

Indigenous Breeding Strategy to Sustain Key Economic Traits of Ankore Cattle in the South-West Agro-Ecological Zone, Uganda

Atuhaire Andrew Mwebaze¹, John David Kabasa², Peter Baine³

^{1,3}National Animal Genetic Centre and Data Bank, P.O. Box 183, Entebbe, Uganda

²College of Veterinary Medicine, Animal Production and Biosciences, Makerere University, P.O. Box 7062, Kampala.

Abstract

Ankore cattle are an important native breed with strong crossbreeding potential, producing resilient hybrids suited to harsh environments. They hold cultural significance, representing identity and playing a role in various social practices, including identity, heritage, bride price, rituals, and feasts. Breeding practices are shifting from traditional to modern scientific approaches. This study identified key traditional practices that yielded traits with high economic value through interviews, focus group discussions, and observations involving household heads, opinion leaders, and breeders in Uganda's South-west Agro-ecological Zone. We explored indigenous breeding technology, selection processes, and delivery mechanisms for desired and most economical traits. Data analysis revealed that the main reasons for breeding Ankore cattle include heritage symbolism (30.1%), milk production (24%), beauty (22%), employment (12%), social satisfaction (9%), and cash income from cattle or milk sales (9%). Key economically valued traits were weaning weight (3,254.13), calving interval (574.23), age at maturity (83.86), and age at first calving (14.4). The findings suggest that current growth-rate traits emphasised in beef breeding offer limited profit margins in Ankore cattle breeding. To ensure sustainability, a strategy is needed that balances economic, ecological and social factors. Effectively integrating traditional and modern practices is critical for improving productivity and conserving Ankore cattle.

Keywords: Ankore Cattle, Breeding Strategy, Modern, Indigenous Approach

Introduction

Ankore cattle are a unique group of related ecotypes within a species, adapted to specific ecosystems and native to the Great Lakes region of East and Central Africa. They are a stable cross between *Bos indicus* (Zebu, a humped cattle breed) and *Bos taurus* (common domesticated cattle). Ankore cattle are known for their elegant gait, large, long white horns, and varied coat colours, often solid cherry red or red with white spots or patches (Wurzinger et al., 2006). They are an important native breed with strong crossbreeding potential, producing resilient hybrid offspring that adapt well to severe environments (Wilson, 2018). More than 75% of the cattle population consists of Ankore cattle. Although they are well adapted to harsh conditions, their average genetic potential for economic productivity is relatively low.

Ankole cattle symbolise heritage, identity and unity. They are used for bride price, building friendships, social status, cultural practices, settling disputes, rituals, sacrifices, feasts, and recreation. The Banyankore people, native to Uganda's South-west Agro-ecological zone, have developed indigenous skills that have sustained Ankole cattle for more than a century. These innovations and management practices have been carefully developed, utilising focused opportunities and clarity to improve and maintain the pure genetic resources of well-adapted Ankole cattle.

Transforming the livestock sector to position Ankore cattle as a leading breed is critical, as they possess well-documented superior genes that produce high-productivity, resilient, and giant hybrid animals. Targeted breeding strategies can enhance Ankore cattle productivity (Njau et al., 2013). These productivity gains are particularly important given rising demand driven by population growth, urbanisation, and rising incomes (Weisbjerg et al., 2018). However, initiatives to increase livestock productivity must be implemented without depleting ecological resources or causing environmental harm. Reducing methane (CH₄) emissions from livestock remains a critical objective.

Ankore cattle, part of the Sanga group, a classification of African cattle comprising Zebu and *Bos taurus* types, have been among the native breeds considered for crossbreeding. Consequently, the National Agricultural Research Organisation (NARO) considered establishing a nucleus herd for breeding and genetic improvement in Uganda's South West Agro-ecological Zone. Individual animal data recording and performance evaluation of the Ankore nucleus herd have been ongoing since 2007. These data inform programme decisions, including nucleus development and producing young bulls for crossbreeding with other native cattle. Indigenous approaches emphasise selecting nucleus herds with higher-quality germplasm (genetic material) (Chasama et al., 2023). In contrast, scientific husbandry often treats all trait selection criteria as equally important, which does not reflect practical realities (Kluyts et al., 2003). Understanding indigenous methods for selecting priority traits and high-economic-value (EV) attributes is critical to promoting and sustaining Ankore cattle. Strengthening selection within the nucleus herd helps distribute higher-quality germplasm to stakeholders. This underscores the importance of identifying traits that align with stakeholders' needs, using modern scientific husbandry, indigenous traditional methods, and economic assessment. Research on Ankore cattle breeding and conservation will not only support the development of a purposeful, focused system with clarity but also prioritise economically valuable traits. It will also promote heritage and reject indiscriminate breeding methods. Integrating scientific breeding husbandry, indigenous technical approaches, and sequential bio-economic modelling will promote ecological sustainability, social acceptance, and an economically viable system for selecting desired priority traits in Ankore cattle. This study aimed to identify the elements and components that confer desired priority traits in Ankore cattle with high economic value and social benefits. The identified knowledge and skills will help researchers, farmers, and policymakers develop, promote, and conserve Ankore cattle and their heritage.

Materials and Methods

Description of the study area

This section provides an overview of the study area, detailing the geographical features, ecological characteristics, and relevant socio-economic factors observed at Nshaara Ranch in Uganda's South-West Agro-ecological Zone. The ranch lies between 7° South of the Equator and 32° East of Greenwich. The South-West Agro-ecological Zone (SWAEZ) covers 4,104 km² and has a population of 213,280 (UBOS, 2022). The ranch covers 4,500 acres, of which 3,500 acres are natural pastures dominated by *Hyparhenia*

rufa. These natural pastures were the sole feed resource for 5,210 heads of cattle on the ranch. The study area and the ranch were selected because of the numbers and duration of Ankore cattle in the area, social attachment to Ankore cattle, and the favourable climate and landscape. The study area is generally characterised by gently undulating topography with flat-topped hills; the altitude ranges from 1,200 to 1,500 m above sea level; the mean annual rainfall ranges from 500 to 1,000 mm; and the temperature ranges from 21 to 34 °C.

