SDP Collaborative Research Report

Characterization of dairy systems in the western Kenya region

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Report of Dairy and Crop Characterisation Activities in Western Kenya
December 2002

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Department for International Development-UK (DFID)

Acknowledgements

Gratitude is expressed to all farmers who participated and contributed to this study. Thanks go the Ministry of Agriculture and Rural Development, KARI and ILRI staff who were tirelessly involved in carrying out and supervising the surveys.

This publication is an output from a research project funded by the United Kingdom Department for International Development (DFID) for the benefit of developing countries. The views expressed here are not necessarily those of DFID

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List of Acronyms

AFC	Agricultural Finance Corporation
DFCS	dairy farmers cooperative societies
ECF	East Coast Fever
FMD	foot and mouth disease
GIS	Geographical Information Systems
HH	household
ICRAF	International Centre for Research in Agroforestry
ILRI	International Livestock Research Institute
KARI	Kenya Agricultural Research Institute
KCC	Kenya Co-operative Creameries
KDB	Kenya Dairy Board
MOARD	Ministry of Agriculture and Rural Development
NDDP	National Dairy Development Programme
PPE	precipitation over potential evapo-transpiration
PRA	Participatory Rural Appraisal
RRC	regional research centre
SDP	Smallholder Dairy Research and Development Project
TBD	tick-borne diseases

Executive summary

Introduction

In the second phase of the Smallholder Dairy Project (SDP), as well as continuing work in central Kenya, attention was given to Western Kenya where lessons learnt from the Central and Coast regions of Kenya would be applied. Western Kenya shares a number of features that present an opportunity for smallholder dairy research and development. The climate is favourable for dairy production and average farm sizes are declining rapidly due to increasing population pressure.

These characterization surveys follow in the sequential process from Geographic Information Systems (GIS) analysis to identify potential sites and participatory rapid appraisals (PRAs) in the selected sites. Priori to these there were sub-regional reviews. Each step informs the design and analysis of next study, building each time a better knowledge and understanding of smallholder agriculture and dairy systems and the constraints and refining the recommendation domains for the pilot interventions to be selected with farmers, market agents, regulators and policy makers. This study was expected to inform the next stages if more in depth studies were required in a particular area.

Objectives

The objectives of the Western Kenya dairy production characterisation survey were to:

- provide baseline data describing the status of the production sub-system;
- learn farmers' objectives and rationale in farming;
- identify and understand factors influencing dairy production, and the constraints and opportunities available to increased production;
- Understand linkages between the production and consumption, processing and marketing systems, and their influences on production;
- Identify recommendation domains for developing policy and technical interventions; and,
- Identify and prioritise researchable issues that, if addressed, will be expected to generate technologies that can impact positively on the dairy system development.

In addition, and as a continuation to the surveys conducted in the other parts of the country (central and the Rift Valley), the exercise was to provide an opportunity to:

- Identify homogeneous groups of smallholder dairy producers in western Kenya based on household and farm resource endowments, production systems and market participation;
- Further test and refine methodologies for the characterisation of dairy production systems, target group identification, and constraint and opportunity analysis to be used in other places with similar set-ups and potential for research and development.

Methodology

The surveys in Western Kenya were designed to gather information on broad agricultural activities. Survey sites were selected based on features described by the spatial mapping of factors crucial to dairy farming. The research team included staff from ILRI, KARI and the Ministry of Agriculture and Rural Development. The main factors were spread of people, cattle, towns and roads. Factors that describe

natural dairy potential: rainfall and humidity, altitude, soils and disease risk were also used. To cover as much of the variation in a district, two sub-locations were picked from each of the two most dominant clusters.

At each site individual household interviews were held. A total of 1,576 households were interviewed using a questionnaire designed and pre-tested by a survey team consisting of MOARD, KARI and ILRI staff.

Results

Most households were agricultural and of those, more than two thirds had cattle. The zebu cattle were more than forty percent while grades were only 13 percent of the households with cattle. This distribution did not change between households with cattle and those without. There was high preference for Zebu cattle contrary to the fact that the agro climatic potential is extremely favourable for grade cattle production and the demand for milk is quite high in the region. Although tethering as the main system of keeping cattle is on the decline, stall-feeding is not very common.

The survey highlights growing importance of dairying as indicated by the prevalence of milking cows and heifers in the herds. The main system of keeping cattle was grazing with some stall-feeding but very little zero grazing was practiced. Grazing was mainly associated with the Zebu while stall-feeding were associated with crosses and grade animals. Cut and carry was common across all animal types whether Zebu or grade. But only less than 16% of the households supplemented their cows with concentrates. About a fifth of the households purchased fodder and stored forage for the dry season. Maize was used as a fodder crop by removing thinnings to reduce the density by the majority of the farmers, but a third also used the extra plants to feed livestock.

The survey shows potential for improving animal productivity through more intensification and utilization of crop livestock interactions. There is room to further improve on the productivity of animals through better forage production and management.

Overall there is need to study factors influencing the predominance of subsistence production and less of market orientation and specialization.

1 INTRODUCTION

In the second phase of the Smallholder Dairy Research and Development Project (SDP), as well as continuing work in central Kenya, attention was given to Western Kenya where lessons learnt from the Central and Coast regions of Kenya would be applied. Western Kenya shared a number of features that present an opportunity for smallholder dairy research and development using results of studies that have been done in the other regions. The climate is favourable for dairy production and average farm sizes are declining rapidly due to increasing population pressure.

The sequential process to be followed was review of the national rapid appraisal, with its broad description, and diagnosis of western Kenya. This would include subsequent sub-regional reviews for each of the mandate areas under the Kakamega and Kisii Regional Research Centres (RRC) of the Kenya Agricultural Research Institute (KARI) (Mudavadi et al, 2001, and Ojowi et al 2001), Geographic Information Systems (GIS) analysis to identify potential sites, participatory rapid appraisals (PRAs) (Waithaka, et al 2000) in the selected sites and finally the characterization surveys. Each step informs the design and analysis of next study, building each time a better knowledge and understanding of smallholder agriculture and dairy systems and the constraints to, and opportunities for, their improvement, and refining the recommendation domains for the pilot interventions to be selected with our clients: the producers, the market agents, the regulators and the policy makers.

Studies of a new area attempt to get a clear picture of the prevailing production systems and in particular the dairy industry and how they have evolved over time. Milk marketing structure is also appraised since it has been learnt from the previous studies that the development of commercial small-scale dairy industry is a function of milk demand and the product delivery systems. Moreover, the very recent but fast changes in milk marketing as a consequence of a liberalised economy have created opportunities for growth in dairy production and milk outlets that have not been adequately studied in these parts of the country.

The initial diagnostic surveys of Western Kenya were expected to provide an avenue through which the current status of the dairy industry can be observed and provide a guide for project entry and implementation. These surveys include spatial analysis of secondary data to target site selection, rapid appraisals and farm characterisation studies that forms a major part of the first months of the project's second phase.

Objectives of the survey

The objectives of the Western Kenya dairy production characterisation survey were to:

- provide baseline data describing the status of the production sub-system;
- learn farmers' objectives and rationale, identify and understand factors influencing dairy production, and the constraints and opportunities available to increased production;
- Understand linkages between the production sub-systems and consumption, processing and marketing sub-systems, and their influences on production;
- Identify recommendation domains for developing policy and technical interventions; and,
- Identify and prioritise researchable issues that, if addressed, will be expected to generate technologies that can impact positively on the dairy system development.

In addition, and as a continuation to the surveys conducted in the other parts of the country (central and the Rift Valley), the exercise was to provide an opportunity to:

- Identify homogeneous groups of smallholder dairy producers in western Kenya based on household and farm resource endowments, production systems and market participation;
- Further test and refine the methodologies for the characterisation of dairy production systems, target group identification, and constraint and opportunity analysis to be used in other places with similar set-ups and potential for research and development.

To focus the selection of research sites within the seven districts (Bungoma, Kakamega, Vihiga, Nandi, Rachuonyo, Kisii and Nyamira), cluster analysis was used as a means of spatial stratification. Instead of simply sampling from the entire subset of sub-locations in these districts, clusters of relatively homogeneous areas were created, to serve as a sampling base.

2 SELECTION OF SURVEY SITES

2.1 A spatial analysis of western Kenya dairy systems

Spatial data, coverage on both biophysical as well as socio-economic characteristics of regions, are indispensable to a research framework for two main reasons. In the first place mapping spatial variation can provide a quick and dirty method for assessing a wide area by simply 'eye-balling' differences between dry and wet, accessible and remote, more and less densely populated areas. In addition, when backed up by a conceptual framework, it can support both predictions of the spatial distribution of (agricultural) activities as well as focus selection and prioritising among potential research sites.

The recently greater availability of digital spatial data and user-friendly Geographical Information Systems (GIS) has allowed us to do both for Western Kenya. A diverse set of data layers on population, market access, climate and cattle distributions were available to depict differentiation throughout the districts down to the sub-location level, cluster these data and even try some preliminary predictions for the distribution of dairy cattle in Western Kenya.

2.2 Dairy related data

Data selection for spatial characterisation in Western Kenya was largely based on conceptual relationships between dairy systems and spatial variables established in other studies. Work in Central Kenya, for instance, shows that apart from individual household characteristics, production and marketing of milk by smallholders are strongly influenced by patterns of human population densities, climate, rainfall and access to urban centres and services (Staal et al, 1997).

Population growth and densities retain a dual relationship with dairy, presenting a market and price incentive for intensified production when numbers are high. At the same time, however, pressure on land and resources may leave farmers with little other choice but to intensify, of course, if they have the means. Closely related to population density is dairy market access. Both the Kiambu study and the other district survey (Staal et al., 1998) show that more intensified systems are mainly found in highly populated areas and close to urban centres, which provide market outlets and good milk prices that act as an incentive to produce. Since the timing of milk delivery and collection is critical, particularly in a smallholder African setting where cooling systems are rarely available, distance to markets and available infrastructure are of prime importance to smallholder farmers. Of course, infrastructure and distances do not only influence market access, they also affect the availability of veterinary and artificial and insemination services. Hence, general accessibility is a most important factor where dairy is concerned.

Apart from factors related to markets, infrastructure and access, there are a number of variables that describe natural dairy potential which mainly include rainfall, overall humidity, temperature, soil and disease risk. Tick-borne diseases present a serious threat to the whole dairy system as a number of them cause mortality. Given the use of crossbred animals and associated susceptibility of imported breeds, disease challenge plays an important role in farmer choice of production systems. (Staal et al, 1999).

However, not all above-mentioned factors were covered by useful data sets. Therefore, only those features for which GIS coverage could be made available within a reasonable time span were used in the initial stratification procedure. The one major setback was that the only available layer for access to urban centres proved to be insignificant in almost all analyses tried. The layer is quite crude and does not take into account that different areas are serviced by different road types and thus show tremendous variations in travel time. However it proved to be quite useful for a general insight into distance to markets and spatial spread of densely populated areas. To deal with the remaining issues, the following comprehensive and relatively recent secondary data were used:

- Population data derived from the 1989 census. Since the survey will focus on households and their practices, household densities have been given preference over population densities as an input for patterns of spatial differentiation.
- To cover climate related factors, annual precipitation over potential evapo transpiration (PPE) proved to be a useful indicator. It combines elevation, rainfall and temperature data into one measure of overall humidity: a PPE value of one indicates that the amount of rain received is similar to the amount lost through evapo transpiration (for comparison: crop production usually starts at PPE greater than 0.7).
- The available layer for access to urban centres was created by ICRAF and estimates the travel time to the nearest urban centre (with population density greater than 2,500 persons per square km) in hours.
- The Kenya Central Bureau of Statistics provided ethnicity data for all districts at sub-location level.
- Data on tick borne diseases were provided by ILRI-GIS section and supplemented by household data on the occurrence of tick related illnesses from the other district survey. The available layers cover brown ear tick distribution data and expert opinions on the spread of East Coast Fever (ECF) and other tick borne diseases.
- Only recently released by the ILRI-GIS section is a dataset on cattle numbers and densities for each division in Kenya. Data for this coverage were obtained from the Livestock Production Department, which provided the latest district level report on livestock numbers (1992-1998).

2.3 Predicting dairy cattle distribution

A first rather rough attempt at characterisation resulted in a map predicting cattle distribution in Western Kenya, based on a model developed for Central Kenya. The central Kenya model combines weighted values of annual PPE, household density, minimum temperature and market access to produce an index of predicted dairy presence. The weights or relative importance of each of the factors were derived from a logit regression analysis. To map the model outcomes, all spatial data layers were multiplied by their specific weight, summed and converted into a probability index (equation 1)

Predicted probability equation:

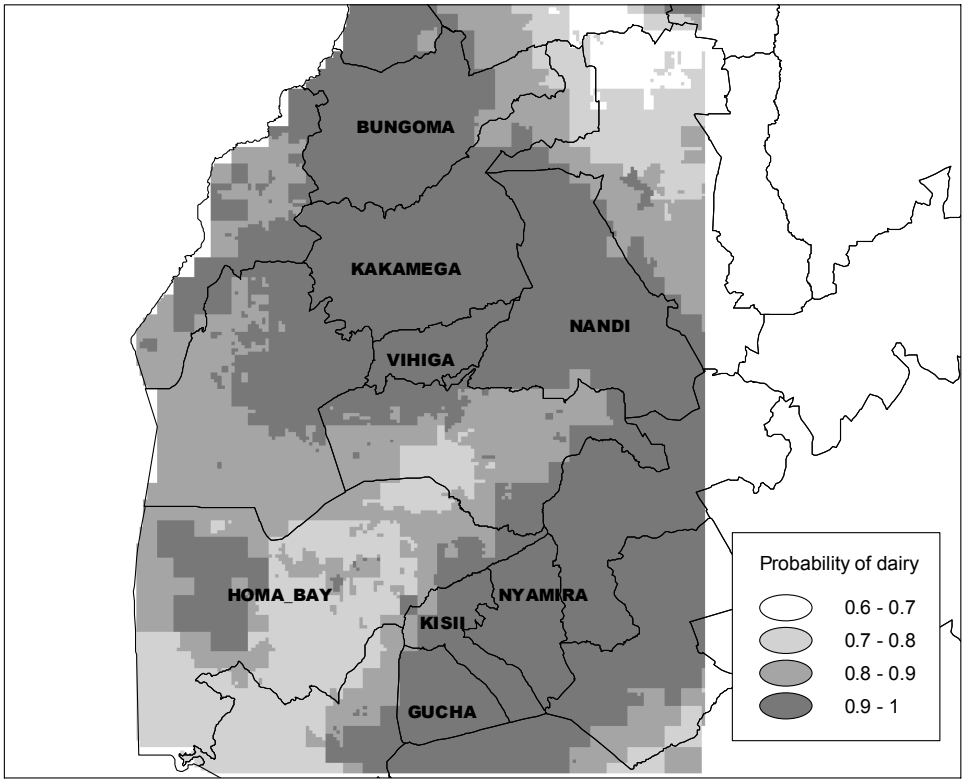
$$\text{Index} = -6.799 + 0.0026 * \text{household density} + 0.00092 * \text{access} + 8.316 * \text{annual PPE} + 0.1217 * \text{annual min temperature} \quad (1)$$

PPE proved to be highly correlated with the presence of dairy cattle and was thus strongly weighted in the prediction model. Quite to the contrary, the only available layer of access to urban centres proved to be hardly significant. Hence, the prediction of dairy probability is mainly based on an indicator of climatic potential and population densities and is therefore rather crude. Of course, the crude outcomes (more than 90% probability of running into a dairy cow in all areas of western Kenya) are not merely caused by a limited number of variables, but probably result even more from the assumption that driving factors in central Kenya would similarly determine cattle distribution in the west (Figure 2.1). Which proves to be partly true because although, climatic conditions and market incentives are important driving factors in western Kenya as well, PRA studies conducted in different districts revealed that dairy prevalence was at much lower levels than anticipated, caused mainly by low feed supply during the dry season and poor husbandry methods. In some specific areas like Kakamega, the prevalence of the Zebus is associated with the cultural practices of dowry payment and prestige since the number of cattle per household is more valuable than the quantity and quality of their produce (Waithaka et al., 2000). The fact that our initial predictions were grossly overstated was further confirmed by a recent national coverage on cattle distributions. This too showed that dairy cattle prevalence is meagre in the western districts (Figure 2.). Hence, the probability model could be much improved on, for instance by incorporating data on distribution of different ethnic groups or disease risk.

2.4 Disease risk

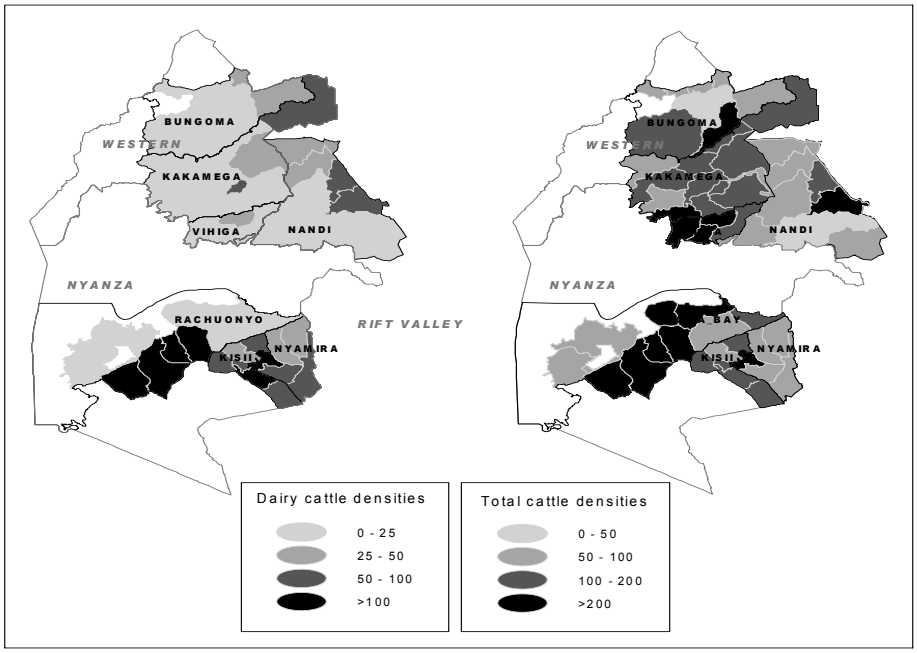
Differences in disease risk can certainly be a factor influencing the spread and adoption of dairy cattle, but so far no highly differentiated spatial datasets have been available. Based on the current coverage, all areas of interest in Western turn out equally infected with ticks and tick related diseases (Figure 2.3).

Figure 2.1 Dairy probability predicted for Western Kenya



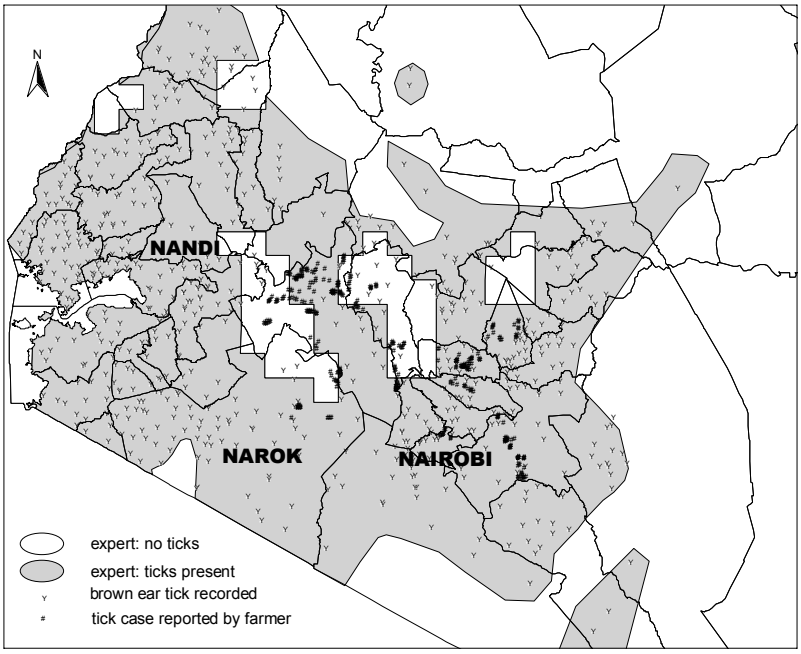
Source: ILRI 1999, Baltenweck & de Wolff

Figure 2.2 Cattle distribution in Western and Nyanza Provinces



To check the consistency of the available tick data, an overlay was made of all tick distribution layers and point data. Data assembled included layers on reported ECF, expert opinions on the spread of ticks and point data on the reported presence of the brown ear tick, compiled by Lessard, et. al. (1990) In addition, household point data on perceived animal health problems and actual reported cases of illness or death were extracted from the other district surveys. The resulting overlay of all available data presented a consistent pattern of expected and reported distribution of tick borne diseases in a broad sense. A vast area in southern Kenya seems to be tick infested. However, no differentiation was possible within the area, which, if improved on, should result in some marked variation between the research areas.

Figure 2.3 Distribution of tick (borne diseases) throughout Kenya

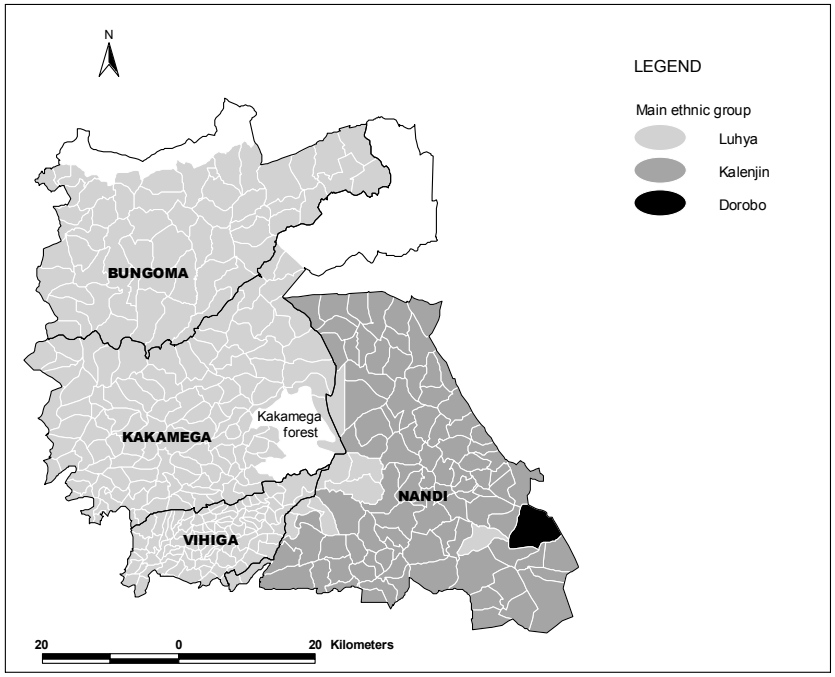


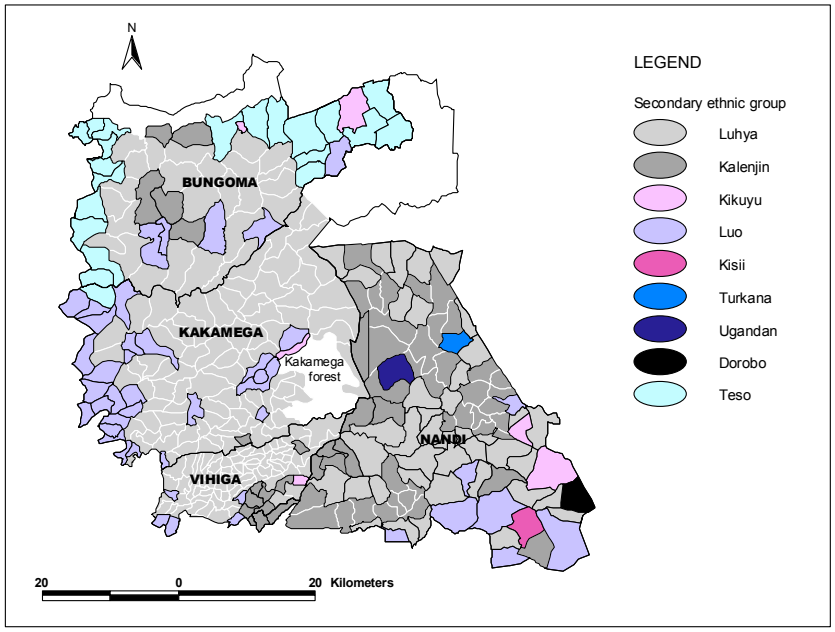
2.5 Ethnicity

As far as ethnicity is concerned, some very useful datasets were made available by the central bureau of statistics (CBS). They were initially used to portray primary and secondary ethnic groups in each sub-location. For all sub-locations with only one predominant ethnic group (being greater than 95% of the total inhabitants) no secondary ethnic group was recorded. Most areas proved to be quite consistent especially in the southern Districts Kisii and Nyamira. In areas with less than 95% consistency, secondary ethnic groups were recorded, the best example of ethnic mixture being Nandi, which harbours a number of other ethnicities apart from the predominant Kalenjin (Figure 2.4 and Figure 2.).

