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FARMER SELECTION OF BIO-PHYSICAL DIVERSITY FOR AGRICULTURAL LAND USES IN DISSECTED HIGHLAND PLATEAUS OF MBARARA, UGANDA

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ABSTRACT

Dissected Highland plateaus of Mbarara district are found in Isingiro and Rwampara counties. They are characterised by high altitude ranges of 1300 – 1800 m above sea level, with steeply sloping hills and ridges, V and U-shaped valleys, and rapid increase in human populations. Such land resources are considered fragile as far as agricultural land use is concerned. Farmers in this area are capable of selecting and manipulating the biophysical conditions of land to meet their increasing needs for food and cash. This work, done in Bugamba, Mwizi, Birere and Kabingo subcounties of Mbarara district aimed at assessing biophysical diversity of the area and indigenous knowledge on utilising it for crop production. The participatory approaches of community workshops and walk transects were employed.

Results indicated that communities are knowledgeable of and able to classify the variability in the landscape types of their area as Hilltops and Shoulders (Ebibungo), Backslopes (Obushozi/Obushumo), Footslopes (Hansi ye' mishozi) Ravines (obuhanga), plains (empita) and Valleys (Empanga). They were able to match the soils with landscape types. Farmers were found to effectively select among these diversities and to utilise them appropriately for crop and livestock production. They grow most of the annual crops on hilltops, perennials (bananas and coffee) on footslopes and valleys and they keep most of the backslopes and plains for grazing livestock. However, where there is shortage of land because of increased population, especially in Mwizi, farmers have attempted growing all the crop diversity and other land uses on all landscape types even on very steep (slope gradient 30 - 70%) backslopes. This enriches the agrodiversity of the region.

Key words: Agrodiversity, Indigenous knowledge, coping strategies, Landscape types, Farmers' soil classification

INTRODUCTION

Biophysical diversity is a major element of Agrodiversity (Brookfield and Padoch 1994) and it includes variations in landscapes, soil characteristics and their productivity as well as the diversity of natural or spontaneous plant life and of the soil biota. Farmers select among this natural diversity for various land uses and they often manipulate it substantially to meet their production and development needs.

The complex landscapes and the demographically and socio-economically dynamic agricultural ecosystems of East Africa pose special challenges to efforts of developing sustainable land management systems. Steeply sloping hilly and mountainous landscapes are known to be susceptible to land degradation processes and therefore classified as marginal lands as far as suitability for agricultural land use is concerned.

Nevertheless, it has been observed that the mountainous ecosystems in East Africa are the ones that carry the highest population densities and also the most intensively cultivated (MAAIF, 1992) and yet the predicted environmental degradation disasters and severe famines have never occurred (Lindblade, Craswell and Tumuhairwe 1998). Lindblade *et al* discovered that rural communities of such fragile environments develop coping strategies for their survival. What is not clear is how such communities ensure sustainability of their land use systems.

It has dawned on natural resource management scientists and policy makers that indigenous knowledge of the land users is a very valuable resource and that participation of the local communities and individual farmers in all processes of technology development is the key to sustainability of any environmental and user friendly land development strategies. It is important to tap this indigenous knowledge through, first documenting it and later on building on it by working with the farmers to develop models of sustainable land use.

In order to be able to plan for sustainable use of land, there is need to characterize the system including indigenous knowledge and innovations. This is then followed by participatory development of appropriate land management technologies. This paper reports preliminary results of participatory assessment of the way farmer communities in the dissected highland plateaus of Mbarara select and use the biophysical diversity for agricultural landuses. This is a first step in participatory development of models for sustainable agricultural land use and management.

The study was based on the hypothesis that sustainable land use can be achieved in complex biophysical and socio-economic conditions, despite (or even because) of large population pressures on land.

Specific objectives are:

To characterize the biophysical diversity of the study area.

To inventory the diversity of land use in the area.

