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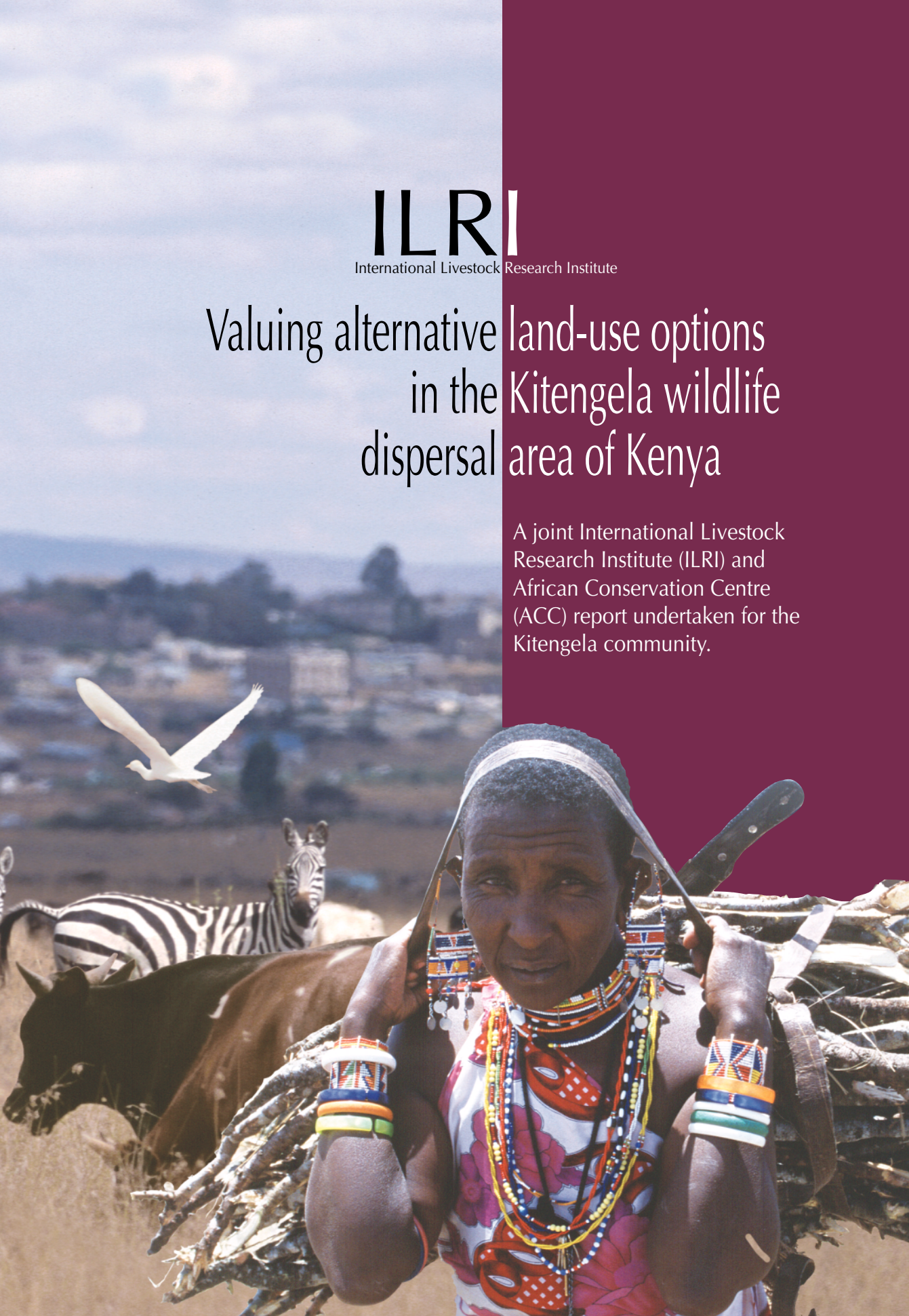
A joint International Livestock Research Institute (ILRI) and African Conservation Centre (ACC) report undertaken for the Kitengela community.



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Abstract

East African pastoral and wildlife systems are currently undergoing severe stress due to a combination of trends including increased human population pressure, economic structural changes and privatisation of land tenure. These are ecosystems with the richest large mammal biodiversity on earth. Most of this wildlife is outside parks in pastoral grazing areas. Pastoralists in Kenya are facing rapid and widespread changes in their traditional lifestyles and appear to be getting poorer. Within the Kitengela wildlife dispersal area adjacent to the renowned Nairobi National Park (NNP), conflicts between landowners and wildlife are becoming more frequent, with serious and potentially irreversible implications for both the communities and the wildlife.

This study builds on a previous socio-economic survey undertaken by the African Conservation Centre (ACC) in 1999 within the Kitengela wildlife dispersal area. Motivated by requests from community members, the primary objective of this follow-up study was to provide critical and timely information to help inform the search for land-use activities that will lead to protection of wildlife corridors and dispersal areas and, at the same time, maximise returns from the land. The second objective was to explore ways in which to integrate the economic data being supplied by the households with information that has been gathered in recent years by ecologists regarding wildlife distributions and patterns in this area. Since there were few empirical studies upon which to model this type of integration of economic and ecological data (particularly within pastoral systems), the approach taken here was fairly novel.

A formal household survey was carried out on a relatively small sample of 35 out of the original 171 households interviewed in 1999. Detailed (and sensitive) information was sought regarding revenues, costs, income sources and income levels under various land-use options. The 35 households were then statistically grouped into four clusters, with each cluster made up of relatively homogeneous households with respect to socio-economic and location characteristics. The range of economic activities covered by the survey included livestock production, subsistence crop production, quarrying and off-farm income (including wage labour, informal sector employment, remittances from relatives and income from investment in businesses).

The results show considerable variation across households„ landholdings, herd size, herd management, level and diversification of income sources and cropping practices. Thus the cluster analysis was useful in terms of distinguishing different types of livelihood strategies with respect to both socio-economic characteristics and geographic determinants of opportunities (e.g. distance to market).

Income from livestock production was generally low and much lower in years in which the long rains failed. Net livestock income averaged around KSh 20,000 per adult equivalent (AE) per year, or roughly US$ (256), per AE per year. On a per acre basis, the

average net income from livestock activities alone was KSh 1400/acre per year, or US$ 17.95. Milk revenues were important to most households and highly dependent on the timing and levels of rainfall across all clusters, and surpassed the value of reported milk consumption.

While 80% of surveyed households grew crops, for most households it is not a profitable undertaking because when crop output was valued at market prices, the costs of production generally outweighed the potential revenues.

The different types of households (i.e. clusters) varied both in the importance of alternate income sources and in levels of income. The market-oriented cluster had the highest levels of annual net income (and highest off-farm income). The traditional cluster had the lowest annual net income (with 90% of total household income coming from livestock). One-third of the respondents had no access to off-farm income, but for the remainder, it can be a very important livelihood option, with some of the ‚wealthiest„ households deriving well over half of their income from off-farm sources.

Overall net income per AE levels ranged from KSh 1772–4956/month. This places all of the Kitengela clusters above the rural poverty line (the amount of money considered by the Government of Kenya to generate inadequate income levels to feed, clothe, educate and pay for basic health care for their families). Two groups fall under the urban poverty line (which is arguably more appropriate for households located so close to Nairobi), and the third group is barely above it. The market-oriented group, with its smaller average family size, earns roughly twice the income per adult of the established urban poverty line. However, over half of the households (54%) earned less than a dollar a day per adult equivalent, a widely used global measure of poverty. Another 26% earned less than US$ 2 per day, 14% earned between US$ 2 and US$ 4 per day and only 2 households (6%) earned over US$ 4 per day per AE.

Looking at the spatial distribution of livestock returns per acre, along with an examination of the spatial distribution of five species of migratory wildlife during the dry season, revealed that there are some households earning very little from livestock even in areas with relatively few wildlife. There were also areas with a lot of wildlife where households earn high livestock income. These observations do not lend support to the notion that households in the densest wildlife areas are worse off. There was no easily discernible spatial pattern to net incomes per person.

The findings of this study were presented in a workshop with community members and were well received. Information received from the community was very useful in interpreting the survey results. Several lessons were also learned regarding methodology, and future analyses will attempt to incorporate more ecological variables in the initial cluster analysis (e.g. measures of soil fertility and degradation, water availability), and averages from several years of aerial survey data, as well as explore methods of using remote sensing data.

1 Introduction

Rapidly increasing human population and changing socio-economic lifestyles (leading to greater natural resource exploitation) have been identified as the greatest threats to wildlife conservation within rangelands the world over (WRI 1997; Ellis et al. 1999; Foran and Howden 1999). Within East Africa, changes in land policies, high human population growth rates, and rapid changes in people„s expectations over the past few decades have resulted in the expansion of cultivation, growth in the number of permanent settlements, urbanisation and diversification of land-use activities around conservation areas. All of these factors have contributed to unprecedented human–wildlife conflicts (Western 1982; Ellis et al. 1999).

The change in land policy from communal to individual landholdings has facilitated a market-oriented economy, which tends to promote expansion of crop agriculture and commercialisation of livestock production systems within rangelands (Galaty 1994). Consequences of these changes on land-use patterns include declining ecological, economic and social integrity of rangelands due to fragmentation of landscapes, declining rangeland productivity, diminishing wildlife migratory corridors, wildlife populations and diversity, and cultural and economic diversification due to immigration (Gichohi et al. 1996).

In Kenya and many parts of the world, protected areas have proved to be too small to sustainably maintain long-term, viable wildlife populations and diversity (Newmark 1993). In Kenya, for example, more than 70% of wildlife is found outside parks and game reserves on private and communally owned lands within pastoral areas/rangelands (Western and Pearl 1989). In the past, under communal landholdings, wildlife coexisted freely with people outside the protected areas. Recently, Kenya has experienced rapid changes in land policies that have transformed former pastoral communal lands into group and individual ranches and private holdings. These changes in tenure systems have led to emergence of a myriad of land-use systems including rain-fed and irrigation crop agriculture, permanent settlement, land sales, quarrying and tented camping sites within private ranches. These changes in land-use are thought to impact negatively on wildlife conservation and pastoralism as a way of life. Given reduction in land sizes and connectivity, pastoral mobility and livestock grazing areas have been reduced/curtailed due to fragmentation, fencing and cultivation. Left with few or no alternatives, pastoralists are struggling to survive in this harsh environment by diversifying their land-use activities, despite the fact that the conditions are not always suitable for the land-use choices they are making. Therefore the role of wildlife dispersal areas and migratory corridors outside the protected areas is critical to wildlife conservation in Kenya. Given the observed high rate of land sales and fragmentation within the rangelands, viable wildlife corridors need to be established before it is too late.

Wildlife–human conflicts have escalated in recent years in areas adjacent to the parks because of changes in land-use, and particularly in response to the expansion and intensification of arable farming, inadequate wildlife control and a ban on hunting. These changes have contributed immensely to the hardships of landowners, who tend to invest and lose more money as they try to cope with the wildlife challenges in their land-use enterprises. Despite the changes in socio-economic lifestyles of the pastoralists, few systematic, comprehensive and objective studies on the returns to the various land-use options (including wildlife) have been done. Past studies mainly focused on the effects of pastoral land policy changes on livestock productivity (Bekure et al. 1991; Rutten 1992; Homewood 1995). Understanding relative economic returns of different land-use options is an important prerequisite to rational and transparent policy formulation and integration of the present conflicting demands of wildlife habitat, tourism/recreation, livestock grazing, crop agriculture and other developments within pastoral rangelands (Western and Gichohi 1993; Ellis et al. 1999). A primary objective of this study is to provide critical and timely information to decision-makers regarding these often conflicting pastoral land-uses.

The study builds on a previous household socio-economic survey undertaken by the African Conservation Centre (ACC) in 1999 within the Kitengela pastoral area adjacent to the renowned Nairobi National Park (Mwangi and Warinda 1999). With the changes in socio-economic conditions, conflict between landowners and wildlife in this area is increasingly becoming a major issue. This study aims at informing the search for land-use activities that will lead to protection of wildlife corridors and dispersal areas and, at the same time maximise returns from the land. In addressing the challenges that surround changes in land-use patterns and economic activities pursued by landowners, the study attempts to address the following questions:

1. What are the socio-economic characteristics of the families living within the Kitengela wildlife dispersal area?

2. What is the range of economic returns to the different land-use options?

3. What incentives exist or can be introduced to encourage wildlife conservation on private lands?

The study attempts to provide information that will help answer these questions for community members, policy makers and other stakeholders involved in wildlife conservation. An opportunity-cost approach was taken to estimate economic returns to existing land-use options and other income-generating activities pursued by Kitengela landowners. In Kenya, valuing alternative uses of land is viewed as one possible approach for estimating the compensation value for wildlife, since wildlife hunting is

illegal and wildlife do not have a recognised market value (other than from tourism) (Norton-Griffiths 1995). The research team used a partial budgeting approach proposed during a stakeholder workshop held in March 2000. A formal household survey was carried out on a relatively small sample of households in order to obtain information on revenues, costs and incomes of the households (comprehensive and sensitive information, hence the small sample). Information on the relative returns of land under various uses is expected to contribute towards a more realistic appraisal of the marginal value of the land (i.e. the value of one additional acre[1] of land) as well as the wildlife that depend on it. A second objective of the study was to look at spatial income-distribution patterns, i.e. do relative economic returns show any discernible spatial patterns and how do they relate to certain geographic factors such as the distance of the household to Nairobi National Park, water sources, the nearest shopping centre, and the closest tarmac road?

