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Livestock ownership among smallholder farming households in Eastern Zambia: a gendered pathway for enhancing climate resilience?

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This study administered 379 questionnaires to smallholder farming households to determine livestock ownership, climate change, and its impacts on livestock production, including measures to adapt livestock production to climate change. Data were analyzed using ordinary least squares regression model, Two sample Z proportions test, and percentages. Results indicate that few livestock were owned by households, commonly cattle, goats, pigs and chickens. Joint ownership dominated, followed by ownership by household heads, be they male or female, then spouses. Non-household heads rarely owned livestock. Joint livestock ownership significantly increases the total livestock units a household owns. The respondents overwhelmingly reported that the climate had changed, with a shorter rainy season, droughts, floods, and higher temperatures. There were slight variations in the perception of climate change across the study sites and by gender. Livestock production had been affected by increased incidences of disease, water, and fodder shortages, ultimately reducing livestock productivity across all the sites. Livestock households have adapted to climate change and other production constraints more broadly by addressing livestock health through administering vaccines, consulting with veterinary officials, and using traditional remedies for livestock diseases. Some respondents supplemented fodder and water, while others resorted to selling off the livestock. More men reported the provision of water as they more likely deal with large livestock that need bigger quantities of water. Similarly, while more commonly reported by men, the provision of fodder shows variability across chiefdoms, suggesting that fodder scarcity is a region-specific constraint. The use of traditional remedies such as herbs remained an important adaptive measure, especially among women. The study concludes that livestock production has high potential to contribute to inclusive climate change adaptation in the study region and more broadly but there is an urgent need to increase the percentage of livestock owning households and the size of the herds for livestock to make meaningful contributions to household welfare and climate resilience.

KEYWORDS

gender norms, quantitative study, livestock disease, rainfall variability, gender-responsive research, food security

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1 Introduction

Efforts to transform African food systems call for enhanced farmer adaptation to climate change via livelihood diversification that includes livestock production to the plethora of adaptation strategies (Jones and Thornton, 2009; Hänke and Jan Barkmann, 2017; Simpkin et al., 2020; Williams et al., 2021). Proponents of this strategy espouse livestock production for several reasons. Livestock contributes to human food and nutrition security directly, and indirectly to food security by increasing crop output through providing manure (FAO, 2012). Livestock enhances total household labor productivity by smoothening the demand on family labor over seasons, genders and generations and buffers the impact of fluctuations in crop production, thus stabilizing food supply (FAO, 2012). The empirical literature on the buffering capacity of livestock in smoothing external weather shocks is mixed (Kazianga and Udry, 2006; Hänke and Jan Barkmann, 2017). Some scholars note that livestock serves as a climate adaptation strategy among smallholder farming households by providing meat and dairy products, and income earning opportunities when crops fail (Sofoluwe et al., 2011; Yesuf et al., 2008). Others contend that the role of livestock assets as a buffering mechanism against the effects of drought on household income and consumption was context-dependent (Acosta et al., 2021). Although livestock are kept by households across all wealth groups, fewer women tend to own them and women are more likely to own smaller livestock (Njuki and Sanginga, 2013; Dumas et al., 2018). Despite women's important contribution and role in livestock management, they often face greater constraints than men in accessing extension services, markets and financial services (Njuki and Sanginga, 2013; Esenu, 2005; Kyotos et al., 2022). These challenges result from traditional gender roles and patriarchal gender relations (Dumas et al., 2018). Women's lower access to and control over livestock affects their livestock based adaptation strategies and could make them less resilient to climate change effects.

In Zambia, the livestock sub- accounts for 42% of the agricultural sector's Gross Domestic Product (GDP) and 50% of employment in rural areas (PMRC, 2021). In the absence of formal insurance, farmers tend to diversify into livestock to achieve a balance between potential returns and the risks associated with climatic variability, and market and institutional imperfections (Alderman and Paxson, 1992). In a study of 761 smallholder farming households in Eastern Zambia, diversification of livestock holding was reported to be a climate adaptation strategy by 49% of the respondents (Umar et al., 2019). Overall, a total of 1,801,075 (or 43.4%) of farming households in Zambia were engaged in livestock production as at 30th April 2022 (Zambia Statistics Agency, 2022). Among the households engaged in livestock production, 73.9% were male headed and only 26.1% were female-headed. This gender gap in access to livestock assets entails higher vulnerability to climate hazards and lower capacity to bounce back after an extreme climate event for female headed households.

With the predicted increase in severity and frequency of extreme climatic events in sub-Saharan Africa (Ayanlade et al., 2022; Christian, 2010; Siatwiinda et al., 2021), livestock production is an increasingly important pathway for enhancing climate resilience through livelihood diversification among smallholder farming households in the region. Smallholder farming households in sub Saharan Africa largely practice rain fed agriculture (Rockström et al., 2004). They are therefore very vulnerable to climate variability and climate change (Pickson and Boateng, 2022). In its various manifestations such as intra seasonal droughts, late onset and /or early off-set of the rainy season and higher temperatures (Sofoluwe et al., 2011; Nhemachena and Hassan, 2007; Nyanga et al., 2011; Umar, 2021), climate change has adversely affected the agricultural productivity of smallholder farming households (Jones and Thornton, 2009; Blanc, 2012). This has resulted in higher household food and nutritional insecurity, and lower household incomes (Connolly-Boutin and Smit, 2016; Misselhorn, 2005; Thompson et al., 2010). Droughts due to the El Niño/Southern Oscillation (ENSO) phenomenon experienced during 2023/2024 left millions of farming households across Southern Africa in hunger (Singh et al., 2023).

Understanding livestock ownership dynamics provides context specific information that is useful in undertaking climate adaptation initiatives that are inclusive and equitable for both men and women across different geographical locations. Thus, this study employs a gender responsive approach to examine livestock ownership dynamics and climate change adaptation strategies for livestock production from three districts in the Eastern Province of Zambia. The main research question for the study was how do livestock ownership dynamics and climate change adaptation strategies affect climate resilience among smallholder farming households in Eastern Zambia? The specific objectives were to: (i) examine livestock ownership dynamics in the study area (ii) investigate the effects of climate change on livestock production in the study area, and (iii) identify adaptation strategies that have been employed by smallholder farmers to respond to effects of climate change on livestock production in the study area. The findings of this study contribute to scholarly knowledge on the potential of livestock production to contribute to climate resilience among smallholder farming households. It highlights how the dynamics of livestock ownership and their gendered nuances affects their ability to respond to climate change and its effects. The study shows smallholder farmers' ability to reframe socio-cultural norms in responding to changing economic circumstances and the climate. This information is of use in development planning for rural farming communities. The findings could inform the formulation of strategies enhancing livestock ownership to foster climate adaptation in the region.

