Tropical and Subtropical Agroecosystems

INTEGRATING INDIGENOUS SOIL AND LAND CLASSIFICATION SYSTEMS IN THE IDENTIFICATION OF SOIL MANAGEMENT CONSTRAINTS IN THE TROPICS: A KENYAN CASE STUDY

[INTEGRACION DE LA CLASIFICACION INDIGENA DE SUELOS Y TIERRAS EN LA IDENTIFICACION DE LIMITANTED DEL MANEJO DE SUELOS EN EL TROPICO: ESTUDIO DE CASO EN KENYA]

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SUMMARY

A field study was conducted in Kenya to capture the farmers' indigenous soil and land classification systems towards identification of soil management constraints and opportunities. The study was conducted through farmer group meetings (based on gender) and also through transects walk. The results of the study indicated that farmers name soils on the basis of color, texture and coarseness or a combination of any two criteria. Further, they describe the soils on the basis of a number of characteristics namely stickiness, hardness, water retention capacity, drainage, erodibility, cracking, fertility and the best time to plough. The result of the gender perspective on soil classification showed that the females recognized more soil types than men as they were involved in more farm activities, especially planting, weeding, terrace making and even to some extent, ploughing. The study also showed that farmers possess a lot of practical knowledge on tillage, management, protection and productivity of the soil. This is based on a long experience with local soil types, their uses and management spanning several generations. Capturing such indigenous knowledge is useful to the scientists as a quick means of gathering data on land management for more responsive research and development activities. Further, there is a sense of belonging among farmers during technology development and transfer, thus leading to enhanced adoption by farmers.

Key words: Indigenous soil knowledge; Farmers criteria; Soil management

RESUMEN

Se efectuó un estudio de campo en Kenya para registrar los sistemas indígenas de clasificación de suelos y tierras para la identificación de limitantes y oportunidades en el manejo de los suelos. El estudio fue realizado mediante reuniones con campesinos en grupos (basados en género) y también mediante la caminata en transectos. Los resultados mostraron que los campesinos nombran los suelos basados en color, textura y tamaño de partícula ó una combinación de dos criterios cualquiera. Más aún, describen los suelos en función de varias características como dureza, capacidad de retención de agua, drenaje, fertilidad, predisposición a la erosión y mejor tiempo para arar entre otros. Desde la perspectiva de género, se encontró que las mujeres reconocen más tipos de suelos que los hombres, dado que están involucradas en más actividades agrícolas, especialmente siembre, deshierbe, preparación de terrazas y incluso arado. El estudio mostró que los campesinos poseen conocimiento práctico en labranza, manejo, protección y productividad del suelo que tiene como base la experiencia con los suelos locales, sus usos y manejo, el cual ha sido transmitido por varias generaciones. Registrar este tipo de conocimiento indígena es útil para los investigadores como medio de colecta rápida de información en manejo de suelo. Más aún, existe un sentimiento de pertenencia entre los campesinos durante el proceso de desarrollo y transferencia de tecnología que conduce a una mejor adopción.

Palabras clave: Conocimiento indígena, criterio campesino, manejo de suelo.

INTRODUCTION

In recent years, there has been a lot of re-thinking in soil research with regard to the management of natural resources of the tropics as involvement of farmers can provide important and consistent information about the land they live on. They can provide information on soil types and their management practices, constraints and opportunities that exist for their sustainable management. Conventional research by soil scientists and strategies that are recommended by rural development agencies more often than not tend to overlook the importance of indigenous soil management practices.

Based on experience with local soil and land types over several generations, farmer's store of practical knowledge can be of tremendous benefit to the soil scientists and other researchers in the formulation of research strategies and interventions. Soil scientists acquire knowledge in their study areas within a relatively short time by conducting quick surveys, sampling and classification of the soil according to some national and international standards. As Guarino (1995) stated, indigenous knowledge (IK) is increasingly being recognized as crucial in agricultural research, extension and development in general. This is because the farmers who are everyday users of soil resources in their localities have information on:

- vernacular names of soils and land types
- the appearance, properties and uses of the soils
- the places where they are found
- the agricultural and management practices which are associated with these soils.

Local soil names and the knowledge that farmers possess for each soil are extremely useful though they have their limitations, especially if one tries to regionalize local names (Tabor *et al.,* 1990). Some soils are well defined and correlated, even across language groups, while others revolve around some general concepts. One reason for this is the extreme complexity and variability of soils. The other reason maybe attributed to newly settled farmers who know very little about the soils in their area of operation.