1.1 Changing land-use in Kitengela

Land tenure policies have changed considerably within Kenyan pastoral areas over the last 40 years. Until the mid-1960„s, land in the pastoral systems was held communally. After Kenya achieved independence from colonial rule, the government encouraged private land ownership in pastoral systems, with the aim of intensifying and commercialising livestock production (Galaty 1994; Homewood 1995). The first major step in privatisation was the introduction of the Group Lands Representatives Act in 1968, which provided for the adjudication of group ranches (Thompson et al. 2000). Under the Kenya Livestock Development Project (Phase I) funded by the World Bank, each large communally owned piece of Maasai land was adjudicated into several group ranches[2] (Grandin 1989). At the same time, some individuals were also able to register titles over privately owned ranches. Group ranches ranged from 3000 to 151,000 ha, while the individual ranches averaged 800 ha.

Group ranches were seen as a compromise between the Government„s preference for individual tenure and the production requirements of a semi-arid zone that necessitates greater mobility of animals than can be attained under a tenure system that is entirely private. Communal land tenure of large territories and a group ranch approach allowed wildlife to coexist freely with the livestock. However, as a result of inefficiencies and failures in the operation of the group ranches, the Maasai started pressing for subdivision. The government officially authorised subdivision of ranches in mid-1983. The Kitengela

[1] 1 acre = 0.4047 hectares.

[2] Group ranches are organisational structures in which a group of people have a freehold title to land, and aim to collectively maintain agreed stocking levels and to herd collectively, although livestock are owned and managed individually.

group ranch, made up of 18,292 ha and 214 registered members, was subdivided in 1988. After subdivision of the group ranch, land fragmentation and sales have continued at a steady and escalating, pace.

Transitions in land tenure have led to changes in land-use activities in the Kitengela ecosystem. This ecosystem acts as a wildlife dispersal area and migratory corridor for Nairobi National Park. Maasai pastoralists in this area have diversified into economic activities other than traditional livestock production. In addition, its close proximity to the city of Nairobi has attracted non-Maasai and increased the pressure for land for permanent settlement, industrialisation and speculation. This area is threatened with increasing human population, permanent settlement and fences, social pressures on traditional Maasai lifestyles and industrialisation of the Athi-River and Kitengela townships. These new developments interfere with the seasonal wildlife migratory routes and reduce wildlife ranges and available habitats. These changes in socio-economic conditions and land-use activities appear to be contributing to escalating conflicts between landowners and wildlife in the area neighbouring Nairobi National Park.

The Kitengela conservation area covers approximately 390 km^2 (GOK 2001b). When Nairobi National Park was established in 1946 under the National Parks Ordinance of 1945, it was immediately recognised that it was too small to meet the ecological requirements for existing migratory wildlife species. Kitengela plains and the Ngong Hills were thus declared conservation areas. However, the status of Kitengela was never legalised and although referred to as a Game Conservation area, the land is now privately owned. The Kitengela area therefore presents a great challenge to conservation. The threats arise from several factors, including increasing human population and settlement along the Mbagathi River (predominantly by the expatriate community who pay high prices to live within view of Nairobi National Park) and the development of the Export Processing Zone (EPZ) in Kitengela town. The EPZ is an industrial park for the manufacture of export goods. Locating the EPZ within this wildlife area has created the following problems:

- Rapid expansion of Athi-River and Kitengela towns into the wildlife habitat as a result of development of subsidiary/ancillary industry and various types of infrastructure supporting the industrial zone.
- Rapid subdivision of land in the neighbourhoodflthe land is purchased largely by non-Maasai, and in turn the funds are used by the old landowners to fence off the remaining tracts of land, for the purpose of defining individual boundaries or keeping wildlife off the land. Land sales have also provided capital for investment in business in nearby towns and led to settlement expansion.
- Expansion of stone quarrying activities within Kitengela, resulting in conversion of good grazing land into wasteland.

The human population within the Kitengela area has more than doubled in the last 10 years, from 6548 in 1989 to 17,347 in 1999 (GOK 1994a; GOK 1994b; GOK 2001a; GOK 2001b). At the same time, the number of households increased nearly five-fold from 1989 to 1999 (1044 to 5005 households). The high population growth rate experienced in this area has been attributed mainly to in-migration, due to Kitengela„s proximity to Nairobi and increasing urban development occurring in the proximity of the town. The immigrants are mainly from the Kikuyu and Kamba communities.

1.2 Livestock and wildlife populations

Livestock and a large number of wild herbivores dominate the Kitengela ecosystem, with wildebeest and zebra constituting over half the total wildlife population. Other wildlife species include: Maasai giraffe, Coke„s hartebeest, black rhino, African buffalo, Grant„s gazelle, Thomson„s gazelle, eland, impala and waterbuck and predators such as lions, cheetahs and leopards as well as a high diversity of bird life. The ecosystem forms an important part of the wet season dispersal area for wildlife that lives part of the year in Nairobi National Park.

Aerial surveys conducted in the Kitengela dispersal area and Nairobi National Park in June 1996 and July 1997 revealed that domestic herbivores (i.e. livestock) accounted for up to 80% of the total herbivore population in 1996, and 86% in 1997 (Gichohi and Sitati 1997). Nineteen species (5 domestic and 14 wild herbivores) were counted within an area of 2750 km^2 in 1996 and 2925 km^2 in 1997 at the beginning of the dry season. Total herbivore (wild and domestic) estimates were 192,862 in 1996 and 272,981 in 1997. However, only 11 wild herbivore species were observed in 1996 compared to 14 in 1997. The increase in herbivore population of 42% was reported to be statistically significant and resulted in a change in herbivore density, from 70/km^2 in 1996 to 90/km^2 in 1997. Domestic herbivores accounted for the largest increase of 52%. This could be attributed to a larger sample area in 1997 compared to 1996 and the absence of three wild herbivore species in 1996. The three species (warthog, waterbuck and oryx) occur in small numbers and could have been totally missed during the 1996 survey. The area has experienced a 50% loss of wildlife populations over the past few years (Table 1). These changes in herbivore populations have been largely attributed to changing conditions resulting from increasing human population and livestock and other human activities, as well as climatic changes. Frequent droughts have also occurred in the recent years especially from 1991 to 1994 and in 1996/1997.

Table 1 also shows that livestock numbers declined markedly in the area until recently. Between 1990 and 1996, 45% of all livestock were also lost from the system. In one year, 1997, livestock populations recovered by more than 50%.

Table 1. *Kitengela and Nairobi National Park wild herbivore and livestock population 1990–97.*

Year	Wild herbivore population	Livestock population
1990	73,711	295,660
1992	74,395	237,925
1993	53,771	184,434
1994	38,437	163,954
1996	38,437	154,425
1997	38,693	234,288

Source: Gichohi and Sitati (1997).

1.3 ACC pastoral survey

The objectives of the 1999 ACC pastoral household survey were to examine the impacts of the wildlife corridor on the welfare of the local community, assess the acceptability of an easement programme to the landowners in the area based on their willingness to accept financial compensation in exchange for allowing free movement of wildlife and examine and propose solutions to the major socio-economic challenges that have hindered development in the area (Mwangi and Warinda 1999). The survey focused on the socio-economic factors associated with sustainable livestock production systems and wildlife conservation in the area and succeeded in describing the range of economic activities pursued by Kitengela landowners although it did not estimate the returns to these activities.

The 1999 survey found that landowners in this area suffer frequently from wildlife-related problems. Over 93.5% of the households interviewed reported a very significant increase in human–wildlife conflicts caused by increased livestock numbers, lack of economic benefits from wildlife, increasing human population, increased risks of human attack, severe competition for water and grass and frequent predation. Each respondent reported an average loss of KSh 15,903 annually through wildlife-related damages. Livestock predation by wild predators is common during the wet season, with some livestock killed in the homestead paddocks at night, and others as they graze during the day. Up to 50 attacks were reported, compared to 20 during the dry season. To reduce human–wildlife conflicts, over 94% of the landowners decided to fence their homesteads, 83% their cultivated lands, 16% the grazing lands, while 3% the fallow

land. Over 68% of the respondents reported willingness to leave part of their land (between 0.5–250 acres) unfenced, if in return they were paid a modest sum of money for accommodating wildlife.

The second objective of the 1999 survey, therefore, was to find out what ‚a modest sum of money„ for accommodating wildlife amounted to. Thus it tested a contingent valuation approach to valuing wildlife by asking respondents how much money they would be willing to accept in order to compensate for wildlife losses incurred on their land (i.e. to keep their land open for the use of wildlife as well as their livestock). Unfortunately, the range of responses (i.e. value of compensation) was so large that this methodology for valuing the land under alternative uses was deemed questionable, and another approach was sought. The average annual amount of financial compensation demanded per household/respondent was KSh 60,022 (roughly US$ 920) per acre.

Based (in part) on the findings of the ACC survey, Friends of Nairobi National Park (FONNAP, a non-governmental organisation) initiated a pilot land-leasing project in 2000. Landowners were paid KSh 300/acre (approximately US$ 3.80/acre) per year in return for agreeing to leave their land open to wildlife and not engage in quarrying, fencing, land subdivision and sale or poaching activities. The pilot project started in April 2000 with a total of 214 acres initially signed up under the lease programme. This increased to 2708 acres in January 2001. As of April 2001, there were 8415 acres on the waiting list. Plans are underway to raise at least US$ 3 million and invest it in an endowment fund where the interest will be used to pay for the leases, consequently ensuring sustainability of the programme. FONNAP partners include the Wildlife Trust based in California (USA) and Kenya Wildlife Trust in the UK, Kenya Wildlife Service (KWS), International Fund for Animal Welfare (IFAW)–East Africa, Africa Wildlife Foundation (AWF) and African Conservation Centre (ACC) among others. The lease programme will be strengthened with the purchase of critical pieces/parcels of land. This ambitious lease programme was officially inaugurated at the launching of the Nairobi National Park Migration Appeal in November 2000.

1.4 Summary of findings from related studies

The problem of human–wildlife conflicts has also been reported in Koiyaki (group ranch), Lemek and Olchoro-Oiroua (individual holdings) in Maasai Mara (Thompson et al. 2000). Apart from competing with the livestock for water and pasture, wildlife facilitates the transmission of certain livestock diseases, increasing veterinary care costs. Wildlife also increases the cost of maintaining fences around bomas and other structures, indirectly through labour. While predation was cited as a serious problem in these areas, damage caused by disease was much higher. About 5% of livestock deaths were due to predation and approximately 50% due to disease.

In Maasai Mara, revenue-sharing programmes have been initiated through the formation of wildlife associations that include Koiyaki-Lemek and Olchoro Oiroua Wildlife Trusts. These associations generate income through a game-viewing fee charged to tourists camping and staying in lodges located on these lands. In addition, there are smaller associations of landowners that deal with individual or groups of tour operators. These form the main mechanism by which income from tourism is made available to group ranch members.

The income is paid out as dividends to individual members, or through investment in community infrastructureflroads, schools, health facilities and water projects. The positive benefits from wildlife in these areas thus have the potential to offset the negative impacts of predation. In a privately owned ranch that manages livestock and wildlife in Laikipia district (Mizutani 1998), loss of livestock to carnivores was reported to be relatively small compared to losses from disease (Table 2). The magnitude of loss to carnivores depended on the type of habitat, policies of livestock management and availability of natural prey.

Table 2**.** *Mean annual percentage loss of cattle and sheep by different causes on the Lolldaiga Hills ranch, Laikipia District, 1971–93.*

Cause of losses	Cattle	Sheep
Disease	49.9	59.4
Accident	11.9	5.8
Theft and missing	14.0	13.4
Snake bite	0.9	2.6
Carnivores	23.2	18.8

Source: Mizutani (1998).

In Mbirikani and Kimana group ranches near Amboseli National Park, similar human–wildlife conflicts were reported (Mbogoh et al. 1999). In these areas, causes of such conflicts included the transmission of diseases from wildlife to livestock, loss of livestock due to predation and loss of human life. In Mbirikani, income from wildlife tourism did not sufficiently offset the losses incurred by wildlife. In Kimana, apart from wildlife tourism enterprises, there is a wildlife sanctuary within the ranch that generates income directly from tourism. In addition to the wildlife-tourism enterprises, these group ranches receive annual grants of up to KSh one million from Kenya Wildlife Service (KWS), from the gate fee collections of Amboseli National Park as well as employment opportunities. There is a comprehensive ecological–economic study currently underway examining the underlying factors of land-use changes within several group ranches near Amboseli that takes a similar approach to the one used in this study (Burnsilver 2000).

2 Methods

The first challenge for this study was to limit the number of economic options to be analysed because the original ACC survey of 171 households demonstrated a wide range of resources and income or food generating activities; thus a ‚representative enterprise„ approach was sought. This is a partial budgeting approach that is commonly used to characterise and analyse crop farm enterprises, but has not been applied widely for semi-pastoral households such as those found in Kitengela (these households are described as semi-pastoral since livestock still move beyond the boundaries of the land that the household owns, but the household is based on a permanent site, usually with some cropping activities).

Table 3**.** *Descriptive statistics of 171 households from original survey and clustering variables.*

Selected variables	N		Mean	Median	Standard deviation	Minimum	Maximum
	Valid	Missing					
Age of respondent (years)	171	0	44	41	14	20	80
Number of dependents	169	2	8	7	5	0	30
Years of formal education	171	0	6	5	6	0	23
Length of stay in the area (years)	168	3	26	25	15	1	74
Amount of land owned (acres)	168	3	156	77	208	2	1,316
No. of cattle sold per year	167	4	4	2	7	0	50
No. of cattle owned (March 1999)	170	1	53	22	87	0	510
Annual milk sales revenue (KSh/year)	160	11	32,076	10,250	58,265	0	491,000
Annual quarrying revenues	170	1	11,635	0	57,407	0	600,000
Land under cultivation (acres)	170	1	2	2	2	0	15
Annual crop income (derived)	171	0	21,010	0	72,835	0	660,000
Kraal distance to the Nairobi National Park (NNP) edge (km)	162	9	7.3	5.9	6.1	0	22.7
Distance to the nearest water point (km)	162	9	1.3	1.2	1.0	0	6.2
Distance to the nearest tarmac road (km)	162	9	6.1	6.6	2.5	0.1	10.3
Distance to the nearest shopping centre (km)	162	9	9.4	9.1	3.1	3.2	16.6

Source: Mwangi and Warinda (1999).

