LUCID's Land Use Change Analysis as an Approach
for Investigating Biodiversity Loss and Land Degradation Project

Livelihoods Diversification Patterns among Households and their Implications on Poverty and Resource Use:

A Case Study from a Kerio River Basin Community

LUCID Working Paper Series Number: 51

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December 2006

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The Land Use Change, Impacts and Dynamics Project
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Cite working paper as follows: Author. Year. Title. Land Use Change Impacts and Dynamics (LUCID) Project Working Paper No. 51. Nairobi, Kenya: International Livestock Research Institute.

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Acknowledgement

This research was made possible through my fellowship program, sponsored by Japan Foundation and International House of Japan, as well as the recipient institution, the International Livestock Research Institute. I would like to express special thanks to all the Rokocho people, who cooperated during my research along with my enumerators, Mathew Kiprono and Rueben Kiprono. I also greatly appreciate Joseph Kimeli and Sally Kimeli, Pastor Walter Kimutai and all the other AIC (African Inland Church) staff for their warm welcome and company during my field research. I thank Patti Kristjanson, Joseph Maitima, and Patrick Kariuki of ILRI for advice on research designing and Ianetta Mutie for assisting with data entry.

1. Introduction

Most rural populations in Africa have been suffering from poverty and environmental degradation. The dismal situation has posed huge challenges for researchers and policy makers to identify and tackle their causes. Since the late 1990s, there has been an increased recognition among researchers that Africans diversify their livelihood strategies, including on-farm (crop, livestock) and off-farm activities or market and non- market activities, to mitigate risks inherent in unpredictable agroclimatic and politico-economic circumstances (Ellis, 1998; 2000, Bryceson, 2002). The academic trend has been followed by policy shifts in that poverty reduction and sustainable development must be formulated by well recognising how and why African farmers pursue diversified livelihoods. Numbers of conceptual debates as well as empirical studies based on sustainable livelihood approach aimed at facilitating and evaluating policies (Ashley and Carney, 1999; Ashley, 2000; Ellis and Freeman, 2004; Driscoll and Evans, 2005; Freeman, Ellis and Allison, 2004; Homewood, ed., 2005; Swallow, 2005) have emerged.

One of the contributions of sustainable livelihoods approach is to deepen the understanding of poverty in rural Africa through empirical studies, where the levels of diversification are more extensive than those in other developing regions (Anderson and Deshingkar, 2005). Diversification has been analysed as a rational response by households to lack of opportunities for specialisation, and was initially considered not the most desirable option. However, recent studies indicate that rather than promoting specialisation within existing portfolios, upgrading them to augmenting income could be more realistic and relevant for poverty reduction (Ellis and Freeman eds., 2005; Freeman and Ellis, 2005). Another is to conceptualise linkages between poverty and environment through employing capital asset concepts (Lélé, 1991; Reardon and Vosti, 1995). In studies investigating factors affecting households' decisions on resource management, the level of capital asset endowment is often hypothesised to affect the capacity of farmers to invest (Clay *et al*., 2002).

The issue is how to reflect those findings to policy formulation at grass-roots level for identifying target groups and guiding interventions. Capital asset categories might not always be readily used as criteria, while indicative in analysing poverty and resource use. For example, Bryceson (2002) criticised that development agencies tend to target the rural poor on the basis of assets such as their landholdings and agrarian capital-stock, but claimed that those criteria may now be deceptive. The researcher stressed the need to understand that poverty in the rural areas in Africa has been based on non-agrarian rather than agrarian assets, while relative importance of off-farm income activities has been increasing. Furthermore, a household's diversified livelihood strategy and engagement in off-farm activities substantially affects its capacity and willingness to invest in natural resource management. Even households with similar capital asset endowments may demand different technologies because different preferences, objectives, constraints and incentives, attached to certain livelihood activities (Barret *et al*., 2002a; 2002b; Place *et al*., 2002). Therefore besides capital asset endowments of households, the means through which households derive income from a particular combination of on-farm and off-farm activities can be a more relevant criterion to understand poverty and resource use.

In our discussion, we define diversified livelihoods portfolios or patterns as combination of various livelihoods such as from crops, livestock and off-farm activities. Dominant

livelihoods activities (crop, livestock, and off-farm income activities) can be further classified into sub-groups with different economic returns and management incentives. This would make it possible to identify certain livelihoods diversification portfolios among households and relate them with poverty and resource use.

[dominant livelihoods activities derived from income contributions by the following sources]
*crop: drought-resistant (sorghum, millet), staple (maize, beans), fruits, commercial (wheat)
*livestock: traditional (indigenous) or exotic (improved)
*off-farm: regular (business, formal), casual (charcoal making, day labour), remittance
[livelihoods diversification portfolios and implications on poverty/resource use
* high-return portfolios [regular off-farm/staple and fruits crop/exotic livestock]
= higher income = more investment in conservation measures
*low-return subsistent portfolios [casual off-farm/drought-resistant crop/indigenous livestock].
= lower income = less investment in conservation measures/exploiting resources

While most households diversify, their portfolios are different, as income levels and resource use practices are. Heterogeneities in livelihood diversification portfolios among households have rarely been empirically investigated, while recent studies to link livelihoods and poverty/resource use to emphasize agroecological, market and infrastructure conditions (Staal *et al*., 2002; Zaal and Oostendorp, 2002; Pender *et al*., 2004; Kruseman *et al*., 2006). Implications of livelihood diversification patterns on poverty and resource use, however, should not be underestimated. For example, households with higher incomes carry out a combination of high-return activities and are more likely to implement integrated crop-livestock management as well as to implement resource conservation measures. Lower income households are less likely to take such measures and depend on casual off-farm activities such charcoal making and exploiting natural resources for survival. Unsustainable use of resources by lower income households might exacerbate the resource base for the whole community.

This paper presents a new perspective to link sustainable livelihood approach and practical policy formulation for identifying target groups and guiding interventions, based on a case study from Kenya. The principal objective of this research is to provide an intensive case study on livelihoods diversification of a community in Kerio River Basin. The community has experienced socioeconomic changes in the past few decades (migration of people into the valley, gradual intensification of agropastoral activities, and integration into wider market economies) in response to infrastructural development and introduction of new crop and livestock technologies. Subsequently with the increase in human settlements and development opportunities, households have more options for income diversifications, while perceiving increased needs for intervention to prevent environmental degradation. This case study would provide empirical evidence on the driving factors and consequences of rural development in Africa.

The overall development of the study area is described in section 2 after which an attempt is made to identify livelihood diversification patterns and link them to resource use and poverty, based on the household-level data. The objectives of the analysis are to—
- identify dominant patterns of livelihood diversification
- identify socioeconomic variables to determine livelihood diversification patterns

● investigate how livelihood diversification patterns affect poverty resource use
● discuss policy suggestions

In Section 2, the backgrounds of the study area are described. Based on interviews with informants as well as on intensive studies with all the households, drivers and agents of development are identified, and changes in livelihoods and land use in response to such development for the past decades are sketched. In Section 3, multivariate analyses to identify clusters of households with similar livelihood diversification portfolios and their determining factors are discussed. Implications of those livelihood diversification portfolios on income as well as implementation of resource conservation measures are also analysed. Based on the findings, targeting issues in rural projects for poverty reduction and sustainable development are discussed in Section 4.

2. Background of the study area

2.1: Kerio Valley Basin, Rift Valley

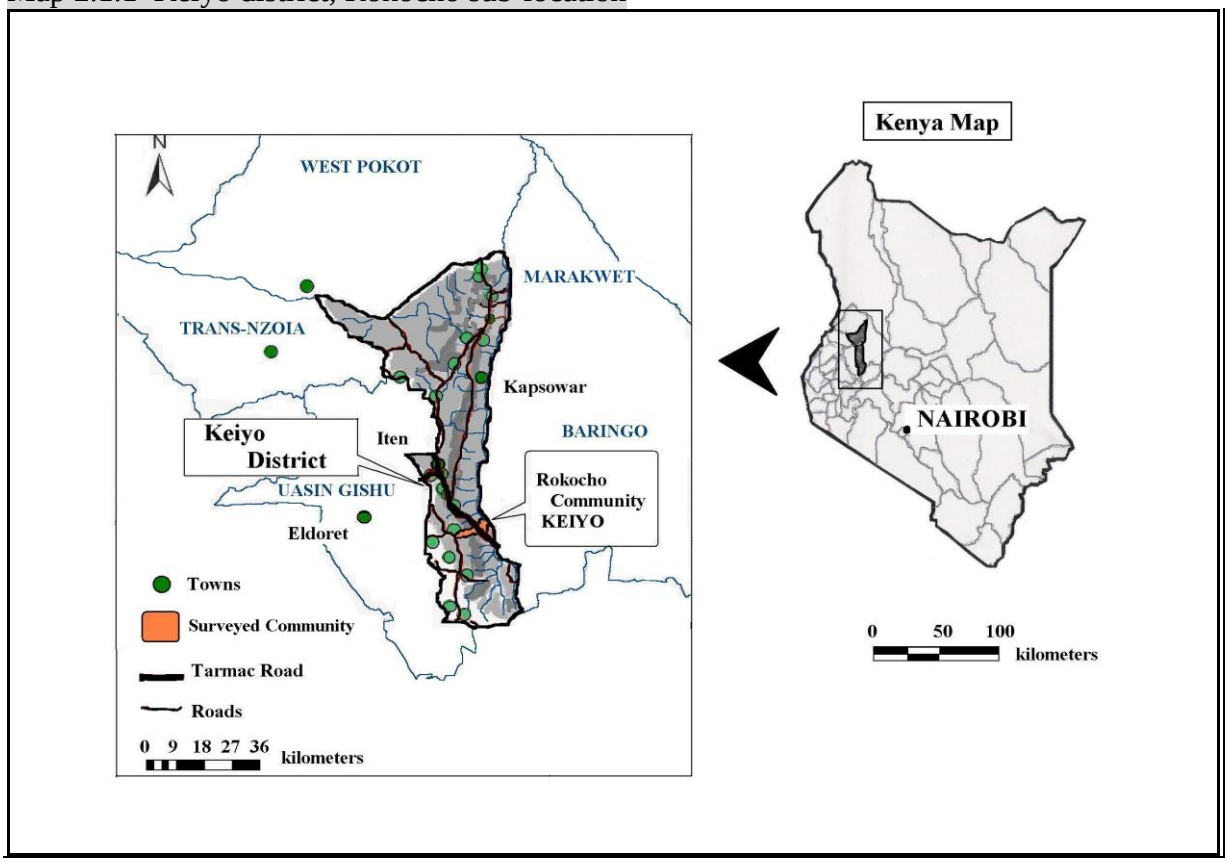
Kerio Valley is along the basin of Kerio River in Rift Valley Province, which flows northwards to Lake Turkana (see Figure 1). The Valley is spanned by three agroecological zones. The highland (> 2,500-3,000 m) lies in the west, the escarpment (1,300-2,500 m) on the intermediate, and the lowland or the Valley floor in the east (1,000-1,300 m) (Muchemi, Mwangi and Greijn 2002a; 2002b).

