RESEARCH REPORT

Breeding management strategies adopted for dairy production under low-input smallholder farming systems of East Africa

HEIFER INTERNATIONAL

East Africa Dairy Development

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Authors

Ojango, J.M.K., Kariuki, K., Njehu A. and Baltenweck, I.*

[1] International livestock Research Institute (ILRI), Nairobi, Kenya

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* Ojango, J.M.K. corresponding author: j.ojango@cgiar.org

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Acknowledgements

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Summary

Designing and implementing sustainable breeding management programmes is one of the most practical means of improving efficiency in livestock production, particularly in developing countries. The success or failure of an improvement programme hinges strongly on the compatibility of the programme with the objectives of the farming community targeted. This report contributes to a better understanding of the pre-existing breeding management strategies within cattle-keeping communities of the EADD project sites, and will help in the definition of appropriate breeding objectives and the design and implementation of a sustainable breeding programme for the small holder farmers.

The farmers in the three countries rear a variety of cattle, classified into two broad categories as exotic and indigenous breed-types. More exotic breed-types are reared in Kenya than in Rwanda and Uganda. Among the exotic breed-types reared, the Holstein-Friesian is most popular in all the countries. The Ayrshire breed-type is also very popular in Kenya. In Uganda, the most common type of cattle are the indigenous Ankole, while in Rwanda, various crosses are popular. There are no written records available on individual animals.

The breed-type of animal raised on a farm is significantly influenced by the age and level of education of the head of the household. On average, in households headed by older and more educated people, there are more exotic breed-types of animals reared. These households also live in areas with higher human population density.

Farmers implement some form of controlled mating, either to minimize inbreeding, or to seek better mates among the population available. There is also some degree of planned cross-breeding taking place in all the countries. On most farms, animals calved down for the first time when they were above 27 months old, with exotic animals calving at a younger age than indigenous ones. Calving intervals were on average longer in Kenya than in the other countries. Indigenous animals tended to calve for the first time at close to four years of age in Uganda where malnutrition was noted as a key factor requiring to be addressed. More than 10% of the animals on farms within the three countries were culled in a 12 month period with a replacement rate of less than 5%, implying an overall reduction in herd size over time.

The most desirable traits in exotic animals raised in all three countries were high milk production and good body conformation. In the indigenous breed-types reared, adaptability was the most important trait in all the countries. An interesting observation was that not all farmers raised the breed-type of animal that they admired most.

It was clear that the farmers were knowledgeable to some degree on several aspects related to selective breeding of animals. To effect change in the existing production systems, in addition to availing improved breeding materials at an affordable cost, capacity development using simplified messages targeted to address specific knowledge gaps concerning breed choice, reproduction and selection decisions is required.

1. Introduction

Livestock breeding management are the practices and institutions that livestock keepers use to implement their decisions as to which animals are allowed to reproduce and which are not. Designing and implementing sustainable breeding management programmes is one of the most practical means of improving efficiency in livestock production, particularly in developing countries. In order to design these, appropriate objectives for rearing the animals must be determined and strategies adopted to achieve the desired goal. The breeding objective includes all relevant characteristics of an animal (e.g production, reproduction, fitness and health) and assigns a value to each trait. Most livestock keepers have some broadly defined objectives and adopt various strategies to meet them. However, these strategies are very diverse and tend to be individually defined. An additional consideration is that production environments in developing countries vary as a result of differing management practices and changing climatic conditions, leading to variability in animal performance. It is important to understand these pre-existing systems, benchmark important traits, identify strategies adopted and reasons for current practices prior to suggesting and making changes. The success or failure of an improvement programme hinges strongly on the compatibility of the programme with the objectives of the farming community targeted.

This report presents the breeding management strategies employed within dairy cattle keeping communities of East Africa at the start of the East African Dairy Development (EADD) project. It is based on empirical data collected through participatory rural appraisal (PRA) approaches and household surveys conducted in 2008/2009 for representative project areas surrounding a central hub in Kenya, Rwanda and Uganda as outlined in ILRI-EADD baseline Report No.1 (2010). A ‘hub’ was conceived as a central location within a project area where activities and services were to be concentrated, and which would generate and distribute services and benefits, primarily to groups targeted by the project. Names used to identify the hubs were subsequently used to identify the project sites in each country. The information in this report is important for the definition of appropriate breeding objectives and the design and implementation of a sustainable breeding programme for small holder farmers in the project countries.

2. Breeds of cattle kept by farmers

Livestock producers need to make a choice of the most appropriate breed or crossbreds to keep before adopting or implementing any breeding programme. From the PRAs, it was evident that there were differences in the breeds of dairy animals reared in the three countries. Community-level results showed that in all the sites found in Uganda, the most common type of cattle were the Ankole which comprised over 60% of all animals reared, while the most common exotic breed type reared was the Holstein-Friesian. In Rwanda, various crosses were popular across all the sites, notably: Holstein-Friesian x Ankole (this was also the most expensive cross to purchase), Jersey x Ankole (popular for good milk production) and the Holstein-Friesian x Sahiwal (said to have good disease resistance and high meat production), while in Kenya, various exotic breed-types were popular.

No written records on the pedigrees of animals reared were available, however, the livestock keepers were able to identify the main breed-type of each animal they reared based on the phenotypes of their animals. Data on milk production by individual animals on a specific day within a lactation was collated from households participating in the survey. This was used to obtain estimated lactation curves for the different breed-types of animals as described by Staal and Omore (1998). Curves derived from the data are presented in Appendix 1. In all the three countries, daily yields recorded were low (<12 kg on average) for all breed-types. Animals with different levels of exotic genetic make-up were identified as either pure-exotic or exotic crossbreds, however the distinction was not very clear. For example, one could not clearly distinguish between the pure-bred Holstein-Friesian and the Holstein-Friesian crosses with varying proportions of indigenous breeds. In evaluating the data on animals collected for the survey it was thus decided that animals would be classified into two broad categories based on their phenotypic description; ***Indigenous types*** (comprising the Zebu, Ankole, Nganda, Sahiwal and Boran breed-types), and ***Exotic types*** (comprising both pure-bred and crosses of Holstein-Friesian, Ayrshire, Jersey and Guernsey breed-types). The main exotic breed-types of cattle reared are presented in Figure 1, while the main indigenous types are presented in Figure 2.

Holstein-Friesian type

Ayrshire type

Jersey type

Guernsey type

Figure 1. *Main exotic breed-types of cattle reared within the East Africa region*

Ankole

Boran

Zebu types

Sahiwal

Nganda

Figure 2. *Main indigenous breed-types of cattle reared within the East Africa region*

Figure 3 shows the distribution of animal breed-types in each country, using data from the EADD project sites surveyed.

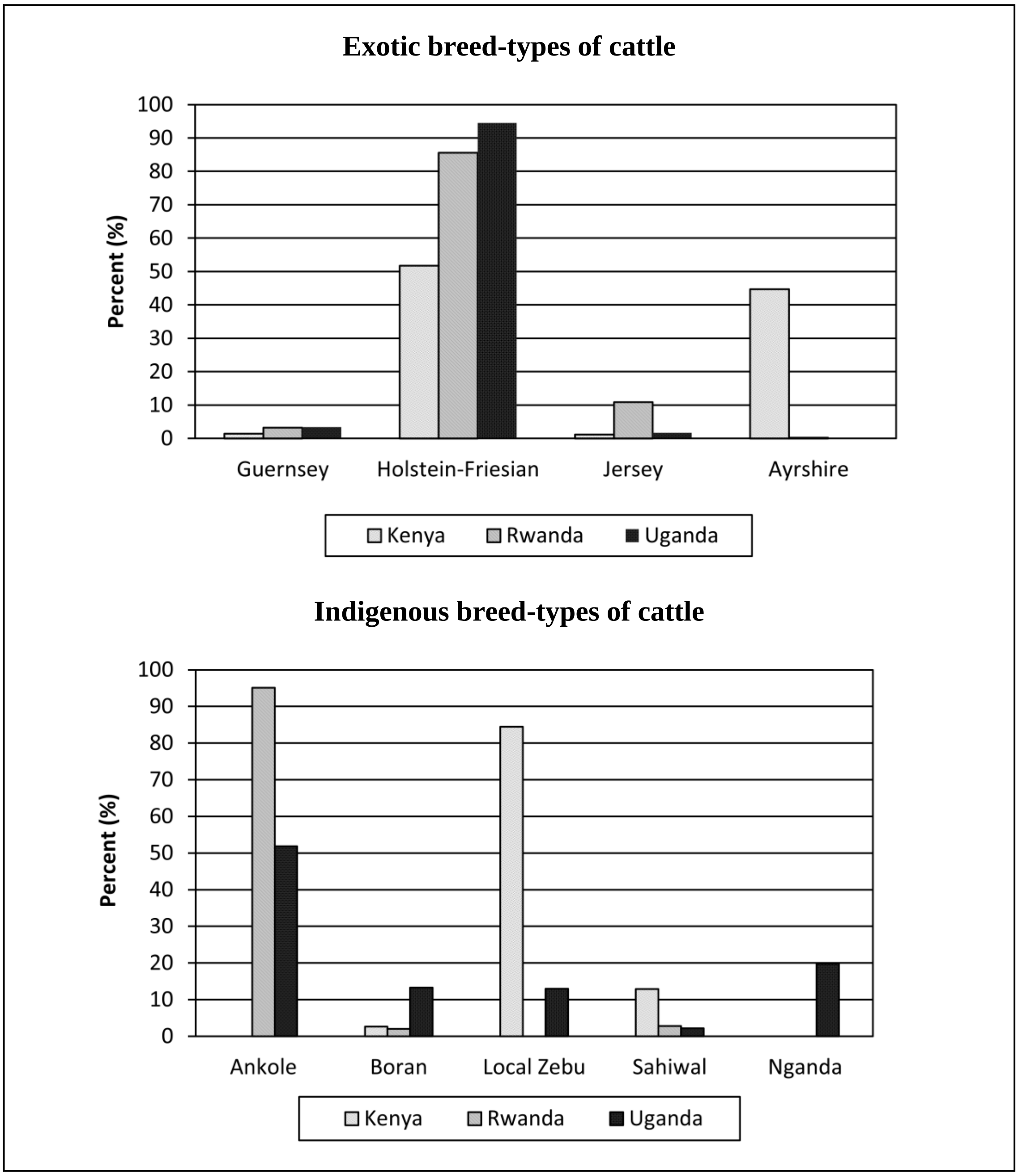


Figure 3. *Distribution of predominant breed-types of cattle in project areas of Kenya, Rwanda and Uganda*

It was evident that among the exotic breed-types reared, the Holstein-Friesian was most popular in all three countries, comprising more than 85% of all exotic breed-types raised in

Rwanda and Uganda, and 50% in Kenya. It was only in Kenya where a second exotic type, the Ayrshire also had a high population (45%). Other exotic types, the Guernsey and Jersey constituted less than 15% of the exotic types reared in all the countries.

Uganda had the highest percentage of indigenous animals (Figure 4). Among the indigenous breed-types reared within the countries, Zebu types were most popular in Kenya while the Ankole breed-types were popular in Uganda and Rwanda (Figure 3).

