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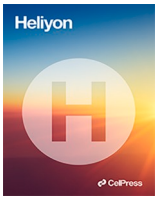

Research article

Assessment of livestock husbandry practices and production constraints among smallholder mixed crop-livestock production systems in the Majang zone, southwest Ethiopia

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ABSTRACT

Livestock production plays a significant role in improving the livelihoods of poor smallholder farmer households in the Majang zone. However, despite its importance, there is limited information on husbandry practices and constraints on livestock production to design and implement effective interventions to maximize productivity. The aim of this study was to assess husbandry practices and major constraints on livestock production in the Majang zone, southwest Ethiopia. A semi-structured questionnaire was used to collect data from a randomly selected sample of 168 households (HHs) through a face-to-face interview from January to May 2021. The results revealed that mixed crop-livestock farming is the dominant livestock production system in the study area. The overall average herd size per household (HH) was 2.15 ± 0.11 cattle, 0.15 ± 0.01 sheep, 0.31 ± 0.09 goats, 0.10 ± 0.02 donkey, 0.04 ± 0.00 mule, 0.13 ± 0.02 horses and 0.24 ± 0.02 chickens. Overall herd size did not differ significantly by AEZ except for sheep ($p < 0.05$). The primary reason for keeping cattle, goats, sheep, equines and poultry were milk production (27.4 %), meat for home consumption (33.9 %), cash income (33.3 %), transportation (85.1 %), and meat for home consumption (72 %), respectively. In the dry and wet seasons, natural pasture, crop residues, indigenous fodder trees and shrubs (IFTSs), nonconventional feed resources (NCFRs), crop stubbles and improved forages were the main livestock feed resources. The majority (60.1 %) of respondents practiced free-grazing systems. Separate sheds, family dwellings, kraals, and open-walled sheds were the main housing systems used for animals. The majority (79.2 %) of respondents used rivers as a source of livestock drinking water. Trypanosomiasis (18.45 %), African horse sickness (66.1 %) and Newcastle disease (47.02 %) were the most important diseases of livestock. Diseases (35.7 %), lack of access to artificial insemination (35.7 %) and inadequate veterinary services (11.3 %) were identified as the top three constraints limiting production. It is recommended that constraints identified by farmers should be considered in developing and implementing effective interventions to improve livestock productivity and their contribution to poverty alleviation in the study area.

1. Introduction

In sub-Saharan Africa (SSA) mixed crop-livestock systems are the dominant farming system [1], and most households use

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crop-livestock integrated farming to overcome food and income problems where land access is restricted [2]. According to Randolph et al. [3], livestock are catalytic in supporting the livelihoods of millions of poor smallholders i n SSA both rural and peri-urban settings (see Fig. 1).

In Ethiopia, over 90 % of agriculture is characterized by mixed crop–livestock farming systems [4]. Livestock contribute approximately 17–25.3 % of the national gross domestic product (GDP), 39–49 % of the agricultural GDP, 50 % of the household income of the country and 60–70 % of the employment in Ethiopia [5,6]. In addition, draft animals provide the power for the cultivation of nearly 96 % of the cropland in mixed crop-livestock farming systems [7]. Livestock also serve as a source of food (eggs, meat and milk), manure, employment opportunities, cash income, and insurance in the case of crop failure and play a significant role in the social and cultural values of rural households in the country [8]. Thus, livestock contribute significantly to poverty alleviation and livelihoods for the vast majority of smallholder rural farmers in the country.

According to the Central Statistical Agency [9], Ethiopia has the largest livestock population in Africa, estimated to be approximately 65.3 million cattle, 39.9 million sheep, 50.5 million goats, 2.1 million horses, 8.9 million donkeys, 0.4 million mules, 7.7 million camels, 59.5 million chickens, and more than 98 % of these animals across the country are local breeds. Despite their large population and exceptional adaptability to local environmental conditions, their performance has remained very low to meet local and export demands due to many constraints, such as insufficient nutrition, diseases, low genetic potential of the indigenous breeds, low productive and reproductive performance, poor management, lack of access to livestock production services, poor extension services, inadequate information to improve animal productivity, water scarcity, access to markets, and limited resources of farmers, among others [4,10]. Therefore, sustainable improvement in livestock productivity will depend on improving management practices, identifying production constraints and introducing appropriate improved technologies.