The rest of the article is arranged as follows. The next section describes the study areas and then details the data collection and data analysis methods. This is followed by a presentation of the results, after which the results are discussed in the context of other empirical studies and theoretical articulations on the research subject. The study then presents the implications of its main results and suggests recommendations.

2 Methods

2.1 Data collection

The primary data for this study was collected during September 2023. Before the main fieldwork, the study team made a reconnaissance visit to the study area in February 2023 to validate research questions. We engaged local stakeholders such as the Ministry of Agriculture and Department of Chiefs and Traditional Affairs. Courtesy calls were paid to the six chiefs in whose localities the study was planned to take place, as per local custom. The purpose of the planned study was

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explained to the chiefs after which they granted permission for the study to be conducted in their chiefdoms. Study approval was granted by the University of Zambia's Humanities and Social Sciences Research Ethics Committee.

2.2 Description of the study area

The study was conducted from six chiefdoms spread across three districts in the Eastern Province of Zambia (Figure 1) namely Lundazi, Chasefu and Lumezi. The Eastern Province typically experiences seasonal rainfall of between 800 and 1,000 mm and a crop-growing period of 100–140 days. It is characterized by three seasons; warm and wet (from November to May), cold and dry (June to August) and hot and dry (September to November). Its predominant socio-economic activity is rain fed smallholder farming.

2.3 Agricultural practices

Smallholder farmers begin their seasonal activities around October by tilling their fields using manual implements such as traditional or Chaka hoes, animal draft powered implements such as oxen- plow or oxen-ripper or mechanized power through the use of tractors. Sowing of crops only commences once effective planting rains are experienced between late November and early December. Nutrient amendment involves the application of mineral fertilizer and/or animal manure. Weeding is accomplished through the use of hand hoes, oxen or

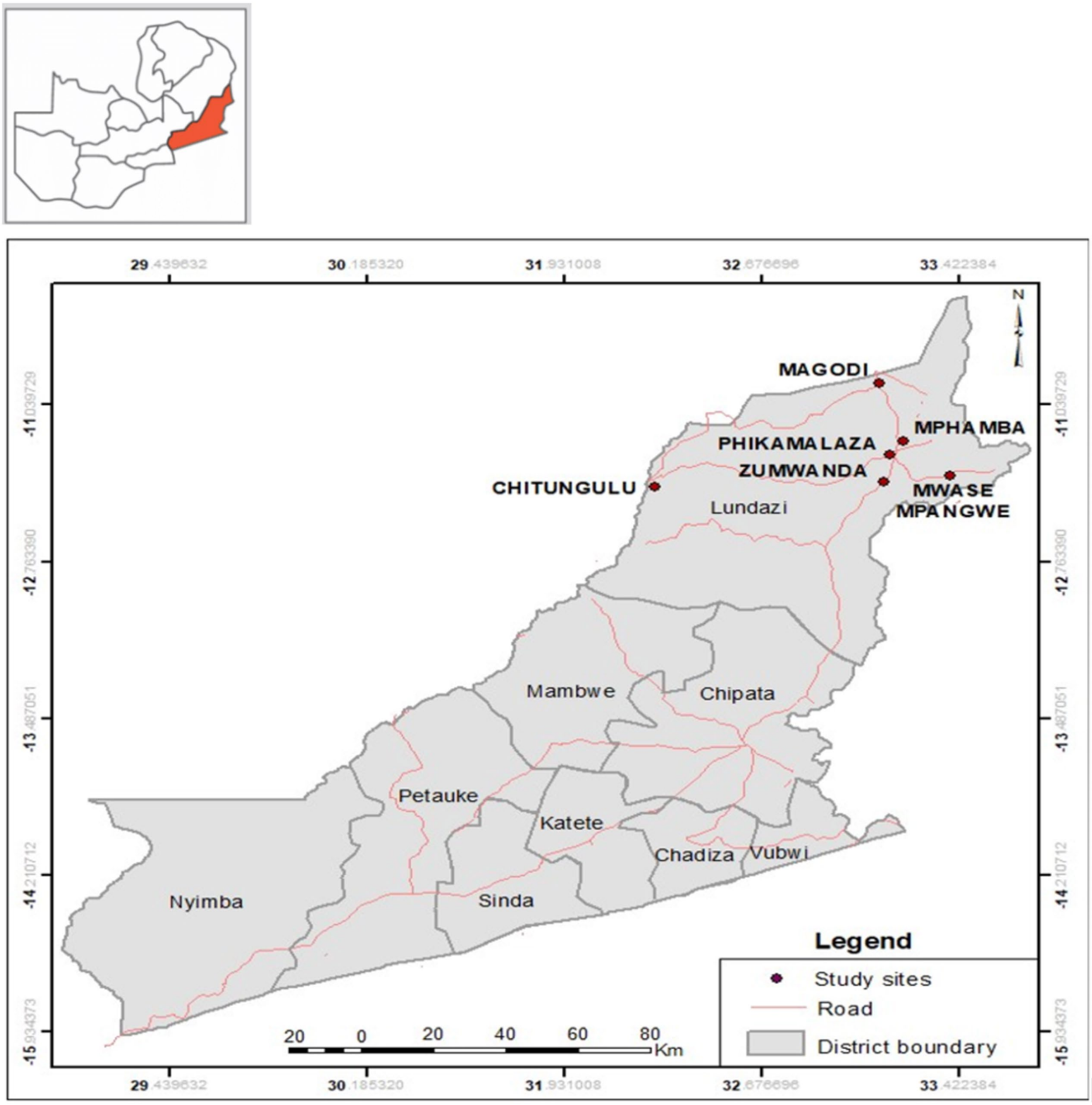

FIGURE 1
Location of study sites, Eastern Zambia.

herbicides. Crop harvesting begins around March and last until July. During the post-harvest season, local norms dictate that agricultural fields should be treated as communal grazing areas and livestock should be allowed to graze from them. It is understood that while livestock feed on crop residues, they deposit dung in the fields, and thus both the crop and livestock farmer benefit from this practice.

Smallholder farming households in the study area practice mixed crop and livestock farming. The main crops grown are maize (*Zea Mays*), groundnuts (*Arachis hypogaea*), cotton (*Gossypium hirsutum*), tobacco (*Nicotiana tabacum*), soya beans (*Glycine max*), sweet potatoes (*Ipomoea batatas*), cowpeas (*Vigna unguiculata*), millet (*Panicum miliaceum*), sorghum (*Sorghum bicolor*), rice (*Oryza sativa*), cassava (*Manihot esculenta*), common beans (*Phaseolus vulgaris*) and sunflower (*Helianthus annuus*). A much smaller proportion of the rural households engage in irrigated production of vegetables during the post-harvest season. Only those with land close to perennial streams, from which they draw water for irrigation participate and produce crops such as tomatoes (*Solanum lycopersicum*), rape (*Brassica napus*), Chinese cabbage (*Brassica rapa* Pekinensis), African eggplant (*Solanum macrocarpon*), carrots (*Daucus carota*), Spinach (*Spinacia oleracea*), onion (*Allium cepa*) and peppers (*Capsicum annuum*). Common livestock reared are cattle, goats, and pigs. Poultry is more prevalent with most households rearing free-range chickens, and less commonly ducks, guinea fowls, and geese.