While a large number of socio-economic factors were examined in the original ACC study, 15 variables were chosen as critical factors for a cluster analysis (described below). A brainstorming session with a stakeholder group judged these variables as the most important factors influencing households„ livelihood strategies. The aim of the cluster analysis was to come up with clusters (groups) of relatively homogeneous households

engaged in similar economic activities. The cluster analysis minimises the variation within a cluster, and maximises variation between clusters (Solano et al. 2001). A sample of households from each cluster was then targeted for a detailed survey (using structured questionnaires) aimed at calculating the revenues and costs of the livestock, crop and other income-generating options utilised by landowners in each cluster, using a partial budgeting approach. The 15 factors hypothesised to have a significant influence on households„ livelihood (or income-generating) opportunities are presented in Table 3.

Details of the statistical procedure used to come up with the household clusters are similar to those found in Solano et al. (2001). The steps involved are briefly described here. First, an initial factor analysis identified a smaller number of factors explaining the majority of the variation observed among the groups. Out of the 15 variables selected, 8 ‚factors„ were obtained in this initial step. This was followed by a cluster analysis of the 8 factors to identify relatively homogeneous groups of cases based on the 15 selected variables. Four principal clusters were identified, with 29, 39, 15 and 46 households. The total number of households captured in these clusters was 129. Table 4 shows the means of these 15 critical variables by cluster relative to the overall population means (of the 171 households surveyed).

Table 4. *Average values for critical variables by cluster.*

	Cluster 1 Traditional	Cluster 2 Near park	Cluster 3 Market-oriented	Cluster 4 Average	Weighted mean
Number of households	29	39	15	46	171
Age of respondent (years)	57	48	39	36	44
Number of dependents	13	7	9	6	8
Years of formal education	2	5	11	5	6
Length of stay in the area (years)	21	36	27	20	26
Amount of land owned (acres)	207	101	85	156	156
No. of cattle sold per year	4	6	2	3	4
No. of cattle owned (March, 1999)	40	55	46	53	53
Annual milk sales revenue (KSh/year)	30,937	43,966	21,934	22,335	32,076
Annual quarrying revenues (KSh/yr)	11,034	13,282	0	5,217	11,635
Land under cultivation (acres)	2	2	6	1	2
Annual crop income (derived)	9,876	14,121	27,867	8,889	21,010
Kraal distance to Nairobi National Park (km)	8.2	3.3	8.7	9.9	7.3
Distance to the nearest water point (km)	1.3	1.0	0.9	1.7	1.3
Distance to the nearest tarmac road (km)	9.1	11.8	6.7	8.7	6.1
Distance to the nearest shopping centre (km)	7.6	6.4	4.4	6.2	9.4
Gross revenues (milk, quarrying, crops) (KSh/yr)	51,847	71,369	42,790	36,441	

Source: Mwangi and Warinda (1999).

The description of the clusters as compared to the whole sample are given below:

- The first cluster includes pastoralists with relatively high landholdings, smaller than average cattle herd size, larger households, relatively low crop income, an older and less educated household head, and was given the description ‚traditional„. This group is located on average 8.2 km far from the park and 9.1 km far from the nearest tarmac road and 7.6 km far from the nearest shopping centre.

- The second cluster was a more diversified group, with relatively large cattle herds, higher revenues from milk sales and some crop and quarrying income. This group of households is located close to Nairobi National Park and has relatively good water point access. The name given to this cluster was ‚near park„.[3]

- The third cluster was called ‚market-oriented„ since it has more educated household heads, less land but with more of it under cultivation, tends to be closer to a tarmac road and a shopping centre, and is a non-quarrying group.

- The fourth group of households has the lowest gross revenues, is located farthest from the park, has the youngest household head, a smaller household size, average landholdings and cattle herd size, and low crop and milk earnings. Households in this group are quite distant from the nearest tarmac road, water point and shopping centre. It is referred to as the ‚average„ cluster.

Spatial distribution of the households by cluster in relation to the park within the wildlife dispersal area is shown in Figure 1. There are slight differences in climate within the dispersal area, with areas near the park receiving slightly more rainfall than areas to the south of the park.

Given the sensitivity of the questions, length of the survey, and the limited resources for the study, a relatively small sample (35 households) of the original households interviewed was targeted in this follow-up survey. A proportional number of households were selected from each cluster: 8 from the traditional cluster, 9 from the near park cluster, 6 from the market-oriented cluster and 12 from the average cluster. Primary data on revenues and expenditures for livestock production, crop production, and quarrying activities was collected from the households in September 2000. Secondary sources of

[3] Areas near the park are more prone to wildlife visits on the outward and return migration and the normal daily movements in and out of the park.

data such as crop prices and historical rainfall patterns were based on interviews with key informants.

Interviews of the Maasai households were typically based on a single visit to each household, with follow-up visits for information where the respondents gave conflicting information or when a household member who was not available during the first visit needed to be consulted. Spatial and descriptive analyses of the socio-economic variables are discussed in the sections that follow. The sample size was too small for meaningful econometric analysis.

There were difficulties during the survey arising from the drought that started in 1999 and lasted throughout 2000. By September 2000, there were a significant number of livestock deaths attributed to the drought. This made it difficult for the respondents to give accurate information regarding herd structure, size and breed, since the livestock had been moved considerable distances from home in search of pasture and water.

Since an objective of the survey was to capture the range of activities and returns to those activities and not their drought coping strategies, the respondents were asked for information regarding a typical good year (defined as both the long and short rains occurring) and a typical bad year (defined as the long rains failing).

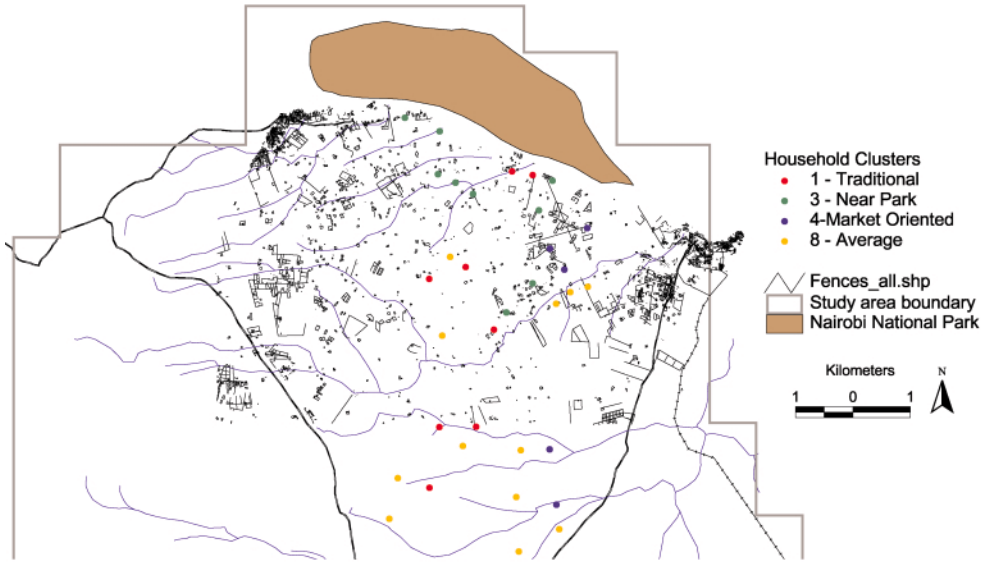

Figure 1. *Distribution of households within the study area.*

Source: ILRI (2000), based on 1994 aerial photography (Gichohi 1996).

3 Results

This section discusses the results obtained from the survey regarding household characteristics, production system (livestock and crop production), off-farm income and quarrying activities.

3.1 Household characteristics

Among the Maasai, a household is defined as all those living within the same homestead, i.e. within the same ‚enkang„ and typically includes the children, husband, wife and also members of the extended family. Out of the 35 respondents, 27 were males (77%) and 8 were females (23%). The household size, expressed in adult equivalents[4] (AE), ranged from 1.7 to 27.5 with an overall mean of 6.1 AEs per household. There were slight variations in household size between clusters with the near park cluster having large households (7.7 AEs) and the market-oriented cluster the smallest (4.2 AEs). The average household size in Kitengela is lower than that reported for Mbirikani (10.8 AEs), but higher than those reported for Kimana (4.1 AEs) (Mbogoh et al. 1999). The respondents were aged between 20 and 70 years with a mean of 40 years. There were no discernible variations in age between the clusters. The level of education (years of formal education) among the respondents averaged 6 years and ranged from no formal education at all to 20 years of education. About 24% of the respondents had no formal education, 47% had less than 10 years of education and 29% had more than 11 years of formal education. The market-oriented cluster had the highest average level of education (11.5 years), while respondents in the traditional cluster had the lowest level of education (4.4 years). Half of the respondents in the traditional cluster had no formal education at all. There was a significant correlation between age of respondent, level of education and household size. The younger respondents were more educated ($r = -0.52$, $p < 0.01$), with relatively smaller household sizes ($r = 0.49$, $p < 0.01$).

3.2 Production systems

Pastoralism has historically formed the central element of the Maasai production system living in the Kitengela area adjacent to Nairobi National Park. New employment opportunities have opened up in recent years in the area with the development of an export processing zone (EPZ) next to Kitengela town. This, coupled with opportunities to purchase land relatively close to Nairobi, has attracted non-Maasai immigrants to Kitengela.

[4] The concept of adult equivalent is based on the differences in human nutrition requirements according to age, where: <4, 5–14 and >15 years of age are equivalent to 0.24, 0.65 and 1 adult equivalent, respectively.

Some of the new landowners are interested (and more experienced than the Maasai) in growing crops. Others appear to be land speculators. There is also a small amount of commercial production of horticultural products for export occurring but not captured in this study.

While the local community (Maasai) still focus on livestock production, they have been diversifying into cropping (mostly maize, beans and potatoes for subsistence) and selling their land and investing in small businesses, wage labour and quarrying activities. Wage labour appears to be an increasingly important activity, including employment in both public and private sectors. The range of economic activities covered by the survey included livestock production, subsistence crop production, off-farm income (from wage labour, remittances from relatives and income from investment in businesses) and quarrying. All 35 households were engaged in livestock production, 28 households (80%) practiced crop production, 21 (60%) received some off-farm income and only 2 households (6%) were engaged in quarrying. To obtain more information regarding returns to quarrying, an additional four households were interviewed solely on their quarrying activities. While livestock production is still the dominant form of production (all households are involved), subsistence crop cultivation has become a central part of livelihood strategies, along with off-farm income from wage labour and business investments.

3.3 Livestock production

3.3.1 Livestock holdings

The Maasai keep cattle, sheep and goats (hereafter lumped together as ‚shoats„) and sometimes donkeys for transportation. The average number of cattle owned per household decreased from 71 in 1998[5] to 58 in September 1999 and 48 in September 2000, i.e. a 17% decrease in the drought year. The size of cattle herd per household ranged from 3 to 290. Similarly, the average number of shoats owned per household had decreased from 152 in 1998 to 88 in September 1999 and to 69 by September 2000, a 22% decrease from 1999 to 2000. Herd sizes continued to decrease after September 2000 and a halt in livestock deaths due to drought did not come until the end of the year. Average landholdings and herd sizes by cluster are shown in Table 5.

[5] Herd and flock sizes for 1998 were derived from the original ACC survey of 171 households in March 1999.

Table 5. *Average land and livestock holdings (absolute numbers) per household by cluster.*

Cluster	Land (acres)	Cattle		Sheep		Goats	
		Sept. 1999	Sept. 2000	Sept. 1999	Sept. 2000	Sept. 1999	Sept. 2000
‚Traditional„	247	53	42	73	57	27	22
‚Near park„	75	41	36	53	38	18	12
‚Market-oriented„	119	37	32	44	33	18	13
‚Average„	219	85	70	81	66	28	22
‚All households„	171	58	48	65	51	23	18

Average landholdings among the clusters ranged from 75–247 acres. Households in the drier area had approximately 3 times (219 acres) more land than households in the wetter area near the park (75 acres). The average cluster with the second highest landholding (219 acres) had the largest number of cattle (70) and shoats (88). Sheep represented 75% of the shoats while the rest (25%) were goats. The traditional cluster with the highest landholdings (247 acres) had 42 and 79 head of cattle and shoats, respectively. The average, traditional and near park clusters reported significant decreases over the year in the number of shoats, i.e. 19, 21 and 30%, respectively.

Livestock holdings were converted to tropical livestock units (TLU), where 1 TLU is equivalent to 250 kg live weight. The TLU enables us to come up with a homogeneous unit for livestock owned for comparison across clusters. In this study, a bull is equivalent to 1.29 TLU, a cow = 1 TLU, a mature steer = 1.05 TLU, a heifer = 0.7 TLU, an immature steer = 0.68 TLU, a calf = 0.4 TLU and a shoat = 0.11 TLU. The TLUs were derived using average weights of the different sex and age categories of cattle and shoats estimated from previous studies (King et al. 1984; Bekure et al. 1991; KARI/ODA 1996). These are shown in Appendix I.