The highland has always been exposed to market opportunities due to its proximity to Eldoret town in Uasin Gishu, which used to be called the "white highlands" and where Keiyo people used to seek employment on the farms until between the 1960s and 1970s. In contrast, before the early 1970s, it was considered unviable to do farming in the Valley because there were no permanent sources of water. People slowly started to settle in the lower parts of the Valley in 1985 after the construction of a tarmac road which led to exposure of the inhabitants to other communities' activities. Churches and NGOs have also brought stimulus for development initiatives, by providing villagers with training on management skills and capital. Furthermore, water projects allowed more people to settle in the valley. Today, people in the valley grow high value crops such as maize, mangoes and bananas, practise zero-/semi-zero grazing with the introduction of exotic/crossbreed cattle and dairy goats. Access to information and market opportunities has prompted more investment in intensive agricultural methods. For a while, the escarpment of Keiyo has always been inaccessible due to the poor availability of service facilities and roads, and people have settled sparsely along springs or streams. Traditional extensive shifting cultivation for subsistent crops, such as sorghum and finger millet, has been long practised in the escarpment (Mizutani *et al*., 2005).

The implementation phase of baseline survey by International Livestock Research Institute and Japan International Cooperation Agency (ILRI-JICA) on Keiyo and Marakwet Districts conducted between December 2004 and January 2005 showed that residents across the agroecological zones share and manage water sources and catchments. In Keiyo District, all the 16 clans live homogeneously, exploiting the same sub-catchments of water from the highland through the escarpment down to the Valley.

Rokocho sub-Location (land of the Rokocho clan) was randomly selected out of the 16 Keiyo clans for the 2004-2005 baseline survey. Entire household lists were created and sample populations of 25 households selected randomly from each agroecological zone, making a total of 75 households (Mizutani *et al*., 2005).

Map 2.1.1–Keiyo district, Rokocho sub-location



The 2006 research was designed to interview all the households in the Valley zone in the Rokocho community, and not a few randomly selected households.

Concentrating on households through complete enumeration made it easy to collect empirical evidence on the holistic rural development process of a community experienced with the following phenomena (ex. SARDEP 2002a; 2002b; 2002c, SNV 2001; Muchemi, Mwangi and Greijn 2002a; 2002b):

- perceived needs for alternative income sources due to population increase/education needs
- introduction of new varieties (crop fruits/animals, exotic and crossbreeds cattle, dairy goats)
- perceived serious environmental degradation due to overgrazing

The process also allowed for highlighting of factors differentiating the capacity of households in overcoming poverty, as well as in their responsiveness to developmental challenges, while the cross-zone survey would mask such household heterogeneities by highlighting differences

in agroecological and politico-economic conditions. Finally, the process could estimate a partial picture of the transformation process of the land tenure system by capturing chronological changes in land use for a group of households settling in a small area.
In the next sub-sections, we briefly describe Rokocho development: its physical conditions and historical events; institutional and livelihoods changes; land use changes over years; current land access and use patterns.

2.2: Background of Rokocho sub-location

2.2.1: Physical, agroecological, socioeconomic conditions

Rokocho sub-Location is in Kibargoi Location, Soy Division, Keiyo District. It is at an altitude of 1,000-1,600 m (SARDEP 2000b) and receives an average of 700-1000 mm of rainfall. It is warm for most part of the year with temperatures rising to between 22 and 31˚C. The Iten- Kabarnet tarmac road that traverses the sub-Location in a North-South direction is fed by several small roads. Other infrastructure such as Rokocho Primary School, the KVDA (Kerio Valley Development Agency) branch and the Cheptebo Africa Inland Church (AIC) conference centre. Most springs in the escarpment supply water for domestic and livestock use. There is need for tap water to reduce the long hours the residents have to queue to get water during dry seasons.

While the Rokocho land from the highland to the valley has belonged to the clan over 100 years, it was after the 1970s that households started settling in the valley floor and development came only after the mid-1980s. Before evaluating the extent of development, it is essential to understand what Rokocho community used to look like before developmental stimulus changed the area. The background of the community is provided, based on the information given by local people.

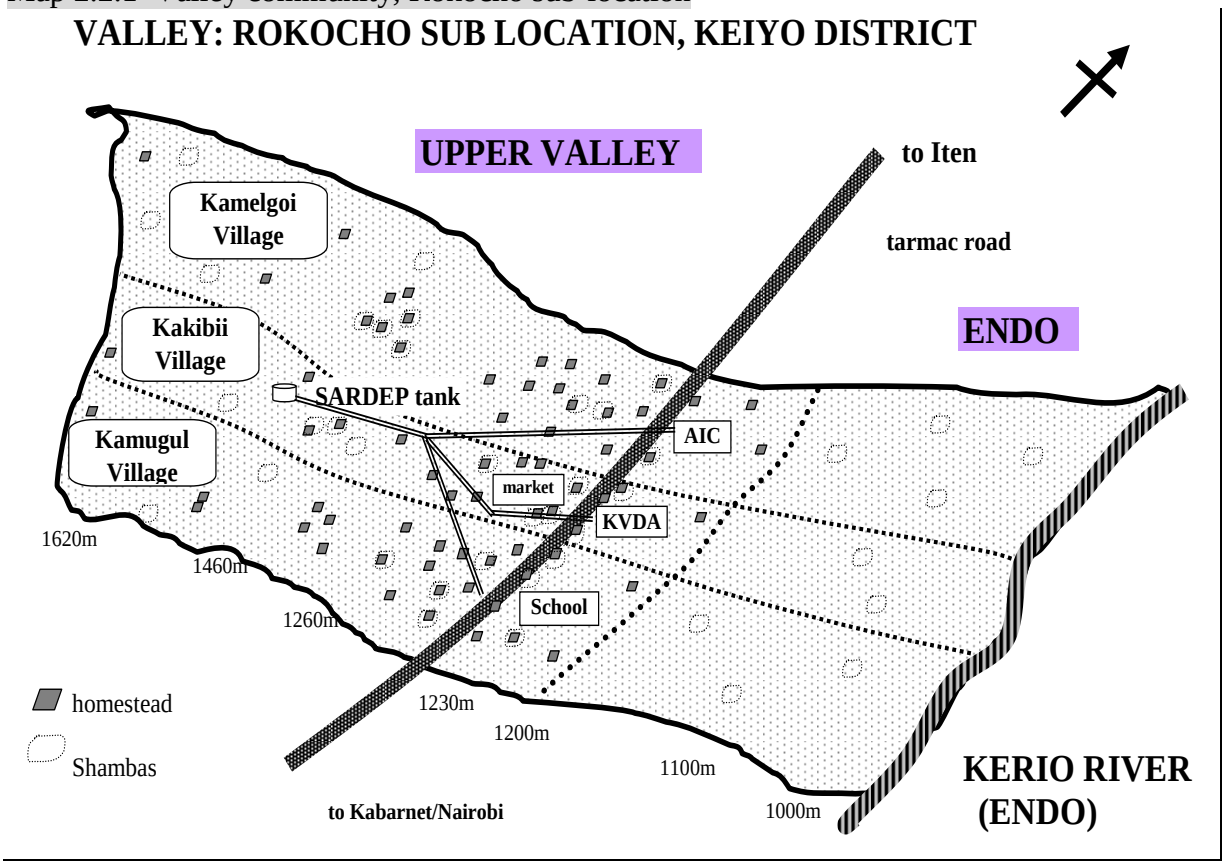
2.2.2: Land in Rokocho

Rokocho sub-Location consists of Kamelgoi, Kakibii and Kamugul villages (Map 2.2.1). The land in each of the three villages has been inhabited by each of the sub-clans for generations: Kamelgoi land by Kamelgoi sub-clan, Kakibii land by Kakibii sub-clan, Kamugul land by Kamugul sub-clan. The AIC training centre is in Kamelgoi, the honey processing facility of KVDA (Kerio Valley Development Agency) in Kakibii and Rokocho Primary School in Kamugul. Sub-clan members of the each village gave out land for those infrastructure.

Upper Valley land had been demarcated and sub-divided for each of the extended families of the sub-clans before the 1930s. Although many of the individual lands have yet to be fenced, their boundaries have been marked with posts/beacons and are recognised by the sub-clan members and sanctioned by clan elders (If you were to remove the beacons, you shall die). Without proper fences, people could graze animals on lands claimed by individual families. After 1978-1981, when the Rokocho market centre was founded, a few people along the road started fencing their individual shambas for exclusive use. Today, many households have established homes along the tarmac road which was constructed in 1985. Most of the homes are fenced with live (planted vegetation) fences while others have barbed wire.

Endo Before the 1970s, the land near Kerio (Endo) river had not been inhabited because of the lack of water as well as cattle rustling and general insecurity with the Tugen. The area remained an open pastureland until 1978, when elders sub-divided and distributed the land to each of the extended family who were there at the time. Cross-boundary grazing continued on land that was not properly fenced.

