Land Use, Soil Loss and Sustainable Agriculture in Rwanda

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The conservation of scarce land resources is essential to the long-term viability of agriculture in Rwanda. High population density, steep slopes and abundant rainfall prevail in the highland portions of this African country, making the task of erosion control uncommonly difficult for the peasant farmer. The specific use to which land is put (e.g., cultivation, fallow, pasture, woodlots) and, if it is cultivated, the particular combination of crops grown, can be seen as contributing to both the cause and the solution of the land degradation problem. Based on data from a nationwide survey of over 4,800 agricultural fields in Rwanda, this study reviews the extent to which the land use and cropping patterns employed by farmers are appropriately suited, in terms of erosion control, to the topographical and environmental characteristics of their landholdings. Analyses of other aspects of the traditional agricultural system, e.g., variations in relative soil fertility, the use of organic fertilizers, and the location of fields relative to the household, are introduced to help explain why farmers often fail to maximize erosion control through land use and cropping practices. Adjustments to current land use practices that can be expected to reduce soil loss are discussed.

Key words: soil erosion; cropping patterns; slope; sustainable agriculture; Rwanda.

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INTRODUCTION

Soil loss is a serious threat to the long term viability of agricultural systems throughout the Third World. Particularly on fragile lands in regions where land resources are scarce and population growth continues to surge, declining productivity due to soil degradation can have crushing long-term effects on human health and nutrition. Awareness of this truism is no greater among members of the scientific community than it is among members of affected peasant villages.

The farmers of Rwanda are especially mindful of the need to conserve their land resources. Rwanda is among the poorest and most densely populated nations in Africa, with an annual population growth rate of 3.7%. Steep slopes, common throughout the nation, coupled with heavy seasonal rains make the task of erosion control essential to the future of Rwandan agriculture. The efforts of individual farmers, working with extension agents and government officials, have emphasized land management engineering, as the dominant approach to controlling soil loss and degradation. Terraces and drainage ditches have been constructed in many parts of the country. Engineering strategies, while potentially very useful, have numerous disadvantages. First, they make hill slopes inherently less stable (Chorley *et al*, 1984) and as such, continuous maintenance of engineering works is invariably required. Second, they are generally expensive to construct, either or both in terms of labor and capital. Third, in the Rwandan setting due to both the steepness of the slopes and the heavy volume of surface water runoff, unlined drainage ditches can eventually lead to gully formation. And finally, in most parts of northwestern Rwanda, topsoils are relatively thin and are underlain with a very acidic B horizon, i.e., the stratum of soil that lies immediately beneath the topsoil layer.

Recently, biological approaches such as planting grass strips and hedgerows have been introduced as complementary methods of reducing soil loss. Yet, because grass strips and hedgerows often remove sizable segments of land from crop production, they can push farmers to cultivate additional, often marginal lands and thereby increase the potential area undergoing accelerated agricultural erosion.

Another biological approach, one that has received relatively little attention from agricultural extension leaders in Rwanda, is the integration of erosional controls into farmers' cropping and land use systems. Crops and other forms of vegetation vary considerably in their ability to protect the soil from the erosive effects of rainfall and runoff. Differences in the rates of maturity, extent of leaf cover, root systems, and crop-specific farming practices, are some of the more important factors that determine the relative effectiveness of various forms of agricultural land use in controlling soil loss. These factors can also affect the overall performance of land engineering strategies. By selectively adapting land use and cropping patterns so that parcels of land particularly susceptible to erosion are covered with vegetation offering effective protection at critical periods during the agricultural cycle, the loss of soil can be minimized. Furthermore, when both environmental and cultural factors figure into the farmer's crop-selection/field-location decision making, not only can soil erosion be reduced, but soil improvement may actually result.