In future modelling procedures, based on analysis of household data from the Western Kenya survey, these data will provide a very useful supplement for further spatial extrapolation and prediction.

Figure 2.4 Distribution of main and secondary ethnic groups in western Kenya





Source: ILRI 2000, de Wolff

Figure 2.5 Distribution of main and secondary ethnic groups in Nyanza Province

3 SURVEY DESIGN AND IMPLEMENTATION

3.1 Targeting the study areas

To focus the selection of research sites within the seven districts (Bungoma, Kakamega, Vihiga, Nandi, Rachuonyo, Kisii and Nyamira), cluster analysis was used as a means of spatial stratification. Instead of simply sampling from the entire subset of sub-locations in these districts, clusters of relatively homogeneous areas were created, to serve as a sampling base.

When running a cluster procedure a number of things can be customized to user preferences. One of was choosing the number of clusters to be created. In the first run, SAS software was used to generate six groups of sub-locations, similar in terms of population densities, market access and climatic potential. Of these six, two clusters were small to display as they contained only one and 15 sub-locations respectively. The four remaining larger clusters were useful with variation between sub-locations ranging from those with high access, climatic potential and high household densities to the more remote and less populated areas (Table 3.1).

Table 3.1 Clusters means

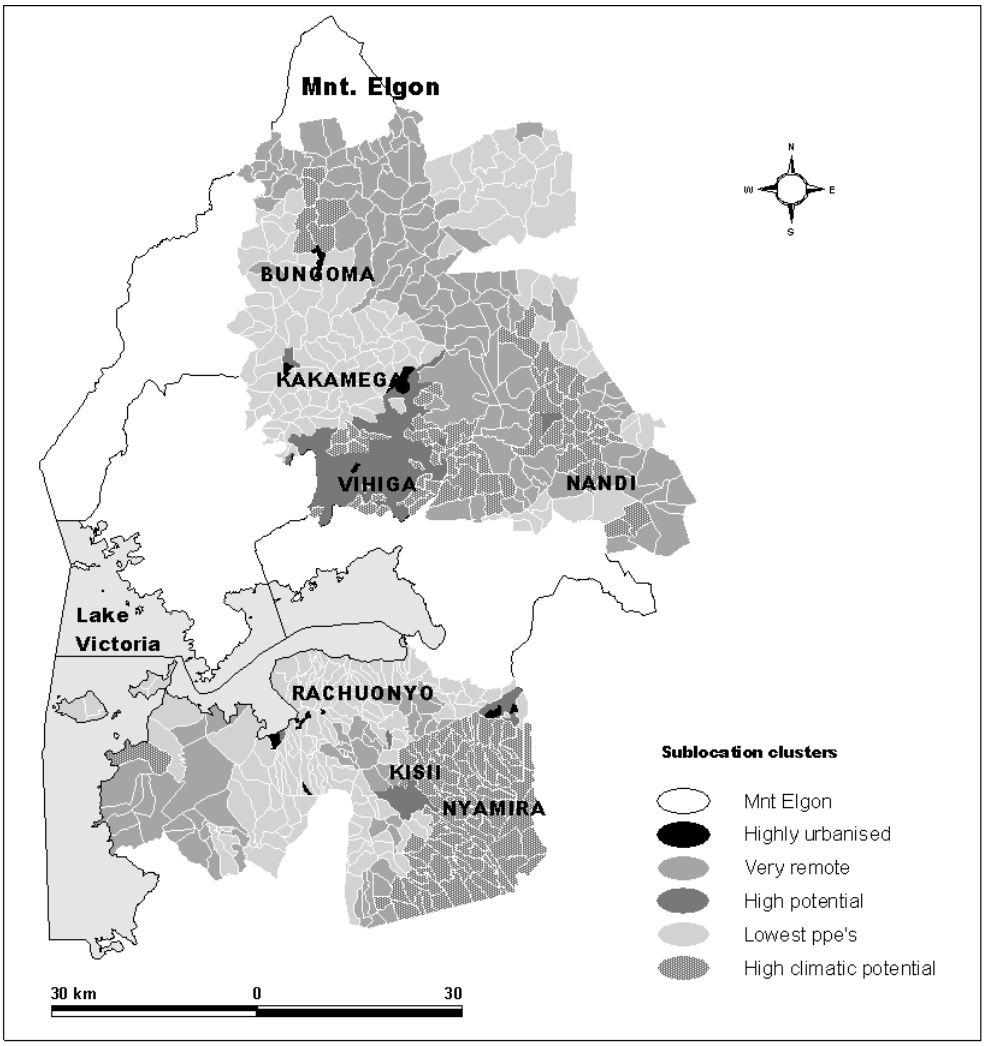
Cluster No.	Number of sub-locations	Mean household density	Mean access	Mean PPE
1	1	0 (low)	5 hrs (poor)	1.07 (high)
2	15	497 (high)	0.2 hrs (high)	0.91 (reasonable)
3	155	53 (low)	2 hrs (poor)	0.95 (reasonable)
4	106	174 (medium)	0.6 hrs (good)	1.07 (high)
5	238	61 (low)	0.8 hrs (reasonable)	0.85 (lower)
6	154	75 (low)	1hr (reasonable)	1.15 (high)

Table 3.2 Cluster description

Cluster	Description
1	Mt Elgon
2	Highly urbanised sub-locations (municipalities)
3	Remote, sparsely populated areas
4	High potential areas (not too many households, good access and climatic potential)
5	Lower density areas with good access but lower climatic potential
6	Similar to 5 but with very high climatic potential

In a second run, the number of clusters was enhanced to nine, in an attempt to pull apart the rather big clusters generated by the first run (155, 106, 238 and 154 respectively, Table 3.1). This resulted in five more equally sized groups, with more distinct characteristics. However, though the second run provided more detailed information, the first run generated a workable number of clusters as well as a distinct spatial pattern, which proved to be most useful for mapping and targeting purposes (Figure 3.1).

Figure 3.1 Clusters of similar sub-locations in Western and Nyanza Provinces



Source: produced at ILRI , Jan 2000

A final outcome of this clustering procedure was a list of almost homogenous divisions (as far as dairy related issues were concerned) from which two contrasting divisions could be selected in each district to serve as the sampling frame for the survey (Table A1.1).

3.2 The questionnaire

The current survey followed a sequential process that started with studies in coastal Kenya, central Kenya, and within western Kenya, sub-regional reviews (Owango et al, 2000, Mudavadi, et al 2001, and Ojowi, et al, 2001), GIS analysis and rapid appraisals (Waithaka et al, 2000). The information collected during these stages, especially the PRAs was used to refine the characterization questionnaire to fit circumstances found in western Kenya. The questionnaire, was developed to fit with the previous work and with an aim of guiding other successive studies in the region (Mullins et al, 1994; Jabbar et al, 1997; Rey et al, 1999) and was designed to be effective in collecting household level data and information encompassing the entire continuum from dairy production, marketing, processing and consumption. The questionnaire was

pre-tested and revised by teams of research and extension staff from ILRI, KARI and MOARD in several district locations before training of enumerators and supervisors commenced. During training, the enumerators and supervisors went through each question with the Nairobi team and revised it and then they pre-tested the questionnaire, discussed it again after which the final version was printed for use in the surveys.

The 42 page questionnaire was divided into sections covering: household composition and labour availability; land size and allocation; farm activities and facilities (including crop husbandry); livestock inventory; dairying history and production practises; dairy marketing; livestock management and health services; co-operative membership; and, household income levels and sources.

The questionnaire was pre-tested in several districts before training sessions with enumerators and supervisors were undertaken where each question was again reviewed and adjusted as necessary.

3.3 Sample size selection and interviewing

The number of households to be surveyed in each sub-location was taken as a proportion of the number of households in the sub-location (Table A1.2) obtained from 1989 census figures (CBS, 1994).

In order to capture as much local variation as possible, the sample in each zone was spread across 56 sub-locations selected randomly. The number of observations in each sub-location was adjusted to reflect the proportion of the number of households, resulting in sample sizes of 15 to 60 in each sub-location. The total sample size obtained for the whole area was 1,563 households (or 2.1 percent of the households in the sample sub-locations), but the total number of households surveyed was 1,576 due to complications arising in the survey process, e.g., some transects had to be elongated when they did not yield enough households, some households could not be interviewed on the same day and had to be revisited later, and so extra households were selected just in case the appointments failed, etc (Table A1.2).

Survey maps for each of the 56 sub-locations were created from ILRI's GIS databases, using ArcInfo software. The survey enumerators, who had previously been trained in the use of the questionnaire, visited their assigned sub-location, and with the help of sub-location Chiefs, marked on the sub-location map the main landmarks. A landmark was defined as any permanent feature like a trading centre, a school, a church, or a factory. Two pairs of landmarks were then selected at random for each sub-location, and line transects were drawn joining each pair. Sampling was thereafter done following as closely as possible the marked transects. Every fifth household on the left and on the right was interviewed alternately, regardless of whether they were agricultural or kept dairy animals. In this way, a random sample of all sub-location households was obtained. The questionnaire was filled out by respondents from representative samples of households drawn from populations representative of the areas surveyed.

The interviews were conducted with preferably the household head or, in their absence, the most senior member available or the household member or manager responsible for the farm. The interviews were carried out between 2nd March and 15th July 2000 by enumerators familiar with the sub-locations, who were selected from among the front-line extension staff of the MOARD. Their superiors from the district together with some KARI researchers supervised them. During the first week of the survey, the

supervisors checked each completed questionnaire within one day of the interview. Any errors were discussed with the enumerator so as to improve the accuracy of subsequent interviews. In some instances the enumerator returned to the household to correct major errors or omissions. Staff from the MOARD, KARI and ILRI who designed, supervised, enumerated and analysed the survey are listed in Annex 3.

The data from the questionnaires were entered into Microsoft Access database management software and checked for data entry errors. Descriptive statistical analyses were carried out using Microsoft Excel and Stata software.

After the initial descriptive statistics were developed, feedback sessions were held with farmers and the research teams in each sub-location. Later, feedback sessions were held with the research teams to propose the way ahead. Inputs from the feedbacks are included in their specific areas in the report.

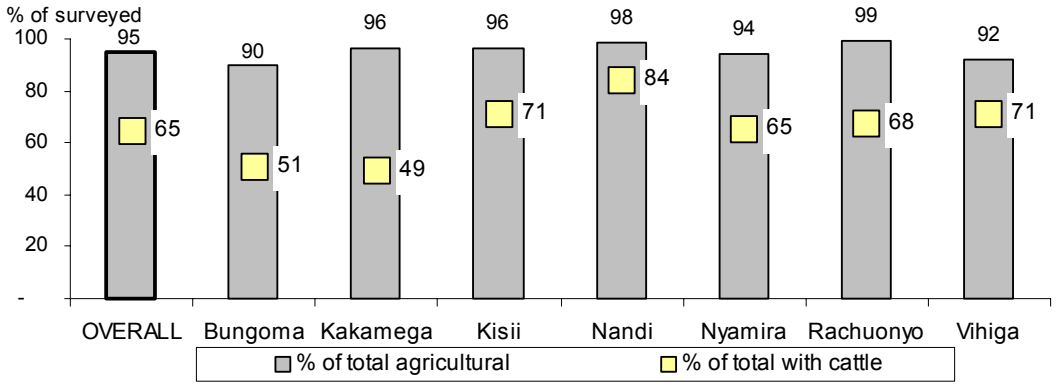
The results of the survey presented in this report are tabular descriptive analyses. The data were later used in principal component and cluster analyses to identify homogenous groups of dairy producers. These clusters represent recommendation domains, which form the focal points for developing policy and technical interventions, by targeting them at identified groups of resource-poor farmers with particular characteristics.

4 DESCRIPTIVE ANALYSIS

4.1 Number of households surveyed and household categories

Of all the households surveyed 95% were agricultural, using part of their land for either crop and/or livestock production (Figure 4.1). This ranged from 90% in Bungoma to 99% in Rachuonyo. Among the agricultural households, 68% kept cattle of various breeds and types. Kakamega had the least number of households with cattle (51%), while Nandi had the most (85%), followed by Vihiga (77%) and Kisii (74%). A household was defined as the smallest decision making unit consisting of people who ate and lived together. It included unmarried members such as students who live elsewhere but depend on the household for income and food, unmarried members working away but regularly bringing in income to support the family and employees living and eating together with the household. Permanent labourers who stayed on the farm but lived independently (made his/her own meals) were treated as outsiders.

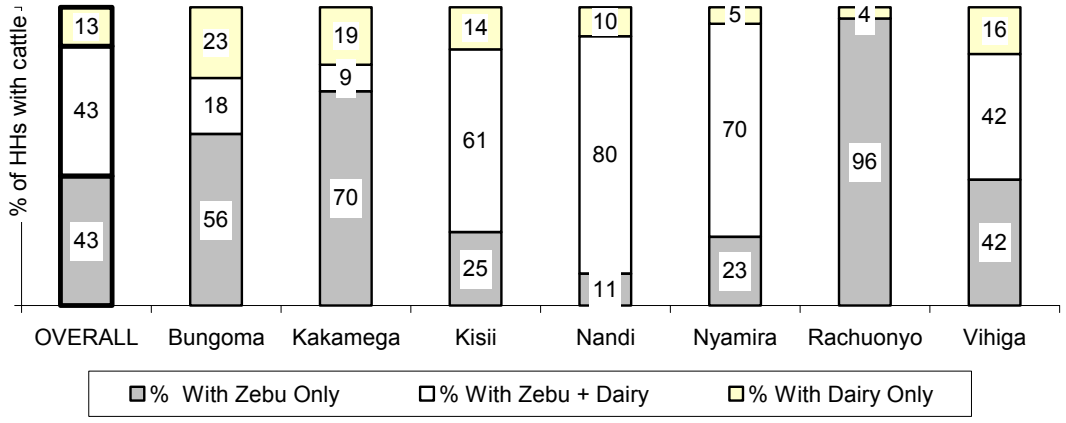
Figure 4.1 Households surveyed, proportion agricultural, and those with cattle



The cattle kept have been split into two main categories: the local zebu and the dairy type or grade cattle (cross breeds or pure grade). Overall, only 13% of the households with cattle solely kept the dairy grades (Figure 4.2). Forty three percent kept zebu alone and another 43% kept a combination of zebu and the dairy grades.

Rachuonyo had the highest percentage of households with only zebus (96%). Bungoma had the highest percentage of households keeping only the dairy types (38%). Nandi had the highest number of households with dairy cattle either the dairy grade alone or in combination with zebu (90%); followed by Nyamira (76%) and Kisii (75%). The district with the lowest number of households with dairy cattle either the dairy grade alone or in combination with zebu was Kakamega with 28%. In Rachuonyo and Bungoma the survey transects left out pockets of areas with dairy cattle as shown in the section on cattle kept.

Figure 4.2 Proportion of households with cattle keeping different classes of cattle



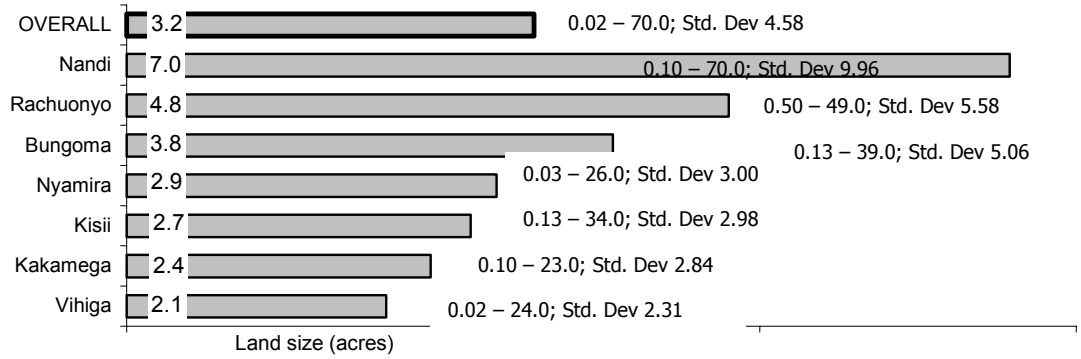
4.2 Household land size, land tenure and land use

4.2.1 Land size

Among the agricultural households, land size per household varied greatly, from a 0.02-acre plot in Vihiga to a 70-acre farm in Nandi (Figure 4.3). The mean acreage for all households surveyed was 3.6 acres (median 2.5 acres). Households in Nandi had the largest farm sizes, with a mean of 8 acres (median 5), followed by Rachuonyo with 5.4 acres (median 4). Vihiga with 2.2 acres (median 1.6) and Kakamega with 2.9 acres (median 2) had the smallest land sizes per household. Depending on where the transects ran through, Kakamega was not well represented as it has higher agricultural land than indicated.

The Non-agricultural households (mainly residential plots in urban and peri-urban centres) comprised 5% of all households surveyed and they had an average land size of 2.5 acres. The mean acreage per household among those with or without cattle, with dairy cattle only, with Zebu only or a combination of the two was about the same at 3.5 to 3.6 acres.

Figure 4.3 Agricultural land sizes in acres

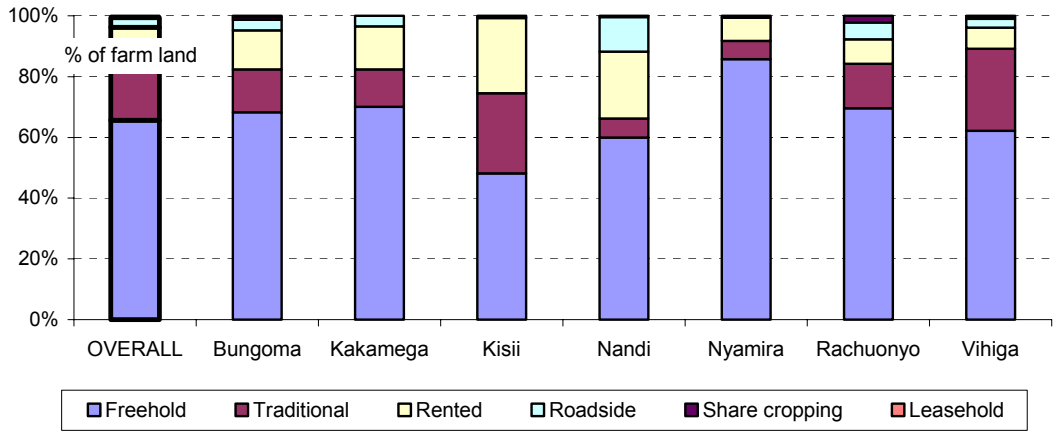


4.2.2 Land tenure

The following land tenure systems were identified:
Traditional: land owned or used by virtue of inheritance from ancestral land and, in this case, any such land where the household head had not acquired a title deed for it yet.
Freehold: land owned (traditional or purchased) for which the owner has a title deed.
Leasehold: land owned but the owner has leased (or rented) to another and was not using at the time of the survey.
Rented land: land rented or leased by the subject household from another for use.

The largest proportion of the land is freehold (65% of all households), followed by traditional land tenure (17%) and rented (14%) (Figure 4.4). Nyamira had most households with freehold (85%) while Kisii had the lowest at 48%. Traditional land tenure was prevalent in Kisii and Vihiga with 26% of the households in either of the districts and lowest in Nandi and Nyamira with 6%.

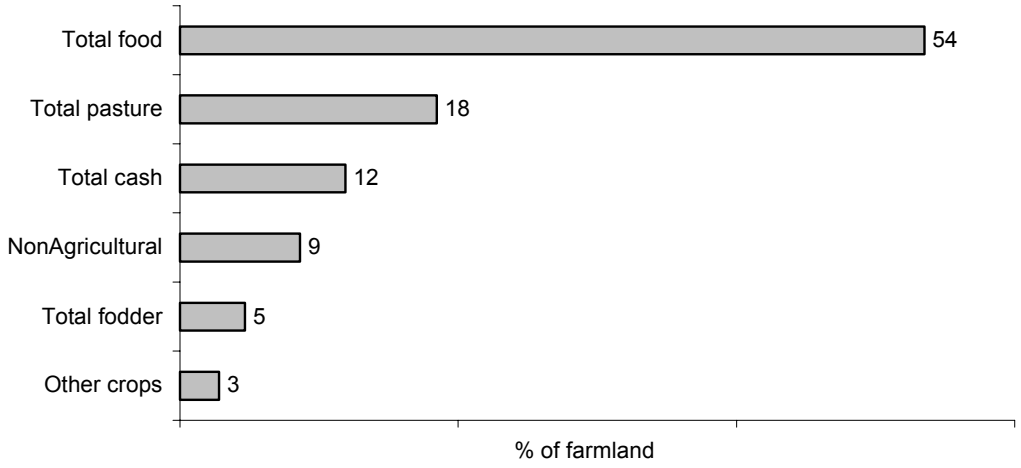
Figure 4.4 Proportions of land under various land tenure systems



4.2.3 Land use

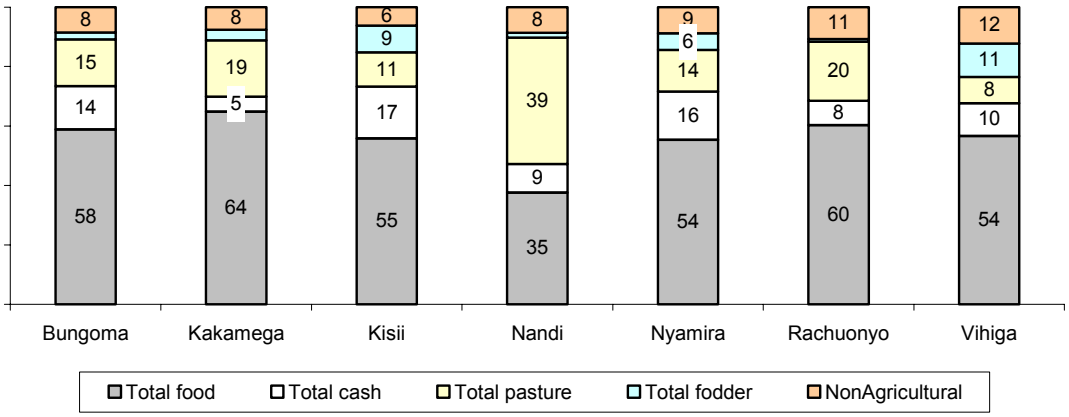
Land allocation to various enterprises is shown in Figure 4.5. Slightly more than half of the land is used in growing food crops. Fallow and natural pasture occupied 20% while planted fodders, including Napier grass was found on only 6%. This allocation pattern was not the same throughout the area (Figure 4.6). Nandi had 40% under pasture, 35% under food crops, and only 8% under cash crops. Rachuonyo had 60% under food crops and 20% under grazing. Kisii had the greatest proportion of land under cash crops (17%) and, along with Vihiga and Nyamira, the largest proportion under planted forages (8 - 10%).

Figure 4.5 Allocation of land to different enterprises



Nine percent of the land under cash crops in Bungoma was allocated to sugar cane while tea had been allocated most of the land in Nyamira (8%), Kisii (7%)and Vihiga (5%) (Figure 4.6 and Table 4.1). In Nandi, sugar sugarcane, tea and trees were the only cash crops mentioned and they shared equal land allocations each, about 3%. Pulses (mostly field beans), was the most prevalent cash crop in Rachuonyo (6%).

