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Full Length Research Paper

Population structure and dynamics of Ankole cattle in Uganda: Implications for sustainable utilisation of the breed

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This study aimed at determination of structure and dynamics of Ankole cattle herds in 248 farms in Kiboga, Mbarara, Mpigi and Sembabule districts of Uganda and was conducted using a pre-tested questionnaire, administered during one-to-one interviews. Farms were randomly sampled along transects originating from the headquarters of the 19 sub-counties studied. Results showed that Ankole cattle provide livelihood support to all households, with 60.9% relying solely on them. Most farms kept a mix of livestock species and breeds, though 44.5% of farms kept pure Ankole herds. Acquisition of cows across the year was mainly through birth (41.5%), gifts (38.7%) and purchase (33.8%), though the number of cattle removed from the herds exceeded the annual acquisitions. Avenues of cattle exit included sales (39.1%), donations (35.5%), death (31.1%), theft (30.5%) and slaughter for home use (30.2%). Conservation of the Ankole breed should involve empowering households who still maintain pure herds. Such households could be given elite bulls through a 'cow for a bull' exchange with the National Animal Genetic Resource Centre which currently operates a nucleus herd at Nshaara ranch. To sustain the relevance of various traits and the breed itself, controlled crossbreeding should be promoted in high milk and meat demand areas.

Key words: Cattle breeding, structure, entry, exit, characterisation, conservation.

INTRODUCTION

Cattle are the most important livestock species in the African continent and in many parts of the world. Ankole cattle in particular exist in several countries, where their different ecotypes are generally identified as Ankole, but also have specific names. Among the ecotypes, the *Inyambo* are found in Burundi and Rwanda, the *Bashi* in Democratic Republic of Congo, the *Bahima* or *Nsagalla* in Uganda and Tanzania, while the *Ankole-Watusi* are found in the USA. Uganda is home to most Ankole cattle in the globe and is generally regarded as the centre of their domestication. Within the country, these cattle are found in the western, central and south western parts, where they are mainly reared under pastoralism, agro-pastoralism and crop-livestock mixed farming systems (Kugonza et al., 2011).

The pastoral system is typically characterized by range grassland vegetation mainly in the relatively dry areas and migratory herding (Twinamasiko, 2001). Livestock breeds kept here are tolerant to migration stress, droughts and periodic nutritional shortages. In the agro-pastoral system, there are sedentary farmers who cultivate food crops both for subsistence and sale while also keeping livestock. Their animals use communal grazing, fallow and crop land after harvest (Twinamasiko, 2001). Livestock in these areas is used for draught, as wealth savings and for milk production. The crop-

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Abbreviations: FAO, Food and agriculture organisation of the united nations; **LPS,** livestock production system; **NAADS,** national agricultural advisory services; **NAGRC**, national animal genetic resource centre and data bank.

livestock system typically has livestock keeping in a predominantly crop cultivation area of relatively high rainfall and high human population density. Crop-based livestock production systems are characterised by the use of crop by-products as animal feed, while livestock provide draft and their waste is used as manure (Ghotge and Ramdas, 2003), in addition to providing milk and, to some limited extent, meat.

Ankole cattle are owned by the Bahima pastoral communities (Kajura, 2001) in the districts that form the Ankole region (Lamwaka, 2006), along with other communities who have hitherto not been documented. These cattle are important for milk, ghee and meat production, and many cultural functions such as slaughter at funerals, as gifts/dowry for marriage, and for religious sacrifice (Infield et al., 2003). The Ankole breed is of great importance due to its adaptation to the local conditions and its preference by pastoralists who value it for cultural and aesthetic reasons. Male Ankole cattle are reared for income from sales, meat for home use and ceremonies, aesthetic value and for maintenance of cultural heritage; while female cattle are mainly for milk production, income from sales, heritage and aesthetics; and in a few cases, for home use as meat (Kugonza et al., 2012). However, breeding to cause a positive change in the productivity of this breed in the traits of interest is yet to be done. Livestock genetic improvement initiatives usually focus on evaluation of the various populations followed by selective breeding and where appropriate, strategic crossbreeding of the desired breed. In order to design a sustainable breeding program for Ankole cattle in Uganda, we need to understand the current structure and population trends of the breed. This component of a wider research study therefore aimed at determining the Ankole cattle herd structure and the breed population trends/dynamics over one year in three livestock production systems of Uganda.

MATERIALS AND METHODS

Study area and design

Using a stratified survey design, with stratification done at district, county, sub-county and parish administrative levels; this study was carried out in Kiboga, Mbarara, Mpigi and Sembabule districts of Uganda (Figure 1). The four districts form part of the extensive cattle keeping corridor of Uganda that runs diagonally across the country from the south west to the north east. Thirty farms were selected in Gomba county (Mpigi district), sixty in Kazo county and seventy-seven in Nyabushozi county (both in Mbarara district), sixty in Kiboga county (Kiboga district), and twenty one in Mawoggola county (Sembabule district). The study counties were selected on the basis that they have the highest Ankole cattle density in Uganda. Two perpendicular transects were drawn across each sub-county, and all parishes along each transect were selected. Within a parish, two villages were randomly selected and along a transect cutting through the centre of the village, every third farm was sampled. The number of farmer respondents per sub-county ranged between 10 and 20 depending on the geographical size and population density of the area (Table 1). For purposes of this study, a household was defined as persons who resided and cooked together; and closely interacted in cattle farming activities of the same farm holding.