This paper demonstrates that there is relatively little association between field slope and crop cover in Rwanda, and examines the question of how this could be so in this highland

African nation, where land is a scarce resource and over 90 percent of all households draw their livelihood from agriculture. It is argued that the reason why farmers do not make more effective use of cropping and land use to control soil loss is not because they are unaware of the soil loss problem. Rather, the traditional settlement pattern and the organization of farming, coupled with more recent demographic pressure, have impeded the development of a cropping system that effectively contributes to the conservation of precious land resources.

LAND USE, SLOPE AND SOIL LOSS

The degradation of Africa's land resources has often been ignored or gone unnoticed unless it has resulted in spectacular or obvious destruction, such as gully erosion (de Vos, 1975). While there is recent recognition of the soil degradation problem throughout Africa, aggressive and concerted efforts to deal with the situation have emerged almost exclusively in the semi-arid areas, where agricultural and pastoral systems have experienced catastrophic declines (United Nations, 1977). In Rwanda and other humid areas of the continent, where the potential for agricultural production is relatively high, the effects of soil loss have been less visible and consequently not perceived to be as damaging as in the drier areas (Lewis and Berry, 1988). Today, however, the problem of land degradation in the humid areas is rapidly gaining recognition (El-Swaify et al., 1985).

Population pressure in Rwanda has pushed farmers onto increasingly fragile lands. Without proper attention, the downward spiral of environmental deterioration in affected areas will be inevitable. In the northwestern region, where the potential for agricultural productivity is high, the expansion of agriculture onto marginal lands is already resulting in serious slope failures (slumps and landslides) (Nyamulinda, 1988). The increase in degradation processes acting on hill slopes will eventually lead to excessive deposition in the valley bottoms——conditions which, over time, can precipitate flood damage and the destruction of lowland crops. In fact, if left untreated, environmental decline will generally accelerate because the various stages of deterioration tend to reinforce one another. Decreasing soil fertility, for example, reduces vegetation cover which, in turn, increases the potential for soil loss and even lower fertility.

The role of plant cover, including both crops and mulches, in controlling soil loss is well established (Wischmeier and Smith, 1978). Vegetation that protects the soil from the direct impact of raindrops are associated with low soil losses. Likewise the application of mulches has consistently proven to be effective in reducing erosion (SCSA, 1979; Wischmeier and Smith, 1978). Furthermore, in highland settings such as in Rwanda, mulches add important nutrients and increase the soil moisture utilization potential, both of which can increase potential yields. In Kenya, for example, thick mulching of coffee crops on slopes in excess of 15 degrees has resulted in soil losses of less than 3 tons per hectare per year (Lewis, 1985). Mulching of coffee is almost a universal practice in Rwanda, and prior research has shown that soil losses on such fields appear minimal (Lewis, 1988) even though the primary purpose of the mulch is to improve the soil moisture, not erosion control. Other recent research has begun to emphasize the importance of continuous crop cover and minimal ground disturbance in reducing soil loss in Rwanda (Lewis *et al.*, 1988).

DATA AND METHOD

Data for this paper are derived from a nationwide stratified random sample of 2,100 farm households, and were collected as part of the 1983-84 National Agricultural Survey in Rwanda (Dejaegher *et al.,* 1988). The survey was sponsored jointly by the Ministry of Agriculture, Livestock and Forests and the U.S. Agency for International Development. Fielded over a twelve-month period, the survey was designed to collect information on agricultural systems in Rwanda from a variety of perspectives.

Topics addressed in the field-level questionnaires included: crops and crop rotations, land tenure, steepness of slope, location of fields on the slope, soil conservation methods, fertilizer use, distance from the household residence, and perceived productivity of the soil. Of particular importance to the present study is the degree to which various combinations of crops and other types of land use help protect the soil from rainfall and runoff. A well-know measure that reflects this protective quality of crops is the C-value.