Table 6. *Livestock holdings (TLU) by cluster.*

Cluster	TLU Sept. 1999	TLU Sept. 2000	Decline in herd size %	TLU/acre Sept. 1999	TLU/acre Sept. 2000	TLU/AE Sept. 2000
‚Traditional„	49.4	41.1	17	0.20	0.17	6.86
‚Near park„	38.7	33.3	14	0.53	0.46	4.83
‚Market-oriented„	35.0	29.6	15	0.31	0.27	6.85
‚Average„	74.5	62.3	16	0.34	0.29	12.58
‚Weighted mean„	52.8	44.4	16	0.31	0.26	8.30

Household herd sizes in September 2000 ranged from 2.4 to 236.7 TLUs. Livestock holdings per acre across the clusters ranged from 0.17 to 0.46 while TLU per adult equivalent across clusters ranged from 4.8 to 12.6 (Table 6). The traditional cluster with the highest landholdings had the lowest TLU per acre. The TLU per adult equivalent for this cluster was almost half that of the average cluster. The near park cluster with the smallest average landholdings and the highest TLU per acre had the lowest TLU per adult equivalent resulting from the relatively large household size (7.7 AEs). The highest TLU/acre thus corresponds to the wettest area of Kitengela wildlife dispersal area. The average cluster with the second largest landholdings had the highest livestock holdings and TLU per adult equivalent, respectively. The market-oriented cluster had the lowest livestock holdings (29.6 TLU) and the second highest TLU per acre (0.29). There was a significant positive correlation between herd size and landholding ($r = 0.4$, $p < 0.01$). Similarly, households with more dependents had larger herds ($r = 0.6$, $p < 0.01$).

The average livestock holdings, TLU per acre and TLU per adult equivalent across all households were 44.4, 0.3 and 8.4, respectively (Table 7). The TLU:AE ratio in Kitengela is 50–70% lower than those reported for Talek, Aitong, Lemek, and Nkorinkori locations in Mara (Thompson et al. 2000).

Table 7**.** *Livestock holdings (TLU) in other areas and group ranches.*

	Average TLU per household	Average TLU per acre	Sample (n)	Source
Kitengela	44.4	0.26	35	This study (2001)
Olkarkar	150.0	0.24	40	Bekure et al. (1991)
Merueshi	130.3	0.10	36	·
Mbirikani	125.6	0.09	250	·
Kimana	28.0	0.37	34	Mbogoh et al. (1999)
Mbirikani	51.0	0.77	27	·
Talek	152.1		25	Thompson et al. (2000)
Aitong	135.6		16	·
Lemek	116.7		21	·
Nkorinkori	99.1		14	·

However, the average TLU per acre of land in Kitengela is much higher than those reported for Olkarkar, Merueshi and Mbirikani group ranches in eastern Kajiado in 1982 (Bekure et al. 1991). This can be attributed to decreasing/smaller landholdings over time. A similar study (Mbogoh et al. 1999) in Kimana and Mbirikani group ranches with average landholdings of 73.8 and 66.6 acres, respectively, reported higher livestock holdings per acre. Although the Kitengela study was conducted in a drought year, the

observed livestock unit per adult equivalent was much higher than those reported for Kimana and Mbirikani group ranches in 1999. Since resource endowments and use under individual land tenure is expected to be different from that in a group ranch and there are ecological differences between the two areas, the comparisons above should be interpreted carefully. The average TLU per acre for all households in Kitengela decreased from 0.31 in September 1999 to 0.26 in September 2000. Across all households, average livestock holdings decreased from 75 TLUs in 1998 to 52.8 in 1999 and 44.4 in 2000, i.e. a decrease of 41% in the past two years. The declining trend in livestock holdings was attributed to diseases (especially after the El Niño rains in 1997/98), increased livestock sales due to cash demand for household needs, recent droughts (1996/97 and 1999/2000), predation, slaughter for home consumption and possible underreporting of actual numbers of animals by some landowners.

3.3.2 Annual offtake and acquisition

Maasai livestock transactions can be grouped into two major categories: offtake and acquisition. Several methods have been used to compute offtake. Bekure et al. (1991) computed total offtake rate of a herd as sales, exchanges, gifts given out and slaughter. Acquisition was defined as purchases, exchanges and gifts received. Nyariki and Munei (1993) computed offtake rate of a commercial ranch as sales only as a measure of output destined for the market. The present study considers sales and slaughter for offtake and purchases for acquisition. Our approach did not capture exchanges and gifts. Over the September 1999 to September 2000 period each of the 35 households sold, on average, 5 cattle and 8 shoats. Table 8 shows reported rates and values for annual offtake and acquisition of livestock per household across the clusters by type of transaction.

Table 8. *Annual offtake and acquisition of livestock by value, rate and transaction type.*

Cluster	Offtake value and rate		Sales and slaughter	Acquisition value and rate	
	Sales (KSh)	Slaughter (KSh)	as a % of total holdings[1]	Purchases (KSh)	Purchases as a % of total holdings
‚Traditional„	46,995	1,830	5.7 (9.4)	9,325	1.4 (1.4)
‚Near park„	37,866	5,378	8.7 (4.4)	10,822	2.7 (0.8)
‚Market-oriented„	80,498	17,642	9.0 (17.6)	17,633	0.8 (7.6)
‚Average„	57,560	1,991	16.2 (18.6	8,217	2.2 (1.8)
‚Weighted mean„	54,013	5,508	9.4 (11.5)	10,754	1.5 (2.6)

1. The figures in brackets represent offtake rates for shoats.

Sales represented the most important reason for offtake of livestock. Across all clusters, sales accounted for over 80% of reported offtake value while slaughter accounted for only 3 to 18% of the offtake value. Annual livestock sales value among the clusters ranged from KSh 37,867 to 80,498. The market-oriented and average clusters had higher livestock sales, with annual sales value of KSh 80,498 and 57,560, respectively. The traditional and near park clusters had lower livestock sales, valued at KSh 46,994 and 37,867 (Table 8). Livestock sales revenue and herd sizes were highly correlated ($r = 0.6$, $p < 0.01$), i.e. households with large herds sold more livestock. The average annual value of livestock sales per household in Kitengela (KSh 54,013) was higher than that reported for Talek (KSh 33,020), but slightly lower than those reported for Lemek (KSh 56,315) in Maasai Mara (Thompson et al. 2000). Offtake rate (as % of total livestock holdings) ranged from 5.7 to 16.2% for cattle and 4.4 to 18.6% for shoats. The average and market-oriented clusters had higher offtake rates than did the traditional and near park clusters for cattle and shoats. Livestock acquisition rates were much lower than offtake rates.

3.3.3 Livestock losses

The number of cattle that died from September 1999 to September 2000 accounted for 15% of the total herd with cluster averages ranging from 10–20% (Table 9). Livestock losses were significant in the traditional (19.8%) and market-oriented (19.5%) clusters. Seventeen percent of the sheep flock and 22% of the goats died during the period as well (and the fact that so many shoats died is a strong indicator of the seriousness of the 1999 drought). Disease and starvation were the major causes of livestock death in the study area during this particular year. East coast fever (ECF) was the prevalent disease affecting livestock, and other diseases mentioned were foot-and-mouth disease (FMD), brucellosis and malignant catarrh fever (MCF).

Table 9. *Livestock losses September 1999 to September 2000 (% of the total herd/flock size in September 1999).*

Cluster	Cattle	Sheep	Goats
‚Traditional„	19.8	21.9	27.4
‚Near park„	10.2	16.6	32.5
‚Market-oriented„	19.5	17.1	22.8
‚Average„	12.8	13.7	12.9
‚Weighted mean„	14.5	16.8	21.8

3.3.4 Herd structure

The structure of cattle herds for the 35 Kitengela households surveyed was classified by age and sex. The results are shown in Table 10.

Table 10. *Cattle herd structure by cluster, September 2000.*

Age and sex of animals	‚Traditional„	‚Near park„	Percent of herd ‚Market-oriented„	‚Average„	‚Weighted mean„
Calves	23	25	20	27	26
Steers	17	23	23	19	18
Bulls	3	2	2	3	3
Heifers	15	12	12	19	17
Cows	42	38	38	33	36

The proportion of the different sexes and age categories ranged from 20–27% for calves, 17–23% for steers, 2–3% for bulls, 12–19% for heifers and from 33–42% for cows. All herds had a large proportion of females (heifers and cows), ranging from 50–57%. The observed herd structure is consistent with those reported for Central division of Kajiado district (Rutten 1992) and Kajiado district as a whole (ASAL 1990).

3.3.5 Livestock gross annual output

Gross annual output of the livestock production system was calculated as the aggregate values of:

- Livestock and by-products sold by the household, including milk, live animals, manure, hides and skin sales.
- Livestock and by-products consumed within the household, including livestock slaughtered and milk consumed.
- Borehole and dip revenues, revenues from traction and revenue from any other livestock or their products (e.g. eggs, chickens).

Actual and average market prices were used to value output sales and consumption. The average livestock sales prices and prices of livestock products reported during the survey are shown in Table 11.

Mature steers fetched the highest prices in the study area. Prices for immature steers were slightly higher than for heifers. There were slight price differences across the different categories of shoats. Gross livestock annual output values for a good and a bad year are summarised in Tables 12 and 13.

Table 11. *Average prices of livestock and products (KSh) in the year 2000.*[1]

Type of animal/product	Market price	Type of animal/product[2]	Market price
Immature steer	7,931	Buck	1,561
Mature steer	15,750	Doe	1,612
Heifer	7,000	Milk	32
Cow	11,441	Manure	3,286
Ram	1,775	Hide	539
Ewe	1,499	Skin	34

1. Prices which respondents received upon selling livestock/livestock product.
2. Milk = KSh/litre, Manure = KSh/lorry, Hide = KSh/hide, Skin = KSh/skin.

Table 12. *Summary of gross annual livestock output in a good year*[1] *(KSh).*

Gross output	‚Traditional„	‚Near park„	‚Market-oriented„	‚Average„	Weighted mean	% of gross output value
Sales						
Cattle	34,500	33,700	58,834	41,342	40,811	24
Shoats	12,494	4,167	21,664	16,216	13,202	8
Milk	61,500	51,917	43,875	59,500	55,329	32
Manure	9,375	10,556	22,500	20,709	15,814	9
Hides and skin	3,351	2,600	3,524	3,238	3,150	2
Sub-total	121,220	102,940	150,397	141,005	128,306	74
Consumption						
Livestock	1,830	5,378	17,642	1,991	5,508	3
Milk	32,961	44,644	31,975	40,688	38,445	22
Sub-total	34,791	50,022	49,617	42,679	43,953	26
Other revenues[2]	450	0	1,533	0	365	0.2
Gross total						
Per household	156,462	152,961	201,547	183,685	172,625	100
Per acre	633	2,029	1,694	839	1,010	
Per TLU	3,807	4,593	6,809	2,948	3,888	

1. Both the long and short rains occurring.
2. Other revenues include borehole, dip and traction revenues and revenue from any other livestock or their products (e.g. eggs, chicken).

Table 13. *Summary of gross annual livestock output in a bad year[1] (KSh).*

Gross output	‚Traditional park„	‚Near oriented„	‚Market„	‚Average„	Weighted mean	% of gross output value
Sales						
Cattle	34,500	33,700	58,834	41,342	40,811	30
Shoats	12,494	4,167	21,664	16,216	13,202	10
Milk	33,000	36,083	18,375	29,625	30,129	22
Manure	9,375	10,556	22,500	20,709	15,814	12
Hides and skin	3,351	2,600	3,524	3,238	3,150	2
Sub-total	92,720	87,106	124,897	111,130	103,106	76
Consumption						
Livestock	1,830	5,378	17,642	1,991	5,508	4
Milk	21,745	39,025	14,706	28,313	27,233	20
Sub-total	23,575	44,403	32,348	30,304	32,742	24
Other revenues[2]	450	0	3,405	0	686	0.5
Gross total						
Per household	116,746	131,508	160,650	141,435	136,533	100
Per acre	473	1,753	743	1,189	798	
Per TLU	2,841	3,949	5,427	2,270	3,075	

1. Long rains fail.

2. Other revenues include borehole, dip and traction revenues and revenue from any other livestock or their products (e.g. eggs, chicken).

In a good year, about 74% of the gross value of livestock output can be considered commercial and 26% for home consumption purposes (Figure 2). Revenues from borehole, dip, traction and other livestock or their products accounted for less than 1% of total gross output. A major difference between a ‚good year„(defined as both rains occurring) and a ‚bad year„(defined as the long rains failing) was reflected in annual revenues from milk sales and the amount and value of milk consumed. Gross revenues from livestock in a good year (including the value of livestock products consumed) per household ranged from approximately KSh 150,000 to 200,000 (Table 12). Cash revenues[6] ranged from approximately KSh 102,000 to 140,000 and made up 67–78% of gross livestock output across clusters. Gross livestock output per acre ranged from KSh 633 for the traditional cluster to KSh 2029 for the near park cluster.

[6] Revenues from sale of livestock and livestock products, excluding value of consumption.

The mean gross livestock output value for the 35 households surveyed was KSh 172,625. Gross output per TLU ranged between KSh 2948 and 6809. The market-oriented cluster had the highest gross output value per TLU, which may be due to the much higher value of cattle sales (and relatively high offtake rates seen in Table 8) for this group of households. Table 13 summarises livestock related revenues in a bad year.

Even in bad years, cash revenues from animal, milk, manure, hides and skin sales make up roughly 76% of the total value of the livestock enterprise for the Maasai households. Annual livestock sales revenues in a bad year ranged from KSh 33,700 to 58,834 for cattle, and from KSh 4167 to 21,664 for shoats (Table 13). Livestock sales represented 32% of gross annual livestock output. The market-oriented cluster had the highest value of livestock sales of KSh 80,498. Table 13 shows that income from the sale of manure is not insignificant (in some cases it is higher than income from milk sales), with average manure revenues varying between KSh 9375 and 22,500 per cluster. Skin and hides revenue was similar and low across all clusters. Revenues from manure, hides and skin accounted for approximately 11–14% of the value of gross annual livestock output. Revenues from boreholes, traction, dips and other livestock and their products were negligible.