2.4 Socio-cultural context

The three main tribes found in the Eastern province are the *Chewa*, *Ngoni* and *Tumbuka*. The *Chewa* are matrilineal while the *Ngoni* and *Tumbuka* are patrilineal. Among the *Chewa*, land and cattle have historically been inherited through women, that is, male children inherited property from their mother's brothers. Among the *Ngoni* and *Tumbuka*, the norm has been for sons to inherit from their parents. Daughters were expected to marry and access such property through their husbands (Umar, 2021). Unmarried women (spinsters, divorcees, widows) that lived in their natal villages had access to land through male relations. Increasingly, shifts from such practices have been noted, with parents bequeathing land and livestock to sons and daughters. Inheritance dynamics influence access to and control over land and livestock by men and women household members, with implications on their decision making. In male-headed households, women are mainly assigned roles related to domestic small ruminant production, while males perform most of the management functions related to large ruminant animals. This division of labor also culturally determines the pattern of livestock ownership, as most women tend to own goats while men dominate cattle ownership (Machina and Lubungu, 2018; Machina and Lubungu, 2019).

2.5 Data collection

A household survey was carried out among 379 smallholder farming households in three districts of Eastern Zambia. From these districts, four chiefdoms were purposively selected as study sites for the household survey namely Mphamba, Zumwanda, Chitungulu and Phikamalaza (Figure 1). It should be noted that while six chiefdoms were included in the overall study which employed a mixed methods design, the household survey was limited to four chiefdoms and forms the basis of this article. The study sites for the household survey were selected to include the three main tribes in the province. The households were randomly selected from the chiefdoms using village registers with the help of village head persons as presented in Table 1.

The questionnaire included questions on household demographics, livestock ownership dynamics, climate change and its effects on livestock production as well as actions undertaken by households to adapt their livestock production to climate change. The questionnaires were administered by six trained enumerators, who were fluent in the local dialects and had comprehensive knowledge of the local farming systems and socio-cultural context. Prior to data collection, a pilot survey was conducted with smallholder farming households from a neighboring district, Chipata. The questionnaire was shortened and vague questions made clearer after the pilot test. This enhanced the validity of the instrument.

A gender responsive approach was adopted for the study. Thus, deliberate efforts were made to ensure that men and women were interviewed and attention was paid to sub-groups within the two gender groups. Specifically, women that headed households (widowed, divorced, and single) as well as married women within male headed households were targeted for participation in the household survey. Further, results are disaggregated by gender when reported and attention is paid to gender relations in the study context. This ensures that gender differences are not masked and all voices are heard. Informed consent was obtained from all the respondents. Confidentiality and anonymity was guaranteed to all respondents. Interviews were restricted to respondents aged 21 and above.

2.6 Data analysis

The data were analyzed using an Ordinary Least Squares (OLS) regression model to assess the associations between various independent variables and the dependent variable, total livestock units. The OLS method was chosen for its robustness in estimating linear relationships between multiple independent variables and a continuous dependent variable. This regression approach facilitates

TABLE 1 Household survey samples by chiefdom, tribe and gender.

Chiefdom	Tribe	Men	Women
Mphamba	Tumbuka	53	57
Zumwanda	Chewa	39	74
Chitungulu	Chewa	26	34
Phikamalaza	Ngoni	39	57
Total		157	222

the estimation of the unique contribution of each predictor while controlling for the influence of other variables in the model.

Several models were developed to understand these relationships. The initial model included only single predictors (unadjusted model) to evaluate their individual effect on the total livestock units. This step was essential to identify the gross effect of each variable before adjustments. Subsequently, a multivariate model (adjusted model) incorporated all predictors simultaneously, allowing for adjustment of confounders and potential interactions between variables. An interaction term between total livestock units owned by the husband and those owned jointly was also included to investigate the potential synergistic effect on total livestock units. A *p*-value threshold of 0.05 was employed as the criterion for statistical significance. A p-value below this threshold suggests that there is a less than 5% probability that the observed association is due to random chance in the context of the null hypothesis. Thus, variables with *p*-values less than 0.05 were considered to have statistically significant associations with the total number of livestock units.

The general form of the OLS regression equation used in our analysis is as follows (Equation 1):

$$\text{Total Livestock Units}\,(\text{TLU}) = \beta 0 + \beta 1X1 + \beta 2X2 + \ldots + \beta kXk + \varepsilon \quad (1)$$

where

TLU: Total Livestock Units, the dependent variable.

β0: Intercept of the model, the expected value of TLU when all independent variables are 0.

β1, β2,..., βk: Coefficients for each independent variable, representing the expected change in TLU for a one-unit change in the corresponding variable, holding other variables constant.

X1, X2,..., Xk: Independent variables included in the model. Independent variables were gender, age, education level, household size, chiefdom, type of livestock ownership and participation in climate change initiative.

ε: Error term, accounting for the variability in TLU not explained by the model.

Descriptive analysis also identified outliers and potential anomalies that could influence the OLS model's outcomes. By understanding the data's distribution, we were better positioned to interpret the regression coefficients meaningfully and to ensure that the assumptions necessary for OLS regression were satisfied. Each parameter estimated in the OLS regression model represents the expected change in the dependent variable (total livestock units) for a one-unit change in the predictor variable, while all other variables in the model are held constant. The coefficient indicates the direction and magnitude of the association. For instance, a positive coefficient suggests an increase in the total livestock units as the independent variable increases, and vice versa. It is essential, however, to acknowledge that the lack of key predictive variables limits the OLS model's capacity to fully capture the complexities of livestock ownership. Thus, the current model is best utilized for hypothesis generation and to inform more targeted future research rather than as a definitive tool for drawing causal conclusions. Two sample Z proportions test was used to investigate differences in perceptions between men and women around effects of climate change on livestock, constraints to livestock management and adaptation measures.

3 Results

Demographic characteristics of the sample seem typical with mean age of household head of 44 and household size of 5 (Table 2). The mean and median years of education for household heads was seven, which is the highest primary level education and suggest modest education levels. The number of males and females above the age of 15, an indication of household labor available for agricultural activities, ranges from 0 to 9 for males and from 0 to 5 for females.

Results are presented under four themes namely livestock ownership dynamics, climate change perceptions, measures undertaken to adapt to climate change and constraints of livestock production.

3.1 Livestock ownership dynamics

We start by presenting a visual of livestock ownership across the four chiefdoms by male and female headed households, shown in Figure 2.

