1.3	3.4

	Al2O3/ Fe2O3	Fe2O3/ FeO
0-10 cm	2.5	56.5
10-20 cm	2.6	57.0
30-40 cm	2.6	57.0

7. Maize

depth	SiO2	Al2O3	Fe2O3	FeO	MgO	CaO	Na2O
0-10 cm	38.9	28.9	11.5	0.3	0.3	0.2	0.1
0-20 cm	39.1	29.0	11.6	0.2	0.2	0.2	tr
30-40 cm	39.1	29.2	11.6	0.2	0.2	0.2	0.1

	K2O	TiO2	P2O5	MnO	BaO	SiO2/ Al2O3	SiO2/ Fe2O3
0-10 cm	0.4	1.4	0.3	1.0	0.1	1.3	3.4
10-20 cm	0.4	1.4	0.3	0.9	0.1	1.3	3.4
30-40 cm	0.4	1.4	0.3	0.9	0.1	1.3	3.4

	Al2O3/ Fe2O3	Fe2O3 FeO
0-10 cm	2.5	38.3
10-20 cm	2.5	58.0
30-40 cm	2.5	58.0

Appendix 5 : Mean chemical content (in % & mmol.kg-1)

	org.carb.	nitrogen	C/N	pH(H2O)	pH(CaCl2)	Basesat	CEC
P24							
dist.	1.7	0.2	9.5	6.3	5.8	25	161
gran.	2.1	0.2	9.7	6.4	6.0	21	184
subang.	1.8	0.2	8.7	6.2	5.7	21	157
P18							
dist.	1.4	0.1	9.7	6.0	5.3	17	164
gran.	1.3	0.1	9.5	6.0	5.2	17	168
subang	1.2	0.1	9.2	6.0	5.2	17	168
random							
1	4.0	0.4	11.6	6.9	6.3	37	214
2	3.2	0.4	7.9	6.2	5.6	34	145
3	3.3	0.4	10.0	6.5	6.0	31	182
4	2.7	0.3	8.9	6.4	5.8	31	166
5	2.6	0.3	9.8	5.8	5.1	21	148
6	2.5	0.3	8.8	6.1	5.6	43	142
7	2.4	0.3	8.3	5.6	4.9	25	135

	Ca2+	Mg2+	Na+	K+	sum bases	H2O-
P24						
dist.	26	5	3	7	41	12.1
gran.	27	5	2	6	39	8.5
subang.	26	5	2	4	36	8.6
P18						
dist.	19	5	2	3	16	6.1
gran.	21	5	< 1	1	28	10.0
subang.	21	6	< 1	2	29	10.0
random						
1	58	5	8	9	80	13.9
2	34	4	1	10	48	14.7
3	43	5	2	7	56	9.0
4	40	3	< 1	4	47	4.8
5	24	5	1	2	30	4.2
6	22	3	2	35	62	4.9
7	16	4	< 1	13	33	3.8

Appendix 6a:Chemical content of the disturbed samples P24 & P18 (in % & mmol.kg-1)

P24 Kathageri (disturbed)

depth	org.carb.	nitrogen	C/N-ratio	pH(H2O)	pH(CaCl2)	Basesat.	CEC
0-15 cm	3.5	0.3	11.6	6.3	5.8	32	211
15-30 cm	2.4	0.2	10.1	6.5	5.9	33	203
30-60 cm	1.2	0.1	8.9	6.5	5.9	30	135
60-120cm	0.7	0.1	8.1	6.0	5.5	16	137
120-200cm	0.6	0.1	8.8	6.0	5.7	15	121

	Ca2+	Mg2+	Na+	K+	sum bases	H2O-
0-15 cm	42	8	4	13	67	5.1
15-30 cm	48	8	2	8	66	4.5
30-60 cm	19	3	3	6	31	5.9
60-120cm	14	4	< 1	4	22	23.8
120-200cm	9	3	< 1	5	18	21.1

