

## SHORT REPORT

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# Livestock herd structures and dynamics in Garissa County, Kenya

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## Abstract

In Kenya's Northeastern Province, pastoralism is the main livestock production system and means of livelihood. However, pastoralists are facing increasing risks such as drought, insecurity, animal diseases, increasing human populations and land fragmentation. This study sought to evaluate household livestock herd structures and dynamics in view of such risks and subsistence and market demands. The study was conducted in Garissa County of Kenya, using a cross-sectional household survey. The data was analysed for descriptive statistics of household livestock status, dynamics and demographic parameters. The results showed that females of reproductive age formed over 50 % of all livestock species. Cattle had the highest turnover and all species' mortalities accounted for the greater proportion of exits. Cattle had the highest multiplication and growth rates, but also the highest mortality, offtake, commercial offtake and intake rates. Goats had the lowest mortalities, offtake, commercial offtake and intake rates. Overall, the herds were structured to provide for both immediate and future needs in terms of milk, sales and herd replacement as well as for rapid recovery after disasters. The livestock herd dynamics indicate efforts at culling, restocking, retention of valuable categories of animals, and natural events. Livestock populations would be annihilated over time if the trends in end balances and negative growth rates were to continue and not be interrupted by the upward phases of the livestock cycles. It was recommended that the Government and development partners should undertake interventions to balance the herd dynamics in favour of entries by improvement of reproduction and reduction of mortalities, and support livelihood diversification to reduce dependence on livestock.

**Keywords:** Demographic, Distribution, Entries, Inventory, Livestock, Structures

## Background

In Kenya's Northeastern Province, pastoralism is the main means of livelihood and livestock trade consists of indigenous livestock of local and cross-border origin. However, there is worldwide concern on the conservation and utilization of these breeds which are also an important source of genetic diversity that can be used for disease resistance and for coping against climate change (FAO 2007). Aklilu et al. (2002) and Pavanello (2010) reported that growing financial pressures, food insecurity and frequent droughts are increasingly pushing pastoralists to sell more animals than before and regardless of productivity, age or sex.

Galaty and Aronson (1980) cited the impact of external changes and altered constraints on traditional range practices, the effects of consumer preferences on herd structures and the significance of increased use of the market as some of the pastoralist research priorities. Bailey et al. (1999) noted that variability in herd structures in the Horn of Africa has not been documented in the past and the factors responsible have not been explained though they are suspected to influence availability of market meat animals. The National Livestock Policy (Government of Kenya 2008) documented that the country is currently not self-sufficient in beef and mutton and recommended that appropriate interventions be put in place to avoid deficits in livestock products. This study therefore clarified the livestock herd dynamics and contributing factors.

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**Study area**

The study was undertaken in Garissa County in northeastern Kenya, where pastoralism is the main livestock production system and means of livelihood. Garissa County lies between latitude 1° N and 2° S and longitude 39° E and 41° E and borders Somalia to the east, Wajir County to the north, Isiolo County to the north-west, Tana River County to the west and Lamu County to the south. The County lies at an elevation of 1,138 m above sea level, the area topography is flat and the climate is semi-arid to arid (agro-ecological zone (AEZ) IV-VI). A map of Kenya showing the Arid and Semi-arid Districts is shown in Figure 1.

The annual rainfall ranges from 300 to 700 mm in two seasons, long rains in March to May and short rains in October to December, often in isolated heavy downpours. Maximum daily temperatures range from 34 °C between June and August to 38 °C in February and March. The climate is thus hot and dry with high rates of evapo-transpiration, interspersed with occasional flooding in poorly drained areas.

Garissa County has an area of 44,952 km<sup>2</sup> and a human population of 623,060 (Kenya National Bureau of Statistics 2010). The inhabitants are pastoralists and agro-pastoralists keeping camels, cattle, sheep, goats and donkeys and doing some crop farming along the river Tana. The County is the immediate catchment for Garissa livestock market which is the largest in East Africa and serves to supply livestock for both the local market and export.