Map 2.2.1–Valley community, Rokocho sub-location



2.2.3: Major events in Rokocho

Here, we pick up major events which have affected development in Rokocho.

Up to the 1970s. Since a long time ago, the land in Upper Valley had been demarcated for families and beaconed by stones. The river basin had been unsafe for settlement and grazing because of cattle rustling between the Keiyo and the Tugen before a peace treaty was signed in 1960, and inaccessibility to permanent water sources.

1970s. Some people from Escarpments/Highlands started to settle into the Valley. The main occupation of the settlers was extensive grazing. There was little perceived potential for agriculture. The government encouraged people to plant cotton and hybrid maize in the basin where tractors could be introduced on flat parts. As people started planting, the need to demarcate clan commonages into individual shambas arose. In 1978, Endo land was sub-divided for the families of the sub-clan members, under an agreement with clan elders. Only ten families were present in the Kakibii Valley while the other Kakibii families were working at white farms in Uasin Gishu till the late 1970's. The land was initially demarcated to the ten

Kakibii families on a first-come/first-served basis. Soon, they started using modern methods of farming including use of manure.

1980s. The tarmac road was completed in 1985.Development initiatives were provided by organisations such as the AIC which came in 1986 which introduced fruit trees and laid water lines (pipes). Others were SARDEP and the World Vision. The organisations also trained the community variously. A few farmers in Kamelgoi started planting fruit trees after 1986.

1990s. SARDEP and AIC provided more extensive training on horticulture after 1996. In 1999, SARDEP completed the construction of a water tank to provide tapped water to broader community people. It became more common to fence shambas, especially homesteads.

2000-2006. Dairy goats were introduced by AIC. Some people started planting green gram.

2.3: Land tenure, land use, livelihoods

2.3.1: "Customary" land tenure system

Land tenure system in Rokocho sub-location, or the valleys in Keiyo District in general, has been called "customary". The land principally belongs to each of the sub-clans (Kamelgoi, Kakibii, Kamugul). Clan land is then divided into extended families by clan elders. The families further sub-divided the land into nuclear families through inheritance. Land in the upper Valley has been sub-divided for extended families since the 1930s while that in Endo started being sub-divided only in 1978.

Traditionally, land is owned by males who also only inherit land and other property. Land sub-division has resulted in individual family members having very small pieces of land. This has led to families determining age at which individuals may inherit land. Those that are not likely to inherit land are expected to buy land elsewhere.

Land registration for individual shambas (for nuclear families) has been practised in the highland since the 1960s. No land has been registered with title deeds in the Valley but customary ownership is recognized. Purchase and rental contracts of shambas are common. The land court, administered by clan elders, mediates transactions and settles disputes. In the past, the transaction of land was carried out through barter trade (paying by animals). This has been replaced by use of currency where one acre sells at KES 20,000 and rented at KES 1,000 per year. People from other clans have not been discriminated against acquiring land through purchase or rental, provided they follow clan rules and respect boundaries. In summary, the customary land tenure system has been well-organized and mediated by the land court. The regulations have been recognized and adhered to by the members, and the transactions have not been discriminative to outsiders.

Land use change in response to diversification/intensification/differentiation
Although beacons (stones) are recognised as boundaries, open land grazing is accepted where land is not completely fenced. Thus, communal and individual land rights overlap especially where there is more land and fewer households engage in intensive agriculture.

But as population increases, sub-divided shambas become smaller and smaller. Educational needs have necessitated villagers to sell livestock and to plant cash crops. Thus, conflicts of interests between extensive grazing of indigenous animals and intensive farming of fruits have arisen over land. Among those trying commercial crops, fencing started in 1978 and became more obvious after the 1990s. For more traditional/conservative pastoralists, grazing commonage is rapidly declining. Owners of fenced shambas often demand high compensations for crop losses to owners of the livestock that trespass on to their fields. These high penalties have discouraged others from keeping large herds of indigenous livestock. Some have shifted their attention to intensive livestock management using exotic animals. It is suggested that individualization /privatization has occurred within the customary land tenure systems. While the system is flexible, balances of livelihoods/land use are not stable.

2.4: Socioeconomic changes for the past decades on the ground

2.4.1:Land use changes over four decades

It is impossible to estimate how development in Rokocho has changed land use pattern in the sub-location for the four past decades (1976/1986/1996/2006), without the past records on shambas, since people started settling in the basin after the mid-1970s. The households were asked to report the year/modes of acquisition of all the shambas they claim to own, irrespective of their locations. They were also asked to provide information on crop types as well as fence materials before and after the acquisition. From this information, chronological changes in the numbers of shambas with land use patterns over the four decades were estimated (Tables 2.4.1 and 2.4.2). At the time of the interview in 2006, 177 households owned 386 shambas. Over years, those shambas may have changed hands and may have been sub-divided, and it is even far more irrelevant to estimate their sizes. While we estimate the trend in land use changes by the ratio of shambas, the figures shown should not be taken strictly.

Table 2.4.1-Changes in the number of plots owned by Rokocho households per crop type.

	1976		1986		1996		2006	
plots per crop type	no.	%	no.	%	no.	%	no.	%
traditional	22	0.06	43	0.11	44	0.11	14	0.04
traditional & exotic			2	0.01	10	0.03	17	0.04
traditional & fruits							1	0.00
traditional, exotic, fruits					1	0.00	2	0.01
exotic	9	0.02	43	0.11	80	0.21	106	0.27
fruits & exotic			1	0.00	3	0.01	8	0.02
fruits			5	0.01	33	0.09	82	0.21
fruits & commercial							1	0.00
commercial	5	0.01	4	0.01	7	0.02	6	0.02
commercial & exotic	4	0.01	4	0.01			4	0.01
nappier							2	0.01
nothing	346	0.90	284	0.74	204	0.53	143	0.37
TOTAL	386		386		386		386	

Table 2.4.1 shows that in 1976, 90% of shambas were bushy, but the ratio decreased to 37% by 2006. For the past four decades, shambas planted with drought-resistant crops, including sorghum and millet increased from 6-11% then stagnated and later was intercropped with other crops by 2006. In 1976, only 2% of shambas were planted with staple food crops such as maize and beans, but substantially increased in 1986 after the 1978 demarcation of shambas in the Endo. In 2006, 27% of shambas were planted with staple food crops (maize, beans, green grams, cowpeas and groundnuts). Fruits growing started in 1986 by a few of farmers who received training from AIC and took advantage of its water project. Between 1996 and 2006, the number of fruits shambas increased from 9-21%, probably because other villagers started emulating successful neighbours thanks to demonstration effects. Tapped water became available to more households after the completion of SARDEP tank in 1999. Table 2.4.2 shows that most shambas for commercial crops in the highlands were fenced with barbed wire. After 1986, the year fruits were initially introduced, the number of fenced shambas increased. In 2006, 25% of shambas were fenced with barbed wire and 10% with live fences, indicating shrinkage of open commonages for grazing animals.

Table 2.4.2:-Changes in the number of plots owned by Rokocho households by fence type

	1976		1986		1996		2006	
plots per fence type	no.	%	no.	%	no.	%	no.	%
barbed wire	10	0.03	22	0.06	58	0.15	98	0.25
livefence			3	0.01	14	0.04	36	0.09
no	376	0.97	361	0.94	314	0.81	252	0.65
TOTAL	386		386		386		386	

Box 2.4.1–Diversification, intensification, differentiation

(*By Joseph Kimeli, AIC Manager*) The past 10 years has witnessed tremendous social changes and diversification in livelihoods in the valley. Horticulture was first introduced in 1986 in AIC with sponsorship by SARDEP, and more extensively after 1996. The initial tradition of farmers keeping more than 300 local goats has gradually been phased out by 5-10% in the past decade after the farmers were fined 5,000-20,000 or arrested by police all the time the goats trespassed on other farmers' shambas. A few farmers have successfully diversified their livelihoods into intensive agropastoral activities to generate more income. Some households however simply lost animals. In Endo, hired casual labour is commonly used to guard shambas at planting and the crops from animals. That may be the reason why some people prefer hiring shambas for planting rather than use isolated shambas, which are more prone to livestock/wild animals damage. Due to the loss of grazing animals and fences, soil erosion has been reduced and the environment has begun healing.

2.4.2 Difference between villages

Data collected between July and September 2006 shows that many households in Kamelgoi village have fruit shambas mostly on their homesteads and fenced with barbed wires or live fences. In Kakibii village, homesteads planted fruits especially along the tarmac roads, while households in either upper parts (near SARDEP tank) or lower parts (near the Endo) of the valley had few fenced orchards. Many Kamugul households had neither developed nor properly fenced their homesteads, leaving them bushy for grazing animals. More Kamelgoi

households own exotic animals, especially dairy goats than those households in Kamugul who have continued to keep goats. The situation in Kakibii is rather transitional.

According to the villagers, Kamelgoi took advantage of the AIC water lines constructed in 1986, earlier than the other two villages which only benefited from the SARDEP tank late in the 1990s. In 1986, a few Kamelgoi villagers were trained at AIC on fruits. Many farmers have learnt from the AIC while many more have learnt from the trained farmers. Households in Kamugul remain relatively conservative, depending largely on extensive grazing of indigenous animals and less on intensive agriculture. AIC has played a major role in disseminating new technologies and knowledge in Rokocho through training. New technologies may have been first disseminated through households nearer to the training centre. To explain differences in land use and livelihood diversification patterns between villagers or even between households in the later analysis (in Section 3,) access to AIC or a local training centre might be a key explanatory variable.

Tables 2.4.1 and 2.4.2 show the estimate on the changes in land use by the village. Because some households happen to own shambas, acquired through inheritance or purchase, in other villages, it is impossible to trace strictly land use changes per village.