In the male headed households section, we see a spread of total livestock units across all chiefdoms, with Zumwanda and Chitungulu displaying a relatively lower range, suggesting modest ownership

TABLE 2 Selected demographic statistics of the sample.

Demographic variable	N	Mean	StDev	Minimum	Median	Maximum
Age of Household head	369	44.222	16.197	18.000	44.000	89.000
Years of education household head	377	6.936	2.613	1.0000	7.0000	16.000
No. of males above 15 in household	341	1.6657	1.1503	0.0000	1.0000	9.0000
No. of females above 15 in household	365	1.5973	0.9166	0.0000	1.0000	5.0000
Total males in the household	360	2.7167	1.6208	1.0000	3.0000	15.0000
Total females in household	361	2.7452	1.3505	0.0000	3.0000	7.0000
Total Household size	377	5.191	2.543	0.000	5.000	18.000

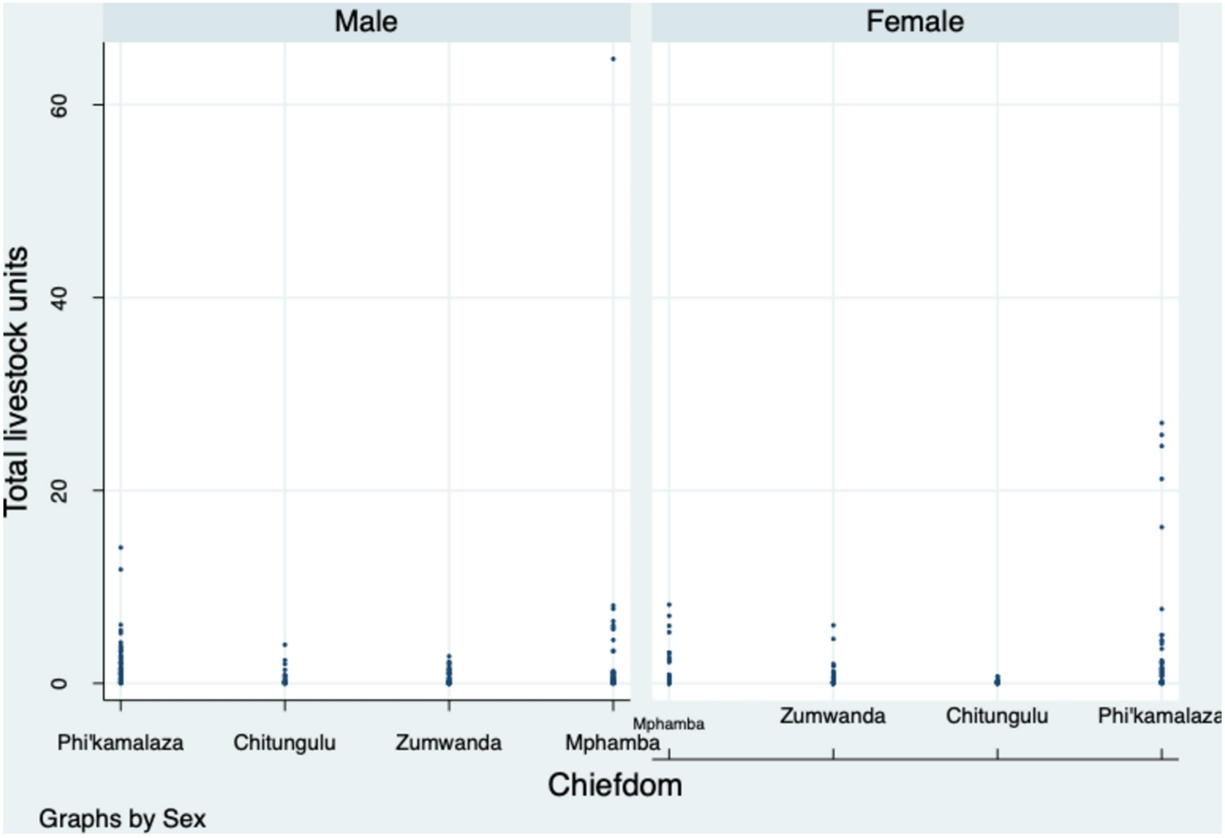

FIGURE 2
Distribution of total livestock units across four chiefdoms separated by the gender of the household head.

among these households in these two chiefdoms. Mphamba and Phikamalaza show more variability, indicating a mix of low to high livestock ownership among male headed households. For female heads of households, the spread is generally similar to that of the males for Zumwanda and Chitungulu, with most women owning fewer total livestock units. However, in Mphamba and Phikamalaza, the range is slightly wider, suggesting that while most women own fewer units, there are instances of high levels of ownership, perhaps reflecting differences in economic status or access to livestock among women in these chiefdoms. The presence of outliers in certain chiefdoms for both genders may point to the existence of individual or group advantages that allow for greater accumulation of livestock, such as access to grazing land, capital, or livestock inheritance practices that favor some individuals over others. Figure 2 illustrates the variations in livestock ownership by gender within specific socio-cultural contexts, indicating that while some patterns are shared between men and women, there are notable differences that could be influenced by local customs, economic opportunities, and resource availability.

The mean total livestock units owned by households was 1.26 and ranged from 0.02 to 16.2 indicating large variability among households (Supplementary Table S1). Specifically, the mean numbers owned per household were 4.6 and 4.6 for cattle, goats, pigs, and chickens. 5.86 and 10.7, respectively, albeit with large variations, as reflected in their large standard deviations. Although some of the livestock were solely owned by the husband, wife, or other male and female household members, joint ownership was the most common type. For instance, for cattle, only 2.7% of cattle-owning households reported having cattle owned by the wife, 16.7% reported ownership by the husband, while 79% of households reported joint ownership. For goat-owning households, 61.5% were jointly owned, 20.5% were owned by the husband, while 15.4 and 2% reported ownership by the wife and other household members, respectively. Similar trends were noted for the other livestock types (Supplementary Table S1). Sole ownership of chickens was higher for wives (22.2%) compared to their spouses (10%) with joint ownership dominating at 88.7%.

Table 3 compares variables influencing total livestock units in unadjusted and adjusted analyses. Notably, the ownership of livestock units—whether by the husband, jointly owned, or by the female—shows a significant and consistent positive association with the total livestock units in both unadjusted and adjusted models (Unadjusted Coefficient = 0.99, $p < 0.001$; Adjusted Coefficient = 0.99, $p < 0.001$), indicating that joint ownership is a significant predictor of increased total livestock units. The data suggests that some chiefdoms have a notable influence on the total livestock units owned. For instance, Phikamalaza Chiefdom shows a positive association in the unadjusted model (Coefficient = 1.26, 95% CI [0.06, 2.47], $p = 0.040$), indicating that being in Phikamalaza is associated with a higher number of total livestock units more than in Zumwanda and Chitungulu Chiefdoms and compared to being in Mphamba Chiefdom. However, this association is not significant in the adjusted model (Coefficient = 0.02, 95% CI [−0.18, 0.21], $p = 0.879$), suggesting that when controlling for other factors, being in this chiefdom does not significantly impact the number of total livestock units. The respondent's gender does not appear to have a strong influence in either model. Age and years of education also show little to no effect on the total livestock units owned. Interestingly, the number of males above 15 years in a household appears to have a slight positive effect in the adjusted model, though not statistically significant [Coefficient = 0.05, 95% CI (−0.04, 0.14), $p = 0.273$].