**Methods**

**Data collection**

One hundred forty-six (146) respondents were interviewed in a cross-sectional survey undertaken in July 2012. Interviewed households were selected from the County using multi-stage cluster sampling technique with random sampling at each level. The calculated sample size was 138 from the formula by Pfeiffer (2010).

The formula:

$$n = Z^2 [p(1-p)/L^2]$$

where

*n* = the sample size;

*Z* = 1.96, the standard normal deviate at the desired confidence interval, 95 %;

*p* = 0.9 (90 %), the assumed proportion (prevalence) of the households who own livestock and engage with the other segments of the value chain;

*L* = 0.05 (5 %), the precision.

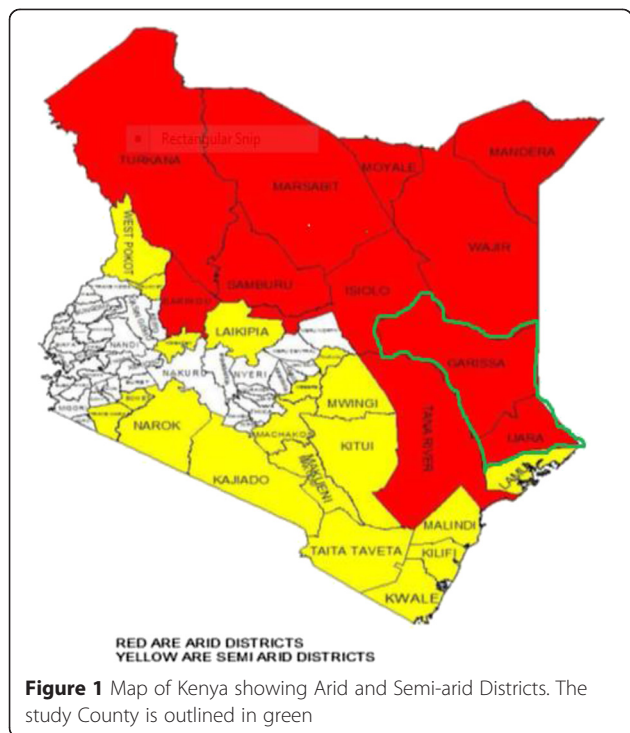
The calculation of the sample size is shown below.

$$\begin{aligned} \text{Sample size} &= 1.96^2 [0.9(1-0.9)/0.05^2] \\ &= 3.84[0.9(0.1/0.0025)] \\ &= 3.84[0.9(40)] \\ &= 3.84[36] \\ &= 138.24 \end{aligned}$$

The method was applied with the objective of getting at least 144 completed questionnaires using eight enumerators. Three Districts were randomly selected from among five out of seven in the County in the first stage. Two Districts, Fafi and Dadaab, were left out due to security reasons. Three Divisions were randomly selected, one from each of the three Districts, in the second stage and nine locations, three from each Division, in the third stage. Sixteen households were then selected from each of the nine locations by roughly dividing it into imaginary quadrants. Eight enumerators interviewed two randomly selected households in each quadrant daily.

The nine locations selected were Dujis, Jarajara and Balambala in Balambala Division, Balambala District (48 households); Saka, Raya and Shimbir in Sankuri Division, Garissa District (51 households); and Hara, Masalani and Korisa in Masalani Division, Ijara District (47 households). Figure 2 shows an illustration of the multi-stage cluster sampling while Figure 3 is a map of Kenya showing Garissa County and the study areas Balambala, Sankuri and Masalani Divisions.

Data on the herd structures and changes was collected using the retrospective 12-month approach discussed by Lesnoff et al. (2010) which depends on the respondents' recall of events of the preceding 12 months. The



**Figure 1** Map of Kenya showing Arid and Semi-arid Districts. The study County is outlined in green



respondents were asked questions on their livestock inventory and the transactions and changes over the preceding 12 months.