Although the farmers know their soils well, the names are not applicable globally or even on a regional scale. For example, farmers in Wera and Toroma sub-counties in the semi-arid lands of Lake Kyoga in Uganda use the terms "hot" or "cold" to describe the water-holding capacity of the soils (Tenywa *et al.,* 1999). Waterlogged soils are described as "cold". But farmers in Haiti use the word "hot" to describe soils that occur in the semi-arid areas (Tabor *et al.,* 1990). They also denote the fertile soils as "fat". The integration of such localized land classification systems by soil scientists and extension agents enhances the quality of research and extension activities with regard to soil management and conservation.

It is in view of the above that a participatory research study was conducted by an interdisciplinary team of scientists with the following objectives:

(i) To capture the indigenous soil and land classification systems that farmers use
(ii) To identify the uses, management practices and constraints of the soils

METHODS

The study was carried out in a sub-location called Kasikeu in Makueni District, Kenya. The sub-location is the lowest administrative area in Kenya and it was expected that the community of farmers living here would have less diversity in the classification of soils and land types. Focussed farmer group meetings involving both men and women farmers were held in order to obtain information on the farmer's knowledge on soils and their management.

Farmers were put into discussion groups to assist them not only to share indigenous knowledge among themselves, but also enable them bring out the constraints and opportunities in soil management. This process gave researchers and extension agents the opportunity to study the farmer's circumstances and obtain reasons for most of their activities. At these meetings, the farmers listed (through visualization) the major criteria they use in distinguishing soils. They further listed the characteristics they use in describing the soils. The soil types were named and described extensively by listing the major uses, management practices and constraints per soil type. For purposes of capturing gender perceptions on soil types, the research team divided the farmer group into a males and females groups. The teams were later combined so as to discuss and compromise on the differences of information they had generated.

To enable the verification of collected information, transect walks were conducted by the farmers for the researchers and extension's to observe as many soils units as possible. The transect walk routes were selected by farmers. The major aspects for verification were the soil types, land use and soil management practices. On-site discussions were held by the whole group. As the farmers located the soil units, profile pits were dug and a soil scientist described and collected soil samples for laboratory analysis and classification.

RESULTS AND DISCUSSIONS

Indigenous soil classification system

Farmers in Kasikeu base their broad soil classification system mainly on color, texture and coarseness just like other regions in the tropics (Tabor *et al.*, 1990; Kante and Defoer, 1994; ICRA, 1998, Tenywa *et al.*, 1999). The farmers in Kasikeu name the soils on the basis of these major criteria or a combination of any two. These criteria are important to the farmer in the sense that they are visible and practical in terms of his management of the soils in the course of crop production.

In terms of color, the farmers classify the soils according to red, black, brown and white with grades of each color for comparison purposes e.g. very red or very black. However, the farmers do not have names for such grades. As Tabor *et al.* (1990) found out in the Eastern Province of Kenya, farmers throughout this region distinguish similar types of soil and group them according to their management. These soil groups usually include numerous soils with different scientific classifications. This apparent consistency is because the scientific classification distinguishes soil complexes while farmers' classification does not (ICRA, 1998).

In terms of texture, the farmers classify the soil on the basis of the sand and clay content. A combination of the two forms the basis for naming a soil. As Kante and Defoer (1994) found out in southern Mali, the texture of the topsoil is also used to differentiate between land types. In this way, using this textural differentiating criterion, sandy soils are called *Guechiens* and clayey soils, *Tiogo* in Mali. The degree of soil adhesion to tillage implements can be a hindrance and this, to a large extent is dependent on texture. Coarseness is used further to differentiate the red soils of Kasikeu. Cultivation of such soils requires the removal of the coarse elements (usually gravel).

Farmers in Kasikeu further described soils according to a number of characteristics which are stickiness, hardness, water retention capacity, drainage, erodibility, cracking, fertility and the best time to plough the soil. Apart from the major criteria and characteristics used in naming a soil type, farmers also describe a soil in terms of management constraints, and practices (to overcome the constraints) and their position on the catena.