Sampling procedure

We employed a multistage sampling technique, with the sampling frame comprising 3 districts. In each district, we randomly selected 2 sub-counties and 4 parishes using random number tables. We purposively sampled 60 households in each district from household lists provided by the Agricultural Extension Services Department, using Ankore cattle-keeping households as the sampling frame, following the method proposed by Poate and Daplyn (1993). Table 1 summarises the descriptions of the study areas.

Table 1: Description of the Study Areas and Sample Sizes Used in the Study

District	Description
Isingiro	Located in Southwest Uganda, bordering Tanzania, in Uganda's cattle corridor. It experiences a tropical savanna climate with annual rainfall of approximately 1,200 mm and a temperature range of 30-170 °C.
Kiruhura	Located in Uganda's cattle corridor, with features of an undulating landscape and extensive rangelands suitable for cattle grazing. Rainfall is bimodal but erratic, leading to prolonged dry periods.
Lyantonde	A key area in Uganda's "cattle corridor," characterised by semi-arid conditions. The economy relies heavily on livestock and pastoralism, with a shift from traditional grazing to commercial ranching that supplies meat and dairy to central Uganda and nearby areas.

Data collection

Primary Data

We conducted individual interviews with purposively selected Ankore cattle farmers, using structured questionnaires administered to household heads. The questionnaires included both closed and open-ended questions and were designed to collect information on households' socio-economic characteristics and Ankore cattle husbandry management practices. In addition, we collected and ranked data on preferred Ankore cattle traits, production potential, calving interval, adaptive characteristics, the role and practice of cultural myths, and the application of indigenous knowledge in breeding. Before the survey, we pre-tested the tool with 30 household farmers.

In addition, we held focus group discussions in each selected village to supplement information gathered through individual interviews. The discussions involved herd owners, children, herdsman, and women familiar with Ankore culture, heritage, myths, and practices, and provided an overview of gender perspectives in the study area. A checklist translated into the local language guided the discussions. It covered a range of topics, including general household information.

Estimates of feeding, veterinary drug, and labour costs were based on the previous production cycle, which ran from January 2024 to November 2025. Feeding costs were estimated for each animal category using

average live weights, available land, and herbage productivity per acre measured during the cycle. Veterinary drug costs were estimated based on weekly acaricide spraying, deworming at six-month intervals according to live weight, vaccinations, and the average number of treated cases. Labour costs were estimated using casual labour rates. The farm incurred no marketing costs for cattle or milk, as it sells animals and milk directly to consumers at the farm gate. Indicative prices for live animals were developed to estimate revenues from cull cows, heifers, and young bulls.

Secondary Data

Most of the secondary data on Ankore cattle production and management were drawn from household and farm herd records. Management data on feeding, breeding, housing and disease control were also collected. Production data included calving rate, birth weight, weaning age, weaning weight, pre- and post-weaning survival rates, culling age for males and females, culling interval, longevity, number of parities per lifetime, and weight at culling.

Data management and statistical analysis

We coded questionnaire data and entered them into spreadsheets for statistical analysis. We used the Statistical Package for the Social Sciences (SPSS) version 11 to compute means, standard deviations, frequencies, and percentages. We handled missing data using listwise deletion to preserve dataset integrity. We synthesised and summarised data from group discussions, providing qualitative insights alongside the quantitative analysis. We computed descriptive statistics for various parameters to provide an overview of the data. We used the chi-square test (χ^2) to assess the significance of differences in proportions; we considered p -values < 0.05 statistically significant across all tests. Before the main analysis, we checked homogeneity and normality. For household socio-economic characteristics and breeding practice frequency traits, we used analyses and chi-square tests to estimate proportions and assess significance. To evaluate differences among herd structures, we used least-squares means. To calculate ranking indices for reasons for using more than one bull, bull selection trait preferences, and cow selection trait preferences, we treated the first three ranks as representative of each of the six consecutive ranks, using Kosgey's (2004) formula.

$$\text{Index} = \frac{\sum[(3 \times \text{rank1}) + (2 \times \text{rank2}) + (1 \times \text{rank3})] \text{ individual trait}}{\sum[(3 \times \text{rank1}) + (2 \times \text{rank2}) + (1 \times \text{rank3})] \text{ overall traits.}}$$

Effective population size (N_e) was defined as the number of individuals contributing to the next generation and was strongly related to population viability. This genetic parameter is important for understanding the relationship between loss of genetic variation and inbreeding (Naveh and Lieberman, 2013). The N_e for a randomly mated population was calculated as follows:

$$N_e = (4N_m \times N_f) \div (N_m + N_f)$$

where N_m is the number of breeding males, N_f is the number of breeding females, and N_e is the effective population size.

The inbreeding coefficient was the probability that two alleles at a given locus are identical. The inbreeding coefficient (ΔF) was calculated from the effective population size (N_e) as follows:

$$\Delta F = 1 \div (2N_e) \text{ (Naveh and Lieberman, 2013).}$$

Sequential bio-economic modelling, following the procedure devised by Ponzoni and Newman (1989), involved specifying the production and marketing system, identifying income and cost sources, determining biological traits linked to the profitability of Ankore cattle production, and deriving economic

values for those traits. The profit function employed marginal analysis to assess the system's sensitivity to changes in biological and economic parameters. Using the profit function, we identified the main sources of income and expenditure and the traits associated with them. We derived the economic values by formulating a profit function in which performance traits were strongly influenced by economic indices (input prices), which we incorporated symbolically to enable stochastic simulation (Davis et al., 2020). The approach eliminated the need to determine fixed costs; income and expenditure differed by a constant amount.