The total number of males and females in the household, as well as household size, show variable influence across models but lack statistical significance, suggesting that these factors do not play a major role in determining livestock numbers owned by households. Lastly, the variable 'male climate change initiative 'which represented participation in climate adaptation initiatives by male household members reflects a negative association in the unadjusted model (Coefficient = −0.59, $p = 0.115$) but is not significant in the adjusted model (Coefficient = −0.10, $p = 0.513$). This suggests that male initiative may not be a strong influencing factor in the context of other variables.

Not shown in Table 3, the model includes an interaction term between total livestock units owned by the husband and total livestock units jointly owned. This indicates that there is an interaction between the livestock units owned by the husband and those owned jointly by the couple. This term aims to measure whether the impact of total livestock units owned by the husband on the total livestock units is different when there is also joint ownership. The coefficient for this interaction term is significant (Coefficient = 1.40, $p < 0.001$) with a relatively tight confidence interval ([1.10, 1.70]). This indicates that joint ownership of livestock with the husband significantly increases the total number of livestock units more than what would be expected by simply adding the husband's and jointly owned livestock units separately. There is a synergistic effect when the husband has ownership and there is also joint ownership, leading to a greater total number of livestock units than the sum of their separate effects.

3.2 Farmer perceptions on climate change

Across the four chiefdoms, respondents perceived that the climate had changed and this change was manifested in a total of nine different ways (Figure 3). Out of all the responses, the late onset of the rainy season was the most commonly reported, followed by above average rainfall in Chitungulu and Phikamalaza Chiefdoms, and a shorter rainy season for the rest.

Noteworthy in the varied responses is that all four chiefdoms and both men and women reported a mixture of drought and flooding incidences. This suggests a more variable climate regime with increased frequency of extreme climate events, in addition to a markedly shorter rainfall season characterized by late onset and early offset. For Chitungulu chiefdom, a higher percentage of women respondents reported more frequent floods than men. Similarly, for Mphamba Chiefdom, a higher percentage of men reported higher temperatures than women. Lower temperatures and more frequent droughts were the least reported.

The respondents were asked how the changes observed in the climate had affected their livestock production. Their responses are presented in Table 4.

TABLE 3 Total livestock units influencing variables.

	Unadjusted			Adjusted		
Variable	Coefficient	95% CI	*p*- value	Coefficient	95% CI	*p*- value
Chiefdom 2	−1.16	[−2.33, −0.00]	0.050	−0.08	[−0.26, 0.10]	0.392
Chiefdom 3	−1.35	[−2.74, 0.05]	0.058	−0.17	[−0.39, 0.05]	0.135
Chiefdom 4	1.26	[0.06, 2.47]	0.040*	0.02	[−0.18, 0.21]	0.879
Gender	−0.52	[−1.44, 0.40]	0.269	−0.01	[−0.16, 0.15]	0.942
Age	0.01	[−0.02, 0.04]	0.589	−0.00	[−0.01, 0.00]	0.897
Years of education	0.12	[−0.06, 0.29]	0.195	0.00	[−0.03, 0.03]	0.849
Males Above 15	−0.03	[−0.47, 0.41]	0.895	0.05	[−0.04, 0.14]	0.273
Females Above 15	0.23	[−0.28, 0.75]	0.370	−0.04	[−0.14, 0.06]	0.421
Total HH Males	0.17	[−0.11, 0.46]	0.234	−0.12	[−0.53, 0.29]	0.564
Total HH Females	−0.02	[−0.35, 0.32]	0.927	−0.08	[−0.47, 0.32]	0.707
Total HH Size	0.07	[−0.11, 0.25]	0.438	0.09	[−0.31, 0.49]	0.646
Livestock Units by Husband	0.76	[0.06, 1.46]	0.033	0.76	[0.06, 1.46]	0.033*
Livestock Units by Wife	0.72	[−0.36, 1.81]	0.19	0.72	[−0.36, 1.81]	0.190
Livestock Units Jointly Owned	0.99	[0.97, 1.01]	<0.001*	0.99	[0.98, 1.01]	<0.001*
Livestock Units by Female	1.22	[−0.72, 3.16]	0.216	1.64	[1.36, 1.92]	<0.001*
Male Climate Change Initiative	−0.59	[−1.32, 0.14]	0.115	−0.10	[−0.41, 0.20]	0.513

*Statistically significant at $\alpha < 0.05$.