The farmers' knowledge on soils differed according to gender. Using local names, the women identified nine soil types that are present in their location: *Kitune, Kitune na mavia, Ikala, Ilivi, Nthangathi nzau, Nthangathi nziu, Yumba, Malamu* and *Mavia.* The men recognized only five soil types namely *Ikala, Yumba, Nthangathi nziu, Nthangathi nzau* and *Kitune*. Therefore the men did not recognize the existence of *Kitune na mavia, Ilivi, Malamu* and *Mavia*. Upon the whole group discussing, they agreed on the nine soil types named by the women. During the discussions, the men concurred with the women that *Ikala* and *Ilivi* soils are two distinct types. While each group had indicated that *Ilivi* soil occurs exposed, upon discussing together they agreed that *Ilivi* occurs as a buried horizon under *Nthangathi nzau.* The men had also indicated *Kitune* as the dominant soil type, whereas the women had indicated *Nthangathi nziu*. But on discussing as a whole group, they agreed that *Nthangathi nziu* is the dominant soil type.

On the basis of the above mentioned major criteria and soil characteristics, the farmers described the nine soil types as shown in Table 1. The scientific classification identified the major soils as *Kitune* (Haplic Ferralsol), *Kitune na mavia* (Haplic Lixisol rudic phase), *Ikala* (Eutric Vertisol), *Ilivi* (Chromic Vertisol), *Nthangathi nzau* (Luvic Arenosol), and *Nthangathi nziu* (Haplic Lixisol). The scientific classification of *Yumba* was not done since the soil was not sampled due to inaccessibility of the soil unit. *Malamu* and *Mavia* were not sampled either as they are ironstones and stones/rocks respectively.

Soil types and their management constraints

The soils of Kasikeu may be grouped into three major categories namely: red, black and sandy soils.

Red soils

These soils are deep, reddish in color and are known as *Kitune* (red). However, the red soils with stones in the profile are called *Kitune na mavia*. Generally, these are deep soils (>120 cm) found on uplands and high on the slope but *Kitune na mavia* has a stony to gravelly layer near the surface. They become sticky when wet and hard when dry and thus pose some limitations to farming operations. Laboratory analysis of these soils showed a high clay content which could be the primary cause of the stickiness and hardness. Ploughing by farmers becomes only possible after the onset of the rains since the soil moisture at this time is just enough to soften the soil. *Kitune na mavia* poses problems in ploughing and other farming operations unless the stony layer is broken and stones removed. Due to their position on the catena, these soils are well drained and have good water retention capacity. According to the farmers, these soils do not give good crop yields unless manure and fertilizer are added. This is because the soils are highly eroded in places where there are no bench or stone terraces. The laboratory analysis results showed that the soils have a low CEC (9.6 – 19.0 me/10g) and low organic matter (0.42 – 0.91% C).

Table 1: Criteria and characteristics farmers use in classifying soil types in Kasikeu Sub-location.

	Soil types						
Major criteria	*Kitune*	*Kitune na mavia*	*Ikala*	*Ilivi*	*Nthangathi nzau*	*Nthangathi nziu*	*Yumba*
Color	Red	Red	Black	Black	Whitish	Brown	Black
Texture	Clay	Clay	Clay	Clay	Sandy	Sandy	Clay
Coarseness	None	Coarse elements	None	None	None	None	None
Characteristics Stickiness	Sticky	As Kitune	Very sticky	Very sticky and slippery	Non-sticky and loose when dry	Very sticky	Very sticky
Hardness	Hard	As Kitune	Very hard	Hard	Soft	Very hard	Very soft
Water retention capacity	Good	As Kitune	Better than Ilivi	Good	Very low	Less than Kitune	Good
Drainage	Good	As Kitune	Poor	Poor	Good	Good	Poor
Erodibility	Easily eroded on slopes	As Kitune	Easily eroded into gullies	Less erodible than sandy and Kitune soils	High	More than Kitune	Poor
Cracking	None	As Kitune	Cracks	None	None	None	None
Fertility	More fertile than sandy soils	As Kitune	Good	More fertile than sandy and Kitune soils	Very poor	Less fertile than Kitune	Not determined
Management constraints	-Difficult to plough when too wet or dry -Moderate fertility (higher than sandy soil)	-Difficult to plough when too wet or dry -Soil is coarse with stones	-Difficult to plough when wet or dry -Prone to river/flood water erosion	-Buried under sand and thus not suitable for shallow-rooted crops -Needs addition of manure to replenish fertility	-Very low fertility and low water retention capacity -Prone to water erosion	-Difficult to plough when dry -Moderate fertility -Prone to water erosion	-Very sticky -Retains water
Management practices to overcome the constraints	-Ploughing after light rains -Manure application is less frequent than sandy soils (once in 2 yrs) -Bench terraces with grass/trash line on slopes	-Same as Kitune but in addition removal of stones to make stone terraces	-Ploughing after light rains -Generally no manure application -Grass strips/stone lining is needed near river bed	-Digging very deep pits to reach the soil type to plant bananas and sugarcane -Addition of manure and trash in the pits	-Ploughing after rains -Manure for vegetables only and is required every year -Grass strips for erosion control -Bucket irrigation for vegetables	-Ploughed after rains -Manure is required every two years -Bench terraces required -Grass/trash lines required on slopes	Crops not grown
Position on catena	Mainly on mid-slopes but may be on the plains	Upper slopes	Plains	Plains (near the river but beneath Nthangathi nzau)	Next to rivers	Everywhere	Lower slopes