The C-value is defined as "the ratio of soil loss from an area with a specific cover and tillage practice to that from an identical area in tilled continuous fallow" (Wischmeier & Smith, 1978). For any given field, the crop cover, canopy, and tillage practices can vary throughout the year. The C-value represents the average soil loss ratio resulting from these factors over the growing season. In the present study, the C-values used (see Table 1 for an illustrative listing) were based on field work undertaken in the Kiambu and Murang'a districts of the Kenya highland (Lewis, 1985) and a pilot study of soil loss in Rwanda (Lewis, 1988).

[see Table 1]

FINDINGS AND DISCUSSION

The selective placement of crops, woodlots and pastures for the purpose of controlling soil loss does not appear to be a common practice among Rwanda's 1.2 million farm households. If it were, then one might expect to find that crops and other forms of land use with low C-values (i.e., those with dense leaf cover and other protective attributes) would be located disproportionately in fields that were particularly susceptible to erosion (notably those with steep slopes). But such is not the case. Table 2 reports the mean C-value for crops and other vegetation grown in fields of varying degrees of steepness. Though there is a slight negative association (*eta*=-.07), we must conclude that C-values do not seem to vary much as a function of field slope. This conclusion is consistent with findings reported earlier on the relationship between slope and crop cover in Rwanda's western provinces along Lake Kivu (Lewis and Nyamulinda, 1989).

[see Table 2]

The intriguing question unearthed by this initial finding asks why, in this country of steep slopes and heavy seasonal rainfall, farmers are not actively pursuing every possible means of protecting their scarce land resources from the damaging erosive effects of the natural environment. Could it be that farmers are simply unaware of the erosion problem or the factors that cause it? Or, might there be other dimensions of their cultural tradition and farming systems that effectively discourage a pattern of land use that will help minimize soil degradation?

Farmer Perceptions and Land Degradation

The proposition that farmers may not be cognizant of the hazards of uncontrolled soil erosion seems implausible for at least two reasons. First, the Government of Rwanda has repeatedly cautioned farmers on the need for proper land management and has initiated nationwide campaigns to encourage farmers to counter soil erosion through conservation investments and reforestation. Data from a recent study of conservation investments in Rwanda show that 76.2 percent of farm holdings have received investments in the form of radical terraces, hedgerows, grass strips or anti-erosion ditches, and that such investments are concentrated on the steeper slopes (Clay and Reardon, 1994).

Second, farmers themselves say that the productivity of their land is declining and that often this is due to soil erosion. The marginal frequencies in Table 3 confirm that farmers have observed a decline over time in the productivity of a full 50% of all of their holdings. In most cases the drop has been small, but farmers report that the decline in productivity has been substantial in nearly one field in 8 (11.8%). In either case, the finding that the productivity of half the country's farmland has declined to any appreciable degree at all is disturbing news. Table III also confirms that fields experiencing the most serious decline tend to be those on slopes of 15 degrees or greater.

[see Table 3]

The perceptions of farmers about the reasons for the declining productivity of their fields focus on two causes: over-cultivation and soil erosion (Table 4). Nearly half (48.7%) of the fields identified as declining in productivity are believed by their operators to be over-cultivated——undoubtedly a manifestation of the subdivision of farms from one generation to the next and, concomitantly, to the gradually disappearing use of fallow periods in the crop rotation cycle. Second only to over-cultivation as a perceived cause of declining productivity is soil erosion, which again indicates a degree of awareness on the part of Rwandan farmers vis-a-vis the problem of soil erosion.

[see Table 4]

Though over-cultivation and soil loss can be closely related, they are often found apart. Over-cultivation tends to occur on relatively gentle slopes (Table 4), since these are the fields that farmers most often cultivate. By contrast, fields suffering from soil erosion problems tend to be those situated on steep slopes. However, a focused look at fields on the steepest slopes (15 degrees or more), shows that both erosion and over-cultivation are commonly identified, indicating that on such fields the two problems may be interrelated. It is probable that declining soil fertility due to erosion may cause fields on steep slopes to be "mined" more rapidly and to regenerate more slowly.

