

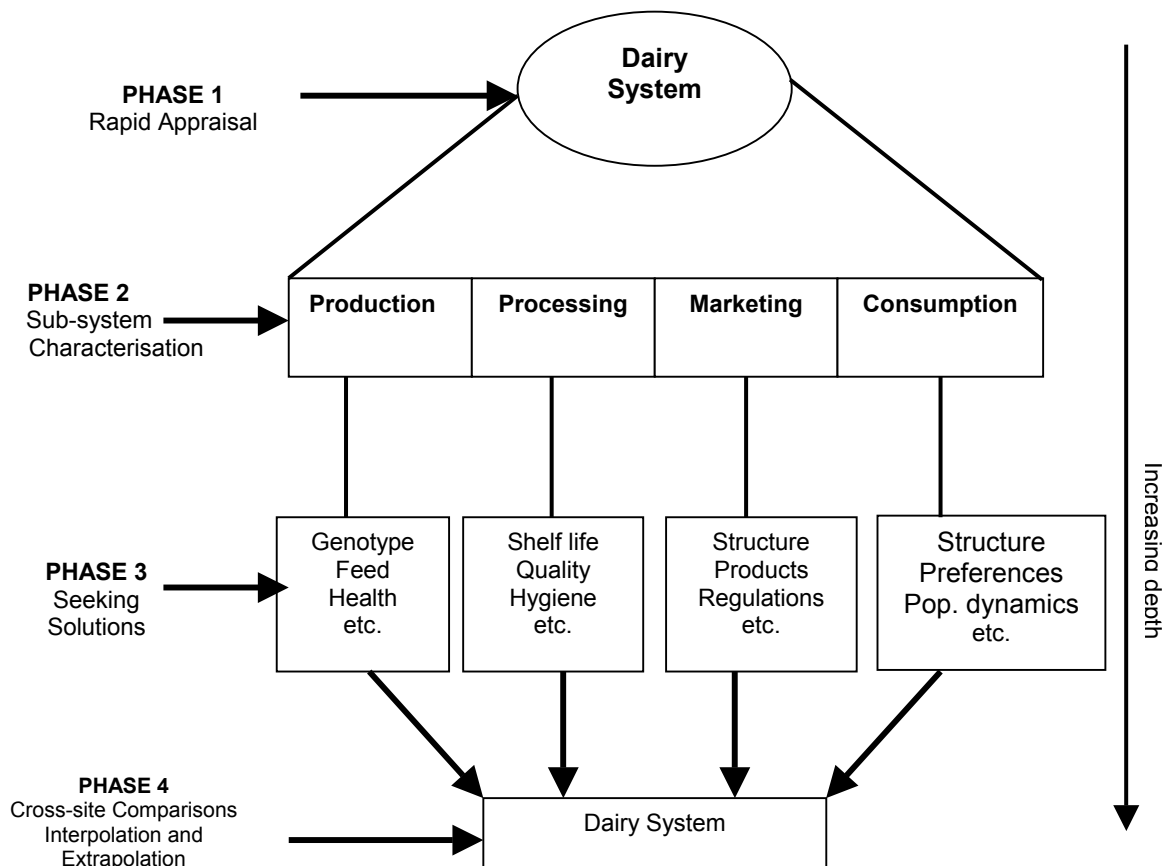
to consumers and the role of small informal milk traders, in spite of the relative state of development of the Kenyan formal dairy industry, is obvious.

### 1.1 Conceptual Framework

The conceptual framework used in carrying out this study derives from Rey et al (1993). According to this framework, a "dairy system" incorporates all areas and production systems producing, and the marketing channels delivering dairy products to consumers in urban centres, including the policy environment.

In this conceptual framework, a study site is defined by a consumer centre, with its dairy shed and the processing and marketing actors and processors linked to them. In the current characterisation survey, the consumer centre is Nairobi, while the other districts represent the milk shed, areas where milk is produced.

For convenience of investigation and analysis, the dairy system is broken up into four different subsystems namely: production, processing, marketing and consumption. Further, each subsystem is constituted by components representing distinct areas of examination and subsequent action. For instance, the production sub-system has genetic, feeding and health components among others. Below is a schematic representation of the conceptual construct described above.