To document indigenous knowledge of biophysical diversity in the rugged terrains of Rwampara and Isingiro counties of Mbarara district.

To establish, together with local farmers, the relationship between landuse types and landscape diversity.

METHODOLOGY

The study area is the dissected highland plateaus of Isingiro and Rwampara counties found in southern part of Mbarara district, in Southwestern Uganda. The area forms a corridor of very rich Agrodiversity as characterized by Tumuhairwe and Nkwiine (1999). Altitude rises from 1300m in Kamuri parish of Kabingo subcounty to 1800 m in Mwizi subcounty. The terrain is rugged; characterised by long ridges with very steep slopes and both V-shaped and U-shaped valleys (in Bugamba, Kabingo and Mwizi) tailing off to plains in the northern parts of Birere (Masha) and Kabingo (Kamuri). The corridor is settled by people of different ethnicity and origins, most of them being immigrants of Bakiga from former Kigezi (currently Kisoro and Kabale districts) as well as Banyankore from the former Mpororo kingdom (currently Ntungamo district), and Igara, Ruhinda and Sheema counties (currently Bushenyi districts). These have intermarried with the native Banyankore of the former Nkore kingdom, presently Isingiro County. Other immigrants include Baganda from Koki County in the east, Bahaya who are kinsmen of those in neighbouring counties of Tanzania and Banyarwanda from Rwanda. (Tumuhairwe *et al.*, Unpublished)

Isingiro and Rwampara counties are the main food baskets for Mbarara district, especially in Bananas and annual crops with surplus being exported to other parts of Uganda as well as Rwanda and Tanzania. It is also a region of highly dynamic Agro-ecosystems in terms of biodiversity, land use and management systems. It is an area that is definitely undergoing drastic socio-economic and ecological transformation as a result of the interplay of several factors such as population growth, market forces, landuse changes and land degradation.

Methods of study emphasized participatory approaches. They broadly included reconnaissance surveys, consultations with local opinion leaders and communities (in groups and/or individual farmers) as well as working together with selected capable local individuals to do the technical measurements and assessments. A reconnaissance survey of the southwestern Uganda region was made by fast driving through to identify the general terrain, landuse and farming systems that are there.

Data on indigenous knowledge of biophysical diversit and its utilisation was obtained through group discussions in community workshops held at central venues in each of the four subcounties. The community groups comprised of adults, both men and women. The discussions followed two sensitization workshops creating awareness about the Project goal and objectives, followed by another workshop giving feedback of results obtained from preliminary/ reconnaissance surveys of their areas. There was harmony and good will among all participants and open discussions to reach consensus on all issues. The consensus answers were then recorded on flip charts either on sketches of landscapes drawn for illustration of their biophysical environments or in tables as appropriate. The language of communication was Runyankore-Rukiga, the local vernacular of the study area.

Semi-detailed characterisation was limited to a corridor of land stretching across Bugamba, Mwizi, Birere and Kabingo subcounties, 5 km wide and 30km long, cutting across the most representative landscapes and land use stages of the study area. Accessibility was obviously one external factor considered in site selection. This corridor was demarcated using GPS. It is hereby referred to as a megatransect. Traversing the Megatransect, eight line - transects of 2km lengths each, were also positioned by GPS cutting across the different representative farming system identified.

PLEC Scientists walked each of the 2 km long line transects, together with some local leaders of each of the communities traversed and two local farmers who assisted the team in naming the villages, the land owners, the soi and the crops or other plant species as required by the scientists. Four other local able-bodied young men had been trained by the same team in field techniques o measurements, counting and sampling, and were thus par of the research team. Distance covered by each land use stage was obtained by measuring length of each segmen of the transect line per change in land use. Efforts were made to ensure that transect line was straight and leadin to a selected point in the land use pattern or farming systen it represents, by using a compass. GIS technology wa used to produce a site characterisation map, based on bot primary and secondary data.