In the light of these findings we reiterate our initial point: that the reason cropping and land use patterns are not effectively used to minimize soil loss in Rwanda is not because farmers are unaware of the soil erosion problem and its related causes. By all counts they are aware and, as the specialists on indigenous knowledge tell us, peasant farmers generally have a very informed and sensible approach to the management of their natural resources.

Soil Loss and the Organization of Farming

Alternatively, we look toward the organization of agriculture and the sociocultural context in which it has evolved for answers to the question of why Rwandan farmers have not developed more effective land use and cropping patterns in their fight against soil erosion. We begin with an examination of some of the spatial aspects of traditional farm settlement in Rwanda.

Through the 1940s the only regions of the country that were extensively inhabited and farmed were those of the western highlands, where abundant rainfall and fertile soils were especially conducive to agriculture (Gourou, 1953). Farmers in these areas initially settled along the upper ridges of their hillsides where soils were more fertile and cultivation was a simpler task than it was farther down, on the steeper slopes and in the marshy valleys. In many parts of Africa, populations have settled in villages. By contrast, Rwandan farmers have dispersed across the tops of their hillsides, with each family constructing a residence compound (*urugo*) near the center of its property.

Immediately surrounding the *urugo*, farmers have traditionally planted groves of bananas. Bananas have special significance in Rwandan culture because they are used for making a unique home-brewed beer which is served at virtually all formal and informal social gatherings. Though essential for sociocultural reasons, bananas and banana beer have become a mainstay of the local cash economy as well. Banana beer is now marketed heavily among households and through small neighborhood taverns, and has consequently become the primary source of cash income for 40% of Rwandan households (Rwanda, 1988). Other essential crops, notably beans, are typically planted in association with bananas in these nearby fields (Rwanda, 1984, p.43).

Another reason why bananas and other important crops are most often planted near the family compound is because Rwandan farmers have limited access to organic fertilizers, derived principally from both animal and human waste, and such fertilizers are rarely transported to their more distant fields. Table 5 reports that while 37.5% of nearby fields (within a 5 minute walk) receive organic fertilizer, either alone or with mulch, only 5.0% to 12.7% of fields in more distant locations are treated with fertilizer.

[see Table 5]

Beyond the inner ring of bananas, a series of outer rings can be identified which farmers have traditionally used to meet the needs of their households (Nwafor, 1979, p. 59). The first such ring is farmed intensively with annual crops for both home consumption and sale. Next, and a bit farther down the hillside, coffee is grown. Coffee is the country's principal export crop and as such is vigorously promoted by the government of Rwanda. Beyond the coffee plots, the slope of the hillside is often at its steepest. Consequently, these areas have traditionally been reserved for pasture and woodlots but also many of the less important crops are grown here and frequent fallow periods are commonly required. At the very outer rings, toward the base of the slope and in the swampy valleys, cropping is done on ridges that are built up to ensure proper water drainage. Sweet potatoes and other vegetables are grown in these more distant plots to ensure a continuous food supply between harvest seasons.

This traditional system of land use has always been subject to wide variation from one farm to the next, and only on occasion can it be found in its "pure" form today. On average, however, its effectiveness in controlling soil loss has been mixed. On one hand, earlier conditions of plentiful land resources allowed farm households to cultivate only the gentler slopes and maintain woodlots and pastures, which provide excellent erosion protection, on the steeper slopes. On the other hand, bananas also provide dense crop cover but tended to be planted on the relatively flat areas around the family compound, while secondary crops such as maize and manioc were planted on steep slopes despite their poor soil conservation qualities.

Though still apparent today, increasing land scarcity due to population growth has obliged many farmers in recent decades to depart from this traditional system. As the preferred lands along the hilltops became occupied, young farmers were faced with the decision to either cultivate smaller and less fertile plots farther down the hillside or to migrate elsewhere in search of sufficient land resources. As early as the mid 1950s a mass exodus from the western provinces was under way (Olson, 1989), which later culminated in a government-sponsored resettlement program (*paysannat*) of grand proportion during the 1960s and 1970s. In all, this program displaced over 80,000 farmers and their families into previously unoccupied areas of the country (Clay *et al.*, 1989a; Rwanda, 1985).