The value of milk sales in a good year across clusters ranged from KSh 43,875 to 61,500, with an overall mean of KSh 55,329 (Table 14). The more traditional pastoralists earn the most from milk in a good year, but not necessarily in a bad year, when they typically earn half as much money from milk as they do in a year when both rains occur. In a bad year, households located closer to the park earn about two-thirds as much as in

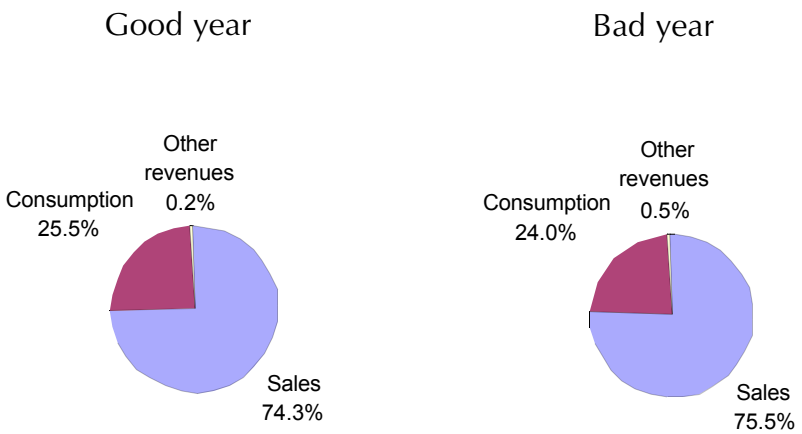

Figure 2. *Contribution of sales, consumption and other revenues to gross livestock output.*

a good year from milk sales, but they still appear to fare better than other members of the community due to higher sales and consumption of milk.

Table 14. *Milk sales revenue and consumption value by cluster.*

Cluster	Average gross milk sales: annual revenue (KSh) Good year	Bad year	Average gross milk consumption: annual value (KSh) Good year	Bad year
‚Traditional„	61,500	33,000	32,961	21,745
‚Near park„	51,917	36,083	44,644	39,025
‚Market-oriented„	43,875	18,375	31,975	14,706
‚Average„	59,500	29,625	40,688	28,313
‚Weighted mean„	55,329	30,129	38,445	27,233

Total milk production (sales and consumption) accounted for 54 and 42% of the gross annual livestock output in a good and a bad year. Milk sales alone accounted for 32% in a good year. Average milk production in a good year during the wet (17.5 litres/day) and dry (8 litres/day) seasons was approximately twice as much as production levels in a bad year, with a wet season production of 9.6 litres/day and dry season levels of 4.5 litres/day.

The household consumed about 33 and 39% of the total milk produced per day in a good year during the wet and dry seasons, respectively. In a bad year, household milk consumption increased to 41 and 49% of total output in dry and wet seasons. The average value of milk consumed in a good and a bad year represented about 22 and 20% of the total value of gross livestock output. For all households, average milk sales

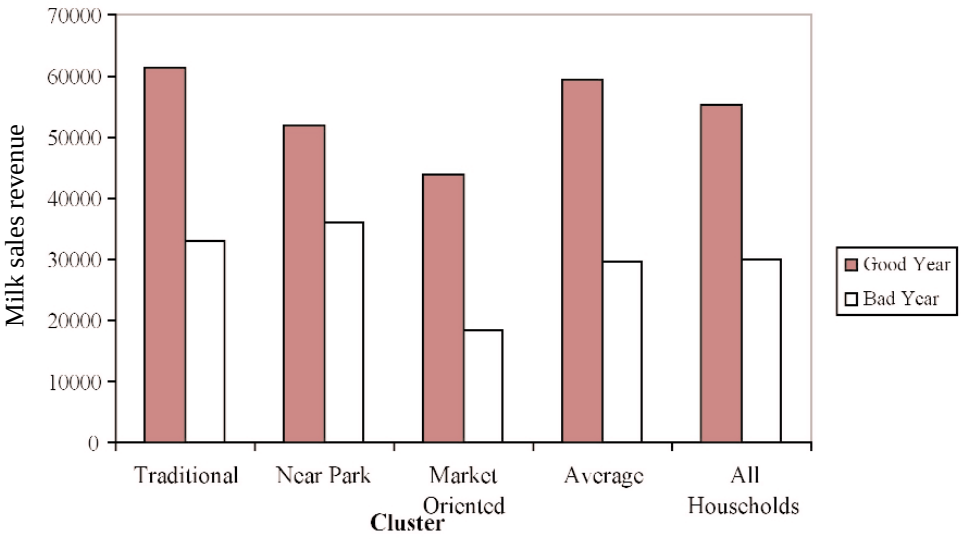

Figure 3. *Annual milk sales revenue by cluster (KSh).*

revenue fell from KSh 55,329 in a good year to KSh 30,129 in a bad year (a 46% decrease). Across clusters, the average decline in milk sales revenue ranged from 31% for the near park cluster to 58% for the market-oriented cluster (Figure 3). Fifty-nine percent of the milk produced is sold, and 41% is retained for household consumption in a good year. The value of livestock slaughtered for home consumption was negligible, at 3% of the total value of gross annual livestock output. Out of this, shoats accounted for 34% of the value of livestock slaughtered for consumption.

3.3.6 Livestock input costs

Livestock input costs include the following:

- veterinary care (vaccines and curative drugs)
- spraying (acaricides), deworming and dipping costs
- hired labour
- mineral supplements
- livestock purchases
- watering and supplement feeds
- operating capital and maintenance costs.

Cash expenditures on individual inputs are summarised in Table 15. The major difference in livestock input expenditures in a good versus a bad year are reflected in the cost of drugs, dipping and watering, minerals and supplemental feeds. There were no large differences reported for the amounts spent on inputs between a good and a bad year, but it is probable that not all the variations in management practices were captured in this ‚one-shot„ survey. It is also possible that their practices do not vary much from year to year, despite the fact that environmental conditions do vary. Drug costs were reported as slightly higher in a bad year, as were supplemental feeds for the few households that actually purchased feed.

Total livestock production costs (including hired labour, all inputs related to livestock production, livestock purchase and capital maintenance and operating costs) were lowest for the traditional cluster (KSh 45,950/year) and highest for the near park cluster (KSh 65,860/year) in a good year. In a bad year, the input costs were again lowest for the traditional cluster (KSh 47,529) but highest for the average cluster (KSh 76,821). Livestock health (drugs, dewormers and acaricides) in a good year accounted for 48% of total expenditures, while labour and livestock purchases accounted for 24% and 18%,

respectively. In a bad year, livestock health, labour and purchases accounted for 45, 22 and 16% of total expenditures.

For all the households, input costs averaged KSh 59,713 in a good year and KSh 65,253 in a bad year (a 9% increase). Average livestock expenditures reported for four locations in Maasai Mara (Talek, Aitong, Lemek and Nkorinkori) in 1999 ranged from KSh 21,735 to 39,630, excluding labour costs (Thompson et al. 2000). Expenditures/TLU on acaricides, drugs, labour and minerals were compared to those reported for Mbirikani and Kimana group ranches (Mbogoh et al. 1999) in a similar survey carried out in Kajiado in 1999 and are presented in Table 16.

Table 15. *Mean annual livestock input cost by cluster (KSh).*

	‚Traditional„	‚Near park„	‚Market-oriented„	‚Average„	‚Weighted mean„
Good year					
Drugs[1]	7,462	8,861	6,267	7,941	7,758
Dewormers[2]	7,399	11,144	4,873	10,550	9,010
Acaricides[2]	11,183	10,848	7,688	15,216	11,880
Mineral supplements	775	633	1,493	3,075	1,650
Supplement feeds	0	0	0	1,133	389
Dipping	0	0	1,500	0	257
Hired Labour[2]	5,318	23,089	22,000	9,475	14,173
Watering	4,375	0	833	6,392	1,334
Capital	113	463	1,167	475	508
Livestock purchases[2]	9,325	10,822	17,633	8,217	10,754
Total Expenditure	45,950	65,860	63,454	62,474	59,713
Bad year					
Drugs[1]	7,866	9,450	7,725	8,899	8,603
Dewormers[2]	7,399	11,144	4,873	10,550	9,010
Acaricides[2]	11,183	10,848	7,688	15,216	11,880
Mineral supplements	700	672	1,190	2,604	1,430
Supplement feeds	0	0	0	11,715	4,017
Dipping	0	0	617	0	106
Hired labour[2]	5,318	23,089	22,000	9,475	14,173
Watering	5,625	0	1,000	9,670	4,773
Capital	113	463	1,167	475	508
Livestock purchases[2]	9,325	10,822	17,633	8,217	10,754
Total expenditures	47,529	66,488	63,893	76,821	65,254

1. Includes the cost of vaccines and curative drugs.
2. Some input costs (dewormers, acaricides and labour) were recorded for a good year only.

Table 16. *Average input cost comparison (KSh/TLU).*[1]

	Mbirikani 1999	Kimana 1999	Kitengela 2000
Acaricides	150	170	227
Drugs	215	256	148[2]
Minerals	59	95	32
Labour	177[3]	327[3]	271[4]
TLU	51	28	52
Sample size	27	34	35

1. Reported livestock numbers were converted to TLU equivalents for comparison.
2. Includes vaccines; 3. Includes the cost of own and borrowed children; 4. Hired labour cost only.
Source: Mbogoh et al. (1999).

Input costs in Kitengela (52 TLUs) are perhaps most appropriately compared to those of Mbirikani (51 TLUs) since average herd sizes are so similar. Acaricide and labour costs per TLU were lower in Mbirikani, while drug and mineral costs were lower in Kitengela. The differences in acaricide input costs may be explained at least in part by average levels of rainfall and ecological differences between the two areas. Kitengela is generally a wetter area than Mbirikani and Kimana, and therefore has a higher population of ticks, thus requiring more acaricides for controlling tick-borne diseases.

3.3.7 Net livestock income

Direct livestock production expenses were deducted from the annual gross output value to derive net livestock income (net income includes value of livestock and products consumed by the household valued at market prices). Annual livestock net income ranged from KSh 87,100 to 138,000, with a mean of KSh 112,916 (Table 17) in a good year.

Table 17. *Net livestock income in a good year by cluster (KSh).*

Cluster	Average gross annual livestock revenues	Average gross annual livestock production costs	Net income from livestock[1]	Net livestock income per adult equivalent	Net livestock income per adult equivalent (US$)[2]
‚Traditional„	156,462	45,848	110,613	15,987	205
‚Near park„	152,961	65,861	87,100	11,670	150
‚Market-oriented„	201,547	63,454	138,093	34,178	438
‚Average„	183,685	62,474	121,212	21,187	272
‚Weighted mean„	172,629	59,713	112,916	19,778	254

1. Includes value of livestock products consumed by the household.

2. US$ 1 = KSh 78 in November 2000.

In a bad year, levels of net income from livestock decreased significantly, ranging from KSh 65,000 to 96,757 (Table 18). The market-oriented cluster had the highest total net livestock income, reflecting the higher revenues due to more animal sales. This cluster also reported the highest livestock income per adult equivalent, with their smaller household sizes. The cluster nearest the park had the lowest livestock net income, with relatively high costs coupled with low revenues due to fewer livestock sales, smaller herd sizes and smaller landholdings. The cluster also reported the lowest livestock net income per adult equivalent, resulting from a larger household size.

Analysis of variance indicates that there is no significant difference in livestock gross revenues, input costs and net income across the clusters or across rainfall scenarios (good versus bad year). This is likely due to the small sample size.

Table 18. *Net livestock income in a bad year by cluster (KSh).*

Cluster	Average gross annual livestock revenues	Average gross annual livestock production costs	Net income from livestock[1]	Net livestock income per adult equivalent	Net livestock income per adult equivalent (US$)[2]
‚Traditional„	116,746	47,529	69,217	11,934	153
‚Near park„	131,508	66,488	65,020	8,444	108
‚Market-oriented„	160,650	63,893	96,757	23,037	295
‚Average„	141,435	76,821	64,614	10,592	136
‚Weighted mean„	136,533	65,254	71,279	11,685	150

1. Includes value of livestock products consumed by the household.
2. US$ 1 = KSh 78 in November 2000.

3.3.8 Comparison of livestock returns across sites

Our estimated range of returns to livestock activities falls within the range estimated for several group ranches near Maasai Mara. The Mara study estimated annual net returns from livestock per household ranging from KSh 15,000 to 125,000 (labour costs excluded) (Thompson et al. 2000). A 1981–83 survey of Olkarkar and Murueshi group ranches in Kajiado District found gross revenues per household ranging from KSh 29,000 to 37,000(Bekure et al. 1991). If we inflate these revenues to reflect what that income would be worth today, using current cattle prices,[7] these figures translate to a range of KSh 287,100 to 366,300, suggesting that these pastoralists may be earning less than half the revenues from livestock than they earned 20 years ago.

3.3.9 Productivity of livestock enterprises

The productivity of the livestock enterprises was measured based on net livestock income per TLU and per acre, allowing a comparison of productivity across clusters with different herd and land sizes (Table 19).

Table 19. *Annual livestock net income per TLU and per acre.*

Cluster	Net livestock income (KSh)	Net livestock income per TLU (KSh)	Net livestock income per acre (KSh)
‚Traditional„	110,613	2,891	377
‚Near park„	87,100	3,391	2,985
‚Market-oriented„	138,093	4,525	1,365
‚Average„	121,212	3,340	950
‚Weighted mean„	112,916	3,454	1,413

The market-oriented group had the highest net livestock income per TLU of KSh 4525 and the traditional cluster the least at KSh 2891. Net livestock income per acre ranged from KSh 377 to 2985. The traditional cluster with the highest landholdings (247 acres) had the lowest net livestock earnings per acre. The near park cluster with the least landholdings (75 acres) had the highest livestock income per acre. This non-intuitive finding, i.e. that those focusing the most on livestock earn the least income from them, reinforces the large variability in this changing pastoral system and requires further study, and may also imply that in some cases, successful intensification of livestock production is happening. It should also be kept in mind that the lower earning households (on a TLU and per acre basis) tend to be located in the drier part of Kitengela (with the near park households located in a wetter area).