Beigh et al. [11] stated that proper feeding is very important in any livestock development program, as optimum expression of the genetic potential of livestock depends on an adequate supply of nutrients. Access to high-quality veterinary services is essential for the prevention, control, and treatment of animal diseases, ensuring the health and well-being of livestock [12]. It has been stated that livestock housing is important for providing comfort, supporting productivity, and preventing theft and prey [13]. Previous studies [14,15] have shown that animal health is a significant source of production losses, such as low weight gain, drought, fertility and lactation performance. Hence, a better understanding of livestock husbandry and management practices and identification of production constraints have a substantial influence on the productivity and livelihoods of farmers.

In the Majang Zone, smallholder crop-livestock production is the main farming system practiced in both the medium and low AEZs. Although livestock play a significant role in the livelihoods of smallholder farmers in the Majang zone, there is no or very limited baseline information on aspects of livestock production systems, management practices, available feed resources, and production

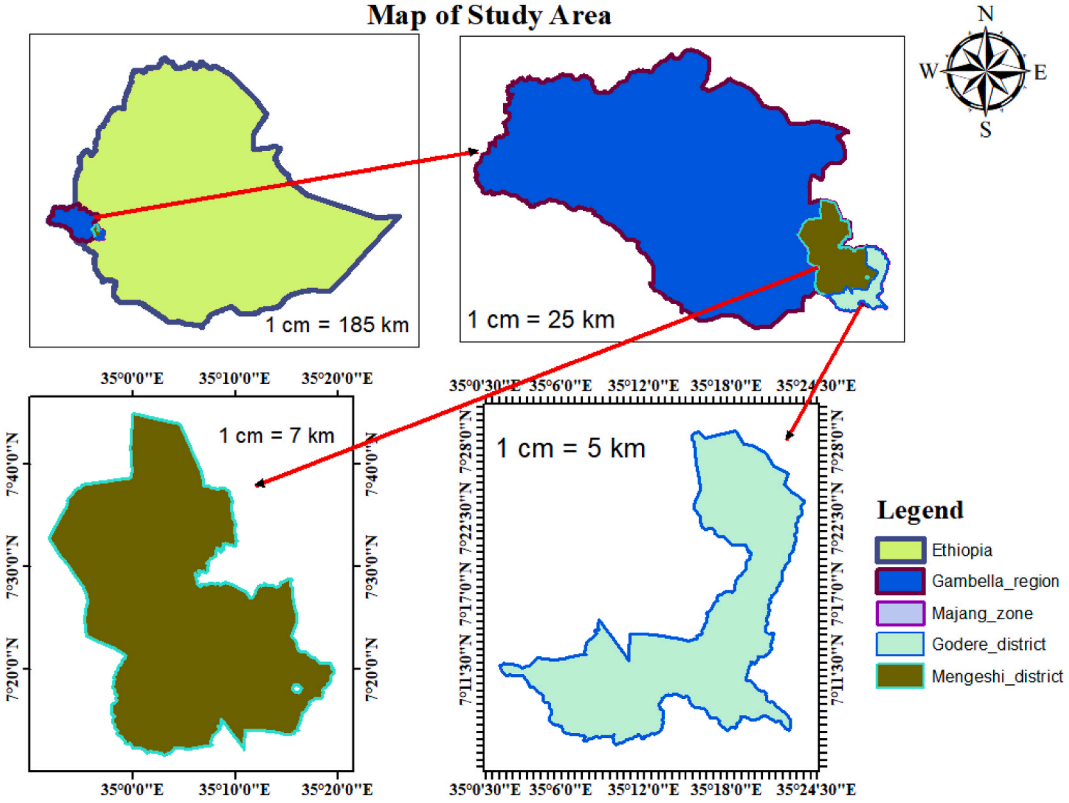

Fig. 1. Map of study area (Mangashi and Godere districts), Majang zone, Gambella regionals state, Ethiopia.

