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Livestock marketing practices and determinants of livestock market supply among pastoralists and agro-pastoralists in the arid and semi-arid areas of Ethiopia

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The pastoral and agro-pastoral production system is the second most common livestock production method in Ethiopia, playing a crucial role in sustaining livelihoods through food provision, income generation, and social capital. However, livestock marketing in these regions face multifaceted challenges. This study investigated livestock marketing practices and identified key determinants influencing livestock market supply among pastoralist and agro-pastoralist communities in the South Omo zone, a major pastoral area in Ethiopia. A cross-sectional research design was employed, integrating both quantitative and qualitative approaches. The quantitative component involved a structured survey of 383 households across four districts, while the qualitative data were collected through eight focus group discussions and 24 key informant interviews. Livestock sales volume, measured as Total Livestock Units (TLU), was analyzed using multiple log-linear Ordinary Least Square (OLS) regression with robust standard errors. Findings revealed that 60.1% of respondents were male and 39.9% female. Market dynamics indicate that goats are the most frequently traded livestock, with 60.1% of households participating in their sale, followed by cattle and sheep. Livestock transactions predominantly take place in formal markets—both primary and secondary—accounting for 88.5% of all transactions, while only a small fraction occurs in informal markets, such as bush and street venues. A significant 61.4% of respondents cited price advantage as the primary factor influencing their market choice. Although 82.6% of participants observed an increase in demand for pastoral livestock, 76.4% primarily sell to domestic traders, indicating a limited integration into formal and higher-value markets. Key positive predictors of livestock sales include: educationa levels ($\beta = 0.108$, $p < 0.001$), access to credit ($\beta = 0.344$,

$p < 0.001$), having diversified income ($\beta = 0.444$, $p < 0.001$), herd size (log-TLU; $\beta = 0.130$, $p < 0.001$), and market information access ($\beta = 0.997$, $p < 0.001$). Conversely, distance to market negatively affected sales ($\beta = -0.057$, $p < 0.001$). The findings suggest that expanding education, credit access, information flow, and infrastructure could significantly enhance market participation and livelihoods in pastoral contexts.

KEYWORDS

factors, livelihoods, log-linear regression model, pastoral, social status, livestock marketing

Introduction

Ethiopia possesses vast livestock resources that are central to its economy - accounting for approximately 40% of agricultural GDP, nearly 20% of total GDP, and contributing about 20% of foreign-exchange earnings in 2017 (World Bank, 2017). Has Among various livestock production systems, pastoral and agro-pastoral (PAP) systems are the second most prevalent, particularly in lowland communities in the southern and eastern regions (Tegegne et al., 2013). Pastoralists depend on herding livestock such as cattle, sheep, goats, and camels, migrating seasonally for grazing and water. In contrast, agro-pastoralists integrate livestock herding with crop farming, balancing agricultural and livestock practices (Dong, 2016; Management Entity, 2021).

These livestock systems are vital not only for nutrition and income, but also for social identity and status among communities (Tolera and Abebe, 2007; Tegegne et al., 2013; Dido, 2019; Tofu et al., 2023). For example, Abdulkadr (2019) reports that pastoralism supplies roughly 20% of Ethiopia's domestic exports, 90% of live animal exports, and some 80% of the country's annual milk production. Despite this high potential, the livestock sector remains under-capitalized at the marketing end largely due to fragemented institutional structurs.

Livestock marketing in Ethiopia operates across four main tiers-bush, primary, secondary, and tertiary/terminal markets-yet overall overall development remains limited (Belachew and Stuart, 2003). Key deficiencies include weak grading, poor information systems, inadequate promotion, and lack of strategic planning. These inefficiencies elevate marketing costs, disproportionately reducing profits for pastoralists, and thus prevent the sector from fully realizing its potential (Fitta, 2008).

A broader literature highlights how fixed and proportional transaction costs influence market participation decisions among smallholders. Key, Sadoulet, and de Janvry (2000) show that these costs influence whether households participate as buyers, sellers, or remain self-sufficient. Similarly, Barrett (2008) underscores that lowering transaction costs and improving asset access are central to commercialization pathways in eastern and southern Africa. Bellemare and Barrett (2006) build on this by using ordered-tobit models specifically designed for analyzing livestock market participation in Kenya and Ethiopia. These structural econometric frameworks, which often combine discrete participation and continuous sales decisions, are particularly relevant for modeling the marketing behaviors of PAP households.

Information frictions also affect market performance. Aker (2010) demonstrates that mobile phone coverage reduces price dispersion and improves efficiency, a crucial benefit for pastoralists who rely heavily on informal networks. Access to credit further alleviates liquidity constraints, facilitating commercialization and adoption of improved technologies, as highlighted in multi-country studies by IFPRI and others (Balana et al., 2020; Lemecha, 2023; IFPRI, 2025).

Despite these insights, Ethiopian research remains largely localized, with limited geographic breadth, and often neglects how smallholder-level constraints hinder broader market integration. Prior studies have shown low levels of formal market participation among PAP communities (Catley et al., 2013; Mohamed, 2019; Lind et al., 2020) and widespread deficiencies in market knowledge, particularly in southern regions (Desta et al., 2019; Dido, 2019). Solomon et al. (2003) further emphasize that inadequate understanding of market structures and pricing mechanisms impedes effective institutional and policy design. Similarly, Tewodros (2008) identifies the absence of market-oriented production strategies as a persistent challenge, while more recent studies (Chekol et al., 2021; Adane and Hidosa, 2022; Kusse et al., 2022) highlight constraints such as weak infrastructure, limited transport, scarce market data, and restricted access to credit.

Notably, many of these studies overlook the South Omo Zone—a core PAP production area, and often fail to capture how local-level supply constraints affect smallholder pastoralists' engagement in livestock markets.

This study addresses these gaps by surveying 383 households across South Omo to assess the current livestock marketing practices and quantify the determinants of market supply using robust econometric approaches that account for transaction costs. By centering on this strategically important yet understudied region, the study provides empirical evidence to inform policy interventions, strengthen market integration, and enhance the economic resielience of pastoral and agro-pastoral communities of Ethiopia.