Figure 4.6 Allocation of land to enterprises by districts



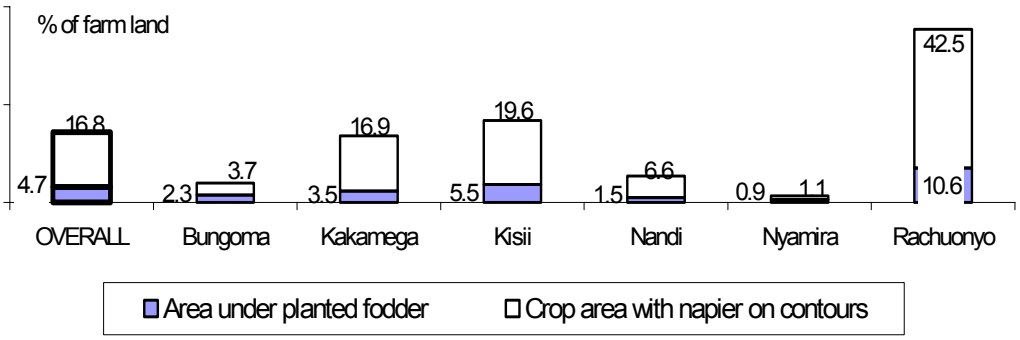
The most common food crops in the whole area were maize at 23% overall, ranging from 19% in Nandi to 28% in Kakamega. Beans took 14% overall ranging from 9% in Rachuonyo to 25% in Kakamega. Rachuonyo had the largest fraction of land under sorghum/millet (17%). The definition of foods and cash crops should be read cautiously since many food crops are a major source of income when they are sold. This becomes quite clear when one considers income sources from farming.

Table 4.1 Spread cash and food crops by percentages of farmland occupied

		Overall	Bungoma	Kakamega	Kisii	Nandi	Nyamira	Rachuonyo	Vihiga
Farm area (acres)									
		5,848	588	716	739	926	1,490	763	627
Food crops	1st	Maize *(23)*	Maize *(26)*	Maize *(28)*	Maize *(27)*	Maize *(19)*	Maize *(22)*	Maize *(21)*	Maize *(24)*
	2nd	Pulses *(14)*	Pulses *(24)*	Pulses *(26)*	Pulses *(12)*	Pulses *(10)*	S/millet *(11)*	S/millet *(17)*	Pulses *(18)*
	3rd	S/millet *(6)*	Banana *(3)*	Banana *(3)*	S/millet *(6)*	Pulses *(2)*	Pulses *(10)*	Tubers *(11)*	Banana *(3)*
Cash crops	1st	Tea *(4)*	S/cane *(9)*	S/cane *(3)*	Coffee *(7)*	Tea *(3)*	Tea *(8)*	Pulses *(6)*	Tea *(5)*
	2nd	Pulses *(2)*	Coffee *(3)*	Tea *(0.5)*	Tea (2)	Trees *(3)*	Pulses *(3)*	Cotton *(0.8)*	Pulses *(2)*
	3rd	S/cane *(2)*	Trees *(1)*	Pulses *(0.4)*	Pyrethrum.*(2)*	S/cane *(2)*	Coffee *(2)*	Trees *(0.8)*	Trees *(0.2)*

Total planted fodder, which included Napier planted as a one-patch stand, occupied 5% (Figure 4.7) of total farmland and was mostly grown in Vihiga, Nyamira and Kisii. However, Napier was also grown along the contours of other crop plots in 20% of total farmland surveyed, with the highest establishment of this kind observed in Vihiga (42%) and Kisii (31%). Other planted forages (forage legumes) were negligible (0.5%) and were only mentioned in Kakamega. Nandi had the highest proportion of land under pasture (39%), followed by Kakamega (23%) and Rachuonyo (20%), while Vihiga and Nyamira had the lowest at 9% and 8% respectively.

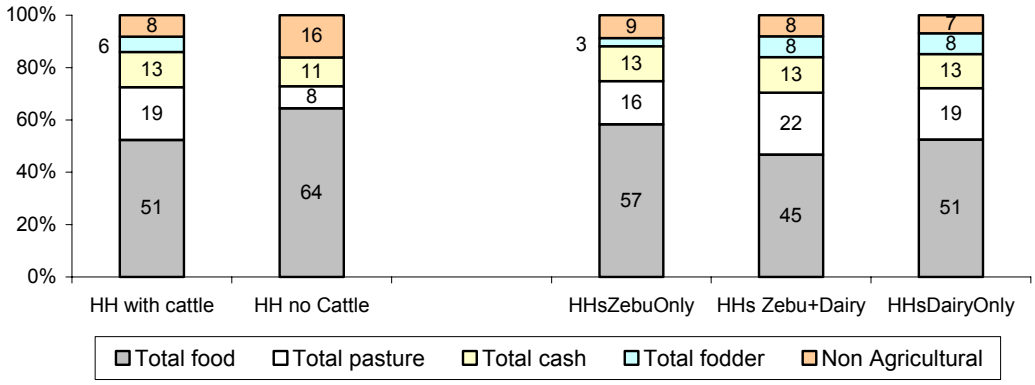
Figure 4.7 Area under planted forages and Napier planted along contours



There was little difference in land allocated to cash crops by the different household categories (Figure 4.8). Land allocated to food crops varied, where households with Zebu only had 57% of their land under food crops, 51% in households with improved dairy cattle only and 45% in households with a combination of Zebu and improved dairy cattle. Households keeping improved dairy cattle only had more

land under maize (24%) than those with a combination of Zebu and improved dairy cattle (at 21%). In addition households with improved dairy cattle had more land under planted forages (8%) than those with Zebu only (3%). They also had more grazing grounds (19% – 22%) than those with Zebu only (16%).

Figure 4.8 Land enterprise allocation by household category



4.2.4 Changes in crop patterns

About 300 households reported a change in the crops they grew 10 years ago that they did not grow at the time of the survey and those they did not grow 10 years ago, but grow them now (Figure 4.9 and Figure 4.10). Among the most dramatic changes were the numbers of households that have taken up Napier, fruit/tree crops, tea and bananas. The number of households that had Napier at the time of the survey but did not have it ten years ago was 243, (16% of agricultural households). This indicates the increase in importance of livestock in the farming systems.

4.2.5 Use of manure and fertiliser

Except for Rachuonyo, 79% of agricultural households in all districts purchased fertiliser for use in their farms; in Rachuonyo only 14% of the agricultural households said they did (Figure 4.11). Seventy five percent of agricultural households indicated they used manure, the highest numbers being in Vihiga (92%), Kisii (82%) and Nandi (80%), and the least, again, being in Rachuonyo (47%). In areas with more grazing, then manure may not be readily collected.

Figure 4.9 Crops grown now and not ten years

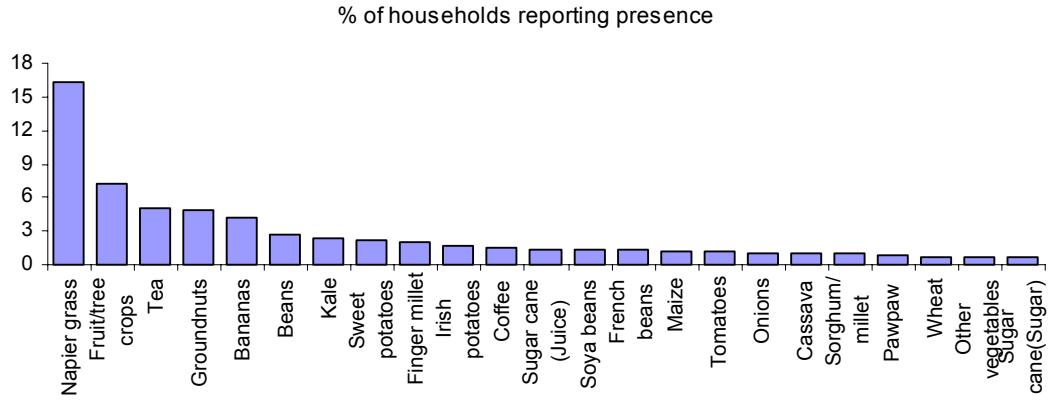


Figure 4.10 Crops grown ten years and not now

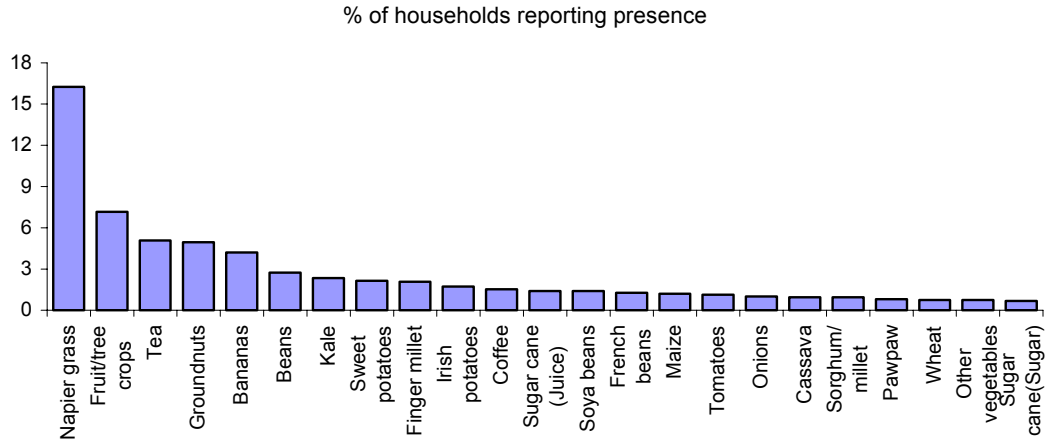
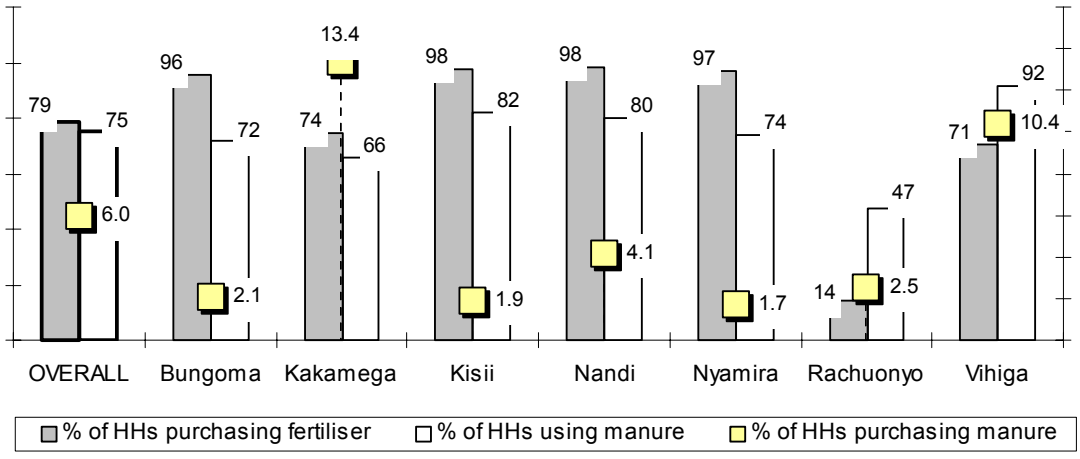


Figure 4.11 Proportion of households using and buying manure and fertiliser



Few households (6%) purchased the manure, with households in Kakamega showing largest numbers of purchase (14%), followed by Vihiga (10%). The manure was applied to maize, beans and bananas in the whole area; as well as to Napier especially in Nyamira and Kisii, sorghum in Rachuonyo and vegetables in Kisii, Nandi and Nyamira. Fertiliser was mainly applied to maize and beans in all the districts, but also to tea in Nyamira and Kisii, sugar cane in Bungoma and sorghum in Rachuonyo.

4.3 Household composition and gender differentiation

4.3.1 Household sizes

The mean household size was 5.8 members per household, ranging from 5.4 in Kakamega to 6.8 in Nandi. Most members fell in the 23 to 65 years age bracket. The dependent population (less than 22 years old) was 64% with a range from 60% in Rachuonyo to 68% in Bungoma (Table 4.2).

Table 4.2 Household size and composition

Age (years)	Overall	Bungoma	Kakamega	Kisii	Nandi	Nyamira	Rachuonyo	Vihiga
0-7	1.2	1.7	1.1	1.2	1.5	1.2	0.9	1.2
8-14	1.3	1.4	1.3	1.5	1.4	1.3	1.2	1.3
15-22	1.2	1.3	1.1	1.2	1.4	1.1	1.2	1.1
23-65	1.9	1.9	1.7	2.0	2.2	1.8	2.1	1.9
>65	0.2	0.2	0.3	0.1	0.3	0.1	0.1	0.2
Total	5.8	6.6	5.4	6.0	6.8	5.5	5.5	5.7

Table 4.3 Household size and composition by household category

Age (years)	Agricultural	Non agricultural	With cattle	No cattle	Zebu Only	Zebu+Dairy	Dairy Only
0-7	1.2	1.2	1.2	1.3	1.2	1.2	1.1
8-14	1.4	0.7	1.5	1.1	1.5	1.5	1.6
15-22	1.2	0.5	1.4	0.8	1.3	1.4	1.6
23-65	1.9	1.6	2.0	1.6	1.9	2.1	2.1
>65	0.2	0.0	0.2	0.1	0.3	0.2	0.3
Total	5.9	4.0	6.4	5.0	6.2	6.5	6.6

Agricultural households had on average more household members than non-agricultural (5.9 versus 4.0), and of the agricultural households those with cattle had more members than those without (6.4 versus 5.0) (Table 4.3). There were no differences in household size among households, related to types of cattle kept; all ranges were found to have between 6.2 and 6.6 members.

4.3.2 Details of household heads

Eighty three percent of the households were headed by males and 17% by females. Kisii had the highest proportion of female-headed households (29%) and Kakamega and Nyamira had the lowest (15%) (Table 4.44). The overall mean age of male household heads was 50 years and 52 years for female heads. The

youngest male household heads (46 years) were found in Kisii and the oldest (53 years) in Vihiga. The youngest female household were in Kisii (43 years) and the oldest in Nandi (59 years).

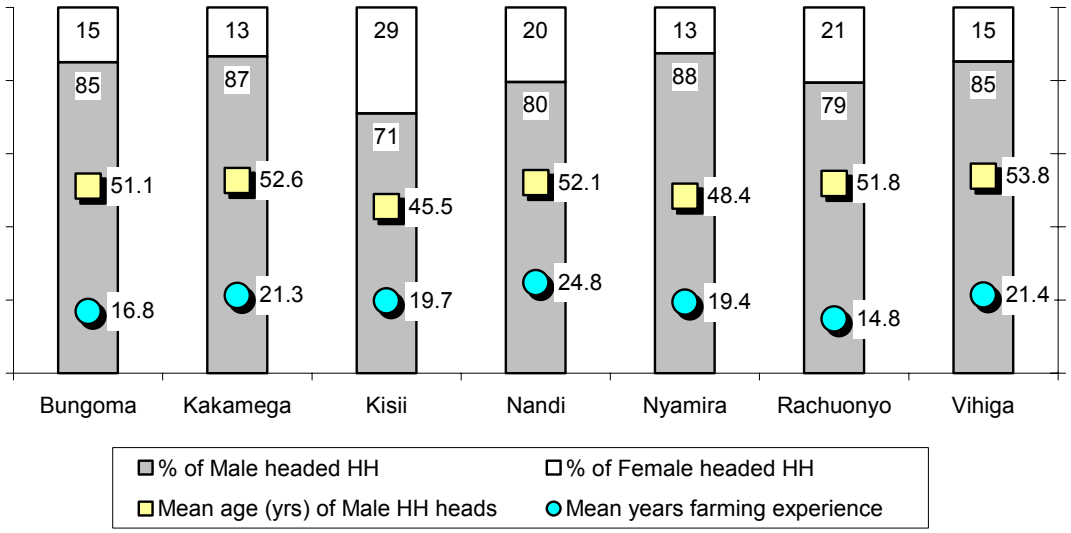
Table 4.4 Gender of household head, farm ownership and education level

Overall (n=1,575)	Male	Female
Sex (%)	82.48	17.52
Age (years)	48.96	51.04
Farm owner (%)	86.4	13.6
Years of farming experience	18.6	26.4
Education (%):		
No formal education	9.0	34.7
Primary	51.0	50.4
Secondary	29.1	12.4
Post secondary	2.9	0.4
University and technical trained	7.1	1.8
Adult education	0.5	0.4
Other	0.5	0.0

Overall, only 9% of male households heads did not have any formal education compared to 35% of the females. The primary level education was attained by 50% of male household heads and the same percentage for females. Only 7% of the male and 2% of the female household heads had University or technical training. Nandi had household heads with the longest farming experience (22 years for males and 36 for females) and Rachuonyo with the least (13 years for males and 20 for females). Bungoma district had the highest number of household heads with secondary and post-secondary education (49%) while Nandi had the least (30%). Kisii had the highest number of female household heads with this level of education (17%) and Nandi the least (4%).

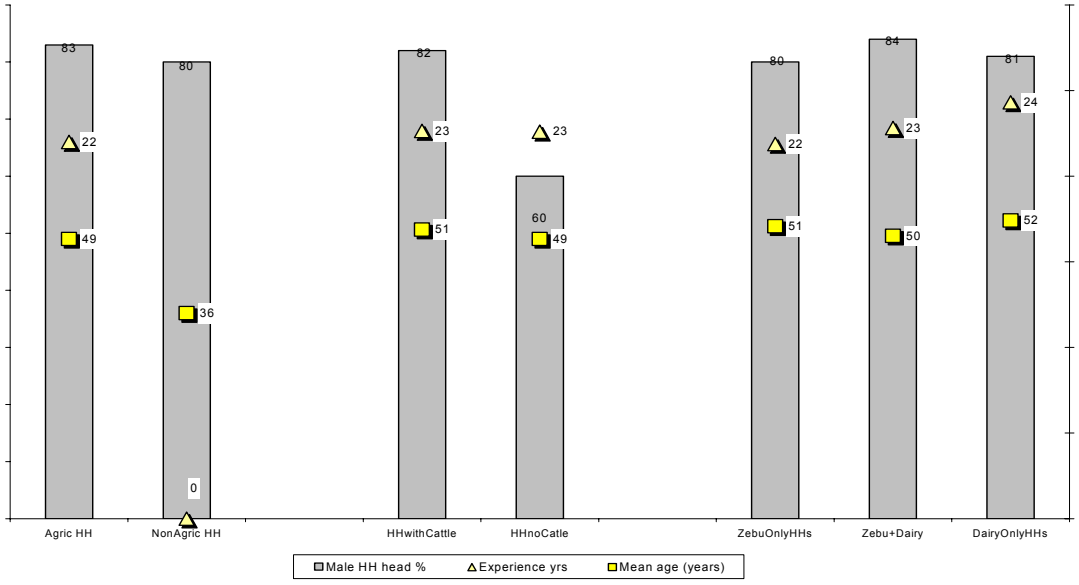
The male to female ratio of household heads remained more or less the same (80% male and 20% female) in the: agricultural households, non-agricultural households, households with Zebu only, households with dairy grade, and households with a combination of Zebu and dairy grade cattle (Figure 4.12). However, in households that had no cattle, females headed 40% of the households.

Figure 4.12 Details of households heads



The mean age of the household head for agricultural households was 49 years while the non-agricultural households was 36 years (Figure 4.13). Non-agricultural households were homesteads in urban and peri-urban areas occupied by business premises like kiosks and dukas, or those homesteads with household heads working off farm. Sixty two percent of non-agric households heads had secondary and post secondary education.

Figure 4.13 Details of household heads by household category



The percentage of households with secondary and post secondary education increased as one moved from households with no cattle, to 26% of those with Zebu only, to 34% of those with only the pure grade and 38% of those with Zebu and improved cattle (Table 4.5).

Table 4.5 Education of household heads by household category

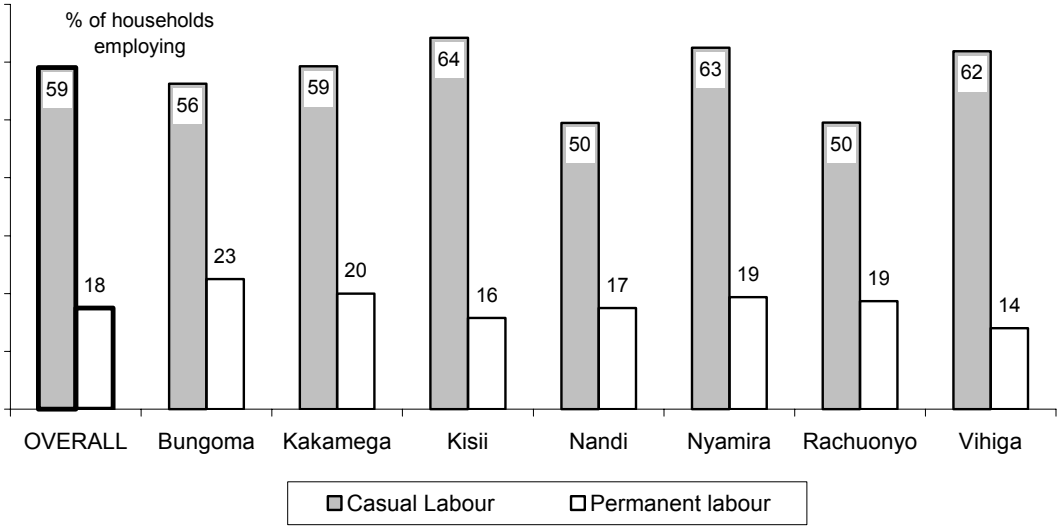
	Agricultural household	Non Agricultural	With cattle	No Cattle	Zebu only	Zebu+Dairy	Dairy only
No formal education	14.0	3.7	14.4	66.7	18.0	12.1	11.9
Primary	51.7	33.3	52.6	33.3	55.0	49.7	53.7
Secondary	25.3	42.0	23.1		18.9	26.5	24.6
Post secondary	2.3	3.7	2.7		2.7	3.0	1.5
University & technical	5.6	16.0	6.2		4.3	7.8	6.7
Adult education	0.5		0.6		0.5	0.5	1.5
Other	0.4				0.5	0.5	

4.4 Labour use and labour division

4.4.1 Labour activity employment

Fifty nine percent of the households employed casual labour (Figure 4.14). Only 18% of the households used long-term labour, and these were mainly involved in activities related to livestock, such as grazing animals (cited as first activity). Bungoma had the highest percentage of households with long-term labour (23%) while Vihiga had the least (14%). Kisii and Nyamira had a high percentage of households using casual labourers (64% and 63%, respectively). Nandi and Rachuonyo recorded 50% each.

Figure 4.14 Proportions of households employing long-term and casual labour



Casual labour is mainly employed in crop related activities (cited as first activity). Thirty percent of the households reported that casual labour is used for preparing fields for food crops, or for planting and weeding Thirty percent of the households cited planting and weeding as both a first and second activity.

Twenty percent of households who employed long-term labour used it for all cattle related activities only as first activity, and while another 20% used them in all crops related activities as second activity.

4.4.2 Livestock management activities and responsibility allocation

Of all the households surveyed, 35% had adult females (other than the household head) taking a bigger role in feeding cattle than all other household members (Table 4.6). This involved grazing and/or cutting and carrying feed. In 30% of the households, this activity was the responsibility of the household head regardless of gender. Forty eight percent of the households surveyed had adult females (other than the household head) responsible for fetching water or watering the animals, while 17% of the households had specifically the household head with this responsibility.

Milking was the responsibility of adult females (other than household head) in 56% of the households surveyed. The adult females in 60% of the households did marketing of milk. Adult females cleaned the milk shed in 56% of the household surveyed and the household heads did it in 18% of the households. The household heads in 46% households did spraying or dipping. The household head also obtained AI and veterinary services in 60% of the households. Children, casual and long-term labourers actually played secondary roles when whoever is responsible (especially the household head) decides what is to be done.

Table 4.6 Household members responsible or involved in livestock activities

Activity	Graze	Cut & carry feed	Feeding	Fetch water & watering	Milking	Sell milk	Clean shed	Spray/dip
Household head	33.3	30.6	31.3	16.9	21.4	19.6	18.1	46.4
Adult males	5.6	6.2	5.0	4.7	5.9	3.8	2.9	9.4
Adult females	33.4	34.7	35.8	48.3	55.7	59.6	55.9	16.7
Any household member	4.4	4.7	4.9	5.1	2.3	2.8	3.9	3.3
Children	5.7	5.2	4.6	7.3	4.0	3.7	4.8	7.4
Long-term labour	8.7	10.1	9.3	9.6	5.9	4.7	7.3	6.5
Casual labour	0.6	1.0	0.9	1.3	0.6	0.5	0.8	2.3

4.5 Household incomes

Over 70% of all the households interviewed got an income of less than KSh 5,000 per month (Figure 4.15). Nyamira alone had (76%), while Nandi had 57% (Figure 4.16) in this category. In Nandi 24% of the households got between KSh 5,000 and KSh 10,000, while 20% got over KSh 10,000. This means that households in Nandi earned the highest income per month as compared to other districts.