As the non-farm sector in Rwanda is still in its infancy, accounting for only 8.6 of all rural employment (Clay et al., 1989c), most young people are obliged to remain in farming. Consequently, farms have become badly fragmented and marginal lands on even the steepest slopes have been brought into production. This is particularly evident in some of the western regions where population densities now exceed 375 persons per km^2 (Delepierre, 1980) .

Data from the current study suggest, indirectly, that even today the household residence tends to be located toward the top of the slope, as 77.6% of fields on the top of the slope are less than a five-minute walk from the *urugo* compared to 45.2% of those located farther down in the valleys. Given the continued social and economic importance of bananas in Rwanda, their location on the preferred upper slopes near the family residence seems entirely reasonable (Table 6). Beans and sorghum are two other crops that are favored by farm households and for this reason are less likely to be found on the steeper slopes. The data also indicate that while beans are often located on the gentler slopes surrounding the family compound, sorghum is commonly located on the low slopes at the base of the hillside and in the valley. By contrast, crops that tend to be grown on the steeper slopes are manioc and maize, both of which, but particularly maize, are relatively ineffective in helping to control soil loss. By and large, the traditional practice of relegating non-cropping forms of land use to steep slopes has been maintained. This is especially true for woodlots, but fields on the very steepest slopes (21 degrees or more) are also very likely to be left fallow.

[see Table 6]

Though woodlots, fallow and pasture all provide effective protection from erosion, recent findings from the Rwanda Non-farm Strategies Survey (Rwanda, 1988) demonstrate that land in fallow and pasture have been declining in recent years because of the need to increase food production (Table 7). Only woodlots seem not to have suffered over the past few years, thanks to a strong government campaign aimed at replanting and maintaining them at both the household and communal levels. Though some of the lost fallow and pasture may be land that is being converted into woodlots, other findings point to the fact that households with insufficient landholdings are being forced to plant ever-increasing proportions of their holdings with manioc and other tubers (Clay and Magnani, 1987; Loveridge, et al., 1988). These tubers have a higher calorific value than do other crops, and tend to grow relatively well in poorer soils (Gleave and White, 1969), such as those commonly found on steeper slopes, but with C-values in the .22 to .26 range, they do not compare with the traditional uses of these slopes, i.e., woodlots and pasture, in controlling soil loss. In fact, they are clearly associated with accelerated soil loss (Ashby, 1985), and their increasing cultivation on steep slopes could be a major factor contributing to increasing sedimentation along the valley bottoms. Sedimentation often increases flooding and can lower the productivity of these bottom lands. Though we have no data to test the hypothesis, we surmise that the increase in food production resulting from the cultivation of these steep slopes, is being offset to some degree by the declining production on the valley floors.

[see Table 7]

CONCLUSIONS

The conservation of scarce land resources is essential to the long-term viability of agriculture in Rwanda. High population density, steep slopes and abundant rainfall prevail in the highland portions of this African country, making the task of erosion control uncommonly difficult for the peasant farmer. The specific use to which land is put, e.g., cultivation, fallow, pasture, woodlots, and, if it is cultivated, the particular combination of crops grown, can be seen as contributing to both the cause and the solution of the land degradation problem. Based on data from a nationwide survey of over 4,800 agricultural fields in Rwanda, this study has reviewed the extent to which the land use and cropping patterns employed by farmers are appropriately suited, in terms of erosion control, to the topographical and environmental characteristics of their landholdings.

The selective placement of crops, woodlots and pastures for the purpose of controlling soil loss does not appear to be a common practice among Rwanda's 1.2 million farm households. C-values appear to vary only slightly as a function of field slope. Crops that tend to be grown on steep slopes are manioc, maize and other crops that do not provide the kind of cover necessary to protect these fragile lands. Population pressure has forced farmers to cultivate their land more intensively so that even pasture and fallow land, which were traditionally found in the steepest slopes, are disappearing.