In this conceptual framework, the process of research diagnosis and solution development has been categorized in phases from constraint and opportunity identification, to seeking solutions for dairy systems and finally to replications to comparable sites. The four phases are:

1. Appraisal (or typification) of a given dairy system, often at a national (or sub-sector) level, to understand the main characteristics of production, processing, marketing and consumption. Information gathered is mostly qualitative, collected from key informants.
2. More detailed characterisation of the dairy system, including quantification of its components at the household level for production and consumption, and at the levels of individual processing and marketing units. The objectives of characterisation are:
  - To provide baseline data on the dairy system performance
  - To understand factors influencing dairy production: constraints and opportunities, farmers' rationale and objectives
  - To understand linkages between different subsystems and their influence on the development of the dairy system
  - To identify and prioritise researchable issues which make an impact on the development of dairy system (at the component level).

The study described in this report fits into this characterisation level of analysis.

3. The third phase seeks ways to enhance the development of specific dairy systems. This phase is also called the intervention phase and its main objectives are to quantify impact of constraints, to design and test alternatives to enhance dairy production and to design and test methodologies.
4. Phase four is cross-site synthesis and involves extrapolation of the findings from phase 2 and phase 3 to areas with comparable agro-climatic and market access characteristics. An important objective in this phase will therefore be the replication of interventions in other dairy systems in other countries and continents.

Phase 1, the Appraisal, was conducted by SDP in 1998, and is presented in Omore et al (1999). This report presents results of the production system characterisation (Phase 2) in the target zone of Central Kenya.

## 2. Materials and Methods

### 2.1 Questionnaire Development

The methodology tested in the Kiambu pilot survey by MOA/KARI/ILRI (Staal et al, 1997) of using a structured questionnaire, was modified in line with the experiences gained and expanded to incorporate data needs of collaborating researchers.

The questionnaire was divided into sections covering household demographics, farm facilities and activities, livestock inventories, feeding, production performance, milk marketing and income ranking. It was pre-tested and the enumerators trained on it before it was then applied in the field.

### 2.2 Site Selection

Contrasting sites, representing combinations of dairy production potential and market access as judged by expert informants, were chosen as shown in Table 1 below (as mentioned Kiambu had been characterised earlier). It was then decided to select two Divisions per District that would be most indicative of dairy production potential within each District. Divisions were selected so as to reflect some contrasts in agro-ecological zone.

**Table 1: Study Sites According To Criteria**

Agro-climatic potential	Market access	District(s)
High	High	Kiambu
	Medium	Kirinyaga, Maragua, Murang'a,
	Low	Nyandarua (South)
Medium	High	Nairobi, Machakos
	Medium	Nakuru
	Low	Narok. (North)

More divisions were included in Nakuru as, along with Nairobi, they represent major urban consumption centres. In total sixteen Divisions in all the Districts were selected (Fig. 1).

The agro-ecological zones described by Jaetzold and Schmidt (1983) were used to make groupings of land-use systems. These are namely Sheep-Dairy (Upper Highlands<sup>1</sup> and UH<sup>2</sup>), Tea-Dairy (Lower Highlands<sup>1</sup> and UM<sup>1</sup>), Coffee-Dairy (Lower Highlands<sup>2</sup>, Upper Midlands<sup>2</sup> and UM<sup>3</sup>), Horticulture-Dairy (UM<sup>4</sup>), Wheat-Dairy (LH<sup>3</sup> and LH<sup>4</sup>) and the township areas, as Urban (Table 2.)



### 2.3 Calculation of the Sample Size

A stratified sampling method was used to select the sub-locations to be surveyed. Based on the agro-ecological zones described by Jaetzold and Schmidt (1983) and field knowledge, six major land use systems, namely coffee/dairy, horticulture/dairy, tea/dairy, sheep/dairy, wheat/dairy and Nairobi were identified in the eight districts. Three population density classes were identified: less than 200 inhabitants per Km<sup>2</sup>, between 200 and 500, and more than 500 (C.B.S, 1994). As a result, twelve stratification groups were considered (not eighteen since some combinations do not exist such as tea/dairy in less than 200 density areas) and some combinations have been grouped to avoid obtaining very small groups.

