SDP Collaborative Research Report

The Kenyan cattle population:

The need for better estimation methods

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List of Acronyms

Acronym	Long name
AEZ	Agro-ecological zones
ASAL	Arid and semi-arid lands
CBS	Central Bureau of Statistics
CHAR, Char	Characterization surveys
FAO	Food and Agriculture Organization
FITCA	Farming in Tsetse Controlled Areas (FITCA) Project
GDP	Gross domestic produce
GT	Groundtruthing survey
HHs	Households
HPI	Heifer Project International
ILRI	International Livestock Research Institute
Indigen	Indigenous (cattle)
KES	Kenya Shillings
MoLFD	Ministry of Livestock and Fisheries Development
NALEP	National Agriculture and Livestock Extension Program
NGOs	Non governmental organizations
SDDP	Small Dairy Development Project

Introduction

Information on livestock populations forms the basis for understanding the relative importance of livestock in a country's economy, and thus estimating the contribution of the industry to the national GDP. Cattle population and distribution data are also critical for helping inform decisions on where and how to target public and private investment in livestock development.

The primary source of livestock population figures in Kenya is the Ministry of Livestock and Fisheries Development (MoLFD), mainly through reports compiled by government workers in charge of various administrative units. It is not clear when the last nationwide livestock census was done and the figures provided by the field offices officials are from diverse and sometimes imprecise methods used to estimate numbers in respective areas.

The Smallholder Dairy Project first became aware of the fact that the official cattle population figures could be different from the actual numbers when the Project attempted to validate data collected during various surveys, comparing them with what the Ministry reported at division level. The differences observed between what was reported and extrapolation from data surveys led to a series of validation efforts to further ascertain these discrepancies.

This report is a compilation of the data analysis and validation activities. The report details the various procedures that compared data from different sources and analytical results which indicate that the country may be having significantly different cattle figures than was being officially reported. The results reveal that there may be more cattle than the officially provided estimates.

The key message of this report is the need for a comprehensive nation-wide farm-to-farm census of livestock, and in particular cattle. In the absence of this a more reliable sampling procedure is suggested. This field manual detailing the procedure is a separate publication (Nyangaga *et al*., 2005) produced by the Smallholder Dairy Project (SDP).

1. Comparing the government cattle population estimates and SDP survey data

The need to re-look at figures of cattle population in Kenya became apparent when an attempt was made to map official divisional level cattle numbers contained in annual reports by the Ministry of Livestock and Fisheries Development (MoLFD 1995-1997). This was a data analysis exercise that was aimed at validating the official cattle estimates (provided by reports from the Ministry) with findings from various SDP surveys that were conducted between 1998 and 2000 that sought to characterize dairy systems in parts of the country.

1.1 The data involved

The official cattle populations used for this validation were from the 1995 – 1997 division level reports on total cattle figures broken down into two broad breed types: grade (dairy animals and crosses) and zebu (beef cattle). The data had to be matched with division level boundaries digitized from District Development Plans. These official figures were to be validated by comparing them to the SDP household level data that involved about 3,000 households over three consecutive survey rounds, starting with Kiambu in the year 1998, the Central and Rift Valley provinces in 1999 and Western Kenya in 2000. Even though these surveys were conducted somewhat later than the Ministry reporting periods, the cattle numbers were considered to be grossly comparable. If anything, the reducing effect of the 1999 drought was expected to counterbalance any growth that might have occurred over that period of time.

1.2 The validation process

The estimation of division level cattle population from SDP's household level data would thus consider the proportion of the households that kept cattle (dairy or zebu), the number of cattle types in each of these households and project to the total population. The number of households used in each division was extracted from the division level census statistics for 1999, which were closer to the 1997 cattle counts. The SDP sample was entirely random, including both farmers as well as urban households (Staal *et al* 2001; Waithaka *et al*, 2002). It was assumed that the proportion of households in the sample that owned cattle could be safely used to extrapolate to derive the animals' population in an entire area (e.g. if a hundred people were sampled in one division, and fifty of those report to have cattle, it was assumed that this proportion of 50% cattle ownership applies to all households in the area). Urban households in each division were subtracted from the total populations unless sublocations containing urban centres were actually sampled, as was the case of Kasarani in Nairobi.

1.3 Results

Table 1 presents summary statistics of the SDP data from various divisions surveyed including the numbers of sample sub-locations and households, proportions of households with cattle and the mean number of cattle in the households with cattle.

Table 1. Sample size, proportions and average cattle numbers per household in various divisions surveyed.

District	Divisions	Number of sub-locations surveyed	Number of households sampled	Mean number of dairy cattle per household	Mean number of zebus cattle per households
Bungoma	Kanduyi/Bumula	3	45	1.2	3.0
Bungoma	Kimilili	4	117	2.6	4.0
Kakamega	Ikolomani	6	249	2.0	2.7
Kakamega	Kabras	2	30	1.9	4.5
Kiambu	Githunguri	8	108	3.3	0.3
Kiambu	Kiambaa	2	28	2.8	0.5
Kiambu	Kikuyu	7	131	2.6	1.1
Kiambu	Lari	5	62	2.7	0.4
Kiambu	Limuru/Tigoni	3	46	3.1	1.2
Kirinyaga	Gichugu	5	49	2.3	1.0
Kirinyaga	Ndia	5	51	1.9	1.1
Kisii	Marani	1	23	2.6	2.0
Kisii	Masaba	4	132	2.7	1.8
Kisii	Suneka	4	114	2.7	2.6
Machakos	Kangundo	1	12	0.0	3.6
Machakos	Matungulu	4	64	1.1	3.4
Machakos	Mwala	4	42	4.3	3.8
Machakos	Yathui	1	10	4.5	3.9
Maragua	Kandara	5	89	2.1	0.0
Murang'a	Kahuro	4	83	2.1	0.8
Murang'a	Kangema	4	60	2.4	0.0
Murang'a	Kiharu	1	17	2.2	0.0
Murang'a	Mathioya	2	24	2.4	0.0
Nairobi	Kasarani	5	136	4.4	0.4
Nairobi	Kibera	5	157	0.0	0.0
Nakuru	Bahati	5	113	2.5	1.3
Nakuru	Elburgon	3	34	3.2	0.0
Nakuru	Keringet	1	13	14.3	0.0
Nakuru	Molo	1	14	2.8	0.0
Nakuru	Njoro	5	94	3.4	1.0
Nakuru	Rongai	5	118	5.5	11.2
Nandi	Kapsabet	3	45	4.8	2.8
Nandi	Kaptumo	1	18	7.0	3.3
Nandi	Kilibwoni	4	60	5.3	4.2
Nyamira	Ekerenyo	4	105	2.4	2.2
Nyamira	Manga	1	41	2.9	2.7
Nyamira	Rigoma	3	105	2.7	1.8
Nyandarua	Kinangop	5	59	6.2	0.0
Nyandarua	Ol Kalou	5	50	4.6	0.6
Rachuonyo	E. Karachuonyo	2	33	2.0	6.7
Rachuonyo	Kabondo	1	15	0.0	6.1
Rachuonyo	Kasipul	3	48	5.0	3.9
Rachuonyo	W. Karachuonyo	2	61	0.0	5.3
Vihiga	Hamisi	4	161	2.6	1.8
Vihiga	Vihiga	4	174	3.6	2.4

Source: SDP 1998-2000

Table 1 above demonstrates the small scale nature of these farms: in more than half of the 45 divisions listed households keep only up to maximum three heads of cattle (64% with three or less of dairy types and 71% with the same number of zebu types) per household.