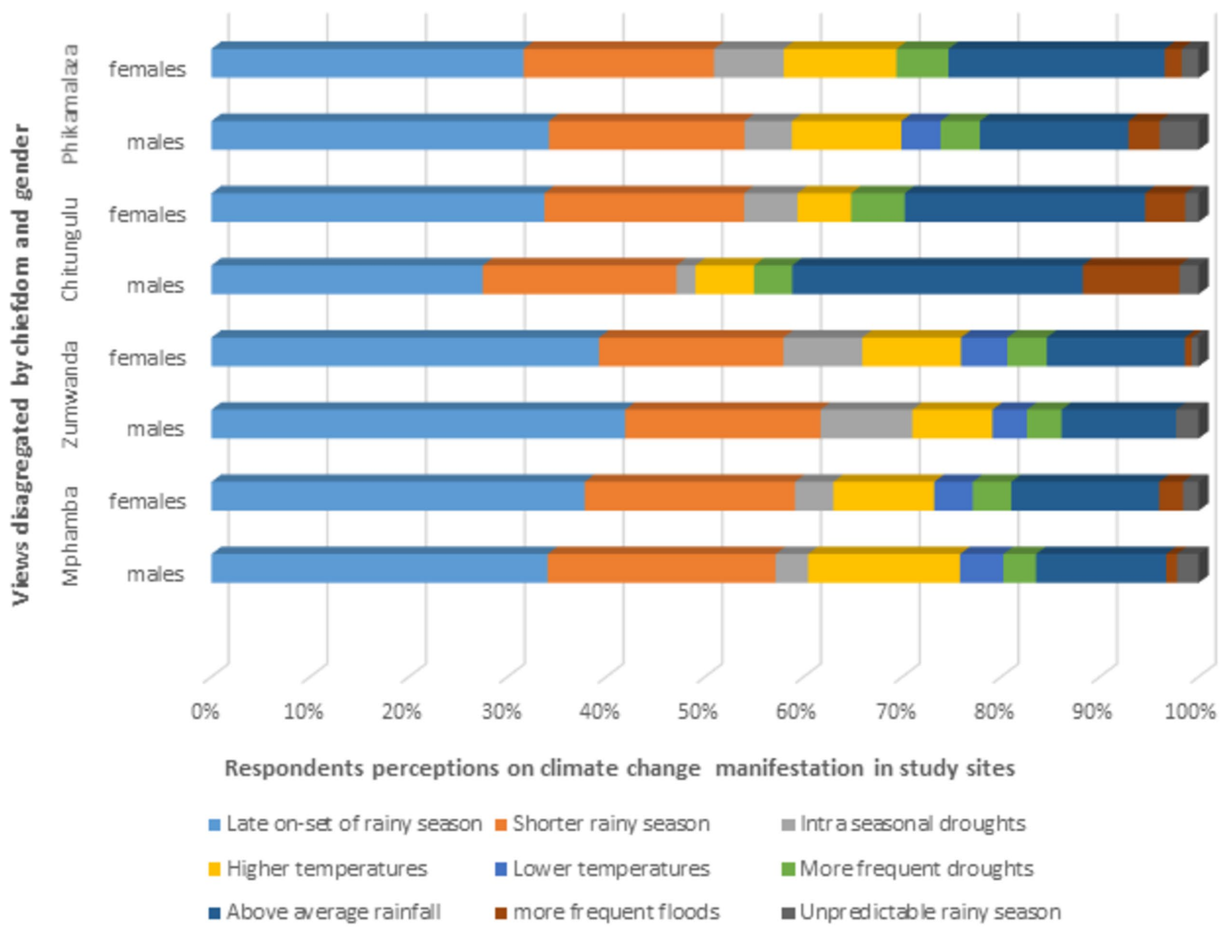

FIGURE 3
Smallholder farmers' perceptions about climate change manifestation in their area, by chiefdom and gender.

TABLE 4 Effects of climate change on livestock production.

Chiefdom	Chitungulu		Zumwanda		Phikamalaza		Mphamba		Total women (n = 222)	Total men (n = 157)	Total (n = 379)
Effects	Men (%)	Women (%)	Men (%)	Women (%)	Men (%)	Women (%)	Men (%)	Women (%)			
Increased diseases	88.5	85.3	76.9	60.8	100	68.4	56.6	56.1	65	78*	70.7
Lack of drinking water	11.5	5.9	30.8	18.9	53.8	12.3	20.8	10.5	13	30*	20.1
Lack of pasture/feed	15.4	8.8	35.9	28.4	56.4	24.6	20.8	22.8	23	32*	26.9
Extreme temperatures	7.7	8.8	0	6.8	5.1	5.3	9.4	10.5	8	6	6.7
Excessive rainfall	0	5.9	0	2.7	0	0	1.9	1.8	2	0.6	1.6
Herbicide pasture poisoning	0	0	2.6	0	2.6	0	0	0	1	0	0.5
Reduced productivity	23.1	11.8	10.3	6.8	15.4	10.5	7.5	10.5	1	0.6	10.8

*Proportions of men giving response was statistically significantly higher than that for women at $\alpha = 0.05$.

TABLE 5 Constraints of livestock production.

Chiefdom	Chitungulu		Zumwanda		Phikamalaza		Mphamba		Total women (*n* = 222)	Total men (*n* = 157)	Total (*n* = 379)
Constraint	Men (%)	Women (%)	Men (%)	Women (%)	Men (%)	Women (%)	Men (%)	Women (%)			
Increased diseases	75	71	84.6	87.8	79.4	78.9	92.5	100	85	83	83.7
Inadequate pasture	15.4	14.7	17.9	6.8	10.3	8.8	15.1	59.6	22	15	19
Expensive vaccines	7.7	2.9	0	2.7	7.7	0	5.7	0	1	5	2.9
No trees for kraal making	7.7	0	0	0	2.6	1.8	0	0	0.5	2	1.1
Livestock theft	0	0	2.6	0	0	0	1.9	10.5	3	1	2.1
Water shortages	3.8	0	0	4.1	0	1.8	0	0	2	0.6	1.3
Goats are destructive	3.8	0	0	1.4	0	1.8	1.9	3.5	2	1	1.6
Cattle requires shepherds	3.8	0	0	1.4	0	1.8	0	1.8	1	0.6	1.1

TABLE 6 Actions undertaken by households to adapt livestock production to climate change.

Chiefdom	Chitungulu		Zumwanda		Phikamalaza		Mphamba		Total women (*n* = 222)	Total men (*n* = 157)	Total (*n* = 379)
Action	Men (%)	Women (%)	Men (%)	Women (%)	Men (%)	Women (%)	Men (%)	Women (%)			
Administering vaccines	46.2	52.9	60	50	74.4	66.7	35.8	47.4	54	53	53.7
Providing water	7.7	5.9	12.8	4.1	17.9	8.8	1.9	10.5	7	10	8.2
Dipping livestock	0	0	5.1	0	0	1.8	0	0	0.5	1	0.8
Administering herbs	30.8	38.2	7.7	6.8	15.4	7	9.4	3.5	11	14	12.1
Providing feed	19.2	2.9	10.3	5.4	20.5	19.3	1.9	21.1	16	11	12.1
Providing clean shelter	0	0	0	0	0	3.5	0	1.8	1	0	0.8
Consult veterinary officers	0	0	7.7	0	7.7	1.8	7.5	3.5	1	0	3.4
Selling off livestock	0	0	0	0	0	1.8	3.8	0	1	6	0.8
Planting trees	0	0	7.7	4.1	0	0	1.9	0	1	3	1.8
Adopting drought-resistant livestock	0	0	2.6	0	2.6	0	3.8	1.8	0.5	3	1.3

Increased incidences of livestock diseases stood out as the most commonly perceived effect across the four chiefdoms and by both men and women. A follow up question exploring constraints of livestock production shows that reports of high incidences of livestock disease dominated the responses with between 70 and 100% of the respondents mentioning it (Table 5).

Over half of the women respondents from Mphamba chiefdom reported that inadequate pasture for livestock was a major constraint. At the same time, less than 20% of the rest cited it, with as low as 7% of the women respondents from Zumwanda Chiefdom.

Adapting livestock production to climate change.

The respondents reported 10 strategies to adapt their livestock production to climate change (Table 6).