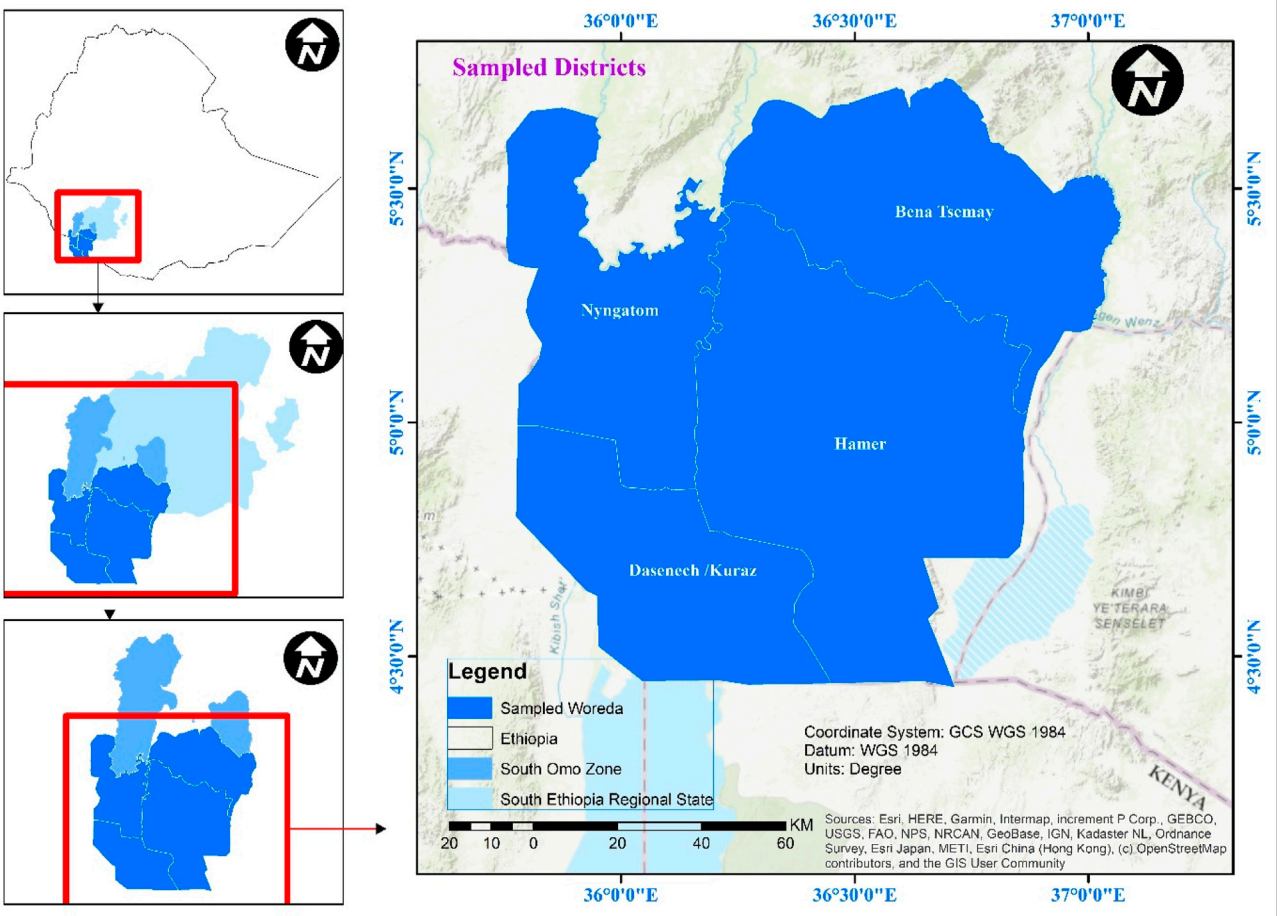

FIGURE 1
Map of the south omo zone.

Materials and methods

Study area

The study was conducted in the South Omo Zone, located in the southwestern part of Ethiopia. South Omo Zone is one of the 12 zones in the South Ethiopia Regional State of Ethiopia. It borders Kenya to the south, West Omo Zone to the west, Keffa Zone to the northwest, Ari and Gofa Zones to the north, Gardula, Ale Zone, and Konso to the northeast, and the Oromia Region to the east. The zone is situated at a latitude of 5° 29′ 59.99″ N and a longitude of 36° 29′ 59.99″ E, with an elevation ranging from 360 to 3500 m above sea level. The administrative center of South Omo is Dimeka.

The South Omo zone encompasses a vast area with sparsely populated agro-pastoral and pastoral communities in the lowlands and densely populated highlands. It boasts significant livestock potential, with a total livestock population comprising 4,757,960 cattle, 2,484,370 sheep, 6,265,051 goats, 2,005,632 chickens, 52,179 horses, 41,036 mules, 355,353 donkeys, and 3,010 camels (South Omo zone Agriculture Department, 2022 unpublished data), representing 36.3% of the region's livestock. The study focused on four pastoral and agro-pastoral districts Benatsemay, Dasenech, Nyangatom, and Hamer out of the eight in the South Omo Zone (Figure 1).

Research design

The study employed a mixed research design that incorporated both quantitative and qualitative methods. This approach was chosen because it offers several key advantages. Firstly, it provides a comprehensive understanding of complex phenomena by combining the strengths of both research types. Quantitative data can show what is happening, while qualitative insights can reveal why these changes occur, offering a dual perspective. Secondly, comparing findings from different methodologies can increase the credibility and validity of the results, helping to minimize methodological bias. Thirdly,

quantitative trends can be given depth and context through qualitative stories, which place statistics within real-life experiences and environmental constraints. This added depth and interpretive nuance are essential for generating actionable insights (Smajic et al., 2022; Oranga, 2025). The quantitative method consisted of a questionnaire survey, while the qualitative methods included focus group discussions (FGD) and key informant (KI) interviews.

Sample size and sampling method

This study used a multistage sampling approach to select the study areas and participants from the South Ethiopia Regional State. Of the 12 zones in the region, the South Omo Zone was selected as it has significant agro-pastoral and pastoral communities. Of the eight districts in the zone, four were purposively selected based on accessibility and stability. Two kebeles (villages) were then chosen from each of the four districts using simple random sampling. Finally, households were selected using systematic random sampling within the kebeles.

Multistage sampling is particularly well-suited to geographically dispersed populations, allowing researchers to progressively focus on smaller units while maintaining representativeness and cost-effectiveness. It reduces logistical burdens and avoids the impracticality of compiling exhaustive household lists across widespread rural areas (Sedgwick, 2015; Nanjundeswaraswamy and Divakar, 2021). While this approach aided in data collection and ensured logistical feasibility, it limits external validity; the purposeful selection of stable districts may restrict the generalizability of our findings to less accessible or more volatile regions.