Table 2 gives a comparison of the MoLFD figures of cattle populations with corresponding estimates based on the SDP survey data.

Table 2. Comparing Ministry (MoLFD) estimates and SDP Characterization survey projections

District	Division	Dairy cattle population		factor	Zebu cattle population		factor
		SDP Survey	MoLFD	SDP/ MoLFD	SDP Survey	MoLFD	SDP/ MoLFD
Bungoma	Kimilili	3,307	1,614	+2	7,677	8,800	-1
Kakamega	Ikolomani	4,318	435	+10	21,601	28,349	-1
Kiambu	Githunguri	80,214	39,900	+2	184	750	-4
	Kikuyu	38,987	13,550	+3	2,695	2,550	+1
	Lari	60,842	16,432	+4	326	255	+1
Kirinyaga	Gichugu	46,728	23,545	+2	2,313	800	+3
	Ndio	37,791	28,875	+1	2,165	5,250	-2
Kisii	Masaba	26,860	15,125	+2	7,479	4,800	+2
	Suneka	14,576	6,261	+2	9,870	9,933	0
Machakos	Mutungulu	2,406	2,100	+1	30,592	38,500	-1
	Mwala	11,697	1,800	+6	49,595	30,000	+2
Maragua	Kandara	41,764	36,800	+1	0	0	0
	Kahuro	39,007	25,500	+2	199	0	-5
Murang'a	Kangema	23,581	15,700	+2	0	0	0
Nairobi	Kasarani	42,205	3,709	+11	306	932	-3
	Kibera	0	2,864	0	0	843	-10
Nakuru	Bahati	37,748	27,000	+1	3,264	3,000	+1
	Njoro	28,612	19,050	+2	397	1,800	-5
	Rongai	37,749	39,500	0	10,987	11,000	-1
Nandi	Kilibwoni	48,928	14,850	+3	9,669	44,440	-5
Nyamira	Ekerenyo	30,245	5,796	+5	9,747	7,155	+1
Nyandarua	Kinangop	175,253	50,434	+3	0	2,790	-10
	Ol Kalou	71,045	80,187	+1	219	815	-4
Vihiga	Hamisi	30,128	1,577	+19	16,212	29,589	-2
	Vihiga	16,058	949	+16	13,835	37,250	-3
Divisional average				**+4**			**-2**

The results of the projections calculations compared to official cattle populations were quite unanticipated. The difference between the official figures and the projections from the surveys was quite significant, especially with dairy type cattle. On average, the survey projections of dairy cattle

populations were four times as high as those provided by the ministry. Even if only those divisions with at least four sampled sublocations are taken into account, the survey figures are still on average four times higher than the figures provided by the Ministry. This translates to anywhere between 200 and 2,000 % more dairy cattle in a division than official records indicate. In moderate contrast, the official population of zebu cattle was generally higher than the SDP projections.

These differences in population, both between grade and zebu type cattle between the Ministry and survey estimations could not be satisfactorily explained. Some of this disparity was attributed to the lack of resources and inadequate accessibility by Ministry personnel to effectively visit all farms. This has led to the field agents using guesstimates to arrive at figures of cattle populations in assigned areas. Some of the workers use arbitrary rates increase and decrease applied on baseline figures that may already be wrong. Many pointed out that they did not have any accurate livestock census figures and did not know where they could get such information if a census had been conducted, thus relying on inherited records for baseline data.

On the other hand, SDP estimates of dairy animals may have been biased upwards especially given the Project's interest in the dairy sector, even though their survey was sampled entirely randomly and actually sought to include as many contrasting sites as possible. The Project's objectives might have influenced the sampling approach in the selection of districts, divisions or sublocations. It is for this reason another field survey exercise was organized to collect data from a larger sample of farm households to further "groundtruth" the cattle populations reported.

2. Groundtruthing cattle populations in Western and Central Kenya

2.1 Introduction

The objective of this exercise was to further validate the official cattle population estimates provided by the MoLFD periodic reports using data collected from a farm/household survey. The difference between this groundtruthing (GT) and the previous Characterization survey was that a larger sample of households or farmers was used to evaluate the reliability of the estimates provided by the ministry.

2.2 Methodology

3.3.1 Selection of sample sub-locations

Four districts were selected from among those where there were wide discrepancies between the ILRI-SDP characterization surveys and the Ministry population figures. These included Vihiga, Nyamira, Nandi, Nakuru and Maragua. From each district, four divisions were randomly picked: two that had previously been sampled and two that had not during the Characterization surveys. Table 3 gives a summary of how the sample divisions and sub-locations from the districts were selected.

Table 3. Categories and numbers of divisions and sublocations selected in a district for the GT survey

Type of divisions	Number of divisions	Type and number of sub-locations
Previously sampled divisions	2 divisions	1 of the already sampled sub-locations + 1 of non-sampled sub-locations Sub total: 4 sub-locations
Non-sampled divisions	2 divisions	2 sub-locations Sub total: 4 sub-locations
TOTAL	4 divisions	8 sub-locations

3.3.2 Selection of sample farms

The number of sample farms required from each of the sample sub-locations was calculated as the number of observations potentially needed to estimate a difference between two means (with a confidence level of 95 percent, a coefficient of variation for the number of cows of 84 percent and to observe a level of difference of 20 percent). This formula was adopted from Staal *et al*, 1998 and is given by:

Where:

$$n = 2x \left[\frac{A \ x \ B}{C} \right]^2$$

Where:

N = The minimum number of sample farms required in each sub-location

A = Level of confidence. For this survey 1.96 for the 95% level of confidence was used.

B = The coefficient of variation where we used 84% based on findings from previous surveys

C = Desired level of. For this survey 20% (i.e.± 20%) of the population mean was used.

This resulted in 135 as the number of farms required from each sub-location. The number was, however, adjusted proportional to the population of households in each respective sub-location using 1999 census (CBS, 2001). A further adjustment was made to ensure an adequate number of farms from each sub-location by raising the minimum to 30 and lowering the maximum to 250.