Other than the response 'administering vaccines,' which had between 46 and 74% of respondents citing it, the other measures were much less prevalent. Curiously, adopting drought-resilient livestock was not mentioned at all by respondents from Chitungulu and was only mentioned by 4% of the men and 2% of the women from Mphamba. Only about 3% of the men from Zumwanda and Phikamalaza mentioned it, while none of the women did. The measure "dipping livestock" is a disease prevention measure in which individual livestock is forced through a dip filled with insecticides that kill off whatever insects or pests may be attached to the livestock. Very few men (5%) in Zumwanda mentioned the measure as an adaptation measure, and 2% of the women respondents were from Phikamalza. Administering herbs entails using traditional remedies based on local plants such as sausage and *Muzabamba* trees (Figure 4). Selling off livestock was the least popular adaptation measure.

4 Discussion

4.1 Livestock ownership dynamics

This study found that the most common livestock ownership type was joint, followed by sole ownership by the husband. Ownership by the wife was less common except for chickens. It was rare for other household members to own livestock. The predominance of joint ownership for all livestock types is noteworthy. While women's very low sole cattle ownership was expected (see FAO, 2013; Njuki and Sanginga, 2013; Dumas et al., 2018; Lubungu and Birner, 2021), less expected were reports of higher sole ownership of goats by male household heads than their spouses and predominant joint ownership of chickens. This may suggest changed gender norms around small livestock, including poultry. Higher sole ownership of goats by men deviates from what has been commonly reported in the literature,

FIGURE 4
(A) Sausage tree fruit used to treat diseases in chickens **(B)** *Mazabamba* tree used to treat mumps in cattle **(C)** Trough for livestock feed and water **(D)** kraal.

which broadly notes men's focus on large livestock such as cattle. This may be due to men being unable to afford cattle and resorting to goats, which are cheaper to buy and manage. The joint ownership of chickens can be linked to the higher demand for free-range chickens created by urbanites. As chicken rearing has become more lucrative, men show more interest, leading to joint ownership. These results suggest that economic considerations stimulate changes to socio-cultural norms. Moreover, they allude to the importance of accounting for local context when framing explanations and avoiding meta-narratives that overlook actors' agency and capacity to adapt to changes. Such adaptations may include negotiations over socio-cultural norms. Alders (1996) asserted that men's interest in poultry increased proportionally with decreasing livestock numbers such as cattle and goats. In some pastoral areas in rural Tanzania, men are not associated with poultry because they are responsible for ruminant stock. In contrast, in the coastal areas with no tradition of keeping large stock, both men and women owned chickens (Kitalyi, 1996).

Relatedly, the study found a compelling synergy in ownership between husband and wife livestock units. The statistical significance of the interaction term between these two variables suggests a synergistic relationship that elevates the total livestock count beyond what might be achieved by either ownership status in isolation. This result underscores a scenario where the combined effect of the husband's ownership and joint ownership is greater than the sum of their individual contributions. This synergistic effect could be indicative of the socio-economic dynamics within households. It might reflect a collaborative approach to livestock production where joint decision-making and shared responsibilities potentially lead to better livestock management and growth. Alternatively, this could suggest that joint ownership models may engage more household resources, including labor and capital, thereby facilitating an environment conducive to expanding livestock units. It would seem that interventions aimed at encouraging joint ownership, especially involving the husband as a stakeholder, could be an effective pathway to enhance livestock production. Previous studies have shown that there is a compelling synergy in ownership between husband and wife livestock units (Islam et al., 2014; Ogolla et al., 2022; Sulastri et al., 2020; Kartiwi et al., 2020). These results show dynamic socio-cultural norms, evidenced by the commonality of joint ownership between spouses. Similar results were reported by Umar et al. (2020), who found that 60% of their study's respondents jointly owned livestock with their spouses, which their key informants corroborated as a shift from past customs. The departure from inheritance patterns associated with patrilineal and matrilineal systems in asset ownership has led married couples to increase their portfolios of jointly owned assets, including livestock. Nowadays, couples are more likely to acquire livestock through purchases and development projects than through bequests to the man from his male relatives. The insignificance of the tribe as an explanatory variable for livestock ownership emphasizes the magnitude of the changes in socio-cultural norms. The results reveal that typical land ownership patterns no longer dominate, as provided for under patrilineal or matrilineal systems. Rather, decades of community development initiatives on gender and women's empowerment by various governmental and non-governmental organizations have led to incremental changes in inheritance patterns, asset ownership, and awareness levels. In response to male-dominated institutions, development initiatives have recently focused on what are generically called women's empowerment programs. Such programs commonly include providing livestock, specifically goats, to women (Nthenga and Bwalya, 2023). In a study from Ethiopia, Galiè et al. (2015) reported that both male and female respondents had noted a growing change in socio-cultural norms and beliefs; more women owned resources usually associated with men, including cattle. This was attributed to the community's acceptance of women's roles and rights due to awareness raising on gender equity and government initiatives to increase resource ownership by women.

4.2 Impacts of climate change on livestock production

The study highlights the multifaceted impacts of climate change on livestock production, as perceived by men and women across the four chiefdoms. A large majority of the respondents identified the increase in livestock diseases as the most pressing issue, reflecting the growing vulnerability of livestock to changing climate conditions. More men than women reported this challenge because of differences in gender roles related to livestock health management. Men are predominantly involved in tasks directly related to livestock health. Culturally, men are expected to take the lead in livestock health matters such as administering vaccines, treating diseases, artificial insemination, aiding livestock in calving, and purchasing livestock medicines.

Water scarcity and a lack of pasture also emerged as critical concerns, particularly in Zumwanda and Phikamalaza. The higher reporting rates among men for this impact indicate their greater involvement in large livestock, such as cattle, which require longer travel for water and pasture than small livestock. Further, the results also reflect regional disparities in the availability of these resources.

While higher temperatures and excessive rainfall were less frequently reported, they still represent significant constraints, particularly as they can exacerbate disease outbreaks and reduce livestock productivity. The lower frequency of reports about herbicides contaminating pastures and by men only suggests that this may be a localized issue. The men observed it because the two activities of looking after large livestock and applying herbicides fall under men's domain of gendered roles. Interestingly, results show reduced livestock productivity being acknowledged by both genders and across the four chiefdoms, although the frequencies are low. This suggests climate change negatively impacts livestock productivity despite most farmers not acknowledging it or linking it directly.

Overall, the results highlight the importance of understanding gendered perceptions and regional differences when addressing the impacts of climate change on livestock production. Tailored interventions considering these factors will be crucial in building climate resilience within rural farming communities.

4.3 Constraints to livestock production

Livestock production constraints reports reveal that disease incidence increases are the most prominent constraint across the four chiefdoms. This aligns with the earlier findings on the effects of climate change on livestock production and with the results of a recent nationwide livestock survey, which reported that the most significant constraint mentioned by livestock-raising households was disease (Zambia Statistics Agency, 2022). The high prevalence of disease suggests that livestock health is severely impacted, likely due to the climatic conditions that have reduced drinking water, pasture shortages, and disease proliferation.