Data collection, handling and analysis

A structured questionnaire was pretested and then administered by a sole interviewer to 248 Ankole cattle farming households. Data was collected on household socio-demographic characteristics, livestock ownership, cattle acquisition (mode and source), dynamics of entry and exit and prevailing population trends. The class variables were livestock production system (LPS), counties, ethnic groups, sex and age of household head, literacy of the household head, source of household income and number of Ankole cattle kept. The completed questionnaires were then coded and data was entered and verified using the Statistical Package for Social Sciences, version 16.0 (SPSS, 2007) computer software. Data analysis was then performed using analysis of variance procedures of Statistical Analysis Systems Institute, version 9.1.3 (SAS, 2004). In the preliminary analysis, variations of the study factors between the class variables were not significant; hence, the entire dataset was analysed as a unit, to generate proportions of farmers in each category.

RESULTS

Socio-economic characteristics of the households

As shown in Table 2, men headed 91.5% of all the 248 households studied, however, considering the livestock production system, the crop-livestock system had the highest proportion (20%) of female-headed households. At county level, more than 90% of all households were male-headed except in Kazo County. Understanding of the gender of household heads is critical in planning gender sensitive livestock breed conservation schemes. The age distribution for household heads across LPSs is presented in Table 2. Generally, most household heads were 30 to 50 years old. The lowest (7.4%) proportion of young household heads (<30 years) and the highest (30.9%) proportion of household heads aged over 60 years were both found in the agro-pastoral system. Hence, Ankole cattle keeping is for the elderly, and points to a threat of disappearance of the breed in future. The average size of households within age category across LPS is presented in Table 2. The average number of boys and girls per household was similar (2.7), and ranged between zero and ten, while among the adults there were four men and three women per household on average. Each household was composed of between 2 and 45 members, and with an overall average membership of 12 individuals. There were six ethnic groups keeping Ankole cattle in the study area (Table 2). The Bahima accounted for over two thirds of all respondents, and followed by the Banyarwanda (20.6%). However, there were no Banyarwanda, Baganda and Alur cattle keepers in the crop-livestock LPS. The Bahima were the only ethnic group found in all the five counties

Figure 1. Map of Uganda showing the study areas.

and their proportion was highest in Kazo county and lowest in Kiboga. Baganda and Banyoro were present in groups keeping Ankole cattle in the study area (Table 2).

The Bahima accounted for over two thirds of all respondents, and followed by the Banyarwanda (20.6%). However, there were no Banyarwanda, Baganda and Alur cattle keepers in the crop-livestock LPS. The Bahima were the only ethnic group found in all the five counties only two counties, while Alur were only found in Kiboga, the county also found to have most ethnic groups. All households earned livelihoods from livestock, with over 60% of them relying solely on livestock. Some households also depended on crops (29.8%), business (14.5%) and salary (5.2%) as well, for their livelihoods.

Table 1. Number of sub-counties, parishes, villages and respondent households sampled in respective counties and livestock production systems.

County	Administrative sub-unit†				Production system		
	Sub-counties	Parishes	Villages	Respondents	Agro-pastoral n = 68	Crop-livestock n = 25	Pastoral n = 155
					Percentage of respondents		
Gomba	4 (2)	15 (10)	153 (21)	30	16.7	3.3	80.0
Kazo	5 (5)	28 (19)	233 (42)	60	63.3	16.7	20.0
Kiboga	10 (6)	20 (14)	154 (60)	60	25.0	0.0	75.0
Mawoggola	5 (1)	23 (04)	140 (07)	21	28.6	4.8	66.7
Nyabushozi	7 (6)	27 (23)	207 (44)	77	5.2	16.9	77.9
Total	31 (20)	113 (70)	887 (174)	248			

† The number sampled are in parentheses.

The main farming activity in the study area was mixed crop-livestock farming, though one third of all respondents kept livestock only.

Livestock species kept, their ownership and herd dynamics

Regarding the types of livestock kept, all the households studied kept cattle, and interestingly, over a quarter of all respondents (25.4%) kept cattle only. Other respondents kept cattle in combination with goats (35.9%), sheep (3.2%) and chicken (0.8%). Some households (8.9%) kept all the four species, while the rest (25.8%) kept cattle in combinations with at least two of the aforementioned species (Table 2). Only 15.7% all the households kept chickens and such households were also closely associated with cropping activity. More households kept chicken in the crop-livestock system (32%) as compared to those in agro-pastoral (23.5%) and pastoral system (9.7%). All households kept some cattle that were indigenous to Uganda and about 45% of all households kept Ankole cattle exclusively. The different cattle breeds were kept either in separate or mixed herds. Of all households that kept more than one cattle breed, 55% kept both Ankole and Friesian × Ankole crosses; 5.6% kept Boran, 4.4% kept Nganda and 4.4% kept Karamojong cattle. Majority (58%) of the households kept less than fifty Ankole cattle (Table 2). Fifty two percent of all households did not have goats or sheep and an overwhelming 84% did not keep any chicken. Besides cattle, goats were the most popular species among the households across all counties.