Black soils

The soils that farmers classify as black are soils which range from dark brown to black and are mostly found on the plains. These are: *Ikala, Ilivi, Nthangathi nziu* and *Yumba* (Table 1). They are very deep (> 120cm) and have clay texture which makes them very sticky and slippery when wet. Due to the clay content particularly the swell-shrink type, these soils become very hard on drying to the extent of developing big cracks (except *Ilivi* soils which never crack even on exposure due to erosion). These black soils become waterlogged after excessive rainfall. Therefore, farming operations are only possible under moderate moisture conditions.

Because of their physiographic position (on lower slopes) on the catena and inherent characteristics, the farmers consider them to be more fertile than the red soils. The fertility is based on the luxuriant growth of weeds which they consider as indicators of high fertility. Such weeds are *Cyperus rotundus, Galinsoga parviflora, Datura stramonium* and *Amaranthus* species.

Depending upon some physical characteristics, the farmers categorize the black soils into *Ikala, Ilivi* and *Yumba*. The main differentiating characteristic between *Ikala* and *Ilivi* is that *Ikala* soil develops cracks when dry while *Ilivi* does not. Further, *Ilivi* is found mostly along the rivers and streams and it is usually buried under sand. *Yumba* soils are found in small isolated pockets only, and are non-cracking, very soft clay and shiny. They are primarily used for pottery.

Sandy soils

Sandy soils are locally known as *Nthangathi*. However, using colour as a differentiating criterion, the terms *nziu* (brown) and *nzau* (white) are used to distinguish between the two types. Combining these criteria, one type is called *Nthangathi nziu* (brown sandy soil) and the other, *Nthangathi nzau* (white sandy soil). The former soils maybe found everywhere along the catena (from top of hills to plains). On the summits, it occurs as a very shallow (30cm), coarse-textured soil, mixed with rocks and boulders. The shallowness is the result of a long period of erosion. On the foot slopes and plains, it is deep, more clayey in texture. Better crop yields are obtained when improved management practices are adopted. Due to the low clay content, these soils are slightly sticky when wet and hard when dry and can only be ploughed only after onset of the rains. *Nthangathi nzau* are whitish soils found mostly near the streams and rivers. They are almost pure sand, poor in water retention capacity and fertility status. Due to high water table (about 2 m) on the plains, vegetable growing is done here by bucket irrigation and manure is applied every year.

A similar ethno-pedology study was done by Tabor *et al.* (1990) in the Embu, Meru, Machakos and Kitui Districts of Kenya. The purpose of the study was to get an insight into the agricultural, social and environmental conditions of the districts and to describe the local land classification systems of some of the ethnic groups that live in these districts. They were to further correlate the local classification systems to the FAO system. The results of the study are presented in Table 2. The table describes the soil groups and their management constraints and opportunities as perceived by the Meru, Mbeere, Kamba and Maasai ethnic groups who live in the above districts. The table shows that some soil names are the same cross some ethnic groups and that farmers possess important clues to the most limiting aspects of land management which would assist the soil scientists identify suitable agricultural interventions for the farmers' benefit, in a relatively short time.

CONCLUSIONS AND RECOMMENDATIONS

Overall, agricultural production can be improved more effectively if the soil surveyors, extensions and researchers integrated indigenous soil and land classification systems into their work. As results of this study showed, farmers were engaged willingly as active players during data collection so as to provide indigenous location-specific information on soils and their management practices, problems, causes and opportunities. This is because, at farm level, the farmers knew in detail the soil types occurring on their farms, their uses and management. This is due to the fact that they have lived and worked on the soils for a long period. The scientists on the other hand were endowed with scientific knowledge and facilities to analyze the soils and provide analytical information to complement the farmers' knowledge on aspects the farmers could not interpret.