The sample size for the quantitative study was determined using Cochran (1977) formula for proportions:

$$n = \frac{Z^2 pq}{e^2} = \frac{1.96^2\,(0.5 * 0.5)}{0.05^2} = 385$$

Where, n is the sample size, $Z = 1.96$, corresponding to a 95% confidence interval; p is the proportion of households interested in livestock marketing, q is *1-p,* and e is the allowable error. For this survey, we considered an expected p of 50%, a 95% confidence level, and an allowable error of 5%. The computed sample (385) was then allocated proportionally across districts: 101 in Benatsemay, 100 in Dasenech, 98 in Hammer, and 84 in Nyangatom. Following data cleaning—excluding two responses with incomplete demographic and outcome data—the effective sample comprised 383 valid responses.

Methods of data collection

We conducted a questionnaire survey involving 385 pastoral and agro-pastoral households from four districts through a face-to-face interview using structured questions. The questionnaire covered socio-economic and demographic characteristics, common livestock raised and marketed, livestock holdings, marketing practices, price determination, market access, access to market information, factors affecting livestock sales volume, and other issues. The questionnaire was rigorously tested for completeness, coherence, and relevance using the KOBO Toolbox. Additionally, we held key informant (KI) interviews with 24 officials and experts from various government offices related to the livestock marketing system across the four districts. Focus group discussions (FGDs) were conducted with pastoralists and agro-pastoralists from the four districts in the study. Two FGDs were conducted in each study district, making a total of eight FGDs. The participants within each FGD ranged from a minimum of 6 to a maximum of 12. The data collection tools were developed in English and translated into local languages for better accessibility. The data collection tools, including the survey questionnaire, focus group discussion (FGD), and key informant interview (KII) checklists and guides, are provided in Supplementary Material S1.

Data analysis

The quantitative data collected from respondents were entered, edited, and coded into a Microsoft Excel 2013 spreadsheet. The analysis was conducted using both descriptive and inferential statistical methods, using STATA software version 17. Descriptive statistics, including frequency, percentage, mean, and standard deviations, were employed.

We initially estimated a multivariable linear regression (MLR) model to evaluate the predictors of livestock sales volume (market supply). However, diagnostic tests revealed that the dependent variable—sales volume—had a right-skewed distribution, violating key assumptions of classical linear regression, such as homoscedasticity and residual normality. To address this issue, we log-transformed the outcome variable to reduce skewness and achieve an approximation of normality, thereby enhancing the validity of the model.

Before estimating the model, the variables were assessed for multicollinearity using Variance Inflation Factors (VIF). VIF values exceeding 10 indicated serious multicollinearity, while values between 5 and 10 suggested moderate concern. Additional regression diagnostics, including tests for heteroscedasticity, specification (RESET), and residual normality, indicated that the classical Ordinary Least Squares (OLS) assumptions were not fully satisfied. To overcome these limitations, we chose to implement a log-linear OLS model with robust standard errors, which is better suited to the characteristics of our data and provides more reliable inference. To further assess model robustness, we re-estimated the model using a Generalized Linear Model (GLM) with a log link and gamma family.

In our log-linear model, we transformed the dependent variable (sales volume) by applying the natural logarithm, while keeping the predictors in their original units. In this context, the coefficient βi for an explanatory variable Xi indicates the approximate percentage change in the original sales volume associated with a one-unit increase in Xi. Specifically, a one-unit increase in Xi corresponds to an expected change of approximately $100 \times \beta i$ % in sales. For larger coefficients, we calculate the exact change using the formula $(e^{\beta i} - 1) \times 100\%$ to enhance precision in interpretation. The findings are interpretaed as "a one-unit increase in predictor X is associated with a Y% change in the expected value of sales, holding all other factors constant."

The dependent variable was the total livestock unit (TLU) sold in the market, while independent variables included respondents' age, gender, family size, education level, marital status, access to market information, credit services, main occupation type, market distance, and herd size in total livestock units. The MLR model was selected for its practicality in identifying factors impacting market supply, as recommended by Tranmer et al. (2020).

The dependent variable, sales volume in TLU, is a standardized metric in livestock management used to aggregate different species—such as cattle, goats, camels, donkeys, and poultry—into a single unit that reflects their relative biomass or metabolic requirements. This enables meaningful comparison of herd sizes, grazing pressure, and feed demand across diverse systems (Gilbert and Rushton, 2020). The TLU is calculated using the following general formula:

$$\text{Total TLU} = \sum_i (N_i \times f_i)$$

where, Ni = number of animals in category i, and fi = TLU conversion factor (coefficient) for that animal category—based on liveweight or energy needs relative to a reference animal.

Although the basic formula is universal, TLU coefficients often need to be adapted to local contexts—accounting for indigenous breeds, seasonal weight fluctuations, and species combinations. For this study, we employed coefficients tailored to pastoral regions of Ethiopia, derived from the 2021/22 Ethiopia Agricultural Sample Survey (CSA, 2023). Accordinly, 1 adult indigenous cattle = 0.8 TLU; 1 adult goat = 0.12 TLU; 1 adult sheep = 0.13 TLU; 1 adult camel = 1.25 TLU; I adult donkey = 0.5 TLU, and 1 chicken = 0.01 TLU. These weights enabled the aggregation of diverse livestock holdings into a single, standardized index that represents overall livestock biomass adapted to local breed characteristics and ecological conditions, ensuring accurate representation in pastoral settings. Taking locally adapted TLU coefficients, the TLU formula applied in our study was:

$$\text{Total TLU} = N_{\text{cattle}} \times 0.8 + N_{\text{goats}} \times 0.12 + N_{\text{sheep}} \times 0.13 + \cdots$$

Given that TLU is measured on a continuous scale rather than as discrete integer counts, modeling techniques intended for count outcomes, such as Poisson or negative binomial regression, are not suitable. Therefore, multiple linear regression was chosen as the appropriate modeling approach, as it effectively handles continuous dependent variables and enables the inclusion of additional predictors, including total household TLU as independent variables.

Description of variables included in the regression model

Age of the households

We include several independent variables in our regression model, including household size, age, gender, education level, herd size, distance to market, market information, credit to access, and dominant occupation. The description, unit of measurement, and the hypothesized sign of each variable are shown in Table 1. Age is a continuous variable measured in years. The coefficient for the age of the household head may be positive or negative. When age is considered as a proxy for experience in marketing, it is anticipated to enhance market participation, leading to a positive coefficient. Older pastoralists often accumulate capital and higher sales volumes. However, the coefficient for age could also be negative, as older households often have more dependents, which may increase consumption and reduce marketable surplus. Additionally, younger individuals are typically more enthusiastic about engaging in livestock markets and are more receptive to innovative ideas, making them less risk-averse compared to their older counterparts (Kibona and Yuejie, 2021).