The number of households to be surveyed in each sub-location was taken as a proportion of the households as estimated from the 1989 census figures (C.B.S., 1994). The sample size was obtained from calculating the number of observations potentially needed to estimate a difference between two means (with a confidence level of 95%, a coefficient of variation for the number of cows of 68% and to observe a level of difference of 20%)<sup>1</sup>. These calculations result in a minimum of 89 households per stratification group. The size of the sample in Nairobi was arbitrarily increased to 280 in order to increase the probability of including agricultural households. Then the sample size in each sub-location was calculated as a proportion of the number of households in the corresponding stratification group: sample size in sub-location *i* in stratification group *j* = (number of HH in *i* / total number of HH in *j*) x 89. If the calculated sample size was less than 10, it was then fixed at 10 in order to get enough observations at that level of analysis. The resulting sample size is 1389, with some heterogeneity between the sample size in each division. The smallest in any one division is 50 in Gichugu and the largest sample is 118 in Rongai. Annex 1 gives the sample size per stratification group and per sub-location surveyed.

### 2.4 Survey Procedure

Survey maps for each of the 82 sub-locations were created from ILRI geographical information systems (GIS) databases, using ArcInfo software. The survey enumerators, who had previously been trained in the use of the survey instrument, visited their assigned sub-locations and marked on the map the main landmarks (any permanent feature like a trading centre, a school, or a church). Two (or three) 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 5<sup>th</sup> 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.

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<sup>1</sup> Calculation of sample size in each stratification group, to estimate a difference, is:

$$n = 2 \left[ \frac{zc}{d} \right]^2$$

where *z* = 1.96 for 95% confidence interval, *c* is coefficient of variation, and *d* is level of difference. (Poate and Daplyn, 1993).

The questionnaires were completed through interviews with the household head or in his/her absence, the most senior member available or the household member responsible for the farm. Enumerators were asked to make appointments if this person was not available. Enumerators were selected among the front-line and supervisory extension staff of the MoA in each district. A supervisor checked each completed questionnaire in order to get as accurate information as possible. The data from the questionnaires were entered into EpilInfo data management software and checked for data entry errors. Descriptive statistical analyses were carried out using Stata software.

The questionnaire was divided into sections covering: household composition, labour availability and use; farm activities and facilities; livestock inventory; cattle feeding distinguishing between on-farm feed and purchased feeding; dairying with emphasis on milk production and milk marketing; livestock management and health services; household income and sources; and cooperative membership, cooperative services and milk consumption.

Simultaneous with the enumeration, of all the farms/households were georeferenced using GPS mapping instruments by the SDP supervisors. The GPS points were downloaded using PCX5 software and with IDRISI used to show the spatial distribution of the farms/households.

### **3. Results From Descriptive Analyses**

#### **3.1 Overview**

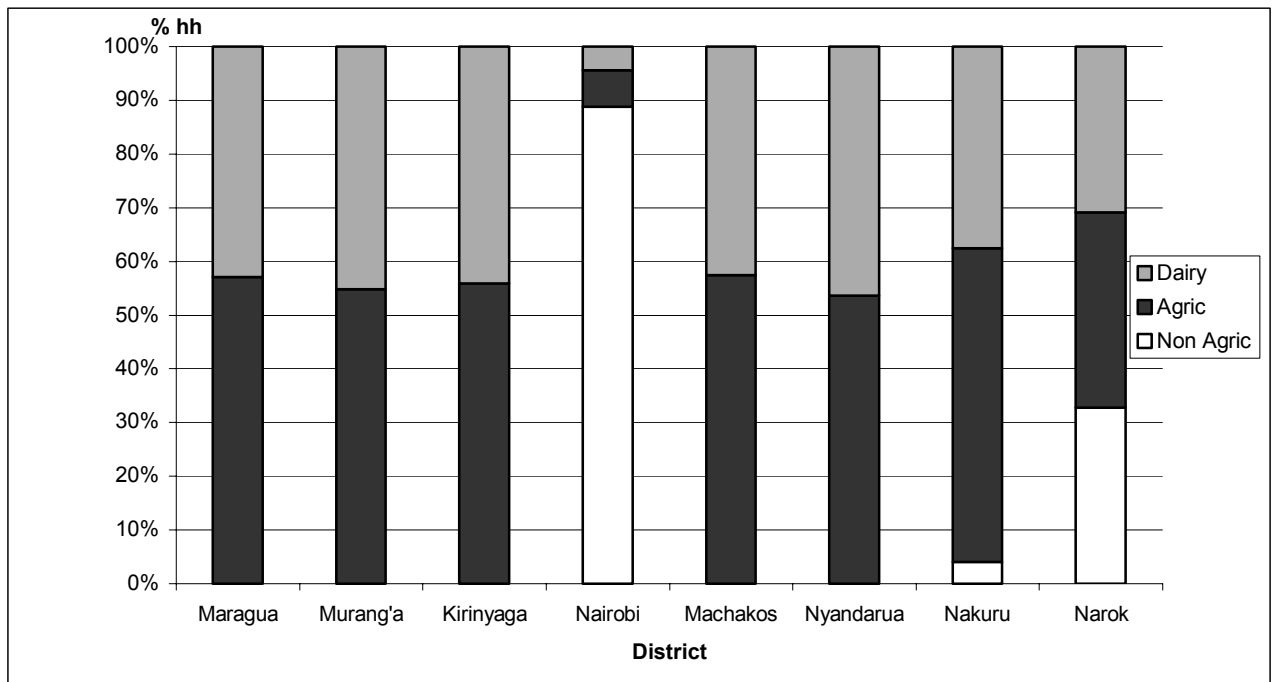
A total of 1,390 households were surveyed. This is fewer than the planned total of 1,401 mainly because in Mau Narok and parts of Molo and Njoro households had fled ethnic clashes, and enumeration was difficult. The results showed that a majority of rural households are agricultural (74.8% of the surveyed households) and many practice dairy farming (75.3% of the agricultural households). There is an increasing shift towards intensification of dairying through growing of fodder crops with “cut-and-carry” feeding systems and keeping of improved dairy breeds on the ever decreasing land available for agriculture.