Detailed characterization of the biophysical diversity an status of the land resources was done in each segment c the line transect according to changes in land use. Dat was collected from a 20m wide belt along the transec line, measuring 10m on either side of the line. Withi each segment records were taken of the landscape type land use types and dominant crops/land use. In the sam area (segment), measurements of topsoil depth were do from 3 borings.

Scientists facilitated the communities of Birere, Kabin and Mwizi to give the names and diagnostic characteristi of the soils in their areas and then to relate the soils to t

landscape diversity, with particular focus on catenary associations. Participants were also facilitated to relate landuse to landscape diversity. Sketches of the terrain for the localities were drawn on flip charts and the dominant landuse types and crops grown on each landscape position were given and recorded by the farmer participants. Similar workshops were held in the study sites to present findings of the transect studies to the farmer communities and get them to review the correctness and representativeness of the data.

Relationships between indigenous and scientific (technical) information were analysed manually since indigenous information was not quantitative. The technical data (e.g. soil depth, and distance coverage of each land use type) however was appropriately summed up according to landscape types or line transects represented and then their means were used to relate with the indigenous information. Such results are therefore presented in descriptive style. Special Package for Social Scientists (SPSS) was used to work out percentage occurrences and cross tabulations for relating land use to landscape diversity.

RESULTS AND DISCUSSION

Biophysical and landuse diversity

Inventory of land use types by line transects gave results shown in Figure 1. Variations of land use types and their dominance along the eight transects are as follows:

Bushwere dominantly grown with annual crops, (annuals) covering 63% of transects distance. The second was the perennial crops (perennials) land use (18%), followed by grasslands 11%.

Ngoma with a dominance of annuals (55%) followed by both perennials and then grassland (10%).

Kashojwa has dominance of perennials (63%) followed by grassland (19%) and the third land use was annuals (15%),

Kigaaga is dominantly grown with annuals (63%) followed by bushland (15%) and followed by perennials (10%).

Rubingo has perennials (55%) as a dominant land use followed by annuals(20%) and followed by bushland (19%).

Kamuli was dominated by perennials (32%) followed by annuals (26%) and followed by grasslands (19%).

Nyakigyera was dominated in almost equal proportions by perennial and annuals (34% each) followed by grassland (20%).

Butenga was a unique transect with a dominance of grassland (62%) followed by annuals (22%).

There are three major land use types namely grassland (livestock), perennials and annuals. Bushlands are generally in small patches throughout the Mega-transect area, especially in uncultivated valley bottoms and very steep backslopes. From this inventory the landuses types can be grouped into four farming systems according to the dominant land use types found along them as follows:

Category of farming system	Transects
1) Annuals based systems	Bushwere, Ngoma and Kigaaga
2) Perennials based systems	Kashojwa and Rubingo
3) Grassland (livestock) based systems	Butenga
4) Integrated Livestock–Perennials and Annuals system	Nyakigyera and Kamuri

During the community workshops the local people divided their terrain into four significantly different landscape types. They were derived at through discussions with reference to sketches of the landscapes of their parishes. The landscape types were locally named against their English nomenclature as shown in Table 1 below.

Table 1: Farmer Classification of Landscape diversity

ENGLISH	VERNACULAR*
Hill top and Shoulders	Ekibungo
Backslope	Ahamushozi or Ahakashumo
Footslope	Hansi y'omushozi
Ravine (Sloping valley)	Akahanga
Valley bottom	Oruhanga
Plains	Oruhita

* Rukiga and Runyankole language

The farmers agreed that some hills have shoulders (i.e. the ridges) and others do not (round topped hills). Also it was agreed that the name Ekibungo refers mostly to those hills which have shoulders (i.e. the ridges), and takes care of both the hilltop and shoulders. Otherwise the tops of rounded hills is also referred to as Ahamushozi and normally used the same way as backslopes.

Both group and individual discussions showed that the Communities are knowledgeable of the catenary associations of their soils. Table 2 shows the results of the community workshops in each of three sub-counties, during which the farmers named the soils in their languages and indicated the positions on the landscapes where each one is most dominant.