Gender of households

The gender of households is considered as an independent variable in the MLR model. In this model, a gender variable is assigned a value of 0 for women and 1 for men. The hypothesis was that male-headed households would contribute more livestock to the market compared to female-headed households. However, there are certain challenges that women face, such as limited access to extension services, lack of capital, and limited access to institutional credit. These barriers can negatively impact women's involvement and effectiveness in livestock production and marketing systems.

The respondent's level of education

The education level of respondents was measured as a continuous variable by recording the total number of years of formal schooling completed. This variable serves as a proxy for human capital, reflecting respondents' knowledge, skills, and ability to process market information. Higher education levels are expected to positively influence market participation, as educated farmers are better able to access market information, negotiate prices, and adopt improved production practices (Altinok et al., 2019; World Bank, 2022).

TABLE 1 Summary of the description, measurement, and expected sign of independent variables.

Variables	Description	Type	Value	Expected sign
Age	Age of household head	continuous	age in years	±
Gender	Sex of household head	dummy	1 if male and 0 otherwise	'+
Marital status	Marital status of household Head	dummy	1 for married, 0 otherwise	+
Fam size	Household family size	continuous	Number	+
Education	Education level of household head	continuous	years of schooling	+
Distance	Distance to the market center	continuous	Walking in hours	-
Credit	Credit access	dummy	1 if has credit access, 0 for lack of credit	+
Herd size TLU	Total livestock in the family	Continuous	Total livestock unit	+
Occupation	'The dominant livelihood system	Dummy	1 for diversified livelihood, 0 for livestock only	+
accesminf	Access to market information	Dummy	1 for access of information, 0 otherwise	+

Family size

The family size of a respondent was one of the independent variables expected to influence the number of livestock brought to the market. It was recorded as a continuous variable. The expected effect was positive, as households with a large number of family members supply more livestock to the market to meet the needs of their larger families (for cash needs, food, fear of livestock death, household investments, etc.).

Market information

This is one of the dummy variables included in the model. It was categorized according to whether respondents had access to market information. "Yes" was coded as 1 and "no" as 0. The hypothesis was that access to livestock price information in local markets would have a positive correlation with a high supply of livestock in the market (Gemechu et al., 2020).

Herdsize or total livestock unit (TLU) in the household

The total livestock holding (TLU owned) was included as an independent predictor to capture the producer's herd size capacity. This is a continuous variable that indicates the overall size of livestock owned by the pastoralists and agro-pastoralists. The relationship between TLU holding by households and the number of livestock sold at the market is expected to be positive, suggesting that higher TLU corresponds to an increased number of livestock brought to market (Negassa et al., 2017).

Distance to market

It is a continuous independent variable measured as the number of hours pastoralists and agro-pastoralists travelled to reach the nearest livestock market. Distance significantly affects their livestock market supply; greater distances result in higher transportation costs, longer travel times, and potential declines in livestock health, which can lower sale prices. Proximity to markets reduces transportation costs, minimizes livestock weight loss from extended treks, and improves access to market information and facilities (Key et al., 2000; Makhura, 2001). Households near markets can supply larger quantities of livestock. It is hypothesized that distance to the market negatively impacts livestock supply.

Credit access

Access to credit postivily impacts livestock market supply. Farmers with access to credit (coded as 1) are expected to supply more livestock to the market compared to those without access (coded as 0), as financial constraints limit their ability to invest in productivity-enhancing inputs such as improved livestock breeds, feed, and veterinary services. Access to credit has been shown to improve agricultural productivity and market participation by easing liquidity constraints and enabling timely input use (Abiye, 2020).

Occupation (livelihood system)

Coded as 1 if the household pursues a diversified livelihood and 0 if it relies solely on livestock farming. Households coded as 1, with multiple income streams, were expected to have greater resources and resilience, enabling higher investment in livestock production, transport, and marketing, and thereby maintain or increase their market participation compared to those rely solely on livestock rearing (coded as 0).

Results and discussions

Demographic characteristics of survey participants

The average age of participants in the survey was 36, with a range from 16 to 85 years. In terms of gender, 60.1% were male

and 39.9% female. Most participants (76.5%) had no formal education, while 20.9% attended primary school (1–8) and 2.6% attended secondary school (9–12). Regarding livelihood strategies, most households (71.8%) practiced a mixed farming system, combining livestock rearing with crop production. Meanwhile, 23% relied solely on livestock, and 4.4% focused entirely on cropping; the remaining 0.8% were involved in other activities. This quantitative data align with insights gathered through KI interviews and FGDs.

For example, a key informant from the Trade and Marketing Development Office in Benatsemay district observed:

> "Pastoralists in the district practice both livestock breeding and crop cultivation. However, crop production is entirely dependent on natural rainfall, leading pastoralists to prioritize livestock farming. When rainfall is abundant, they can benefit from both crops and livestock, allowing for a diversified income rather than solely relying on livestock."

Livestock marketing practices

The survey showed that livestock husbandry is a common practice in the South Omo Zone. Out of the 383 respondents surveyed, 98.96% reported keeping livestock of different species. Cattle, sheep, and goats were the most common types of livestock. On average, each household owned 40 livestock, with ownership ranging from 0 to 950 animals. Most (63%) often sell goats at markets to cover family expenses, while 15% sell cattle as their second most common livestock transaction. Additionally, around 11% have experience selling cattle, goats, and sheep. Goats are the predominant livestock raised and sold by pastoralists and agro-pastoralists in the study area. This is attributed to the prevailing semi-arid to arid climate in the area. This finding is consistent with other research indicating that goats thrive in tropical pastoral regions because of their adaptability to heat, ability to survive on sparse vegetation, and efficient foraging habits. They require less water than other livestock, can eat a wider variety of plants, and are known for their hardiness, allowing them to endure harsh environmental conditions. This adaptability makes goats suitable for smallholder farming and enhances the economic stability of rural communities (Nair et al., 2021). Additionally, goats provide various products like meat, milk, and fiber, which are valuable for both subsistence and commercial purposes. They also reproduce quickly, ensuring a steady supply (Nguluma et al., 2022). Furthermore, the high demand for goat meat in both local and international markets may be another reason why goats are the primary livestock raised and sold by pastoralists and agro-pastoralists in South Omo. A qualitative study conducted among Ethiopian pastoralists identified a significant process of "market sensing" and "market responding." Experienced pastoralists monitor buyer preferences, adapt their herd composition, and selectively fatten animals for sale. This demonstrates how local knowledge and strategies influence market integration (Gugissa et al., 2021).