Figure 4.15 Proportions of households by monthly income categories

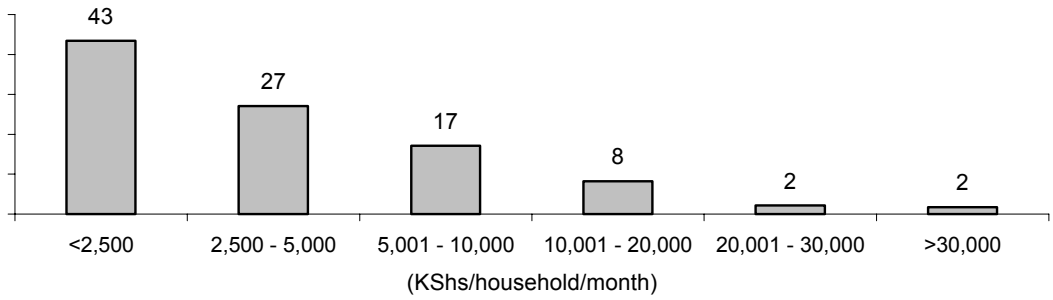
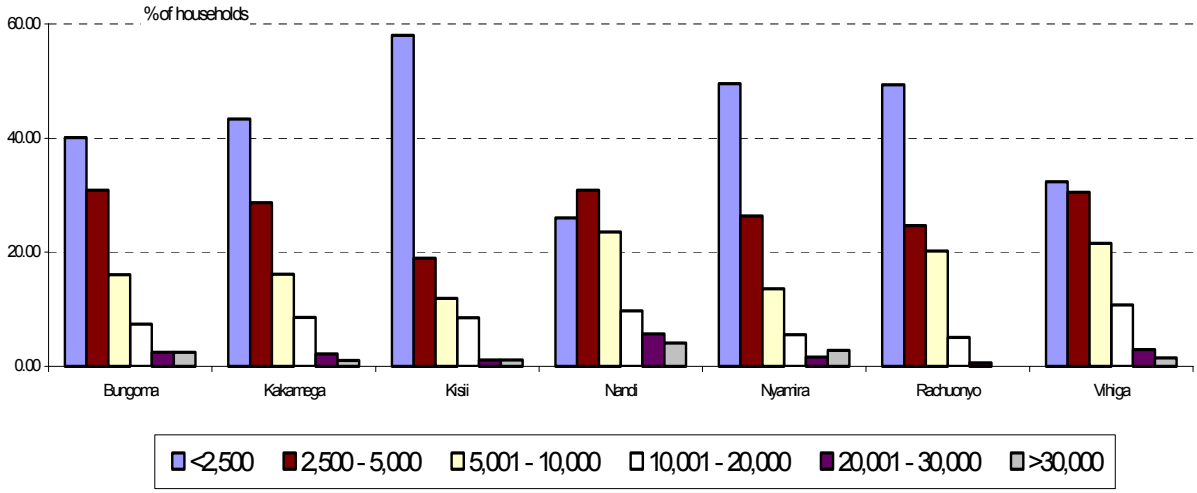


Figure 4.16 Proportions of households by monthly income (KSh) categories

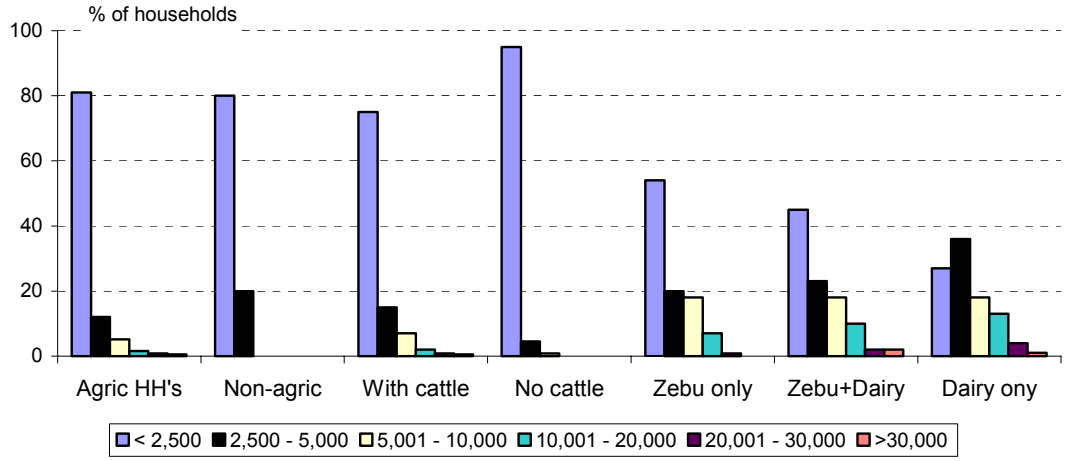


The income levels for non-agricultural households were lower than expected. Possible reasons could have been that there was a general reluctance to indicate true incomes and this may have reduced the final sample size and given an un-representative summary. The households may have deliberately refused to indicate off-farm incomes.

All non-agricultural households earned less than KSh 5,000 per month (Figure 4.17). Although 90% of agricultural households earned less than KSh 5,000 per month, their incomes were higher than for non-agricultural households.

Ninety percent of the households with cattle earned at most KSh 5,000 while compared to the households without. This means that households with cattle earned more than those without. As one moves from households with Zebu to those with pure dairy grades only, income per month increases.

Figure 4.17 Proportions of households by monthly income (KSh) and household categories



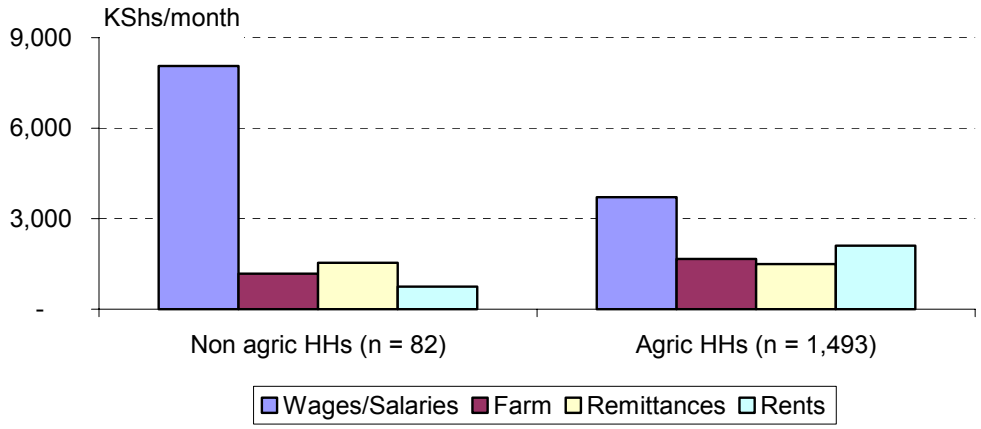
The bulk of income to the households came from outside the farm, mainly by way of salaries and wage earnings from off-farm employment (Table 4.7). Among agricultural activities, the income from dairy farming was higher than that from all the other enterprises except for Nyamira and Rachuonyo districts where cash crops incomes were the highest.

Table 4.7 Household income sources and proportions contributed by source

	Overall	Bungoma	Kakamega	Kisii	Nandi	Nyamira	Rachuonyo	Vihiga
Number of households	1,493	162	279	269	123	250	158	334
% of total income								
Wages/salaries	44.20	52.44	41.10	45.16	57.71	42.72	48.91	40.95
Farm	18.04	16.78	13.35	22.39	19.40	21.30	11.19	20.45
Remittances	16.29	12.90	19.35	18.16	5.03	9.60	24.77	16.14
Rents	21.47	17.88	26.20	14.29	17.85	26.38	15.14	22.46
% Off farm income								
Dairy activities	27.26	50.23	33.46	21.96	44.26	14.60	21.04	31.04
Cash crops	24.12	9.54	25.91	12.96	22.71	46.09	32.13	10.13
Food crops	17.12	31.32	13.77	12.16	26.45	18.29	26.29	30.84
Horticulture	6.86	13.96	5.18	2.97	3.69	10.26	0.00	10.53
Wood/timber	7.37	2.26	4.06	15.62	2.38	5.79	15.38	14.28
Other livestock	17.26	0.00	17.63	34.33	0.52	4.97	5.16	3.19

The bulk of income to the households came from outside the farm, mainly by way of salaries and wage earnings from employment off-farm, especially for non-agricultural households. (Figure 4.18). Among agricultural households, the income from dairy activities was higher than that from all other farm enterprises except for Nyamira where cash crops incomes were the highest (Table 4.12).

Figure 4.18 Household income sources

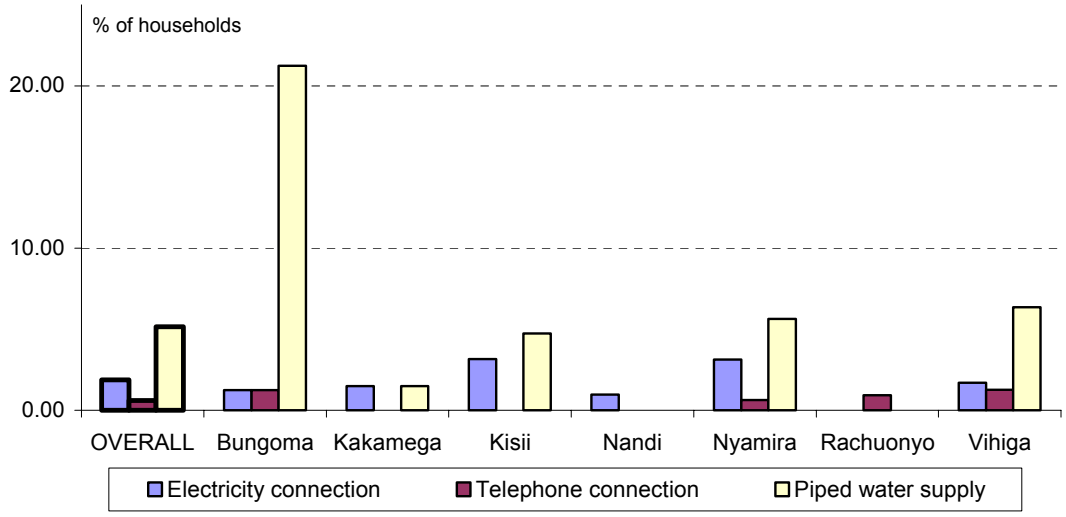


4.6 Farm infrastructure and transport

Only 5% of all households surveyed had piped public water supply, 2% had electricity, and less than 11% had a telephone connection (Figure 4.19). Bungoma had the highest proportion of households with water supply (21%). There was none in Nandi and Rachuonyo. Three percent of the households in each of Kisii and Nyamira had electricity connection.

The distance from households to a road open to vehicles all year round ranged from 0 to 30 Km, with a mean of 3.2 Km (median of 2 Km) (Figure 4.20). The distance of households to a road passable only during the dry season ranged from 0 to 5 Km, with a mean of 300 metres (median of 0 Km). The distance from households to the closest market or trading centre ranged from 0 to 13 Km, with an average of 1.8 km (median 1.5). Households in Nandi were found furthest from a road open all year round (8 km) and those in Kakamega were the nearest (2 km).

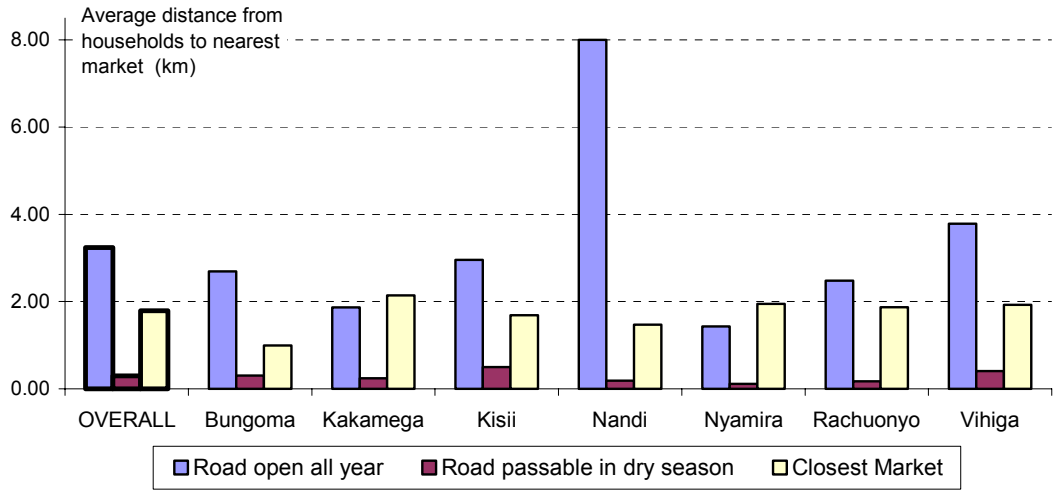
Figure 4.19 Proportion of households with access to public utilities



The distance to a road passable only during the dry seasons was longest in Kisii (500 metres) and shortest in Nyamira (100 metres). Bungoma had households closest to markets or trading centres (100 metres) while Kakamega had the furthest (2 km).

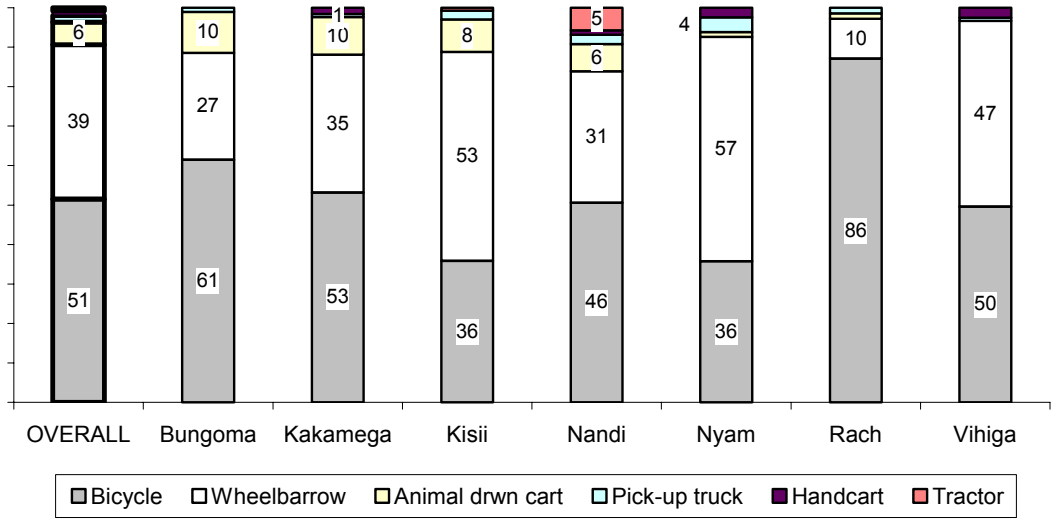
Forty four percent of all the households did not have any mode of transport (Figure 4.21). Among those who had, the bicycle was the most common, cited by 60% of the households as the first or only mode of transport they possessed, and by 72% as the second. Bicycle was less common in Vihiga and Kisii at 50% and 46% respectively. The only other popular means of transport was the wheelbarrow (listed by 33% as first or only item and 12% as second).

Figure 4.20 Proportion of households with access to different types of roads



Animal drawn carts were very rare, and cited by only 2% as the 1st item, and by 4% as the second item. Bungoma and Kakamega had 3% and 6% of the households respectively, with animal drawn carts. Only 1% overall had pickup trucks which were listed by 10% of the households in Kisii. Less than 1% had a car or tractor and only 3% in Nandi had tractors as first while 9% had them as the second item of transport owned.

Figure 4.21 Transport facilities owned by households



4.7 Livestock inventory and herd sizes

4.7.1 Cattle inventory and numbers kept per household

Overall, only 13% of the households with cattle solely kept improved dairy cattle. The others kept either Zebu alone (43%) or a combination of Zebu and improved dairy cattle (43%) (Table 4.8). Bungoma had the highest number of households with the improved dairy cattle alone (23%). The same district had 56% of households with Zebu only. Nandi had the highest number of households with a combination of the improved dairy cattle and the Zebu (80%), with 10% of other households keeping improved dairy cattle alone. Rachuonyo had most households keeping only the Zebu (96%). In general, there was a mean of 2.2 heads of cattle per household. Nandi alone had 4.5 while Rachuonyo had 3.3 (Table 4.8).

It is worth noting that the sub-locations were selected on the basis of factors identified as contributing to the presence of dairying in an area. Since transects were later drawn randomly within the sub-locations, it is highly likely that the samples selected do not reflect the true distributions in a sub-location. Further analysis comparing the numbers derived from the surveys and those given in annual reports show that on average the national figures under report the actual numbers by up to four times.

Table 4.8 Mean number and types of cows owned per household

District	Overall	Bungoma	Kakamega	Kisii	Nandi	Nyamira	Rachuonyo	Vihiga
Local Zebu	1.1	1.9	1.3	0.5	0.6	0.4	3.2	0.8
Dairy cross	1.0	0.5	0.2	1.1	3.5	1.2	0.0	0.8
High grade	0.1	0.0	0.1	0.1	0.4	0.1	0.0	0.2
Total number	2.2	2.4	1.6	1.7	4.5	1.7	3.3	1.8

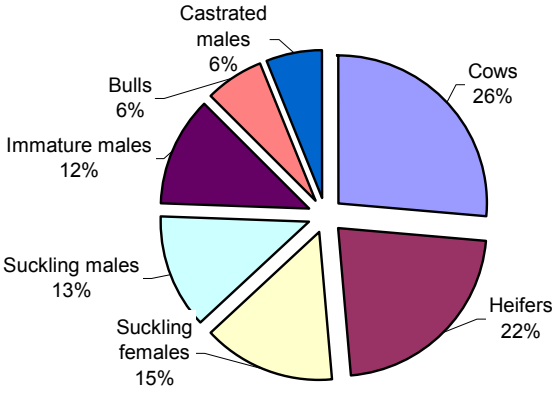
Forty eight percent of the households had on average one Zebu per household and 46% had one dairy cross. This varied across districts. 79% of the households in Nandi had 4 dairy cross and 13% had one

local Zebu per household. Rachuonyo had 99% of households with an average of three Zebus per household. There was less than one high-grade cow per household in all the districts.

4.7.2 Cattle herd distribution

In all the households cattle population, 26% were milking cows, 22% heifers, and only 6% males (bulls and castrates), (Figure 4.22). This varied across districts with Rachuonyo having 25% milking cows, 21% adult bulls and 20% heifers, (Figure 4.23). Bungoma herd composition was 23% heifers, 21% cows and 20% castrated males.

Figure 4.22 Overall herd distribution and composition



4.7.3 Other livestock inventory

Eighty percent of the agricultural households kept local chicken (Table 4.9). The maximum number of birds kept per household was 90, with a mean of 8 per household. Local chicken rearing was most common in Rachuonyo, with 85% of agricultural households and 84% in Nandi, and a mean of 10 per household in the two districts. Bungoma had the lowest with 68% of the households keeping the local birds.

Local (indigenous) goats were the second most common type of non-cattle livestock, kept by 21% of the agricultural households, while sheep were third with 16% of the households rearing them. Goats were most popular in Rachuonyo with 59% of the households and least in Bungoma and Kakamega at 3% (Table 4.10). Sheep were most popular in Nandi, with 47% of the households keeping an average of 4 per household.

Figure 4.23 Herd distribution by district

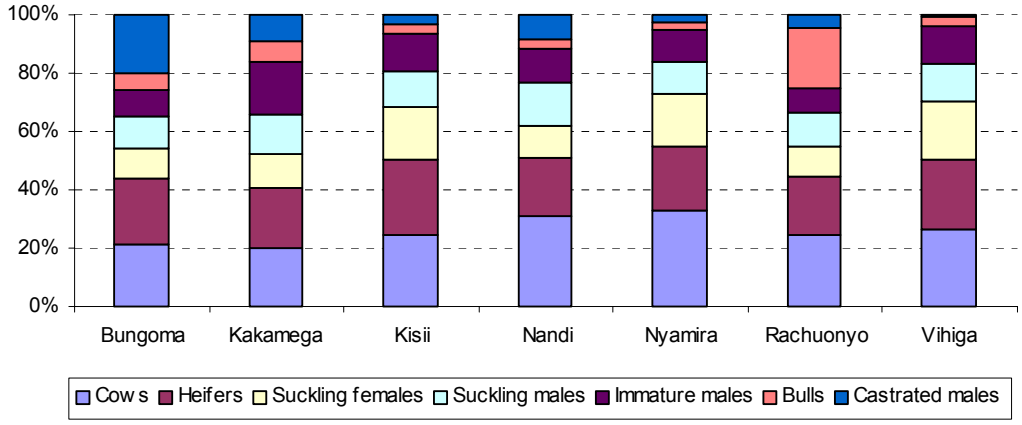


Table 4.9 Overall ownership of livestock other than cattle

type	% of agricultural households owning/keeping	Mean number per household	Maximum number per household
Poultry: local	80.0	8.4	90
Poultry: layers	5.4	12.7	150
Poultry: broilers	0.1	12.0	20
Pigs	1.7	1.7	5
Sheep	16.3	3.2	20
Goats: local	21.0	3.3	24
Goats: dairy	2.2	2.4	10
Donkeys	1.7	1.5	3
Rabbits	2.9	3.9	30
Turkeys	0.3	3.3	5
Beehives: traditional	2.1	2.7	12
Beehives: improved	1.1	3.4	12

Table 4.10 Ownership of other livestock by district

	Number of agricultural households	Bungoma 145	Kakamega 269	Kisii 259	Nandi 121	Nyamira 237	Rachuonyo 156	Vihiga 308
Local chicken	%	67.6	77.3	78.8	84.3	74.6	84.7	77.5
	mean	9.0	8.1	10.1	10.9	7.3	10.3	7.4
Layers	%	3.4	4.1	6.6	5.0	7.2	5.7	4.2
	mean	5.2	5.3	20.1	12.2	16.5	11.4	10.2
Broilers	%	0	0	0	0	0	0	0.7
	mean	0	0	0	0	0	0	12.0
Pigs	%	18.6	0	0	0	0	0	0
	mean	1.7	0	0	0	0	0	0
Sheep	%	24.1	15.2	9.3	47.1	10.2	20.4	7.2
	mean	3.2	2.6	2.9	4.0	2.7	4.9	1.9
Local goats	%	3.4	3.0	29.3	9.9	26.3	58.6	17.3
	mean	2.4	3.1	3.1	6.3	2.7	4.7	1.9
Dairy goats	%	2.8	0.4	1.2	3.3	0.8	3.2	3.9
	mean	2.5	3.0	2.3	2.8	3.5	3.2	2.2

The other livestock were dairy goats were kept in 4% of the households in Vihiga, 3% in Nandi, Rachuonyo and Bungoma, but less than 1% in Kakamega and Nyamira. Broiler chicken were found in only 0.7% of agricultural households in Vihiga. Pigs were only noted in Bungoma in 18% of agricultural households.

Table 4.11 Ownership of other livestock by household category

	Category	With cattle	No cattle	Zebu only	Zebu + Dairy	Dairy only
	Number of households	1021	474	440	441	132
Local goats	%	24.6	12.0	26.7	21.6	27.6
	mean	3.5	3.0	3.7	3.2	3.5
Dairy goats	%	2.7	0.6	2.3	3.0	3.7
	mean	2.5	3.7	2.8	1.8	3.6
Sheep	%	20.4	5.7	21.0	18.9	23.9
	mean	3.5	2.0	3.4	3.5	3.9
Local poultry	%	82.0	67.9	81.3	82.5	84.3
	mean number	9.6	6.4	9.0	9.3	12.0
Broilers	%	< 1%	0	2.7	0.5	1.5
	mean	12		1.75	1.5	3
Pigs	%	1.7	2.1	2.7	<1%	1.5
	mean	1.4	1.8	1.8	1.5	3

Most households (80%) kept local chicken while less than 15% of households with no cattle kept other livestock as well (Table 4.11). All households with different classes of cattle (Zebu only, dairy type cattle only or the combination) had other livestock.

4.8 Cattle production systems and feed resources

4.8.1 Production systems

Fifty six percent of households with dairy cattle mostly fed them on grass (pasture) with some stall-feeding, while 22% just grazed them (Table 4.12). Stall-feeding alone (zero-grazing) is practiced by only 5% of the households, whereas 17% of the households supplement these stall-fed animals with a little grazing. For those keeping Zebus, forty eight percent of the households mainly grazed their Zebu cattle while 45% grazed their Zebus with some stall-feeding (Table 4.13).