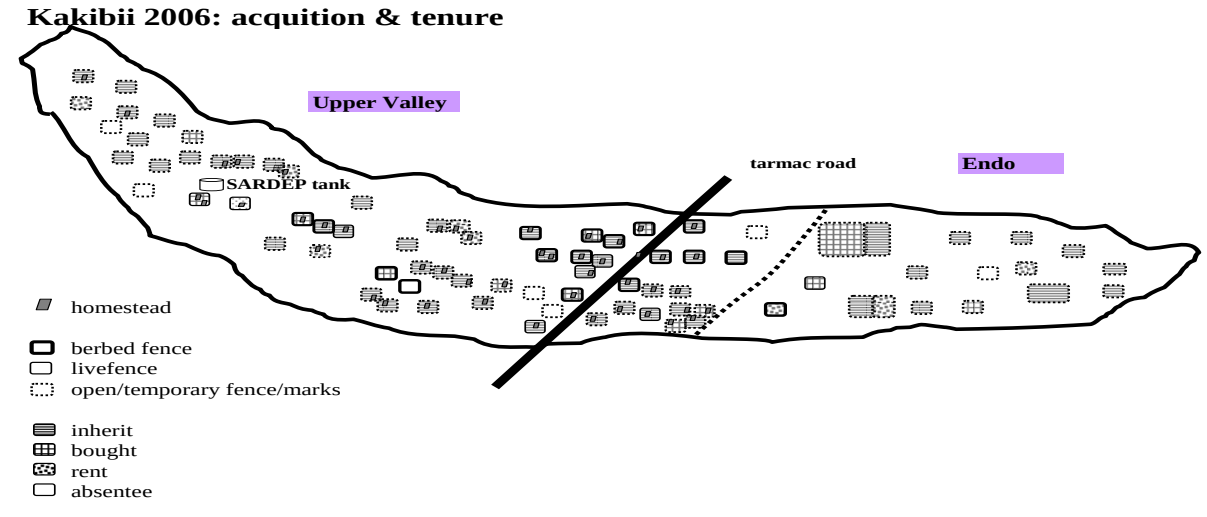
2.5: A case study from Kakibii village

Out of the three villages, plots (homestead and others) of the 47 Kakibii households (26%) were geo-referenced to produce maps on land use, tenure forms and livelihoods. Even without proper fences, villagers recognize the boundaries of individual shambas of their neighbours. Here, we provide images of landholding and land use changes in Kakibii.

2.5.1: Mode of acquisition

In 2006, most of the shambas were acquired through inheritance and sub-division while a few villagers bought plots. In Endo, some people hire shambas to plant staple-drought resistant crops.

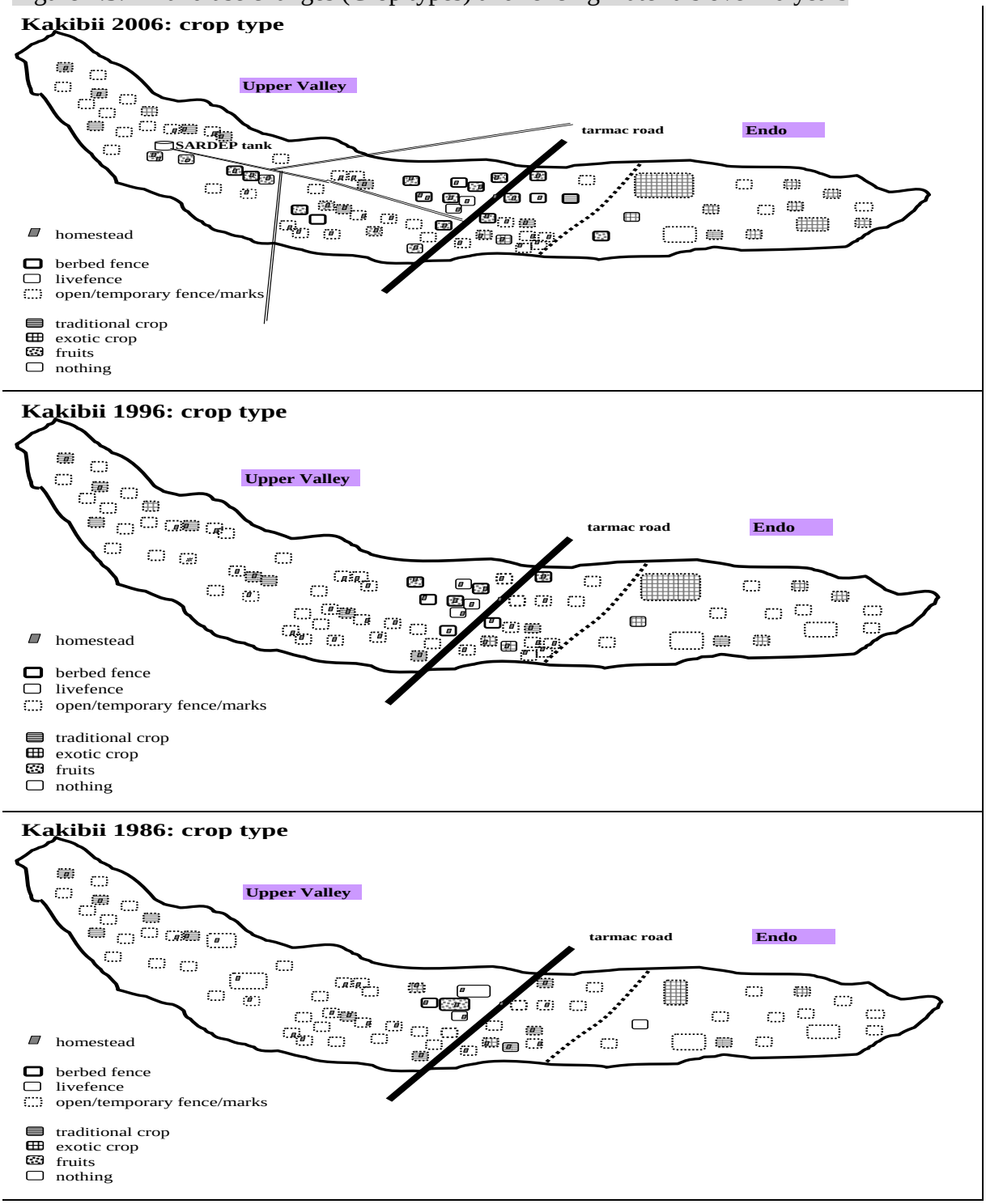
Figure 2.5.2–Means of acquisition of shambas by 2006

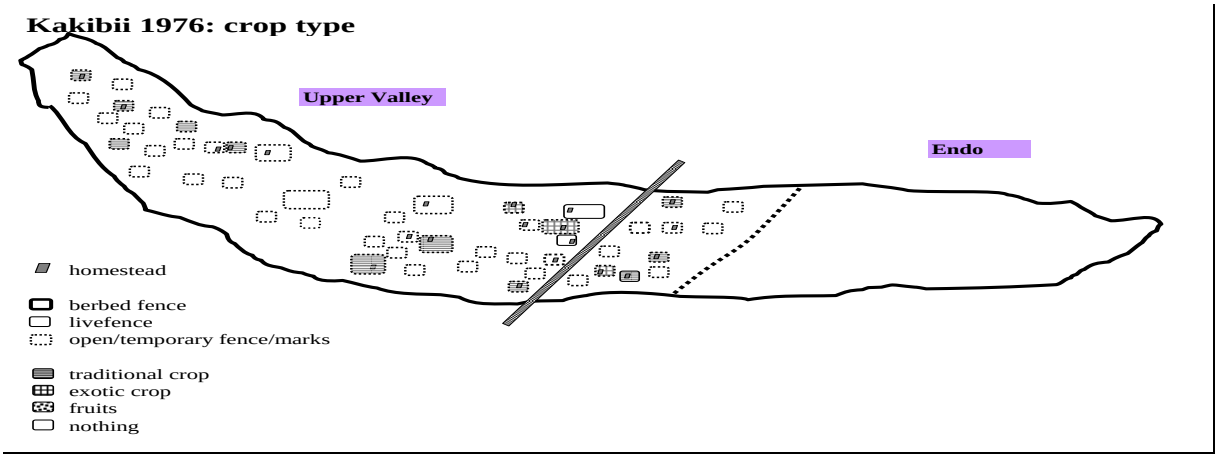


2.5.2: Land use changes

Land use in Kakibii in 2006 is shown in Figure 2.5.2. There were more farmers planting fruits on plots fenced with barbed wire near water tanks along tarmac roads than those planting staple food crops in unfenced shambas in Endo. Drought-resistant crops were common in upper parts, along with bushy ones.

Figure 2.5.2–Land use changes (Crop types) and fencing materials over 40 years





In summary, land use in Kakibii may have evolved over the decades with human settlement and development as shown below.
by 1976: Land in Endo had not yet been sub-divided. Open grazing commonage for the clan
by 1986: Land in Endo was demarcated in 1978. Tarmac road was completed in 1985
by 1996: A few shambas got fenced. A few started planting fruits
by 2006: SARDEP water tank in 1999. More fenced, more fruits shambas, more rented shambas.

3. Livelihood diversification patterns: determinants and implications

3.1:Data and analytical framework

Rokocho Valley community consists of 177 households in three villages. All the households were enumerated to determine livelihood diversification and the effect on welfare and the environment (high-return or subsistent crop, livestock, off-farm activities, as well as aspects of intensification). A questionnaire was designed to capture variable aspects of livelihood diversification in "types" and "combination" of activities.

