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REGULAR ARTICLES

Characterization of production systems and management practices of the cattle population in Zambia

Idowu Kolawole Odubote[1]

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Abstract

This study was an attempt at the analysis of the Zambia cattle population, its production systems and management practices using data collected during the 2017/2018 livestock and aquaculture census. The Public User Microdata Sample dataset provided by the Central Statistics Organization were analyzed using both qualitative and quantitative methods. Traditional system and free range grazing were found to be the main production system and feeding practices (97.2%). Despite large expanse of arable land, crop and fodder production, there was poor integration with cattle production system thus predisposing the animal to poor productivity due to inadequate nutrition. The management practices were found to be limiting and a hindrance to improved performance. The study revealed diverse cattle genetic resources comprising of local and exotic breeds, and their crosses at different genetic proportions. The local breed crosses were mainly directed at exotic beef breeds (and evidence of crosses with exotic dairy breeds) as smallholder farmers tend to improve on the production performances and productivity. Disease prevalence was high and had been an impediment to the growth of the cattle industry. It was clear that cattle production development must be anchored on a value chain system approach. Efforts aimed at capacity building should be targeted at the smallholder farmers with the bulk (93.5%) of the cattle population. This should include impacting farmers with husbandry skills through provision of elaborate livestock extension services aimed at integrating crops and fodder production in feeding practices, communal grazing management and adequate access to veterinary services to control disease prevalence. Value addition and market development would be helpful in unlocking the potential of the beef meat and milk products industry.

Keywords Cattle · Population · Census · Production systems · Management practices · Zambia

Introduction

Zambia is endowed with abundant natural resources (arable land and water bodies) which if well managed and harnessed could contribute immensely to the livestock industry. The livestock sub-sector in Zambia is an important component of the agricultural sector contributing 42% of the agricultural sector's gross domestic product (GDP) and 50% in employment for rural areas. The government identified the livestock sub-sector as one of the key sectors to drive economic growth under the Zambia Seventh national Development Plan (SNDP). The livestock sub-sector continued to provide a robust food security through rich animal sourced protein food products (meat, milk and eggs), employment, income, draught power and manure as organic fertilizer. For majority of the rural population, livestock acts as insurance in the case of crop failure. PRMC (2021) noted that livestock offers an economic and social safeguard against shocks and therefore represents part of the family's risk management strategy. Cattle production in Zambia like many other sub-Sahara countries is intrinsically linked to several agricultural production activities such as field preparation, transportation of inputs supplies and produce, post-harvest processing, biogas production and soil regeneration.

Cattle production is significant for its high investment value compared to other smaller domesticated livestock species and can contribute immensely to the socio-economic upliftment of the smallholder rural farmers from abject poverty. A number of development agencies working in Zambia realized and have adopted cattle production in a number of their development programmes. Notwithstanding the above, the development of

✉ Idowu Kolawole Odubote
kola.odubote@gmail.com

[1] Zambia Academy of Sciences, C/O NISIR, P. O. Box 310158, 10101 Lusaka, Zambia

cattle production continues to lag behind as production and productivity appeared to be stagnant. Deliberate actions must therefore be instituted to achieve optimal contribution to the GDP but this is hinged on the production and availability of quality data to inform policy (World Bank 2011; Ministry of Agriculture and Livestock 2012; Odubote 2019).

The recently conducted stand-alone comprehensive 2017/2018 Livestock and Aquaculture census by the Ministry of Fisheries and Livestock (MoFL) and the Central Statistics Office (CSO) (now Zambia Statistics Agency, ZAMSTAT) to obtain baseline livestock population and production data was a step in the right direction (Pica-Ciamarra et al. 2014; FAO 2014). The demographic and agricultural characteristics of households (HH) and establishments (business firms and organizations) engaged in livestock activities were as highlighted in the summary report of the census by the Ministry of Fisheries and Livestock (2019a). The summary report highlighted the number of cattle raised, its distribution by province and establishment and herd size distribution as presented in Tables 1 and 2 below.

The summary report, however, did not address the production environment and other production parameters. This study was, therefore, an attempt to analyze the cattle census data and provide estimates of critical information on cattle population herd structure, herd dynamics, production systems characteristics and management practices which would be useful in policy formulation aimed at further development of cattle production in Zambia.