At the household level, there were differences in the combination of animal breed-types reared. Figure 4 shows the percentage of surveyed farmers keeping either exotic breed-types only, indigenous breed-types only or a combination of the two.

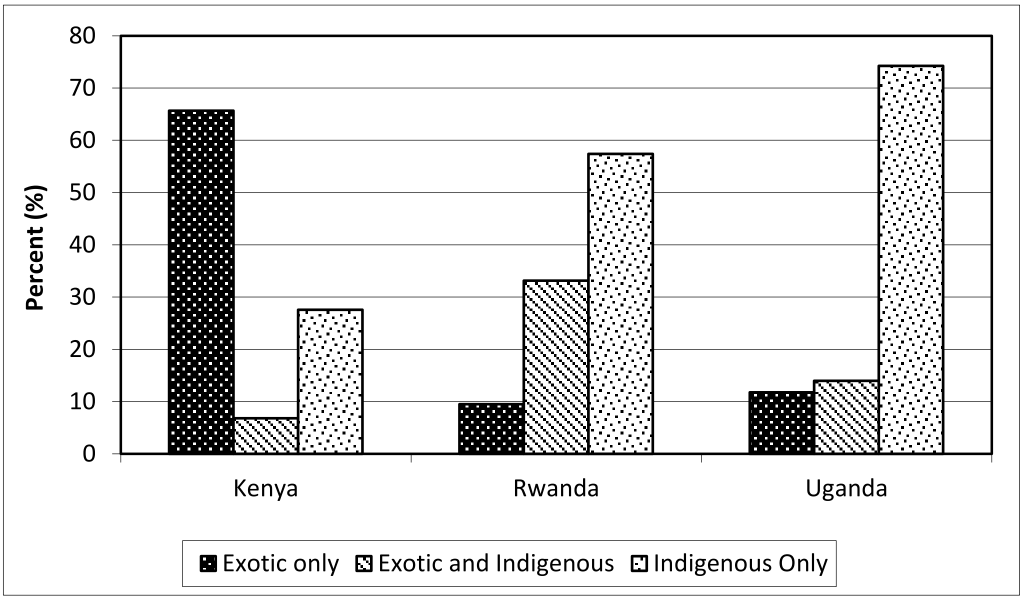


Figure 4. *Percentage of dairy farmers keeping cattle breed-types in Kenya, Rwanda and Uganda*

Kenya had the highest percentage of farmers raising only exotic breed-types (66%), but less than 7% of the farmers are keeping both exotic and indigenous types. In Rwanda and Uganda, more farmers raised only indigenous breed-types: 73% in Uganda and 58% in Rwanda. A notable percentage of farmers in Rwanda (33%) keep both exotic and indigenous breed-types.

The differences in breed-type reared, evident at country level, were evaluated to determine if these were similar at site level within each country. Numbers of households, and percentages of each breed-type within each site surveyed are presented in Table 1.

Table 1. *Estimated number of households and the percentage keeping cattle by breed-type within project surveyed sites of Kenya, Rwanda and Uganda*

Site	No.of hhs in site[1]	% of hh keeping cattle	% of hh keeping various cattle breed-types			Total % Exotic and Indigenous animals in site	
			Only Exotic	Only indigenous	Both exotic and indigenous	% Exotic	% Indigenous
Kenya							
Kabiyet	9,991	93.3	**92.0**	0.0	**1.3**	99.6	0.4
Kaptumo	11,158	97.3	60.0	25.3	12.0	56.5	43.5
Metkei	5,342	94.7	48.0	44.0	2.7	49.7	50.3
Siongiroi	12,909	92.0	**37.3**	**45.3**	9.3	51.0	49.0
Soy	7,667	89.3	74.7	5.3	9.3	90.5	9.5
Rwanda							
Bwisanga/Gasi	6,666	57.3	**10.7**	**36.0**	10.7	67.4	32.6
Kabarore Kibondo	12,166	53.3	**2.7**	30.7	20.0	41.1	59.0
Mbare (Terimbere Mworozi Coop)	3,384	68.8	5.2	27.3	**36.4**	27.9	72.1
Uganda							
Bbaale/ Bugerere	2,624	53.3	9.3	33.3	10.7	40.2	59.8
Luwero	16,008	37.3	2.7	29.3	5.3	5.7	94.3
Masaka	11,694	41.3	8.0	29.3	4.0	15.7	84.4
Kakooge	3,353	69.3	1.3	**60.0**	8.0	4.4	95.6
Mukono	16,642	57.3	**13.3**	24.0	**20.0**	28.9	71.1
Dwaniro SALL Cooler	5,092	51.7	6.9	35.2	9.6	19.0	81.0

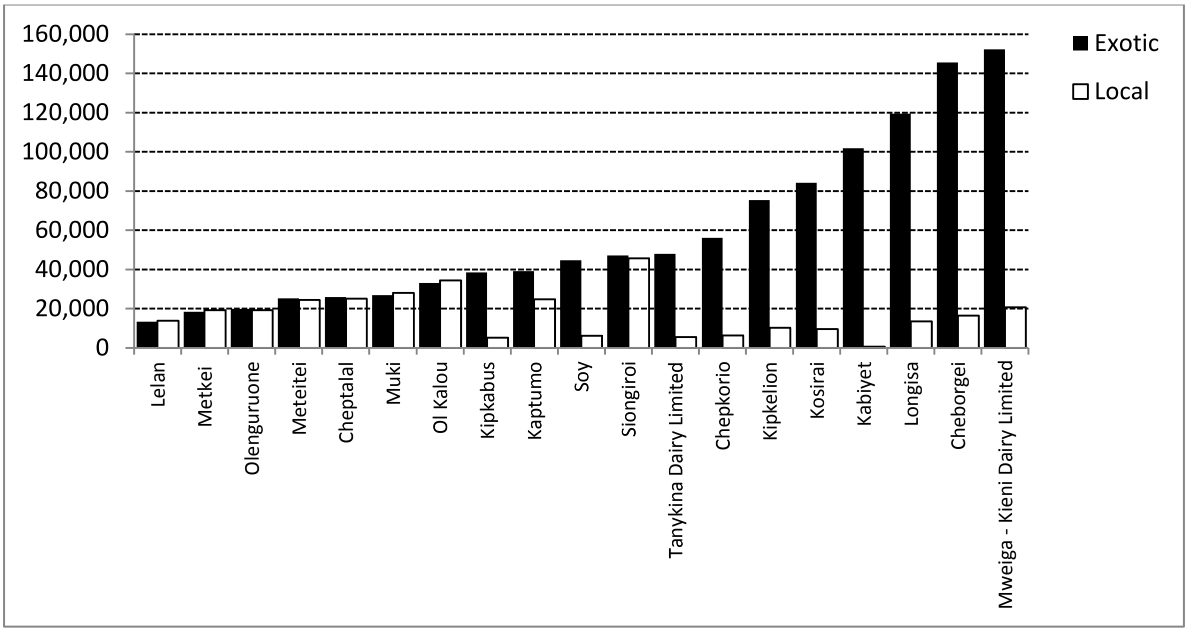
- Results in bold and blue indicate sites with characteristics that were distinctly different from the others
- Data sources: [1] extrapolation based on census data (see Appendix 2); other data: EADD baseline household survey

The proportion of exotic and indigenous breed-types reared by various households was not the same for the different sites within a country, indicating the need to design and adapt improvement breeding strategies based on pre-existing conditions at site level rather than country level. In Kenya, Kabiyet site had the highest percentage of households rearing only exotic breed-types (92%), with no household raising only indigenous breed-types and 1.3% of the household keeping both exotic and indigenous breed-types (Table 1). The site with the lowest proportion of exotic breed-types in Kenya was Siongiroi, where 37.3% of households raised exotic animals exclusively, 45.3% raised only indigenous animals and 9.3% of the households raised both breed-types.

In Rwanda, Bwisanga/ Gasi site had the highest proportion of households (10.7%) rearing only exotic breed-types (Table 1). A similar percentage of the household reared a combination of exotic and indigenous breed-types, while 36% of the households reared only indigenous breed-types. Within this country, Kabarare Kibondo had the lowest proportion of household rearing exotic breed-types (2.7%), while Mbare site had the highest proportion of household keeping both exotic and indigenous breed-types (36.4%) (Table1).

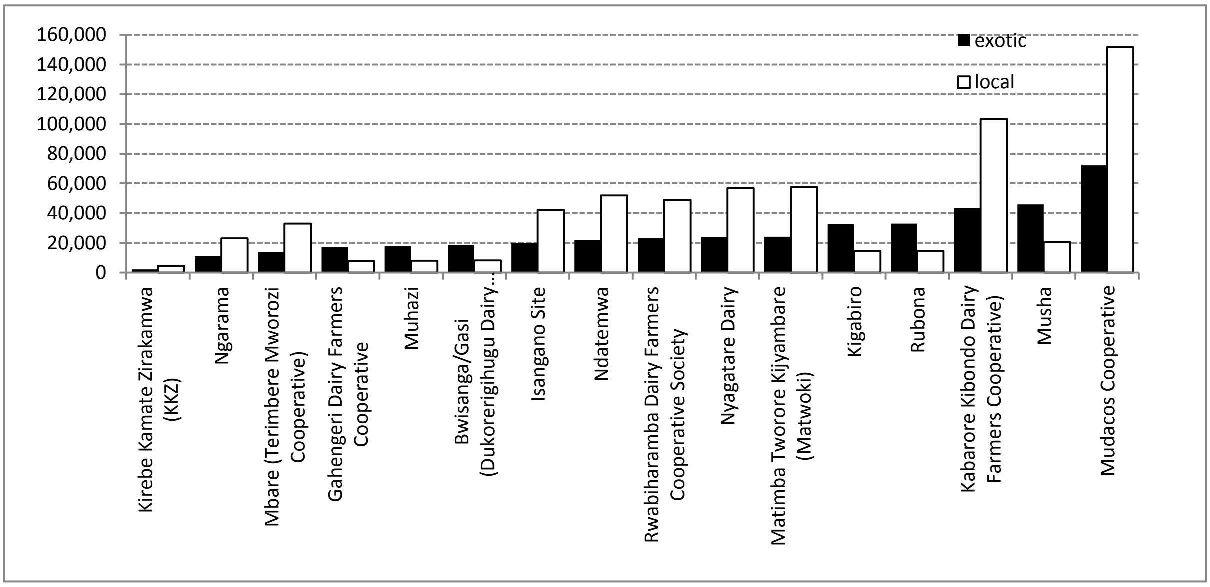
In Uganda, more households kept only indigenous breed-types of cattle than only exotic types (Table 1). Kakooge site had the highest proportion of household (60%) rearing only indigenous breed-types, while Mukono site had the highest proportion of household (13.3%) rearing only exotic breed-types (Table 1). Mukono site also had the highest proportion of household rearing both indigenous and exotic breed-types (20%).

Using census data on total number of households within each site catchment area and survey observations, the number of heads of cattle by breed-type was estimated. Details of the computation are described in Appendix 2. The estimated numbers of exotic and indigenous breed-types of cattle are presented in Figure5, Figure 6 and Figure 7 for the three countries.