### Data analysis

The data was entered into Microsoft Excel 2007 and Statistical Package for the Social Sciences (SPSS) 18 and analysed for descriptive statistics of the livestock inventory and herd structures; herd status and changes, entries and exits; and demographic parameters.

## Results

### Livestock inventory and herd structures

The study area household livestock inventory and herd structure by species, age and sex categories are shown in Table 1. Goats came first, in proportions of total herd size, followed by cattle, sheep, camels and lastly donkeys. Females formed the greater proportion of herds in all species. However, the ratio of males to females was higher than would be expected for purposes of breeding alone. The age trend in male cattle (younger more in herd than older) also contrasted that in females where the older and therefore of proven performance formed

the larger proportion. There was a small steers to males ratio in cattle and a relatively high proportion of young stock in all species.

### Household livestock herd dynamics

Table 2 shows the livestock entries and exits by species, sex and age. Exits were more than entries in all species. Cattle had the highest turnover followed by goats, sheep, camels and then donkeys.

In all species, sex and age categories, purchases accounted for the greater proportion of entries followed by births, then in-donations. Mortalities accounted for the greater proportion of exits, followed by sales, out-donations, consumptions and unexplained losses in that order. In all the entry and exit events combined, purchases came first, followed by deaths, sales, births, out-donations, in-donations, consumption and lastly unexplained losses. End balances were negative except for camel female calves, cattle males of 1 to 3 years of age, cattle females of 3 to 6 years of age, cattle female calves, lambs, kids and donkeys.

Table 3 shows variables of the herd that describe their state at the time of the study and over the preceding 12 months. The variables are used to calculate the

**Table 1** Households' livestock inventory and herd structures by species, age and sex

	N <sup>a</sup>	Min.	Max.	SD	Mean	% of total	% of categories
Adult male camels	42	1	22	4.5	4.5	20.2	Ratio of males to females 1:3
Adult female camels	55	1	50	12.8	11.7	52.5	
Camel male calves	26	1	13	2.4	2.7	12.1	All calves 27.3 % of camels
Camel female calves	34	1	16	3.1	3.4	15.2	
<i>Total camels and % in herd</i>					22.3	10.5	
Steers	5	1	6	2.0	2.8	3.9	Ratio of steers to other males 1:8; Ratio of reproductive males to reproductive females 1:2; Reproductive females 37.2 % of cattle All calves 13.8 % of cattle
Entire males >6 years	47	1	50	9.7	7.0	9.9	
Entire males 3 to 6 years	51	1	30	7.5	7.5	10.6	
Entire males 1-3 years	49	1	70	13.2	8.2	11.5	
Cows >6 years	83	1	180	31.3	16.5	23.2	
Cows 3 to 6 years	66	1	56	12.3	9.9	13.9	
Female cattle 1 to 3 years	48	1	103	17	9.3	13.1	
Male calves	47	1	46	7.3	4.5	6.3	
Female calves	46	1	69	10.4	5.3	7.5	
<i>Total cattle and % in herd</i>					71	33.4	
Ewes	102	1	236	34.9	21.2	55.9	All lambs 24.8 % of sheep; ratio of rams to ewes 1:3
Rams	86	1	102	13.1	7.3	19.3	
Lambs	95	1	126	15	9.4	24.8	
<i>Total sheep and % in herd</i>					37.9	17.8	
Does	137	1	350	60.0	50.1	63.1	All kids 19.6 % of goats; ratio of bucks to does 1:4
Bucks	125	1	128	20.3	13.7	17.3	
Kids	130	1	113	15.7	15.6	19.6	
<i>Total goats and % in herd</i>					79.4	37.3	
<i>Donkeys and % in herd</i>	76	1	14	2.3	2.2	1	
<i>Total herd</i>					212.8	100 %	