[7] The average price of a male animal (all breeds) was approximately KShs 1,194 in Emali market between 1981–84, a similar animal now costs KShs 11,840.

3.4 Crop cultivation

Farming is not a major economic activity in Kitengela, although 80% of the households engaged in some cultivation. Land under crop cultivation was relatively small and represented less than 2% of the total landholdings. The major crops grown in this area were maize, beans, potatoes and sometimes cowpeas, mainly for subsistence.

Table 20 shows the distribution of cropped area among the clusters and average crop production levels per household in good and bad years. It can be seen that output estimates for a bad year still average from 255–852 kgs per household, i.e. even with the failure of the long rains, most households feel that they get some maize outputflone has to keep in mind that the optimal way of calculating this would be to measure actual household output over several years.

Yields across Kitengela are extremely low. For the traditional cluster, with an average cropped area of 2.21 acres, maize yields range from roughly 115 to 340 kg/acre. Bean yields range from 316 to 571 kg/acre from a bad year to a good year. Yields appear to be the highest for the group nearest the park (with an average area under cultivation of 2.38 acres). Maize yields vary from around 358 to 605 kg/acre and bean yields from 546 to 830 kg/acre.

Table 20. *Average crop output per household, kgs/year.*

Cluster	Maize		Beans		Cropped area (acres)	% of landholding cropped
	Bad year	Good year	Bad year	Good year		
‚Traditional„	255	750	698	1,262	2.2	0.8
‚Near park„	852	1,440	1,300	1,975	2.4	3.2
‚Market-oriented„	653	1,305	878	1,560	3.9	3.3
‚Average„	446	889	577	1,211	2.4	1.1

For the market-oriented group, with the highest amount of land under cultivation (averaging 3.92 acres), maize yields range from 166–333 kg/acre and bean yields from 224–398 kg/acre. For the average cluster (with an average area under cultivation of 2.67 acres), maize yields vary from around 167–334 kg/acre and beans from 216–454 kg/acre. It should be noted that the yield variation seen among the clusters likely reflects both biophysical differences within the dispersal area (with the wetter areas having higher crop yields than the drier areas) and management differences that are difficult to separate out.

Table 21. *Average annual gross crop revenues (KSh) value by cluster.*

Cluster	Good year revenues[1]	Bad year revenues[2]
‚Traditional„	21,173	17,009
‚Near park„	33,881	37,992
‚Market-oriented„	26,033	24,635
‚Average„	19,423	16,377

1. Good year crop revenues were calculated using the following 1998 local harvest time prices for a 90 kg bag: KSh 600 for maize, KSh 1000 for beans and KSh 500 for potatoes (130 kg bag). Production used for home consumption was valued using the same prices.

2. Bad year crop revenues were calculated using the following 1999 local harvest time prices for a 90 kg bag: KSh 910 for maize, KSh 1800 for beans and KSh 725 for potatoes (130 kg bag).

When total crop production was valued using harvest-level prices from ‚representative„ good and bad years, the cluster located nearest the park had the highest valued crop production, followed by the market-oriented cluster, with the average group earning the least from crops. This ordering holds for both good and bad years. The value of crop production was actually higher for the near park cluster in a bad year, since although output was lower, prices were significantly higher in the bad year at harvest time.

The annual crop expenses (labour, seed and ploughing costs) were deducted from the gross output value to derive the net crop income. The net income and crop returns are shown in Table 22.

Table 22. *Average annual net crop income by cluster (including labour costs).*

Cluster	Good year (KSh)	Bad year (KSh)	Good year (KSh/acre)	Bad year (KSh/acre)
‚Traditional„	1,469	–5,141	668	–2,337
‚Near park„	7,464	12,693	3,110	5,289
‚Market-oriented„	–3,295	–2,109	–845	–541
‚Average„	1,215	786	506	327

The cluster located nearest the park, with the least land under crop production (averaging 2.38 acres per household) had the highest net crop income (and income/acre) in a good year, followed by the traditional group (which probably reflects their low input use and costs). The market-oriented group (with the most land under crops, at an average of 3.9 acres per household) earned the least income from crops, except in a bad year when the traditional cluster earned the lowest income and income/acre.

Table 23. *Average annual net crop income by cluster (excluding labour costs).*

Cluster	Good year (KSh)	Bad year (KSh)	Good year (KSh/acre)	Bad year (KSh/acre)
‚Traditional„	12,290	8,159	5,586	3,709
‚Near park„	18,020	18,607	7,508	7,753
‚Market-oriented„	13,789	14,841	3,536	3,805
‚Average„	11,448	10,683	4,770	4,451

When labour costs are excluded (i.e. family labour time is not valued), the returns to cropping marginally improve in all clusters, ranging from KSh 4770–7508 in a good year and KSh 3709–7753 in a bad year (Table 23). Similarly, the differences in crop returns in a good and a bad year are smaller (less than KSh 350), except for the traditional cluster.

3.5 Off-farm earnings

Out of the 35 households interviewed, 60% of the respondents had someone in their household involved in off-farm activities that brought in some income to their households. Off-farm income levels were estimated from respondent„s description of the type of activity and monthly income range (<1000, 1000–5000, 5000–10,000, 10,000–20,000, >20,000 KSh/month). Besides the monthly income ranges, the respondents were also asked to estimate the proportion of off-farm income as a percentage of their total household income.

Out of the 24 people with some type of off-farm employment, 11 (46%) engaged in various business activities, which included selling charcoal or firewood, operating a small shop, livestock trading, and real estate business. The remaining 13 (54%) were formally employed in the public and private sectors. The type of off-farm activity and number of people involved, and the estimated household monthly and annual off-farm income levels by cluster are shown in Table 24. Over 80% of those engaged in business activities were from the near park and average clusters, while almost half of the formally employed were from the average cluster. Approximately 70% of people with some off-farm income were from the near park and average clusters. Respondents near the park were more likely to be involved in real estate business.

Table 24. *Type of off-farm income activity, number of people involved and estimated off-farm income earnings by cluster (KSh).*[1]

Type of activity	‚Traditional„	‚Near park„	‚Market-oriented„	‚Average„
Government employee	–	2	1	3
Private sector employee	2	–	2	3
Real estate business	–	2	–	–
Other business	1	3	1	4
Average monthly off-farm income (KSh)	938	7,000	9,583	6,250
Average annual off-farm income (KSh)	11,250	84,000	115,000	75,000

1. Monthly and annual off-farm income was estimated using midpoints of the income ranges reported by respondents.

The off-farm income levels ranged from KSh 939 per month for the traditional cluster to 10 times higher for the market-oriented group (Table 24). Extrapolating to estimate annual off-farm earnings suggests a substantial contribution to household earnings for 3 of the 4 clusters (75,000 to 115,000 KSh/year). This extrapolation needs to be treated with caution, however, as it assumes regular monthly payments throughout the year, which may or may not occur, and accurate estimates of non-farm earnings are acknowledged to be very difficult information to obtain.

Respondents were asked to estimate how much of their overall income came from off farm sources (Table 25). The ratio of off-farm income to total household income[8] varied from 0 to 90% for all households. One-third of the households received no income from off-farm sources, while another one-third received between 10 and 30% of their total household income from off-farm sources.

Table 25. *Contribution of off-farm income to total household income.*

Proportion of off-farm income to total household income (%)	Number of respondents	As a percentage of all households interviewed
0	12	34
10–30	12	34
31–60	5	14
>61	6	17
Total	35	100

[8] Total household income includes net income from livestock and crops in a good year and off-farm income.

For the 35 sampled households, off-farm income accounted for an average of 38% of total household income (Figure 4). Among the clusters, off-farm income accounted for 9 to 47% of total household income. The near park and market-oriented groups had higher percentages of total household income attributable to off-farm sources, which equals to 47 and 46%, respectively. In the average cluster, where at least 75% of the households received some off-farm income, off-farm income accounted for 38% of total household income. In contrast, the ratio of off-farm to total household income in the traditional cluster was low, i.e. 9%.

3.6 Quarrying

Out of the 35 households randomly selected from each cluster, only two (6%) were engaged in quarrying. To obtain more information on returns to quarrying, an additional four households engaged in quarrying were interviewed. Annual gross revenues from quarrying ranged from KSh 98,400 to 880,200. Annual costs (excavation, drilling, blasting, shaping and loading) ranged from KSh 39,740 to 64,200. For those who leased out land, there were no expenses involved. Net income earned from quarrying varied considerably, from KSh 34,200 to 840,460. We were not able to estimate net returns per acre. A number of landowners nearer the Park (especially at Emakoko) decided to fill their quarries after realising how destructive the activity could be to their land. Most of those who own quarries do not engage themselves directly in quarrying, but lease out small parts of their land so that they can receive monthly payments from companies engaged in the excavation activities. The richest area in building stones in Kitengela remains the Enkurunka valley, which runs along the Kapio tributary (of the Empakasi River). Besides recent demand for building stones from the cement factories nearby (East African Portland Cement Company and more recently Bamburi Cement), there is also an increased demand for quarry chips which are used in the manufacture of cement. We estimate that less than 15 landowners have leased their land to quarry operators in the stone-rich zone (Enkurunka and Emakoko). There is suitable land that has not been put under quarries and may be susceptible in the future if landowners do not have other sources of income.

3.7 Net income summary by cluster

Net household income is an aggregate value of livestock, crop and off-farm income. Quarrying income is not included here since only two households out of the 35 were engaged in quarrying. For the 35 households surveyed, total livestock and off-farm income averaged 61% and 38% of household income (Figure 4).

The traditional cluster had the lowest off-farm income, contributing to the lowest overall income of KSh 123,332 per year (Table 26). Earnings from agriculture (crops and livestock) amounted to KSh 112,082, or (US$ 1437[9] annually, which works out to roughly US$ 5.82/acre per year for this group with an average landholding of 247 acres).

The group located nearest to the park earns the least from livestock, but the most from crops in a good year, coupled with a fairly high off-farm income. Their total earnings of KSh 178,564 is equivalent to US$ 2289/year. Average annual income from the farm (crops and livestock) for this cluster works out to KSh 94,564 (US$ 1212, or US$ 15.54/acre per year) for this group that has the smallest average landholdings (75 acres). Thus in a good year, it is this group that earns the most income on a per acre basis from farming and livestock

The market-oriented household cluster earned the most from livestock and off-farm income, but earned the least from crops, probably because their crop input costs are higher than the other groups (and they are growing maize in a dry area, where millet or sorghum would be more appropriate). This cluster earned the most overall due to their high off-farm income earnings. Their average total annual earnings of KSh 249,799 convert to US$ 3203. The average annual crop and livestock income of KSh 134,799 (US$ 1728) works out to KSh 1133/acre (US$ 14.52/acre), for a mean land size of 119 acres within this cluster. The cluster named average, distinguished largely by its average landholding and herd size characteristics, has low crop revenues, and livestock and off-farm income levels that fall in between the lowest and highest extremes for each group.

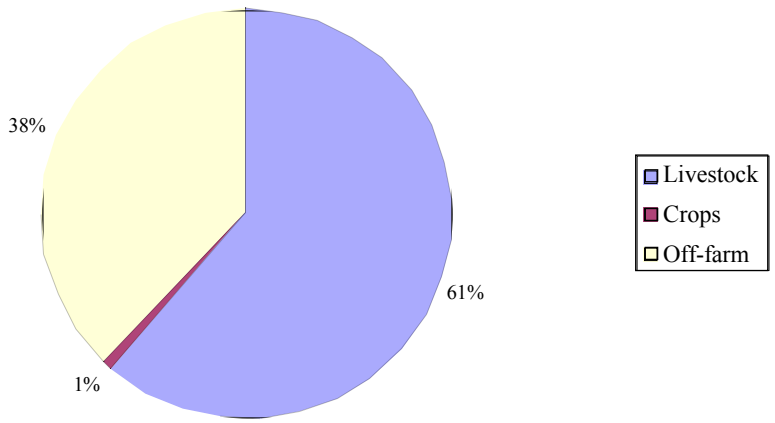

Figure 4. *Contribution of livestock, crops and off-farm income to overall household income in a good year.*

[9] US$ 1=KSh 78 in November 2000.

Their average total annual earnings of KSh 197,427 convert to US$ 2531. This group has an average agricultural earnings of KSh 122,427 (US$ 1570, or US$ 7.17/acre for an average landholding of 219 acres).

Table 26. *Annual net household income by cluster.*

Cluster	Good year annual net household income[1] (KSh/year) from:				Average adult equivalent (AE)	Total annual income /AE	Total monthly income/ AE
	Livestock	Crops	Off-farm	Total			
‚Traditional„	110,613	1,469	11,250	123,332	5.8	21,264	1,772
‚Near park„	87,100	7,464	84,000	178,564	7.7	23,190	1,932
‚Market-oriented„	138,093	-3,295	115,000	249,799	4.2	59,476	4,956
‚Average„	121,212	1,215	75,000	197,427	6.1	32,365	2,697

1. Includes value of livestock and crop products consumed by the household.

Income from livestock accounted for 49–90% of total household income across clusters. Household off-farm income ranged from 9–47%, and crop income accounted for less than 2% of total income with the exception of the near park cluster (4%). Livestock income in the traditional cluster represented 90% of total household income (Figure 5). The near park cluster had similar contributions to household income from livestock (49%) and off-farm income (47%). Off-farm income is substantial for all but the traditional cluster. Despite the considerable variation between clusters in these income calculations, an analysis of variance revealed that statistically there were no significant differences among the clusters regarding net incomes from livestock, off-farm opportunities and crops. Across all households, there was no statistically significant relationship between wealth level (measured using herd and land sizes as wealth proxies) and percent contribution of income from livestock to total household income (excluding quarrying). The above results are likely due to the small sample size.