Participants also gave the diagnostic characteristics of the named soils (Table 3), which in most cases were based on

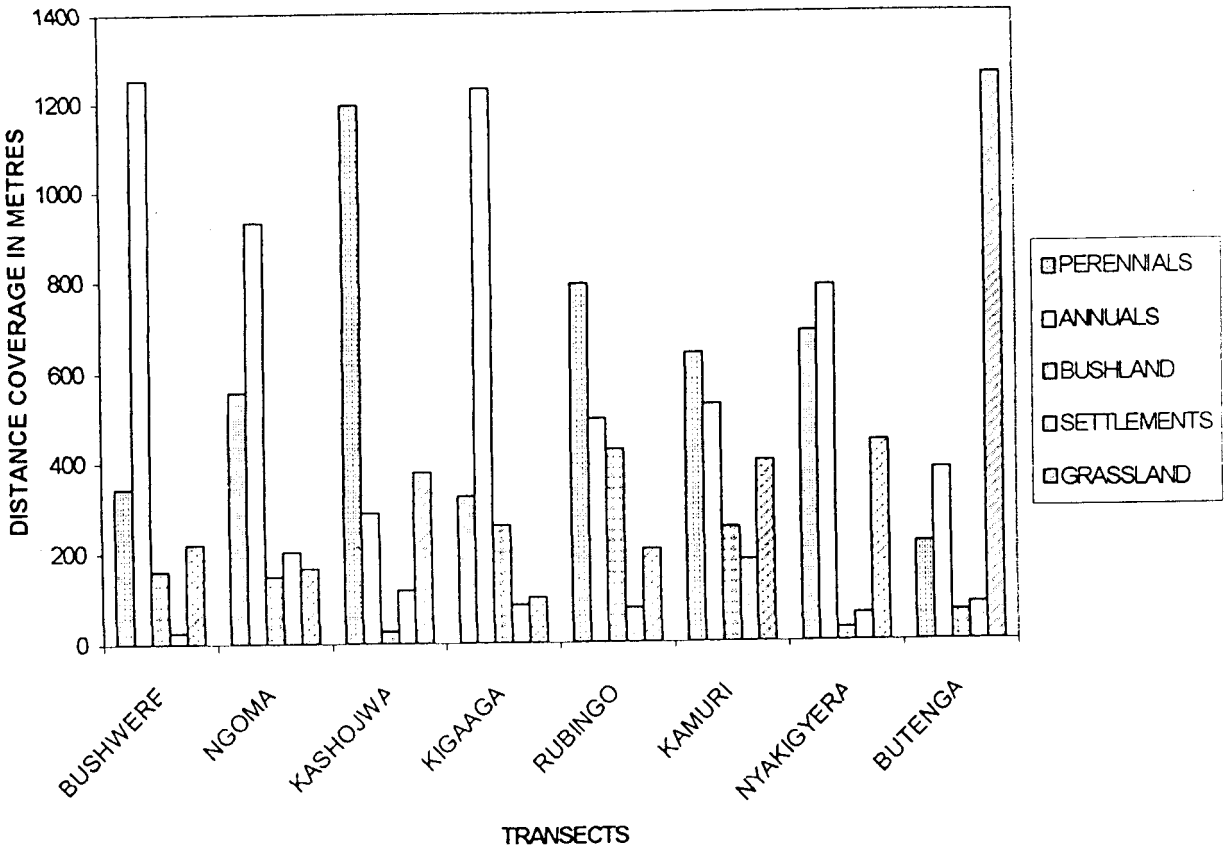

Figure 1: LANDUSE TYPES ALONG THE EIGHT TRANSECTS

Table 2: Relationship of Major landscape positions with soil types

	LANDSCAPE POSITION AND THEIR SOIL TYPES					
Subcounty	Hilltops	Backslopes	Footslopes	Ravines	Valleys	Plains
Mwizi	Orushenyi (Kg) Orubare (Nk)	Ekisooni (Nk) Orushenyi (Kg) Ebibare	Enombe Ekitaka	Ekitaka Eririkwiragura	Ibumba (w)	N.A.
Kabingo	Orubare	Ekigugwe (Nk) (Ekigugwe)	Enombe Ekitaka	Ekitaka	Eririkwiragura (nv) Ibumba (w)	Orushenyi (Nk)
Birere	Orushenyi (Kg) Orusheregyenyi Ebibare	Ebibare	Enombe	Ekitaka	Ibumba	Omushenyi

Kg = Bakiga; Nk = Banyankore; nv = narrow valleys; w = wide valleys; N.A. = Not Applicable.

textural properties. The farmers reported that these are determined visually and through their feel and workability solum depth and colour also seemed to be important criteria for some soils.

Relationship between Landuse and Landscape diversity

Farmers reported that most ridges have cultivable hilltops and shoulders. Most of the cultivable ridges are in all the five parishes of Mwizi subcounty namely Bushwere, Ngoma, Kashojwa, Kigaaga and Ryamiyonga; but only in Ibumba parish of Birere, Kagarama, Katembe and Nyakigera parishes of Kabingo. Most of the hilltops and backslopes in the rest of Birere and Kabingo soils are not cultivable due to rocky surfaces and extremely shallow soils. Such areas are used for communal grazing of livestock. All footslopes and valleys are cultivable. Through probing, farmers were led to report the most suited crops grown on each soil type. However, participants confessed that utilisation of these soils is not limited to only what they are suited for, but rather many other different crops due to shortage on land. Efforts to verify the farmers classification of soils implied that the "orushenyi" according to Bakiga seem to be closely related