Box 3.1.1–Variables collected using the household questionnaire

HOUSEHOLD / HOMESTEAD CHARACTERISTICS AND INCOME PROFILES
*family, gender, clan, martial status /educational attainment, participation in farmers' group, migration experience
*homestead characteristics: access to town, markets, AIC
*off-farm (regular/casual/remittance):crop (traditional / exotic / fruits):livestock: (traditional / exotic)
LAND AND CROP PRODUCTION
*no. / acres / % of land ownership (owned / hire / borrow)
*no./acres/% of land fenced (barbed wire /livefences / no)
*no. / acres/ % of land in terms of acquisition (inherit / bought / hire /borrow)
*no./acres/% of land used & cultivated / rented out
*no./acres/% of crop type (with traditional crop / exotic crop / fruits / commercial crop)
* labour, manure-fertilizer inputs, yield and revenue in ksh, per shamba (% of home consumption, surplus)
ANIMALS AND LIVESTOCK MANAGEMENT
* no. of exotic / traditional animals and how/when they were acquired

* net-gross income (sales of milk & animals - costs) from exotic / traditional animals
* where to graze livestock (family / own village / others, upper/Endo, zero-grazing)

PERCEPTIONS

*changes in relative contribution of livelihood activities
*perceived incidents of animal trespassing in 1996 / 2006

In Kerio Valley, most households diversify their income sources into more than one including sub-groups of crops, livestock and off-farm income activities. In the following analyses, livelihood diversification patterns or portfolios as combination of sub-groups of crop, livestock and off-farm income activities are explained. Only a few households receive some income from leasing land. Dominant livelihood activities can be further classified into the following sub-groups with different economic returns and management incentives.

- crops: drought-resistant (sorghum, millet), staple foods (maize, beans), fruits, commercial (wheat, etc.)
- livestock: traditional (indigenous cattle, sheep, goats) or exotic (improved cattle, dairy goats)
- off-farm: regular (business, formal), casual (charcoal making, day labour), remittance
- land rental

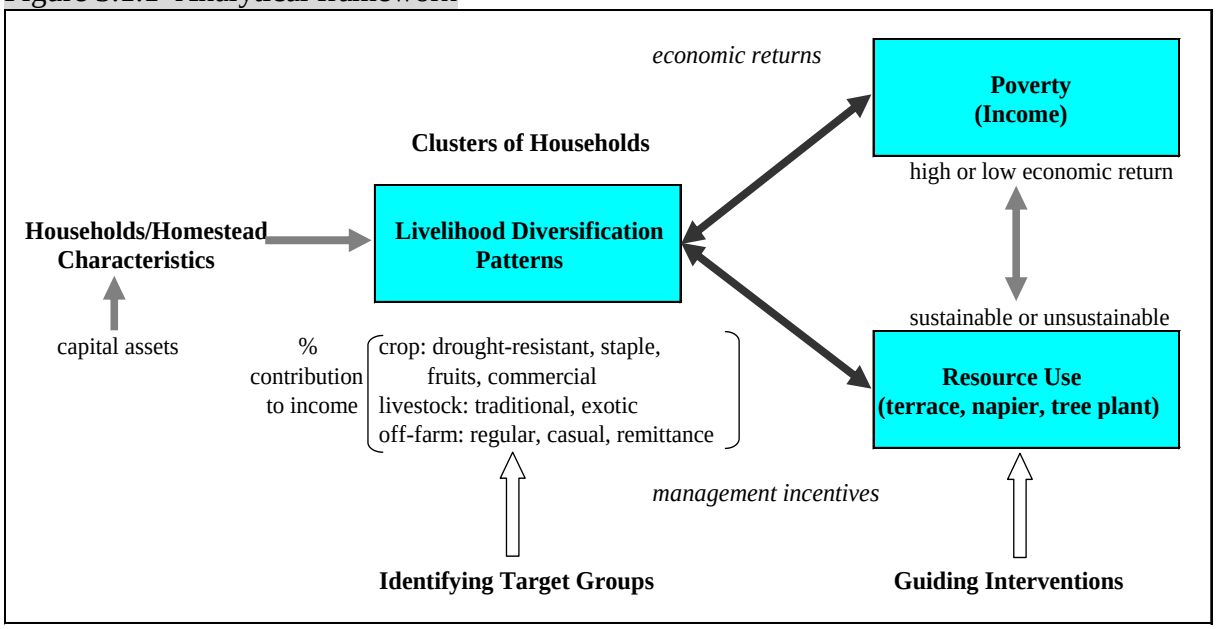
Here, analytical processes are explained briefly. Figure 3.1.1 shows a conceptual framework. The 177 households of the study area were classified into groups with similar patterns of livelihoods diversification. For deriving typologies of household livelihood strategies, variables indicating percentage contribution of each livelihood activity to the total income were used as described by Ellis (2000) and Freeman and Ellis (2005). For example, a household was characterised as primarily pursuing a livelihood strategy if it obtains two-thirds or more of its income from an activity or combination of activities (Freeman and Ellis, 2005). In our study, rather than using the threshold of two-thirds of income, cluster analysis was used to sort out observable choice of activity and income data. Cluster analysis is very useful for the exploration of complex multivariate data (Everitt and Dunn, 2001). It should help in treating heterogeneous households in different ways in terms of extension strategies (Solano *et al*. 2001, Kristjanson *et al*. 2002).

Second, determinants of livelihood diversification strategies with logit regressions were examined. It is estimated that whether or not a household pursues a particular livelihood diversification pattern as a function of variables representing household/homestead characteristics (such as age, gender, education of the head, distance to a local training centre from homestead) and engagement in particular farm activities (acres devoted to particular crop types as well as livestock holdings by animal types). These variables can be interpreted as capital asset endowments of households, i.e. human (knowledge, labour) and financial (land, livestock) capital assets, and will help us understand their linkages with poverty and resource use through livelihood diversification patterns.

Third, the effects of particular livelihood diversification patterns on poverty were estimated. Types of livelihood activities which households are engaged in may have substantial impacts on income (Ellis and Freeman eds., 2005, Anderson and Deshingkar 2005). For example, livelihood portfolios dependent on subsistent crop/livestock activities can be associated with lower income than those dependent on high-return commercial crops and exotic livestock. Equally, a livelihood diversification pattern dependent more on casual off-farm income may tend to have lower income than the one dependent more on regular off-farm income. A

regression equation was tested to estimate whether variables representing clusters of livelihood diversification patterns have significant impacts on the level of total household income, along with household/homestead characteristic variables.

Figure 3.1.1–Analytical framework



Fourth, the effects of livelihood diversification portfolios on resource use were tested. Different livelihood diversification patterns may entail different incentives for resource use (Reardon and Vosti 1995; Barrett *et al.* 2002a; 2002b). For example, resource conservation investments or allocation of labour to natural resource management may not be a priority for the poor households dependent on off-farm income. While those dependent more on income from profitable cash crops and/or exotic animals may tend to invest more in resource bases on which they rely, households depending more on low-return subsistent farming might not afford to do so. For estimates of factors affecting resource investment measures, such as terracing and planting grass/trees, variables representing farm characteristics are often included, such as location, slope, soil type, etc (Clay *et al.* 2002; Freeman and Coe, 2002; Overmars and Verburg, 2006). For our study, variables representing physical characteristic of farms during the implementation of the survey were not collected. In this paper, because we are interested in the implications of livelihood diversification portfolios on decisions by households to invest in resource conservation measures, we examine whether the cluster variables affect implementation of resource conservation measures, while recognising some shortcomings.

3.2: Dominant livelihoods diversification patterns

Cluster analysis was performed, with variables representing the percent contribution of crop incomes (drought-resistant, staple, fruits, commercial), livestock incomes (traditional and exotic), off-farm incomes (regular, casual, remittance) and land rental income. Five clusters or dominant livelihood diversification patterns were identified (Table 3.2.1).

Table 3.2.1-Clusters of livelihood diversification patterns

cluster characteristics	**[1] casual off-farm income**	**[2] traditional livestock grazing**	**[3] exotic crop**	**[4] fruits+ exotic animal integration**	**[5] regular off-farm income**
main components					
CROP	exotic	exotic	exotic+++	fruits +++	fruits
LIVESTOCK	traditional	traditional+++	traditional	exotic	both animals
OFF-FARM	casual+++	casual	casual	remmitance	regular+++
no. of households	61(34%)	21(12%)	20(11%)	33(19%)	42(24%)
each component's contribution to total income(%)					
traditional crop	0.01	0.01	0.03	0.02	0
exotic crop	0.06	0.08	0.59	0.05	0.06
fruits	0.05	0	0.02	0.32	0.07
commercial crop	0	0	0	0.05	0.02
traditional livestock	0.08	0.73	0.16	0.09	0.08
exotic livestock	0.01	0	0	0.13	0.08
regular off-farm income	0	0.02	0.01	0.07	0.71
casual off-farm income	0.78	0.09	0.11	0.10	0
remittance	0	0.06	0.07	0.13	0
land rentak income	0.01	0.01	0.01	0.04	0
income in ksh					
total off-farm income(ksh/year)	26,589	10,400	17,690	21,948	113,407
total gross crop(ksh/year)	6,579	5,481	49,237	45,004	27,288
total livestock income(ksh/year)	3,668	31,687	13,703	28,141	21,531
land rental income(ksh/year)	123	57	870	1,403	268
total gross income	36,959	47,625	81,500	96,495	162,494

[1]Livelihoods pattern specialised in casual off-farm income (Charcoal burning)

Sixty-one households (34%) in Rokocho belong to this cluster. On average, their annual gross income is KES 36,957 [1](KES 3,000 per month). They derive 78% of their total gross income from casual off-farm income (KES 26,589 or KES 2,200 per month), 8% from traditional livestock and 5-6% from staple food crops and fruits. The main sources of casual off-farm incomes are in most cases, from charcoal burning activities (KES 200 bagx10-12 bags per month), and some time from casual labour (KES 100 day). They survive by exploiting natural resources in the form of felling trees in their villages.

[2]Livelihoods pattern specialised in traditional livestock

Twenty-one households (12%) in Rokocho households fall in this cluster. On average, their annual gross income is KES 47,625 (KES 4,000 per month). They derive 73% of their total gross income from traditional livestock (KES 31,687 or KES 2,640 per month), 9% from

[1] 1 Kenyan shilling (KES) was equivalent to 0.0142 US dollars (or US$1 was KES 70) in 2006.

casual off-farm income and 8% from staple crops. They should be considered conservative subsistent pastoralists.