Participants indicated where they sold their livestock, with 49.6% reporting sales in primary markets and 38.9% in secondary markets. Additionally, 5.2% sold in street markets, 3.4% sold everywhere, and 0.8% in bush markets, while 2.1% had no selling experience (Figure 2). In Ethiopia, livestock markets are categorized into four main types based on the number of animals and participants each market day: bush, primary, secondary, and terminal markets. Bush markets are informal, facilitating direct transactions between producers and buyers without formal infrastructure. Primary markets are the first formal sales points, usually in rural areas, where producers sell their animals to traders or buyers. Secondary markets are larger and more organized, acting as aggregation points where livestock from primary markets are sold to larger traders or exporters. Terminal markets are the final sales venues, typically in major urban centers, where livestock from secondary markets is sold to large-scale buyers, including exporters and processors (Bereda et al., 2016).

According to the survey, 76.2% of respondents sell their livestock to domestic livestock traders, while 7.8% mentioned selling to any buyer offering a better price. Additionally, 6.5% sell to exporters, and 7% sell to local butchers or restaurants. Lastly, 2.5% reported having no experience selling livestock (Table 2). The focus group discussions confirmed these findings, with participants indicating that they mainly supply their livestock to domestic traders in the market. Some participants also mentioned their willingness to sell to anyone if the price offered is favorable.

The survey findings revealed that 47.5% of respondents believed livestock market prices are set through direct negotiations between buyers and sellers. Meanwhile, 45.4% indicated that the price solely by the seller, 4% reported that brokers are responsible for price setting, and only 1% stated that the buyer detrmines the price. Additionally, 2.1% of respondents had no information about pricing, as they were not actively engaged in livestock sales (Table 2). Figure 3 illustrates the distribution livestock sales volume (log TLU) among the households.

The results align with previous studies indicating that cattle market prices are predominantly negotiated between buyers and sellers, often based on visual estimation of the animal's body weight. In contrast, price determination by sellers alone is less frequently reported (Chekol et al., 2021; Adane and Hidosa, 2022).

However, in contrast to the survey responses, insights from FGDs and KIIs suggest a different narrative. Most participants in these qualitative sessions emphasized that brokers or traders are the primary determinants of livestock prices, often leading to suboptimal returns for producers. They expressed concerns that brokers typically set prices in favor of traders or buyers and

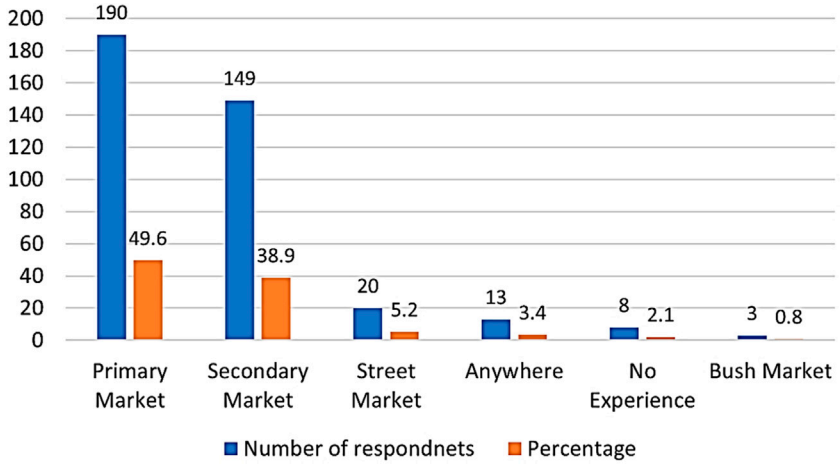

FIGURE 2
Common market types in the south Omo zone for livestock sales.

TABLE 2 Main buyers of pastoral livestock and price determination mechanisms in the South Omo Zone.

Items	Category	Number of resp	Percentage (%)
Main Buyers	Domestic Livestock Traders	292	76.2
	Exporters	25	6.5
	Butchers/Hotels	27	7.0
	Any Buyer Offering Better Price	30	7.8
	Did Not Sell	9	2.5
Price Setting Mechanism	Negotiation	182	47.5
	Seller	174	45.4
	Broker	15	4.0
	Buyer	4	1.0
	Not Selling	8	2.1

influence market dynamics by acting as both price-setters and purchasers.

For instance, during an FGD held in Naweyape village of Nyangatom district, participants remarked,

> "Due to the market being far from our homes, we can not directly negotiate and sell our goats to the buyer, consumer, or even the wholesaler. As a result, we often find ourselves compelled to sell our goats to the local brokers at the lower prices they set."

Such statements reflect widespread dissatisfaction with the lack of pricing transparency. Many pastoralists and agro-pastoralists feel exploited by middlemen, who are often perceived as manipulating prices through collusion with traders. These findings underscore the need for more transparent and regulated market systems, alongside improved access to timely and reliable market information for livestock producers.

Survey participants reported that, on average, each household sells approximately 13 livestock per year, though this figure varies significantly across individuals and districts. The highest average number of livestock sold was reported in Benatsemay district (22 animals per household), followed by Hammer district (19 animals). In contrast, the lowest average was observed in Dasenech district, where households reported selling only about three animals annually (Table 3).

Despite the relatively large livestock population in the area, it appears that the overall volume of livestock sold per household remains low. Findings from FGDs and KIIs help explain this

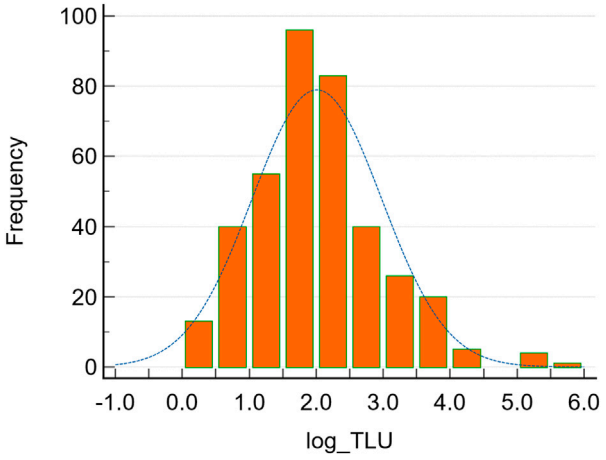

FIGURE 3
Distribution of livestock sales volume measured by Total Livestock Unit (TLU) among households.

trend. Among South Omo pastoralists, livestock are not typically viewed as market commodities but rather as assets of social, cultural, and economic significance. Livestock ownership is closely associated with wealth and social status—larger herds reflect greater prosperity. As a result, sales are generally reserved for times of necessity, such as during periods of drought, hunger, or urgent financial needs.