to "orubare" of Banyankore, and were the most dominant soils on hilltops and shoulders of ridges in all three subcounties. They also stretch to most backslopes of Mwizi subcounty. Observations confirmed what participants reported that the orubare/orushenyi supported all crops but exclusively peas and Irish potatoes in Mwizi and onions in Kabingo.

The ravines in Mwizi are almost all covered by banana plantations while those of Kabingo are under natural bushlands. All the ravines and narrow valleys, normally V or U-shaped in Mwizi and to a lesser extent in Kabingo, were occupied by the Ekitaka/Eririkwiragura soils. These were almost exclusively cropped with bananas in Mwizi and Kabingo. The wider valleys like Kyonyo village in Mwizi, Kamuri in Kabingo and Ibumba village of Birere all carried Ibumba soil, which is clayey and occasionally poorly drained. Such soils were used for some annuals (mostly sweet potatoes, sorghum, maize and beans but not onions, solanum potatoes nor peas). It was only in Kyonyo where bananas are also grown on Ibumba soil – but only where there is some slope (5 – 10%) or under artificial drainage. The plains were mostly sandy (omushenyi) and sandy loams (orushenyi).

Transect results summarised in Table 4 show mean percentage occurrence of major land uses on major landscape types. Land uses here are specified by the dominant crop or useat the time. The greatest diversity in land uses is on backslopes and footslopes, with 23 and 22 out of the 25 recorded landuses, respectively. Footslopes here include valleys, since most valleys were too narrow and footslope too short to be separated. Farmers also do not distinguish them except in rare cases, where foot slopes are long, as in Kabingo. Almost all the landuse diversity on backslopes was recorded in Mwizi while the landuse diversity on footslope was recorded in almost equal proportions in all the eight transects. Landuse diversity on all tops and shoulders was also greatest in Mwizi.