<sup>a</sup>N is the sub-sample size and differs between species and categories because such owning households are less than the sample size of 146. The numbers also reflect the frequency of ownership. Values in italics indicate the sub-totals of the categories above

**Table 2** Mean annual number of livestock entries and exits by species, sex and age

Species	Sex	Age	Entries				Exits						End balance
			Born	Bought	Given	Total	Sold	Gave	Ate	Died	Lost	Total	
Camels	Males	Adults		1	1	2	2.5	1	1	1.7	0	6.2	-4.2
		Calves	1.8	0	0	1.8	1.8	1	1.3	2	0	6.1	-4.3
	Females	Adults		2	3.7	5.7	1.9	1.3	1	3.2	1.5	8.9	-3.2
		Calves	2.3	3	0	5.3	1	1.5	0	2.3	0	4.8	0.5
Cattle	Steers	≥6 years		0	0	0	1.7	0	0	0	0	1.7	-1.7
		3 to 6 years		2.6	1	3.6	2.8	1.8	1	2.1	1	8.7	-5.1
	Males	1 to 3 years		6.7	1	7.7	2.4	1.5	1.5	2.4	0	7.8	-0.1
		Calves		13.5	1	14.5	1.7	1.8	1	2.4	1	7.9	6.6
		Calves	4.4	0	0	4.4	6	0	0	1.9	0	7.9	-3.5
	Females	≥6 years		2	1.6	3.6	1.6	3.3	1	5.1	0	11	-7.4
		3 to 6 years		10.6	1	11.6	2.6	1.5	0	3.7	1	8.8	2.8
		1 to 3 years		0	1.3	1.3	1.4	1.5	0	2.8	0	5.7	-4.4
Calves		4.9	3	0	7.9	0	0	0	1.6	0	1.6	6.3	
Sheep	Rams		3.2	1.7	4.9	4.1	1.4	2.2	4.1	1	12.8	-7.9	
	Ewes		3.7	3	6.7	3.4	1.9	1.8	4.3	3.3	14.7	-8	
	Lambs	7.1	1	0	8.1	0	1	1.5	4.3	0	6.8	1.3	
Goats	Bucks		8.4	2.3	10.7	6.3	1.9	2.8	5.5	3.8	20.3	-9.6	
	Does		7.6	3	10.6	3.8	2.8	2.5	5.2	3.5	17.8	-7.2	
	Kids	10.1	0	0	10.1	1.3	2	1.8	4.2	0	9.3	0.8	
Donkeys		2	1.4	1.9	5.3	1.8	0	N/A	1.4	1	4.2	1.1	

Values in italics indicate the sub-totals of the categories above

overall demographic indicators, in Table 4, which summarize the herd dynamics and production over the year. Cattle had the highest multiplication and growth rates followed by goats, sheep, then camels in that order. Cattle also had the highest mortality, offtake, commercial offtake and intake rates. Goats had the lowest mortality, offtake, commercial offtake and intake rates.

## Discussion

The bias towards females seen in the herd structures, also discussed by Bailey et al. (1999) for other pastoral areas,

ensures adequate provision of milk, an important source of food and income, and continued reproduction of replacement stock for rapid recovery after drought, disease or other disasters. However, in cattle, the high males to females ratio and the contrasting age trends between males and females suggest that young males were the herd fraction that was accumulated at the risk minimization stage, to be sold later at the risk absorption stage, when efforts are made to sustain the most valuable animals while selling the less valuable (Rota and Sperandini 2009).