Table 4.12 Frequency of production systems for dairy animals

	Overall	Bungoma	Kakamega	Kisii	Nandi	Nyamira	Rachuonyo	Vihiga
Number of households	575	27	40	143	98	123	1	143
Only grazing (free range / tethering)	22	22	35	8	52	11	100	20
Mainly grazing + some stall feeding	56	67	40	72	44	64	0	45
Mainly stall + some grazing	17	11	10	15	2	19	0	31
Only stall (zero-grazing)	5	0	15	6	2	6	0	4

Stall-feeding (zero-grazing) with or without some grazing was most common in Vihiga with 35% of the households in the district while. Kakamega and Nyamira had 25%; Kisii 21% and Nandi had only 4%. Zero-grazing was almost non-existent in Rachuonyo where cattle are grazed.

Table 4.13 Frequency of production systems for zebu animals

	Overall	Bungoma	Kakamega	Kisii	Nandi	Nyamira	Rachuonyo	Vihiga
Number of households	555	62	123	73	9	48	105	135
Only grazing (free range / tethering)	48	47	37	10	78	29	92	51
Mainly grazing + some stall feeding	45	53	62	77	22	56	8	37
Mainly stall + some grazing	5	0	2	11	0	13	0	10
Only stall (zero-grazing)	1	0	0	3	0	2	0	1

There was less grazing as one moved from households with Zebu only to those that kept dairy grades only but the change is marginal (84 to 78% of the households with cattle) (Table 4.14). Only 21% of households keeping dairy types alone and 23% of households with the combination of zebu and dairy types practised stall-feeding (zero-grazing), with or without some grazing.

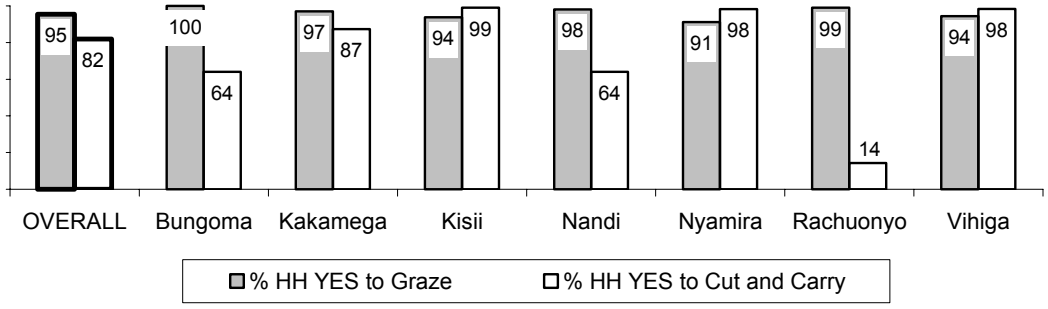
Table 4.14 Frequency of livestock production systems by household category

	Zebu only	Zebu + Dairy	Dairy only
Number of households	28	427	115
Only grazing (free range / tethering)	50.0	18.0	28.0
Mainly grazing with some stall feeding	36.0	59.0	51.0
Mainly stall with some grazing	11.0	17.0	18.0
Only stall (zero-grazing)	4.0	6.0	3.0

4.8.2 Feeding systems

Ninety five percent of all households with cattle said they grazed their animals at one time or another, and 82% provided their cattle with cut and carry forage, either as a sole practice or as a supplement to grazing (Figure 4.24).

Figure 4.24 Proportion of households that graze cows or cut and carry fodder



Eighty two percent of households keeping dairy grades only indiscriminately gave cut and carry forage to all groups of cattle while 80% of households keeping the combination (Zebu and dairy grade) and 78% of the households keeping Zebu only did the same (Figure 4.25). Ten percent of households keeping dairy grade types alone gave cut and carry forage exclusively to lactating cows while the same proportion of households with the other categories of livestock gave the forage to cows whether lactating or not. Going by the definition of stall-feeding, it is worth noting that in drought all animals are stall-fed regardless of the type of animal. The shortage of land and increasing intensification means animals are increasingly being stall-fed.

Over 84% of all households with cattle said they experienced feed shortage. This response ranged from 72% in Kisii to 98% in Rachuonyo (Figure 4.26). Currently, the most popular strategies undertaken during feed shortage included taking the cattle out of the homestead for pasture elsewhere (24% of households), using cut and stored forage (9%) as well as purchased fodder (19%) (Figure 4.27).

Figure 4.25 Animals given cut and carry fodder

Only 16% of all the households supplemented pasture and forage with concentrates, this ranged from none in Rachuonyo to 47% in Nandi (Figure 4.28). More households keeping a combination of Zebu and dairy grade cows used concentrates (29%), than those keeping dairy grades alone (22%) and Zebu alone (2%).

Fewer households in Kisii than elsewhere showed they had experienced feed shortage. This is so since the rain patterns there are different than in the other districts allowing the availability of forage most of the year. Sugar cane was clearly not a prominent feed resource despite its heavy presence in the area. Sugarcane tops dry up very fast and by the time of harvesting mature cane, the feeding value to animals is at its lowest.

Figure 4.26 Percentage of households experiencing feed shortages

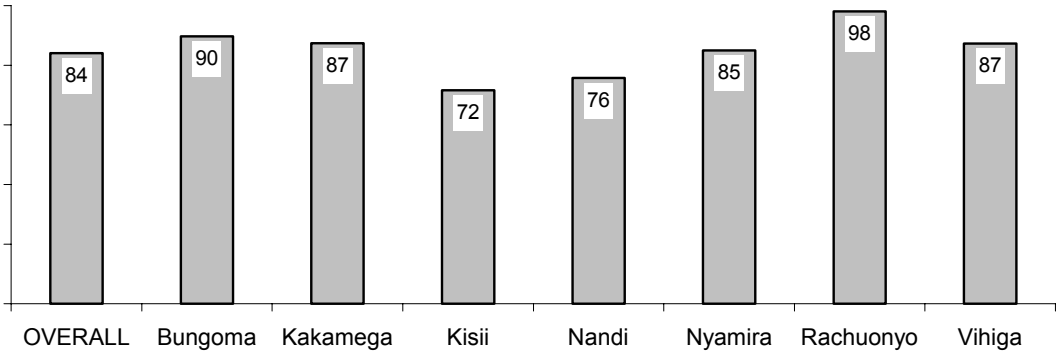
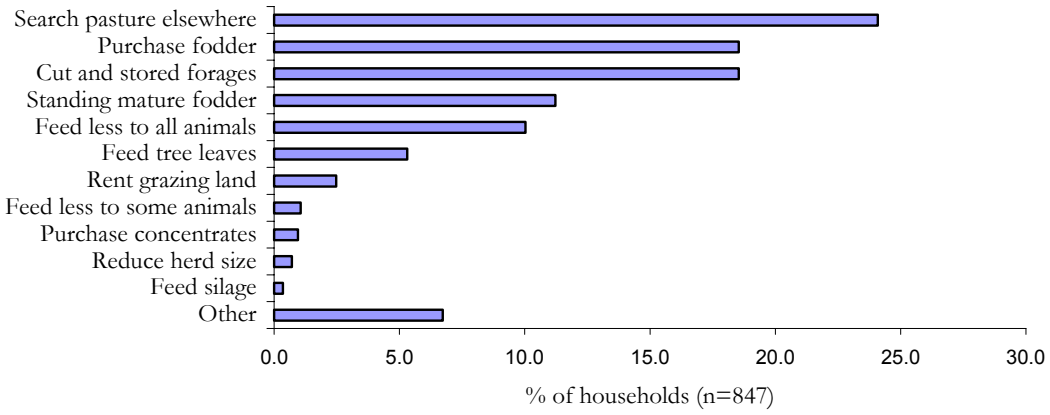
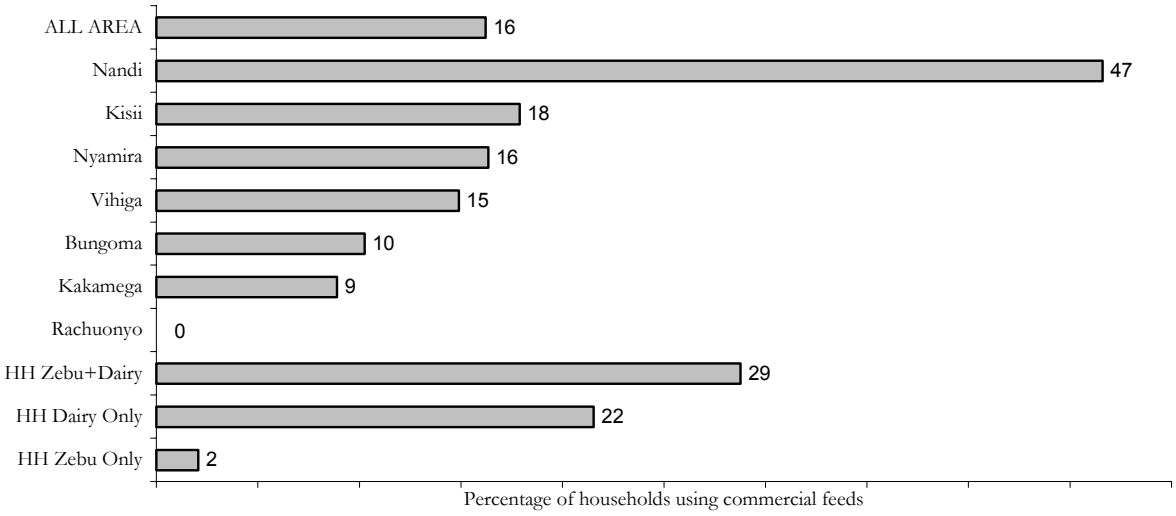


Figure 4.27 Percentage of household and strategies taken in feed shortage



Dairy meals were used in 77% of all the households (Figure 4.28) using concentrates. Nandi had 16% of the households giving reject maize grains after harvesting as a concentrate, where it is given as ground meal or whole.

Figure 4.28 Percentage of households supplementing pasture/fodder with concentrates



4.8.3 Use of tree and pasture legumes

Very few households (14 out of the total 1,012 with cattle or 1.4%)) reported the use of herbaceous legumes as feed for animals (Table 4.15). On the other hand, 254 households (25% of households with Cattle) had legume trees. The highest percentages of these were in Nyamira 41%, followed by Vihiga 35% of households with cattle. The most common legume tree was Sesbania, planted by 41% of those having legume trees (or 7% of households with cattle), followed by Calliandra (22%, or 4% of households with cattle) (Table 4.16. Grevillea was also pointed out as legume tree by 23% of households with the forage.

Table 4.15 Numbers of households with and using pastures and forage legumes

	Overall	Kakamega	Kisii	Nandi	Nyamira	Vihiga
Number of households with pasture legumes	14	1	3	2	4	4
Desmodium	10		2		4	4
Lucerne	2	1		1		
Other, Russian Comfrey	1			1		
Other, Sweet Potato	1		1			

It is worth noting here that pastures were used broadly to capture planted improved fodders and both pastures and leys were lumped together as pastures.

The reported relatively high presence of tree legumes was not indicative of the extent to which they are used as livestock feed. It would be useful to consider quantities actually used. As so many farmers though not a tree legume, indicated Grevillea.

Table 4.16 Numbers of households with and using pastures and tree legumes

	Overall	Bungoma	Kakamega	Kisii	Nandi	Nyamira	Rachuonyo	Vihiga
Number of households with legumes trees	254	12	28	46	7	67	12	82
% households with cattle	24.9	14.6	20.3	24.1	6.8	41.1	11.2	34.7
Sesbania	41.3	33.3	50.0	39.1	42.9	34.8	0	51.9
Calliandra	22.2	25.0	17.9	30.4	0	10.6	0	33.3
Leucaena	8.3	33.3	14.3	0	0	3.0	50	6.2
Tithonia	1.2	0	7.1	0	0	1.5	0	0
Others	1.2	0	7.1	0	0	0.0	0	1.2
Grevillea	22.6	8.3	3.6	28.3	28.6	42.4	50	7.4
Indigenous trees	3.2	0	0	2.2	28.6	7.6	0	0

4.8.4 Use of maize and sorghum as fodder

Eighty six percent and 78% of households with cattle planted more than one maize seed and more sorghum seeds per hole or line, respectively, than recommended rates (Figure 4.29). The main reason for this (given as first reason by 73% of the households answering for maize and 84% of the households answering for sorghum) is to increase germination, (Figure 4.30). On the other hand 40% of households keeping Zebu plus dairy types planted more maize seeds so as to later feed livestock, compared with 37% who did so to increase germination.

Figure 4.29 Percentage of households planting many maize/sorghum seeds per hole

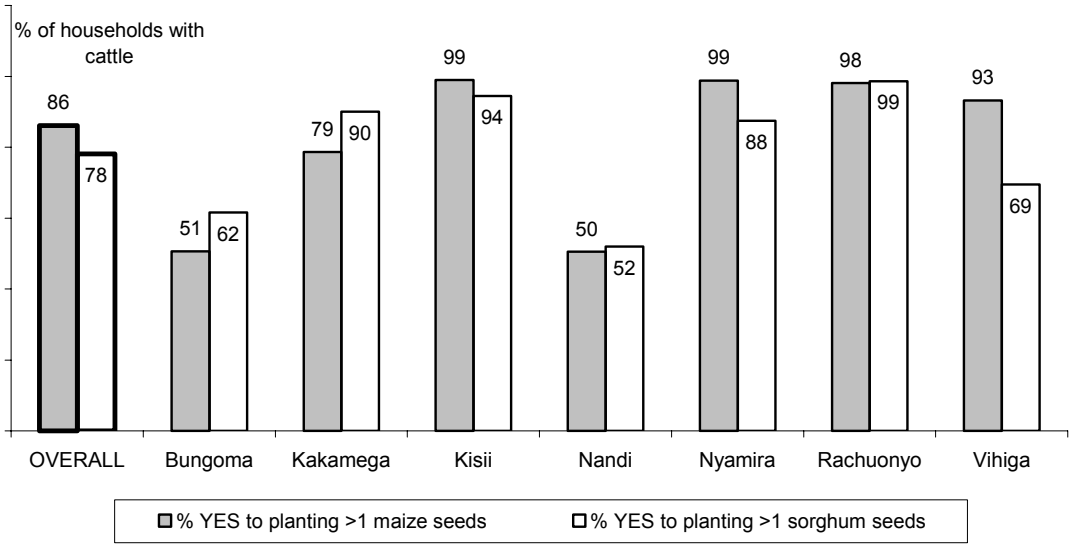
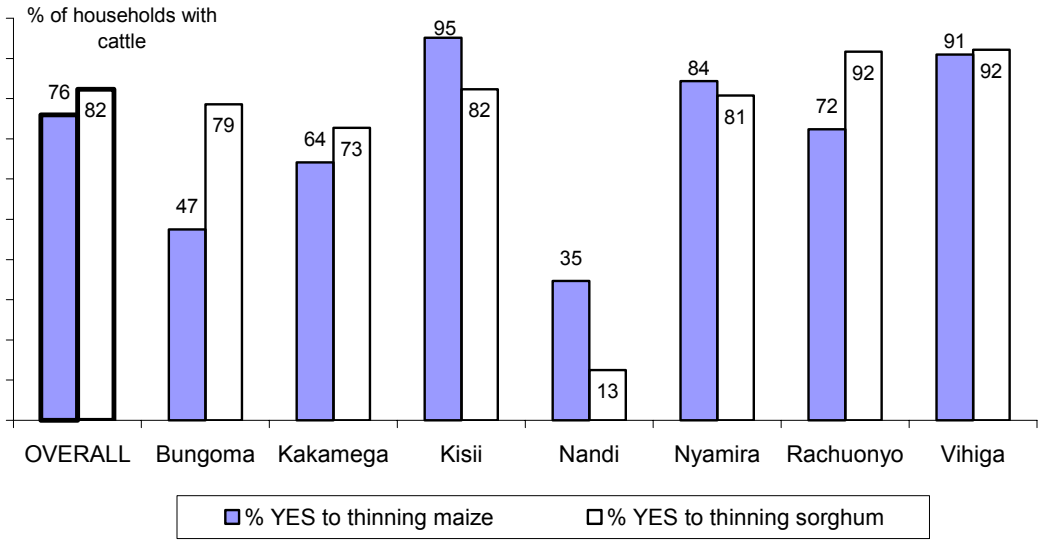


Figure 4.30 Reasons for planting many maize/seeds

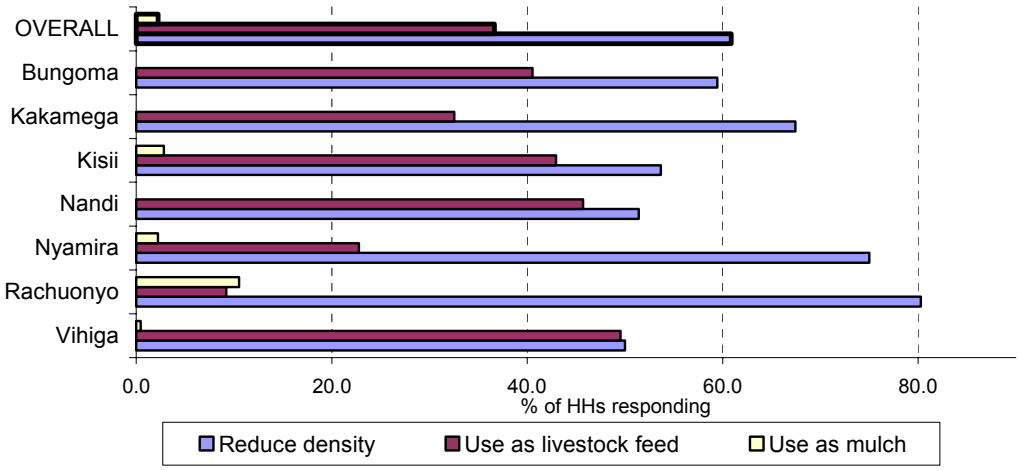
In all the districts, 76% of the agricultural households with maize and 82% of those with sorghum thinned the crops, (Figure 4.31).

Figure 4.31 Percentage of households thinning maize and sorghum



The main reasons for thinning maize (Figure 4.32) was to reduce density (61% of the households) and to use the thinnings as livestock feed (37% of the households) while the reasons for thinning the crop were largely to use the leaves as livestock feed (70% of the households) and, less importantly, to reduce crop density (60% of the households in Nyamira).

Figure 4.32 Reasons for thinning maize



Eighty four percent of the households thinned sorghum to reduce density and very few stripped the crop. Stripping/defoliating was done by 70% of the households to feed livestock. The highest rates were in Bungoma and Vihiga at 90% and Nandi at 93% while the lowest was Rachuonyo at 42%. 22% stripped/defoliated to reduce density while 6% use the material as mulch with the highest occurrence being 36% in Rachuonyo.

4.9 Livestock management services

4.9.1 Long term credit

Only 38 (2.5%) of all the agricultural households had ever obtained long-term credit for use in their farms (Table 4.17). Twenty of them used the credit to purchase improved dairy cattle.

Table 4.17 Number of households that have received farming long term credit

District	Overall	Bungoma	Kakamega	Kisii	Nandi	Nyamira	Rachuonyo	Vihiga
Total number households used credit	38	6	5	1	9	5	1	11
Purchase improved dairy animals	20	4	3		6	4		3
Cattle housing	1							1
Purchase of feed	2				1			1
Dairy equipment	2				2			
Loan of cattle	5			1		1		3
Other	8	2	2				1	3

Non-use of long-term credit was common in this area because 44% of the households did not know about it. Rachuonyo led with 64%, Vihiga and Nyamira 48% and Kisii at 46%. Nineteen percent never thought about getting it, and 18% were afraid of being unable to pay back (Figure 4.33 and Figure 4.34).

Figure 4.33 Reasons for not getting credit

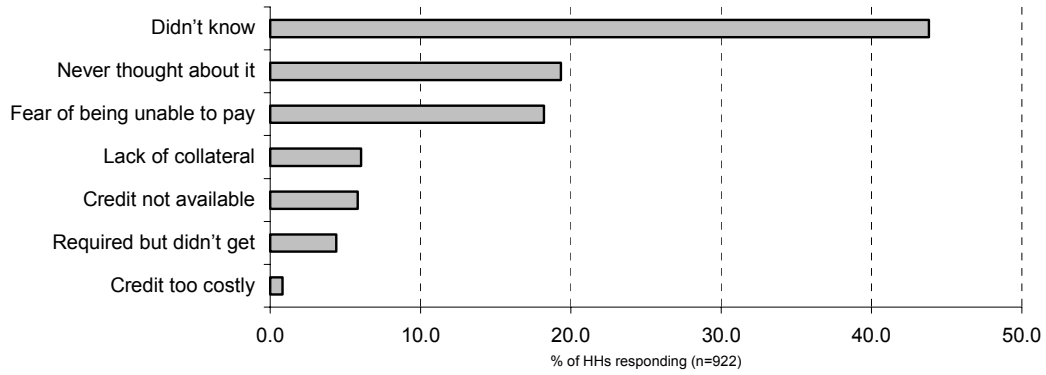
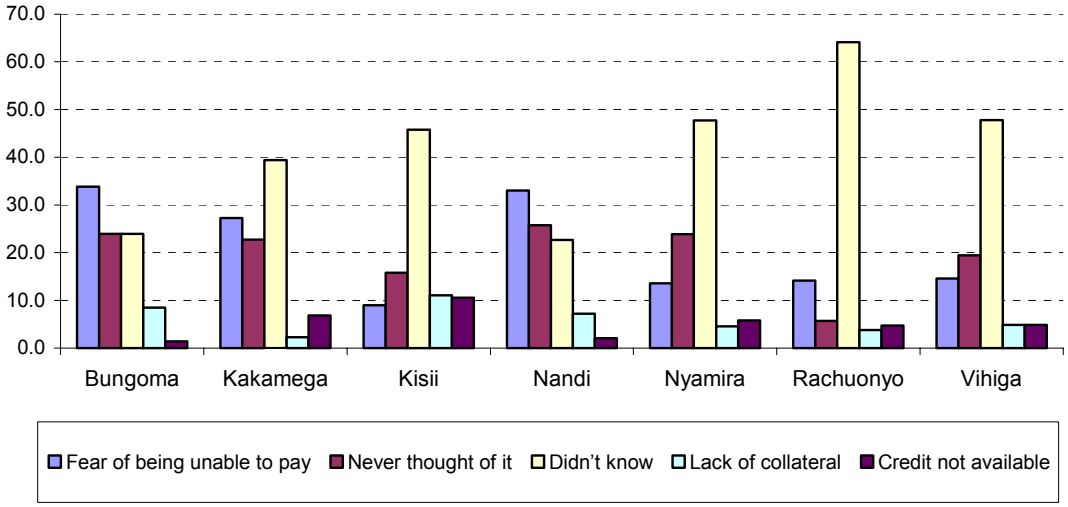


Figure 4.34 Reasons for not getting credit by district

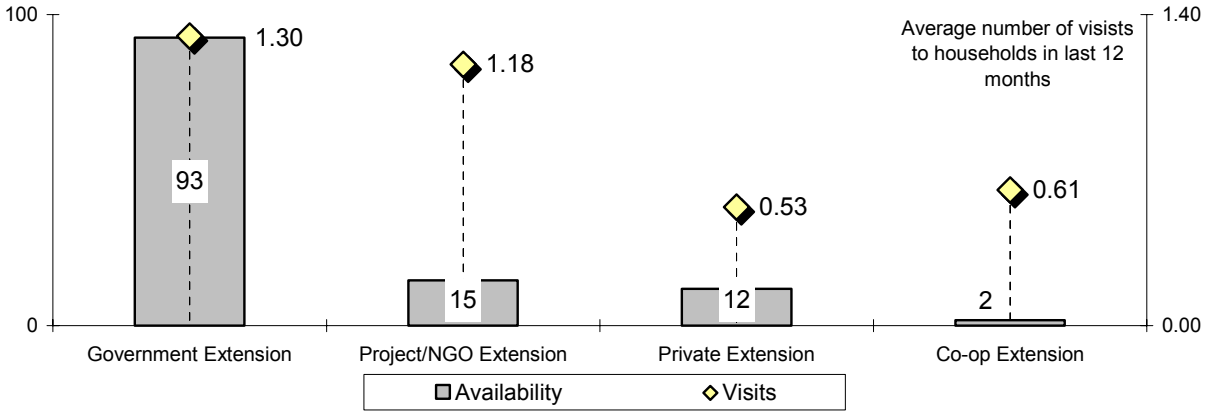


Out of 1,000 households responding to this question, only 12 indicated ever having obtained feed on credit 1 in Kisii, 4 in Nyamira, and 7 in Vihiga.