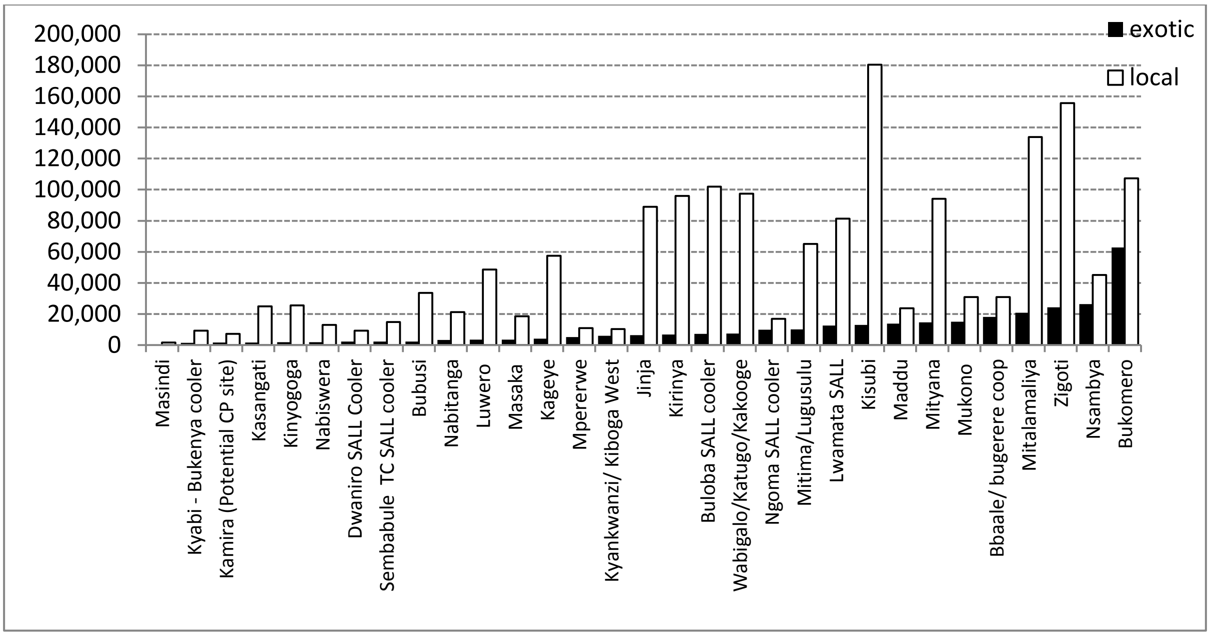
*N.B. All sites are 20km radius around central hub

Figure 5. *Estimated number of cattle heads, by breed-type, Kenya sites*



*N.B. *All sites are 15km radius around central hub*

Figure 6. *Estimated number of cattle heads, by breed-type, Rwanda sites*



*N.B. All sites are 20km radius around central hub

Figure 7. *Estimated number of cattle heads, by breed-types, Uganda sites*

Due to a high population density in Kenya sites, the high percentage of farmers keeping exotic cattle translated into a high number of exotic cattle in the majority of sites (compared to indigenous cattle, and compared to the other countries). The estimated number of cattle raised in the sites in Kenya were 1,114,901 exotic and 328,633 indigenous breed-types; in Uganda, 313,011 exotic and 1,657,264 indigenous breed-types, and in Rwanda 402,644 exotic and 638,838 indigenous breed-types. Overall, exotic cattle are the dominant breed-type in Kenya, in contrast with Uganda and Rwanda. There are 7 sites (out of 19) in Kenya with more than 50,000 heads of exotic cattle, but only 1 (out of 16) in Rwanda and 1 (out of 31) in Uganda.

It is generally believed that farmers in developing countries are risk averse, and tend to retain a variety of breed types of animals as security. Results from the survey indicated that within a given area, diversity in breed-type of animal reared was evident mainly between farmers, and in few cases within farms. This should be supported through improvement programmes implemented. Results from a study on dairy cattle production in Uganda over five years (ILRI-BOKU Project 2009) showed that indeed the farmers retained indigenous cattle breeds as well as exotic types because during outbreaks of diseases such as Rinderpest or Rift valley fever, indigenous animals survived, while most exotic animals were lost. Changes in the proportion of different breed-types reared, reasons for change, and the impact of the change on household incomes over the duration of the project will be of great interest.

3. Household characteristics influencing the breed-type of animals reared

One of the key strategies of the EADD project is to facilitate farmers to start keeping cross-bred (exotic x indigenous) cattle by providing subsidized AI services for indigenous cows. In a number of sites however, some farmers started keeping exotic breed-types of cattle before the project, as seen in the previous section. This provides us with the opportunity to identify factors affecting farmers' decision to keep exotic cattle by determining characteristics that distinguish farmers keeping exotic cattle from those with only indigenous cattle.

Existing literature and field observations from the project baseline survey suggest factors likely to affect farmers' decision to keep exotic cattle. These include the characteristics of the household head such as age, gender and level of education. Other factors are household characteristics like land size, number of adults, proportion of women and dependency ratio[1] . Finally, external factors could also play an important role in explaining breed-types reared. These include the climatic conditions (captured here as the length of growing period), market access (travel time to nearest large urban centre), population density, defined as those above 250,000 people (to take into account pressure on land at the local level), and, country specific conditions such as general level of infrastructure and the policy environment.

Table 2 presents the average values of the factors listed above. Heads of households in which exotic breed-types of cattle were reared, were on average more educated than those households only keeping indigenous cattle. Households with exotic breed-types also had a larger labour force (number of adults), but relatively fewer dependants (Kenya only). As might be expected, households keeping exotic breed-types live in areas where land pressure is higher (higher population density, in Kenya), and closer to larger urban centres (in Uganda). In Rwanda, households with more land tended to keep exotic animals possibly due to issues related to wealth (wealthier farmers in Rwanda had more land and were able to keep exotic animals). The length of the growing period, influencing feed availability, also significantly

[1] *number of dependents divided by total family size where dependents are defined as members below 15 and above 60 years*

influenced the keeping of exotic animals in Rwanda and Uganda. In Kenya, differences due to the growing period were not significant.

Table 2. *Mean values of selected variables, differentiating farmers with exotic breed-types of cattle (with = 1) and those without (= 0) (only cattle keepers)*

(s.e. in brackets)	Kenya (n = 458)			Rwanda (n = 169)			Uganda (n = 230)		
	Without	With	T-test	Without	With	T-test	Without	With	T-test
Gender (1 = male, 0 = female)	0.80 (0.035)	0.83 (0.021)		0.78 (0.042)	0.86 (0.041)		0.85 (0.027)	0.81 (0.051)	
Age of household head (years)	49.8 (1.44)	49.0 (0.78)		48.1 (1.51)	52.2 (1.88)	*	47.0 (1.05)	48.7 (1.93)	
Number of years of education (household head)	6.4 (0.37)	8.34 (0.27)	***	3.7 (0.31)	5.6 (0.53)	***	5.6 (0.32)	7.8 (0.61)	***
Number of adults	2.5 (0.12)	3.1 (0.09)	***	3.0 (0.16)	3.7 (0.25)	**	2.7 (0.10)	2.9 (0.20)	
Proportion of family members who are women	0.51 (0.044)	0.47 (0.027)		0.51 (0.051)	0.44 (0.059)		0.49 (0.038)	0.49 (0.065)	
Dependency ratio	0.49 (0.044)	0.43 (0.027)		0.42 (0.050)	0.42 (0.058)		0.51 (0.038)	0.46 (0.065)	
Land size (acres)	10.4 (4.07)	11.0 (1.27)		8.4 (1.29)	39.0 (9.38)	***	177.4 (51.6)	292.5 (125.9)	
Human population density (per $100m^2$)	1.5 (0.21)	2.8 (0.42)	*	1.8 (0.39)	1.8 (0.38)		1.3 (0.15)	1.7 (0.37)	
Travel time to urban centres (min)	573.7 (22.5)	549.1 (12.2)		256.2 (9.82)	245.7 (10.06)		176.4 (5.64)	150.6 (8.91)	***
Length of growing period (days)	208.8 (6.36)	208.5 (2.73)		159.1 (1.93)	148.9 (1.75)	***	226.3 (1.89)	239.6 (4.71)	***

[a] difference statistically significant at 1% (***), 5% (**) and 10% (*) level, blank = non-significant (> 10% level)

To model the relationship between the decision to keep exotic breed animals and multiple factors and to control for correlation between those factors (for example areas with high population density are likely to be close to urban centres), a logistic regression was used. Results are presented in Table 3.

Table 3. *Logistic regression results*

	Odds Ratio (s.e.)	**z**	**P>z**
Gender of household head (1 = male, 0 = female)	0.83 (0.183)	-0.84	0.399
Age of household head (years)	**1.02 (0.006)**	**2.58**	**0.010**
Number of years of education of household head	**1.13 (0.024)**	**5.91**	**<0.001**
Number of adults	**1.20 (0.074)**	**2.89**	**0.004**
Proportion of family members who are women	0.70 (0.239)	-1.05	0.295
Dependency ratio	0.91 (0.380)	-0.22	0.826
Land size (acres)	1.00 (0.0001)	-0.33	0.744
Human population density (per 100m^2)	**1.04 (0.026)**	**1.63**	**0.103**
Travel time to urban centres (min)	1.00 (0.0004)	-0.53	0.598
Length of growing period (days)	1.00 (0.002)	0.69	0.491
Country effect: Uganda vs. Kenya	**0.13 (0.036)**	**-7.49**	**<0.001**
Country effect: Rwanda vs. Kenya	**0.37 (0.099)**	**-3.70**	**<0.001**
% correctly classified- sensitivity	79.3%		
% correctly classified- specificity	63.3%		
% correctly classified- overall	71.9%		

* Response = decision to keep exotic (or crossbreed exotic x indigenous) breed type cattle (1 = yes, 0 = no)
No interactions significant
Pseudo R-squared = 18.2% variation accounted for by the model

Factors in bold had a significant effect ($p<0.10$). The results corroborate those presented in Table 2. Older and more educated heads are more likely to keep exotic cattle. Indeed, older households are usually more experienced and able to acquire and maintain exotic animals that are more costly. This observation however means that the EADD target to mobilize young farmers may be difficult to reach, suggesting the need for specific strategies. The positive relationship between education level and decision to keep exotic cattle has been found in earlier analysis (see for example Baltenweck and Staal, 2007); for EADD, this calls for targeted training towards less educated farmers to help compensate for lower school training. Interestingly, whether the head was a man or a woman does not impact significantly on the decision to keep exotic cattle). Households with more labour availability were also more likely to keep exotic cattle, which is consistent with the fact that keeping exotic breed cattle is a labour intensive activity. For EADD, this suggests that interventions that decrease the workload may be needed to ensure that labour constraints do not prevent farmers from starting dairy farming. Interestingly, land size did not affect significantly the decision to keep exotic cattle, suggesting that even farmers with small land size could start dairy production using exotic breed-types. This justifies EADD strategy to target poor farmers who usually have smaller land sizes: because feed can be obtained from outside the farm (ILRI-EADD Baseline Report 3, 2010).