With Rwanda's continuing population growth and the heavy reliance on the agricultural sector, the need for maintaining the resource base is of paramount importance to the national government. The long-term future of its economic development depends on not just maintaining, but actually improving its resource base, and on ensuring that food production will continue to increase. Yet, individual farmers, with limited landholdings (less than 1.2 hectares on average) and capital, are compelled to find ways to "maximize" their agricultural outputs within each growing season. Often these short-term strategies run counter to the longer-range need for environmental stability. Thus there is a need to develop policies that merge the long-term national needs (environmental maintenance and improvement) with the farmers' short-term needs to maximize calorific outputs from their fields. Similarly, there is an immediate need for Rwanda's agricultural research and extension programs to focus on the changing use of these steep and fragile slopes and to experiment with practices that will improve the sustainability of the country's agricultural systems.

In Rwanda today, following recommendations made by the World Bank (Jones and Egli, 1984), farmers in certain regions are being encouraged to thin their banana fields in order to increase the yields of associated crops grown under the banana canopy. This is not a favorable strategy from the farmers' perspective given the important role of bananas, both socially and economically. Likewise, it contributes little toward improving the resource base in the long-term since steep fields still remain in production with crops that do not minimize soil loss. But if farmers were presented with the option of planting their bananas more densely on relatively steeper fields, or thinning them when planted on gentler slopes, it is possible that the current campaign's acceptability would grow in the eyes of farmers, while simultaneously improving the longer-term viability of the steeper slopes.

Another strategy that would help farmers to incorporate, to a greater degree, physical environmental factors into their agricultural system would be to encourage them to plant other protective crops, such as coffee or peas, on their steeper lands. Likewise the use of mulches and fertilizers, which are generally concentrated on the fields with lower erosional risks, needs to be extended to fields on steeper slopes. Additionally, new crops must be introduced into the traditional crop mix that can meet both the short term requirements of the farmers as well as the long term needs for environmental conservation. Recent research indicates that the introduction of shrub crops, *e.g.*, Sesbania) in the form of alleycropping, is one such possibility (Eylands and Yamoah, 1989). Clearly, reorienting the spatial arrangement of crops to correspond with variations in topography will create more work for members of affected households, and will undoubtedly run against the grain of certain well-established cultural traditions. However, if the current pattern of crop distribution remains unchanged, the Rwandan landscape will continue to degrade, *ceteris paribus*, both to the detriment of individual farmers and to the country as a whole.

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Table 1. Crop Cover Value (C-value) for Selected Crops in Pure Stands and in Association

Crop		C-value	Crop		C-value
1.	Coffee	.02	14.	Beans/sweet potato	.20
2.	Banana	.04	15.	Peanut/beans	.21
3.	Banana/beans	.10	16.	Manioc/beans	.22
4.	Manioc/banana	.10	17.	Potato	.22
5.	Fallow	.10	18.	Sweet potato	.23
6.	Pasture	.10	19.	Eleusine	.25
7.	Woodlot	.10	20.	Manioc	.26
8.	Beans/banana	.12	21.	Maize/beans	.30
9.	Banana/sorghum	.14	22.	Sorghum/manioc	.31
10.	Peas	.15	23.	Cocoyam	.33
11.	Sorghum/banana	.18	34.	Maize	.35
12.	Beans	.19	25.	Sorghum	.40
13.	Beans/potato	.20	26.	Tobacco	.45

Table 2. Mean Crop Cover Value (C-Value) by Steepness of Slope (in degrees) of fields in Rwanda.

Slope	Mean C-Value	(N)
0 - 5 Degrees	.17	(1135)
6 - 9 Degrees	.18	(785)
10 - 14 Degrees	.17	(998)
15 - 20 Degrees	.16	(967)
21+ Degrees	.16	(931)
Total	.17	(4817)

Eta = -.07 Sig.= <.001

Table 3. Decline in Productivity of Cropped Fields by Steepness of Field Slope (in degrees).