Table 2 shows the ownership of cattle by the different household members. In 56% of the households, all the cattle belonged to the household head alone, and 93% of such households were headed by men (Table 2). The proportion of women who owned all the cattle in a household was only 16.7% in Kazo, 7.1% in Gomba, 6.5% in Kiboga, 3.7% in Nyabushozi and none in Mawoggola County. It was only among the Bahima and Banyarwanda that cattle ownership went beyond the household head to other members of the household such as children, spouse and siblings. Joint ownership of cattle by the household head and spouse was rare (15%) and daughters did not have any ownership rights over cattle. In Mawoggola county, household heads owned all cattle or in combination with their spouses and/or sons. Nyabushozi County had the highest (72%) proportion of households where the household head owned all the cattle, while Kazo County had the highest (23%) proportion of households where cattle are owned by the whole family. Interestingly, while cattle were owned by individual household members in general (Table 2), land for grazing the cattle was family owned (Table 2) and the amount owned per household did not widely vary by LPS (Figure 2).

The dominant method of acquiring Ankole cows among LPS's and ethnic groups was inheritance (Table 3), while purchase was minimal, except for the non-pastoral ethnic groups. All respondents acquired their cows through more than one

Table 2. Characteristics of Ankole cattle keeping households studied.

Factor	Level	Number (%)
Sex of household head	Female	21 (8.5)
	Male	227 (91.5)
Age of household head	<30 years	22 (8.9)
	30–50 years	139 (56.1)
	>50 years	87 (35.1)
Literacy level of household head	Can read and/or write	172 (69.3)
	Cannot read or write	76 (30.7)
Number of household members	5 or less	27 (11.8)
	6 –10	101 (44.3)
	11–15	60 (26.3)
	>16	40 (17.5)
Ethnicity of household	Bahima	168 (68.0)
	Banyarwanda	50 (20.0)
	Others[§]	30 (12.0)
Source of household income[°]	Livestock	248 (100.0)
	Crops	74 (29.8)
	Non-agricultural business	36 (14.5)
	Salary	13 (5.2)
Other livestock species kept[#]	Goats	174 (70.2)
	Sheep	80 (32.3)
	Chickens	40 (15.7)
Breeds of cattle kept	Ankole only	110 (44.5)
	Ankole and crosses with Friesian	136 (55.0)
	Ankole and others[¶]	36 (14.4)
Number of Ankole cattle kept	<50	144 (58.1)
	50–100	69 (27.8)
	>100	35 (14.1)
Ownership of Ankole cattle	Household head alone	140 (56.2)
	Household head and spouse	36 (14.7)
	Whole family	71 (29.0)
Grazing land area (ha)	<100	151 (61.0)
	100–200	52 (20.8)
	> 200	45 (18.2)
Ownership of grazing land	Household owned	205 (82.7)
	Rented	10 (4.0)
	Communal	20 (8.1)
	All three	13 (5.2)

[§]Others include non-Bahima Banyankole, Baganda, Banyoro, Alur; [°]Some households had more than one source of income, 60.9% got all their income from livestock; [¶]Other breeds kept were Boran, Nganda and Karamojong; [#]Some households kept more than one animal species.

method. Over 80% of all respondents had inherited some cows, 53.6% had purchased some of their cows and in 35.4% of the households, some cows had been acquired as dowry, when the family had married off their daughters. On the other hand, purchase was the most common method of acquiring breeding bulls (Table 3). Other options of acquiring bulls were: raising the bull from within the owners' herd (36.5%), and acquisition

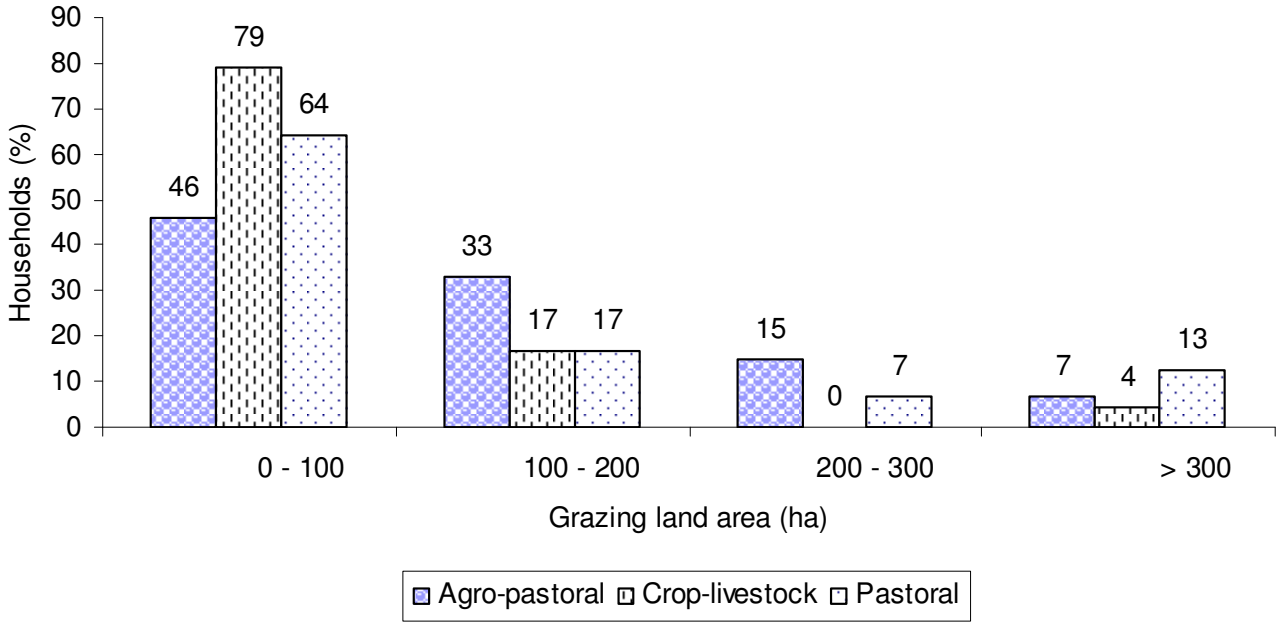

Figure 2. Grazing land area per household among production systems.