#### **3.2 Households**

Below we examine the basic characteristics of the surveyed households, in order to place in context their agricultural and livestock production activities. Households’ characteristics such as whether agricultural or non-agricultural, composition, gender of household head, income and so on are presented in this section. Comparisons between districts are made and a discussion of the differences and similarities presented.

##### **3.2.1. Proportion of Non-agricultural, Agricultural and Dairy (cattle keeping) Households**

About 74% (1,015) of all households owned agricultural land and of these 73% had dairy cattle<sup>2</sup> (Fig. 2). This underlines the fact that a majority of rural households are engaged in agricultural activities and many practice dairy farming.



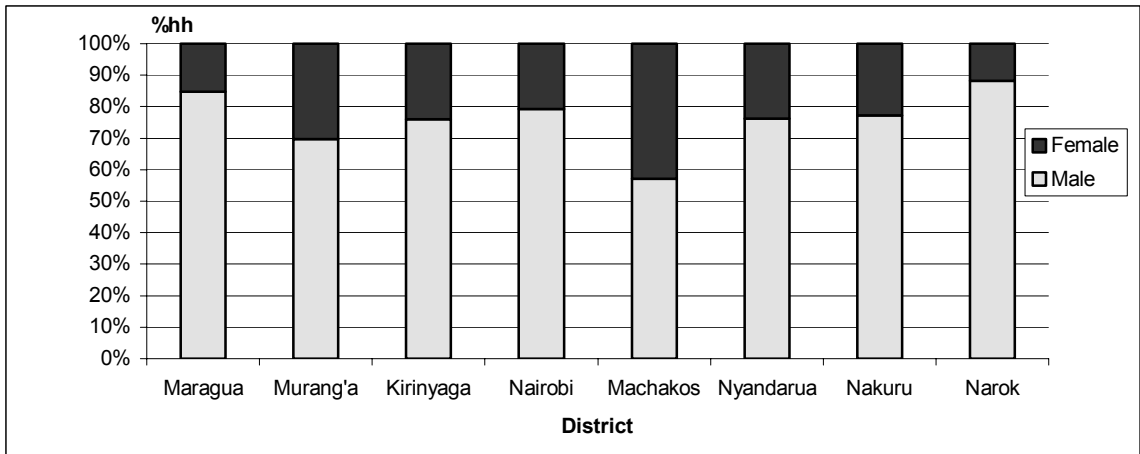
**Figure 2: Percent Non-Agricultural, Agricultural and Dairy Households**

In Nairobi over 90% of households were non-agricultural with Narok township sub-location also contributing to the high percentage (47%) of non-agricultural households found in Mau Narok. Among other districts, Nyandarua and Kirinyaga showed the highest proportion of agricultural households (nearly 100%), as well as a high proportion of dairy farmers.