The positive relationship between human population density and keeping exotic cattle suggests that EADD efforts will have to be more intense in low population density areas to promote exotic crossbred dairy animals. Finally, households in Uganda and Rwanda are less likely to currently keep exotic breeds. This is explained by historical reasons with Kenya having benefited from presence of exotic cattle from the beginning of the 20^{th} century.

4. Herd composition and reproductive performance

Herd composition

The composition of the herd on farms within each country was determined to gain insights on what priority the farmers gave to different animal categories (calves, immature animals, castrates, breeding males and breeding females), what mating strategies were adopted, and if there were opportunities for on-farm selection of replacements (i.e. animals born into herd).

The relative percentage of different categories of animals reared for exotic and indigenous breed-types kept by the farmers are presented in Figure 8.

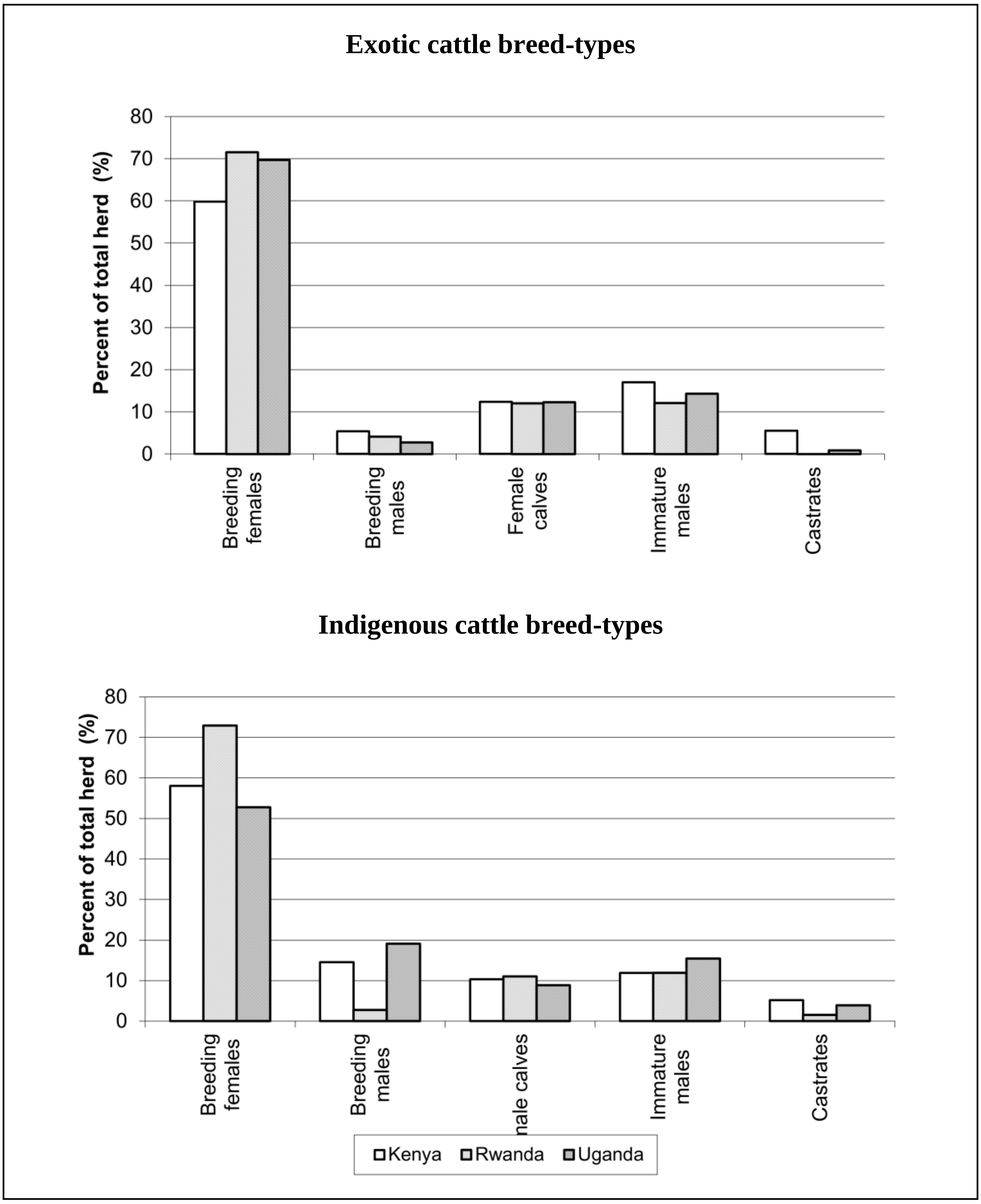


Figure 8. *Percentage of categories of animals reared by farmers for exotic and indigenous breed-types of cattle kept in Kenya, Rwanda and Uganda*

In all countries, for both exotic and indigenous cattle breed-types, the farmers had herds comprising, on average, of more than 50% of breeding females. The proportion of breeding males reared tended to be higher where farmers reared indigenous breed types than where exotic breed-types were reared in both Kenya and Uganda, indicating a tendency to use more natural mating among indigenous breed-types. It was interesting to note that in Rwanda, breeding males comprised less than 5% of the herd irrespective of the breed-type reared. The percentage of female calves within herds was also quite low (<12%) in all countries. This was an interesting observation as it implies a challenge to the implementation of on-farm selection of replacement animals. Low numbers of replacement animals available on-farm tend to lead to farmers retaining breeding animals to an old age, even when their productivity has greatly diminished.

Reproductive performance

Within the production systems under study, average milk yields per animal across a lactation were low. From the lactation curves presented in Appendix 1, the average daily milk production for the various exotic breed-types was less than 10kg. Daily milk production greatly depends on the stage of lactation, with higher outputs attained earlier in the lactation than later. Information was collected from a sub-sample of farmers within each country on the age at first calving (AFC) for animals reared, and the calving intervals for each. Averages of values obtained per country are presented in Table 4.

Table 4. *Average age at first calving (months) and Calving intervals (months) for breed-types of animals reared in project sites of Kenya, Rwanda and Uganda*

Breed-Type	Age at first calving (months)		Calving interval (months)	
	Mean	**CV (%)**	**Mean**	**CV (%)**
Kenya				
Exotic				
Ayrshire	29	16.8	15	26.7
Guernsey	32	33.7	16	31.3
Holstein-Friesian	29	22.4	16	25.0
Jersey	29	18.8	14	21.4
Indigenous				
Boran	28	24.7	26	42.3
Local Zebu	36	21.8	18	33.3
Rwanda				
Exotic				
Ayrshire	36	--	.	.
Holstein-Friesian	29	17.9	14	28.6
Jersey	28	14.1	13	15.4
Indigenous				
Ankole	34	23.1	15	33.3
Boran	34	8.3	12	--
Sahiwal	30	21.4	12	0.0
Uganda				
Exotic				
Ayrshire	30	--	11	--
Guernsey	26	11.9	13	15.4
Holstein-Friesian	30	14.6	14	21.4
Jersey	32	24.5	14	7.1
Indigenous				
Ankole	41	22.4	15	20.0
Boran	36	47.5	15	20.0
Local Zebu	43	19.3	14	21.4
Nganda	37	20.7	15	20.0
Sahiwal	29	7.4	12	--

Animals reared in all three countries tended to calve for the first time (AFC) when they were above 26 months of age. Exotic breed-types tended to first calve at an earlier age than the indigenous ones. This difference was particularly notable in Uganda, where Ankole, Nganda and Local Zebu animals calved for the first time when they were more than three years old (>36 months). The late age AFC for indigenous breed-types could either be due to their inherent genetic make-up, or as a result of differential treatment often given to these animals, particularly in terms of feeding, resulting in their later maturation.

Calving intervals were variable within breed-type between the countries. In Kenya, the calving interval tended to be longer for all breeds than in the other countries. Here, a prolonged calving interval was particularly notable for the Boran and Local Zebu animals (>18 months). Within dairy production systems, protracted calving intervals are undesirable as they tend to result in higher costs of production. Calving interval is intrinsically linked to an animal's milk production. Though an animal may produce more milk with more days in milk, the longer the lactation length, the lower the daily milk yield. Livestock keepers should aim to raise animals that are able to regularly reproduce in order to maintain a reasonably high level of milk production. Factors influencing calving intervals would need to be carefully evaluated and targeted interventions designed within the project areas in order to improve on productivity.

5. Selection and mating strategies used by farmers

A sample of the project surveyed farmers were requested to identify which selection and mating strategies they had ever used on their farms. Strategies identified, and the percent of farmers citing the use of each are presented in Table 5.

Table 5. *Percentage of households citing various selection and mating strategies used (ever), and those used in the last 12 months*

	Kenya		**Rwanda**		**Uganda**	
	Percentage of farmers citing strategy used					
Breeding strategy identified	Ever used	In last 12 months	Ever used	In last 12 months	Ever used	In last 12 months
Artificial Insemination	21.9	17.8	7.8	3.9	11.8	5.9
Castrating non-productive males	41.4	29.0	7.8	3.9	50.0	20.6
Controlled mating - Best males to best females *	**65.7**	**39.6**	**82.4**	**62.7**	**38.2**	**32.4**
Controlled mating - To avoid mating of close relatives	59.8	36.1	49.0	37.3	44.1	29.4
Controlled mating – Other[1]	11.2	7.7	19.6	19.6	5.9	2.9
Cross breeding	39.6	26.0	21.6	15.7	38.2	33.8
Culling or selling non-productive animals	55.0	33.1	11.8	13.7	64.7	41.2
Gift, loan, exchange or purchase of high quality animals	59.8	33.1	43.1	33.3	51.5	26.5
Using best animals available	38.5	26.0	41.2	33.3	44.1	27.9

**Using best males from own herd, multiplier associations, or neighbouring (or other) farm*
[1]Use of corrective mating

It was evident that in all three countries the livestock keepers implemented some form of controlled mating within their herds, most commonly attempting to mate the animals they identified as their best to the best mate available. Farmers were also aware of inbreeding, and practiced the mating of unrelated individuals in order to keep levels of inbreeding low. In Kenya and Uganda, more than 40% of the farmers indicated that they castrated non-productive males, however, only 22% of the farmers in Kenya and 12% of those in Uganda had ever used artificial insemination (AI). This implies a high use of bulls within the countries. Details on the adoption and use of AI within the sites surveyed are outlined in ILRI-EADD Baseline Report 2 (2010). For a classical breeding strategy, the EADD project will face the challenge of illustrating the improvements in productivity possible through use of "proven[2]" bulls, via AI, rather than using "village" bulls.

Crossbreeding as a strategy was used by a number of farmers within all countries. In both Kenya and Uganda, more than 30% of the farmers indicated that they used crossbreeding, while in Rwanda 22% of the farmers used crossbreeding. The objectives for crossing were not outlined by the farmers.

5.1. Culling strategies used by farmers

Culling of dairy cows is a complex decision for farmers involving several factors, and is generally classified into two major categories, involuntary and voluntary. Cows leaving the herd voluntarily are culled either due to low production, poor type or poor dairy characteristics, whereas those culled involuntarily have health problems, reproductive disorders, mastitis, or die due to severe disease and accidents (Oltenacu *et al*., 1984). The level of ***involuntary culling*** in a dairy herd is an important indicator of health and adaptability, whereas ***voluntary culling*** is indicative of management strategies and objectives of the producer. A high culling rate results in insufficient generation of heifer replacements to maintain and expand the dairy herd. This may lead to increased replacement costs resulting from the purchasing of replacements from outside the herd.