To randomly select the sample farms in the field, the enumerators visited farms along transect routes between pairs of randomly selected landmarks. The respondents found in the farms were asked whether the farm or household had cattle and, if there were any, the number of the two broad breed types kept: dairy types and zebus. The dairy breeds included both the pure (exotic) high-grade cattle and crosses between them and the local breeds.

The estimation of division level cattle populations from the farm level data was computed as the product of the total number of households in the Division, using the 1999 National human census data times the proportion of households with cattle, times the mean number of cattle owned.

2.3 Results

Table 4 shows estimates of the cattle populations from the GT data compared with the official figures from the MoLFD. The GT estimates of dairy cattle population were more than twice the corresponding MoLFD figures in more than half of the sample divisions. Like the earlier findings using Characterization data, the GT results suggested that on average there were four times more dairy cattle per division than the official figures indicated. The differences in the two sets of dairy cattle populations were highest in divisions Nyamira and Vihiga districts. The GT zebu cattle population projections also differed from the official figures by MoLFD, with the former often being higher. On average, a division was found to have three times the number of zebu cattle reported by the MoLFD. The GT survey also found zebu cattle in divisions where the official figures indicated none, like Kandara in Maragua District, and Kilibwoni and

Kosirai in Nandi district. On the other hand, the GT survey indicated that there were no zebu cattle in Maragua Division compared to 2,300 reported in the official records.

Table 4. Comparing Ground truthing survey cattle populations with Ministry estimates

District	Division	Dairy cattle population		Comparison Index (GT/MoLFD	Zebu cattle population		Comparison Index (GT/MoLFD
		GT Survey	MoLFD Estimates		GT Survey	MoLFD Estimates	
Maragua	Kandara	65,477	35,000	1.9	64	0	>1
	Maragua	33,876	12,790	2.6	0	2,300	<1
	Makuyu	1,672	5,320	0.3	629	1,600	0.4
Nakuru	Bahati	34,013	25,950	1.3	10,448	2,000	5.2
	Kuresoi	16,754	18,015	0.9	14,811	3,400	4.4
	Mbogoini	11,051	7,400	1.5	112,025	14,000	8
	Rongai	1,818	30,234	0.1	42,852	7,150	6
Nandi	Kaptumo	14,166	10,820	1.3	1,845	330	5.6
	Kilibwoni	58,940	61,020	1.0	729	0	>1
	Kosirai	41,788	33,130	1.3	341	0	>1
	Tinderet	20,044	8,750	2.3	18,625	14,370	1.3
Nyamira	Nyamira	34,870	6,814	5.1	18,716	5,500	3.4
	Manga	30,962	11,830	2.6	1,875	7,852	0.2
	Ekerenyo	45,007	2,600	17.3	9,161	3,704	2.5
	Rigoma	21,009	9,376	2.2	11,230	3,183	3.5
Vihiga	Sabatia	22,855	3,818	6.0	27,426	16,978	1.6
	Tiriki East	13,601	1,004	13.5	11,188	30,850	0.4
	Tiriki West	12,354	1,695	7.3	23,113	10,455	2.2
	Vihiga	13,922	2,059	6.8	19,676	20,680	1
	Mean			4			3

The mean number of dairy and zebu cattle in the farms were reasonably comparable between the GT and Characterization surveys in all the sample Districts except Nakuru. The inter-survey differences in mean size of dairy herd per farm appeared to be significant in Nyamira and Vihiga Districts, while those of the zebu cattle were significant in Vihiga. The average size of herds of dairy and zebu cattle in the various districts demonstrated the small-scale nature of cattle production activities in these parts of the country. On average, both surveys found the dairy herd size ranging from 2.0 to 4.8 animals per farm, while that of zebu was between 0 and 3.6 (Table 2 and 4).

Table 4 also compares estimated cattle populations based on the GT survey results and the corresponding MoLFD estimates. The index of comparison used was the ratio of the GT survey to MoLFD population figures and results show quite a large difference between two sets of cattle populations. The GT dairy cattle population is more than twice the corresponding MoLFD estimate in

more than half the sampled divisions and on average four times more than what is in the Ministry reports. This compares with the contrast observed earlier between the MoLFD estimates with the Characterization projections. The differences between the two sets of dairy cattle populations were highest in some divisions of Nyamira and Vihiga districts. Zebu cattle estimates by MoLFD in most of the sampled divisions also differed from the GT survey projections, with the former figures being mostly lower. On average, a division was found to have three times the number of zebu cattle reported by the MoLFD. The GT survey found zebu cattle in divisions (Kandara in Maragua District, and Kilibwoni and Kosirai in Nandi) where the Ministry had indicated none, while suggesting there were no zebu cattle in Maragua Division of Maragua District compared to 2,300 reported in the corresponding Ministry information.

Projections of cattle population in a district from the GT and Characterization data were generated by multiplying the total number of households in each district with the estimated proportion of households with cattle and the average number of cattle per household in the district. Tables 5 shows how the projected district populations from the two surveys compare between what is reported by the Ministry, using the ratio of the surveys' projections to the estimates.

Table 5 Comparing district cattle populations from the SDP surveys with the Ministry estimates

CHAR = Projections from Characterization surveys; GT = Projections from Groundtruthing survey; MoLFD = Estimates from Ministry reports

	Dairy cattle population						Zebu cattle population					
District	CHAR	GT	MoLFD	CHAR / MoLFD	GT / MoLFD	CHAR / GT	CHAR	GT	MoLFD	CHAR / MoLFD	GT / MoLFD	CHAR / GT
Maragua	136,116	136,649	79,850	1.7	1.7	1	0	6,312	3,900	0	1.6	
Nakuru	747,057	281,848	210,258	3.6	1.3	0.4	106,722	519,008	62,660	1.7	8.3	4.9
Nandi	454,459	373,059	232,370	2	1.6	0.8	66,275	65,366	34,430	1.9	1.9	1
Nyamira	133,998	148,712	50,684	2.6	2.9	1.1	38,285	46,046	31,416	1.2	1.5	1.2
Vihiga	110,986	95,843	12,726	8.7	7.5	0.9	170,179	124,245	119,534	1.4	1	0.7
Mean				3.7	3	0.8				1.6	2.9	

The findings from the two surveys more or less collaborate since both their ratios to the MoLFD figures are fairly close in all the districts except Nakuru. In addition, the ratios of the two survey's populations figures (i.e. Characterization populations divided by GT populations) are close to 1.0 in all the districts (except Nakuru) indicating that district populations projected from the two methods are nearly similar.
A similar trend is observed with zebu cattle populations.