[3]Livelihoods pattern with staple food crops, traditional livestock, casual off-farm income
Twenty households or 11% in Rokocho households belong to this cluster. On average, their annual gross income is KES 81,500 (KES 6,800 per month). They derive 59% of their total gross income from staple crop, 16% from traditional livestock, and 11% from casual off-farm income.

[4]Livelihoods pattern with fruits and exotic animal integration
Thirty-two households (19%) in Rokocho households fall in this cluster. On average, their annual gross income is KES 96,213 (KES 8,000 per month). They derive 32% income from fruits, while 14% is from exotic animals and 12% from remittance. One of the reasons why the households in this cluster tend to adopt new varieties, i.e. horticulture and exotic animals, can be attributed to information and knowledge from family members working elsewhere. Horticulture and exotic animals could be managed in a more integrated way. For instance manure from animals kept on their family shambas could be used on staple crops leading to higher yields (Iiyama, 2006).

[5]Livelihoods pattern specialised in regular off-farm income
Forty-one households (24%) in Rokocho households consist of this cluster. On average, their annual gross income is KES 163,666 (KES 13,500 per month), far higher than the other clusters. They derive 72% income from regular off-farm income (KES 115,295 or KES 9,600 per month), while 7-8% from traditional and exotic animals, and 6% from staple crop and fruits. They do not earn from casual off-farm income and remittance. Employment opportunities around the study area are few, and the households belonging to this cluster are those few regularly employed or running own business. Their occupations include teaching, business (brick-making, kiosks, middlemen), NGO staff, policemen and watchmen.

In comparison, while cluster [5] is highly specialised in regular off-farm income activity, [3] and [4] have more diversified their livelihood income sources in terms of the number of activities (i.e. crops, off-farm income, and livestock), than [1] and [2], deriving more than 70% of their income from casual off-farm and traditional livestock respectively. Furthermore, comparisons either between [1] and [2] or [3] and [4] tell us that components and combination of livelihood activities are different. While their average incomes from either casual off-farm or livestock are higher than those for the other clusters, they derive neither income from exotic animals nor crops. For example, cluster [3] is combining staple crop and traditional livestock, and more crop income than the other clusters, but between the activities there may be little integration. On the other hand, cluster [4] is integrating fruits production with exotic livestock, possibly with more intensive management (Iiyama, 2006b). While the differences in livelihood differentiation portfolios would not be the sole factors directly affecting income levels, they might also have environmental implications, through different management and resource use incentives (extensive/intensive).

3.3:Determinants of livelihoods diversification patterns

We tried to identify socioeconomic variables differentiating livelihood diversification patterns among households. Since we dealt with one small sub-location, the households share similar agroecological (in terms of climate) and physical (in terms of access to regional markets, etc.) conditions, while not in terms of walking distance to a local training centre, local markets and tarmac roads. It is important to know then why households are so heterogeneous in their choosing livelihood diversification strategies. We tentatively assumed that households with better access to knowledge on new ideas and varieties as well as to market and infrastructure would be more likely to choose high-return livelihood portfolios. Table 3.3.1 shows the results of logistic regressions to examine which variables would affect the probability for households to be in one particular livelihood cluster. Variables included those representing household characters (age, gender, education years of the head, years in involvement in farmers' group, experience of having stayed and migrated to the current location, minute distance to a local training centre, the number of family members in Adult Equivalent[2]), and those indicating involvement in particular crop-livestock activities, i.e., the size of land dedicated to particular crop types and the number of livestock holding in the Total Livestock Unit (TLU)[3]. The prediction ratios for each cluster were 79-92%.

For cluster [1] or livelihood pattern specialised with casual off-farm income activity, age and education years of the head, areas with drought-resistant and staple crops, and the numbers of exotic and traditional animals are all negative. This suggests that households with relatively young uneducated heads, rarely engaged in farming activities, as well as with fewer livestock tend to fall in this cluster.

For cluster [2], or livelihood pattern specialised in traditional livestock, minute distance to a local training centre and the traditional animals are significantly positive, while areas with drought-resistant crops and fruits are significantly negative. This implies that you find more conservative pastoral households having their homesteads situated relatively far from development agencies (and far from the tarmac road). They plant less fruits too.

For cluster [3], or livelihood pattern with staple crop along with casual off-farm and traditional livestock, the dummy variable to indicate whether a household migrated from outside areas, minute distance to a training centre, the number of exotic animals in TLU are significantly negative, while the areas with staple crop is significant and positive. This can be interpreted to mean that households specialised in staple crop are less likely to own exotic animals. Furthermore, old Rokocho members staying in the area for years and nearer to development agencies are more likely to fall in this cluster.

[2] A person over 15 is equivalent to 1AE, 0.65AE for over 5 to 14, and 0.24 for under 4.

[3] The TLU is calculated as following: a bull is equivalent to 1.29 TLU, cow 1 TLU, calf 0.7 TLU, sheep and goat 0.11TLU (Kristjanson *et al.* 2002).

Table 3.3.1–Determinants of livelihoods diversification patterns

	[1] casual off-farm				**[2] traditional livestock**				**[3] exotic crop**				**[4] fruits+exotic animal**				**[5] regular off-farm**			
no. of households	61(34%)				21(12%)				20(11%)				33(19%)				42(24%)			
	B	Sig.	Exp(B)		B	Sig.	Exp(B)		B	Sig.	Exp(B)		B	Sig.	Exp(B)		B	Sig.	Exp(B)	
age	-0.03	0.05	0.97	*	0.02	0.39	1.02		-0.01	0.75	0.99		0.01	0.53	1.01		-0.01	0.56	0.99	
gender dummy	-0.47	0.37	0.63		-1.27	0.13	0.28		-0.02	0.98	0.98		1.00	0.07	2.72	*	-0.75	0.38	0.47	
education years	-0.15	0.05	0.86	**	-0.25	0.16	0.78		-0.13	0.37	0.88		-0.11	0.17	0.89		0.28	0.00	1.32	***
years in farmer group	-0.07	0.32	0.93		0.04	0.52	1.04		0.00	0.98	1.00		0.05	0.23	1.05		0.05	0.36	1.05	
move dummy	0.68	0.18	1.97		0.97	0.18	2.63		-2.17	0.09	0.11	*	-0.48	0.40	0.62		-0.12	0.83	0.88	
min distance to AIC	0.01	0.28	1.01		0.02	0.06	1.02	*	-0.07	0.07	0.94	*	-0.01	0.39	0.99		-0.05	0.06	0.96	*
Adult Equivalent	0.21	0.16	1.23		0.30	0.15	1.35		-0.13	0.60	0.88		0.26	0.09	1.29	*	-0.01	0.97	0.99	
exoticTLU	-1.84	0.02	0.16	**	-78.53	0.98	0.00		-2.67	0.00	0.07	***	0.40	0.00	1.49	***	0.08	0.53	1.08	
traditionalTLU	-0.33	0.00	0.72	***	0.17	0.00	1.18	***	0.03	0.51	1.03		-0.03	0.51	0.97		0.02	0.67	1.02	
acres traditional crop	-1.08	0.09	0.34		-1.52	0.05	0.22	*	1.31	0.15	3.70		0.21	0.77	1.23		-0.05	0.95	0.96	
acres exotic crop	-0.56	0.02	0.57	**	-0.29	0.29	0.75		1.09	0.00	2.97	***	-0.07	0.58	0.93		-0.34	0.07	0.71	*
acres fruits	-0.17	0.44	0.84		-2.21	0.09	0.11	*	0.20	0.57	1.22		0.23	0.23	1.25		-0.15	0.48	0.86	
acres commerical crop	-1.55	0.21	0.21		-29.12	1.00	0.00		-31.12	1.00	0.00		0.37	0.52	1.44		0.41	0.51	1.50	
Constant	2.75	0.02	15.6	**	-3.74	0.09	0.02	*	-0.26	0.91	0.77		-2.94	0.04	0.05	**	-1.47	0.30	0.23	
-2 Log likelihood	143.17				65.01				65.58				126.79				128.26			
Cox & Snell R Square	0.38				0.30				0.28				0.20				0.31			
Nagelkerke R Square	0.52				0.59				0.56				0.33				0.47			
Prediction rate																				
no	82.61				98.08				98.73				95.17				93.33			
yes	73.77				52.38				45.00				34.38				57.14			
overall	79.55				92.66				92.66				84.18				84.75			

For cluster [4], or crop-livestock integration livelihood pattern, combining fruits and exotic animals, the number of exotic animals in TLU is significantly positive, while the education year of the head is negative. It is rather unexpected to have a negative sign for the education years of the head, because managing exotic animals would require expertise and knowledge for intensive grazing and better disease control. On the other hand, while this cluster derive proportionally more income from fruits, area planted with fruits is not significant. It may be possible that income from fruits might not be so much related to the areas fruit trees are planted, but more to the intensity, types of fruits, years since planted, and management.

Finally, for cluster [5] or livelihood pattern specialised in regular off-farm income, education years of the head is significantly positive, while minute distance to AIC and areas with staple crop are significantly negative. To get formal employment or start own business in the Rokocho where such opportunities are limited, education is essential. Shorter distance to or better access to development agency is also an important factor.

3.4: Implications on poverty

It is likely that there is a linkage between the types of livelihood diversification patterns and income level through differences in economic returns of livelihood components. We estimate effects of particular livelihood diversification portfolios along with variables representing household and homestead characteristics on the total gross income through ordinary least squares (OLS) estimation. We included the four dummy variables to represent the clusters: [1] specialisation in casual off-farm, [2] specialisation in traditional livestock, [4] fruit-exotic animal integration, [5] specialisation in regular off-farm, and excluded [3] staple crop livelihood pattern for control because this cluster was moderate in terms of the level of specialisation and contained the least number of households.