Annualised total marginal profit was computed using the formula below.

$$\pi_T = R_T - VC_T$$

Where π_T is the total marginal profit per cow per year in Uganda shillings (Ugx), R_T is the total revenue per cow per year (Ugx) (accrued from selling cull cows, bullocks and cull heifers). VC_T is the total variable cost per cow per year (Ugx) (incurred in cattle nutrition (mineral supplements), breeding, health (tick control, de-worming, vaccination, and other routine treatments) and labour.

Results

Household Characteristics

Children contributed significantly to household labour, and the sizes varied, with Nakasongola having the largest. Focus group discussions indicated that men owned and utilised most of the land. Table 2 illustrates the household characteristics of households in the surveyed Districts. Each district was listed with the number of participants and the corresponding mean value.

Table 2: Ankore Cattle Farms' Household Characteristics as per the Study District

Characteristic	District Mean		
	Isingiro	Kiruhura	Nakasongola
Age of respondents	36±3.9	37±7.9	43.2±18.2
Number of children in household	5.82±1.32	5.1±2.1	6.3±4.3
Farming experience	25.4±6.9	24.9±9.9	26±12.6
Household size	8±4	9.9±4.9	8.4±5.4

Socio-Economic Characteristics of Ankore Cattle Household Farms

Potential gender bias, with men predominantly making key breeding decisions, was evident. Nevertheless, no significant association was found between household head status and education level, suggesting that educational opportunities are accessible to other household members. Landholdings varied significantly across districts. Table 3 presents the socio-economic characteristics of farmers who breed, raise and manage Ankore cattle.

Table 3: Socio-Economic Characteristics of Ankore Cattle Household Farms

Household characteristics	District and the percentage of samples			Overall %	p-value	Chi-Square Value
	Isingiro %	Kiruhura %	Nakasongola %			
Level of education					<0.001	137.53

Pre-primary	26.72	43.32	22.5	31		
Primary	28.35	11.71	40	27		
Secondary	19.23	13	27.5	20		
Tertiary	9.7	18.66	5	11		
Post tertiary	16	13.31	5	11		
land holding					<0.001	249.73
>1ha	21.69	10	10	13		
1.1 - 2ha	20	8.3	12.41	14		
2.1 - 3ha	13.31	0	11.59	8		
3.1 - 4ha	5	6.7	17	10		
>4ha	40	75	49	55		
Bull possession					<.001	198.62
Having no breeding bull	16.7	12.5	35	21		
Having one breeding bull	68.3	77.5	45	63.6		
Having >1 bull	15	10	20	15.4		
Sources of bull					<.001	145.68
Born in a herd	45	62	48.3	52		
Purchased in private	30	20	31.5	27		
Gifted	25	18	21.2	21		
The purpose of keeping a bull					<.001	107.82
Mating	80	67.5	56.4	68		
Socio-cultural	20	32.5	43.6	32		
Mating practice					<.001	232.52
Controlled	1.7	97.5	18.3	39.2		
Uncontrolled	98.3	2.5	81.7	60.8		
Reason for uncontrolled mating					<.001	261.17
Graze together	98.3	100	81.7	93.3		
Lack of awareness	1.7	0	18.3	6.7		
Culling bull/% (Yes)	100	100	100	100.0		
Reason for culling					<0.01	234.24
Sickness/disease	0.09	0.05	0.09	26		
Age/oldness	0.11	0.38	0.3	21		
Infertility	0.29	0.33	0.02	18		
Financial constraint	0.32	0.08	0.25	19		
Feed shortage	0.2	0.16	0.35	16		
Culling methods					<.001	89.36
Selling	46.7	75	91.7	71.1		
Castration	41.7	25	8.3	25.0		
Slaughter	11.7	0	0	3.9		
Main preferred colours					<.001	356.37
Dark tan	91.7	25	58.3	65		

Cherry red	0	47.5	0	19.4		
Brown and white	6.7	0	0	5		
Black	0	0	31.7	10.6		
Main Unreferred colours					<.001	289.4
White	86.7	100	8.3	71.6		
Cream	0	0	35	11.7		
Brown and white	8.3	0	41.7	16.7		

Herd Structure of Ankore Cattle

The study analysed 180 households across 18 villages in 6 sub-counties and 3 districts. The maximum herd size was 180 cattle, the minimum 15 cattle, and the mean 63.7 h/c. The herd structure comprises Ankore (76.57%), crosses (21.34%), and exotics (2.09%). Table 4 presents the mean herd structure for Ankore cattle in the study area.

Table 4: Herd Structure of Ankore Cattle

Physiological status	Number of cattle per herd by districts			Overall
	Isingiro	Kiruhura	Nakasongola	
	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE	
Bull	1.18 $\pm$ 0.08 ^b	1.22 $\pm$ 0.08 ^{ab}	1.03 $\pm$ 0.08 ^b	1.03 $\pm$ 0.08
Steers	2.70 $\pm$ 0.16 ^a	2.58 $\pm$ 0.16 ^a	1.25 $\pm$ 0.16 ^b	1.57 $\pm$ 0.17
Male calf	4.02 $\pm$ 0.17 ^a	2.38 $\pm$ 0.17 ^b	0.23 $\pm$ 0.17 ^d	1.69 $\pm$ 0.18
Female calf	7.9 $\pm$ 0.28 ^a	6.18 $\pm$ 0.28 ^b	2.51 $\pm$ 0.28 ^d	4.29 $\pm$ 0.31
Heifer	4.67 $\pm$ 0.17 ^a	0.08 $\pm$ 0.17 ^d	0.80 $\pm$ 0.17 ^{bc}	1.55 $\pm$ 0.18
In calf heifers	2.75 $\pm$ 0.18 ^a	3.12 $\pm$ 0.18 ^a	0.23 $\pm$ 0.18 ^c	1.50 $\pm$ 0.19
Cow	7.07 $\pm$ 0.31 ^a	4.87 $\pm$ 0.31 ^b	1.83 $\pm$ 0.31 ^c	3.56 $\pm$ 0.33
Total female	14.49 $\pm$ 0.56 ^a	8.07 $\pm$ 0.56 ^b	2.86 $\pm$ 0.56 ^c	6.61 $\pm$ 0.61
Total cattle	22.38 $\pm$ 0.77 ^a	14.25 $\pm$ 0.77 ^b	5.38 $\pm$ 0.77 ^d	10.9 $\pm$ 0.83
Male: female ratio	1.00:1.81	1.00:1.32	1.00:1.22	1.00:1.53
Bulls: cows' ratio	1.00:62	1.00:41	1.00:1.82	1.00:3.54
N _e	20.45	14	8.52	10.41
ΔF	0.02	0.04	0.06	0.05