4.9.2 Extension

Ninety three percent of the households indicated availability of extension services from the government extension workers. The Project/NGO gave extension service to 15% of the households while 12% got the service from the private sector and 2% from cooperatives (Figure 4.35).

Figure 4.35 Availability of extension services and visits in last 12 months



Both government and Project extension services recorded one visit per household in the previous 12 months while private extension and cooperatives had less than one visit. The government extension services were most available, with 99% of the households in all the districts, recording an average of 5 visits per year. The Project and NGO extension services and visits were more popular in Rachuonyo (37% of the households recording 2 visits per year). The private sector gave extension service to 31% of households in Kisii and 22% in Vihiga although the number of visits was less than one visit per household

per year. Farmers were not asked the number of times they have sought extension agents and also when they attend group extension activities. This might have given more information.

Food crop management and feeding of the dairy cow were the topics more frequently covered by extension. Twenty percent of the households reported that these two topics were among the top three addressed (Table 4.18). The following were the most common topics addressed by extension agents according to districts: Planting forages was 21% for households in Bungoma; food crop management 29% of the households in Kakamega, 27% in Nandi and 52% in Rachuonyo; feeding the dairy cow 20% of the households in Kisii, 27% in Nandi, 28% in Nyamira and 21% in Vihiga.

Table 4.18 Extension topics most frequently covered

	Overall	Bungoma	Kakamega	Kisii	Nandi	Nyamira	Rachuonyo	Vihiga
Planted forages	16	21	14	16	16	11	5	20
Food crop management	20	19	29	19	27	15	52	10
Feeding of the dairy cow	20	13	18	20	27	28	4	21
Health management	14	12	15	13	6	17	9	21
Cash crop management	10	12	3	11	11	10	11	9
Forage/fodder conservation	3	7	3	7	1	1	4	2
Fodder legumes	4	6	3	5	1	2	7	6
Farm management/ economics	3	4	5	3	7	6	3	0

4.9.3 Artificial insemination

Fifty nine percent of all the households in the area reported having received AI services from the government while 20% received from the private sector (Figure 4.36). The government AI services were most common in Vihiga, where 88% of the households in the district received it. Nandi had 77% and Bungoma had 74% and the lowest was Rachuonyo with 31% (Figure 4.37) receiving Government extension services. NGOs provided 5% overall and 13% in Vihiga while private sector provided 67% in Kisii and less than 1% in Kakamega and Rachuonyo. Cooperatives provided 33% in Vihiga and 17% in Nandi.

Figure 4.36 Available AI services and average visits per household in last 12 months

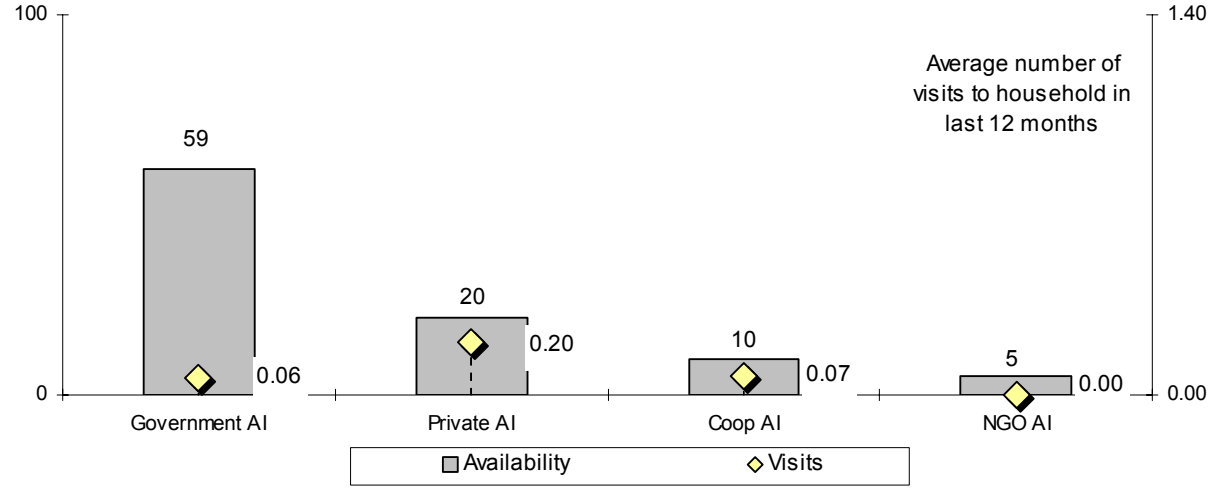
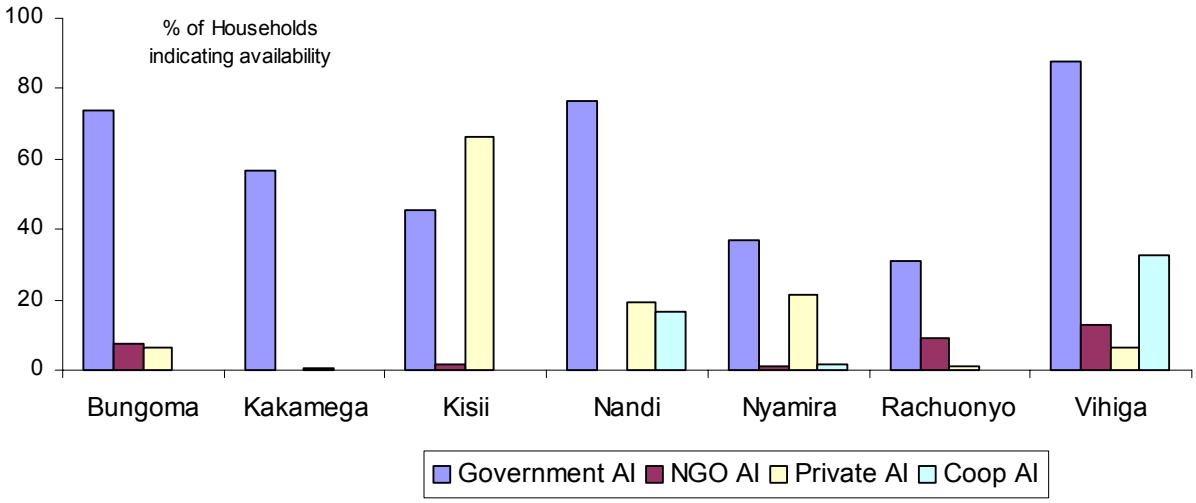


Figure 4.37 Availability of AI services by district



4.9.4 Animal health services

Among all the households in the area, the most common livestock diseases were East Coast fever, where 15% of the households mentioned the disease, and Anaplasmosis with 14% households (Figure 4.38). However there were variations in disease prevalence among the districts: 34% households in Kisii and 31% in Vihiga reported intestinal worms. Anaplasmosis was reported by 23% of the households in Rachuonyo and 25% in Nyamira (Table 4.19). 37% of the households in Nandi and 16% in Bungoma reported East Coast Fever. Finally 18% of the households in Bungoma and 14% in Kakamega mentioned the Foot and Mouth disease.

Figure 4.38 Percentage of households and three worst animal diseases

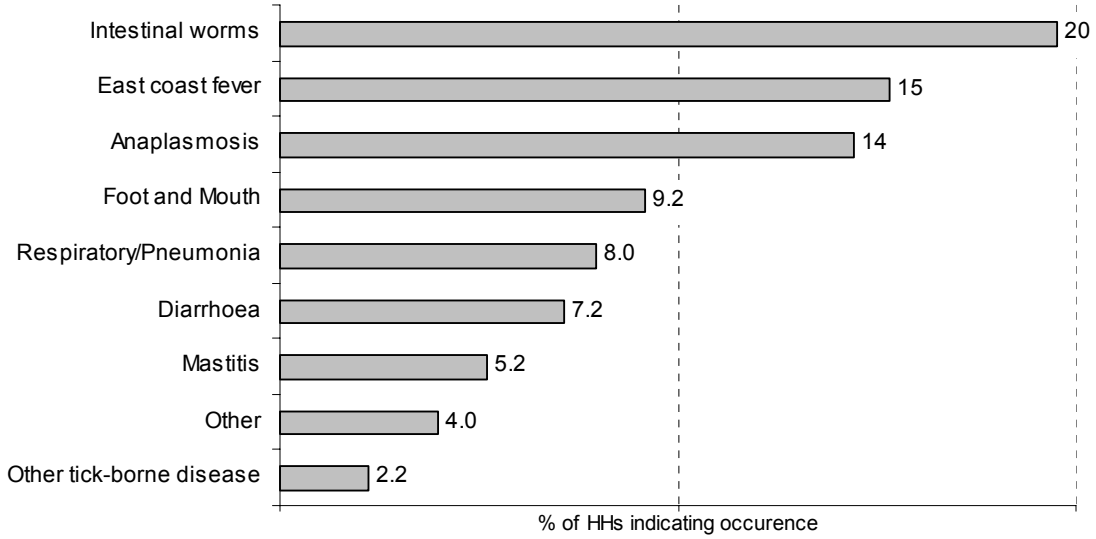


Table 4.19 Percentage of households and three worst animal diseases on farm

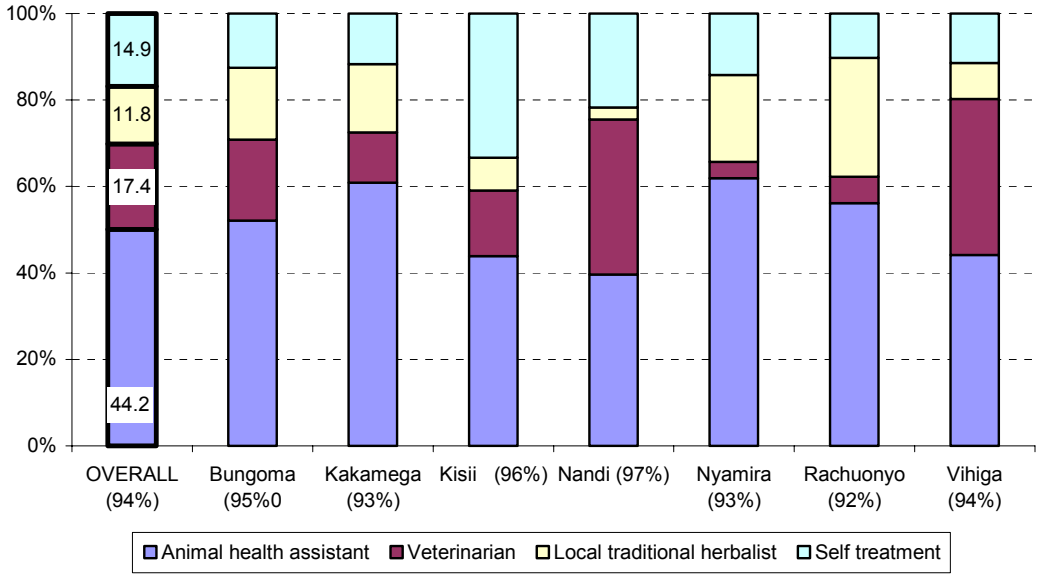
	Bungoma	Kakamega	Kisii	Nandi	Nyamira	Rachuonyo	Vihiga
Intestinal worms	6.9	12.5	34.4	6.1	16.8	10.3	31.3
East coast fever	16.4	10.3	14.8	36.7	19.4	8.4	7.6
Anaplasmosis	12.7	10.3	17.5	6.8	24.5	23.4	11.1
Foot and Mouth	17.5	14.0	5.8	5.4	5.8	15.0	5.3
Respiratory/Pneumonia	5.3	19.9	3.7	1.4	5.8	6.5	11.5
Diarrhoea	5.8	15.4	2.6	5.4	2.6	11.2	7.3

The animal health services were available in all districts with a record of 94% of the households having received these services from different sources (Figure 4.39). The animal health assistants were most popular, having given the service to 44% of the households, followed by veterinary officers, recorded by 17% of the households.

Twenty nine percent of the households in Nandi and 34% in Vihiga used animal health assistants. The use in Nyamira and Kakamega was 56% and in Rachuonyo 51%. There are some cases where households (15%) treated their own livestock without seeking external services, more so in Kisii with 31% and the rest with less than 15% cases of own treatment.

Traditional herbalists featured more prominently than veterinary officers in Rachuonyo, Nyamira and Kakamega, with 25%, 18% and 15%, respectively using herbs. Bungoma recorded 13% of the households using traditional herbalists, same proportion as those using veterinary officers (14%).

Figure 4.39 Percentage of households indicating source of veterinary services



4.9.5 Vaccinations, tick control and trypanosomosis

Sixty-one percent of households had had their cattle vaccinated in the last 12 months. However, this ranged from 38% in Kakamega to 92% in Nandi (Figure 4.40). Ninety percent of the households with cattle controlled ticks using Acaricides (Figure 4.41). Kakamega had the least percentage of households using Acaricides (78%) where some households (13%) controlled the ticks by handpicking and 6% did not carry out any control measures. Acaricides were applied by hand spraying (65% of all households), dipping (25%), or hand washing (9%). This was done once weekly in 55% of the households to both adult and young stock, once fortnightly in 17% of the households, and irregularly or occasionally in 13% (Table 4.20).

Figure 4.40 Percentage of households that vaccinated cattle in the last 12 months

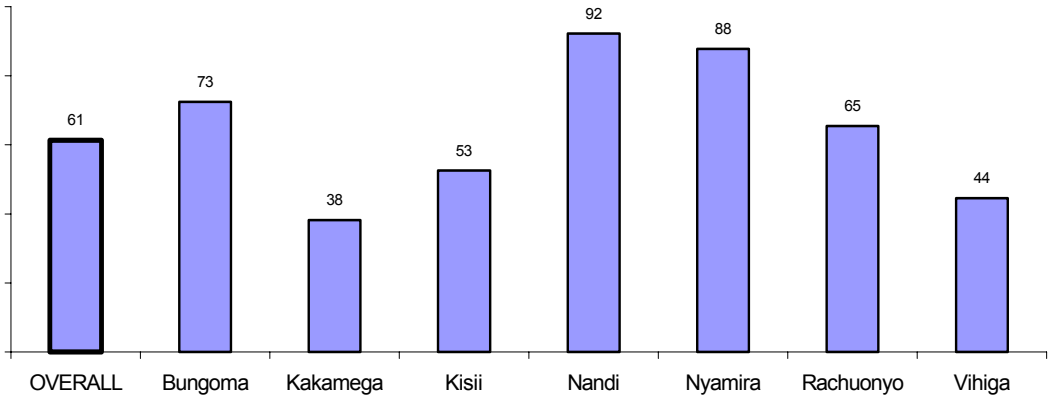


Figure 4.41 Percentage of households and methods of tick control

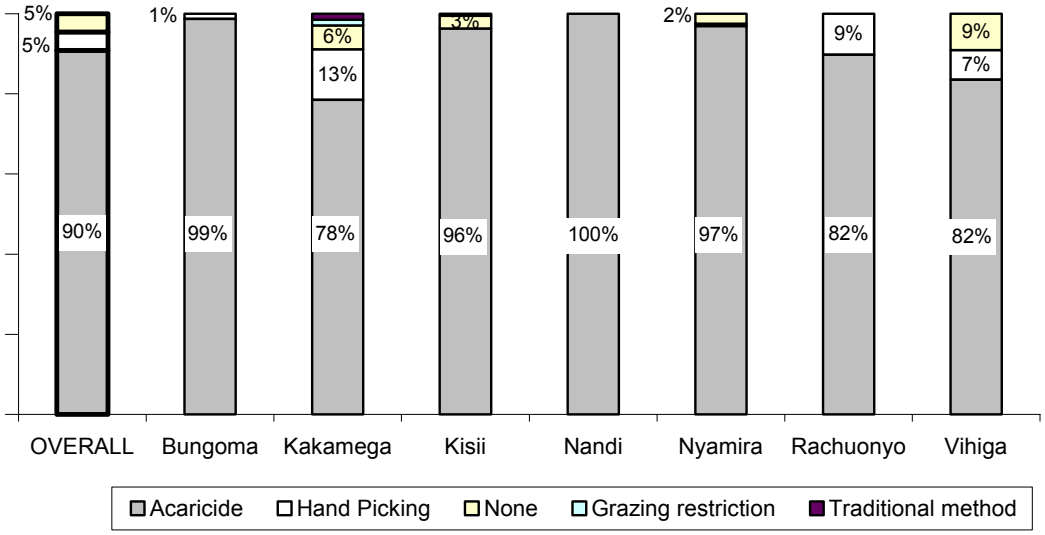


Table 4.20 Percentage of households and methods of acaricide application

Method	Overall	Bungoma	Kakamega	Kisii	Nandi	Nyamira	Rachuonyo	Vihiga
Hand spraying	65	59	75	70	30	71	78	65
Dipping	25	40	14	22	66	18	14	18
Hand washing	9	1	10	8	4	11	6	16
Pour-on							2	
Other			1			1		1

Of all the households with cattle, 4% were certain that their livestock had incidences of Trypanosomosis but 18% did not know if their livestock had ever been affected. Seventy eight percent said that Trypanosomosis was not a problem (Table 4.21). The biggest proportion of those households affected came from Rachuonyo. Trypanosomosis is a constant problem in Bungoma but with an irregular occurrence. Its presence can only be captured by a longer seasonal study.

Table 4.21 Percentage of households with a Trypanosomosis

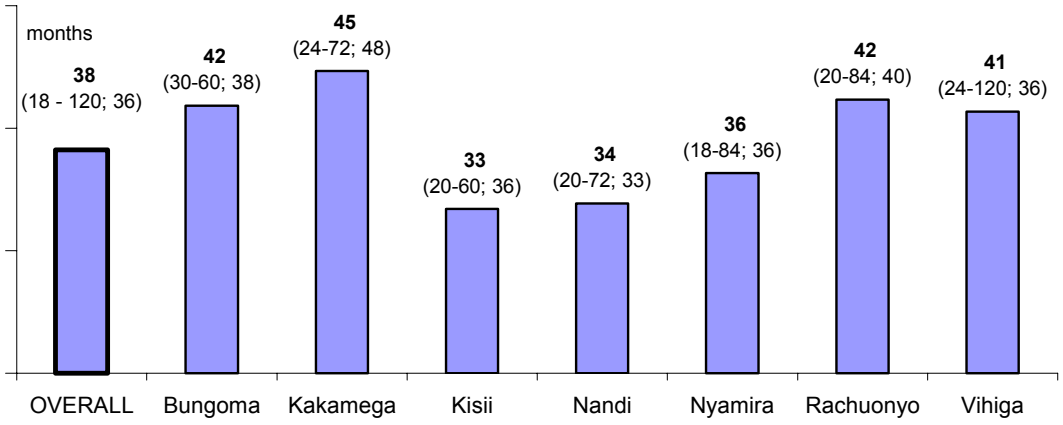
	Overall	Bungoma	Kakamega	Kisii	Nandi	Nyamira	Rachuonyo	Vihiga
No	78	76	89	78	61	77	54	92
I don't know	18	23	10	21	37	22	17	8
Yes	4	1	1	2	2	2	29	0

4.10 Dairy cattle performance

4.10.1 Age at first calving

The age at first calving was 38 months (range: 27 to 120; median 36). It was longest in Kakamega (mean 45) and shortest in Kisii (mean 33) (Figure 4.42).

Figure 4.42 Average age of cattle (months) at first calving, range and median



The age at first calving is almost uniform across all the dairy breeds (32 to 34 months) but older for zebu cows (44 months) (Figure 4.43). When comparing household categories, the mean age at first calving for dairy cows is more or less similar (mean: 33 months), regardless of the households where they were kept (Figure 4.44).

Figure 4.43 Average cattle age at first calving, range and median by breed

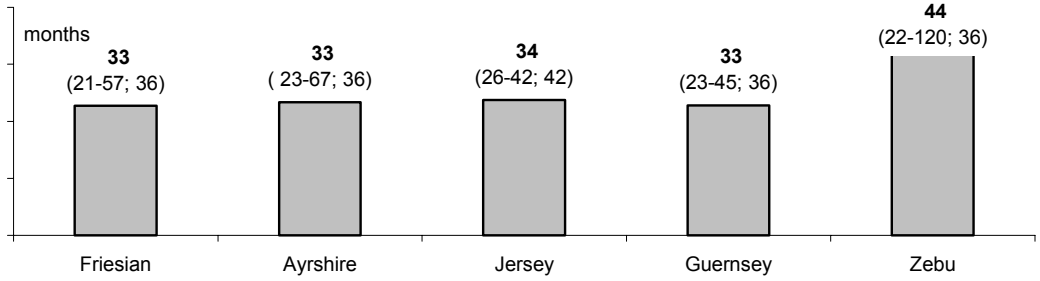
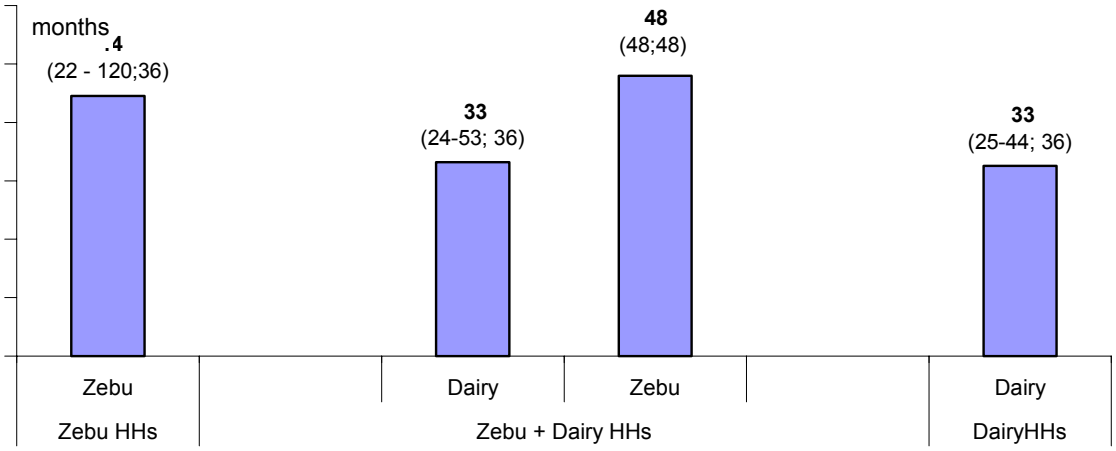


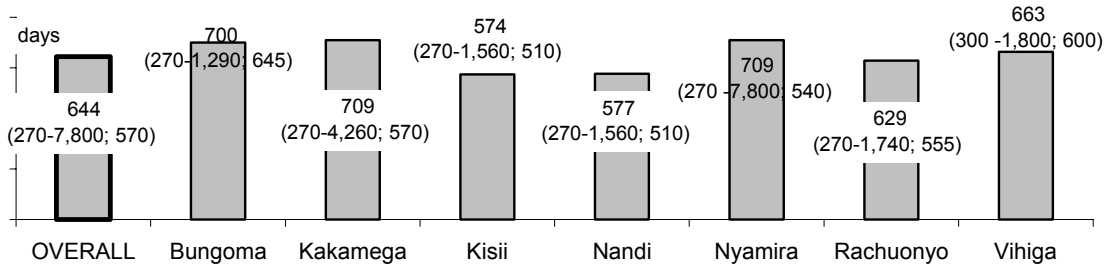
Figure 4.44 Average cattle age at first calving, range and median by household category



4.10.2 Calving interval

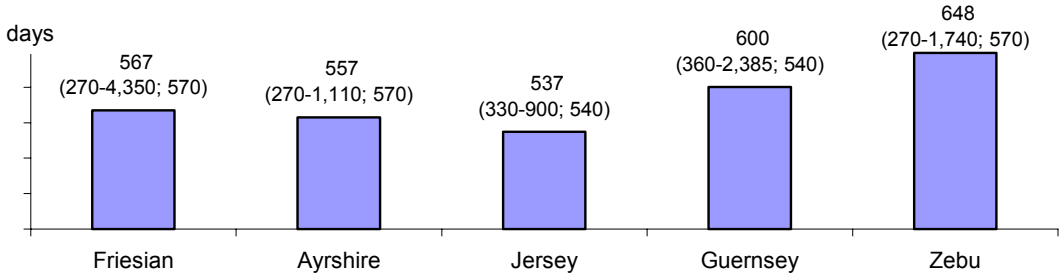
The mean calving interval was 644 days (Range 270 to 1290; median 570) for the whole area (Figure 4.45). Kisii and Nandi had the shortest intervals with means of 574 and 577, respectively and those with the longest were Kakamega and Nyamira (709 each) and Bungoma (700).