The result is shown in Table 3.4.1. The variables explained 38% of variances in the total gross income. The significant variables are age and education years of the head, participation years in farmers group, Adult Equivalent, and cluster [1] dummy. The cluster dummy [1], specialisation in casual off-farm, is negative, suggesting engaging in this livelihood pattern substantially reduce the total gross income by KES 42,000 annually. On the other hand, for variables representing household/homestead characteristics, households with older and educated heads as well as longer participation in local farmers group would have higher total income. Though not statistically significant, cluster [2] has a negative sign, indicating the livelihood pattern specialised in traditional animals is also somewhat associated with lower income due to diversification into a few low-return activities.

Table 3.4.1-OLS estimation of determinants of total gross income

	Unstandardized Coefficients			
	B	t	Sig.	
(Constant)	-50621.21	-1.40	0.16	
[1]casual off-farm cluster dummy	-47301.74	-2.36	0.02	**
[2]traditional livestock cluster dummy	-41970.21	-1.66	0.10	*
[4]fruits+exotic livestock cluster dummy	-16319.49	-0.73	0.47	
[5]regular off-farm cluster dummy	26816.27	1.19	0.24	
age	1332.01	2.89	0.00	***
gender dummy(male1,female0)	19684.32	1.31	0.19	
education years	7923.72	3.92	0.00	***
years in farmers group	3783.09	2.87	0.00	***
moved dummy	12888.13	0.95	0.34	
minute distance to AIC	-175.33	-0.66	0.51	
Adult Equivalent	5400.56	1.56	0.12	
R	0.66			
R Square	0.43			
Adjusted R Square	0.39			

3.5: Implications on resource use

Lastly, we estimate the implications of livelihood diversification patterns on resource use. We try to examine whether particular types of livelihood diversification might affect the decisions by households to undertake resource conservation measures, along with variables representing household/homestead characteristics. Table 3.5.1 shows the results of logistic regressions for the undertaking of terracing, planting napier grass[4], and tree planting[5]. Among the households, 57% answered they do terracing, 34% planting Napier grass, and 69% tree planting. The variables included were the same as for OLS regression to estimate the determinants of total gross income presented in Table 3.5.1. The overall prediction ratios were between 74.6 to 83.1%.

[4] Napier grass is a specialised planted fodder to feed animals, and widely grown in Kenya highland. Napier cultivation yields more fodder per land unit than is available through grazed pasture. If farmers choose to grow Napier instead of pasture, animals are generally stall-fed, sometimes exclusively (zero-, semi-zero-grazed), with the Napier then cut and brought to them (Staal *et al*., 2002). Napier also serves to protect soil erosion as planted along contours.

[5] Households were asked whether they plant trees, except fruit trees, for purposes to protect soil from erosions.

Note that terracing is more likely to be substantially influenced by farm-specific factors, such as slope and soil types (Clay *et al*. 2002). In Kerio River Basin in general, homesteads and shambas located in the upper Valley parts shall require more terracing, while those in flat parts in the lower Valley does not. Even terraces range from those requiring long-term construction (stone-terracing) to more temporary ones (Barret *et al*. 2002b; Freeman and Coe, 2002). Considering some biases by missing farm-specific variables, on the other hand, gender dummy and the cluster dummies for [1], [4], [5] are significant and all positive. This suggests households with male heads as well as livelihood patterns with specialisation in casual off-farm, fruit-exotic animal integration and specialisation in regular off-farm income, tend to increase the probability of undertaking the measure by households. While it is not clear why cluster [1] households invest in terracing, probably influenced rather by farm-specific factors, it is indicative that cluster [4] and [5] households would do more.

Table 3.5.1-Determinants of undertaking resource conservation measures

	TERRACE				NAPPIER				MULCHING				TREE PLANGING			
households practicing	101	57%			40	23%			49	28%			121	69%		
	B	Sig.	Exp(B)		B	Sig.	Exp(B)		B	Sig.	Exp(B)		B	Sig.	Exp(B)	
age	0.00	0.93	1.00		0.01	0.47	1.01		-0.01	0.42	0.99		-0.04	0.02	0.96	**
gendermale1female0	1.14	0.01	3.14	**	2.38	0.03	10.83	**	1.60	0.02	4.97	**	0.51	0.25	1.66	
education years	0.03	0.68	1.03		0.19	0.01	1.21	**	-0.01	0.84	0.99		-0.01	0.87	0.99	
years in farmer group	0.07	0.09	1.07	*	0.05	0.34	1.05		0.09	0.02	1.10	**	0.01	0.80	1.01	
moved dummy	-0.13	0.76	0.88		-0.65	0.22	0.52		-0.52	0.27	0.60		0.70	0.12	2.01	
minutes distance to AIC	0.00	0.94	1.00		-0.01	0.61	0.99		-0.03	0.11	0.97		0.01	0.46	1.01	
Adult Equivalent	0.08	0.44	1.09		0.13	0.35	1.14		0.06	0.60	1.07		0.10	0.37	1.11	
[1]casual off-farm cluster dummy	1.06	0.07	2.90	*	0.42	0.64	1.52		1.36	0.11	3.89		-1.48	0.02	0.23	**
[2]traditional livestock cluster dummy	-1.31	0.14	0.27		-0.41	0.77	0.67		0.42	0.72	1.52		-0.31	0.69	0.73	
[4]fruits+exotic livestock cluster dum	1.52	0.02	4.57	**	1.61	0.09	5.02	*	1.91	0.03	6.76	**	-0.12	0.87	0.88	
[5]regular off-farm cluster dummy	1.46	0.03	4.30	**	0.67	0.46	1.95		1.65	0.06	5.20	**	-0.50	0.51	0.61	
Constant	-2.07	0.06	0.13	*	-6.26	0.00	0.00	***	-2.66	0.07	0.07	**	-0.50	0.51	0.61	
-2 Log likelihood	195				138				168				190			
Cox & Snell R Square	0.22				0.25				0.20				0.15			
Nagelkerke R Square	0.30				0.38				0.29				0.21			
Prediction rate																
no	60.00				93.38				90.55				40.00			
yes	83.17				42.50				38.78				91.74			
overall	73.30				81.82				76.14				75.57			

For planting Napier grass, gender dummy, education years, and the fruit-exotic animal integration cluster [4] variables are significantly positive. This suggests that households with relatively educated male heads and those taking crop-livestock integration pathway are more likely to plant Napier grass. Because owners of exotic animals are more likely to manage their animals with zero/semi-zero grazing (Iiyama, 2006b) with intensive inputs, they might have incentives to plant grass feed by themselves on family plots.

Lastly, for tree planting, age of the head and cluster dummy [1] are significant and negative, while the dummy variable indicating the experience of having stayed outside is positive. This implies that households with younger heads subsisting on casual off-farm income are less likely to undertake tree planting, while those coming

from other areas tend to do more. These households have few options but felling and burning trees to sell charcoal for survival.

In summary, cluster [4] (integration of fruits and exotic animal) is more likely to undertake the measures. Cluster [4] take more measures than [5] (specialisation in regular off-farm), probably because households in [4] are more likely to be full-time farmers and able to allocate their labour to these resource investment measures, while the households in cluster [5] are either formally employed or engaged in business and could not allocate their time on daily basis. Cluster [1] is found positive with terracing but negative on tree planting. In fact, cluster [1] survive by cutting trees in open areas, therefore they are heavily dependent on natural resources without investing in them. Cluster [2] (traditional livestock) are found not significant with any of the measures, but its signs are all negative. While they should depend on natural resources through grazing animals, they do not make investment. Among variables representing household and homestead characteristics, gender affected terracing and Napier. Education increases the probability to plant Napier, while experience of having stayed outside positively affect tree planting.

4: Conclusions

In this study, an intensive case study on livelihoods diversification of the Kerio River Basin community is presented. Section 2 shows that, the community has experienced socioeconomic changes such as migration of people into the valley, gradual intensification of agropastoral activities, and integration into wider market economies, in response to development for the past few decades. Subsequently with the increase in human settlements and in development opportunities in the valley floor, households have more options for income diversifications, while perceiving increased needs for intervention to prevent environmental degradation. It is important that livelihood diversification patterns adopted by households meet both welfare and environmental goals. If not, there is a room for policy intervention and a need to identify target groups for such intervention,

Section 3 attempts to identify dominant livelihood diversification patterns derived from variables representing income contribution of sub-groups of crop, livestock and off-farm income activities. Their implications on poverty and resource use are examined. There were five dominant livelihood diversification patterns identified through cluster analysis: [1] specialisation in casual off-farm (34% of households), [2] specialisation in traditional livestock (12%), [3] staple food crops (11%), [4] fruit-exotic animal integration (19%), and [5] specialisation in regular off-farm (24%). Cluster [5] is highly specialised in high-return regular off-farm income activity, and [3] and [4] are more diversified in their income sources relative to [1] and [2]. More than half (58%) of the surveyed households are categorised as the two contrasting clusters heavily dependent on off-farm income activities, i.e. [1] or [5]. This finding confirms the trend reported by livelihood specialists that differentiation between

households based on non- agricultural activities in rural Africa has deepened (Ellis, 2000; Bryceson, 2002; and Ellis and Freeman, eds., 2005).

Livelihood diversification portfolios affect income levels through economic returns attached to components of livelihood activities. Low-return combinations of activities without much diversification, such as [1] and [2], yield little income, while low income does not allow households to move out of the vicious cycle of poverty traps. At the same time, livelihood diversification patterns also have environmental implications. These associations exist because of differences in management and investment incentives of resources attached to components of dominant activities. Households deriving most of their income from exploiting common natural resources are less likely to undertake resource conservation measures, while deriving few cash income flows from subsistent and extensive on-farm activities.

For the study area, the fact that a third of households falls in cluster [1] category is quite alarming, as they are surviving by exploiting common resources. Some suggestions can be inferred from the findings. Because both poverty and resource use are found associated with particular patterns of livelihood diversification, it should not be difficult to identify households in need of intervention through observing their livelihood patterns. It is not practical to expect the poor households without capital to promptly adopt livelihood diversification patterns with high economic returns but with high requirement for capital assets, and that is why they have remained as they are. Extension projects should promote alternative easier-to-adopt technologies of crop-livestock integration to targeted households.