Materials and methods

The 2017/2018 Livestock and Aquaculture census was conducted by the Government of the Republic of Zambia through the Ministry of Fisheries and Livestock, and the Central Statistics Office (CSO) in 2018. Stratified cluster sampling method was employed which allowed for every household in the selected clusters to be enumerated. The selected clusters were based on information obtained on livestock raising households in the earlier 2010 Population and Housing Census. Odubote (2020) in an earlier report on the Livestock and Aquaculture census had provided a synopsis of the design and described the provincial administrative structure and agro-ecological regions (AER) of the country. The detailed information on the sample design specification and sampling of households and establishments could be obtained from the summary report by the Ministry of Fisheries and Livestock (2019a).

Table 1 Number of cattle raised by households and establishments January 2018

Province	Households	Establishments	Total	Provincial percentage
Central	743,595	92,025	835,620	22.5%
Copperbelt	74,628	18,801	93,429	2.5%
Eastern	597,149	4,772	601,921	16.2%
Luapula	10,789	1,597	12,386	0.3%
Lusaka	147,574	25,186	172,760	4.7%
Muchinga	81,829	3,333	85,162	2.3%
Northern	47,841	689	48,530	1.3%
North-western	95,484	3,188	98,672	2.7%
Southern	1,225,090	90,148	1,315,238	35.4%
Western	450,116	833	450,949	12.1%
Zambia	3,474,095	240,572	3,714,667	

Compiled from Ministry of Fisheries and Livestock (2019a)

Data collection

The protocol for the Public User Microdata Sample (PUMS) dataset was as earlier reported in Odubote (2020). However, for the purpose of this study, only information that were related to cattle production were selected and these include demographics of households raising cattle, population (herd size, structure, dynamics), production systems, management (housing, feeding practices, water access), diseases and veterinary care, breed types and breeding, milk production, manure management and record keeping. Tablets with pre-installed Census and Survey Processing system (CSPro) software were used to obtain the data which were later relayed to the CSO Central system for verification, cleaning, organization and safe keeping.

Data analysis

Data were analyzed using simple descriptive statistics following IBM SPSS statistics procedures (IBM Corp. Released, 2015). The statistical analyses comprised both qualitative and quantitative methods. Tests of significance were carried out using one-way analysis of variance and were considered significant at only $P < 0.01$. Data were presented in tables.

Results and discussion

Cattle population

Table 1 shows that four provinces, namely, Southern, Central, Eastern and Western provinces of Zambia accounted for almost 90% of the national herd. The four provinces in land size occupied 356,722 sq. km of the national 752,612 sq. km (roughly 47%). However, in the last two decades, the Southern province (which alone accounted for 35.4% of the national herd) have been facing acute climate change effects with the attendant drought, flash floods and conflicts with

Table 2 Cattle population parameters in Zambia

Characteristics	Description	*N*	Population	Percentage
Total population:			3,714,667	
	From HH	347,030	3,474,095	93.5%
	Establishments	1,049	240,572	6.5%
Cattle herd size (mean)	From HH		10.01	
	Establishments		229.3	
Cattle herd size distribution:	1–5	190,056		54.8%
	6–10	77,551		22.3%
	11–15	30,162		8.7%
	16–20	16,167		4.7%
	21–30	15,540		4.5%
	>31	17,555		4.8%
Cattle sex ratio	Males			43.7%
	Females			56.3%

Compiled from Ministry of Fisheries and Livestock (2019a)

access to water (Zambian Academy of Sciences 2013). It was instructive to note that the majority of the water bodies are predominantly in the northern part which also boasts of large expanse of vegetation and rangelands. Cattle farmers from Southern province have been reported to be shifting up north to escape the vagaries of the weather and take advantage of the vegetation upland. Therefore, efforts aimed at construction of more dams to increase access to clean water in the southern part and establishment of farming blocks in the Northern circuit which will incorporate livestock production should be intensified to improve on cattle production and productivity. The three agro-ecologically regions are conducive to all the main local breeds irrespective of their origin as confirmed in this study. Cattle from the Southern part of the country notably the Barotse, Baila and Tonga breeds are known to be prevalent in the Northern part and same with the Angoni breed in the Southern part of the country Ministry of Fisheries and Livestock (2019b).