^{abc} Means within rows with similar superscripts are similar; N_e = effective population size; ΔF = Inbreeding coefficient

Desirable Traits of Ankore Cattle

Farmers ranked performance indicators, opportunities, and enablers to identify the most desirable Ankore cattle traits. This process drew on the technical knowledge, experience, and skills that have, over time, contributed to the innovative presentation of Ankore cattle breeding practices. The team ranked and prioritised traits by their social, economic, and ecological significance. A socially constructed system centred on Ankore cattle and their heritage, comprising consultants, academics, technicians, and support staff with well-defined tasks, produced a realistic, comprehensive social scorecard. The scorecards identified, appraised, and ranked performance indicators, opportunities, and enablers, measuring them

against ecological sustainability, social acceptability (physical stature, temperament, and skin colour), and economic value in selection and breeding. The indigenous breeding structure created space and time to measure, discuss, and rank each cattle in the herd. Desirable Ankore cattle traits were indexed and ranked, as shown in Table 5 below.

Table 5: Desirable Traits of Ankore Cattle

Desirable trait	Study districts													Over all index
	Isingiro				Kiruhura				Nakasongola					
	Rank			Inde x	Rank			Inde x	Rank			Inde x		
1s t	2n d	3r d	1s t		2n d	3r d	1s t		2n d	3r d				
Breeding bull														
Larger body size/Stature	25	35	0	0.4	50	8	1	0.41	35	7	8	0.35	0.39	
Coat Colour	33	13	4	0.35	9	33	13	0.26	1	26	12	0.19	0.27	
Walking ability	2	2	3	0.04	5	17	4	0.13	7	12	24	0.19	0.12	
Temperament /docility	0	3	2	0.02	1	9	18	0.1	0	2	26	0.08	0.07	
Adaptability	0	0	31	0.09	0	5	1	0.03	1	12	14	0.11	0.08	
Shape of the horns	29	16	5	0.42	14	12	5	0.43	7	2	15	0.15	0.33	
Libido	0	7	24	0.1	1	9	9	0.07	16	1	0	0.14	0.10	
Breeding cow														
Milk yield	36	15	9	0.41	42	6	1	0.37	34	0	26	0.35	0.38	
Coat Colour	4	33	8	0.24	1	15	8	0.11	0	39	13	0.25	0.20	
Calf growth rate	12	3	7	0.14	5	15	5	0.13	1	0	12	0.04	0.10	
Age at sexual maturity	0	0	3	0.01	2	7	11	0.08	0	3	5	0.03	0.04	
Calving interval	0	6	15	0.08	4	14	18	0.15	0	5	9	0.05	0.09	
Larger body size/stature	8	3	13	0.12	11	3	17	0.16	25	13	0	0.28	0.19	
Longevity	8	13	7	0.14	5	16	15	0.13	1	0	12	0.04	0.10	
Calf														
Birth weight (BW)	33	13	4	0.35	9	33	13	0.26	1	26	12	0.19	0.27	
Weaning weight (WW)	12	3	7	0.14	5	15	5	0.13	1	0	12	0.04	0.10	

Post-weaning dairy gain (PoDG)	3	6	15	9	0.41	42	6	1	0.37	34	0	26	0.35	0.38
Age at first calving (AFC)	2	5	35	0	0.4	50	8	1	0.41	35	7	8	0.35	0.39
Calving interval (CI)	1	4	23	8	0.24	1	15	8	0.11	0	39	13	0.25	0.20
cultural obligation	0	0	0	0	0	0	0	6	0.02	0	6	34	0.17	0.06

Practices and Procedures Implemented by Farmers to Sustain Ankore Cattle

Ankore cattle farmers are resolute in selecting the ideal bulls at birth to cultivate their desired product traits. This strategy reflects a vision shaped by opportunities, critical enablers, and effective delivery mechanisms, all rooted in strong social networks. At the helm, the head of the household, much like an executive director, initiates the networking and selection process, often in partnership with a close family member dedicated to nurturing the calves and meticulously tracking their growth. The breeding team, comprising the head stockman and other stockmen, works alongside trusted technicians, often family friends or relatives. Gathering at the onset of the dry season, the passionate, socially selected breeding team works in unison with these technicians. Selection meetings are a testament to collaboration, shared commitment and vision. The head of the household leads these gatherings, guiding final decisions on selection and breeding strategies, fuelled by the team's collective knowledge and passion to cultivate, preserve and enhance the desirable traits of their cherished herd.

Ankore Cattle Herd Management and Performance Metrics at Nshaara Ranch

The Ankore cattle herd at Nshaara Ranch was effectively managed through open grazing in the ranch's designated paddocked grazing area. During each day's grazing session, calves under six months were systematically separated from the main herd at the start of the grazing period and returned to their dedicated resting areas after about four hours. Calves are separated by age and physical development to prevent overexertion and ensure calf welfare and safety. Adult animals were securely housed in barbed-wire kraals, while calves were kept in a chain-link paddock.