From the information collected at household level, ***involuntary culling*** was classified into three broad categories namely, Diseases, Accidents and Malnutrition. The numbers of animals culled involuntarily and the proportionate loss due to different reasons based on farmer recall of events in the preceding 12 months are presented in Table 6.

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[2] A bull that shows superior genetic merit for specific traits of interest, based on an evaluation of the same in comparison to other bulls within a large population

Table 6. *Numbers of animals lost due to involuntary culling in the previous 12 months, and the percentage loss attributable to each cause in the project countries*

Country		Total no of animals kept	Number lost (N)	% of Total no lost	Proportionate loss by cause (% of N)		
Cause of loss					**Disease**	**Accident**	**Malnutrition**
Kenya	**Exotic**	2,162	126	5.8	77.8	21.4	0.8
	Indigenous	945	50	3.0	84.0	14.0	2.0
Rwanda	**Exotic**	890	18	2.0	61.1	38.9	--
	Indigenous	1,492	30	2.0	63.3	33.3	3.3
Uganda	**Exotic**	756	32	4.0	71.9	28.1	--
	Indigenous	3,711	87	2.0	73.6	18.4	8.1
All countries combined	**Exotic**	3,808	176	4.6	75.0	24.4	0.6
	Indigenous	6,148	167	2.2	74.9	19.8	5.4
	Total	9,956	343	3.0	74.9	22.2	2.9

A total of 343 animals representing 3% of the population sampled were reported to have died due to involuntary causes in the preceding 12 months. 51.3% of these were of exotic breed-type, while 48.7% were indigenous breed-types. The highest percentage loss of exotic type animals was in Kenya (5.8% of total exotic breed-type population) followed by Uganda where 4% of the exotic breed-type cattle population sampled were lost (Table 6). Diseases were reported to be the main cause of involuntary loss, accounting for 75% of animals lost in the three countries, while accidents and malnutrition accounted for the remaining 25%. The EADD project may thus gain high benefit from developing a strategy for disease control, for all the breed-types of animals. Tick born diseases were identified to be the greatest source of concern within the project areas (ILRI-EADD Baseline Report 4, 2010). Malnutrition had the greatest impact on loss of indigenous animals in Uganda (8%). This could also be an underlying cause of the lower reproductive performance of these animals shown in Table 4.

When a livestock keeper made a decision to sell an animal or to pass it on for a social or cultural reason, the animals were considered to have been ***voluntarily culled***. Further use of these animals, whether for production in other herds or if slaughtered for beef was not determined in the survey. Numbers of animals reported to have been sold or given away based on farmer recall of events in the preceding 12 months and the reasons for sale or transfer are presented in Table 7.

Table 7. *Number of animals voluntarily culled (sold or transferred) and the percentage voluntarily culled in the previous 12 months attributable to different reasons in the project countries.*

Country		Total no animals kept	No. lost (N)	% lost of Total	Percentage voluntarily culled by reason (% of N)				
Reason for sale					**For Cash**	**Low Fertility**	**Old Age**	**Social***	**To Reduce herd**
Kenya	**Exotic**	2162	205	**9.5**	62.4	26.8	4.4	2.4	3.9
	Indigenous	945	55	5.8	61.8	12.7	9.1	7.3	9.1
Rwanda	**Exotic**	890	32	3.6	50.0	31.3	--	--	18.8
	Indigenous	1492	112	**7.5**	65.2	13.4	2.7	3.6	15.2
Uganda	**Exotic**	756	22	2.9	54.6	31.8	--	9.1	4.6
	Indigenous	3711	107	2.9	66.4	16.8	6.5	8.4	1.9
All countries combined	**Exotic**	3808	259	6.8	60.2	27.8	3.5	2.7	5.8
	Indigenous	6148	274	4.5	65.0	14.6	5.5	6.2	8.8
	Total	9956	533	5.4	62.7	21.0	4.5	4.5	7.3

*Social reasons include use for dowry payment or as gifts at various functions

A total of 533 animals representing 5.4% of the total number of animals kept by surveyed households within the sites sampled were culled voluntarily (Table 7). 51.4% of these were indigenous breed-types, while 48.6% were exotic breed-types. For all countries, the most common reason for voluntarily culling animals was for cash (62.7%), followed by problems due to fertility (21%). Old age and social reasons accounted for the lowest overall proportion of voluntary culling (4.5% each). The highest level of voluntary culling occurred in Kenya among exotic breed-types, where 9.5% of these animals were culled, mainly to obtain cash (62.4%). Rwanda had the highest level of voluntary culling for indigenous breed-types (7.5%), similarly for cash.

The overall culling in a 12 month period based on farmer recall, comprising both voluntary and involuntary culling was above 10%. Both exotic and indigenous breed-types were culled in almost equal numbers (435 exotic and 441 indigenous), however, in proportion to the total population by breed-type, a higher proportion of exotic animals were culled than indigenous animals (11.4% exotic, 7.2% indigenous). Among the animals culled, diseases and cash accounted for the greatest proportions of culling reasons. Detailed information on economic issues affecting animals within the project areas is presented in ILRI-EADD Baseline Report 5 (2010). Surprisingly, a low level of milk production was not cited as a major reason for culling, rather, more emphasis was on fertility and animals exhibiting infertility were sold (Table 7).

5.2. Replacement strategies used by farmers

Replacing animals, either through rearing new animals on-farm or buying in new animals is costly, and it is not always feasible to replace whole herds. Also, the replacements available may not be compatible with those desired in the breeding objective.

Numbers of animals entering the herds in a 12 month period based on farmer recall and the reasons given by the farmers for acquiring the new animals are presented in Table 8.

Table 8. *Total number of cattle entering farms (acquired) in the previous 12 months and the percentage acquired for various reasons in the project countries*

Country	Genotype	Total No animals kept	No. Acquired (N)	% of Total kept	Percentage acquired by reason for entry (% of N)					
					To Improve herd	Social	To Increase herd	As an investment	For draft power	Other
Kenya	**Exotic**	2,162	106	4.9	57.6	0.9	17.0	2.8	7.6	14.2
	Indigenous	945	42	4.4	35.7	4.8	21.4	9.5	28.6	--
Rwanda	**Exotic**	890	28	3.1	67.9	10.7	10.7	--	3.6	7.1
	Indigenous	1,492	42	2.8	31.0	28.6	7.1	--	2.4	31.0
Uganda	**Exotic**	756	11	1.5	36.4	9.1	36.4	9.1	--	9.1
	Indigenous	3,711	50	1.3	34.0	4.0	28.0	8.0	6.0	20.0
	Total	9,956	279	2.8	46.2	7.5	18.3	4.3	9.0	14.7

The percentage of new animals entering herds in all countries over the 12 month period was below 5%. Additionally, a higher percentage of exotic types of cattle were acquired than the indigenous breed/types, mainly to improve the milk production of the herd (Table 8). More indigenous breed-types than exotic types were acquired for social reasons and provision of draft power. Kenya had the highest number of animals acquired, many of which were exotic breed-types.

The diverse reasons given for acquiring animals indicate that farmers in the targeted areas value animals for more than their milk production ability. In introducing improved breeds, the EADD project needs to be sensitive to this, and to avail alternative options in order to address the farmers' social needs while improving overall herd productivity.

The sources of replacement animals indicated by a sub-sample farmers are presented in Table 9.

Table 9. *Percent of a sub-sample of farmers obtaining cattle from various sources over a 12 month period*

Means of acquiring animal	**Kenya** (N=126)	**Rwanda** (N=57)	**Uganda** (N=58)
Bought from farmer	53.2	50.9	62.1
Bought from institution	2.4	3.5	0.0
Bought from market	0.8	0.0	1.7
Bought from traders or brokers	42.9	14.0	29.3
Gift from project or NGO	0.0	14.0	0.0
Gift from relatives	3.2	19.3	6.9
Loan from project	0.0	1.8	1.7
Other	0.8	1.8	0.0

In all countries, the majority of farmers bought animals directly from other farmers. Traders or brokers also served as a significant source of animals, especially in Kenya and Uganda. In Rwanda, more farmers received animals as gifts from relatives and through non-governmental organizations than in the other countries.

From the PRA group discussions, farmers indicated that they reared animals raised as calves on their own farms or purchased them from other farmers either living in the same region or in a different region of the country. Differentiating sources of new animals depending on the breed-type was not possible. In Uganda and Rwanda, groups indicated that new animals could be accessed through the government or various NGO's while this was not possible in Kenya.

To determine the number of farmers replacing animals and the type of animals used as replacements, the farmers were requested to indicate which type of animal had been culled, and which type of animal was purchased to replace it. The outcomes from this exercise are presented in Table 10.

Table 10. *Numbers of farmers replacing cattle of various breed-types within the project countries over the previous 12 months*

		No. of farmers reporting cattle exits	No. of farmers replacing cattle	% of farmers replacing cattle	No. of farmers replacing cattle with given breed-type	
					Indigenous	**Exotic**
Kenya	**Indigenous**	51	2	3.9	2	0
	Exotic	127	14	11.0	0	14
Rwanda	**Indigenous**	33	6	18.2	5	**1**
	Exotic	17	4	23.5	**2**	2
Uganda	**Indigenous**	85	12	14.1	11	**1**
	Exotic	33	4	12.1	**2**	2

Numbers in bold & blue indicate farmers using a different breed-type for replacement

Although farmers in all countries acquired new animals in the past 12 months, the percentage of farmers acquiring animals as replacements was low for both indigenous and exotic breed/types. Those who replaced animals tended to retain the original breed-type of animal, however, in a few instances in Uganda and Rwanda (Table 10, indicated in bold & blue), farmers replaced exotic genotypes with indigenous breed types and vice versa.

It is interesting to note that the number of animals exiting farms was greater than the replacements reported. This would imply a reduction in herd size over time.

6. Desirable traits in dairy cattle reared

Individual animal characteristics identified by PRA participants to be important when selecting a dairy cow are presented in Table 11.

Table 11. *Characteristics identified to be important in selecting dairy cows in Uganda, Rwanda and Kenya*

Country	**Site**	**Characteristic of importance**								
		Milk Production	Udder characteristics	Body conformation	Feed requirement	Disease resistance	Milk Quality	Age	Fertility	Colour
Kenya	Siongiroi	✓	✓	✓	✓	✓		✓	✓	✓
	Metkei	✓	✓	✓	✓	✓			✓	
	Kabiyet	✓		✓	✓	✓			✓	
Rwanda	Mbare	✓					✓			
	Kabarore-Gatsibo	✓		✓		✓	✓			
	Bwisanga	✓		✓		✓	✓			
Uganda	Buikwe	✓	✓		✓ High					
	Baale		✓	✓						
	Luwero	✓	✓	✓						
	Kakooge		✓							
	Masaka		✓	✓						

Milk production and body conformation were important characteristics in all three countries. Although communities in three sites in Uganda did not select high milk production directly, they rated characteristics related to the size and shape of the udder (udder characteristics) as important since it was assumed that a large udder indicated good potential for high milk production. The quality of milk produced was only rated as important by communities in Rwanda, whereas fertility was important only in Kenya. Communities in Kenya went a step further and gave scores for different characteristics they considered important within the various breed-types of cattle reared. Average scores across project sites in Kenya for different characteristics (0 – Lowest importance to 3 – highest importance) are illustrated in Figure 9.