It is important also to note that certain specific landuses are either very dominant or exclusively occurring on particular landscapes. For instance bananas in footslopes and backslope, maize, peas and Irish potatoes on hilltops, grasslands on backslopes. The small patches of natural forest, sugarcane and pineapples were also encountered only on backslopes. These associations seem to be related to the suitability of the various soils highlighted by participants of the community workshops (Table 3). This probably requires further study and analysis before drawing conclusive inferences.
When the above general results were shared with the Mwizi and Kabingo communities, specific relationships

Table 3: Farmers Diagnostic characteristics of soils in Birere, Mwizi and Kabingo

Local Soil Name	Diagnostic characteristic s	Most suited crops
• Orusheregyenyi	Very Gravelly	Onions and peas
• Ebibare (Kg)/Eryamabare (Nk)	Rocky	Millet and maize
• Orubare (Nk)	Gravelly (murram) and stony	All crops especially Irish and peas
• Orushenyi (Kg)	Gravelly (murram)	All crops especially Irish and peas
• Orushenyi (Nk)	Sandy loam	Sweet potatoes, maize and bananas
• Enombe	Reddish, hard and blocky when dry, sticky when wet.	Sweet potatoes, maize and bananas
• Omushenyi	Sandy	Sweet potatoes, maize and bananas
• Ekitaka	Deep, friable and no gravel	Grasslands
• Eririkwiragura	Dark and loamy	All crops especially bananas
• Ekigugwe/Ekisooni	Soft friable rock material	All crops especially bananas and millet
• Ibumba	Clay and very sticky	Swamp grasses and if drained sweet potatoes

The "Orushenyi" is a name used by both Bakiga (Kg) and Banyankore (Nk) people to refer to different soils.

Table 4: Percentage occurrence of major land uses on particular landscape positions

Major land use	Occurrence per landscape positions			
	HT	Sh	BS	FS
Eucalyptus	6.6	-	2.5	1.7
Sorghum	4.0	2.4	3.1	3.4
Banana	13.1	7.1	20.1	29.7
Finger millet	9.2	4.8	4.4	3.4
Maize	26.3	16.7	6.3	3.4
Coffee	1.3	-	5.0	3.4
Sweet potatoes	5.3	4.8	2.5	0.8
Fallow	7.0	21.4	12.6	7.6
Pasture	2.6	1.3	2.5	3.4
Peas	4.0	7.1	-	0.8
Beans	5.3	4.8	3.1	5.1
Grassland	1.3	11.9	18.2	11.9
Settlement	2.6	3.6	3.1	2.5
Sugarcane	-	-	0.6	-
Bushland	2.6	6.0	6.3	7.6
Cassava	-	-	2.5	0.8
Natural Forest	-	-	0.6	-
Irish potatoes	4.8	3.6	0.6	0.8
Road	2.6	2.4	1.2	7.6
Groundnuts	1.3	2.4	1.9	1.7
Soybean	-	-	0.6	-
Gully	-	-	0.6	1.7
Pineapple	-	-	0.6	-
Kraal	-	-	0.6	0.8
Wetlands	-	-	0.6	1.7
Total	100	100	-	-
			100	100

of the major land uses to landscape types for the two areas were distinguished as indicated in Figure 2 and 3. Although the landscapes differ significantly in shape, a common feature in both sites is the tendency of growing bananas on footslopes/valleys and annuals on hilltops (shoulder inclusive). The main difference is that the backslopes of Kabingo are exclusively not cultivated while those of Mwizi are increasingly being cultivated due to the high population pressure on land of Mwizi compared to that of Kabingo. Bugamba landscape shape is closer to Mwizi Figure 2 and Birere landscape is closer to Kabingo (Figure 3).

Backslopes in this table also include ravines since the latter are technically dissections in the former and both are generally steeply to very steeply sloping. The distribution of the different landuses, on different landscape position indicates the farmers' ability to select among the diversity in natural environments for production and development. This includes even settlement and roads on ridge tops and footslopes. The distribution of the banana landuse in particular, is a good example. The variations in banana dominance along landscapes probably relate to soil depth and both surface and internal drainage.