### 3.2.2 Household Head Gender Differentiation and Education level

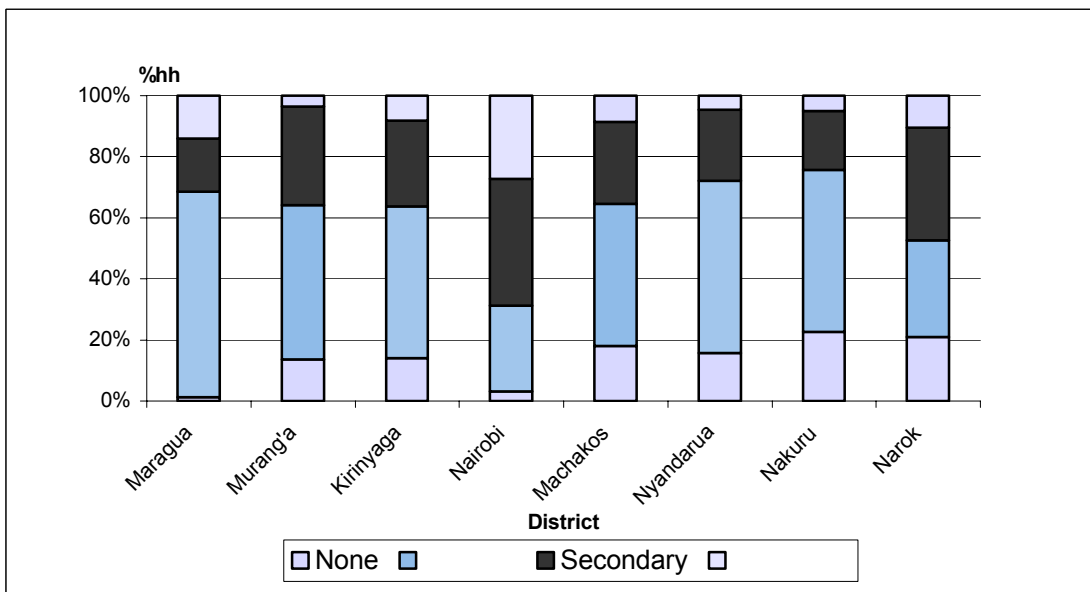
The head of a household was defined as the person most available at the homestead and who makes the day-to-day decisions concerning food, expenditures, farm enterprises etc. As shown in Fig.3, on average about three quarters of farm/households were headed by males, with the remainder being female headed. This compares closely to the figure of 28% female headed for households in Kiambu (MOA/KARI/ILRI 1998). The percentage of female-headed households was highest in Machakos (43%) as the male spouses are often away working in Nairobi. In Narok most households were male headed (88%) probably because the society is polygamous and less inclined toward urban employment.

<sup>2</sup> Dairy cattle are defined as those having some measure of *Bos taurus* dairy breed genes, thus either cross-bred or grade.



**Figure 3: Gender of Household Head by District**

The education level of the household head was also analysed as shown in Fig. 4. The majority of the sample households in all Districts (68-85%) had some primary or secondary level education. The mean age of the household head was 47 years.



**Figure 4: Education Level Of The Household Head**

Respondents were also asked to state the primary activity of the household head. Among other things, this question was meant to elicit information on off-farm employment opportunities for the household head. Results showed that for most (52%) of them farm management was their primary activity. Table 3 below gives the proportion of household heads whose primary activity was off-farm employment.

**Table 3: Proportion of Household Heads with Off-Farm Employment**

District	%
Maragua	36.36
Murang'a	32.31
Kirinyaga	18.00
Nairobi	89.08
Machakos	37.50
Nyandarua	23.85
Nakuru	41.19
Narok	68.42
Overall	47.93

### 3.2.3 Household Sizes and Composition

The average household size, as shown in Table 4, was 5.7 (sd 3.2) persons centred around approximately 2 adults in the age group 23 to 65 years. The other groupings of less than 8 years, 8 to 14, 15 to 22 and over 65 years had 1.2, 1.1, 1.0 and 0.2 persons respectively. This scenario varied across sites and indicated that the largest households occurred in Machakos (7.1 members). Household sizes are expected to influence labour availability for dairy and crop production, although conversely, small households may indicate low rural employment opportunities, leading to rural-urban migration.