In Nakuru the District Livestock Production Office pointed out that the sublocations sampled for the district were not likely to give a true picture of the cattle population and composition in the whole district. The district was much too large and quite diverse, and the numbers of sublocations selected for the district too few to be representative of the total district area. Figures 1, 2 and 3 shows the distribution of the sample sub-locations in Nakuru with reference to factors that could influence cattle population including PPE, household density, and cattle density based on the MoLFD figures.

Figure 1. Distribution of the sub-locations surveyed in Nakuru with reference to cattle density

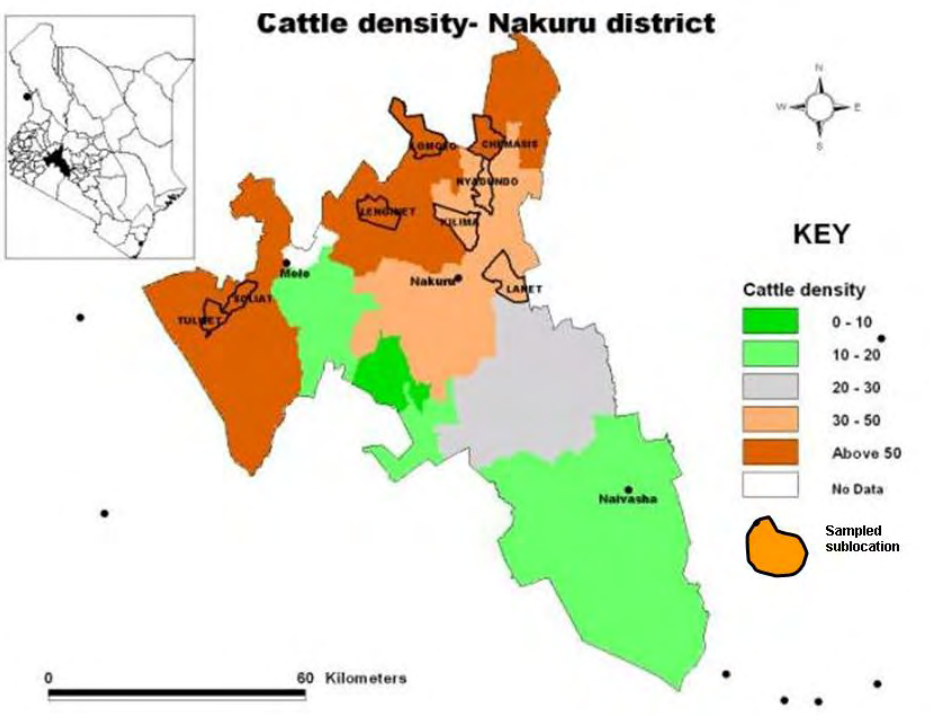


Figure 2. Distribution of the of the sub-locations surveyed in Nakuru with reference to household density

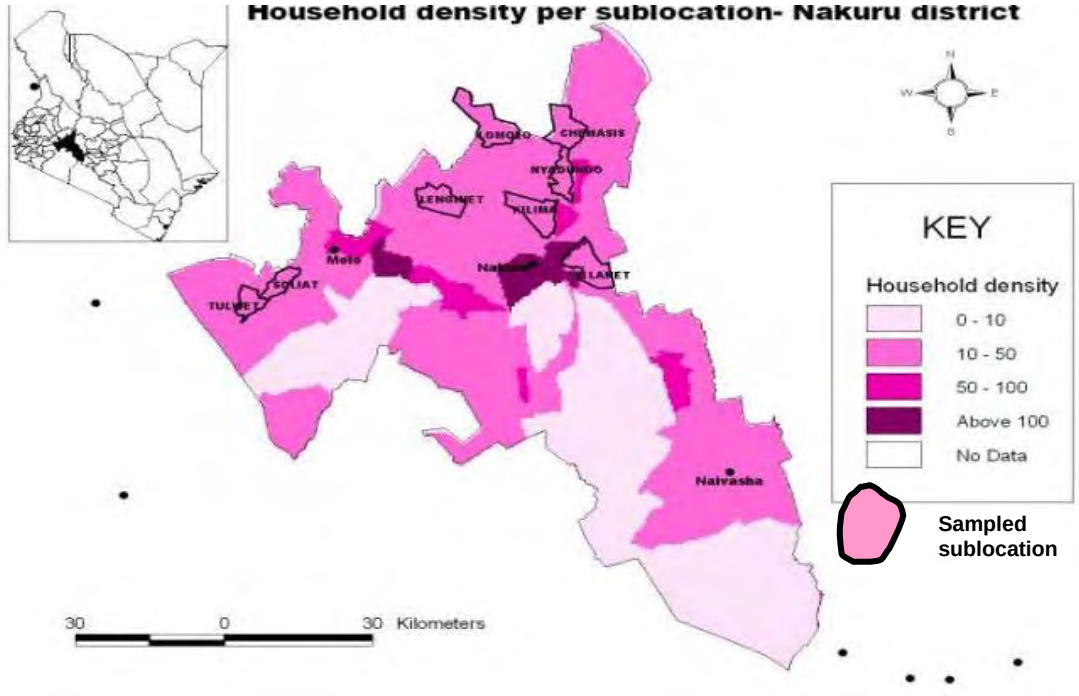
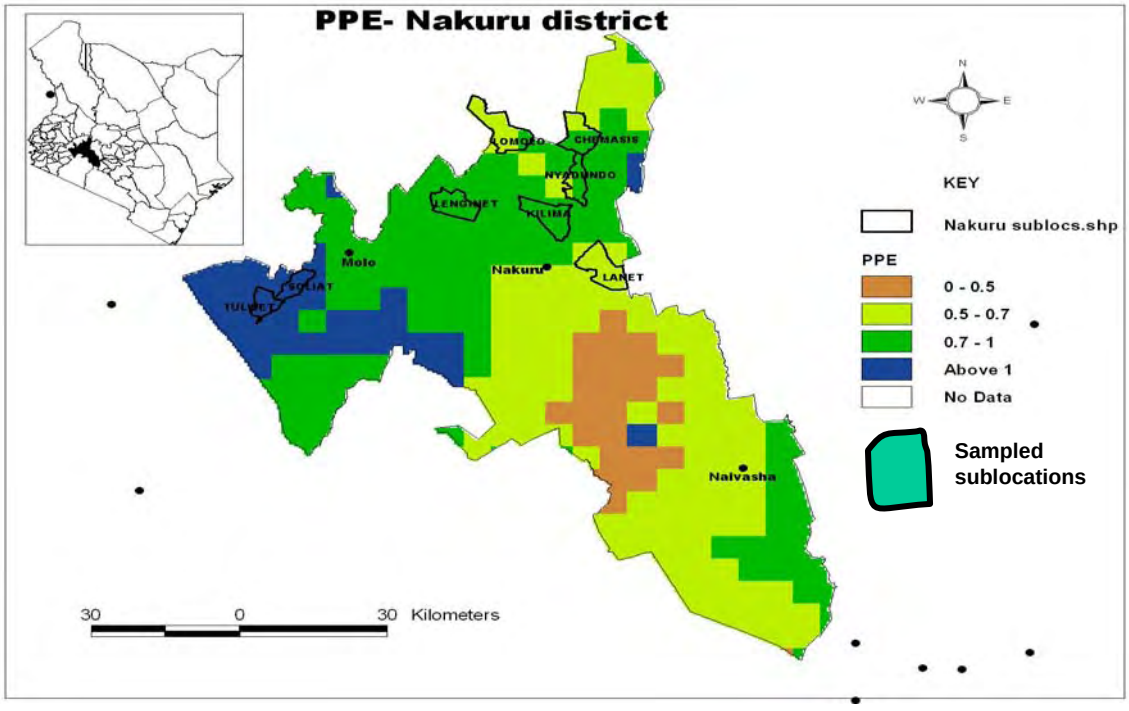