P18 Kigumo (disturbed)

depth	org.carb.	nitrogen	C/N-ratio	pH(H2O)	pH(CaCl2)	Basesat.	CEC
0-35 cm	2.1	0.2	8.3	5.6	5.0	20	196
35-100cm	1.3	0.1	11.0	6.1	5.3	14	163
100-160cm	0.7	0.1	9.8	6.2	5.6	16	133

	Ca2+	Mg2+	Na+	K+	sum bases	H2O-
0-35 cm	29	7	2	2	4	2.8
35-100cm	16	5	< 1	< 1	23	12.5
100-160cm	11	4	2	4	21	2.9

Appendix 6 b:Chemical content of the structure elements P24 & P18
(in % & mmol.kg-1)

P24 Kathageri (granular)

depth	org.carb.	nitrogen	C/N-ratio	pH(H2O)	pH(CaCl2)	Basesat.	CEC
0-15 cm	3.6	0.3	11.1	6.5	5.9	25	212
30-60 cm	1.5	0.2	9.3	6.4	6.0	25	162
60-120cm	1.2	0.2	8.8	6.4	6.0	13	178

depth	Ca2+	Mg2+	Na+	K+	sum bases	H2O-
0-15 cm	38	5	3	7	53	4.3
30-60 cm	27	6	< 1	7	41	3.6
60-120cm	15	5	1	3	24	17.6

P24 Kathageri (subangular blocky)

depth	org.mat.	nitrogen	C/N-ratio	pH(H2O)	pH(CaCl2)	Basesat.	CEC
0-15 cm	3.4	0.3	10.2	6.4	5.8	29	204
30-60 cm	1.1	0.1	8.1	6.3	5.7	17	142
60-120cm	0.9	0.1	8.3	5.8	5.2	17	121

depth	Ca2+	Mg2+	Na+	K+	sum bases	H2O-
0-15 cm	47	6	4	6	60	4.6
30-60 cm	18	5	< 1	3	27	12.6
60-120cm	14	4	< 1	2	21	8.6

P18 Kigumo (granular)

depth	org.mat.	nitrogen	C/N-ratio	pH(H2O)	pH(CaCl2)	Basesat.	CEC
0-35 cm	1.9	0.2	11.2	5.8	5.1	19	172
35-100cm	1.2	0.1	9.3	6.0	5.2	17	179
100-160cm	0.8	0.1	8.0	6.3	5.3	15	154

depth	Ca2+	Mg2+	Na+	K+	sum bases	H2O-
0-35 cm	23	6	< 1	2	32	4.3
35-100cm	23	5	< 1	< 1	30	4.8
100-160cm	16	4	< 1	< 1	22	20.9

P18 Kigumo (subangular blocky)

depth	org.mat.	nitrogen	C/N-ratio	pH(H2O)	pH(CaCl2)	Basesat.	CEC
0-35 cm	1.9	0.2	11.1	5.9	5.0	19	181
35-100cm	1.0	0.1	8.3	5.9	5.2	17	175
100-160cm	0.7	0.1	8.1	6.2	5.4	16	147

depth	Ca2+	Mg2+	Na+	K+	sum bases	H2O-
0-35 cm	25	7	< 1	< 1	34	7.0
35-100cm	21	6	< 1	2	30	4.5
100-160cm	16	5	< 1	2	24	18.5

Appendix 6 c. Chemical content of the random samples (in % & mmol.kg-1)

Random samples

1. Mango

depth	org.mat.	nitrogen	C/N-ratio	pH(H2O)	pH(CaCl2)	Basesat.	CEC
0-10 cm	4.3	0.4	10.8	6.8	6.2	43	226
10-20 cm	4.6	0.4	13.1	6.8	6.3	32	225
30-40 cm	3.1	0.3	10.8	7.0	6.4	36	192