constraints. Due to its remoteness in location, the efforts put by the government on livestock development and research to improve productivity in the study area is very low. To the knowledge of authors, livestock husbandry practices and constraints have not been described, and the present study is the first attempt to get detailed baseline information of livestock production system and major constraints hampering productivity in current study area. Thus, to design and implement effective interventions, baseline data on livestock husbandry and production constraints are needed to improve livestock productivity and enhance livelihoods and poverty alleviation of resource poor households in the current study area. Therefore, the aim of the present study was to assess husbandry practices and to identify the major constraints limiting livestock production among smallholder mixed crop-livestock farmers in the Majang zone, southwest Ethiopia.

2. Materials and methods

2.1. Study area

This study was conducted in two districts, namely, the Mangashi district (midland) and Godere district (lowland) agro-ecological zones (AEZs) of the Majang Zone of the Gambella National Regional State, southwest Ethiopia, between January and May 2021. The districts were selected based on differences in agroecology, viz., midland (1501–2550) and lowland (500–1500 m above sea level). The Mangashi district is located between 7° 19′ 09″ N latitude and 35° 07′ 36″ E longitude east. Its altitude ranges between 1500 and 2350 m above sea level. The mean annual minimum and maximum rainfall are 1500 and 2200 mm, respectively. The mean annual minimum and maximum temperatures are 27.5 and 32.5 °C, respectively.

The Godere district is situated at 35° 06′ 16″ N latitude 7° 25′ 52″ E longitude. Its altitude ranges from 500 to 1500 m above sea level. The mean annual minimum and maximum rainfall are 1000 and 1800 mm, respectively. The mean annual minimum and maximum temperatures are 28.5 and 34.5 °C, respectively. Mixed farming (animal husbandry and crop production) is the main livelihood strategy of smallholder farmers in the zone. The crop types grown in the zone included maize, sorghum, coffee, spices and root crops. The livestock population of the Majang Zone in 2021 was estimated to be 17,347 cattle, 5764 goats, 9221 sheep, 34,116 poultry, 123 pigs, 869 horses, 179 mules and 425 donkeys. Moreover, bees are kept in 240 transitional beehives, 1125 frames or modern beehives, and 55,534 traditional beehives (Majang Zone Agricultural Development Office, 2021).

2.2. Study design, sampling techniques and determination of sample size

The study employed a cross-sectional survey design on a randomly selected sample of 168 farmers. Participants were recruited using a multistage sampling technique. In the first step, the Mangashi District and Godere District were purposely selected considering the livestock production potential of the district and agro-ecological representations. In the second stage, the two districts were purposively categorized into ML (Mangashi district) and LL (Godere district) agro-ecosystems based on differences in altitude. Third, three *kebeles* (the lowest administrative division next to the district) from each AEZ (Goshene, Akashi, and Mekmetti from the ML; and Dushi, Shone, and Kumi from the LL AEZs) were purposively selected based on livestock population potential. Fourth, 90 HHs from the ML AEZ (27 in Goshene, 30 in Akashi, and 33 in Mekmetti) and 78 HHs from the LL AEZ (27 in Goshene, 30 in Akashi, and 33 in Mekmetti) were randomly selected proportionally for the sampling frame of each kebele by using a simple random-sampling method. Finally, 168 livestock-producing HHs were randomly selected for the survey (Table 1).

The sample size was determined according to the formula recommended by Ref. [16].

The sample size was determined according to the formula recommended by Ref. [17].

$$n = z^2pq/d^2 \quad (1)$$

where n = sample size, z = level of significance at 95 % CI (=1.96), p = population, variability of 15 % or 0.15 %), q = 1–p = 0.85, and d = degree of accuracy desired, usually set at 0.05.