through gifts (20.2%) or hiring from other farmers (2.5%). Out-sourcing of breeding bulls was practiced by most (63.5%) of the households. Probing further into the origin of such bulls, this study revealed that sourcing within the sub-county, was most prevalent (31%). Very few households sourced bulls within their village herds (Figure 3).

Herd characteristics provide indications on the levels of herd productive performance. Particularly, the flow of animals in and out of a household provides valuable information on the levels of production, income and numeric productivity. Table 4 shows the annual dynamics of Ankole cattle herds. The number of cattle entering each herd annually was in the range of 0 to 60 for males, 2 to 80 for females, and the overall mean for both was 29 animals. Male cattle were mainly added to herds through births, while females were mainly through births and gifts. With exception of a breeding bull being the added animal, additions of male cattle to herds was significantly influenced by birth rate, while births and gifts were both significant ($P < 0.05$) for female cattle. On average, 30 cattle were removed/exited from each household in the year before this study. Most exits were through sales and donations ($P < 0.05$) (Table 4). Some households also reported that during the previous twelve months, animals were slaughtered at home for festivities, died or were lost through theft.

Across the study area, majority of the households added 1 to 10 male and 10 to 20 female cattle (Table 4). The ratio of male and female cattle added per household per year were: born, 1:1; bought, 1:4; gifts, 1:25; while the ratio between male and female cattle exits per herd over a previous twelve months period were: died, 1:3; sold, 1:1; donated, 1:6; slaughtered, 7:1; and stolen, 1:9. Households sold their cattle both at the market or at home, the public market being used by 92.8% of those in the pastoral system, 94.8% of those in agro-pastoral and 95.5% of those in crop-livestock system. Sale of cattle on-farm to traders was by 68.2% of crop-livestock farmers, 41.4% of farmers in the pastoral LPS and 22.4% of those in the agro-pastoral system. Ankole cattle were mainly (99.5%) sold to meet domestic household cash needs, especially in the crop-livestock system where small herd sizes were kept. Elsewhere, cattle were also sold to control stocking density (5.6%), or as a culling strategy (to remove unproductive animals) (8.4%). Ankole cattle population size was generally perceived to be on the decline in all production systems studied (Table 5). This is attributed to the competition between the Ankole and exotic breeds, according to 46% of the respondents. However, 31.5% of the respondents perceived the population to be increasing because according to these people, farmers' interest in this indigenous breed is increasing. Interestingly, 93% of the households considered exotic cattle numbers to be increasing. Correlation between proportion of exotic cattle in the household herd and age of household head was strong and negative ($r = -0.51$; $p = 0.01$) (Table 4), while correlation with household size ($r = 0.33$), acreage of grazing land cleared of bush ($r = 0.38$) and household income ($r = 0.16$) was positive. Trend comparisons with cattle populations over the past decade would have been appropriate; however, data over the past years was not available.

Table 3. The methods of Ankole cattle acquisition.

Type of cattle	Category	Variable	No.	Cattle acquisition method (%)				
				Inheritance	Purchase	Gifts	Own herd	Hired
Cows	LPS	Agro–pastoral	68	91.2	7.4	1.5	-	-
		Crop–livestock	25	88.0	8.0	0	-	-
		Pastoral	155	81.3	17.4	0	-	-
	Ethnicity	Bahima	168	88.7	9.5	0.6	-	-
		Bairu°	19	78.9	15.8	0	-	-
		Banyarwanda	51	84.3	15.7	0	-	-
		Others§	10	33.3	66.7	0	-	-
	Overall		248	84.7	13.7	0.6		
Bulls	LPS	Agro–pastoral	61	0	37.7	19.7	37.7	4.9
		Crop–livestock	23	0	47.8	13.0	34.8	4.4
		Pastoral	149	0	40.9	21.5	36.2	0.7
	Overall		233	0	40.8	20.2	36.5	2.5

LPS = livestock production system; °Also identified as non-Bahima Banyankole; §Others include Baganda, Banyoro and Alur.