Table 2 establishes that of the 3,714,667 heads of cattle in the country, 93.5% (3,474,095) were raised by households while 6.5% (240,572) were raised by establishments. Herd size on the average was approximately 1:10 and 1 to 1:230 for households and establishments respectively. By implication, the bulk of the national herd are in the hands of the rural smallholder farmers while a paltry percentage are in the hands of commercial and institutional farms. Efforts aimed at improving cattle production must therefore be targeted at the smallholder rural farmers for impact. Notwithstanding the above, there must be conscious efforts aimed at establishing or encouraging cattle commercial farms and institutional farms to thrive. Efforts such as having cattle anchor farm(s) in a farming block can serve as catalysts for the transformation of the cattle production systems.

It was significant to note that low herd size of 1–5 accounted for 54.8% of the households' stock compared with 22.3% and 8.7% for herd sizes of 6–10 and 11–15 respectively. It also goes without saying that for impact the larger population of households with low herd sizes should be targeted. Households with herd sizes of less than 15 accounted for 85.8% of the households' stock and this cut across all the provinces. There were, however, pockets of large herds with over 150 heads of cattle in almost all the provinces with the exception of Northern, Luapula and Muchinga provinces. This is similar to the reports for a number of sub-Sahara countries such as Tanzania, Malawi and Zimbabwe (Otte and Chilonda 2002).

Herd structure

The herd structure below (Table 3) appeared healthy for mating and breeding strategies. It hold across provinces except in a few instances (Northern, Muchinga and North Western with higher number of bulls to cows ratio; Muchinga and Luapula with very low number of trained oxen) where the deviations were large.

The male calves' population was almost the same as the number of bulls in service and as such present safe haven for bulls' replacement. The female calves, however, were significantly higher than the male calves. While the heifers represents 29% replacement for the cow herd, the heifers and cows constitute more than half of the breeding population with the female calves as further reserve to draw from. The bull cow ratio observed was the same across the ten provinces. The bull to cow mating ratio of approximately 1:11 excluding the calves was almost half the recommended and acceptable practice of 1:25 for large-scale commercial productions system (Timlin et al. 2021). However, it must be emphasized that the above acceptable practice above is not applicable to smallholder systems since breeding is mostly communal and inefficient with heat detection being at the

Table 3 Herd structure of the cattle population

Classes	Number (% of total in bracket)	Sub-categories		
		Male castrated (% of total in bracket)	Male intact (% of total in bracket)	Female (% of total in bracket)
Calves	441,365 (11.9%)	na	192,876 (5.2%)	248,488 (6.7%)
Oxen:		na		na
Untrained	146,289 (3.9%)	146,289 (3.9%)		
Trained	660,667 (17.8%)	660,667 (17.8%)		
Steers	218,364 (5.9%)	218,364 (5.9%)	na	na
Heifers	464,175 (12.5%)	na	na	464,175 (12.5%)
Cows	1,603,078 (43.1%)	na	na	1,603,078 (43.1%)
Bulls	180,749 (4.9%)	na	180,749 (4.9%)	na
Total	3,714,667	27.6%	10.1%	62.3%

Compiled from Ministry of Fisheries and Livestock (2019a)

instance of the bull. The implication of the above herd structure on breeding is the possibility of indirectly selecting the males for draught power at the expense of production of meat and milk products. It was, however, not clear if selection for draught power was of higher priority than selection of bulls as parents for the following generation.

Herd dynamics

In Table 4 below, the live born gave a general fertility rate of approximately 25.3% per annum (405,220 from 1,603,078 cows) which is much lower than earlier estimate of 55% by the Ministry of Agriculture and Livestock (2012). The animals recorded as sold could either be for slaughter or production except there was no indication of being captured in the entry, if it was the latter. At the same time, the number sold was higher than the number slaughtered but it was difficult to separate the categories because of the confounded nature. Discarding the number sold will give a positive net flow of 130,368 for the 15-month period; otherwise, it will be a negative net flow of 59,650. It is possible that the number sold (through middle men and informal markets) could have been captured multiple times as the cattle exchange hands within the time period (Lubungu et al. 2015). Hence, as guided by Pica-Ciamarra et al. (2014) and Odubote (2019), the exit and net flow must be treated cautiously given the challenges in livestock census data capture and the analysis.