For methodological issues, clustering method turned out to be useful in identifying targeting groups and guiding interventions at grassroot level. For example, among capital asset variables, education year of the head was found significant and negative for [4] as well as [1]. On the other hand, [4] was more associated with higher average income and better resource investment, while [1] was significantly associated with poverty and less investment in tree planting. This suggests that livelihood diversification portfolios derived from observable choice of activity and income data are better and easily identifiable criteria for targeting than capital asset endowments. The findings from this case study would contribute to linking sustainable livelihood approach and practical development policy formulations.

5. References

Anderson E. and Deshingkar P. (2005). 'Livelihood Diversification in Rural Andhra Pradesh, India', in Ellis and Freeman (Eds.), Rural Livelihoods and Poverty Reduction Policies. *London and New York: Routledge*. pp.62-81.

Ashley C. (2000). Applying Livelihood Approaches to Natural Resource Management Initiatives: Experiences in Namibia and Kenya. ODI Working Paper 134, London: Overseas Development Institute.

Ashley C. and Carney D. (1999). Sustainable Livelihoods: Lessons from Early Experience. London: Department for International Development.

Barrett C.B., Place F. and Aboud A.A. (2002a). Natural Resources Management in African Agriculture: Understanding and Improving Current Practices. Oxon and New York: CABI publishing.

Barrett C.B., Place F., Aboud A.A. and Brown D.R. (2002b). 'The Challenge of Stimulating Adoption of Improved Natural Resources Management Practices in African Agriculture', in Barrett et al. (Eds.), Natural Resources Management in African Agriculture: Understanding and Improving Current Practices. Oxon and New York: CABI Publishing. pp 1-21.

Bryceson, D.F. (2002) "The Scramble in Africa: Reorienting Rural Livelihoods." *World Development.* 30(5), pp.725-739.

Clay D.C., Kelly V., Mpyisi E. and Reardon T. (2002). 'Input Use and Conservation Investments among Farm Households in Rwanda: Patterns and Determinants', in Barrett, Place and Aboud. (Eds.), Natural Resources Management in African Agriculture: Understanding and Improving Current Practices. Oxon and New York: CABI publishing. pp 103-114.

Driscoll R. and Evans A. (2005). 'Second-Generation Poverty Reduction Strategies: New Opportunities and Emerging Issues'. *Development Policy Review*. 23(1), 5-25.

Ellis F. (1998). 'Household Strategies and Rural Livelihood Diversification'. *The Journal of Development Studies*. 35(1), 1-38.

Ellis F. (2000). Rural Livelihoods and Diversity in Developing Countries. Oxford: Oxford University Press.

Ellis F. and Bahiigwa G. (2003). 'Livelihoods and Rural Poverty Reduction in Uganda'. *World Development*. 31(6), 997-1013.

Ellis F. and Freeman H.A. (2004). 'Rural Livelihoods and Poverty Reduction Strategies in Four African Countries'. *The Journal of Development Studies*. 40(4), 1-30.

Ellis F. and Freeman H.A. (Eds.) (2005). Rural Livelihoods and Poverty Reduction Policies. *London and New York: Routledge*.

Ellis F. and Mdoe N. (2003). 'Livelihoods and Rural Poverty Reduction in Tanzania'. *World Development*. 31(8), 1367-1384.

Ellis F., Kutengule M. and Nyasulu A. (2003). 'Livelihoods and Rural Poverty Reduction in Malawi'. *World Development*. 31(9), 1495-1510.

Everitt B.S. and Dunn G. (2001). Applied Multivariate Data Analysis: Second Edition. London: Arnold.

Freeman A.H. and Coe R. (2002). 'Smallholder Farmers' Use of Integrated Nutrient-Management Strategies: Patterns and Possibilities in Machakos District of Eastern Kenya', in Barrett *et al.* (Eds.), Natural Resources Management in African Agriculture: Understanding and Improving Current Practices. Oxon and New York: CABI publishing. pp 143-154.

Freeman A.H. and Ellis F. (2005). 'Implications of Livelihood Strategies for Agricultural Research: A Kenya Case Study', in Ellis and Freeman (Eds.), Rural Livelihoods and Poverty Reduction Policies. *London and New York: Routledge*. pp 198-212.

Freeman A.H., Ellis F. and Allison E. (2004). 'Livelihoods and Rural Poverty Reduction in Kenya', Development Policy Review. 22(2), 147-171.

Homewood K. (Ed.). (2005). Rural Resources and Local Livelihoods in Africa. New York: James Currey Ltd.

Iiyama M. (2006). Implications of Crop-Livestock Livelihoods Evolution on Welfare and Environment: A Case Study from Kerio River Basin Community. Land Use Change Impacts and Dynamics (LUCID) Project Working Paper 52: Nairobi, Kenya: International Livestock Research Institute.

Kristjanson P., Radney M., Nkedianye D., Kruska R, Reid R., Gichohi H., Atieno F., Sanford R. (2002). Valuing Alternative Land-Use Options in the Kitengela Wildlife Dispersal Area of Kenya. A Joint International Livestock Research Institute (ILRI) and the African Conservation Center (ACC) report undertaken for the Kitengela community. Nairobi: International Livestock Research Institute.

Kruseman G., Ruben R. and Tesfay G. (2006). 'Diversity and Development Domains in the Ethiopian Highlands'. *Agricultural Systems*. 88, 75-91.

Lélé S.M. (1991). 'Sustainable Development: A Critical Review'. *World Development*. 19 (6), 607-621.

Mizutani F., Kariuki P.C., Iiyama M., Matsumoto K., Kariuki P.N., Kiprono M., Cherwon K. and Kristjanson P. (2005). Kerio Valley Baseline Survey: Advancing Capacity of the Community through the Baseline Survey for Sustainable Rural Development in Marakwet and Keiyo Districts. Nairobi: International Livestock Research Institute in collaboration with Japan International Cooperation Agency.

Muchemi J., Mwangi W. and Greijn H. (2002a). 'Participatory Land Use Planning towards Community-based Natural Resource Management in the Districts of Keiyo and Marakwet, Kenya: A GIS and Remote Sensing Approach', mimeo. http://www.ermisafrica.org/doc/kmplup.pdf.

Muchemi J., Mwangi W. and Greijn H. (2002b). 'GIS in support of participatory land use planning in the Districts Keiyo and Marakwet, Kenya', http://www.gisdevelopment.net/proceedings/gisdeco/sessions/ muchepf.htm.

Murray C. (2001). Livelihoods Research: Some Conceptual and Methodological Issues. Background Paper 5. Chronic Poverty Research Centre, University of Manchester.

Overmars K.P. and Verburg P.H. (2006). 'Multilevel Modelling of Land Use from Field to Village Level in the Philippines'. *Agricultural Systems*. 89, 435-456.

Pender J., Jagger P., Nkonya E. and Sserunkuuma D. (2004). 'Development Pathways and Land Management in Uganda.'. *World Development*. 32 (5), 762-792.

Place F. Swallow B.M., Wangila J. and Barrett C.B. (2002b). 'Lessons for Natural Resource Management Technology Adoption and Research', in Barrett *et al*. (Eds.). Natural Resources Management in African Agriculture: Understanding and Improving Current Practices. Oxon and New York: CABI publishing. pp. 275-285.

Place F., Franzel S., DeWolf J., Rommelse R., Kwesiga F., Niang A. and Jama B. (2002). 'Agroforestry for Soil-Fertility Replenishment: Evidence on Adoption Processes in Kenya and Zambia', in Barrett, Place and Aboud. (eds.), Natural Resources Management in African Agriculture: Understanding and Improving Current Practices. Oxon and New York: CABI publishing. pp.155-168.

Reardon T. and Vosti S.A. (1995). 'Links between Rural Poverty and the Environment in Developing Countries: Asset Categories and Investment Poverty'. *World Development*. 23(9), 1495-1506.

SARDEP. (2002a). Strengthening Capacities: Empowering Local Communities, Semiarid Rural Development Programme, 1999-2001, Mid Term Progress Report. Iten: The Semi-Arid Development Programme.

SARDEP. (2002b) SARDEP Keiyo/Marakwet, Participatory Land Use Plans for Community-based Natural Resource Management, Transect E. Iten: The Semi-Arid Development Programme.

SARDEP. (2002c). SARDEP Keiyo/Marakwet, Participatory Land Use Plans for Community-based Natural Resource Management, Transect H. Iten: The Semi-Arid Development Programme.

SNV Kenya. (2001). Outline for SARDEP Strategy Development Based on Districts Analyses of Poverty, Target Groups and the Institutional and Governance Environment in Kajiado, Laikipia, Keiyo and Marakwet Districts, Kenya. Nairobi: SNV Netherlands Development Organization-Kenya.

Solano C., León H., Pérez E. and Herrero M. (2001). 'Characterising Objective Profiles of Costa Rican Dairy Farmers'. *Agricultural Systems*. 67, 153-179.

Staal S.J., Baltenweck I., Waithaka M.M., deWolff T. and Njoroge L. (2002). 'Location and Uptake: Integrated Household and GIS Analysis of Technology Adoption and Land Use, with Application to Smallholder Dairy Farms in Kenya'. *Agricultural Economics*. 27, 295-315.

Swallow B. (2005). 'Potential for Poverty Reduction Strategies to Address Community Priorities: Case Study of Kenya'. *World Development*. 33 (2), 301-321.

Williams T.O., Tarawali S., Hiernaux P. and Fernández-Rivera S. (Eds.). (2004). Sustainable Crop-Livestock Production for Improved Livelihoods and Natural Resource Management in West Africa. Nairobi: International Livestock Research Institute.

Zaal F. and Oostendorp R.H. (2002). 'Explaining a Miracle: Intensification and the Transition Towards Sustainable Small-scale Agriculture in Dryland Machakos and Kitui Districts, Kenya', *World Development*. 30 (7), 1271-1287.