Bananas are most dominant on footslopes where soil is generally deep and drainage is relatively good unlike the valley bottom (Figure 2). Bananas are rarely grown on ridge shoulders and on round tapped hilltops and backslopes (Figure 2) where soils tend to be shallow and excessively drained. It was observed that Mwizi farmers who grow bananas on backslopes and revines practice more intensive soil erosion control and runoff water harvesting using trenches and mulching, than their counterparts in valleys and flat ridge tops. This agrees with Busingye *et al.*, (1999) and Nsubuga *et al.*, (1999) who found that Mbarara farmers consider terrain or landscape type and soil conditions, among other factors in choosing to adopt different soil and water conservation technologies, for agriculture. The other factors include economic benefits or market trends in the crops grown, which implies that the efforts by farmers to grow bananas at almost all landscape types in Mwizi and Bugamba is a coping strategy to increase banana production for both food and cash benefits. This is one example of the way farmers select and manage the biophysical diversity for increasing production and also for sustainability of the agro-eco-system. Table 4 also shows that fallowing is more on shoulders and backsslopes which are fragile. This is a traditional method of managing productivity land resources.

CONCLUSION

Farmers in the dissected highland plateaus of Mbarara are very knowledgeable of the diversity in their natural environment, landscape and soils in this case. They are able to relate the important characteristics like drainage and productivity, and then select among these variations

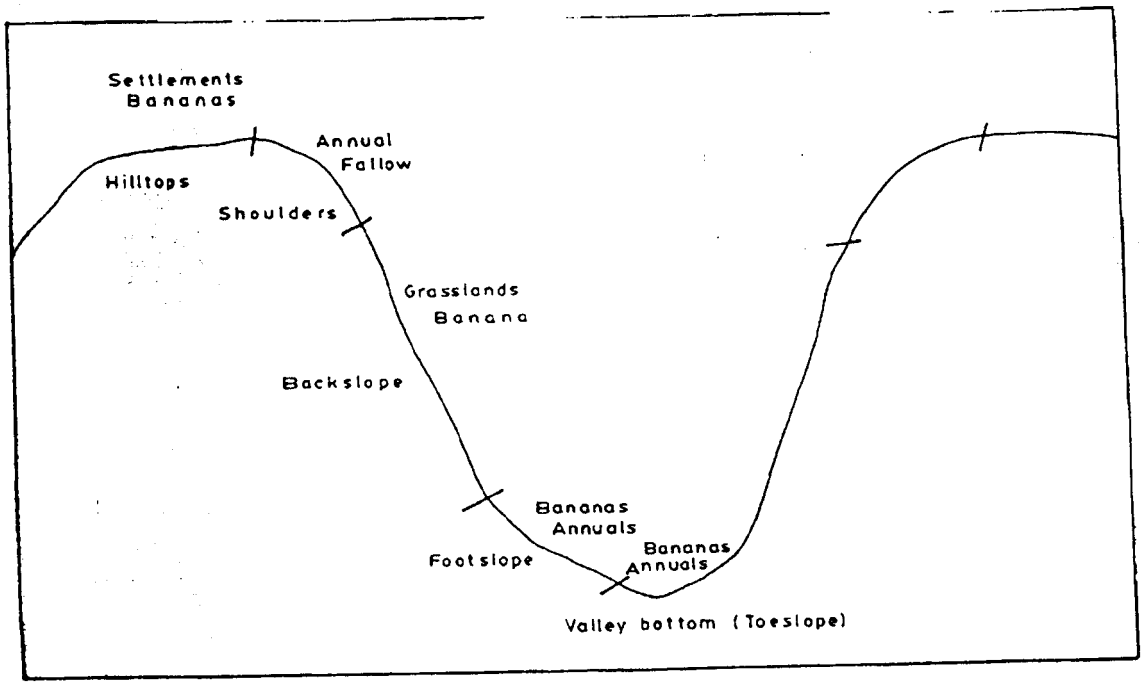

Figure 2 . Distribution of the first 2 most dorminant land uses along the landscapes of Mwizi