This sentiment was echoed by participants from Rate Borkonech village in the Nyangatom district, who stated:

> "Our livestock is not for sale, but when we face difficulties and need money to cover some problems such as health issues, lack of fodder and the like, we mostly sell our livestock."

These findings align with earlier studies conducted in pastoral and agro-pastoral regions of Ethiopia, which similarly reported that livestock sales are driven primarily by household emergencies rather than market incentives (Chekol et al., 2021; Adane and Hidosa, 2022).

Survey participants reported varying frequencies in buying and selling livestock, with no consistent pattern observed throughout the year. As indicated in Table 4, transactions occur at different intervales-weekly, monthly, quarterly, biannually, or annually-depending on individual circumstances. In Lobeet village of Dasenech district, FGD participants noted that livestocks are generally not fattened for commercial sale. Instead, households tend to sell a few goats when in immediate need of cash and later restock by purchasing animals, thereby maintaining herd size and avoiding visible reductions that might affect their social standing.

A key informant from the South Omo Zone Livestock and Fisheries Office highlighted that pastoralists are often reluctant to sell their livestock due to deep-rooted cultural values. In these communities, household prestige is closely tied to livestock ownership, with families—particularly men—gaining social respect based on the size of their herds. This cultural norm discourages regular livestock sales, especially if it may be perceived as diminishing the household's wealth.

Additionally, brokers play a significant role in influencing market behavior. Several participants expressed concern that brokers often pressure pastoralists to sell goats at below-market prices, further discouraging active market engagement. This reliance on unplanned, distress-driven livestock sales undermines the financial resilience of pastoralist households. When sales are delayed until emergencies arise—such as during droughts or family crises—producers are often forced to accept unfavorable prices, resulting in substantial financial losses.

Moreover, the absence of structured and strategic marketing practices limits pastoralists' ability to invest in income-generating opportunities or adopt proactive risk management strategies. This reactive approach restricts their capacity to cope with economic shocks, climatic variability, and broader livelihood challenges.

Survey results further indicated that 79.9% of respondents do not have regular livestock suppliers, while only 20.1% reported having established supply relationships. Similarly, 80.4% of respondents lack regular customers, leaving just 19.6% with a consistent clientele base (Table 4). These findings suggest a high level of market instability in the livestock trade.

Focus group discussions conducted in Dasenech and Nyangatom districts further underscored this issue. Participants emphasized that the absence of stable supply chains and customer networks forces pastoralists to sell livestock opportunistically—to whoever offers the highest price at a given time. This lack of continuity in market relationships poses several challenges: it undermines producers'

TABLE 3 The average number of livestock sold by the respondents per year based on district.

District	Mean sales	Number of respondents	Minimum	Maximum	Std. Deviation
Benatsemay	21.8	101	0	840	102.7
Dasenech	2.6	100	0	24	3.7
Hammer	19.3	98	0	420	57.5
Nyangatom	8.5	84	0	120	18.3
Overall	13.2	383	0	840	61.2

TABLE 4 Livestock market interaction patterns, customer relationships, and market trends.

Items	Category	Number of resp	Percentage (%)
Selling Frequency	Weekly	55	14.4
	Monthly	89	23.2
	Every 3 months	89	23.2
	Every 6 months	73	19.1
	Yearly	77	20.1
Buying Frequency	Weekly	54	14.1
	Monthly	66	17.2
	Every 3 months	69	18.1
	Every 6 months	63	16.4
	Yearly	131	34.2
Do you have regular suppliers that you buy from regularly?	Yes	77	20.1
	No	306	79.9
Do you have regular customers that you sell to regularly	Yes	75	19.6
	No	308	80.4
How do you assess the trends in livestock demand in the market?	Constant (same)	9	2.4
	Decreasing	45	11.7
	Increasing	317	82.8
	Do not know	10	2.6
	Unpredictable	2	0.5

ability to plan livestock production, manage herd inventory effectively, and negotiate favorable prices. As a result, pastoralists remain vulnerable to market fluctuations and are often disadvantaged in commercial transactions.

Respodents were also queried about market demand for pastoral livestock, with 82.8% believing it is increasing. Incontrast, 11.9% think the demand is decreasing, 2.4% feel it is stable, and 2.6% are uninformed about current trends, and 0.5% consider the trend unpredictable, fluctuating between rises and falls (Table 4). Key informant interviews and focus group discussions across the four districts confirmed a rising demand for pastoral livestock, aligning with survey findings.

The survey assessed participants' access to market information. The results indicated that 70.1% of the respondents did not obtain any market-related information before selling their livestock, while the remaining 29.9% did have access tosuch information. Among those who accessed market information, the sources varied: 21.8% relied on neighbors, 13.3% gathered information through direct market visits, 11.4% used mobile phones, 5.2% consulted relatives, 2.2% received updates from government employees, and 46.1% utilized a combination of these sources. These findings were corroborated by FGDs conducted with pastoralists and agro-pastoralists accross the four study districts, who confirmed that informal networks such as neighbors, friends, and relatives were the predominant sources of market information.

The reliance on informal and often unreliable sources highlights a critical gap in the availability of accurate, timely, and accessible market information for pastoralists. This limitation is consistent with findings from other pastoral regions in Ethiopia. For example, Benti et al. (2021) reported that most pastoralists in the Afar region depend on nearby markets or mobile phone communication to obtain livestock price information. Similarly, Adane and Hidosa (2022) observed that pastoralists in Benatsemay district mainly rely on friends, relatives, and information from previous weeks' markets. In the Borena pastoral area, Dido (2019) found that producers typically gather market information through direct observation, neighbors, and extended family members.

Access to reliable and up-to-date market information is vital for pastoralist communities, whose livelihoods depend heavily on livestock sales. In the absence of such information, producers often depend on intermediaries, who may exploit their limited

TABLE 5 Results of multicollinearity assessment using Variance Inflation Factor (VIF).

Predictor	VIF	1/VIF (tolerance)
Family size	1.38	0.724409
Age	1.37	0.729204
Sex	1.24	0.809628
Occupation	1.27	0.784502
Education	1.26	0.791189
Marita status	1.19	0.840001
Access to market information	1.34	0.748443
Distance to market	1.25	0.796818
Access to credit	1.11	0.901536
Herd size (Log TLU)	1.08	0.922019
Mean VIF	1.25	

knowledge by offering unfavorable prices. This dynamic perpetuates economic vulnerability and limits opportunities for pastoralists to engage competitively in the livestock market. Furthermore, a lack of accurate information impedes their ability to identify potential buyers, monitor price trends, diversify products, or tap into emerging markets. These constraints ultimately hinder business development and broader livelihood improvements (FAO, 2010).