**Table 4: Household Sizes and Composition**

District/Years	Number in each Age Category (sd)					Total
	< 8	8-14	15-22	23-65	>65	
Maragua	0.8 (1.0)	1.4 (1.6)	0.7 (1.0)	2.1 (1.1)	0.3 (0.6)	5.2 (2.7)
Murang'a	0.8 (1.1)	0.1 (1.1)	0.9 (1.7)	1.8 (1.1)	0.3 (0.6)	4.6 (2.9)
Kirinyaga	0.1 (1.2)	0.1 (1.2)	0.9 (1.1)	2.1 (1.3)	0.3 (0.7)	5.3 (2.5)
Nairobi	1.1 (1.1)	0.7 (1.0)	0.9 (1.0)	2.3 (1.7)	0.1 (0.3)	5.0 (2.8)
Machakos	1.7 (1.7)	1.2 (1.2)	1.1 (1.3)	2.6 (1.4)	0.4 (0.6)	7.1 (3.0)
Nyandarua	1.6 (1.7)	1.2 (1.3)	0.9 (1.4)	2.5 (2.7)	0.2 (0.5)	6.4 (4.0)
Nakuru	1.4 (1.6)	1.2 (1.4)	1.2 (1.5)	2.4 (1.6)	0.2 (0.5)	6.3 (3.3)
Narok	1.1 (1.7)	1.1 (1.3)	0.1 (1.4)	2.2 (1.0)	0.1 (0.2)	6.3 (3.7)
Average no.	1.2 (1.5)	1.1 (1.3)	1.0 (1.4)	2.2 (1.6)	0.2 (0.5)	5.7 (3.2)

### 3.3. Farm Holdings

#### 3.3.1 Land Use And Cropping Practises

The survey attempted to quantify the production of the cash and food crops, including coffee, tea, maize, beans and Irish potatoes, and to identify interactions with dairy production and the growing of animal fodder (mainly napier grass). Farmers caution, however, that even within Districts crops are region-specific and any generalisation could be misleading.<sup>3</sup>

Coffee was confined to Central Province and Machakos with average acreage being 0.83, 0.39 and 1.01 for Maragua, Murang'a and Kirinyaga respectively and 0.76 in Machakos for the dairy households (Table 5). Tea was also predominantly grown in Maragua, Murang'a and Kirinyaga with 0.10, 0.34 and 0.14 acres recorded per farm. Wheat was grown in the southern Rift Valley Districts with Narok having the largest tracts (14.69 acres). Growing of napier grass as a fodder has been widely adopted across all Districts, apart from Narok, where the predominant system for keeping cattle is grazing. The acreages of napier may be underreported because of difficulty of measuring napier planted on boundaries, ridges and as terraces.

**Table 5: Acreage of Food and Cash Crops**

District	Type of hh	N	Coffee	Tea	Wheat	Napie r	Maiz e	Beans	Irish Potatoes
Maragua	Dairy	58	0.83	0.10	0.00	0.43	0.55	0.26	0.06
	Non-dairy	16	0.45	0.01	0.00	0.10	0.47	0.16	0.01
Murang'a	Dairy	14 3	0.39	0.34	0.00	0.56	0.56	0.23	0.04
	Non-dairy	30	0.17	0.49	0.00	0.39	0.43	0.21	0.02
Kirinyaga	Dairy	73	1.01	0.14	0.00	0.33	1.13	0.71	0.15
	Non-dairy	17	0.62	0.03	0.00	0.04	0.44	0.37	0.08
Nairobi	Dairy	13	0	0	0.00	3.46	0.99	0.06	0.00
	Non-dairy	6	0.00	0.00	0.00	0.00	0.13	0.09	0.00
Machakos	Dairy	76	0.76	0	0.02	0.19	1.09	0.83	0.01
	Non-dairy	25	0.61	0.00	0.00	0.03	0.52	0.51	0.03
Nyandarua	Dairy	91	0.01	0.01	0.74	0.24	0.99	0.28	0.80
	Non-dairy	13	0.00	0.00	0.00	0.01	0.30	0.08	0.311
Nakuru	Dairy	21 6	0	0	0.65	0.18	1.35	1.03	0.26
	Non-dairy	10 3	0.00	0.00	0.08	0.01	0.74	0.65	0.13
Narok	Dairy	32	0	0	14.69	0.00	1.52	0.92	1.50
	Non-dairy	6	0.00	0.00	0.00	0.00	2.03	0.61	

<sup>3</sup> The sample of agricultural/dairy farmers in Nairobi was small and included a large farm with 265 acres and 170 animals which biases the mean values for Nairobi.