Figure 3. Distribution of the of the sub-locations surveyed in Nakuru with reference to agro-climate (PPE)



The distribution indicates that low rainfall and cattle density areas were not represented in the sample. An important lesson here is that it may be useful to characterize a region and use sampling procedures that ensure representative samples of sublocations and farms across the entire target area when conducting surveys to estimate cattle population.

2.4 Conclusions and Recommendations

The results from the GT survey are almost similar to the findings from the Characterization surveys, with projections resulting in higher cattle populations than those stated in the MoLFD reports. This discrepancy further confirms the possibility of inaccuracies in figures provided by the Ministry and calls for better ways of deriving more accurate populations. Or points to the need of detailed cattle census to generate more accurate information on national cattle herd sizes. The numbers so obtained can then be used by field agents as a baseline starting point for population estimation hen they apply rates of increase and decrease.

Since a comprehensive house-to-house livestock will require resources (funds, personnel and time) beyond what is normally allocated to the field offices, the sampling approaches used in the two surveys offer an alternative that may be relatively cheaper, quicker and relatively more reliable than the estimation methods currently used by Ministry staff.

3. Reviewing related data and reports

3.1. Introduction

Following the discovery of disparity of the cattle populations projected by SDP Characterization and 'groundtruthing' surveys when compared to Ministry estimates, supplementary analyses were carries out on more data and literature reviews. This was done to further establish if the differences from the official population figures and the findings from the two survey population estimations were valid.

3.2. Cattle populations vs. per capita milk production and consumption

The task was to compare per capita milk availability using cattle populations from GT projections and MoLFD estimates and compare these with per capita consumption (using data from the Characterization surveys) to see if the figures concur. The findings were then to be correlated with what is known about the direction of flow of milk supply in the districts. Traditionally, Nandi Maragua and Nakuru are known to be milk surplus districts. Vihiga falls in a milk deficient region of Western Kenya while Nyamira is known to be just self-sufficient.

3.2.1. Methodology

Per capita milk availability was calculated using the formula:

$$M_{pc} = \frac{\sum_i P_i \times C_i \times M_i}{HP}$$

Where:

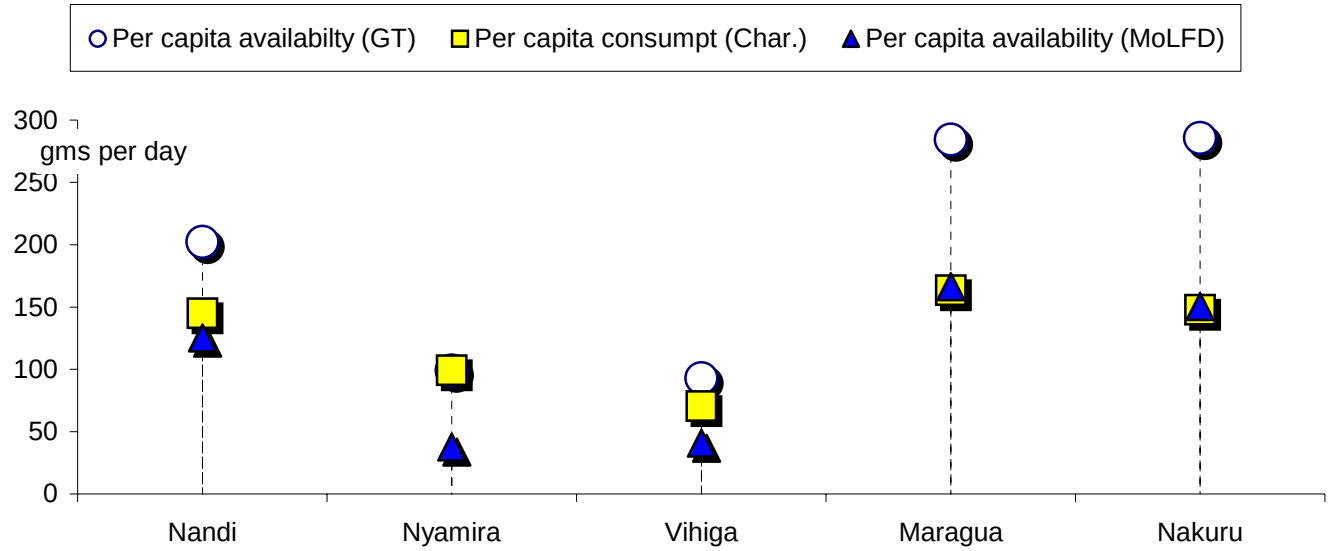
- M_{pc} = (Apparent) milk available per capita in a given district
- P_i = Cattle population (using GT projections or MOLFD estimates) of type i in the district
- i = Cattle types i.e. dairy or local
- C_i = Estimated proportion of cows in herds (Characterisation survey data)
- M_i = Estimated milk yield of a cow per year
- HP = Human population in the district ('99 census)

Milk availability was annualised using estimated milk yield per cow per lactation cycle which was calculated from standard lactation curves.

3.2.2. Results

The findings comparing expected milk production and per capita consumption are shown in Figure 4.

Figure 4. Comparing per capita milk consumption to availability: GT projections vs. Ministry estimates



The apparent GT milk per capita availabilities in Nandi, Maragua and Nakuru are higher than per capita consumption (by almost double in Nandi and Nakuru). This confirms the general milk surpluses observed in these districts. In comparison the MoLFD per capita availability is equal to consumption in Nakuru and Maragua but lower in Nandi. In Nyamira, the GT milk availability is about the same as consumption while the MoLFD based availability is less than half the per capita consumption. The Ministry population estimates suggest that the Nyamira is a major milk deficit area, contrary to reports (Waithaka *et al*, 2000) that indicate that the district is just about self sufficient in milk. In Vihiga district, the GT shows a higher availability than consumption milk contrary to the common observation that the district is a net milk importer from neighbouring districts such as Nandi. In Nyamira (where GT projects a cattle population 2.4 times the MOLFD estimates) the per-capita milk availability and consumption are equal as expected *apriori*, in line with lower productivities reported from the district (Ref cattle productivities in Characterization reports).