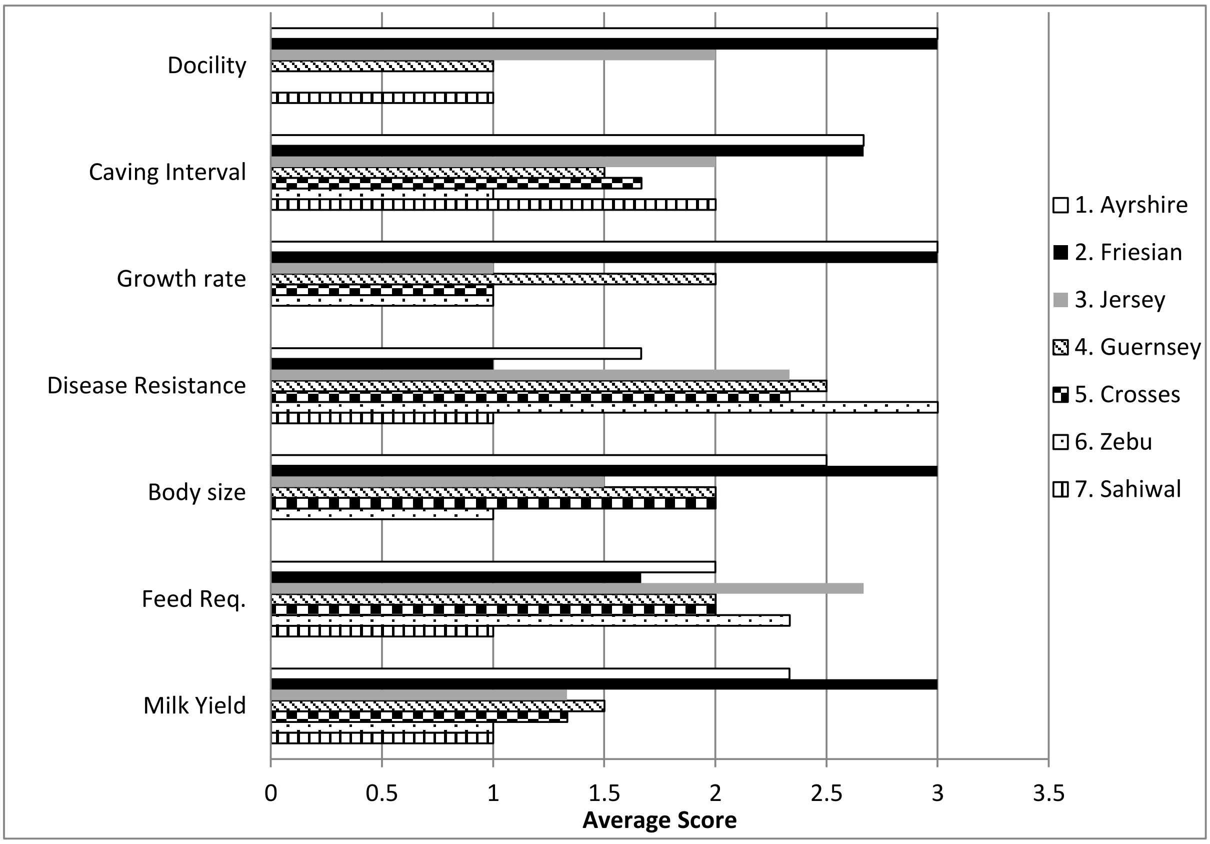
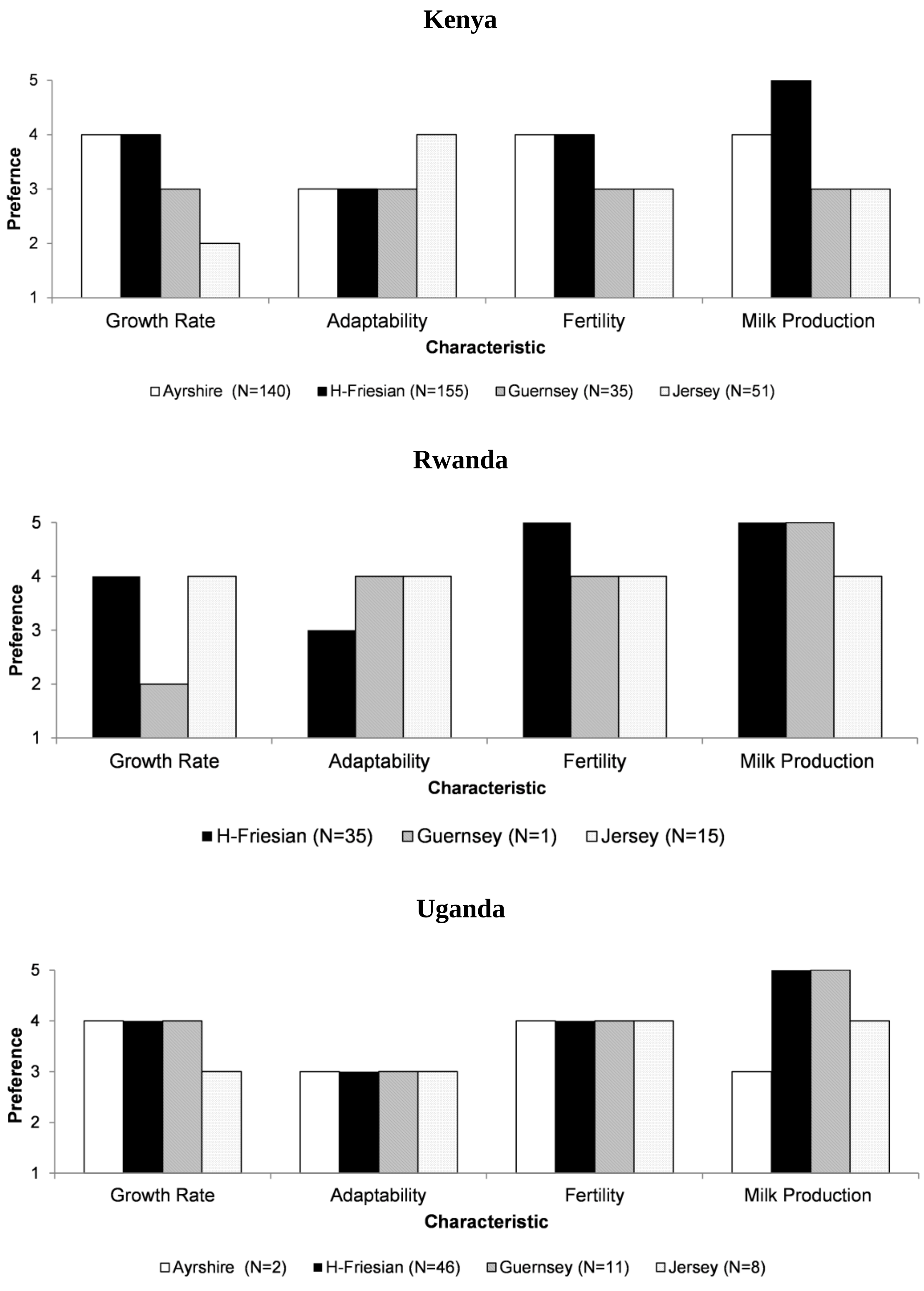


Figure 9. *Dairy cattle characteristics of interest, and their relative rating for various breed-types raised by small-holder farmers in Kenya (0-Lowest to 3-highest; Breed-types 1-5=Exotic, 6-7 indigenous)*

Among the exotic breed-types, not all characteristics were given the same scores; milk yield was rated very important for the Friesian and the Ayrshire breed-types (including pure and crosses), while disease resistance was more important for the other breeds. Livestock keepers also rated highly non-milk production traits such as docility, calving interval and body size in the Friesian and Ayrshire breed types relative to other breeds.

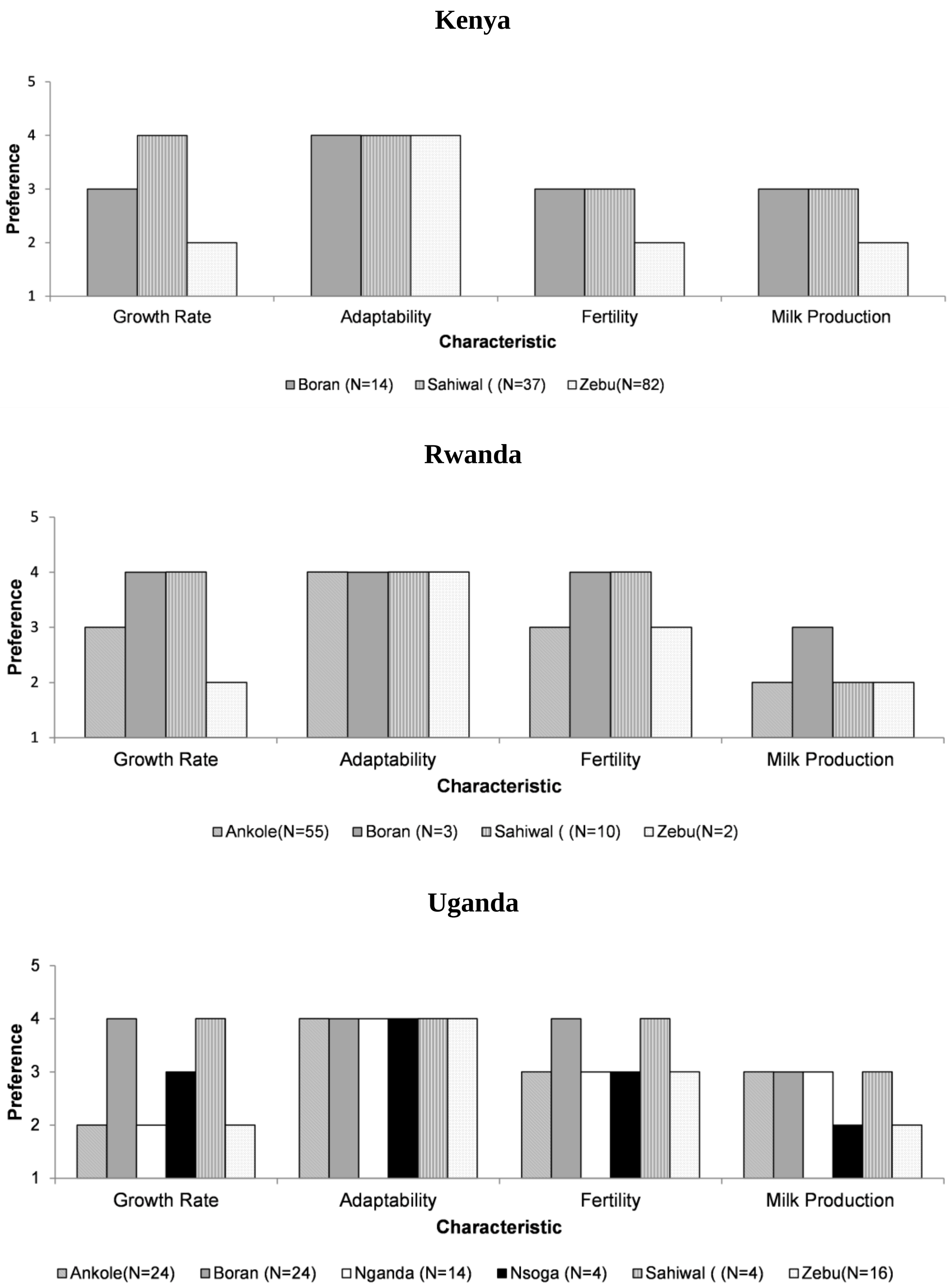
In the PRA, the overall ranking in terms of preference for both indigenous and exotic breed types by the communities from most to least preferred was: Ayrshire, Friesian, Jersey, Guernsey, Crosses, Zebu and Sahiwal. It was however noted that although the Friesian breed-type may be a desirable animal, its feed requirements were too high.