Figure 4.45 Average calving intervals by districts



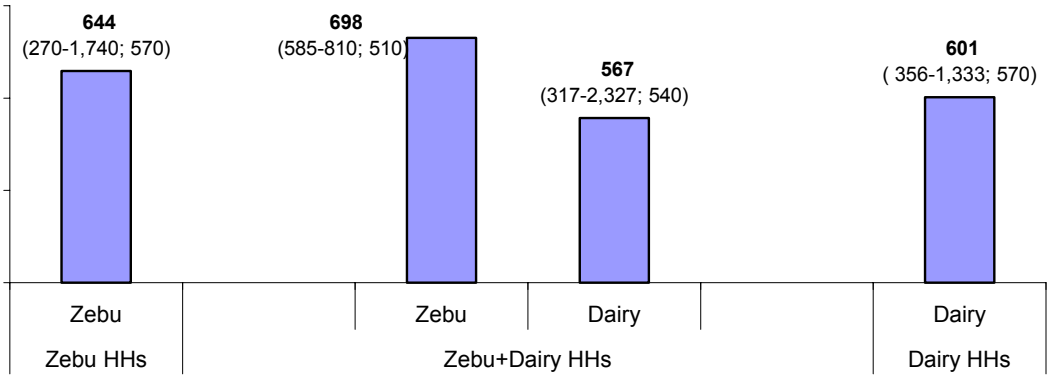
Zebu cows had a calving interval of 648 days (range: 270 to 1,740; median 570), and Jerseys recorded the shortest interval of 537 days (range: 330 to 900; median 540). Friesian and Ayrshire cows had a mean of 567 and 557, respectively (Figure 4.46).

Figure 4.46 Average calving intervals by breeds



The mean calving interval for households keeping dairy cattle alone was surprisingly longer than for those keeping zebus alone or the combination (695 versus 637 to 639 days) (Figure 4.47). The mean interval for dairy cows kept by households keeping a combination of zebu and dairy cattle was shorter (567 days) than for cows kept by households keeping only dairy cattle (601 days). The mean interval for zebu cows in households not practising any dairy was shorter (644 days) than for zebu cows in the other households (698 days).

Figure 4.47 Calving intervals by cattle types by household category



4.10.3 Milk production

This refers to average production per day along the entire lactation length, and has been worked using a model that utilizes production at calving, at mid-lactation (milk yesterday taken to be mid lactation) and at drying. Regardless of breed, cows in Kisii and Nandi showed the highest production per day (3.1 and 3.0 litres, respectively), while those in Rachuonyo produced the least (1.7 litres) (Figure 4.48).

Pure grades kept by households keeping only dairy cattle had higher production levels (5.1 litres) than those kept by households keeping a combination of dairy and zebu types (4.4 litres) (Figure 4.49), but there was no difference in the production by crossbreds in both households. Production by zebu cows in households keeping the combination was 2.7 litres, twice that of the ones kept by households keeping zebu alone (1.9 litres).

Figure 4.48 Average, maximum and standard deviation of milk production

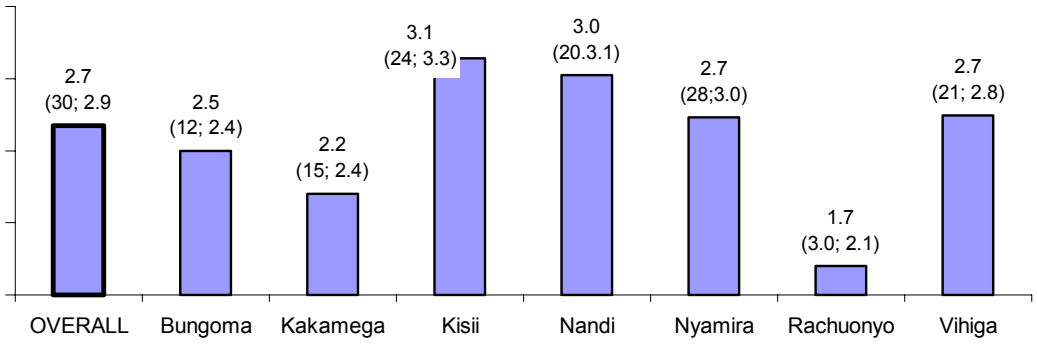
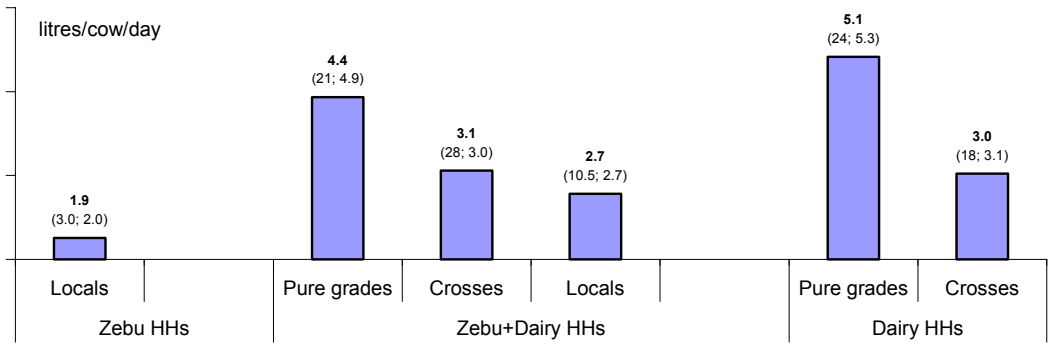
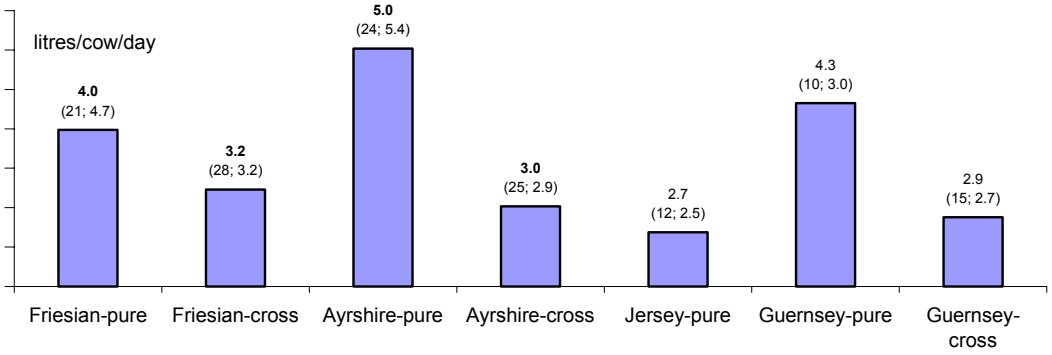


Figure 4.49 Average, maximum and standard deviation of milk production by cattle types by household category



Among the dairy breeds, production by pure Ayrshire cows (5.0 litres) and pure Guernsey cows (4.3 litres) was higher than that of pure Friesian cows (4.0 litres) (Figure 4.50).

Figure 4.50 Average, maximum and standard deviation of milk production by cattle breeds

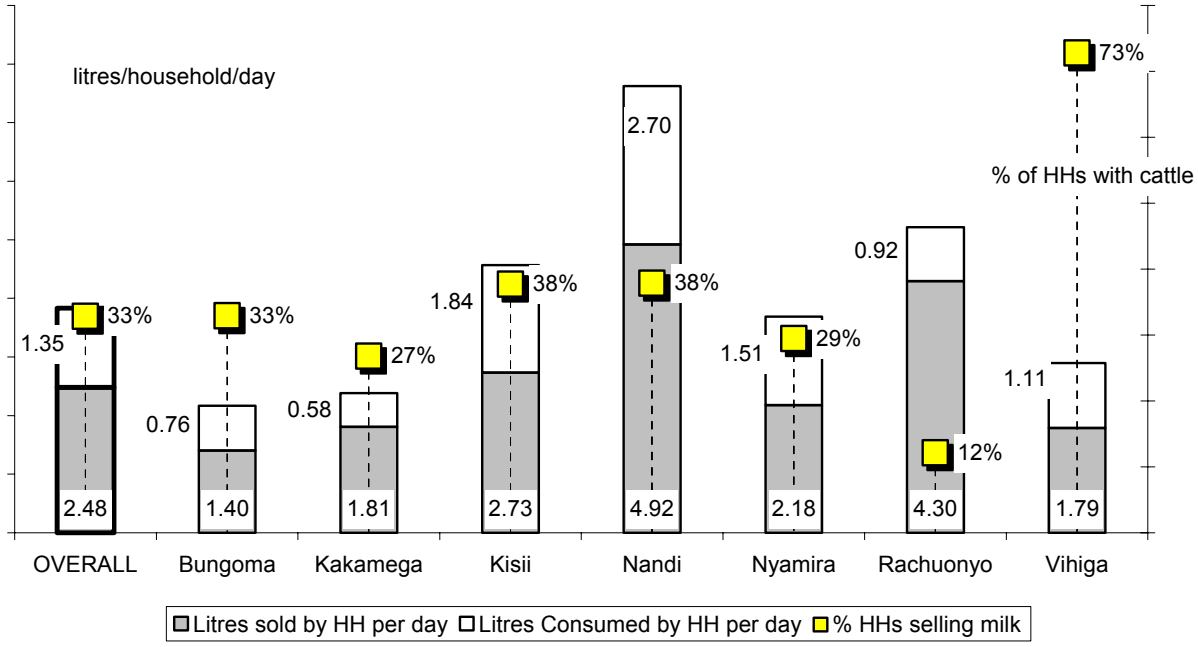


4.11 Milk consumption and marketing

4.11.1 Milk consumption

The amount of milk consumed in households with cattle was an average of 1.35 litres per day per household. It was highest in Nandi (2.70) and lowest in Bungoma (0.76) and Kakamega (0.58) (Figure 4.51).

Figure 4.51 Average milk consumption, sales and percentage of households selling milk



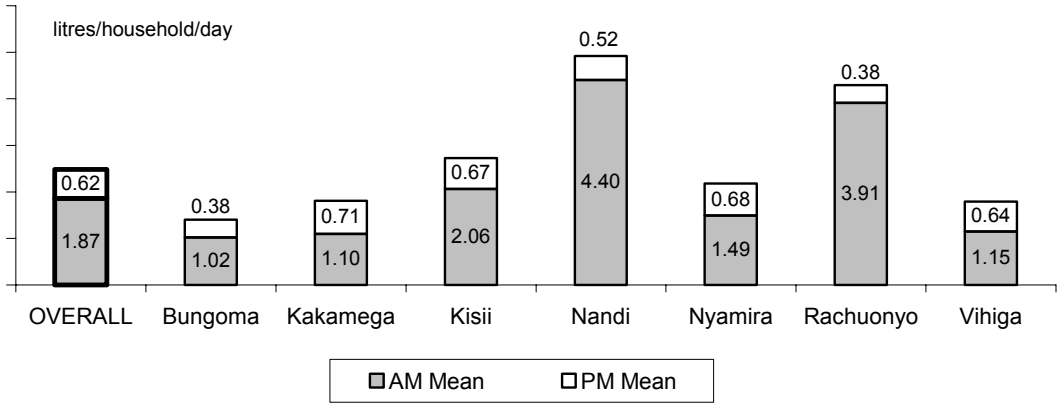
4.11.2 Milk marketing

Three hundred and thirty-five households (33% of households with cattle) indicated that they sold some of the milk they produced (Figure 4.52). The proportion was highest in Vihiga (42%), Nandi (38%) and Kisii (38%) and lowest in Rachuonyo (12%).

The average number of litres sold per household was 1.9 in the morning and 0.6 in the evening (Figure 2.1). Nandi sold the highest amounts per household per day (4.9 litres) while Bungoma sold the least (1.4 litres). Nandi sold the highest amounts both in the mornings (4.4 litres per household) while each of Kisii and Nyamira sold the highest in the evenings (0.7 litres per household).

Individual consumers bought the largest amount of milk at both times of the day (57% of the morning milk and 85% of the evening milk) (Table 4.22). Some of the morning milk was bought by private traders (17%), hotels and restaurants (15%) and retails shops and kiosks (7%). Private traders bought only 7% of the evening milk, while hotels and retail shops took minimal amounts (4%) each. To capture instances where households have difficulties selling milk while others seek certain buyers, amounts given to calves, periodic sales of sour milk and differences between rural and urban consumption patterns can only be done in a consumption study.

Figure 4.52 Average milk sold per household per day



In Nandi the picture was different from the whole area: private traders bought 63% of the morning milk and 41% of the evening milk. The second most important buyers of morning milk in Bungoma and Kisii were hotels/restaurants who purchased 20% and 44% of the milk sold, respectively. In Vihiga it was the retail shops/kiosks who bought 24% of the morning milk. In Nandi and Nyamira private traders bought 41% and 17% of the evening milk and in Vihiga 13% went to retail shops.

Table 4.22 Percentage of morning and evening milk buyers and consumers

		Overall	Bungoma	Kakamega	Kisii	Nandi	Nyamira	Rachuonyo	Vihiga
Morning milk	Individuals	73.2	83.3	86.4	63.0	36.7	93.1	90.0	79.3
	Hotels/Restaurants	8.5	16.7	0.0	28.3	3.3	3.4	0	0
	Private traders	9.9	0	4.5	2.2	53.3	3.4	0	3.4
	Parastatal collection	0.5	0	0	0	3.3	0	0	0
	Coop collection point	0.5	0	0	0	3.3	0	0	0
	Retails shops/Kiosks	6.6	0	9.1	4.3	0	0	0	17.2
	Institutes	0.9	0	0	2.2	0	0	10.0	0.0
Evening milk	Individuals	91.0	100.0	100.0	96.2	77.8	78.9	100.0	90.2
	Private traders	3.3	0	0	0	11.1	15.8	0	0
	Retail shops	2.5	0	0	0	0	0	0	7.3
	Hotels	2.5	0	0	0	11.1	0	0	2.4
	Other	0.8	0	0	0	0	5.3	0	0

Parastatal and cooperative collection points have only been mentioned by 3% (each) of the households in Nandi. Individuals offered the highest prices per litre (KSh 22.15) of milk bought on the farm (farm-gate price) followed by retails shops/kiosks (KSh 21.65) and hotels/restaurants (KSh 20.15) (Table 4.23). Vihiga sold milk at highest prices: KSh 26.70 to hotels/restaurants and private traders. Milk was sold at lowest prices to cooperatives (KSh 14.00) and parastatal collection points (KSh 16.00).

Table 4.23 Farm gate prices offered by different milk buyers per litre

	Overall	Bungoma	Kakamega	Kisii	Nandi	Nyamira	Rachuonyo	Vihiga
Individual customer/consumer	22.15	23.14	25.48	20.87	17.36	19.56	16.93	24.43
Retail shop	21.65		19.33	20.67				22.15
Private milk trader	17.25		16.00	20.00	15.49	19.67		26.67
Institutions (schools/hospitals)	19.33			20.00			18.67	
Hotel/restaurant/office	20.15	25.33		19.44	16.83	14.67		26.67
Parastatal collection point	16.00				16.00			
Cooperative collection point	14.00				14.00			
Other	30.00					30.00		

4.11.3 Milk processing

Beside the milk sold to processors, a half of households with cattle (50%) indicated that they made and sold sour milk (Table 4.24 and Table 4.25). The proportion was highest in Nyamira (77%) and least in Kakamega (15%). Nandi households sold the biggest amounts (6.7 litres on average per day). More of the households practising dairy (51 to 64%) made and sold sour milk than those that do not (35%) (Table 4.24). Sour milk was sold for KSh 25 to 30 per litre, the highest prices being recorded in Nandi, Nyamira and Vihiga.

Table 4.24 Households making and selling sour milk

	Overall	Bungoma	Kakamega	Kisii	Nandi	Nyamira	Rachuonyo	Vihiga
Households with cows	1,020	82	138	191	103	163	103	236
Percent making sour milk	50	22	15	61	58	77	30	58
Percent selling sour milk	48	22	14	59	57	75	29	55
Litres sold per day	2.9			2.0	6.7	4.8	1.2	0.8
Selling price (KSh/litre)	27.63			25.01	29.19	30.30	25.08	29.75

Table 4.25 Households making and selling sour milk

	Zebu only	Zebu +Dairy	Dairy only
Number of households with cows	439	438	134
Percent making sour milk	35	64	51
Percent selling sour milk	33	63	49

5 PRINCIPLE CLUSTER ANALYSIS

5.1 Methodology

Adoption of dairy technologies such as use of specific feeds or feeding strategies, husbandry practices, or breeds of animals, is dependent on household resource constraints, as well as the market and policy environment that the household faces. Thus research aimed at developing appropriate interventions to assist smallholder dairy producers requires a clear understanding of the dairy systems of the target farmers. This is particularly important where considerable heterogeneity exists among the sample population. Understanding patterns existing in this heterogeneity may be particularly important when the intention is to replicate interventions in similar recommendation domains (Gockowski and Baker, 1996).

In order to distinguish characteristic patterns of dairy activity existing among the surveyed households, a clustering method was applied to some primary variables. This method is based on Gockowski and Baker (1996), and uses principal component analysis followed by cluster analysis. The methodology has been tested, during the Kiambu pilot survey and other eight districts surveys (Staal et al 2001).

Underlying this combined method is the desire to reduce the number of variables used in the clustering without omitting potentially important information (variation). Traditional clustering methods require the selection of a few variables considered to be centrally important in differentiating the household sample and clustering the observations around the variation in that group of variables. With the addition of more variables to the cluster analysis, the difficulty of sensibly interpreting the cluster results grows geometrically. Using fewer variables, on the other hand, increases the chance of not including important variables that explain farming patterns. The principal component method alleviates this constraint by allowing the apparently most important variation from a larger set of variables to be identified and then used to cluster the household observations. Carter (1997) applied a similar methodology to spatial rather than household data.

The process thus consists of two steps:

1. Principal component analysis of several sets of original household variables to identify, within the vector space formed by those variables, new vectors along which most of the variation is observed to occur
2. Households are then scored along the new vectors, and the newly created variables are used in a standard cluster analysis.

This combined approach allows the variation obtained from a larger set of variables to be synthesised into a more compact cluster analysis.

5.2 Identification of principal components

Given a matrix of household variables $\mathbf{X} = (X_1, X_2, ..., X_n)$ with positive definite covariance matrix $var(\mathbf{X}) = \mathbf{S}$, principal components can be identified through linear combinations $Y = a_1X_1+a_2X_2+...a_nX_n$. This is done by finding arbitrary values of the matrix of coefficients $\mathbf{a}=(a1,a2,..,a_n)$

such that the variance of Y is maximised, where var(Y) = var(**a'X**) = **a'Sa,** and where **a** is normalised so that **a'a** = 1. The first principal component then corresponds to the normalised characteristic vector $\mathbf{a_1}=(a_{11},a_{12},...,a_{1n})$ associated with the largest characteristic root of **S**. Subsequent principal components are found in a similar step-wise fashion, subject to the additional restriction of zero covariance with previous components. The proportion of total variation associated with each principal component is thus largest for the first, and successively smaller for subsequent components. (Gockowski and Baker, 1996). In the SAS FACTOR procedure used to carry out this analysis, the original variables are standardised to unit variances and mean 0, in which case the covariance matrix yields simple correlations instead of covariance. The resulting values of a_{ij} are thus simple correlation coefficients between the original variables $\mathbf{X}_i$ and the principal component $\mathbf{Y}_j$, and when interpreting the results, can be used to determine the relative importance of the original variable to that principal component. To assist interpretation, the resulting principal component vector, or factors, is rotated, to yield more meaningful patterns without altering the statistical explanatory power of the factors. Even with orthogonal rotation, the factors remain uncorrelated. Standardised scoring coefficients are also produced by the procedure, so that individual household observations can be created along a new variable composed of the linear combination of first principal component scores multiplied by original variable values, for example, so that the new variable has variance of one and mean of zero (SAS, 1987).

5.3 Selection of variables used in principal component analysis

The groups of variables used in the principal component analysis were selected *a priori* on the basis of "themes" considered centrally important not only to the observed heterogeneity among the sample, but also the planned focus of eventual research and interventions.

The themes chosen were:

a. Livestock management of the dairy system,
b. Management of the land
c. Cropping system
d. Level of access to input and output markets, and services.

For each theme, a set of variables considered to reflect the primary measures of variability within that theme, was chosen.

5.4 Principal component analysis

5.4.1 Principal component analysis by level of intensification

Measures of the level of intensification of the dairy system were considered to be centred on the amount of purchased feeds, and the amount of feed available from own land resources. The variables chosen to reflect own feed resources were acres of maize planted per unit of dairy cattle, acres of Napier planted per unit cattle, and total household land available per tropical livestock unit (TLU). Land available can be considered a measure of availability of gathered fodder and pasture. Measures of purchased feeds are the amount of fodder and concentrate purchased per unit cattle. The measures of intensification were milk produced per acre and percentage grade cattle (local, upgrade and grade cattle). These variables and their

means are shown in (Table 5.1). To obtain complete data for all the variables used in the principal component analysis, the number of dairy household observations was reduced to 711 for which data were complete.

Table 5.1 Means and standard deviations of variables for level of dairy intensification

Name	Description	Mean (n=711)	Std dev
Maiz_cat	Acreage of maize planted per TLU of dairy cattle	0.62	0.68
Nap_cat	Acreage of Napier acreage planted per TLU of dairy cattle.	0.16	0.27
Conc_cat	Concentrate feed purchased, in KSh, per TLU of dairy cattle	964	2.317
Fodd_cat	Fodder purchased, in KSh, per TLU of dairy cattle	1,003	3,357
Land_cat	Total household land in acres per TLU of livestock	2.29	2.33
Milk-acr	Milk produced per acre	0.56	2.26
Pctgrade	Percentage grade cattle	0.50	0.47
PPE	Precipitation	1.07	0.16

Principal component analysis was carried out on this set of eight variables, using data from the 711 dairy households. Table 5.2 shows the resulting eight principal components, with associated eigen-values and contributions to variation in the eight variables. Gockowski and Doyle (1996) suggest that a common rule of thumb for selecting significant principal components is to consider those with eigen-values of greater than one. If less than one, they can be alternatively chosen by reference to significant gaps between them. Based on these rules of thumb, the first three principal components were selected, and then rotated orthogonally to improve interpretability.

Table 5.2 Principal components associated with level of intensification

Priniple component (#)	Eigenvalue (λ_i)	Total variation (%)	Cumulative variation (%)
1	1.8695	23.4	23.4
2	1.4966	18.7	42.1
3	1.0335	12.9	55.0
4	0.9295	11.6	66.6
5	0.8144	10.2	76.8
6	0.7921	9.9	86.7
7	0.7034	8.8	95.5
8	0.3610	4.5	100

The first principal component exhibits the largest eigen value, and alone explains 23% of the variation. The first three principal components (or factors) together explain more than half of the total variation existing in the chosen variables. The rotated correlation coefficients of these factors on the original variables are shown in Table 5.3. Since the variables were standardised in the analysis to have a zero mean and unit variance, a correlation coefficient or weighting of one indicates strong positive correlation, zero is neutral and negative one shows strong negative correlation.

Table 5.3 Rotated factor pattern for level of dairy intensification

Variable	Factor 1	Factor 2
	Ownfodd	Intense
Maiz_cat	0.8306	0.0193
Nap_cat	0.3504	0.5676
Conc_cat	0.1344	0.6380
Fodd_cat	-0.1075	0.29868
Land_cat	0.8865	0.0711
Milk_acr	-0.3228	0.5055
Pctgrade	0.0602	0.6382
PPE	-0.1320	0.3316

The first factor weighted according to the land held by the household, acreage of maize and planted Napier. This factor thus defines a new variable, which we call OWNFODD, which can be considered an index of the level of use of fodder produced on the farm, and more generally an index of level of intensification of use of own land and fodder resources.

The second factor represents purchases of concentrates, percentage of cattle exotic genes use of own fodder and milk produced per unit of the land. This indicates an intensified specialised system with optimal resources, which we call INTENSE.

The third factor is essentially neutral with respect to all variables except purchase of fodder and precipitation, with which it is almost perfectly oppositely correlated. This new variable, SUBSIST, thus represents low output low inputs situation, and was dropped in subsequent analyses.