3.2.3. Conclusions

The MoLFD-based milk availability estimates are lower than expected in four of the five sample districts, confirming the GT findings that the official MoLFD population estimates in these districts could be lower than actual cattle population figures. While the GT- based results of milk availability fit well with the general direction of the flow in the milk supply in most of the sample districts, it is also possible that the results could be biased upwards. This is observed in Vihiga – a known milk deficit district. Unfortunately, any level of biasness of the GT cattle population projections can only be ascertained by milk availability and consumption if the inter-district milk flow volumes are known.

3.3. Predicting cattle populations based on expected growth rates and mortalities

The expected cattle population was worked out from rates of natural growth and mortalities applied to known cattle population figures. This method was used earlier by Omore *et al*, 1997, based on the cattle populations recorded in 1986, to predict the population in 1996.

3.3.1. Methodology

This methodology was used to estimate the 2001 cattle population from the 1996 figures using the rates adopted from Omore *et al* (1997). These included an initial rate of growth of the dairy herd of 5% which decreases at a rate of 0.10% per annum. A stable rate of growth of 1.1% per year was assumed for the local zebu herd. These rates of growth had been determined from herd dynamics between 1986 and 1996 using data from MoLFD reports. The cattle population figures in base year 1996 are used because some attempts had been made to verify cattle populations in numerous districts around the same time.

$$Z_{2001} = Z_{1996} \left(\left(1 + Z_{gr} \right) \right)$$

$$D_{2001} = D_{1996} \left(\left((1 + D_{gr}) - \left(I \times D_{dec} \right) \right) \right)$$

Where (for each district):

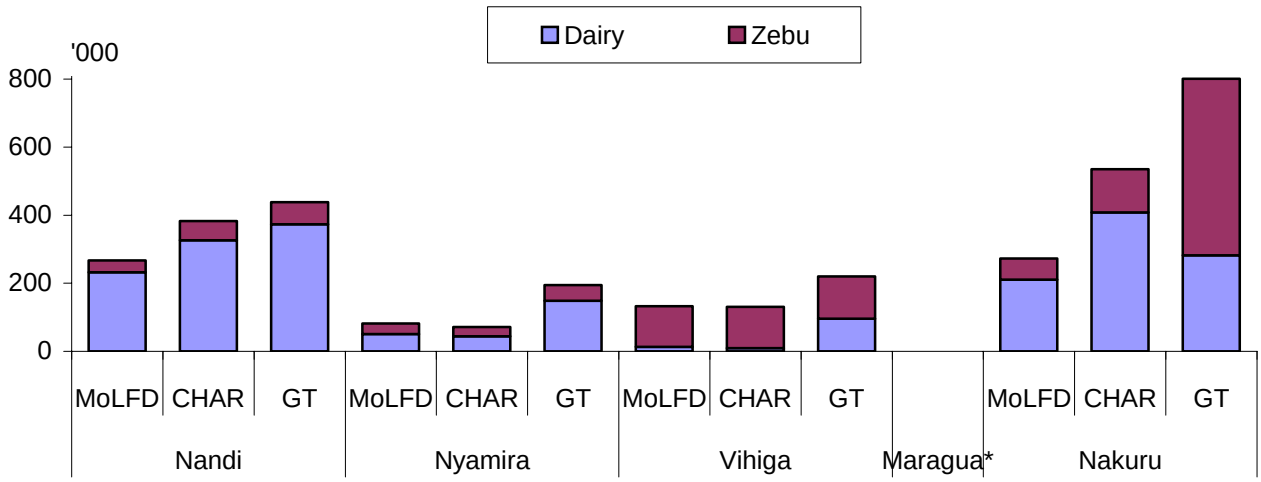
Z_{2001} = Projected number of zebu cattle in the year 2001
D_{2001} = Projected number of dairy cattle in the year 2001
Z_{1996} = Zebu cattle population in 1996
D_{1996} = Dairy cattle population in 1996
D_{gr} = Dairy herd growth rate = 5.0%
Z_{gr} = Zebu herd growth rate = 1.1%
D_{dec} = Decrease in dairy herd growth rate = 0.10%
I = Number of years 1996 to 2001

3.3.2. Results

A comparison of the calculated cattle numbers, the official estimates and the GT projections revealed no consistent trend across the different districts (Figure 5). The projected cattle numbers based on the Omore method compared fairly well with the GT figures in Nandi but not in Nyamira and Vihiga where they better well with the official figures. In Nakuru, the three sets of figures showed wide discrepancy.

Figure 5. Comparing predicted cattle populations using expected growth rates and mortalities

(CHAR = Projections from Characterization surveys; GT = Projections from Groundtruthing survey; MoLFD = Estimates from Ministry reports)



* Maragua did not exist as a separate district in 1996.

3.3.3. Conclusion

There was no consistent trend on the expected populations using base figures from the SDP surveys and Ministry estimates. Drawing any firm conclusions from this analysis was constrained by the uncertainty of the accuracy of the base populations assumed. This is because the Ministry updates conducted around 1995 did not cover the whole country and their method of implementation was not uniform. This would make the 1996 base year figure an assumption.

3.4. Review existing reports on actual cattle populations

3.4.1 Methodology

The task was to review recent population estimates or surveys carried out by other (institutions) and compare them with Ministry estimates of the time. The team was also to consider the methodologies used in the surveys and estimations.

3.4.2 Results

A detailed search for any nationwide census in related government offices did not yield any evidence of a livestock census recent or in the far past. There was mention of a livestock census that was carried out in 1962 and a survey in 1969 but no record of such an exercise and its results have yet been found. The sole source of livestock populations in Kenya is the Ministry. World development bodies like FAO and The World bank have only on a few occasions used surveys in a few select areas to update and strengthen the estimates provided by the Ministry reports.

At much lower scales an actual census was conducted in Githunguri division of Kiambu and a census survey in Busia (72%) and Teso (58% of '99 National total households). Table 6 shows the censuses or surveys and their findings compared to the Ministry estimates reported just before each survey.