The number recorded as slaughtered was also a matter that requires further investigation. It was a fact that the number of slaughtered animals was likely to be grossly under reported given the prevalence of unofficial slaughter houses, abattoirs and farm stead slaughters. To further compound the issue was the actual

Table 4 Entry and exit of cattle in the herd between Oct 2016 and Jan 2018 (15-month window)

Characteristics	Description	Number	% of live born	% of population
Entry:	Born	506,526		
	Subtotal	506,526		
Exit:	*Sold*	*190,018*	*37.5*	*5.1*
	Slaughtered (offtake)	90,402	17.8	2.4
	Disease (mortality)	177,625	35.1	4.8
	Theft	17,922	3.5	0.5
	Accident	13,303	2.6	0.3
	Others	76,906	15.1	2.1
	Subtotal	376,158		
	Net flow	130,368 (59,650)		
Growth rate recorded		307,735		

Compiled from Ministry of Fisheries and Livestock (2019a)

growth rate recorded of 307,735 animals within the 15-month period when contrasted with the exit and entry records. It is therefore necessary that a more detailed study is commissioned to understand the herd dynamics and reduce the discrepancies to a large extent.

The high mortality rate of 35.1% and exit of 15.1% categorized as 'others' constitute 50.2% of the live born. While the disease burden was noted to be heavy (shown later in this study), the losses attributed to 'others' should be interrogated to determine the immediate and remote cause and offer checks for the losses.

In this study, offtake was found to be at an average of 5.1% with households recording 4.38% compared with 15.7% for the establishments. Of concern was the issue of low offtake rate by the smallholder farmers and it has been reported that smallholder farmers mostly do not rear cattle as a business but (as shown later in this study) more for draught power, social and cultural prestige. This calls for mindset change to reap from the increase in the animal sourced protein consumption pattern of the affluent medium income populace. Market development (Lubungu et al. 2015; Mumba et al. 2013) has been suggested as a veritable tool or incentive to promote and incentivize the transformation of the cattle production system. In line with the above, the Ministry of Fisheries and Livestock (2019b) reported that the government in its desire to promote commercialization of livestock production recently established livestock slaughter and market facilities around the country to promote value addition. Livestock cooperatives were established nationwide and members trained on the above two concepts since informal trading in live animals were prevalent.

Production system

Purpose of raising cattle

Slightly below two-thirds of the households reported draught power as the main purpose for raising cattle (Table 5). This could explain the higher proportion (21.7%) of the oxen compared with the intact males (4.9%) in the herd structure. This was also in agreement with literature that maintained that cattle production largely underpins smallholder farmers' crop production (Aregheore 2009). This may also explain the poor body condition of the oxen at the time of offtake due to work exhaustion coupled with poor nutrition. The high number of HHs that indicated, selling for income, as their purpose for raising cattle, however, was not in sync with the low offtake rate. The low number of HHs that reported meat (home consumption) and milk consumption was a reflection of the culture of raising cattle but not partake in nourishing the household with nutritious meat and milk products.

The provinces were mostly not significantly different from the national average for the purposes of raising cattle. However, meat (home consumption) was significantly lower for Southern province (0.1%) which incidentally had the highest cattle population in the country. It was also worth noting that both Luapula and Muchinga provinces had significant lower and higher percentages for draught power and selling for income respectively as reasons for raising cattle. This could be attributed to the low agricultural production in the two provinces as they mostly concentrated on fishing-related

Table 5 Purpose of raising cattle by households in the provinces

Province	Percentage of households that indicated purpose of raising cattle						
	Meat (home consumption)	Milk	Draught power	Aesthetic value	Selling/income	Manure	Others
	%	%	%	%	%	%	%
Central	2.9	0.7	71.6	5.1*	18.0	0.3	1.6
Copperbelt	3.5*	4.1*	62.8	2.1	25.1	0.1	2.3
Eastern	1.1	0.3	67.8	1.0	28.4	0.2	1.1
Luapula	1.4	0	2.6*	1.4	90.2*	0	4.4*
Lusaka	1.9	1.5	68.5	2.3	24.9	0	0.9
Muchinga	3.3	1.8	10.8*	3.5	77.0*	0.6	3.0
Northern	4.9*	0.4	55.6	0.9	32.7	0	5.5*
North-western	2.9	1.0	34.5	3.2	55.4	0.3	2.7
Southern	0.1*	0.5	75.4	1.3	20.8	0.1	1.9
Western	2.3	0.9	53.5	1.8	33.6	6.3*	1.5
Zambia (average)	1.5	0.7	65.7	2	27.7	0.7	1.7

*$P < 0.01$

activities due to the abundance of water bodies. Western province on the other hand had the highest percentages of HHs who raised cattle for the purpose of making use of the manure ostensibly for agricultural production. Of the HHs that indicated draught power, 87.3% indicated land preparation for crop production as the main purpose with transport at 12.3%.