Decline in Productivity	Steepness of Field Slope % 0 - 5 Degrees	 % 6 - 9 Degrees	 % 10 - 14 Degrees	 % 15 - 20 Degrees	 % 21 + Degrees	Total %
No decline	53.3	53.8	47.7	49.9	44.3	50.0
Small decline	36.9	39.3	41.5	34.3	39.2	38.2
Large decline	9.8	6.9	10.8	15.8	16.5	11.8
Total	100.0	100.0	100.0	100.0	100.0	100.0
(N)	(1041)	(740)	(907)	(837)	(755)	(4279)

Gamma = .10 Sig < .001

Table 4. Primary Reason for Decline in Productivity of Cropped Fields by Steepness of Field Slope (in degrees).

Reason for Decline in Productivity	Steepness of Field Slope % 0 - 5 Degrees	% 6 - 9 Degrees	% 10 - 14 Degrees	% 15 - 20 Degrees	% 21 + Degrees	Total %
Soil erosion	3.8	5.3	11.2	18.1	38.1	15.2
Over-cultivated	58.6	60.7	50.4	40.4	33.8	48.7
Disease	3.7	5.3	4.1	3.3	4.3	4.1
Other	25.4	24.9	27.1	33.3	18.1	25.8
Don't know	8.5	3.8	7.1	4.9	5.7	6.2
Total	100.0	100.0	100.0	100.0	100.0	100.0
(N)	486	342	475	419	420	2142

Gamma = -.19 Sig < .001

Table 5. Use of Organic Fertilizer and Mulch by Distance (in minutes) of Field from the Household Residence

Use of org. fertilizer and/or mulch	Distance from Residence (in minutes)					Total
	0 - 5	5 - 15	16 - 30	31 - 45	> 45	
None	50.8	79.6	89.0	82.8	89.7	60.9
Fertilizer only	33.9	11.6	4.8	5.8	5.0	26.1
Mulch only	11.6	7.6	5.7	9.1	5.3	10.2
Fertil. & mulch	3.6	1.1	0.5	2.3	0.0	2.8
Total	100.0	100.0	100.0	100.0	100.0	100.0
(N)	(2920)	(874)	(309)	(83)	(92)	(4279)*

* No information on use of manure and mulch on fields in pasture or woodlot

Table 6. Land Use by Steepness of Field Slope

Land Use	Steepness of Field Slope % 0 - 5 Degrees	% 6 - 9 Degrees	% 10 - 14 Degrees	% 15 - 20 Degrees	% 21 + Degrees	Total %
Bananas	11.6	11.6	12.9	9.9	7.7	10.8
Beans	17.5	20.2	20.9	16.9	11.3	17.3
Sorghum	10.2	10.8	9.6	7.1	4.2	8.8
Sweet Potatoes	12.4	8.5	7.1	9.3	9.9	9.5
Coffee	4.3	4.6	5.7	6.6	5.5	5.3
Maize	1.7	1.4	2.1	2.7	3.4	2.3
Manioc	4.0	9.2	8.3	7.4	10.5	7.7
Fallow	8.7	6.9	8.9	9.7	14.0	9.7
Woodlot	3.1	1.3	3.0	6.6	10.9	5.0
Pasture	4.0	2.4	3.9	4.2	5.3	4.0
Other	22.4	23.0	17.7	19.6	17.5	20.0
Total	100.0	100.0	100.0	100.0	100.0	100.0
(N)	(1135)	(785)	(998)	(967)	(931)	(4817)

Table 7. Change in Fallow, Pasture and Woodlot over the Past Two Years as Reported by Heads of Households

Land Use	Change over Past Two Years: More	Less	Same	(N)
Fallow	15.8	28.0	56.2	(1,015)
Pasture	2.4	13.1	84.5	(1,015)
Woodlot	21.7	6.3	72.0	(1,015)