All animals are dipped weekly to control tick-borne diseases such as East Coast fever and anaplasmosis, and dewormed every three months to manage internal parasites. Vaccinations are administered according to schedule, targeting major endemic diseases including foot and mouth disease, lumpy skin disease, black-quarter, and contagious bovine pleuropneumonia. Additional treatments are provided as needed, such as antibiotic therapy for bacterial infections, supportive care for mastitis, and vitamin supplementation when required. Table 6 presents the performance of the Ankore herd at Nshaara Ranch for the 2024/2025 cycle.

Table 6: Ankore Cattle Herd Performance Metrics at Nshaara Ranch, 2024/25

Performance Characteristics	Unit	Mean ± SE
Calving rate of the herd (CR)	%	74.63 ± 2.4
Birth weight for males	kg	25 ± 2
Birth weight for females	kg	22.5 ± 3.1
Pre-weaning Survival Rate (PrWS)	%	95.71 ± 1.3

Post-weaning Survival Rate for growing animals (PoWS)	%	96.76 ± 2.3
Mortality rate for cows (MR _c)	%	2.9 ± 1.1
Weaning/culling age for males and females (WA)	days	246 ± 15
Culling rate for males (CR _m)	%	95 ± 3
Culling rate for females	%	25 ± 2
Culling rate for cows	%	5 ± 2
Reproductive longevity for cows (L)	days	3562 ± 356
Cow parities per lifetime (CPL)	number	8 ± 2
Age at First Calving (AFC)	days	820 ± 35
Calving interval (CI)	days	360 ± 29
Weaning weight for males (WW _m)	kg	160 ± 33
Weaning weight for females (WW _f)	kg	137 ± 25
Age at maturity for males (AM _m)	days	728 ± 33
Age at maturity for females (AM _f)	days	549 ± 27
Weight at First Calving (WFC)	kg	337 ± 34
Weight at Maturity for males (WM _m)	kg	259 ± 16
Weight at Maturity for females (WM _f)	kg	236 ± 14
Weight of cow at culling (WCC)	kg	382 ± 28
Post-weaning daily gain for males	kg/day	0.43 ± 0.12
Post-weaning daily gain for females	kg/day	0.32 ± 0.14

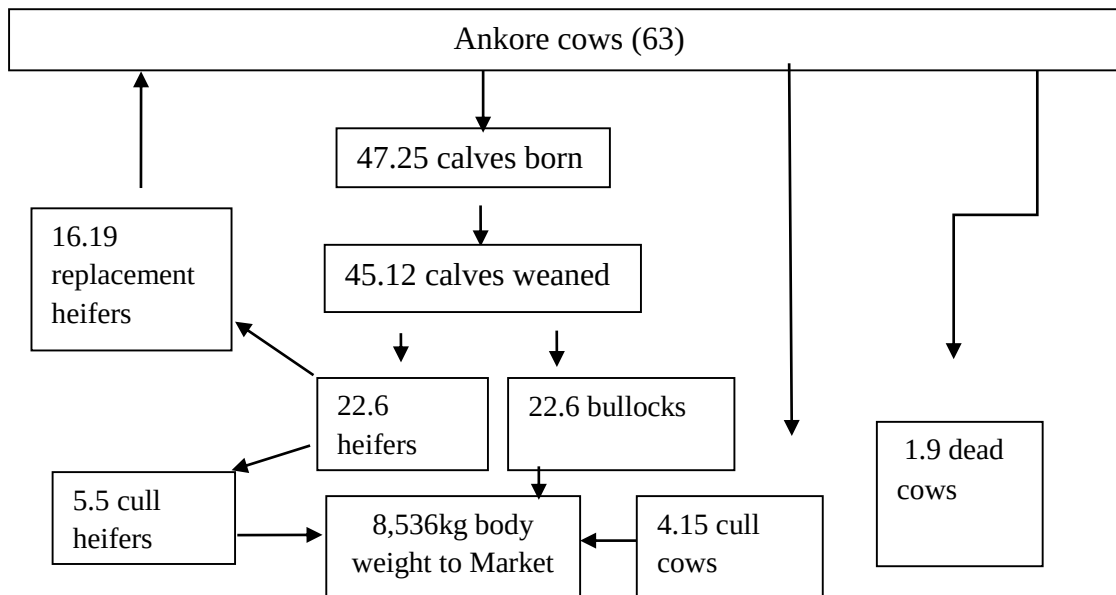


Figure 1: Ankore Cattle Life-Time Production Cycle Model at Nshaara Ranch for 2024/25

Costs for managing Ankore Cattle at Nshaara Ranch

During the production cycle, the Ankore herd at the Nshaara ranch grazed on natural pasture, with herbage estimated from biomass production per unit area and land cost. Labour for attending Ankore cattle was

costed per month per head. Health management costs were estimated for dipping, deworming, vaccination, and treatments. Off-take valuation was based on an indicative price of UGX 12,000/kg live weight. Table 7 shows the main per-unit expenditure for Ankore cattle management at the Nshaara ranch.

Table 7: Cost Per Unit for Managing Ankore Cattle at Nshaara Ranch

Item	unit	Mean price value ± SE
Price of beef output (Live animal)	Ugx/kg live weight	12,000 ± 500
Price of feed (forage)	Ugx/ kg of feed	50 ± 5
Wages of animal attendants (Labour)	Ugx/head/month	2,507 ± 43
Cost of acaricides for ecto-parasite control	Ugx/head/week	112.5 ± 17.3
Cost of dewormers for endoparasite control	Ugx/head/dose	2015 ± 65
Cost of vaccines	Ugx/ml/head	780 ± 20
Cost of other veterinary drugs	Ugx/ml/head	112 ± 15

Profitability of the Ankore Cattle

A 63-cow life-cycle model (Figure 1) shows that Ankore cows generate an annual marginal profit of UGX 78,680,274 (Table 8). Feed is the highest cost, followed by salaries and wages. The primary income source is from selling bullocks. Heifers, mainly kept for herd expansion, contribute less profit at UGX 13,565,804 compared to bullocks, which bring in UGX 63,716,015. Profitability is also affected by changes in farmgate prices in Uganda's South West Agro-Ecological Zone.