DISCUSSION

Most household income comes from livestock in all the production systems, however, crops, salary remittances and small scale businesses also contribute (Table 2). Therefore in our study area, livestock play crucial roles in the livelihoods of their keepers' households, unlike in Rwanda and Tanzania where Ankole cattle keeping households were recently found to rely more on crop production for their livelihoods (Wurzinger et al., 2007). The socio-economic characteristics described show that Ankole cattle are owned by old farmers. Hence, Ankole cattle and pastoralism in general are facing extinction risk due to the young people lacking pastoralism interest and their urbanisation tendencies. The keeping of both Ankole and other cattle breeds and also the existence of keeping multiple species is in agreement with the study of Wurzinger et al. (2006) who nevertheless reported lower proportions of pure Ankole herds in Uganda. This possibly is because the geographical scope of their study (Luweero and southern Mbarara) is known for keeping exotic breeds and their crosses. The keeping of mixed cattle breeds is a threat to the conservation of the Ankole breed, and efforts should be put in encouraging keepers who still have pure Ankole herds to maintain them. The keeping of chickens was very limited as chicken meat is not traditionally part of the pastoralists' diet, hence the observed low frequency of chicken keepers. However, in the crop-livestock LPS, many households kept sheep and goats as well, though in numbers much lower than cattle. Studies elsewhere (Mwacharo and Drucker, 2005; FAO, 2003) reported that the cattle herd and goat flock in a household are almost similar in size. It was apparent that pigs are hardly kept by cattle keepers. Further probing during the interviews showed that pastoralists believe that pigs transmit many diseases to cattle. Besides, pastoralists culturally believe that pig farming is socially degrading. Religious restrictions were not a factor because Bahima, the predominant ethnic group that keeps Ankole cattle is largely Christian. Also, the diet of the Bahima is predominantly composed of milk and cereals.

Cattle ownership was independent of production system, possibly because ownership is mostly culturally influenced and not so much a result of production system. Keeping cattle is part of the Bahima culture, while the other tribes have largely adopted cattle keeping for its commercial benefits. Household heads, 93% of whom were men, owned all the cattle in 56% of the households. This is consistent with the culture and norms of pastoralists in other parts of Africa (FAO, 2003). The other household members who owned cattle in our study were the spouse or son of the household head. These results contrast with Wurzinger et al. (2006) who reported ownership of 80% (spouse), 33% (son) and 13% (daughter) in the same area. In Eritrea, where there is a combination of patriarchy culture and Islamic teaching, ownership of cattle is almost entirely by men (FAO, 2003).

Ankole cows were mainly acquired through inheritance and gifts in all production systems and pastoral tribes (Table 3). This compared closely with how Zebu cattle are acquired elsewhere (Rege et al., 2001). In the crop-livestock system, where non pastoral tribes (Baganda, Banyoro and Alur) predominated, acquisition was mainly through purchase. The use of cattle as dowry was common among Banyarwanda, but relatively rare among Banyankole and the other tribes, which may indicate a

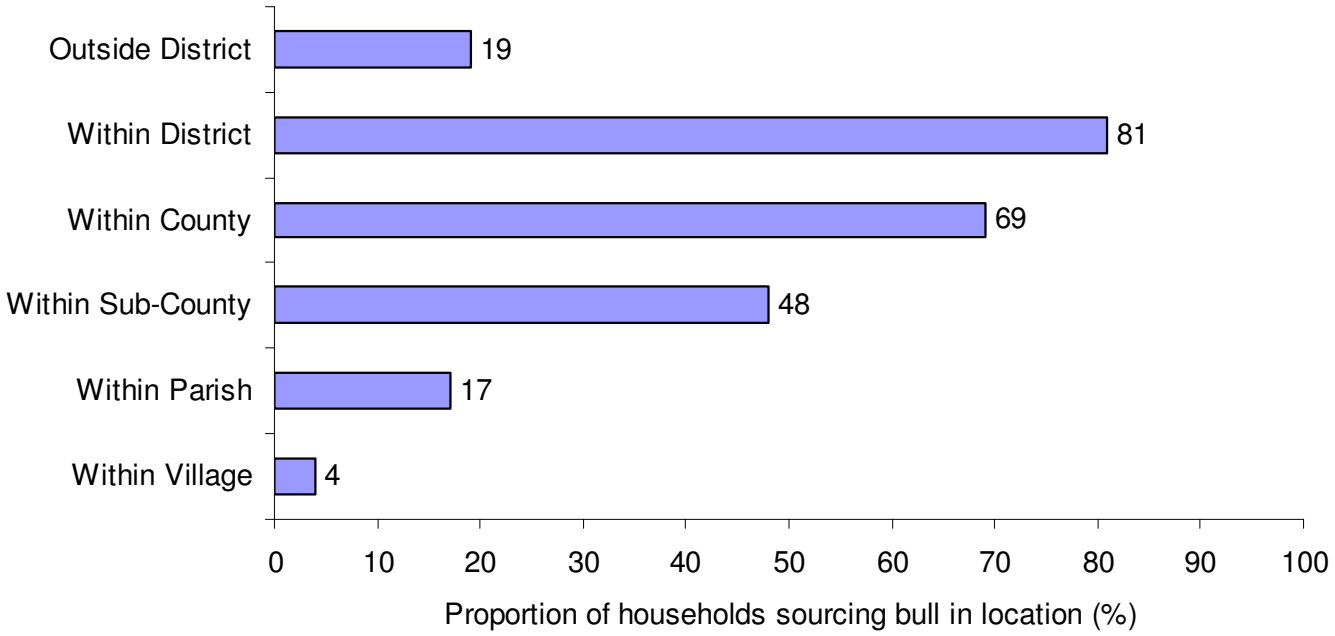

Figure 3. Sources of introduced bulls among households.

decline in use of cattle as a form of dowry among Ugandans, due to changes in socio-economic and religious values. The current trend is an increased use of exotic dairy cows for dowry; as a target for producing more milk so as to boost milk yields and income from its sale. Breeding bulls were acquired in similar ways across production systems. Most of the bulls were purchased, followed by selection from calves born within herds, gifts and hiring. Comparatively, in South-East Kenya, most bulls are born within herds, and a few are purchased from nearby markets (Mwacharo and Drucker, 2005). Purchase, if from unrelated herds, ensures out-breeding and practicing similar breeding objectives and have similar herd management practices. On the contrary, a bull raised from within the herd would mate with a high proportion of his relatives, potentially increasing incidence of inbreeding. Progress could also be slowed down or even negated if the resident bull is replaced through un-informed bull purchase especially from genetically inferior herds. Hiring of bulls was common in crop producing areas because access to good bulls is limited due to few numbers of herds and the small herd sizes, whereas keeping of bulls in each herd would not be necessary due to the fact that they are under utilised.