Inadequate pasture is another notable constraint, although it was less reported than disease. There was variance in responses among the chiefdoms and between genders, with women in Mphamba reporting it more frequently than men. This may indicate differences in access to grazing land. Mphamba may be more affected by this constraint because of the expansion in the urban space since the chiefdom covers the district headquarters and the central business district. This disparity underscores the need for targeted interventions to improve pasture availability, particularly in regions with more acute constraints. The constraint is generally less common due to the cultural norms prevalent in rural communities across Zambia that dictate that individually owned agricultural fields become communal grazing lands post-harvest. During this period, livestock were allowed to graze in any agricultural field. The chief announces the beginning and end of the period. This long-standing tradition allows livestock households access to more pasture and for non-livestock-owning households to have dung (animal manure) added to their soil.

The cost of vaccines poses a significant challenge for some respondents, especially given the high disease burden. This constraint was more reported by men than women across the four chiefdoms. We attribute this to the different gender roles around livestock health management. Further, this indicates that economic constraints further exacerbate the difficulties of managing livestock health, limiting the ability of smallholder farmers to protect their livestock from diseases.

Other constraints, such as the lack of trees for kraal making, livestock theft, and water shortages, were mentioned by a few respondents, suggesting that these issues are localized. The lack of trees for making kraals was highest reported by men in Chitungulu chiefdom. The Chiefdom is located in a game management area next to a national park. Livestock in this chiefdom is at high risk of predation from wild animals; hence, the focus is on kraals for their protection. Human-wildlife conflicts increase during food and water shortages for domestic and wild animals.

Though livestock theft was scarcely reported, it was observed more by women in Mphamba chiefdom, which covers the urban part of the district. This indicates women's difficulties in livestock security due to their proximity to urban centers, where thefts are more likely. Further, constraints such as the destructive behavior of goats and cattle requiring a shepherd were uncommon but more frequently mentioned by women. Local taboos against women shepherding livestock mean that women tether goats around their homesteads or access male labor to shepherd the large livestock.

4.4 Measures taken to adapt livestock production to climate change

There was quite a diverse range of measures undertaken by households to adapt their livestock production to climate change, with notable variability across chiefdoms and between genders. Four of the 10 measures directly related to treating livestock diseases. The administration of vaccines stands out as the most commonly employed measure. This reflects a widespread recognition of the importance of disease prevention in safeguarding livestock health against climate-induced stresses among livestock owners across the study sites. However, the preoccupation with vaccines also suggests a vulnerability, as the effectiveness of this measure is contingent on the availability and affordability of vaccines, which supply chain disruptions or economic constraints could challenge.

Providing water and feed were the following most common adaptation strategies, though they are significantly less prevalent than administering vaccines. The regional and gender disparities in these practices, particularly the higher reporting of water provision by men in Phikamalaza compared to women, indicate that water scarcity may be more acute in this chiefdom compared to others. Further, the frequency is high because men deal with larger livestock that need larger quantities of water. Similarly, while more commonly reported by men, the provision of fodder shows variability across chiefdoms, suggesting that fodder scarcity is a region-specific issue that might require targeted interventions. It is also worth noting that Phikamalaza chiefdom has the highest frequency of responses for fodder provision by both genders, with the frequencies almost tallying. This indicates the severity of pasture shortage in the chiefdom and is reflected in men's responses to water shortages. A study examining climate adaptation strategies of farmers in the Limpopo Basin of South Africa reported irrigation and supplementing livestock fodder (Gbetibouo et al., 2010). In our study, irrigation was absent, as limited perennial water sources may have precluded this option.

Traditional disease treatment practices such as administering herbs remain an important adaptive measure, especially among women. Traditional knowledge is critical in livestock management, particularly without access to modern veterinary services. Further, this could also indicate the lower knowledge levels of women farmers in modern veterinary medicines. Rural women face limited access to animal health information more than men (Galiè et al., 2017). In addition, the cost of vaccines may also limit women's access to vaccines, hence their fall back to traditional remedies as cheaper alternatives. Relatedly, measures such as dipping livestock, consulting veterinary officers, or adopting drought-resistant livestock indicate that there may be barriers to accessing these adaptation measures, such as cost, availability, or awareness. Smallholder livestock farmers are already rearing traditional drought-resilient livestock, which limits their options for drought-resistant livestock. The very low engagement in long-term resilience-building measures, such as planting trees or construction of dams for year-round water provision, points to a potential gap in adaptation measures.

5 Conclusion

This study employed a gender-responsive approach to examine livestock ownership dynamics and climate change adaptation measures for livestock production in three districts of Eastern Zambia. The results show that joint ownership of livestock by married couples was the most common form of ownership, and had a likelihood of higher total livestock units than households where sole ownership by a male household head dominated. Age, gender, location, and education were not significant factors in determining the total livestock units owned by households. This suggests that cultural norms around livestock ownership, which had previously limited co-ownership by women in patrilineal societies, have changed, presenting opportunities for increased ownership by women and possibilities to use livestock for adaptation to climate change and improved household food and nutrition security. Recognition of joint ownership is an essential step toward joint decision-making over the livestock, which ultimately matters more in moving toward women's empowerment and deriving the food security and improved resilience that follows.

Climate change has affected livestock production via increased livestock disease, shortages of fodder and water, and consequently, lower livestock productivity. Climate change has exacerbated livestock production constraints ubiquitous in the region, such as high incidences of livestock diseases and dependence on rain for fodder production, leading to shortages during reduced rainfall, higher temperatures, and water scarcity. Men and women reported these challenges, with nuances mediated by gender roles. Thus, efforts to adapt to the changed climate focused on preventing and treating livestock diseases and providing water and fodder. The measures were mainly at the household level with limited impacts. More collective action around efforts such as building dams, running disease prevention awareness, and improving fodder production programs could raise the prominence of livestock production in the province and contribute to more climate-resilient and inclusive food systems with production anchored on mixes of crop and livestock production activities.

In conclusion, livestock production has a high potential to contribute to inclusive climate change adaptation in the study region and, more broadly, through its various roles. However, there is an urgent need to increase the percentage of livestock-owning households and the size of the herds so that livestock can make meaningful contributions to household welfare and climate resilience. We call upon agricultural development actors to upscale their livestock production interventions and focus on climate-smart livestock production activities such as drought-resistant fodder species and water storage, increasing productivity of disease and climate-tolerant livestock breeds, and improving farmer knowledge. We further recommend that the nationwide agricultural subsidy program be retailored to include livestock production inputs. For future research, we recommend exploring intra-household decision-making around livestock activities.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by University of Zambia Humanities and Social Sciences Ethics Boards. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

BB: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. BC: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Writing – original draft, Writing – review & editing. KM: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted without any commercial or financial relationships that could potentially create a conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2024.1487798/full#supplementary-material

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