Table 8: Profitability Analysis for the Ankore Cattle at Nshaara Ranch

Variable costs by animal category					
Cost item	Cows	Young bulls	Replacement heifers	Cull heifers	Total
Feeds	11,497,500	3,650,000	2,372,500	1,277,500	18,797,500
Salaries and wages	1,895,292	601,680	391,092	210,588	3,098,652
Acaricide	341,712	108,480	70,512	37,968	558,672
Vaccine	196,560	62,400	40,560	21,840	321,360
De-worming	253,890	80,600	52,390	28,210	415,090
Veterinary drugs	342,800	108,825	70,737	38,090	560,452
Total cost	14,527,754	4,611,985	2,997,791	1,614,196	23,751,726
Revenue by cattle category					
	Cows	Young bulls	Replacement heifers	Cull heifers	Total
Revenue	18,924,000	68,328,000	0	15,180,000	102,432,000

Profit by Cattle Category					
	Cows	Young bulls	Replacement heifers	Cull heifers	Total
Profit	4,396,246	63,716,015	-2,997,791	13,565,804	78,680,274

Ugx stands for Ugandan shilling

Priority Traits in the Profit Function and their Economic Value

A cow's lifetime output depends mainly on two factors: the number of offspring produced and their selling weight. Several elements impact the number of animals sold, including pre-weaning survival (PrWS), post-weaning survival (PoWS), age at maturity (AM), age at first calving (AFC), calving interval (CI), and longevity (L).

Selling weight is closely associated with birth weight (BW), weaning weight (WW), and post-weaning daily gain (PoDG). Furthermore, feeding significantly affects sale body weight, influencing sale value and input costs. Other variable costs relate to either the number of animals or both the number and weight of the animals. The traits incorporated numerically into the profit function are birth weight (BW), weaning weight (WW), Reproductive longevity (L), age at maturity (AM), age at first calving (AFC), calving interval (CI), and post-weaning daily gains (PWdG). This profit function was developed based on the performance traits of 63 Ankore cows at Nshaara ranch, along with the economic indices of the production system, and is expressed by the following equation:

$$\pi_T = 12,000 (4.15WCC + 21.9WW_m + 5.5WW_f) - 63(8CI - AFC) - 47.3(BW_m + (WW_m - BW_m) \div 2) - 22.6(WW_f + 0.5PoDG_f (AM_f - 337) - 29.1((BW_f + 0.5(WW_f - BW_f) - 23,751$$

where π_T is marginal profit, WCC is the weight of a cow at culling, WW_m is the weaning weight for males, WW_f is the weaning weight for females, BW_m is the birth weight for males, BW_f is the birth weight for females, AM_f is the age at maturity for females, AFC is the age at first calving, CI is the calving interval, and PoDG is the post-weaning daily gain for females.

Generated Economic Value of Priority Traits

Economic values from the stochastic simulation varied widely, ranging from -145.6 Ugx/kg for birth weight to 3,254.13 Ugx/kg for weaning weight (Table 9). Growth traits had the highest extreme values. Developmental traits like age at maturity (AM) and age at first calving (AFC) had low positive values of 83.86 and 14.4, respectively. The calving interval, a fecundity trait, had a relatively high economic value of 574.23, while longevity had a low value of -3.93.

Table 9: Economic Value of Priority Traits of Ankore Cattle at Nshaara Ranch		
Trait	Unit	Economic Value
Birth Weight (BW)	Ugx/Kg	-145.6
Weaning Weight (WW)	Ugx/Kg	3,254.13
Post-weaning Daily Gain (PoDG)	Ugx/Kg/day	-123.3
Age at Maturity (AM)	Ugx/day	83.86
Age at First Calving (AFC)	Ugx/day	14.4
Calving Interval (CI)	Ugx/day	574.23
Longevity	Ugx/day	-3.93

Discussion

Male household leadership and cattle ownership align with findings from Chenyambuga et al., (2008), who observed male control over cattle and decision-making in agro-pastoral communities. Most respondents were aged 35.2 – 47.6, indicating that livestock managers are in their prime working years. However, 58% had only pre- or primary education, consistent with the 2021 National Livestock Census Report, which limits their capacity to document their innovative breeding decisions.

In the Ankore cattle breeding system, household heads typically made selection and breeding decisions, including purchasing, gifting, and culling, aligning with Kugonza et al., (2012). The study highlighted a clear division of roles between males and females, consistent with Mugisha et al. (2005), who noted distinct men's and women's tasks in Southwestern Uganda's pastoralist system. Preferences for physical appearance, production, adaptive characteristics, and cultural value indicate the breed's current status in the region (Kahi et al., 2012). Cattle symbolise wealth and prestige; they dominate mythical, material, and social networks. According to Museveni (1997), a household head with fewer than 100 heads of cattle would not receive a respectable burial upon his death. For every 100 heads of cattle, the strongest and favourite cattle were tagged with a bell (*Omurebe*) around the neck; more bells in the herd indicated more cattle and therefore more wealth. To avert risks during epidemics, household heads loaned heifers as gifts (*empano*) to friends and relatives (Nakimbugwe and Muchunguzi, 2003). This practice played an important social role, enabling individuals, households, and families to participate in an innovative form of gifting that motivated the building and maintenance of social links and networks. The gifting process remained close, a traditional mechanism that facilitated Ankore cattle farmers' recovery from losses and the import of new genes, while accounting for their gains in wealth. Ankore cattle were the most preferred enterprise because they could improve living standards, generate income, and create employment, and because they also serve as a symbol of wealth, consistent with Haumba and Kaddu (2017). Milk yield and stature were widely regarded as important indicators of sound breeding management, likely because they are direct outputs. The relationship between physical appearance and milk production was weak, suggesting that most respondents did not consider the genotypic quality of breeding bulls in terms of economic outputs.