A recent welfare monitoring survey established a rural poverty line for Kenyans of KSh 1239/adult equivalent per month, and an urban poverty line of KSh 2648 per month (GOK 2000). Kenyans living below these standards are thus considered to generate inadequate income levels to feed, clothe, educate and pay for basic health care for their families. All the Kitengela groups are above the rural poverty line and two are under the urban poverty line. One group is barely above the urban poverty line, which is arguably more appropriate for households located so close to Nairobi. The market-oriented group, with its smaller average family size, earns roughly twice the income per adult equivalent of the established urban poverty line.

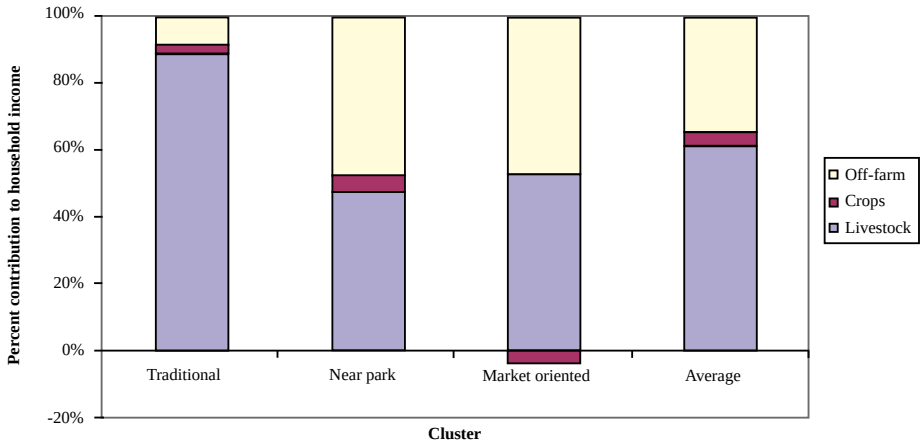

Figure 5. *Contribution of livestock, crops and off-farm income to total household income by cluster.*

4 Spatial distribution of returns

Figure 6 shows livestock returns per acre for the surveyed households, along with the spatial distribution of five species of migratory wildlife (aggregated, including zebra, wildebeest, Grant„s gazelle, Thomson„s gazelle and kongoni) during the dry season. While the sample size was too small to undertake statistical analysis of the explanatory power of spatial determinants of household income levels, the relative level of returns was mapped out in order to see if any interesting patterns could be observed.[10]

Figure 6 shows that 9% of the respondents (3 households) were making greater than US$ 40/acre (>3200 KSh), 11% (4 households) were making between US$ 20–40/acre (1600–3200 KSh) and 14% (5 households) were making between US$ 10–20/acre (800–1600 KSh). The other 66% (23 households) made less than US$ 10/acre (800 KSh). Four of the households with higher livestock earnings were near the park, but a few were located relatively far from the park.

In relation to where the most wildlife are found during the dry season, it can be observed that there are some households earning very little from livestock even in areas with fewer wildlife. There are also areas with a lot of wildlife where households are earning high livestock income, which does not support the notion that households in the densest wildlife areas are worse off.

When incomes were examined on a per adult equivalent (AE) basis, annual net income (including livestock, crop, off-farm and quarrying incomes) per adult equivalent ranged from KSh 25,762 to 795,300 (Figure 7). Over half of the households (54%) earned less than a dollar a day per adult equivalent, a widely used global measure of poverty. Another 26% earned less than US$ 2 per day (KSh 28,500–57,000/AE per year), 14% earned between US$ 2 and US$ 4/day (KSh 57,000–114,000/AE per year). Only 2 households (6%) earned over US$ 4 per day (>KSh 114,000/AE per year). In over half of the households, cropping costs were greater than the value of the output they produce in a good year (excluding family labour costs). There is no easily discernible spatial pattern to net incomes per person, with the few higher income households distributed throughout the study area. Other than the fact that the wealthiest households do not fall in the ‚pixels„ with the most wildlife, a relationship between income and wildlife cannot be seen using this income measure either.

[10] The information on spatial distribution of migratory wildlife during the dry season included here is not ideal since it comes from a single dry season aerial survey. Work is currently underway to develop both dry and wet season distribution maps based on 4–5 years of aerial survey data.

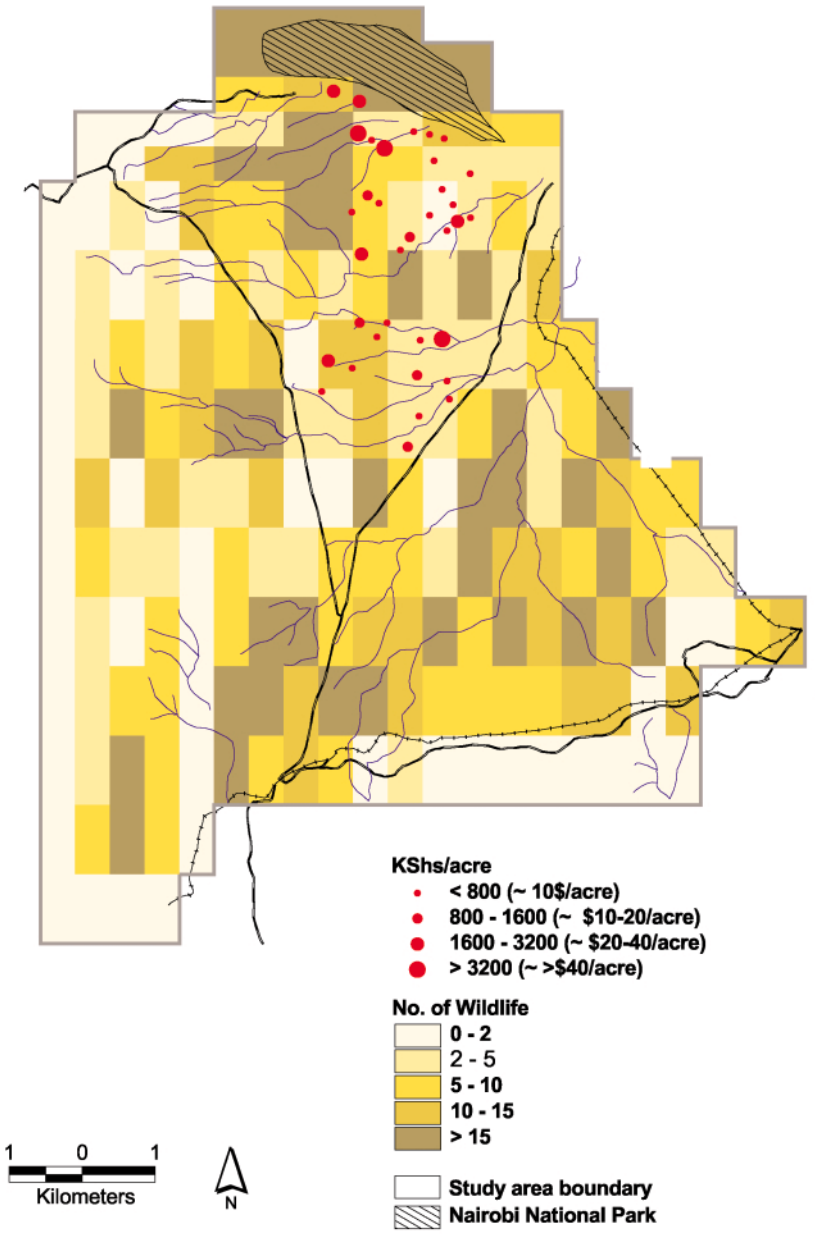

Figure 6. Livestock returns and dry season wildlife (five speciesflzebra, wildebeest, Grant„s gazelle, Thomson„s gazelle and kongoni) density for surveyed households (KSh/acre) in Kitengela wildlife dispersal area.

Sources: Survey results and Gichohi (1998), unpublished data.

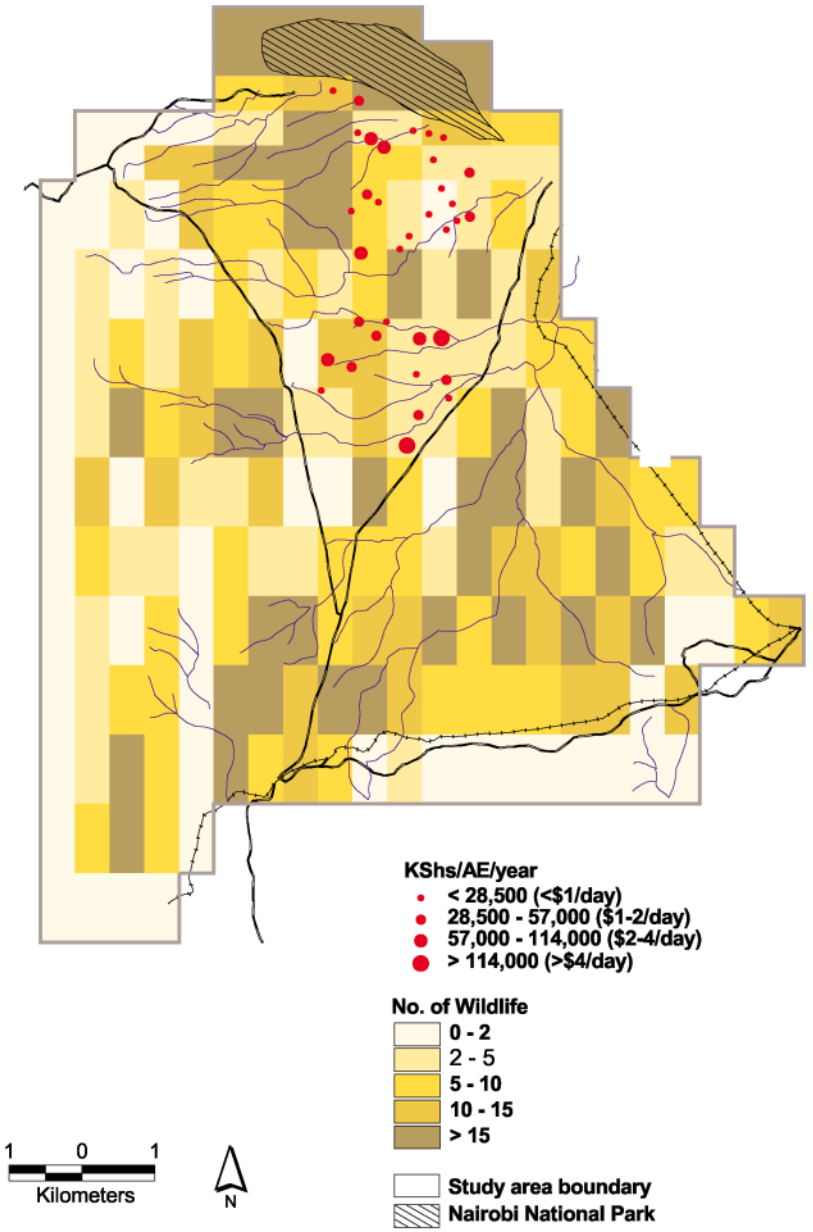

Figure 7. Annual net income per adult equivalent and dry season wildlife density (five speciesflzebra, wildebeest, Grant„s gazelle, Thomson„s gazelle and kongoni) for surveyed households (KSh/AE per year) in Kitengela wildlife dispersal area.

5 Feedback from the community and implications

A workshop with community members, including those involved in the survey plus several chiefs and a councillor from the area was held in April 2001 in Kitengela town. The objective of the workshop was to present the survey findings to the community and elicit feedback from them. The major issues that arose and main topics of discussion during the daylong workshop are summarised below by topic.

5.1 Wildlife–livestock conflicts

Livestock deaths due to predators were major concerns expressed by many community members at this time of the year (beginning of long rains). High presence of wildlife was reported in the dispersal area, including buffalo, zebra, and eland which were roaming outside the park. Wildebeest were also calving in areas around Lenchani and Enkirgirri. Predation by leopard, lion, cheetah and hyena had increased, with more than 20 sheep killed the night before the workshop. Residents think the reason conflicts have increased is that wildlife prefers to graze in the areas outside the park where livestock graze. Wildlife avoid the park because high grass provides cover for ambush predators such as lion.

5.2 Livestock herd size

Despite decreasing cattle herds over the years (1998, 1999 and 2000), cattle numbers probably did not drop as much as indicated by the survey figures. The declining trend in cattle numbers was attributed to the following factors:

- Increased cattle sales due to high demand for cash to meet household needs such as school fees, medical care and others
- Increased incidence of disease (East Coast fever, ECF)
- Frequent droughts (1996/97 and 1999/2000) and
- Underestimation of herd sizes due to cultural beliefs

Herd sizes for shoats derived from the survey were said to be consistent with the actual situation. Shoat numbers have drastically decreased over the three years. Outbreak of the blue tongue disease after the long El Niño rains in 1997/98 coupled with drought and predation from wildlife has contributed to declining shoat numbers.

5.3 Livestock output

Participants largely agreed with the survey definitions of a good versus a bad year, i.e. good year when both long and short rains fall and bad year when the long rains fail. Among the Maasai, good year scenarios are characterised by good precipitation, plenty of milk and lower incidence of disease. On the other hand, bad years are characterised by the failure of the long rains („Inkokua„), because the long rains generate the most pasture. Even when the short rains („Oltumuret„) come, the year could still be considered a bad one since precipitation is almost always low without the long rains.

Milk and live animal sales profits depend on rainfall. Milk provides income to most households in the study area. Participants perceived the value of livestock slaughtered for home consumption to be very low. After discussions, which included the range of values as compared to the average values presented to them, the figures were thought to be representative of what happens within the community.

Manure sales were dependent on proximity to either shopping centre or good road (accessibility). The price of manure was higher for those households nearer to the roads than those farther away. Average prices as reported by the participants ranged from KSh 3500–4000 per lorry carrying 7 t of manure.