The small steers to males ratio in cattle shows that castration is not a common practice in this pastoral

**Table 3** Aggregate herd status and changes per species in Garissa County, Kenya (These figures are used in the calculation of demographic rates in Table 4 below)

Variable/species	Camels	Cattle	Sheep	Goats
Mean herd size, at the date of survey	7.1	30.5	24.9	75.2
Mean entries	14.8	54.6	19.7	31.4
Intakes	10.7	45.3	12.6	21.3
Mean exits	26	61.1	34.3	47.4
Offtakes	15.3	36.1	17.3	27
Mean sales	7.2	20.2	7.5	11.4
Mean herd size, 12 months ago	18.3	31.5	39.5	91.2
Mean herd size over the year	12.7	31	32.2	83.2

Herd size 12 months ago = size at the date of survey – entries + exits. Intakes = purchases + in-donations. Offtakes = sold + out-donated + consumed. Assume mean herd size over the year = (herd size to date + herd size 12 months ago)/2. Intakes are entries without births; offtakes are exits without mortalities and unexplained losses. Thus, intakes and offtakes are deliberate management entry/exit events

**Table 4** Overall livestock demographic indicators by species

Variable/species	Camels	Cattle	Sheep	Goats
Annual multiplication rate (herd size at the date of survey/herd size 12 months ago)	0.39	0.97	0.63	0.82
Annual population growth rate (annual multiplication rate - 1) * 100	-61 %	-3 %	-37 %	-18 %
Annual production rate ( $P/N$ )	-0.5	-0.3	-0.3	-0.1
$P$ = (herd size at the date of survey - herd size 12 months ago) + (number of offtakes over the year - number of intakes over the year) $N$ = mean herd size over the year				
Annual mortality rate(probability or hazard rate for an animal to die a natural death = (number died in 12 months/herd size 12 months ago) * 100)	50 %	69 %	32 %	16 %
Offtake rate(probability or hazard rate for an animal to exit the herd as offtake = (offtake/herd size 12 months ago) * 100)	83.6 %	116.5 %	43.8 %	29.6 %
Commercial offtake rate (sales/herd size 12 months ago) * 100	39.3 %	64.1 %	18.9 %	12.5 %
Intake rate(probability or hazard rate for an animal to enter the herd as an intake = (intake/herd size 12 months ago) * 100)	58.5 %	143.8 %	31.9 %	23.4 %

subsistence production. The practice is probably used as a breeding rather than a marketing tool since the greater number of the entire males enhances the reproductive potential of the herd. The high proportion of young stock in all species suggests a high birth rate or low pre-weaning mortality.

It is difficult to determine definite trends from the livestock herd dynamics, but one can discern efforts at culling, restocking, retention of valuable categories of animals, natural events and sometimes action that apparently had no clear explanation. However, Pavanello (2010) reported that, due to livelihood pressures, pastoralists were selling more animals than before and regardless of productivity, age or sex. Thus, there were higher entries for males than females in cattle and goats and sales were distributed among all age groups of all species including animals at their prime and valuable categories such as cattle females of 3 to 6 years of age and calves and kids.

The findings on the end balances and the negative growth rates indicate that the livestock populations would be annihilated with time if the trends were to continue and not be interrupted by year-on-year differences in population dynamics, especially the upward 'boom' phases of the livestock cycles discussed by Scoones (1996) and Bailey et al. (1999). The multiplication and growth rates are less than 1 reflecting the decrease in all species' herd sizes over the 12 months.

The herd dynamics result from the natural performance of the herd and those related to the owners' decisions, management objectives and livelihood needs. The variation in mortality rates reflected the different species' sensitivity to risk such as drought and diseases.

## Conclusion

Livestock herds were structured to provide milk, replacement stock and income insurance. Goats were the main pillar of subsistence. The exit factors in the herd dynamics prevailed over the entry factors, and this was not favourable for herd re-building and maintenance. The Government should therefore intervene to smoothen livestock cycles and keep track of the dynamics.

## Abbreviations

AEZ: agro-ecological zone; FAO: Food and Agricultural Organization of the United Nations; SPSS: Statistical Package for the Social Sciences.

## Competing interests

The authors declare that they have no competing interests.

## Authors' contributions

PMM collected the data, did the analysis and led the writing of the paper. RGW assisted in the data analysis, writing and generation of some charts. LM and PK contributed in the writing and editing. All authors read and approved the final manuscript.

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