All cattle in the herd were given individual names that precisely described them. These descriptions supported memorised record-keeping and selection, as they were based on physical, social, and behavioural characteristics, including coat colour and patterns; sex; horn, ear, leg, and eye shapes; distinctive features; behaviour; ancestry; associations with special events; and mode of acquisition. This precise description enabled individual cattle in the herd to be readily identified; the name prefix indicated whether the animal was a calf, heifer, cow, or male. Detailed descriptions of individual cattle enabled traceability of genealogical relationships back four generations. Although most cattle breeders do not keep written pedigree records, ancestral information was a central selection criterion, particularly for breeding bulls. Ankore cattle keepers trace their cattle's genealogical relationships back 10 generations (Nakimbugwe and Muchunguzi, 2003). However, in this study, most farmers relied solely on memorised records and could not accurately trace ancestral information for breeding bull lines beyond three generations. Tolerance to disease, drought, and heat indicates that Ankore cattle possess adaptive traits that enable them to withstand environmental stresses, aligning with Anderson (2003), who reported that adaptive breed characteristics are important when animals are reared under harsh conditions. The high adaptability of Ankore cattle enables them to perform better under poor husbandry conditions, indicating that they require low capital investment and are affordable within national prosperity programmes.

Therefore, breeders should leverage Ankore cattle's adaptive traits to design and develop a breeding strategy that enhances productivity and conserves the Ankore breed. Promoting cultural values would also counterbalance economic pressures on Ankole cattle (Infield 2001), suggesting that culture is not static. Because conservation involves managing change in dynamic systems, evolving cultures can balance economic pressures, reflecting the dynamics of Ankole cattle management and conservation systems. Analysis of economic values for Ankore cattle's desired traits at Nshaara ranch indicated that weaning weight (WW), calving interval (CI), age at maturity (AM), and age at first calving (AFC) were promising traits for enhancing profitability, with economic weights decreasing in that order. The high positive economic value for WW, an intermediate growth trait, was an outlier, as birth weight (BW) and post-weaning daily gain (PoDG) had negative values. Negative economic values for growth traits differ from Annor's (1996) findings for Ghanaian cattle but align with Gebre-Mariam et al. (2018) for Begait cattle in Ethiopia. The prevalence of negative economic values among growth traits reflects high feeding costs (Hietala et al., 2014), suggesting that improving growth performance may increase weight gain output but also raise input costs, thereby reducing profitability.

The economic values estimated in the study indicate that selecting for shorter calving intervals (CIs) can be an effective breeding strategy for the Ankole herd. Annor (1996) and Gebre-Mariam et al. (2018) also reported positive economic value for calving interval. The high economic value of CI observed in this study and reported by Annor (1996) and Gebre-Mariam et al. (2018) reflects the constraint of high feeding costs in traditional cattle production systems, where shortening CI reduces cow maintenance costs for calf production (Burgers et al., 2021). Feed resource challenges, particularly given the high cost of farmland in the South-west Agro-ecological Zone of Uganda, should not discourage the breeding and conservation of Ankole cattle. Instead, they should prompt consideration of multifaceted strategies to improve productivity. Given the trait's low heritability and late expression, it is necessary to capitalise on reproductive management to enable timely mating and early conception after calving. This can enhance the exploitation of cows' longevity by producing many calves, which are ultimately sold to generate income. Therefore, producing many calves and culling at weaning are management strategies that enhance the productivity of Ankole cattle on the farm. Innovations in developing and designing strategies to improve Ankole cattle performance and conservation should prioritise interventions that integrate measures to reduce feed costs and increase milk yield and post-weaning growth.

Conclusion

Designing an effective and efficient Ankore cattle breeding and development strategy requires clarity on breeding opportunities, enablers, and delivery mechanisms to achieve the desired economic traits. Based on the socio-economic ranking index and sequential bio-economic modelling, large body size and stature, coat colour, and good temperament were considered the most important traits when selecting a breeding bull. Weaning weight, milk yield, calving interval, and age at first calving were prioritised traits for selecting cows. The need to multiply and conserve Ankore cattle reflects cultural values that enable support, reduce economic resistance, and help indigenous cattle breeders justify Ankore cattle improvement and conservation in ways that reflect their true significance to local communities.

Recommendations

- The strategy for translating indigenous breeding knowledge, appropriate technologies, and skills for fashionable Ankore cattle should incorporate indigenous technical procedures, knowledge, and skills, with a focus on economically viable traits to improve productivity and preserve the desired genotype.
- Urgent need to develop and implement an improvement and conservation strategy for Ankore cattle that integrates indigenous technical knowledge with modern scientific breeding technologies to mitigate the current high risk of breed dilution.
- Indigenous Long-horned Ankore cattle farmers should always be involved in identifying opportunities, critical factors, and strategies to improve Ankore cattle, since effective breeding management requires clear objectives, careful planning, and accurate forecasting to predict outcomes.
- A more detailed study of the cost-effectiveness of birth-based bull selection should be conducted at Nshaara ranch to validate the study conclusions and to develop an evidence-based multi-criteria selection index to support sustainable improvement and conservation of Ankore cattle.
- Ankore cattle breeders should be skilled in their gender-specific roles and responsibilities within their ecosystem. For example, women should be skilled in milk processing and marketing to add value. At the same time, men should be skilled in husbandry practices to improve livestock breeding, welfare, nutrition and health.
- Evolving cultural practices should be integrated into Ankore cattle breeding management to promote Ankore cattle conservation and heritage, thereby protecting biological diversity and economic empowerment.