5.4 Livestock input costs

Ticks had increased rapidly since the onset of the rains and the cost of acaricides and curative drugs had also increased. Participants generally agreed with the concept of derived income[11], which includes sales and consumption, given the fact that if you do not produce for household consumption, you would buy from the market, hence by producing for consumption, the household saves some money.

5.5 Crops

Crop yield figures from the survey were considered to be very high by many workshop participants. A consensus was reached after considerable discussion that in general, maize yields vary from 4–5 bags/acre while bean yields vary from 6–7 bags/acre in a good year, which is lower than the average yields of 9 bags/acre for maize and 13 bags/acre for beans from the survey findings. Crop cultivation differs between the Maasai and the immigrants from other tribes. Among the Maasai, crop cultivation is purely for subsistence as opposed to their immigrant counterparts. Maasai devote most of their time

[11] Derived income includes value of output sold and value of output consumed within the household.

to livestock-related activities and very little time is spent on crop production. Lack of technical knowledge on crop cultivation among the Maasai has led to:

- Intercropping of more than two crops, e.g. maize, beans, potatoes and bananas leading to low yields,
- Late land preparation, planting and weeding and
- Use of poor quality seeds.

Land preparation costs were considered high, ranging from KSh 1500–4000/acre for cultivated land and new land, respectively.

5.6 Off-farm income

Off-farm income levels, especially for those involved in small businesses, may have been negatively affected by the drought. Participants reported that some small shops might have closed during the drought due to lack of business.

5.7 Quarrying

The participants agreed that the relatively high returns we presented could be attributed to some landowners who leased land to big cement producing companies. Other landowners sold a lot of hard-core in addition to leasing out land.

5.8 Additional issues raised by participants included:

• Across the community, record keeping is poor for sales or production amounts (for both crops and livestock).

- Drugs and technical assistance are very costly and there are no veterinarians to assist, therefore most people treat livestock themselves.
- Lack of water is a major problem for livestock and crop production.
- The immigrants make more profits from crop cultivation than the Maasai.
- More education was needed for the local people and organisations such as ILRI and ACC could assist through provision of funds to the needy students and development of schools.
- Land sizes are shrinking and therefore intensification is inevitable.
- Wildlife predation, crop damage and spread of diseases were reported to have increased resulting in people–wildlife conflicts. Good fencing around

homesteads and sharing of wildlife revenues with the local community were perceived as possible solutions.

- Commercial livestock production, a gradual change to improved livestock breeds, and education on animal and crop husbandry were seen as ways to increase agricultural productivity in this area.

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Appendix I

Definitions

- Good yearfllboth long and short rains occurring
- Bad yearfllong rains fail

Livestock output

Livestock output includes the sales and consumption values for live animals and their products.

- Livestock salesfllderived as the product of the annual livestock sales and the sales price, taking into account the different age categories and types of livestock.
- Livestock consumptionfllderived as the product of the annual number of livestock slaughtered for consumption within the household and the sales price, i.e. price at which they would sell the livestock.
- Livestock products include; milk, manure, hides and skin. Other products from the livestock production system such as traction, borehole, dip and revenue from other livestock (apart from cattle and shoats) and their products were also included.

Milk output

- Data for total milk output, milk sales and milk consumption were reported for two distinctive seasonsflwet and dryflto account for seasonal fluctuations in milk production on a daily basis.
- Seasonal production, sales and consumption quantities and values were derived from the number of months in a given season and the average number of days in a month (30 days).

Assumptions for calculating yearly milk production

Good year	Bad year
Wet seasonfl5 months	Wet seasonfl3 months
Dry seasonfl5 months	Dry seasonfl5 months
2 monthsflno milk production	4 monthsflno milk production

- The rainfall pattern in a good year in the survey area as reported by one of the key informant is:

- The long rains (April, May and June), normally with the highest amount of rainfall. It is the wettest season of the year and fits the farmer‚s definition of a wet season.
- The short rains (October, November and December) are wet also, but the amount of rainfall received is slightly less than during the long rains.
- Calving rates do coincide with the rainy season, and more calves borne during the long rains as compared to the short rains within a given year. Milk production therefore is likely to be higher during the long rains as compared to the short rains although both seasons are wet.
- Using the calving rates, the numbers of calves borne during the short rains are two-third of those borne during the long rains.

Using the same argument, the three months of milk production during the short rains are equivalent to two months of milk production during the long rains. Therefore the total number of the ‚real„ wet months in a good year was 5.

- The dry months are January, February, March, July, August, and September. March and September are very dry months with zero milk production.
- As compared to January and February, milk production in July and August is slightly high. January and February are the dry months according to the farmer‚s definition.
- Using the ratio of calving rates as a proxy for milk production, the two months of milk production (July and August), just after the long rains are equivalent to three months of milk production during the dry months. Therefore the total number of dry months in a good year is 5.

Recall, from our survey definition, a bad year is when the long rains fail.

- In a bad year the wet season is 3 months in duration (October, November and December).
- Four months (July, August, September and March) are very dry months with zero/no milk production.
- However, there are 5 months with little milk production (January, February, April, May and June).
- Although April, May and June are very dry months, more calves are borne during this time, and therefore some little milk will still be produced.

- Milk salesflvalued as the product of milk output sold directly to shopkeepers and hotels and the sales price, only for the households that sold milk. The seasonal sales values were summed up to derive the annual milk sales value.

- Milk consumptionflvalued as the product of milk output consumed within the household and the milk sales price. For those households that were not selling milk, the average milk sales price for the ‚milk-selling„ households was used to value their consumption. The seasonal consumption values were summed up to derive the annual milk consumption value.

- Manureflderived as a product of the average quantity of manure (number of lorries) sold in a year and the sales price. Manure revenues were calculated only for those households that were selling manure.

- Hides and skinflthe total number of hides and skin available to the household at any given point in time depends on the number of cattle and shoats that have been slaughtered for home consumption as well as those that have died. However, not all are sold, some are retained by the household for other uses. Since most of the households surveyed are near to at least a market centre and based on discussions with the key informants, the analysis assumed that 75 percent of the of the hides and skins are sold.

- Revenues from animal traction, dips, boreholes and revenues from other livestockflchickens and eggs, pigs or donkeys were also estimated.

The individual outputs were summed to give the total annual gross output from the livestock production system.

Livestock inputs

The inputs included in the analysis were; vaccines (preventative medicine), drugs (curative medicine), dewormers, acaricides (for spraying), dipping costs, hired labour, mineral supplements, supplementary feeds, watering costs, livestock purchases and capital maintenance and operating costs.

Tropical livestock unit (TLU)

Livestock holdings were converted to tropical livestock units (TLUs) to allow for comparisons between the households and clusters, where 1 TLU equals 250 kg live weight. The average weights of the different management groups from previous studies (Table A2) were used to estimate the TLUs together with the breed information collected during the survey (Table A1).

Table A1. *Cattle breed as reported by the respondents.*

Breed of bulls	Percent of households reporting	Breed of cows	Percent of households reporting
Indigenous	36.4	Indigenous	31.4
Indigenous – Boran cross	15.2	Indigenous– Boran cross	31.4
Indigenous – Sahiwal cross	30.3	Indigenous – Sahiwal cross	25.7
Pure Sahiwa	12.1	Pure Sahiwal	8.6
Indigenous – Simmental cross	6.1	Friesian	2.9
Total	100	Total	100

Source: Survey data (2000).

Approximately 64% of the respondents reported having bulls that were either crosses or pure Sahiwals. Only 36% of the respondents reported having bulls of the indigenous breed. In comparison, 69% of the households reported having cows that were either crosses or pure exotic breeds (Friesians and Sahiwals), and only 31% having cows of indigenous breed.

The approximate weight for all breeds of adult males was used to calculate the TLU for bulls (King et al. 1984). The approximate weight of the Small East African Zebu (SEAZ) was used to calculate the TLUs for heifers, cows and steers (Bekure et al. 1991). Besides, the survey data was collected in a bad year when majority of the cattle were in poor body condition. Other parallel studies on livestock marketing indicate that towards the end of the year (2000), most of the animals presented for sale were the SEAZ. The majority of the crosses and pure exotic breeds died as a result of the drought.

Table A2. *Mean weights by age and sex of cattle and shoats.*[1]

	Age (years)	Weight (kg)	TLU equivalent[2]
Cattle			
Calves	0–2	100.00	0.40
Heifers	3	174.00	0.70
Cows	>3 251	1.00	
Immature steers	2–4	171.00	0.68
Mature steers	>4	262.00	1.05
Bulls	322	1.29	
Shoats			
Lambs	<5 months	11.90	0.05
Rams		37.00	0.15
Ewes		28.00	0.11
Kids	<7 months	9.10	0.04
Bucks		43.50	0.17
Does		28.00	0.11

1. Sources: King et al. (1984); Bekure et al. (1991); KARI/ODA (1996).

2. Tropical livestock unit (TLU) is equivalent to 250 kg live weight as defined by Food and Agriculture Organization of the United Nations (FAO).

Adult equivalents (AEs)

For analysis of the survey findings at household level, the household size was standardised to adult equivalents (AEs). The concept of AE is based on the differences in nutrition requirements according to age and sometimes sex. It assumes that the life-cycle stages have an important influence on the needs of members or individuals of the same household. Various consumption weights have thus been proposed over time. The study adopted the consumption weights used by the Ministry of Finance and Planning in Kenya, GOK (2000), and is shown below.

Table A3. *Consumption weights by age.*

Age (years)	Consumption weight (AE)
0–4	0.24
5–14	0.65
15+	1.00

Source: GOK (2000).

Crop output

The annual gross crop output was derived from the long and short rains output. In a good year, the crop revenues were calculated using the 1998 local harvest time prices of KSh 600 for maize (90-kg bag), KSh 1000 for beans (90-kg bag) and KSh 500 for potatoes (130-kg bag). Production used for home consumption was valued using the same prices. In a bad year, crop revenues were calculated using the 1999 local harvest time prices of KSh 910 for maize (90-kg bag), KSh 1800 for beans (90-kg bag) and KSh 725 for potatoes (130-kg bag).

Crop inputs

The main inputs used in the analysis were; labour inputs (for land preparation, weeding and harvesting), ploughing costs and seeds.

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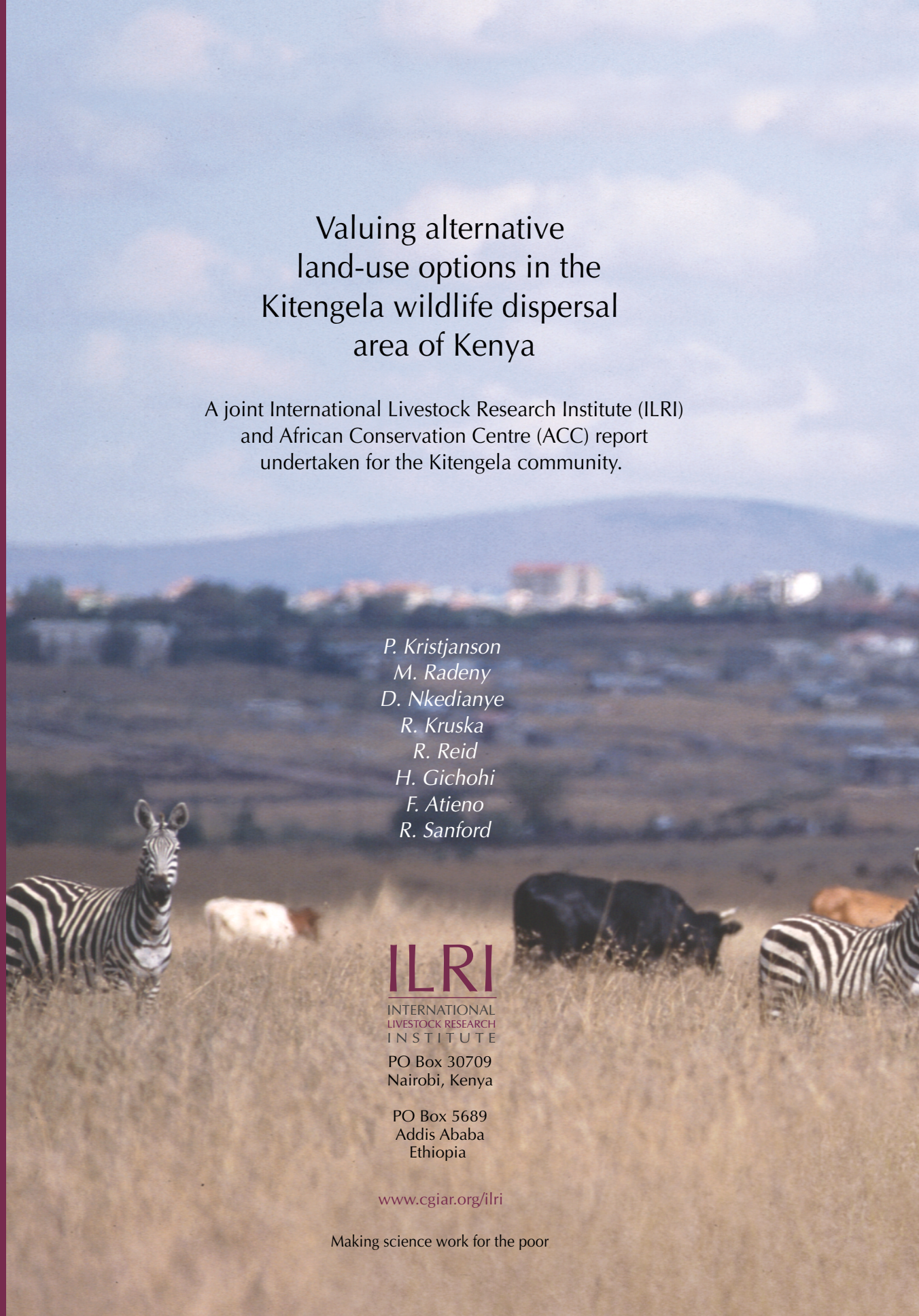

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