Table 6. Comparing Ministry estimates and findings from other population surveys

District, Division	MoLFD reported figures (before survey)		When census was done and by who	Census findings	
	Dairy	Indigen.		Dairy	Indigen.
Githunguri, Kiambu	42,684	1,670	MoLD in 2001	35,540	0
Busia district	5,500	126,684	FITCA in 2000/2001	2,371	198,765
Teso district	1,319	25,481	FITCA in 2000/2001	1,709	31,647
Taita Taveta district	33,800	101,030*	SDDP or HPI in 1998	12,330	106,600*

* Not clear if the census included the indigenous herd.

It is clear that where they have been conducted, cattle population censuses and surveys have found numbers at variance from MoLFD estimates. In Githunguri, the census conducted by Ministry personnel found that there was actually fewer cattle in the division than the official figures indicated. This included the revelation that there were no zebu type cattle contrary to what was indicated in the reports. Conversely, the survey by FITCA between 2000 and 2001 indicated that there was actually more cattle (both dairy and zebu) in Teso district and less dairy but more zebu cattle in Busia District.

3.5. Ministry methods of estimating cattle numbers

Discussions with various government officers on the methods employed to estimate cattle populations in their areas revealed that there was a lack of resources to do a thorough and detailed count of all livestock in their jurisdiction. The staff workers employ methods that they hoped give them closest estimates to the actual.

In all cases they relied on a presumed base figure from which they adjusted annually (or monthly) using arbitrary rates of increase or decrease as a result of births, migrations and mortality. In many cases the base figures were captured during free or compulsory disease vaccination campaigns or from dipping registers maintained by the Veterinary department. These rates of adjustments were not uniform across the country and even in the same district. They were based on knowledge of area, events or situations that influenced livestock populations thus relying much on individuals' perceived trends. In some cases a mini-census exercise may have been conducted by NGOs operating in a small section of the area (location or division) and the results then used to estimate the number in the rest of the district.

All in all, all the Ministry staff interviewed acknowledged that the projected base figures and rates of increase and decrease were mere guesstimates and not quite reliable.

4. Cattle Census in selected sublocations

4.1 Introduction

The 'ground-truthing' sampling procedure employed in predicting livestock populations in a division or district was to be further validated through an actual census in selected areas. Thus the objective of the cattle census was to carry out a house-to-house census to assess the accuracy of cattle population projections earlier made using the cattle ground truthing (GT) survey data. The results would be used to indicate the appropriateness of the GT methodology in appraising cattle populations and also show whether any modifications are needed to fine tune the formula.

4.2 Methodology

Three sub-locations, each from Vihiga, Nakuru, and Maragua districts were selected from a list of fifteen where both the Characterization (Char) and GT surveys had been conducted. The sublocations were also selected based on the clusters they fell into relation to differences in agro-ecological zones (AEZ), market access and farming systems (Box 1).

4.3 Findings

The three sublocations selected for the census had some unique features, though the cattle production systems in all tended to be similar (Box 1).

Box 1. Main features of the sublocations selected for the sublocation census to verify the groundtruthing results and findings

Magui Sub-location , Vihiga District

Magui sub-location covers a small area of about 3.7km^2 and is predominantly comprised of small sized family farm holdings. The sub-location is located in the milk deficit region of western Kenya. Milk/cattle production is mainly geared towards subsistence with many of the households keeping one to two cows, mainly the local zebu breed. The sublocation had a total 1,000 closely placed farms. This was about 30% more households than had been counted during the 1999 census, the increase largely attributable to the natural growth rate in human population.

Kilima Sub-location, Nakuru District

Kilima is fairly big covering about 56.4km^2. The farms are structured along the original large-scale farms and together define the sub-location. These farms include both small-scale farms (keeping 3 – 5 cattle) and large-scale farms (keeping more than 10 cattle, and in a few cases 30–80 heads). Zero-grazing is the predominant system of livestock production in the small-scale farms and some farmers graze their animals away from their homes e.g. in roadsides and a neighbouring government forest reserve. The breeds of cattle kept are mainly high-

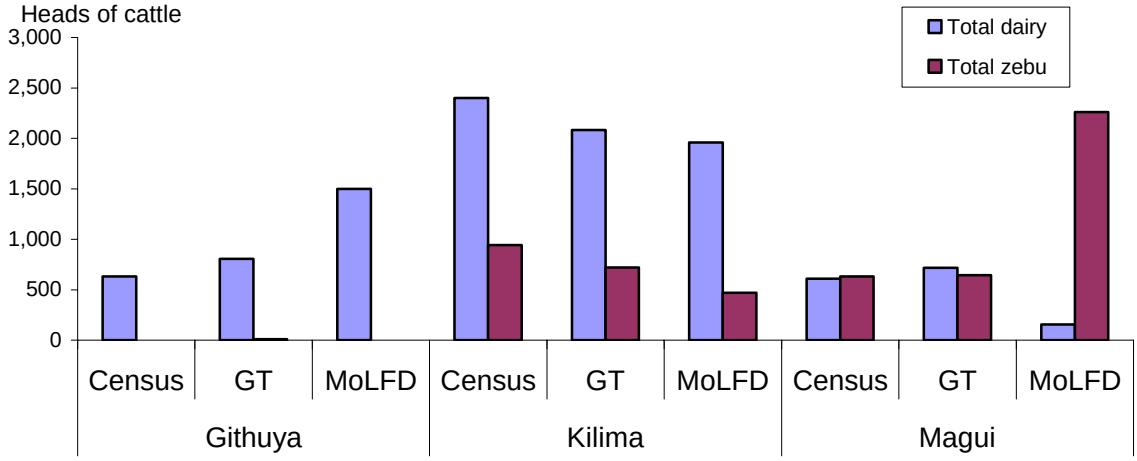
level grade types. The reserve (the Menengai Crater) has been inhabited by nomadic pastoralists for the last 20 years. The 2,200 households visited in the sublocation were 13% more than reported in the 1999 census.

Githuya Sub-location, Maragua district

Githuya is also a small sub-location covering about 3km^2. Farm holdings are mainly small, with intensive zero-grazing systems. The type of cattle is almost exclusively high-level crosses to pure grades, mostly Friesians. A total 493 households were visited, an increase of about 10% from the 1999 Census figure.

Figure 6 compares actual cattle populations from the mini census with the GT survey projections. The projected numbers of cattle compared well with census figures with ratios of the census to the projected numbers averaging nearly unity in all the cases. In Magui sublocation, the Ministry estimates were quite contrasting with the census and SDP Projections.

Figure 6. Comparing cattle census in three sublocations with Ministry estimates and GT figures.



The results confirm that cattle population can be derived using projections based on random sampling methods employed by the Characterization and GT approach. However, note that the farmers in these districts are quite sedentary and have small sizes and production systems that are typical to the highlands of Kenya where human densities tend to be rather high. The sampling procedure for estimating cattle populations may thus only be suitable to regions similar, that is the Kenyan highlands.