Production system

With 92.3% of the HHs reporting traditional production system and an additional 4.9% practicing the extensive production system, we have a production system that is largely subsistence. It was a low input and low output production system. There is need for the transformation of the cattle production system to deliver on the aspirations of the government, cooperating partners and the smallholder farmers. This will require rigorous livestock extensions services and trainings at the lowest level of interaction with the view to bring about change in the production system that has resulted in low performance of the cattle production and productivity. While the commercial establishments have cost efficiency and profit as the drivers, preservation of stocks and socio-cultural values were the hallmark of the traditional production system (Mumba et al. 2013).

The combination of communal grazing near villages, transhumance and tethering cattle grazing systems were practiced by almost equal number of HHs (98.1%) that were reported to practice traditional and extensive production systems. It could be concluded that the production system was intrinsically linked to the feeding—grazing system. With the very high number of HH practicing communal grazing, it was inevitable that over grazing would be the resultant effect. Over grazing would lead to decline in forage quality which presents a case for communal management of grazing land to accommodate stocks in a sustainable manner.

Zero grazing and fenced paddocks which are forms of semi intensive and intensive production systems were the other grazing systems reportedly practiced but mostly by the establishments with high financial outlay. This is in agreement with the livestock development theory that as capacity to provide adequate fodder/grasses, water, housing, veterinary care increases and there is access to market, small holder farmers tend to shift towards zero grazing (Odubote, 2020).

Cattle breeds and population

Table 6 shows the HH raising different cattle breeds and their crosses. The table showed that the main local breeds kept by the HHs were Angoni, Tonga, Barotse, Mambwe, Baila and Lenje breeds. Other HHs reported keeping Nsenga, Lozi and Swaka although in very few numbers and restricted to particular geographical locations. The breeds in low frequencies may actually be strains of the main breeds as indicated in the Zambia Farm breed survey (Zulu et al. 2003). Mwenya (1999) and Simbaya (2011) both provided phenotypic and utility characteristics of the indigenous breeds of cattle while AU-IBAR (2019) noted their disease resistance, tolerance, hardiness, mobility and thriftiness in arid environment characteristics.

Table 6 HHs raising cattle breeds and their crosses

Main breeds and their crosses	Frequency	Percentage	Cumulative
No of respondents	44050		
No response	25970		
Angoni	3720	26.1%	65.2%
Tonga	3050	21.4%	
Barotse	2150	15.1%	
Mambwe	240	1.8%	
Baila	80	0.6%	
Lenje	30	0.2%	
Local crosses	690	4.8%	4.8%
Local exotic beef crosses	1060	7.5%	14.2%
Local exotic dairy crosses	930	6.5%	
Local exotic beef dairy cross	30	0.2%	
Exotic Boran	310	2.2%	6.8%
Exotic Afrikander	320	2.3%	
Exotic Brahman	220	1.5%	
Exotic Friesian	70	0.5%	
Exotic Jersey	30	0.2%	
Exotic Bonsmara	20	0.1%	
Exotic beef crosses	770	5.4%	5.4%
Don't know	508	3.6%	3.6%
Total	14228	100%	100%

The main exotic breeds include Boran, Brahman, Afrikander, Bonsmara, Jersey and Friesian. Other exotic breeds reported in small numbers include Charolais, Angus, Simmentals, Sussex and Ayrshire. The census revealed various crosses among and between local breeds and exotic breeds which ultimately broadened the genetic diversity of the cattle breeds in Zambia.

The HH that mainly kept local breeds and exotics were 70% and 12.2%, respectively while 3.6% of the HHs were unaware of the breeds of cattle raised. HH that kept crosses of local breeds were low at 4.8% whereas 12.2% kept exotic crosses. The local-exotic crosses were kept by 14.2% HH and were mainly with Boran, Brahman, Afrikander and Friesians breeds. The high percentage of HH with local-exotic crossbreds (26.4%) could be the outcome of direct government actions to improve on the performances of the local breeds by promoting crossbreeding programmes with exotic breeds. The crossbreds were then made available to the smallholder farmers through sales or donation through programmes such 'stocking and restocking' and 'Pass on the gift'. The actions of non-government organizations, emergent and commercial farmers that

have been promoting crossbreeding cannot be overemphasized. The inflow of live cattle genetics was reportedly from South Africa, Namibia and Botswana while semen was sourced from the USA, Netherlands, Switzerland and the UK.