Almost all, the respondents sold their cattle at the markets; however, in Nyabushozi County, 69% of cattle sales were done on-farm, with traders coming to the farm to purchase the available stock. This was because at the time of the study, livestock markets in two of the sub-counties were closed due to a Foot and Mouth Disease outbreak. Herd size characteristics provide indications on the levels of herd productive performance. Particularly, the flow of animals in and out (dynamics) of herds provides valuable information on the overall production, income and numeric productivity. It is also related to maintenance of optimum stocking rates. As would be expected, more female cattle were bought or received as gifts as compared to males in each household, while the births by sex type were similar (Table 4). The ratio of female to male cattle that annually exited each household was remarkably high. Also, the death rate of three females per male was rather high. The dynamics of the cattle generally show that Ankole herd sizes are declining and could substantially diminish since females number are declining at a faster rate than males. Nevertheless, the modes of entry and exit of cattle reported in this study also exist elsewhere for other breeds (FAO, 2003; Homann et al., 2004; Loquang, 2003; Mwacharo and Drucker, 2005), albeit with the contributions of the different methods differing across locations.

Although, Ankole cattle were generally preferred over other breeds, the population of Ankole cattle is considered to be decreasing in all LPS (Table 5), and this was in agreement with the herd size dynamics discussed above. The decrease as perceived by two thirds of the people in the crop-livestock LPS and one half of those in the pastoral LPS is due to stiff competition between Ankole and exotic breeds, for both increased meat and milk production. Overall, 46.9% of the respondents believe that the breed population is stable or increasing because the farmers' interest in the breed is growing. We deduced that for Ankole cattle to be sustainably conserved, focus should be put on improving its productivity through a well-planned breeding programme,

Table 4. Ankole cattle that entered or exited each household in the past 12 months.

	Factor	Category	No.	Mean + s.e	Min	Max	Total			
							0	1–10	10–20	>20
							Percentage of households			
Male cattle	Entry	Born	104	8.8 + 0.9[a]	0	60				
		Bought	75	0.5 + 0.2[b]	0	10				
		Gifts	75	0.3 + 0.1[b]	0	10				
		Sub-total		9.8 + 1.3	0	60	1.4	64.9	24.3	9.5
	Exit	Sold	89	8.2 + 0.9[a]	0	50				
		Slaughtered	81	1.4 + 0.2[b]	0	10				
		Donated	69	1.3 + 0.5[b]	0	30				
		Died	78	0.7 + 0.2[b]	0	8				
		Stolen	71	0.1 + 0.1[c]	0	5				
		Sub-total		11.2 + 1.4	0	50	1.5	55.4	32.3	10.8
Female cattle	Entry	Born	103	11.3 + 1.1[a]	2	60				
		Bought	84	1.8 + 0.3[b]	0	20				
		Gifts	96	5.6 + 0.8[c]	0	50				
		Sub-total		19.0 + 1.8	2	80	-	34.2	36.7	29.1
	Exit	Sold	97	9.7 + 1.0[a]	0	50				
		Slaughtered	75	0.2 + 0.1[b]	0	6				
		Donated	88	6.0 + 0.9[c]	0	54				
		Died	77	2.4 + 0.4[d]	0	15				
		Stolen	76	0.6 + 0.2[b]	0	8				
		Sub-total		19.1 + 2.1	0	54	-	33.3	31.9	34.8

Means within factor having same superscript are not significantly different ($p > 0.05$).

Table 5. Ankole cattle population trend and the causal factors.

Category	Factor	Production system (%)			
		Agro-pastoral (n = 68)	Crop-livestock (n = 25)	Pastoral (n = 155)	Overall
Population trend					
	Increasing	32.3	32.0	45.0	40.2
	Stable	9.2	0.0	6.7	5.7
	Decreasing	58.5	68.0	48.3	53.1
	Total	27.2	10.5	62.3	100
Reason for increasing population trend					
	Increased interest of farmers	27.7	25.0	34.3	31.5
	Breed is still available	7.7	4.2	13.3	10.8
Reason for decreasing population trend					
	Competition with exotic breeds	52.3	66.7	39.9	46.1
	Heavy cattle sales	4.6	4.2	7.0	6.0
	Grazing area is decreasing	3.1	0.0	3.5	3.0
	Decreased interest of farmers	4.6	0.0	2.1	2.6