5.4.2 Principal component analysis by level of household resources

The same procedure was applied to address the theme of household resources available to the dairy activity and to the household in general. The variables selected as important measures were female-headed, off-farm employment by household members, the overall household income level, the total land held by the household and the ratio of dependants (children under 15 and adults over 65 years) to adults in the household (Table 5.4).

Female-headed households were postulated to have poorer access to resources such as formal credit facilities. Off-farm employment of household members influences availability of important inputs to dairying. Monthly cash income level and total land held were considered indicators of wealth. Dependants' ratio is correlated to household income earning capacity and availability of household labour.

Table 5.4 Means and standard deviations of variables for level of household resources

Name	Description	Mean (n=1018)	Std dev
Femhead	Household is female-headed, 1=no, 0=yes	0.82	0.38
Off_adt	Proportion of household adults (>16 years) working off-farm	0.042	0.095
Income	Total household cash income: 1 =< KSh. 2,500, 2 = 2,500 - 5,000, 3 = 5,001 - 10,000, 4 = 10,001 - 20,000, 5 = 20,001 - 30,000 and 6 > 30,000	2.15	1.22
Totland	Total acres of land held by household	3.81	5.24
Depen_rt	Ratio of dependants to adults	0.45	0.23

Table 5.5 Principal components associated with level of household resources

Principle component number	Eigenvalue	Total variation (%)	Cumulative variation (%)
1	1.4653	29.3	29.3
2	1.0965	21.9	51.2
3	0.9631	19.3	70.5
4	0.7705	15.4	85.9
5	0.7046	14.1	100

The results of the principal component analysis are shown in Table 5.5. Complete data were available from 1018 dairy households. The analysis in this case yields two factors with an eigen-values over one, which together explain 51% of the variation in the selected variables. These factors were thus retained and the correlation coefficients with the original variables are shown below (Table 5.6).

The first factor is weighted significantly negative to the dependants ratio and proportion of household adults working off-farm. The association of off-farm employment and income has been shown in previous studies to be important to dairy intensification (Kaguongo, 1996) and in this case the first factor is significantly correlated to, less to income. It indicates association of number of able-bodied adults in a household either working on or off-farm and dependency ratio and is called OFF-FARM.

Table 5.6 Rotated factor pattern for level of household resources

Variable	Factor 1	Factor 2
	Off-farm	Resources
Femhead	-0.1613	0.5751
Off_adt	0.7449	0.1066
Income	0.2423	0.7018
Totland	0.0211	0.6826
Depen_rt	-0.7880	-0.0155

The second factor identified by the principal components is seen to be strongly correlated with both income and total land holdings. This factor was thus identified as being an index of wealth of the farm/household, and so was given the name resources.

5.4.3 Principal component analysis by level of market access

The final step of the principal component analysis procedure was to apply the procedure to the group of variables selected as indicators of market access. These included 2 types of roads (best and worse) to nearest town, the availability of veterinary services (offered mainly by the government and NGO sector), GoK extension services, the farm-gate price of milk received by the farmers, co-operative membership, and milk sales to informal market outlets. The variables are described in Table 5.7. The study shows that government veterinary and extension services were still significant to over ninety percent of the farmers. Complete data was available from 219 dairy farm/households.

The results of the principal component analysis for market access, shown in Table 5.8 reveal one significant factor that alone explains 20% of the variation in the seven selected variables; it has a large eigen value of 1.42. There were three factors which had an eigen value greater than one. The factor loadings against the original variables are shown in Table 5.9

The first factor has strong correlation with all weather road type and participation in the co-operative output market but neutral to other variables. This variable we shall call Mktacc. The coefficients of the second factor show strong correlation with bad road type but a strong negative correlation with farm-gate milk price (Table 5.9). The new variable defined by this factor was given the name Nomktacc. The negative correlation to farm-gate milk price has in this case been shown to be lower with bad roads. The third factor had a strong correlation with veterinary and extension services, which had been shown to be over ninety-five percent present, and this factor was dropped in subsequent analyses.

Table 5.7 Means and standard deviations of variables for market access

Name	Description	Mean	Std dev
Rdtype1	Distance to nearest town for road type 1 in KM	21.39	20.07
Rdtype3	Distance to nearest town for road type 3 in KM	2.49	3.18
Vetavail	Availability of veterinary services (1=yes, 0=no)	0.95	0.23
Extavail	Availability of extension services (1=yes, 0=no)	0.94	0.24
Pricelt	Average price received per litre of milk in most recent dry season	21.29	5.49
Coopmemb	Co-operative membership: 1=yes, 0=no.	0.037	0.189
Infrmkt	Milk sales to non-co-operative outlet in last 12 months, 1=yes, 0=no	0.99	0.11

Table 5.8 Principal components associated with market access

Principle component number	Eigenvalue	Total variation (%)	Cumulative variation (%)
1	1.4196	20.9	20.3
2	1.2102	17.3	37.6
3	1.1074	15.8	53.4
4	0.9531	13.6	67.0
5	0.8908	12.7	79.7
6	0.8109	11.6	91.3
7	0.6081	8.7	100

Table 5.9 Factor pattern for level of market access

Variable	Factor 1 Mktacc	Factor 2 Nomktacc
Rdtype1	0.7453	-0.0450
Rdtype3	-0.1441	0.8356
Vetavail	0.1275	0.1102
Extservice	-0.1644	-0.0834
Pricelt	-0.2288	-0.7311
Coopmemb	0.6009	-0.0174
Infirmkt	-0.5470	-0.1486

5.5 Cluster analysis

5.5.1 Cluster analysis using the new variables

Cluster analysis was then carried out using the variables described above, which were considered to contain most of the variation relevant to the desired characterisation of the farm/households. The SAS procedure Fastclus was used, which employs a standard iterative algorithm for minimising the sum of squared distances from the cluster means. Each observation is assigned to only one cluster. The number of clusters was set to different values and the results compared and interpreted for ability to differentiate the observations along the desired axes. Clustering into eight clusters was selected. Table 5.10shows the frequency of households falling under the different clusters, and the mean values of the newly defined variables.

Table 5.10 Frequency of households by cluster, variable means for dairy intensification, household resources and accessibility to services

	Freq	Extlanded	Intense	Offfarm	Wealth	Mktacc	Nomktacc
1	164	-0.1460	-0.3538	-1.1568	-0.1244	0.0632	1.0983
2	226	-0.4750	0.4630	-0.1468	0.6750	-0.4066	0.3003
3	269	-0.1285	-0.6452	0.1715	0.5264	-0.1675	-0.7323
4	50	-3.2781	6.8333	-0.7332	-1.3124	0.0813	-0.8924
5	111	-0.0928	0.4516	0.1794	-1.7401	-0.2894	-0.4885
6	57	0.2613	2.0996	0.6568	-0.1568	4.7122	1.2319
7	83	2.5696	0.2541	0.2097	0.0611	1.4147	-0.5284
8	60	0.2317	-0.0296	2.3117	-0.2027	0.4427	0.6936

5.5.2 Cluster groupings

The cluster results show four clusters containing most of the farm/household observations with cluster 1 containing the largest group. It should be remembered that these variables have mean 0 and variance of 1, thus negative means indicate levels lower than the overall sample means etc. The largest cluster (cluster 3) had the least intensification, a higher percent of adults working off-farm and had the second lowest market access and second highest wealth level. We shall call this group of dairy farmers resource endowed

poor access (REPA). The second largest is cluster 2, the intensive specialized dairy farmers (ISD) who are most intensified and wealthy but had a lower market access with insignificant number of adults working off-farm.

Cluster 1 farmers exhibit an extensive farming, therefore low levels of purchased fodder, low levels of wealth and poor market accessibility and are therefore the resource poor dairy farmers (RPOOR). Cluster 5 potentially represents the dairy producers, who are intensive with a significant number of adults working off-farm, less wealth and low market access. This last group can therefore be called intensive part-time (SPF) producers. These general characterisations will be further detailed by examination of more of the original variables underlying the clustering.

5.5.3 Cluster means of original variables

Table 5.11 shows mean values by cluster for a number of variables obtained from the farm/household survey. They generally emphasise the distinctions between the clusters. The resource poor group can be seen to be a third of the overall clustered sample and are distinguished by having average land sizes, among the smallest acreage of Napier planted, lowest purchase of fodder and concentrates and below average incomes. Table 5.11 shows mean values by cluster for a number of variables obtained from the farm/household survey. They generally emphasise the distinctions between the clusters.

The Resource poor groups- REPA and RPOOR constitutes over 50 percent of the target clustered sample and are distinguished by having the lowest average acreage of Napier and maize planted, among the lowest purchases of fodder and concentrates and generally low grade cattle and lower milk yields. However the REPA group are more disadvantaged as compared to RPOOR by having less land sizes, lower dairy cattle per TLU, lower incomes and poor market access which resulted in less milk sales.

The intensive group of farmers-ISD and IPT on average purchase more fodder and concentrates and produce more milk. They also have more multiple market outlets which enable them to negotiate for higher milk prices and hence able to market more of their milk. The major distinction between the two groups of intensive farmers is that IPT is more female headed and this seems to be so because more adults work off-farm and also seem to allocate more land per TLU than the ISD

Table 5.11 Means of farm/production, household and market/institutional participation characteristics for the major target groups

cluster	resource endowed poor access	intensive specialised	resource poor	intensive part-time
Number of Households	164	226	269	111
Production characteristics				
Farm size (acres)	2.1	2.2	3.2	3.6
Napier acreage	0.1	0.2	0.1	0.5
Maize acreage	0.6	0.6	0.9	0.9
Dairy cattle TLU	1.4	1.8	2.1	2.1
Farm acres per TLU	1.8	1.5	1.9	2.1
Napier acres per TLU	0.1	0.2	0.1	0.3
Maize acres per TLU	0.5	0.4	0.6	0.5
Concentrate purchased KSh/TLU/year	370.5	1026.0	292.2	1609.1
Fodder purchased KSh/TLU/year	443.1	1192.6	422.8	1618.7
Milk produced (litres/day)	0.7	1.7	0.6	1.9
Milk produced per day (litres/acre)	0.4	0.9	0.3	0.9
Percentage grade	0.4	0.7	0.3	0.7
Household characteristics				
Age of household head	49.3	48.4	50.7	51.8
Years farm established	26.8	21.7	23.7	26.0
Years dairy experience	25.3	20.0	22.5	23.0
Female heads (%)	31.7	92.0	98.1	83.8
Total household size	5.3	6.4	6.7	6.3
Household adults working off-farm (%)	2.2	0.6	1.1	19.2
Income category	1.3	1.8	2.1	3.0
Dependency ratio	41.5	58.4	54.4	19.2
Market /institutional participation characteristics				
Distance road type 1 (km)	18.9	18.1	21.2	16.3
Distance road type 3 (km)	3.3	2.7	1.9	1.8
Co-op membership (%)	2.4	2.2	1.9	3.6
Availability of veterinary services (%)	93.9	92.3	96.6	99.1
Availability of extension (%)	91.5	96.0	95.2	99.1
Informal milk market participation (%)	100.0	100.0	100.0	100.0
Multiple market outlets (%)	3.8	10.9	5.9	5.4
Average milk price (KSh/l)	17.1	19.5	24.9	24.3
Average milk sold (litres/day)	1.7	3.5	2.2	4.1

6 Conclusions

Most households were agricultural and of those more than two thirds had cattle. Zebu cattle took more than forty percent of the households with cattle while grades were only 13 percent and this distribution did not change between households with cattle and those without. As was indicated in the PRAs, there were very few small ruminants (sheep and goats) and their contribution in providing milk and manure to different systems was minimal. There was high preference for Zebu cattle contrary to the fact that the agro climatic potential is extremely favourable for grade cattle production and the demand for milk is quite high in the region. Although tethering as the main system of keeping cattle is on the decline due to increasing pressure on land, stall-feeding is not very common while the cattle appear to be under fed. Thus many opportunities exist for promoting livestock productivity through improved nutrition.

The growing importance of dairying was further indicated by the prevalence of milking cows and heifers in the herds. The main system of keeping cattle was grazing with some stall-feeding but very little zero grazing was practiced. Grazing was mainly associated with the Zebu while stall-feeding was associated with crosses and grade animals. Cut and carry was common across all animal types whether Zebu or grade. Only less than 16% of the households supplemented their cows with concentrates. About a fifth of the households purchased fodder and stored forage for the dry season. The majority of the farmers used maize as a fodder crop by removing thinnings to reduce the density. A third of the farmers used the extra plants to feed livestock. The majority of farmers indicated that they purchased fertilizers and applied manure but there was no sale or purchase of manure except in Rachuonyo.

Most farms were free hold although there were pockets with traditional land ownership and little incidences of leasing land. Most of this land was used for food crops followed by pasture, cash crops and little fodder crops. In many instances the food crops were also cash crops as they were a major source of income. There was however, more Napier grown on contours than as a fodder on its own. This allocation did not change whether the farm had cattle or not. The only exception again was Nandi which had more pasture than even the food crops. This implies that most farming is subsistent and commercial farming is also common and there is scope for improving animal productivity through more integration of cattle in the farming systems and growing of more fodder crops.

Major changes that have occurred in terms of crops not grown in the last ten years but grown now were: Napier grass, fruit trees, tea and bananas. Those that were grown ten years ago but were no longer grown were cassava, sorghum, millets and sweet potato. This indicated the growing importance of cattle and early stages of intensification.

Non-agricultural households tended to have fewer household members because they were urban. The majority of household heads were men who also happened to own the land. However most adult women took care of cattle in grazing, cutting and carrying fodder. 60% of household females also took charge of selling milk and milking but the male household heads specialised in animal health related tasks such as artificial insemination, spraying and seeking treatment.

There was generally low engagement of long-term labour though there was slight employment of casuals. These were employed to help in planting and weeding of food crops. This further supports subsistence orientation of production.

Most households had little income and only those with cattle especially dairy enjoyed much higher incomes. Milk output was quite low at an average of 2.7 litres per cow per day with the grades reaching only 5.1 litres per day. Most of this milk was consumed at home as there were little sales to individuals.

The prevalence of public utilities such as piped water, electricity and telephone were less than 5%. The shortest roads to the nearest market centres are only accessible in the dry season. The main mode of transport was the bicycle and animal drawn carts.

Credit use was very low as many had never thought of such services or were afraid that they would be unable to repay once they got it. Availability of public extension service was very high though some from NGOs and private agents also existed. However, there was only one visits per year.

The worst diseases were helminthiasis, ECF and anaplasmosis. Presence of veterinary service was high but paravets were also common.

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Annex 1 Selection of sub-locations

Table A1.1 Western divisions grouped by dairy related characteristics

Access	PPE		
	Low (0.7-0.85)	Medium (0.85-1)	High (>1)
Kakamega			
Medium (1-2 hrs.)		Malava/Kabras (46)	
High (< 1hr.)		Butere (91), Lurambi (61), Mumias (103)	Ikolomani (120), Kwisero (108), Shinyalu (157)
Bungoma			
Low (> 2 hrs.)		Kapsokwony (59) Kimili (121)	
Medium (1-2 hrs.)	Tongareni (35)	Kanduyi (72), Sirisia (52), Webuye (57)	Nalondo (75)
Nandi			
Low (> 2 hrs.)			
Medium (1-2 hrs.)			Mosop (22), Aldai (32), Kapsabet (41), Kilibwoni (32), Tindiret (45)
Vihiga			
High (< 1hr.)			Emuhaya (188), Hamisis (119), Sabatia (180), Vihiga (164)
Nyamira			
High (< 1hr.)			Borabu (30), Ekerenyo (207), Magombo (96) Nyamira (98)
Rachuonyo			
Medium (1-2 hrs.)		Oyugis (61)	
High (< 1hr.)	Kendu Bay (61)		
Kisii			
Medium (1-2 hrs.)		Bosongo (85), Suneka (105)	Marani (109), Nyamache (91), Ogembo (99)
High (< 1hr.)		Kisii Municipality. (132)	Irianyi (96), Masaba (89)

Table A1.2 Number of households (1989 census) for survey sub-locations

Cluster	District	Sub-location	Total Population	Total Households	Sample	
					Calculated	Sampled
3	Bungoma	Kimilili Township	5,949	1,402	105	59
		Kimilili	14,557	2,590	19	19
		Kamukuywa	16,944	2,938	19	19
		South Nalondo	17,029	2,,479	12	15
		Kibingei	18,121	3,098	19	19
	Kakamega	Surungai	3,221	551	5	15
		Samitsi	8,271	1,301	11	15
	Kisii	Bomariba	12,135	2,306	25	27
	Nandi	Ndubeneti	1,927	361	8	15
		Lelwak	2,070	374	8	15
		Songoliet	2,386	420	8	15
		Kapchorwa	7,770	1,237	8	15
		Chepkongony	8,286	1,922	18	18
	Rachuonyo	Kawere Kamagak	5,780	1,155	13	15
		Kachieng	6,179	1,292	17	16
4	Kakamega	Shisejeri	5,560	961	50	57
		Shitoli	6,783	1,321	39	41
		Musoli	7,478	1,429	28	28
		Shibuname	7,550	1,588	52	52
		Shivagala	10534	2,119	49	49
	Nyamira	Mwabundusi	7,020	1,291	41	41
		Boikeira	15,869	2,794	27	26
	Vihiga	Gimamoi	4,767	852	43	31
		Kapsotik	5,740	1,002	42	42
		Gavudunyi	7,909	1,437	44	45
		Magui	3,469	618	52	50
		Mahanga	5,815	1,072	47	47
		Mbihi	6,591	1,244	84	60
5	Kakamega	Shikulu	7,958	1,519	24	23
	Kisii	Bogitaa	5,572	1,151	19	20
		Bomokora	7,436	1,464	23	23
		Bomorenda	14,001	2,646	44	44
	Nyamira	Magwagwa	8,878	1,521	21	26
	Rachuonyo	Kakangutu West	2,882	637	12	16
		North Kachien	3,513	574	11	17
		Kajiel	2,670	547	11	18
		Kamser Seka	4,870	885	17	17
		Kanyapir	4,376	856	19	19
5	Rachuonyo	Komulo Njira	3,325	693	42	42
6	Bungoma	West Nalondo	13,728	2,155	16	15

Cluster	District	Sub-location	Total Population	Total Households	Sample	
					Calculated	Sampled
		North Nalondo	14,353	2,182	13	15
	Kisii	Kiamokama	4,914	938	43	42
		Mogweko	5,455	891	29	34
		Boguche	5,772	959	25	16
		Ichuni	6,580	1,253	39	40
		Metembe	10,237	1,807	23	23
	Nandi	Kaptildil	2,439	403	6	15
		Arwos	3,020	520	12	15
		Cheboite	5,777	899	11	15
	Nyamira	Girango	8,474	1,504	30	29
		Bomwagamo	11,587	2,097	24	24
		Bocharia	14,579	2,789	45	45
		Bonyaruande	14,826	2,503	27	27
		Mwagechure	16,196	2,766	30	30
	Vihiga	Gimarakwa	4,777	851	31	43
		Chagenda	3,990	788	16	16
Totals				72,249	1,556	1,575
Percentages					2.15	2.18

Annex 2 Feedback from research teams

Farmers' feedbacks were carried out in two sites per district from Monday 23rd October to Thursday 2nd November 2000. Staff feedback review meeting held at the Naselica hotel in Kisumu 23rd to 24th may 2001.

The way forward:

The participants agreed that future reviews of survey findings should be shared with a larger group of sector stakeholders, so as to have a more conclusive discussion on the way forward. Notable exclusions in the meeting were the veterinary section (private and public), and other developmental organizations in the region (NGO's, Lake Basin Development Authority, etc). After extensive discussions the following were identified as constraints and the expected players to address them through suggested opportunities.

	CONSTRAINT	OPPORTUNITY	PLAYERS
1.	Poor adoption of available technologies. Failure by extension agents to understand farmers' objectives and choice of enterprise. Policy constraints contributing to poor adoption	Understanding why technologies are not adopted; understanding the farmers' choice of enterprise and management practices	SDP through studies and surveys, NALEP, Private NGO's
2.	Inadequate technology transfer mechanisms. Poor contacts between extension and farmers. Inadequate livestock management ability among farmers. Poor entrepreneurship skills	NALEP approach, group extension, decentralisation of GoK operational funds at district level, payment for education by end-user	Farmers, extension and services providers – private and public
3.	Lack of credit facilities.	Revolving funds in kind (heifer-in-trust); strengthening farmer groups; participatory monitoring and evaluation by the groups and participating institutions.	NGO's, CBOs development projects, banks
4.	Poor marketing systems, Collapsed infrastructure, collapsed co-operatives	Collective action, strengthening farmer groups, development of milk marketing information	SDP, extension agents, KDB, processors, NGOs, CBOs input suppliers, KEBS
5.	High start-up capital for dairy systems	Consideration of alternatives to dairy cows – dairy goats, etc.	HPI, Kenya dairy goats association, KARI, Farm Africa

In his closing remarks, Mr. Wycliffe Omutsani, PLPO Western Province lauded the efforts and requested that data collected and information derived from the survey be shared with extension staff and other

collaborators. He also called for attention to cultural issues that may impeding adoption of technology and development of the dairy industry in general (e.g. the practise of witchcraft) deserve some attention in future studies. Other areas that should merit more studies include milk marketing structure and organisation and constraints.

Annex 3 List of supervisors and enumerators

ILRI

William Thorpe	Field Manager
Steven Staal	Agricultural Economist
Julius Nyangaga	Research Assistant
Michael Waithaka	Research Officer
Patrick Wanjohi	Research Assistant
Liston Njoroge	Research Assistant

KARI

Apollo Orodho	Centre Director, Kakamega
Felista Makini	Centre Director, Kisii
Kinyua Muriuki	Technical Officer
Meschack Ojowi	Research Officer
Patrick Mudavadi	Research Officer

MOARD

Hezekiah Muriuki	Project Manager
Angela Wokabi	Senior Livestock Production Officer
George Gichungu	Senior Livestock Production Officer
Wycliffe Omutsani	PLPO, Western
Jacktone Okumbe	PLPO, Nyanza
Titus Mutisya	Bungoma
Phillip Lang'at	Nandi
Henry Anjira	Kakamega
Timothy Wesonga	Kakamega
Simon Wesechere	Vihiga
Dickson Mottanya	Nyamira
Alice Manoti	Kisii
Willam Nyambaga	Rachuonyo

Enumerators

Name	**sub-location**	**District**
Maurice Watela	North Nalondo	Bungoma
Joseph Lubumbu	South Nalondo	Bungoma
Charles Aluda	Kibingei	Bungoma
Simiyu Khaemba	Kamukuywa/Kimilili	Bungoma
Gabriel Wakhanu	Cheboite	Nandi
Ann Yegon	Kaptidil/Kapchorwa	Nandi
John Bor	Arwos/Ndubenei	Nandi
Ignatius Rotich	Songoliet/Lelwak	Nandi
Lumiti Gaitano	Shivagala/Shikulu	Kakamega
Joseph Odhiambo	Surungai/Samitsi	Kakamega

Adonijah Adipo	Musoli/Shisejeri	Kakamega
William Ligono	Shitoli/Shibuname	Kakamega
Arthur Chunguli	Gimamoi/Gimarakwa	Vihiga
Peter Noyi	Kapsotik/Gavundunyi	Vihiga
Alex Adala	Chagenda/Mahanga	Vihiga
Ezakiel Ngaira	Magui/Mbihi	Vihiga
Martin Oyugi	Magui/Mbihi	Vihiga
Wycliffe Wafula	Samitsi/Shibuname/Shitoli	Kakamega
Samuel Onguso	Bonyarorande	Nyamira
Charles Kubwa	Magwagwa/Bonyengwe	Nyamira
Jackson Monte	Bomwagamo	Nyamira
Jones Mumbo	Bocharia and Girango	Nyamira
Patrick Mariita	Mwabundusi/Mwageginre	Nyamira
Bernard Muthini	Bomokora/Bomorenda	Kisii
Arthur Ahona	Ichuni/Matibo	Kisii
Oirongo Joseph	Bogitaa/Bomariba	Kisii
Leonard Omariba	Kiamokama/Bogeche	Kisii
David Otundo	Metembe/Mogweko	Kisii
Edith Kiche	Kachieng/North Kachien	Rachuonyo
Wilson Owino	West Kakangutu/Kawere Kamagak	Rachuonyo
Kennedy Osoro	Kanyipir/Kamser Seka	Rachuonyo
Dennis Omondi	Kajiei/Komulo Njira	Rachuonyo