Soil surveys are generally expensive and using indigenous systems of soil and land classification can save the soil scientists an incredible amount of time and money. In this study, the researchers and extension's used village and farmer interviews to rapidly identify all the soils that are of importance to the farmer and determine each soil's relative productivity. Collecting this information, along with a wealth of other natural resource information, would require a large amount of time and expense if the soil scientists worked independently of the farmers.

Table 2: Local soil types, their management constraints and opportunities as identified by some ethnic groups of Kenya

Soil group	FAO classification	Local name(s) and ethnic tribes	Constraints	Opportunities
Salty soils	Mollic Solonchak	Empulia (Maasai) King'enyo (Mbeere) Kithaio (Kamba) Munyu (Meru)	-Gully erosion due to high sodium contents -Can cause sores on animal lips	A source of salt for livestock and wildlife
Dark brown to black clayey soils with vertic properties	Pellic Vertisols	Enkusero (Maasai) Nthaka (Mbeere) Ilimba (Kamba) Gitaka (Meru)	Cash crops like coffee cannot be grown	Agriculturally good to marginal for mainly annual crops
Dark brown or black soils that do not have vertic properties	(Not determined)	Rurii (Mbeere)	Poorly drained (depressions) and prone to flooding	Fertile agricultural soils because of deposition of erosion material
Dark brown or black soils that occasionally flood	Chromic Vertisol	Ilivi (Kamba) Kianda (Meru)	Are prone to flooding during heavy rains	Very good agriculturally because of loamy textures. The soils are also fertile.
Sandy loam to loamy soils	Chromic Vertisol	Nthangathi (Meru, Mbeere, Kamba) Oloibor enterit (Maasai)	Drainage problems during heavy rains becoming marginal to fair agriculturally	-Best agricultural soils during the light rainy season for sweet potatoes and cassava.
Pure alluvial sand	Luvic Arenosol	Kithangathi (Kamba) Muthanga (Meru, Mbeere) Osunyai (Maasai)	Coarse and fine gravels	Used for construction
Red deep soils	Rhodic Ferrasol	Gitune (Meru) Ituuru (Mbeere) Kitune (Kamba) Olodo enterit (Maasai)	-Fertilizer has to be used to maintain good crop yields -Soil conservation structures have to be used	Have good soil structure (considered best agricultural soils over all for all crops)
Red clayey subsurface material	(Not determined)	Yumba (Kamba, Meru, Mbeere)	Rare in occurrence and not cultivated	Used for pottery because it does not crack when dry
Gravelly or Lateric soils	Orthic Ferrasol	Kibuthi (Mbeere) Kivuthi (Kamba) Olkarrkar (Maasai) Malamu (all tribes)	Low agricultural potential because of low fertility and gravels	A deep non-gravelly surface which makes them fair to good agriculturally

Soil classification names by farmers were based mainly on top soil characteristics. The scientific classification on the other hand is based on national and international standards which can disregard separation of soil units on the basis of characteristics important to the farmer. To this regard, farmers in Kasikeu pointed out some of the characteristics that are important to them, and which needs a soil scientist to emphasize when conducting a soil profile description. Some of the information they felt was important to them was:

1. The topsoil observations and soil analysis for fertility status, and the type of fertilizer to apply during planting and top-dressing especially for maize.
2. Scientists should emphasize soil sampling in the major occurring soils since the results will benefit more farmers.
3. Depth – it will indicate the types of crops that can be grown.
4. Porosity – to indicate aeration of lower horizons and thus penetration of roots.
5. Salinity tests of the soils – to know whether the soils are saline.

Further knowledge generated by farmers and scientists is that they identified agricultural technologies that farmers in Kasikeu needed as a way of enhancing agricultural production from their soils. These technologies were to be based on:

- the enhancement of quality and quality of organic fertilizers
- the efficient use of inorganic fertilizers
- methods for introduction of suitable crop rotations
- integrated nutrient management
- water harvesting and deep tillage
- diversification of farming systems

The sharing of information between scientists and farmers and the appreciation of each others' knowledge underscored the fact that both farmers and scientists need each other. This is because the farmers possessed important clues for the most limiting aspects to land management which assisted the scientists to identify further research areas so as to provide agricultural interventions which could be implemented by the farmers. The results of the study thus showed that the generation of information on soils should start with farmers and be complemented by the scientist's knowledge through analytical and other scientific information.

ACKNOWLEDGEMENTS

The authors acknowledge with much appreciation the cooperation of the untiring farmers of Kasikeu during data collection and the assistance offered by the local administration.

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Submitted January 6, 2005 - Accepted May 9, 2005
Revised received May 24, 2005