Acknowledgement

The authors thank Makerere University, the Ankore cattle farmers, and various authorities in Isingiro, Kiruhura and Nakasongola Districts, with special acknowledgement to H.E. the President of Uganda for his personal input during this study.

References

1. Anderson, S. 2003. Animal genetic resources and sustainable livelihoods. *Ecological Economics* 45: 331–339.
2. Annor, S.Y. 1996. Development of a breeding objective for beef cattle in Ghana. MSc.Thesis, Massey University, New Zealand.
3. Burgers, E.E.A, Kok, A., Goselink, R.M.A., Hogeveen, H., Kemp, B. and Van Knegsel, T.M. (2021). Revenues and costs of dairy cows with different voluntary waiting periods based on data from a randomised controlled trial. *Journal of Dairy Science* 105:4171-4188. <http://dx.doi.org/10.3168/jds.2021-20707>.
4. Chasama, G.L., Hepelwa, A.S., Chibwana, F.D. and Katandukila, J.V. 2024. Development of Breeding Objective for Tanganyika Shorthorn Zebu. *Tanzania Veterinary Journal* 38 (2): 11–20. DOI: <https://doi.org/10.4314/tvj.v38i2.2>
5. Chasama, G.L., Katandukila, J.V., and Hepelwa, A.S. 2023. Adapting selection schemes for indigenous cattle improvement in sub-Saharan Africa: a review. *European Journal of Agriculture and Food Science* 4(1): 14–20.
6. Chenyambuga, S.W., Nalaila, S. M., and Mbaga, S.H. 2008. Assessment of uses, special qualities and management aspects of Iringa Red Zebu cattle in Tanzania. *Livestock Research for Rural Development*. Volume 20, Article #17. <http://www.cipav.org.co/lrrd/lrrd20/2/chen20017.htm>.

7. Davis, R.B., Norberg, E. and Fogh, A. 2020. Estimation of Genetic Parameters for Young Stock Survival in Beef x Dairy Crossbred Calves. *Animal* 14(3): 445–451.
8. FAO 2021. Repurposing food and agricultural policies to make healthy diets more affordable. In the State of Food Security and Nutrition in the World 2022. OECD/FAO, Rome. <https://doi.org/10.4060/cc0639en>.
9. Haumba, E. N., and Kaddu, S. (2017). Documenting and disseminating agricultural Indigenous knowledge for sustainable food security in Uganda. University of Dar Es Salaam Library Journal, 12(1), 66. <https://www.ajol.info/index.php/udslj/article/download/164197/153714>
10. Hietala, P., Wolfova, M., Kantanen, J. & Juga, J. 2014. Economic values of production and functional traits, including residual feed intake, in Finnish milk production. *Journal of Dairy Science* 97:1092-1106. <http://dx.doi.org/10.3168/jds.2013-7085>.
11. Kluyts, J.F., Naser, F.W.C. and Bredfield, M.J. 2003. Development of breeding objectives for beef cattle breeding: Derivation of economic values. *South African Journal of Animal Science* 33: 142–158.
12. Mark Infield. 2001. Cultural Values: a Forgotten Strategy for Building Community Support for Protected Areas in Africa. *Conservation Biology* 15(3): 800–802. <http://www.blackwell-synergy.com/doi/10.1046/j.1523-1739.2001.015003800.x>
13. Marstrand, D.M., Hansen, H., Madsen, J., McAinsh, C.V., Larsen, C. E. S., Kimambo, A.E., Laswai, G.H., Mgheni, D.M. and Pereka, A.E. 2004. Livestock banking in Africa – the tragedy of the commons and/or a blessing for the poor? Tanzania Society of Animal Production conference series, 31: 1 – 9
14. Mugisha, A., McLeod, A., Percy, R. and Kyewalabye, E. 2005. Strategies, effectiveness and rationale of vector-borne disease control in the pastoralist system of south-west Uganda. *Tropical Animal Health and Production*, 37 (6), 479-489
15. Museveni, Y.K., 1997. Sowing the Mustard Seed: The Struggle for Freedom and Democracy in Uganda. 224 Macmillan London
16. Nakimbugwe, H.N, and Muchunguzi, C. 2003. Bahima pastoralists keepers of the long-horned Ankore cattle in Uganda; The Karen Commitment: Proceedings of a conference of indigenous Livestock Breeding Communities on Animal Genetic Resources. Karen, Kenya, 27-30th October 2003.
17. Njau, F.B.C., Lwelamira, J., Hyandye, C. (2013). Ruminant livestock production and quality of pastures in the communal grazing land of semi-arid central Tanzania. *Livestock Research for Rural Development* <http://www.lrrd.org/lrrd25/8/Njau25146.html>.
18. Ponzoni, R.W. and Newman, S. 1989. Developing breeding objectives for Australian beef cattle production. *Animal Production* 49:35-47.
19. Twomey, A.J. and Cromie, A.R. (2023). Impact of age at first calving on performance traits in Irish beef herds. *Journal of Animal Science* 101: skad008. Doi: 10.1093/jas/skad008.
20. UBOS 2021 Population and Housing Census, Uganda Bureau of Statistics.
21. Weisbjerg, M.R., Terkelsen, M., Hvelplund, T., Lund, P., Madsen, J. (2018). Increased productivity in Tanzanian cattle is the primary means of reducing methane emissions per unit of product. *Tanzania Journal of Agricultural Sciences* 18(1): 13–21.
22. Wilson, R.T. (2018). Crossbreeding cattle in Africa. *Journal of Agriculture and Environmental Sciences* 7:16-31.
23. Würzinger, M., Ndumu, D., Baumung, R., Drucker, A., Okeyo, A., Semambo, D., Byamungu, N. und Sölkner, J. 2006. Comparison of production systems and selection criteria for Ankore cattle among breeders in Burundi, Rwanda, Tanzania, and Uganda. *Tropical Animal Health and Production* 38 (7-8):571–581(11)