and maintaining production systems such as agro-pastoralism which suit the breed best. Animal breeding programmes are totally dependent on the environmental conditions, the production system and the objectives for which the animals are bred (Philipsson et al., 2006). Whatever the state of the environment is, to ensure sustainability, the breeding programme must be market-oriented, while also considering the multiple uses of the animals and the long-term benefits to the farmer. We proposed that farmers in pastoral systems should be encouraged to sustain their indigenous stock through selective improvement. Efforts should include empowering and providing incentives to households who still keep pure indigenous animals. Such households could be given elite Ankole bulls through a 'cow for a bull' exchange with the government-owned NAGRC–Nshaara ranch that operates a nucleus breeding scheme. After its stabilisation and active involvement of farmers, this nucleus could be opened and bulls could be sourced externally. Farmers need to be involved in such a scheme early enough in order for their needs to be taken into account, and for them to provide their support for the programme to work (Van der Westhuizen et al., 2005; Kosgey et al., 2006). Related selection procedures were proposed for Nguni cattle (Scholtz, 1988, 2005) but after implementation, mixed results were obtained, mainly resulting from the nucleus being initially stocked with animals inferior to those kept by farmers (M. M. Scholtz, Agricultural Research Council, Irene, South Africa, personal communication). For Ankole cattle, an open-nucleus scheme can therefore be expected to lead to long term improvement in the milk productivity and growth rate of animals of this breed. Our experience with this type of scheme for Mubende goats is that success is attained if the characterisation (Kugonza et al., 2001a, 2001b) is followed by intensive selection within a nucleus. However, considering that cattle have a longer generation interval, and productivity variation may not be as large as in goats, genetic progress may be slower. Also, with experiences of failed open nucleus schemes on government ranches in other countries, mainly as a result of mismanagement, limited financial support and political interference; the need for semi-autonomous implementation of our proposed strategy cannot be over emphasized.

For the peri-urban areas, where a high demand for milk exists, a feasible breeding scheme should involve production of F1 heifers at government or private but registered farms. The pregnant heifers can then be sold to smallholder farmers (Philipsson et al., 2006), while new males may enter the farmers' herd live or by artificial insemination. The authors also proposed a scheme based on continuous use of F1-males on indigenous and crossbred females in village herds, allowing a maximum of 50% exotic genes to be incorporated in the female stock. Difficulties in sustaining the production of females may exist, but can be overcome through systematic crossbreeding at village level, as had been observed earlier (Ahuya et al., 2004). According to Osinowo and Abubakar (1988), the greatest bottlenecks in genetic improvement programs of livestock such as the Ankole cattle are technical and infrastructure related. Some of the critical issues include identification of clear breeding objectives, establishment of realistic pedigree and performance recording systems; application of quantitative and molecular techniques (if infrastructural concerns are addressed); market structure, access and information system, and establishment of community breeding organisations (Kosgey and Okeyo, 2007). These are issues that need to be addressed if the improvement and sustainable utilisation of Ankole cattle breed is to be attained. Ankole cattle need to be targeted for improved beef production under planned crossbreeding programs.

Conclusion

Ankole cattle are kept mainly by the Bahima ethnic group and are the sole source of income for most households. Indiscriminate cross breeding is rampant and increasing in all production systems and the major driver is the increasing meat and milk demand, probable increase in prices of livestock products and increased access to markets. Also, improved access to exotic germplasm through proliferation of private AI service providers may be partly responsible. On the other hand, inadequacy of facilities such as veterinary services and water for livestock in pastoral LPS areas necessitates that indigenous cattle should be maintained, to utilise this niche and to maintain the livelihoods of pastoralists there. In addition, Ankole cattle have many roles, which cannot be substituted for by single-purpose breeds.

RECOMMENDATIONS

From our findings on the structure and dynamics of Ankole herds, the cattle keepers should be empowered to enable them establish an Ankole cattle breeders' association, by building on the existing relatively strong social networks. Making an Ankole cattle nucleus breeding scheme operational within the NAGRC framework, to provide elite bulls and technical backstopping to farmers should be prioritised. Nshaara ranch should be a focus for the proposed Ankole breed nucleus development work. Local Governments and the National Agricultural Advisory Service (NAADS) should strengthen their extension activities on cattle production and management in the study area. In addition, mandated organisations such as NAGRC should promote a strategic and regulated Ankole cattle crossbreeding programme for particular zones identified in our study.

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REFERENCES

Ahuya CO, Okeyo AM, Mosi RO, Murithi FM (2004). Growth, survival and milk production performance of Toggenburgs and their crosses to East African and Galla goat breeds in the Eastern slopes of Mount Kenya. In: Smith, T., Godfrey, S.H., Buttery, P.J. and Owen, E., (Eds.) The Contribution of small ruminants in alleviating poverty: communicating messages from research. Proceedings of the 3rd DFID Livestock Production Programme Link Project workshop for small livestock keepers. Izaak Walton Inn, Embu, Kenya, 4-7 February.

FAO (Food and Agriculture Organisation of the United Nations) (2003). Understanding the indigenous knowledge and information systems of pastoralists in Eritrea. Commun. Dev. Case Stud. 26:1-40.

Ghotge N, Ramdas S (2003). Livestock and livelihoods. In: Conservation and sustainable use of agricultural biodiversity. A Sourcebook. CIP-UPWARD, GTZ, IDRC, IPGRI and SEARICE. pp. 190-196.

Homann S, Rischkowsky B, Steinbach J (2004). Herd mobility leads the way for sustainable pastoral development: the case of Borana rangelands, southern Ethiopia. Deutscher Tropentag, Conference on International Agricultural Research for Development, Berlin, October 5-7, 2004, p. 10.