The census was only carried out only in three sublocations which was rather low for carry out any meaningful analysis of differences between the methodologies. However, the cattle populations projected by the GT sampling method comes close to what the actual census found when compared to the Ministry estimates.

4.4 Conclusion

The census results lead us to two conclusions. The figures obtained by the Characterization and groundtruthing projections, though more or less similar, are quite contrasting from the Ministry estimates confirming that the later reports are at variance with what be actual numbers. The GT projections of cattle populations come close to the actual census figures, implying that the sampling approach used in the Characterization and groundtruthing surveys can be applied to derive better estimates of cattle numbers in an area.

5. National implications and policy recommendations

5.1 Introduction

The results from the preceding surveys, data analyses and reviews indicate a degree of uncertainty with the officially reported populations provided by the Ministry. In particular, there are possibilities that there could be more dairy cattle than are officially reported. On a national scale this has implications on other derived parameters on livestock production such as supply of livestock products and the contribution of the livestock sector to the national GDP. To explore this situation, an attempt was made to estimate the country's cattle population using data sets from all the surveys conducted by SDP.

5.2 Methodology

The objective of this exercise was to estimate the national herd by dividing the entire country into clusters of similar sublocations and using Characterization or GT data from representative sublocations.

Three key factors have been found to affect dairy cattle distribution in Kenya. These are human population density, climatic potential - using potential evapo-transpiration (PPE) as an index – and market access. All the rural sub-locations in Kenya were clustered into eight groups of homogenous sub-locations using varying scales of these factors. SDP characterization survey data was used to estimate the proportion of households with cattle and the mean number of cattle pet per households, first averaged out across the sampled sub-locations within a cluster, then at the cluster level.

Table 7 presents the results of the clustering of rural sub-locations based on the levels of the human population densities and market access (relative time taken to travel to nearest market point).

Table 7. Clusters of rural sub-locations on the basis of human density, agro climate and market access

Cluster	Human pop density	PPE	Travel time	Total number of sub-locations in Cluster	Proportion of sublocations in Custer to Total	Number (and %) of surveyed sub-locations in each Cluster
000	0	0	0	335	5.45	13 (5)
001	0	0	1	1,986	32.32	9 (3)
010	0	1	0	389	6.33	16 (6)
011	0	1	1	359	5.84	6 (2)
100	1	0	0	527	8.58	43 (15)
101	1	0	1	210	3.42	1 (0)
110	1	1	0	1,829	29.77	172 (62)
111	1	1	1	509	8.28	19 (7)
Total				6,144		279 (4.5% of total)

0 indicates low values, i.e. low human pop density, low PPE, short travel time (i.e. high market access)
1 indicates high values, i.e. high human pop density, high PPE, long travel time (i.e. low market access)

The total number of cattle in a cluster was estimated as the product of total number of farm households' in the cluster, the estimated proportion with cattle and the estimated mean number of cattle kept per households with cattle. The estimated total number of cattle was then summed up across clusters to give an estimate for the total number of dairy cattle in the country, especially in the highlands where most of the clusters were found.

5.3 Results and implications on national cattle herd, milk availability and consumption

The results revealed that there are about 1.8 million smallholder farm/households in the areas that largely characterize the highest dairy production zones in the country – the Kenyan highlands. These households own or keep about 6.8 million dairy cattle made up of 2.8 million high grade types or breeds and 4 million crosses (Table 8). The zebu herd in these farms stands at about 3.7 million. Note that the larger zebu herd in the country is found in the drier zones, especially with the pastoralists in the ASALs. The important finding from this exercise is that the projected number of dairy cattle could be more than twice the officially reported national population figure of about three million dairy cattle.

Table 8. Projected cattle numbers and milk production in the Kenyan highlands

	High grade	Crosses	Zebu	Total
Cattle numbers (millions)	2.77	4.01	3.71	10.49
Milk production (million litres/year)	1,934	1,933	179	4,046

Based on the estimated dairy and zebu cattle populations and milk production levels from these cows, it was estimated that total milk production in the rural highlands is about 4 billion litres per annum. The rural areas have an estimated population of about 14.5 million people. Assuming that the estimated 9.6

million people living in the urban areas mainly depend on milk from the high potential areas, and that 13 percent of the milk produced goes to calf feed or spoilage (Omore *et al*, 1999 and Lore *et al*, 2005) milk availability from the highlands was estimated to be about 145 litres per person per year. Previously, milk consumption in central and Rift-valley provinces, which are important milk production areas, has been estimated to be 152 and 144 litres per person per year. However, the estimated per capita consumption in other provinces is much lower, mostly ranging between 38 – 54 litres of milk per person per year.

5.4 Conclusions

The country's dairy cattle are mostly found in highlands which receive relatively high rainfalls and have good (milk) market access. The total dairy cattle herd could be close to 7 million head of dairy cattle types, which is twice more than what is officially recorded by Ministry reports. These cattle are kept by about 1.8 million rural small sub holdings or farms.

These results further confirm the uncertainty of the country's cattle population, pointing to an urgent need to carry out a more comprehensive enumeration exercise. The larger cattle populations are likely to show the country produces more milk than is officially recognized and milk availability and consumption levels could be different from what is officially known. Given that livestock populations are part of what is used to determine the country's economy a detailed census of cattle (and other livestock species) will be very useful in establishing a more accurate degree of the contribution the sector makes to the national GDP.

6. Other Outputs

6.1 The policy brief

The work of analysing SDP survey data on cattle populations and their deviations from the official supplied led to the development of a Policy brief entitled "*The Uncertainty of Cattle Numbers in Kenya*". The brief is part of a series of similar outputs by SDP and is targeted at policy makers and other related players in the livestock sector. The brief summarises all findings described in the preceding chapters, highlighting the uncertainty of cattle populations in the country. Key points have been extracted from the various SDP studies detailing the discrepancy between projections from surveys and the officially reported populations. There are also summaries of support findings mentioned in this report, and implications of the inaccuracy on the populations of particularly dairy cattle.

The message is that until a way of establishing the exact number of cattle (and possibly all other livestock) in the country is found, the many parameters that use the official population reports could be off the mark, and downplaying the role of livestock in the national economy.

6.2 A cattle counting manual and poster

Results from the Characterization and 'Groundtruthing' surveys lead to the development of the sampling methodology into a procedure that could be used by field officers to make better approximations of cattle populations in their assigned areas. This approach is specifically designed for highlands and high potential districts of Kenya where livestock production occurs mainly on numerous small farms with more or less permanent settlement.

The procedure is described in details in a booklet (Nyangaga *et al*, 2005) that will be distributed to all Ministry of Livestock field offices but can be obtained from the SDP Offices and the Ministry Headquarters, Hill Plaza. The procedure has also been summarised graphically on a poster for display as well as a teaching aid when training the about methodology.

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