It must be mentioned that Zambia is landlocked with each of the administrative provinces sharing border with one or two neighbouring countries. Exchange of animal genetic resources between the neighbouring countries was therefore inevitable. The high number of HHs that did not respond to the question is of concern which could be due to lack of knowledge or appreciation of their significance. There may be a need for diligent cattle genetic characterization studies involving phenotypic and molecular to come up with breed standards. Although AU-IBAR (2019) had reported a threat of crossbreeding with the exotics, the local-exotic cross proportion in the study is moderate at 14.2% and is therefore not considered a threat for now. Notwithstanding, the use, development and conservation of local cattle genetic resources should be pursued with vigour. Indiscriminate crossbreeding must therefore be discouraged in the quest to improve production performances and productivity.

Milk production

Only 11.8% HHs confirmed milking their cattle and this represent a total of 54,390 cows while the remaining 88.2% HH did not perform milking on the cows. The milking was mostly done by the male spouse or child (73%) against the female spouse and female child (27%). The milk obtained were mainly used for food (86.4%), sale (13%) and processing (2%). The milk sales took place at the homestead (41.9%), within the community (35.5%), milk collection centre (13.2%) and infrequently outside the community (9.3%). Milking was mostly conducted within the kraal (60.6%), outside the kraal (37.2%) while only a few HHs (1.6%) milked from milking parlour. Only 10.3% HHs made use of stainless steel buckets while the vast majority made use of plastic (83%). Others (6.3%) made use of metal containers and carved wooden device called 'Sikundu' in Lozi. The above may have implication for milk hygiene and milk spoilage due to the likelihood of high unsanitary conditions.

Seasonal variation was recorded in the milk production and this has been attributed to the onset of rainfall and subsequent availability of pasture for the milking cows. During the peak period of milk production (rain season), the farmers (5543HHs) produced on the average 27,242 l of milk per day compared to 16,723 l in the lean period (dry season). Given the above production figures for the two seasons from 5543 HHs, we can project that the average national daily milk production is 21,982.5 l for the 5543 HHs *ceteris paribus*. If we further assume the same for all the 347,031 cattle raising HHs and that each milking cow produces for 200 days per year, therefore:

$$\text{Total annual national milk production} = 21{,}982.5\ \text{l} \times 200\ \text{days} \times 347{,}031/5543 = 275{,}251{,}992\ \text{l}$$

The national annual milk production could also be estimated according to FAO (2018) using the number of live births reported to be 506,526 over 15 months' period to give us an annual live birth of 405,220. Mean daily milk production during the rain and season were found to be 5.27 and 2.13 l respectively to give us an overall average of 3.7 l *ceteris paribus.* Therefore,

$$\text{Total annual national milk production} = 3.7\ \text{l} \times 405{,}220\ \text{milking cows} \times 200\ \text{days} = 299{,}862{,}800\ \text{l}$$

This is consistent with the report by Mwenya (1999) that recorded maximum daily yield of between 3.24 and 5.29 l for local breeds of cattle in Zambia.

The above two different estimates of national milk production were examples of the challenges of livestock data collection. It must be pointed out that the above estimates assumed no mortality or diseases among other limiting factors which could adversely affect milk production. Nonetheless, the estimates computed were below the estimates for the same period found in literature of between 455 and 617 million litres per annum (Ministry of Fisheries and Livestock 2019b; Cheelo et al. 2019; and FAO 2021).

Table 7 below gives indication of the lactation length observed by the different HHs that milked their cows during the different seasons. It was observed that a higher number of farmers milked cows for a longer period during the rainy season compared to the dry season. Almost two-thirds of HH stopped milking during the dry season compared with only a quarter in the rainy season as at the end of the second month. Aregheore (2009) had already reported that milk production is higher and for a longer period during the rainy season compared with the dry season due to improved nutrition brought about by the availability of forage and fodder as a result of the onset of the rainy season. Notwithstanding the above, there may be the need to conduct further studies on the milk production potential especially in the traditional production system. Feed intervention strategies during the long dry season remain top priority for body maintenance and sustainable milk production.

Milking has also been observed to be affected by animal welfare issues which bordered on poor management

Table 7 Lactation length observed by percentages of households in different seasons

Season	Lactation length (months)				
	1	2	3	4	5
Rain season	7.6%	17.6%	36.7%	21.9%	16.1%
Dry season	31.5%	26.4%	22.7%	12.1%	7.3%

practices, inappropriate housing, poor feeding practices, body injuries, mastitis, lameness among others (Aleri et al. 2012). Hence, cattle welfare issues should be accorded importance during training of smalholder farmers.