Analysis of determinants of livestock sales volume

We began our analysis with multivariable linear regression models (both simple and multiple) to identify key predictors of livestock sales volume (market supply) (Supplementary Material S2). Prior to estimitating the MLR, we conducted rigrous diagnostic tests to assess multicollinearity among the predictor variables. Multicollinearity among the variables was evaluated using the variance inflation factor (VIF). For all variables the mean VIF was 1.25, which is well below the commonly accepted thresholds (i.e., >5 or >10), indicating low risk of collinearity-related bias (Table 5). These results confirm that multicollinearity is unlikely to compromise the precision or reliability of coefficient estimates in our model.

However, further diagnostics revealed that assumptions underlying classical linear regression, such as homoscedasticity, normality of residuals, and correct specification tests, were not consistently met (Supplementary Material S3). Consequently, we adopted a log-linear OLS regression with robust standard errors, which better accommodates the right-skewed distribution of the dependent variable (sales volume) and improves inferential validity Although the RESET test flagged potential omitted nonlinear relationships, alternative functional forms were explored, and the substantive conclusions remained consistent (Supplementary Material S4). As such, the log-linear model with robust SEs was designated our primary analytic framework.

The log-linear OLS model demonstrated good explanatory power, with an adjusted R^2 of 0.690, indicating that approximately 69% of the variation in livestock sales volume was explained by the predictors included in the model. The model was highly significant overall ($F(10, 372) = 63.61$, $p < 0.001$), supporting the joint predictive strength of the variables. Key positive predictors included education ($\beta = 0.108$, $p < 0.001$), access to credit ($\beta = 0.344$, $p < 0.001$), having diversified income ($\beta = 0.444$, $p < 0.001$), herd size (log-TLU; $\beta = 0.130$, $p < 0.001$), and market information access ($\beta = 0.997$, $p < 0.001$). Greater distance to market reduced sales ($\beta = -0.057$, $p < 0.001$). Predictors such as age, sex, marital status, and family size were not statistically significant, indicating no measurable effect on sales volume in our model (Table 6). To assess robustness, we re-estimated the model using a Generalized Linear Model (GLM) with a log link and gamma family. The results were consistent with the log-OLS estimates, providing additional confidence in the findings (Supplementary Material S5). Summary statistics for variables in the OLS model of livestock market supply determinants have been provided in Table 7.

Education level of households

Our analysis indicates that household heads with higher education levels supply significantly more livestock to the market ($p < 0.001$). Specifically, each additional year of education is associated with an expected 11.4% ($e^{0.108}-1$) increase in livestock sales volume. , controlling for other factors. This aligns with previous research showing that education enhances adoption of agricultural innovations—including livestock marketing—by improving market access, negotiation skills, and networking capacity (Negassa et al., 2017; Gemechu et al., 2020; Tilahun et al., 2023). These findings underscore the potential of educational interventions to boost livestock market participation among pastoral and agropastoral households. However, it is possible that education serves as a proxy for other advantages such as wealth, resource access, or institutional connections. Future research should consider structural modeling or incorporate explicit wealth indicators to more precisely isolate the causal effect of education.

Credit access

Our results show that access to credit is significantly associated with livestock supply to the market ($p < 0.001$): Households with credit access have about 41% ($e^{0.344}-1$) higher sales volume compared to those without access. Than those without access. This resonates with studies like Gemechu

TABLE 6 Log-linear OLS regression results (robust SEs).

Predictor	Coef	Robust Std. Err	t	p	[95% Conf interval]	
Age (years)	−0.005	0.004	−1.50	0.136	−0.013	0.002
Sex	−0.022	0.058	−0.38	0.703	−0.137	0.092
Marital status	−0.078	0.102	−0.76	0.446	−0.278	0.122
Family size	0.024	0.015	1.66	0.098	−0.005	0.0537
Education (years)	0.108	0.019	5.55	<0.001	0.069	0.146
Distance to market	−0.057	0.012	−4.63	<0.001	−0.081	−0.033
Access to credit	0.344	0.086	4.01	<0.001	0.175	0.513
Occupation	0.444	0.052	8.50	<0.001	0.342	0.547
logTLU	0.13	0.03	4.33	<0.001	0.071	0.189
Access to market information	0.997	0.08	12.44	<0.001	0.84	1.16
Constant	0.366	0.141	2.58	0.010	0.087	0.644
Model Fit						
Observations =	383					
Adjusted R^2 =	0.690					
F-statistic (10, 372) =	63.61					
Prob > F =	<0.0001					
Root MSE =	0.5804					

et al. (2020) and Abiye (2020), which highlight credit as a key enabler for investing in production inputs and market participation. Conversely, credit constraints restrict farmers' ability to scale production and engage more fully in market-oriented livestock systems (Khanal and Omobitan, 2020; Langyintuo, 2020). These outcomes emphasize the urgent need to enhance financial inclusion and credit availability for pastoral and agropastoral communities.

Access to market information

We found that access to market information is significantly associated with livestock supply ($p < 0.001$). Access to market information is associated with an approximate 171% ($e^{0.997}-1$) increase in sales volume. This aligns with theoretical models where reduced fixed transaction costs improve participation (Key et al., 2000; Barrett, 2008). This aligns with the value-chain analyses of beef cattle conducted by Gemechu et al. (2020), which identify access to information as a crucial factor in optimizing market participation and output. Similarly, Tilahun et al. (2023) noted that the absence of updated market information is one of the key factors affecting smallholder livestock producers in southwest Ethiopia regarding their participation in livestock markets.

Distance to the market center

The findings indicate that an increase in travel time to the market significantly ($p < 0.001$) affects livestock sales volume. Specifically, for every additional hour of travel to market, there is approximately a 5.5% ($e^{-0.057}-1$) decrease in sales volume. This relationship highlights the impact of distance on market dynamics, suggesting that greater distances can elevate transaction costs and subsequently diminish market engagement for sellers. This observation aligns with existing literature that emphasizes the importance of accessibility in market participation (Abate and Addis, 2021).

Dominant livelihood system (occupation)

Consistent with our hypothesis, livelihood diversification shows a significant positive association with livestock market supply ($p < 0.001$). Households with diversified livelihoods sell more livestock than households relying solely on livestock keeping. Specifically, households with diversified livelihoods sell about 56% ($e^{0.444}-1$) more than livestock-only households.