	Ca2+	Mg2+	Na+	K+	sum bases	H2O-
0-10 cm	65	5	17	11	98	11.4
10-20 cm	62	6	< 1	5	73	17.0
30-40 cm	47	5	5	12	69	13.4

2. Firewood

depth	org.mat.	nitrogen	C/N-ratio	pH(H2O)	pH(CaCl2)	Basesat.	CEC
0-10 cm	3.5	0.5	7.9	6.1	5.6	33	123
10-20 cm	3.4	0.5	7.9	6.2	5.6	29	171
30-40 cm	2.6	0.3	7.8	6.2	5.5	40	140

	Ca2+	Mg2+	Na+	K+	sum bases	H2O-
0-10 cm	31	2	< 1	8	41	10.1
10-20 cm	37	5	< 1	6	48	15.1
30-40 cm	34	5	2	15	56	18.8

3. Coffee

depth	org.mat.	nitrogen	C/N-ratio	pH(H2O)	pH(CaCl2)	Basesat.	CEC
0-10 cm	3.9	0.4	10.5	6.3	5.7	29	186
10-20 cm	3.3	0.4	9.5	6.6	6.1	35	187
30-40 cm	2.7	0.3	10.0	6.7	6.1	28	174

	Ca2+	Mg2+	Na+	K+	sum bases	H2O-
0-10 cm	43	4	< 1	6	53	4.8
10-20 cm	47	6	3	9	65	4.2
30-40 cm	38	5	< 1	6	49	18.0

4. Maize & Beans

depth	org.mat.	nitrogen	C/N-ratio	pH(H2O)	pH(CaCl2)	Basesat.	CEC
0-10 cm	3.0	0.3	8.9	6.3	5.8	22	186
10-20 cm	3.1	0.3	10.1	6.4	5.8	45	104
30-40 cm	2.1	0.3	7.6	6.4	5.9	25	208

	Ca2+	Mg2+	Na+	K+	sum bases	H2O-
0-10 cm	33	3	< 1	5	41	4.6
10-20 cm	42	2	< 1	3	47	4.3
30-40 cm	44	5	< 1	3	52	5.6

5. Maize

depth	org.mat.	nitrogen	C/N-ratio	pH(H2O)	pH(CaCl2)	Basesat.	CEC
0-10 cm	2.6	0.3	9.4	6.0	5.2	22	144
10-20 cm	2.6	0.3	9.4	5.8	5.1	20	153
30-40 cm	2.5	0.2	10.7	5.7	5.0	20	146

	Ca2+	Mg2+	Na+	K+	sum bases	H2O-
0-10 cm	26	5	< 1	< 1	31	3.6
10-20 cm	22	4	2	3	31	4.2
30-40 cm	24	5	< 1	< 1	29	4.8

6. Maize

depth	org.mat.	nitrogen	C/N-ratio	pH(H2O)	pH(CaCl2)	Basesat.	CEC
0-10 cm	2.4	0.3	8.6	6.4	5.9	57	149
10-20 cm	2.5	0.3	8.7	5.9	5.4	37	140
30-40 cm	2.6	0.3	9.2	6.1	5.5	35	137

	Ca2+	Mg2+	Na+	K+	sum bases	H2O-
0-10 cm	26	5	< 1	54	85	3.9
10-20 cm	22	2	< 1	28	52	4.4
30-40 cm	19	3	3	23	48	6.4

7. Maize

depth	org.mat.	nitrogen	C/N-ratio	pH(H2O)	pH(CaCl2)	Basesat.	CEC
0-10 cm	2.5	0.3	7.5	5.6	4.9	29	133
10-20 cm	2.4	0.3	8.1	5.7	5.0	27	131
30-40 cm	2.2	0.2	9.2	5.6	4.9	18	141

	Ca2+	Mg2+	Na+	K+	sum bases	H2O-
0-10 cm	14	3	< 1	21	38	3.5
10-20 cm	17	3	< 1	16	36	3.8
30-40 cm	18	5	< 1	3	26	4.0