Infield M, Rubagyema P, Muchunguzi C (2003). The names of Ankole cows. Fountain Publishers Ltd. Kampala, Uganda, P. 107.

Kajura S (2001). Beef Production. In: Agriculture in Uganda. Livestock and Fisheries. Mukiibi, J.K. (ed). Fountain Publishers /CTA/NARO, 4:1-17.

Kosgey IS, Okeyo AM (2007). Genetic improvement of small ruminants in low input, smallholder production systems: technical and infrastructural issues. Small Rumin. Res. 70(1):76-88.

Kosgey IS, Baker RL, Udo HMJ, van Arendonk JAM (2006). Successes and failures of small ruminant breeding programmes in the tropics: a review. Small Rumin. Res. 61:13-28.

Kugonza DR, Bareeba FB, Kirembe G (2001a). Characterisation of meat goat management systems in three districts of central Uganda. MUARIK Bull. 4:26-29.

Kugonza DR, Bareeba FB, Petersen PH (2001b). Response to phenotypic screening of Mubende meat goats. MUARIK Bull. 4:18-24.

Kugonza DR, Nabasirye M, Mpairwe D, Hanotte O, Okeyo AM (2011). Productivity and morphology of Ankole cattle in three livestock production systems in Uganda. Anim. Genet. Resour. 48:13-22.

Kugonza DR, Nabasirye M, Hanotte O, Mpairwe D, Okeyo AM (2012). Pastoralists' indigenous selection criteria and other breeding practices of the long-horned Ankole cattle in Uganda. Trop. Anim. Health Prod. 44(3):557-565. doi: 10.1007_s11250-011-9935-9.

Lamwaka S (2006). Ugandan pastoralists hit by market reforms. PANOS Features, PANOS, London. Available at www.panos.org.uk/newsfeatures/featuredetails.asp.

Loquang TM (2003). Karamojong, Uganda. In: Köhler-Rollefson, I., Wanyama, J. (eds), The Karen Commitment: Proceedings of a conference of indigenous livestock breeding communities on animal genetic resources, German NGO Forum Environ. Dev. Bonn. pp. 24-29.

Mwacharo JM, Drucker AG (2005). Production objectives and management strategies of livestock keepers in South-East Kenya: Implications for a breeding programme. Trop. Anim. Health Prod. 37:635-652.

Osinowo OA, Abubakar BY (1988). Appropriate breeding strategies for small ruminant production in west and central Africa. In: Adeniji, K.O. (ed.), Improvement of small Ruminants, Proceedings of the Workshop on the Improvement of Small Ruminants in West and Central Africa. 21–25 November 1988, Ibadan, Nigeria, pp. 71-84.

Philipsson J, Ojango JM, Malmfors B, Okeyo AM (2006). ILRI-SLU Animal Genetics Training Resource, CD Version 2. ILRI (International Livestock Research Institute, Nairobi, Kenya, and SLU (Swedish University of Agricultural Sciences), Uppsala, Sweden.

Rege JEO, Kahi AK, Okomo-Adhiambo M, Mwacharo J, Hanotte O (2001). Zebu cattle of Kenya: Uses, performance, farmer preferences, measures of genetic diversity and options for improved use. Anim. Genet. Resour. Res. ILRI, Nairobi, Kenya. p. 103.

SAS (Statistical Analysis Systems) (2004). SAS OnlineDoc Version 9.1.3. English edition, SAS Institute, Inc., Cary, North Carolina, USA.

Scholtz MM (1988). Selection possibilities of hardy beef breeds in Africa: The Nguni examples. Proceedings of the 3rd World Congress on sheep and beef cattle breeds. Paris, France, 19–23 June 1988. Vol. 2:303-319.

Scholtz MM (2005). The role of research and seed stock industry in the *in situ* conservation of livestock genetic resources. Proceed. 4th All Afr. Conf. Anim. Agric. 31st meeting Tanzanian. Soc. Anim. Prod. 4:311-316.

SPSS (Statistical Package for Social Scientists) (2007). Statistics package for social sciences. SPSS Inc., USA. Available at http://www.spss.com.

Twinamasiko NI (2001). Dairy Production. In: Agriculture in Uganda. Livestock and Fisheries. Mukiibi, J.K. (ed). Fountain Publishers /CTA/NARO 4:18-42.

Van der Westhuizen J, Scholtz MM, Mamabolo MJ (2005). Importance of infrastructure and system for livestock recording and improvement in developing countries. Proceed. 4th All Africa conf. Anim. Agric. 31st meet. Tanzanian Soc. Anim. Prod. 4:343-348.

Wurzinger M, Ndumu D, Baumung R, Drucker A, Okeyo AM, Semambo DK, Byamungu N, Sölkner J (2007). Comparison of production systems and selection criteria of Ankole cattle by breeders in Burundi, Rwanda, Tanzania and Uganda. Trop. Anim. Health Prod. 38:571-581.

Wurzinger M, Ndumu D, Baumung R, Drucker A, Okeyo AM, Semambo DK, Sölkner J (2006). Indigenous selection criteria in Ankole cattle and different production systems in Uganda. 55th Annual Meeting of the European Association for Animal Production (EAAP), Uppsala, Sweden, 5–8. June.