To augment the information obtained from the various communities on the general rating of traits and animals, a sub-set of households within each country were requested to provide information on their choice of breeds and the ranking of each based on various characteristics of importance. Participating farmers were requested to provide a score ranging from ***1*** to ***5*** of what characteristics they perceived to be most important in the different breed-types of cattle reared. A score of ***5*** for a characteristic meant that it was very important when evaluating an animal of that specific breed-type, while a score of ***1*** meant the characteristic was not critical for that breed-type. The results from this exercise are presented in Figure 10 for exotic breed-types and Figure 11for indigenous breed-types.



Scale 1-5; 1=Never preferred, 5= Most preferred

Figure 10. *Ranking of characteristics of importance in selection of exotic breed-types of dairy cattle based on preference*



Scale 1-5; 1=Never preferred, 5= Most preferred

Figure 11. *Ranking of traits of importance in selection of indigenous breed-types of dairy cattle based on preference*

In all countries, exotic breed-types scored higher than indigenous breed types for milk production, while indigenous breed types rated higher than exotic types for adaptability (Figure 10 and Figure 11). Among the exotic breed-types in all the countries, the HF was most preferred for its high milk production potential (average score 5), good growth rate and fertility (average score 4). The breed-type however did not score well in terms of adaptability (average score 3). The Ayrshire was rated close to the HF in Kenya in all traits except for milk production where its score was lower than that of the HF. This breed did not feature in the rating carried out in Rwanda.

The Guernsey in Kenya was rated moderate for all characteristics (score 3), however, in Uganda and Rwanda, its rating was on par with the HF in terms of milk production (score 5), and for growth rate in Uganda.

The Jersey breed in Kenya was most preferred for its adaptability (score 4), however, for the other characteristics its score was lower than other breeds. In Rwanda, the Jersey was well appreciated for all characteristics with an average score of 4. In Uganda the Jersey was preferred for fertility and production (score 4), but not so preferred for growth and adaptability. It should however be noted that all exotic breed types received the same average rating on adaptability and fertility in Uganda.

Among the indigenous breed types reared, the Sahiwal and the Boran were generally rated highest for all characteristics in all countries (Figure 11). The breed with the lowest rating on milk production and growth in all countries was the zebu. All indigenous breeds were given a similar rating on adaptability in the countries (score 4). Rating on fertility was mainly average (score 3) for these animals, except for the Sahiwal and Boran in Uganda and Rwanda which were rated well (score 4).

Information in the household questionnaires on breeds-types reared by specific farmers was compared against breed-types preferred by this sub-set of farmers. The outcome from this comparison is presented in Table 12.

Table 12. *Percentage of households rearing specific breeds of cattle versus their stated preference for that particular breed*

		Percentage of farmers keeping preferred breed- type		
	Preferred breed:	**Kenya (N=173)**	**Rwanda (N=61)**	**Uganda (N=78)**
Exotic Breed-types	**Ayrshire**	49.1	1.6	0
	Guernsey	14.3	100.0	18.2
	Holstein-Friesian	57.8	29.5	23.1
	Jersey	1.8	16.7	3.2
Total for exotic breed-types		39.0	16.4	9.6
Indigenous breed-types	**Ankole**	--	91.2	33.3
	Boran	14.3	33.3	25.0
	Local Zebu	51.8	--	16.7
	Nganda	--	--	66.7
	Sahiwal	8.1	50.0	25.0
Total for Indigenous breed-types		35.8	80.6	21.3

There was large variation in the three countries in the breeds kept relative to the breed preferred (Table 12). Among the exotic breed-types, on average, 39% of the households kept the breed they preferred. Although farmers in Uganda and Rwanda indicated that they would prefer to keep an Ayrshire, less than 2% of the farmers actually kept these animals

Among the exotic breed-types, the percentage of Jersey animals kept was the lowest, although it was a breed indicated as one they would like to keep by more than 60% of the households, notably for its adaptability (Figure 10). This is an interesting result, as the fact that a farmer rears a particular breed-type of animal does not mean that it is the breed-type that the farmer would prefer to keep. The EADD project will thus need to provide information on different breed types, develop simple criteria and present options to guide farmers in deciding which breed is best for them.

7. Conclusions and Recommendations

- Results from this report indicate that farmers within an area of the EADD project countries retain diversity of animal populations. It is important that the project is able to support existing diversity within the countries for example when supplying semen for AI, semen from breeds such as the Holstein-Friesian, Ayrshire (Red breeds) and Jersey animals should be made available, and advice given to farmers on what should influence their choice when looking for a good dairy animal. To improve the overall animal productivity within the dairy systems, the group of traits that need to be selected for on-farm include production (milk yield and milk quality), reproduction (fertility and calving traits) and longevity (ability to have a long productive life in order for the farmers to reap the benefits of having animals in older parities (4-7) producing milk which is generally much more than they produce in the early parities).

- The rationale applied by farmers in acquiring animals depended on the planned use of the animals. Exotic breed-types tended to be acquired for increased milk production, while indigenous types were acquired mainly for social reasons and for provision of draft power. In the absence of clear information on which are the best breeds for the diverse environments, it is important for the project to avail genetic improvement material from selected and improved populations of the prevailing improved breeds within each country as these have adapted to the existing environments. In some areas, use of cross-bred bulls as sires of more hardy calves rather than AI may be a better option.
- Farmers in Rwanda and Uganda were less likely to exclusively keep exotic breed-types. In these areas, the EADD project would need to provide more information on the attributes of the different breeds and cross-breds that are adapted within the East Africa region to the farmers in order to facilitate them make informed choices on what animal is best for them.
- To address differential educational levels of farmers within the project areas, in addition to general farmer training, there should be some targeting towards the less educated farmers since the analysis shows that less educated farmers are less likely to keep exotic breed-types. These could be most effective using farmer to farmer field days and on-farm demonstrations. Visits and discussions with expertise within the project and collaborating partners from institutions external to those working on the ground help to re-enforce messages within farming communities.
- In all countries, farmers had ready access to bulls—either their own, or that of a neighbour for insemination. The EADD project will need to provide intensive training

on attributes of AI, and educate the farmers on the benefits of not having a bull within the vicinity to "interfere" with the AI services provided. Costs of raising male calves against their intended use (if not for breeding) need to be calculated and presented to farmers for them to make optimal decisions on how long they should retain these animals. In addition, in areas where bulls are used to provide draft power, interventions that decrease the manual workload are needed to ensure that labour constraints would not prevent farmers from culling male animals.

- To effect change in the existing production systems, in addition to availing improved breeding materials at an affordable cost, the EADD project needs to carry out targeted capacity development using simplified messages targeted to address specific knowledge gaps concerning breed choice, reproduction and selection decisions.

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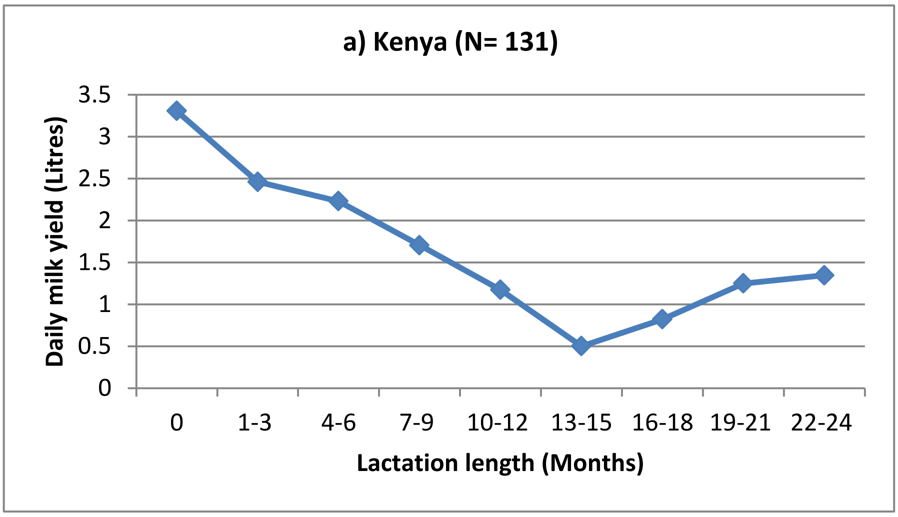
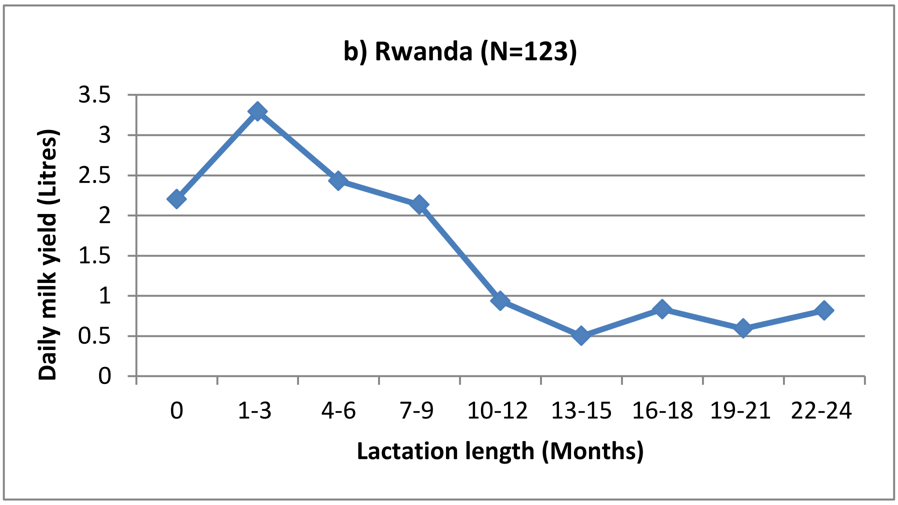
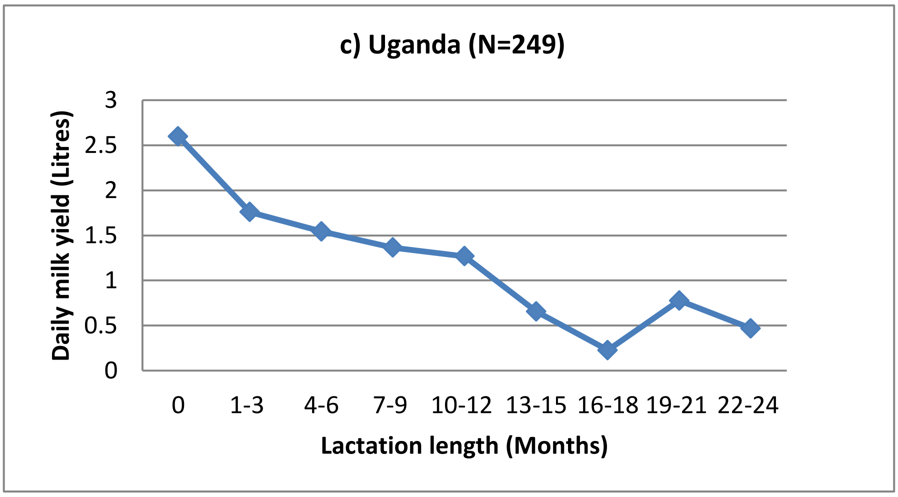
Appendix 1: Lactation curves for breed-types