This reflects the idea that households with multiple income streams have enhanced resources and resilience—enabling them to invest in livestock-related activities such as production,

TABLE 7 Summary statistics for variables in the linear regression model of livestock market supply determinants.

Variable	Category	Frequency	Percent (%)	Average sales volume (TLU)
Sex	Female	153	39.9	6
	Male	230	60.1	14
Age of the participants (in years)	16–30	162	42.3	1.87
	>30	221	57.7	10
Education level of households (number of years attended school)	0	293	76.5	10
	>1	90	23.5	12
Family size	<8	339	88.5	7
	>8	44	11.5	19
Dominant livelihood	Livestock only	88	23	10
	Diversified	295	77	11
Marital Status	Married	349	91.1	10
	Widow/divorced	34	8.9	12
Distance to market (in hours)	<1	168	43.9	11
	>1	215	56.1	10
Credit service	Yes	100	26.2	27
	No	281	73.8	5
Access to market information	Yes	114	29.9	13
	No	269	70.1	4
Number of livestock purchased	<10	336	87.7	2
	>10	47	12.3	70
Total livestock holding (TLU)	<12	288	75.2	5
	>12	95	24.8	28

transport, and marketing. Moreover, livelihood diversity helps buffer against risks associated with price fluctuations or climate variability, allowing households to maintain or increase their market participation (Gemechu et al., 2020).

Herd size or total livestock unit (TLU)

Our analysis confirms a strong positive relationship between the herdsize (total livestock units) held by a household and market supply ($p < 0.001$). Specifically, a 1% increase in herd size (TLU) is associated with a 14% ($e^{0.130}-1$) increase in livestock sales. Since livestock constitute the primary saleable asset for pastoral and agropastoral households, it is unsurprising that larger herd holdings directly translate to higher surplus available for sale. This finding is supported by Abiye's (2020) research in the Kaffa Zone and further corroborated by studies emphasizing herd size as a critical determinant of livestock market supply among pastoral communities (Negassa et al., 2017).

A GLM robustness check produced consistent results. Our modeling choice parallels econometric best practices in market participation analysis—modeled sequential participation and quantity decisions (Bellemare and Barrett, 2006) and accounted for heteroskedasticity and sampling through robust specifications.

Synthesis and broader implications

The findings indicate that livestock marketing among pastoralists is influenced by both fixed transaction costs (such as education and information) and variable costs (like distance and access to credit). This aligns with the theories proposed by Key et al. (2000) as well as Barrett (2008). Access to information empowers producers to minimize price dispersion, a concept that is well-supported by research conducted in West Africa (Aker and Fafchamps, 2015).

Credit plays a critical role in facilitating commercialization, allowing producers to invest in marketing and production

activities. This observation is consistent with studies from IFPRI and others that emphasize the importance of financial inclusion in rural markets (IFPRI, 2025). Additionally, our finding that larger herd size and livelihood specialization enhance market participation echoes insights from Phadera et al. (2021), who show in four African contexts that smallholders with greater asset endowments—such as livestock—are more capable of commercializing their production, owing to improved risk resilience and investment capacity.

Our analysis employs log-linear and generalized linear models (GLM), validated through alternative methods, thereby building on established econometric frameworks. Future research may benefit from utilizing two-stage models or instrumental variable (IV) approaches when practical instruments are available (Lewbel, 2012).

Limitations of the study

While this study possesses several strengths, it is important to acknowledge its limitations as well. Among the eight districts in the South Omo Zone, only four were purposefully selected based on their accessibility and stability. This selection process excluded unstable or remote areas, which may restrict the generalizability of the findings. Therefore, we recommend that future studies include a broader range of districts to enhance external validity. Although the present mixed-methods strategy enriches contextual understanding, the cross-sectional and self-reported nature of the data restricts our ability to establish causality, and may introduce biases, such as social desirability or recall bias. Additionally, we were unable to implement a reliable instrumental variable (IV) strategy; our attempts to use seasonal supply shocks and distance-adjusted transaction costs did to satisfy the core assumptions of relevance and exclusion restriction, potentially biasing the inferred causal relationships. We suggest conducting longitudinal follow-up studies in the future to more accurately establish a causal relationship between the explanatory variables considered and the volume of livestock sales in pastoral areas. Although education is identified as a determinant of market supply in this study, it likely serves as a proxy for other confounding variables. Unfortunately, we were unable to conduct further analysis to isolate the effects of education from these potential confounders and to establish a clrearer causal link between education and market participation supply. Furthermore, the study did not evaluate the extent of women's decision-making power or their control over market transactions, which is another limitation worth noting. These considerations should be taken into account for future research on the topic within similar contexts.

Conclusion

The study reveals that the South Omo Zone has substantial livestock potential, primarily consisting of goats, cattle, and sheep. However, the traditional production system emphasizes quantity over quality, resulting in a livestock industry that is not market-oriented. Pastoralists typically avoid selling their animals unless faced with hunger, drought, or urgent financial needs, as they aim to increase herd numbers. Consequently, they average only 13 animal sales per year. With no established market linkages, most sales are made to domestic livestock traders. The study identified several factors influencing the annual livestock market supply, including education level, access to credit services, purchase volume, primary occupation, total livestock units held by a household, and access to market information, each of which can positively or negatively impact sales. To enhance pastoralists' benefits from their livestock and contribute to Ethiopia's national economy, recommendations include improving education access, providing awareness training, enhancing market information access, and improving credit and financial services.

The study was limited to accessible districts within the South Omo Zone. Therefore, the findings should be interpreted cautiously as they may not fully reflect the pastoral realities of the entire zone. Contextual factors such as drought, disease prevalence, and infrastructure gaps—issues commonly reported in South Omo Zone—could further affect livestock market participation. While the associations identified are robust, the causal relationships remains uncertain due to the cross-sectional study design used. Interrelated factors, such as household wealth, educational levels, and social capital, may concurrently influence livestock acquisition, herd size, and market participation. Future studies should address these variables through structural modeling or experimental designs.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/Supplementary Material.

Ethics statement

The studies involving humans were approved by Institutional Research Ethics Review Committee, Hawassa University. 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

RA conceptualized the study, designed the study, analysed the data and reviewed and prepared the final manuscript. AY and

NA were involved in field data collection and drafted the first manuscript. AF, YA, and HW were involved in field data collection and qualitative data transcription. MM followed up on the field data capture and contributed to the data analyses. MG provided critical input in the analyses of data and contributed to the study design and revision and editing of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontierspartnerships.org/articles/10.3389/past.2025.14402/full#supplementary-material

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