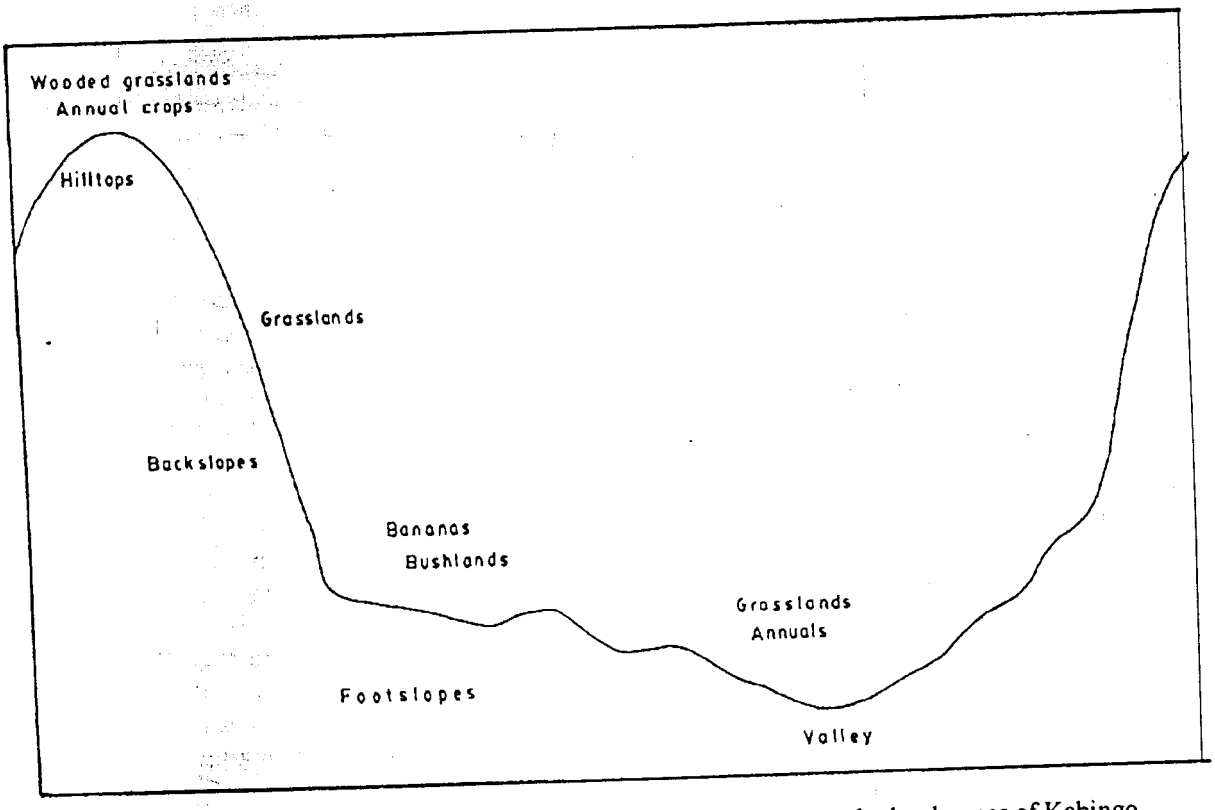

Figure 3. Distribution of the first two most dorminant land use types along the landscapes of Kabingo

for different landuses. This has led to the diversified landuses and management systems. Bananas are grown in deep and well drained soils and the shallow soils and poorly drained plains or valleys bottoms are used for grazing. However, where there is land shortage, the farmers devise means of managing the fragile land types for sustainable production. For instance there is more fallowing of annual crop fields on shoulders and backslopes and more soil and water conservation technologies in bananas fields found on backslopes and ravines. Valley bottoms are drained for certain annual crops. The gravelly soils (orubare) of hilltops are used profitably for high value and exacting crops like onions, irish potatoes and peas. The consequence of all this is a rich agrodiversity. Further participatory work in this region should lead to development of sustainable land management strategies.

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