Management practices

The management practices recorded were not very different from the earlier report by Odubote (2020) on goat production in Zambia as the animals were at times reared together especially during the post-harvest season. It was very clear that the production system to a large extent determined the feeding practices as 93.6% HH reported practicing free range on mostly communal grazing lands. Concentrates and mineral supplementations were provided occasionally by the farmers for the cattle farmers to meet their nutritional requirements. The vast majority of livestock farmers also cultivate crops and to a lower extent fodder with the proportion of HHs ranging from the lowest of 60% in Luapula province to close to 100% in Southern province. OIE (2021) had noted that the nutritional requirements are major factors affecting growth, feed efficiency, reproductive efficiency, body condition and milk production.

Majority of farmers (87.5% HH) reported planting wide range of crops for household consumption and sales while few farmers (0.5% HH) mentioned growing pasture and fodder production for cattle production aside depending on communal grazing land. The farmers however mostly depended on the stovers following harvest of crops for feeding their cattle. Odubote (2020) had reported on the variety of crops and fodder/pasture being promoted. It was, however, surprising that given the array of crops and fodder grown, the produce were not integrated into the cattle production system as reported in the production system.

Meanwhile, Simbaya (2002) and Aregheore (2009) had noted that the most important sources of feed for ruminants in the smallholder sector are natural pastures and crop residues and therefore suggested the need for farmers to be trained in conservation of excess herbage in the wet season to help improve utilization of natural pastures; encourage farmers to collect and process all crop residues post-harvest for use during the long dry season rather than allowing animals to graze them in situ; encourage the use of fodder trees by smallholders; encourage farmers to establish fodder gardens for feeding their stock in a cut and carry system; and encourage farmers to match animal numbers to the feed resources.

Access to water

HHs that provided water to their cattle were 40% while the other HHs believed the animals will fend for themselves. Water sources for the animals include rain water, streams, dambos, lakes, dams and rivers as they walked an average of 0.68 km (range is 0.2–5.3 km) per day. There should be improvement in the herd management to reduce on the distance covered by the animals as this constitute stress factor. Cattle found in Agro-Ecological Regions III (AER III) and those found near rivers, lakes and dams were likely to receive adequate water being areas with high number of water bodies. With declining rainfall amount and changing rainfall patterns, there would be need for deliberate actions to explore water harvesting and storage options especially for use during the long dry season. Ayalew et al. (2013) observed that water is a major component of the cattle body weight and driver of all metabolic activities of the body. However, the quantity of water required by cattle in the sub-Sahara for the different classes of cattle has not been established although Ayalew et al. (2013) suggested 10–40 l/day depending on the stage of growth, pregnancy and lactation.

Housing

HHs that reported confining their animals in sheds and kraals mostly to pass the night were 80% while 15% HHs had no form of housing or confinement. Others (5%) only have fences and paddocks. Housing of cattle is very important especially during the periods of very low and high temperature, and rainy season as the cattle are exposed to inclement of weather with attendant discomfort, infections and disease outbreaks. OIE (2021) had noted that the housing condition must be conducive for normal functioning of the animal as this is directly correlated to welfare issues. Housing to a large extent can also serve as a deterrent for theft and cattle rustling although majority of the farmers do not have any form of fencing for the farm.

Disease prevalence

HHs that reported being affected by cattle diseases were 59.1%. East Coast fever (ECF)/Corridor disease was reported as a major disease affecting cattle by 24.1% HHs that reported diseases in cattle followed by lumpy skin disease (LSD) at 18.5% and in the third place was black quarter (BQ) at 15.9%. Other diseases recorded in order of prevalence include foot and mouth disease (FMD), cowdriosis (heart water), contagious bovine pleuro-pneumonia (CBPP), foot rot, brucellosis, anthrax, mange, helminthiosis, tick borne diseases, babesiosis (red water), trypanosomiasis and haemorrhagic septiceamia (HS). Of concern was the fact that 10% HHs did not know the diseases that affected their herds. The high mortality rate of the live born (35.1%) in the census as reported above must have been an impediment to the development of the cattle industry.

Lubungu et al (2015) had also reported on the prevalence of cattle disease in the country and noted that mortality rate

is higher in the smallholder farms compared to the commercial farms. Management practices to reduce on disease outbreaks must be accorded importance to reduce on losses (treatment costs, morbidity and fatality) suffered by the farmers.