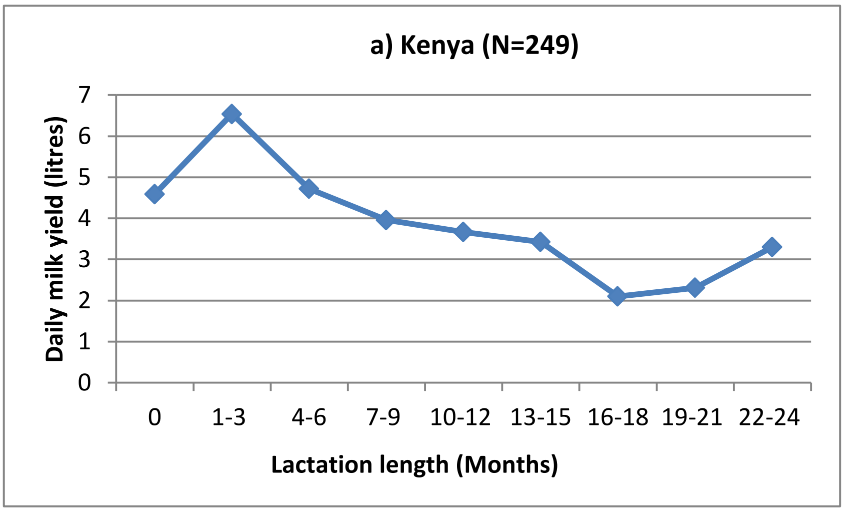
1. Lactation curves for Indigenous breed-types in the three countries

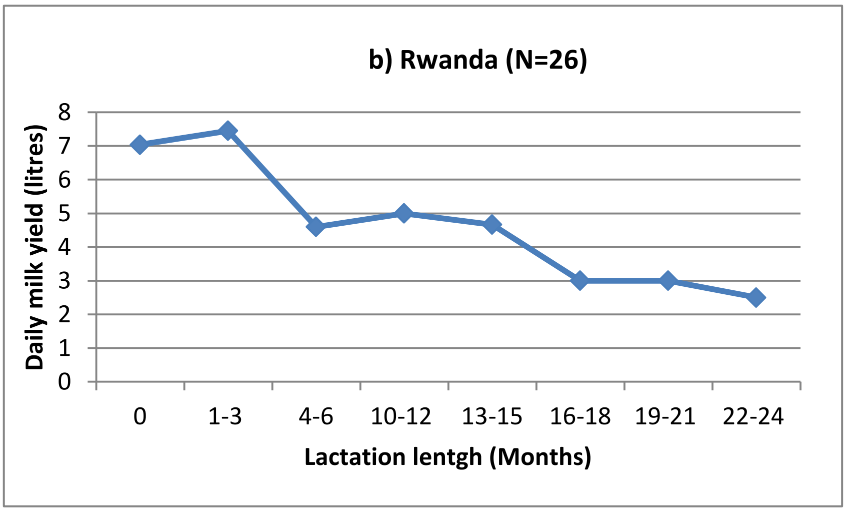


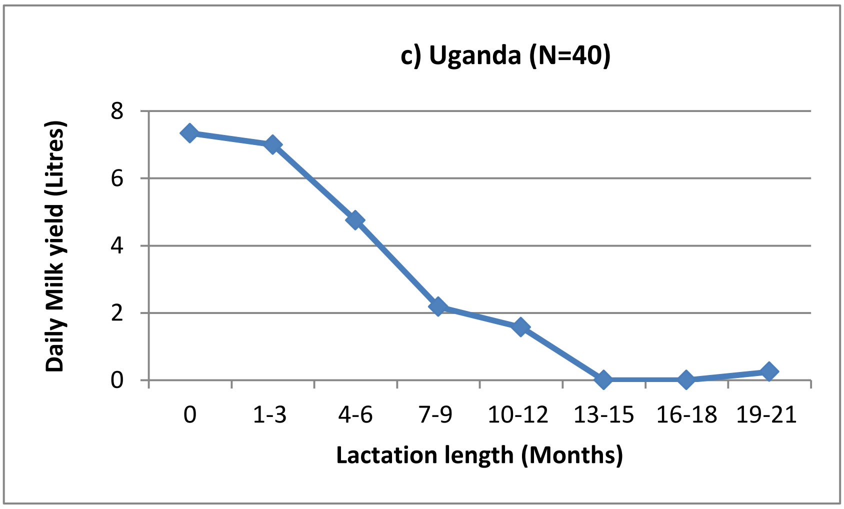




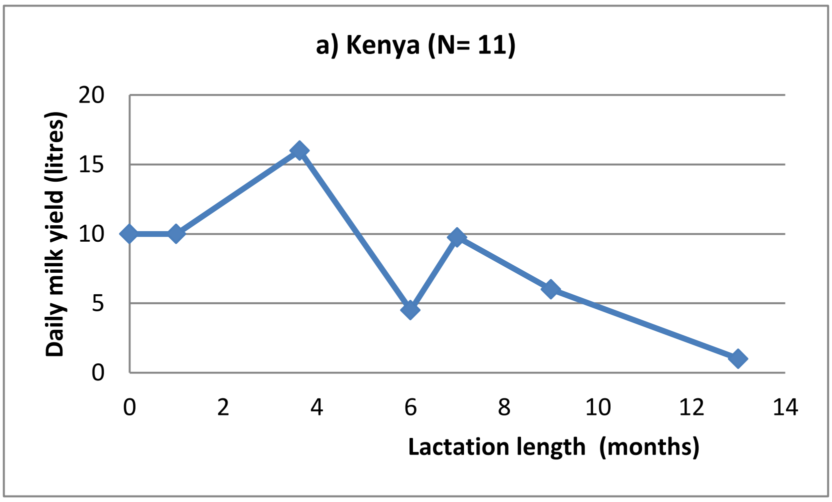
2. Lactation curves for exotic crossbreds in the three countries

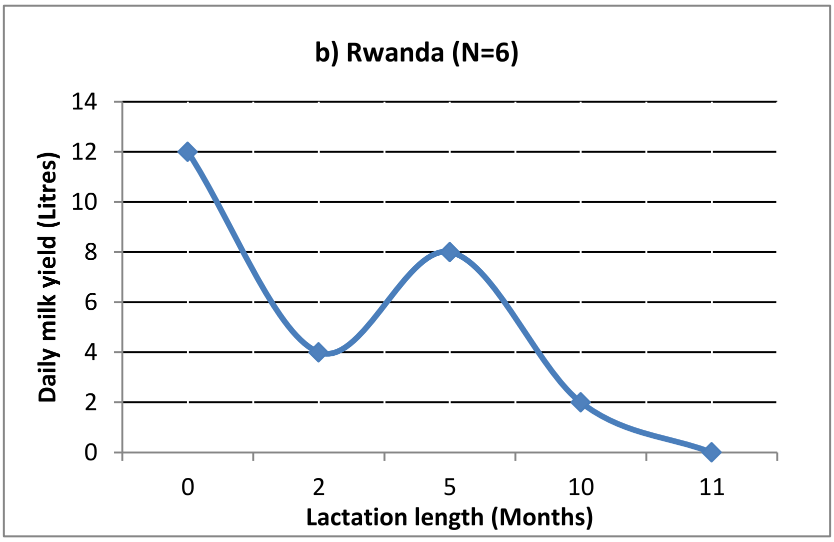


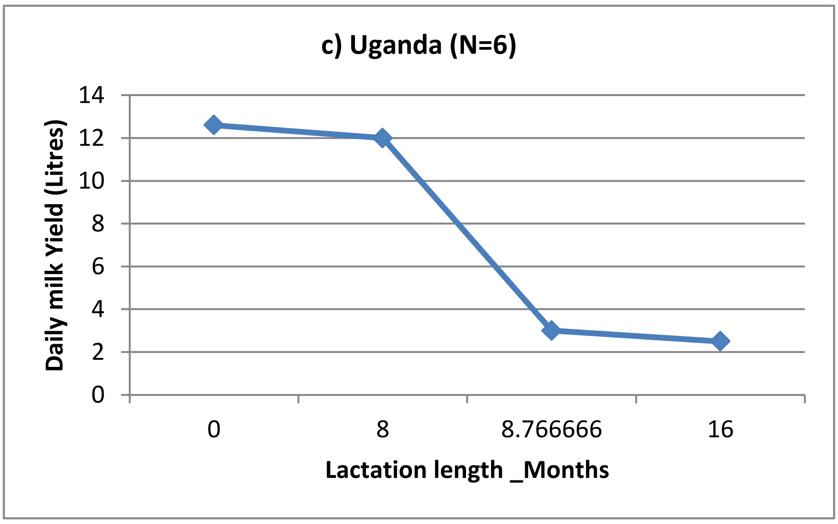




3. Lactation curves for exotic breed-typed in the three countries







Appendix 2: Methodology used to extrapolate household and cattle numbers

1. Recommendation domains consisting of 2 criteria: market access and LGP were extracted for all the EADD sites across the 3 countries.[A recommendation domain can be defined as the characterization of an area using certain criteria (agricultural potential, market access, human population density, etc) into homogeneous zones where similar activities can be proposed].
2. Total household numbers within the catchment areas for each site were extracted from GIS datasets and these were apportioned appropriately in areas where there were overlaps in the catchments. Data sources are latest available national census data: Kenya 1999, Rwanda 2002 and Uganda 2001.
3. Sites were grouped based on similar recommendation domains e.g. Bbaale had poor market access and low LGP from the recommendation domains dataset. Bukomero and Maddu had similar recommendation domains to Bbaale, and thus they were grouped together.
4. Baseline survey data were then used to extract cattle numbers (split into types of cattle) for the sites that were surveyed. Percentages were then calculated for the different types of cattle per site as follows

   ***Equation1**:*

   *% hhs keeping exotic cattle = (No. of hhs keeping exotic cattle/Total no. of surveyed hhs)*100*

   ***Equation 2**:*

   Estimated no. of hhs keeping exotic cattle = (Equation1 no. of hhs/site)*

   ***Equation 3**:*

   *<u>No of exotic cattle</u> = Eq2 * avg no of exotic cattle kept by farmers keeping exotic animals only.*