Disease control

HHs that reported not using any disease control method was 13.3% while an additional 19.5% resorted to traditional medicine in the control of diseases and this should be a source of concern for animal health and public health practitioners. It could be due to limited access to veterinary services and personnel. Mixing of treated and untreated animals at common watering or grazing lands could also be problematic for disease control for obvious reasons such as reinfection and drug resistance.

Slightly above half of the HHs (54%) made use of conventional medicines while 12.9% HHs used vaccination to control the diseases. Further investigation is however required to determine the efficacy of indigenous knowledge as a therapy. Vaccinations were prevalent in the traditional cattle rearing areas Central, Southern and Eastern provinces. HHs that vaccinated against cattle diseases confirmed that they vaccinate against the major diseases highlighted earlier in this report. Vaccination has been well documented as an effective measure to prevent disease outbreaks and therefore must be strengthened with stakeholders' involvement. Zambia was noted to depend on other neighbouring SADC countries for vaccine development and supply. It is therefore important that preventive measures such as regular vaccinations, dipping and spraying are put in place by the government with the commitment/support of the farmers. Biosecurity plans (OIE 2021) should therefore be designed and implemented to control the major sources and pathways for spread of pathogenic agents.

Breeding practices and genetic improvement

Natural mating was the main breeding strategy practiced by 98% HHs and was largely indiscriminate within the community as the bulls were run together on communal grazing lands and water points. The use of reproductive technology such as artificial insemination (AI) was very low at 0.2% HHs. It must be mentioned that castration was mostly practiced on bulls to be used for draught power while culling of bulls to prevent indiscriminate breeding was rare. This has implications for rapid distribution of improved genetics within the community. Haile et al. (2018) had noted that communal breeding structure with the use of communal sire could prove pivotal for community based breeding programme (CBBP) to improve on traits of economic importance. The group approach to breeding could also help prevent genetic erosion while lending itself for crossbreeding programmes. Nevertheless, characterization of the local breeds remains top priority as the adaption to the environment and competitiveness in low input low output system was never in doubt.

Manure

Usage of cattle manure by the farmers was minimal as only 11.2% HHs claimed to have made any use of it. Notwithstanding, almost all (99.3%) of HHs that reported making use of it as manure on their crop fields and were concentrated in Eastern, Southern and Central provinces. Knowledge sharing on the collection, storage and application of cattle manure must be intensified to maintain good cattle or kraal house hygiene, prevent spread of diseases, reduce odour and more importantly apply in crop fields as organic fertilizer. Zambia can benefit greatly from an integrated manure management system which prevents nutrient losses, improve crop production, provide clean and renewable energy and improve farm income from savings on fertilizer costs. It is, however, important to note that the success is hinged on a good housing design that allows for collection, storage and utilization of the manure (Teenstra et al 2016; Odubote 2020).

Record keeping

Record keeping among cattle smallholder farmers were very minimal at less than 4% of the HHs. Responses were often recalled from memory and associated events that occurred at the same time. The importance of record keeping cannot be over emphasized (Odubote 2019) and the farmers should be encouraged to keep simple records to help with their management decisions and monitoring of production, productivity and profitability among others. Records are also vital in genetic improvement programmes as it helps to prevent inbreeding, measure performances and monitor trends.

Conclusions

The conduct of regular livestock census is vital in the provision of critical evidence-based data necessary for livestock policy decisions. Cattle production system was largely traditional with the population concentrated in Eastern, Central and Southern provinces. Free range on communal grazing lands was the most preferred feeding practices among the HHs. Despite high level of crop production and vast arable land, there was little crop livestock integration and fodder/pasture production in the feeding of the cattle. Most of the HHs lack the husbandry skills required to achieve improved performances hence the need for training in best practices.

There were very little management interventions in the keeping of the animals. The disease prevalence was very high with the attendant high mortality rates leading to very low growth rate, poor production performances and equally poor productivity. The high population of local genetic resources presented an opportunity for the development of the local breeds for traits of economic importance. The contributions of the dairy cattle were not adequately explored in the census/study.

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Author contribution The author was responsible for the design of study, performed the statistical analysis and prepared the manuscript.

Data availability The datasets analyzed during the current study are not publicly available but can be accessed from the national repository, Zambia Statistics Agency, upon reasonable request.

Code availability Not applicable.

Declarations

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