Sample size (n) $= z^2pq/d^2 = (1.96)^2$ x (0.15) x (1–0.15)/0.0025 = 3.84 x 0.15 x 0.85 = 196

Cochran's correction formula for a population <50,000 is $n1 = no/1+no/N$ (2)

Table 1
Summary of the *Kebeles* selected for the cross-sectional surveys and the number of households sampled for interviews.

AEZ	Study kebeles	Total HHs	Number of livestock Keeping HHs	Sample size	Sample proportion	Agro- ecology (%)
ML	Goshene	416	186	27	0.15	ML (54)
	Akashi	448	200	30	0.15	
	Mekmetti	913	224	33	0.15	
LL	Dushi	856	164	24	0.15	LL (46)
	Shone	1035	260	38	0.15	
	Kumi	450	112	16	0.15	
Total		4118	1146	168		100

AEZ, agroecological zone; HH, household.

n1 = 196/(1 + 196/1146) = 168. where population size = 1146 and n0 = the required return sample size according to Cochran's formula = 196, where n1 = the required return sample size because the sample >5 % of the population.

2.3. Method of data collection

Primary data were collected through face-to-face interviews using a semistructured questionnaire from January to May 2021. The questionnaire contained both open and closed questions. Before the formal survey, the questionnaire was pretested to ensure its suitability before the schedules of the respondents were fixed. Based on the feedback received from the pretesting study, necessary changes were made to the questionnaire. The questionnaire was administered to the household heads in the Amharic and Majang local languages by trained enumerators with close supervision of the first author. The main emphasis of the questionnaire was to collect information related to the livestock species and herd/flock size, reasons for keeping livestock, feed and feeding system, housing system, sources of water and frequency of watering, major livestock health problems and control measures, newborn calf management, sources and division of labour for livestock management activities, and major livestock production constraints. In addition, to validate the data from the individual farmer interviews, one focus group discussion at each AEZ with a group of 15 participants and key informant interviews with district livestock production officers, veterinarians and local development agents focused on livestock husbandry and management practices, major feed resources, common livestock diseases, and major constraints on livestock production. Before starting the survey, each respondent was given a brief description of the nature and purpose of the study, and only respondents who provided oral consent to participate were surveyed.

2.4. Statistical analysis

Data analysis was performed using Statistical Package for Social Sciences (SPSS) software version 20. Descriptive statistics, including means and standard errors for quantitative variables and frequencies and percentages for perceptions/qualitative variables, were calculated. An independent *t*-test was used to compare the means of quantitative variables between the midland and lowland agro-ecological zones. The differences between means were considered significant at $P < 0.05$.

3. Results

3.1. Farming system

The results of the focus group discussions demonstrated that mixed crop and livestock farming was the predominant livelihood of the respondents. The major crops grown in both AEZs of the study area included maize (*Zea mays*), sorghum (*sorghum bicolor*), and coffee (*Coffea arabica* L.). These were produced for household consumption and as sources of cash income. Livestock are an integral component of mixed farming systems, and the maintenance of livestock serves multiple purposes. Cattle, goats, sheep, equines and chickens/poultry were the main livestock species reared by the respondents, with cattle being the most dominant species. In the study area, crop and livestock farming were strongly integrated. Livestock provide milk and meat for home consumption and draught power and manure for crop production, while crops provide crop residues as sources of basal diet for livestock, particularly during the dry season.

3.2. Livestock composition and herd size

Table 2 summarizes the livestock composition and herd size per HH in the study area. Overall livestock composition data revealed that cattle were the most common, followed by goats and sheep. Other livestock species included mainly horses, donkeys, mules and local chickens. The mean overall livestock herd size per HH did not differ significantly between the two AEZs, except for sheep ($P < 0.05$), in which there were more sheep per HH in the ML than in the LL AEZ. The mean overall livestock herd size per HH was 2.15 ± 0.11 cattle, 0.31 ± 0.09 goats, 0.15 ± 0.01 sheep, 0.14 ± 0.02 donkey, 0.03 ± 0.00 mule, 0.13 ± 0.02 horses and 0.24 ± 0.02

Table 2
Average numbers of livestock of different kept per household in the two surveyed agro-ecological zones of the study area.

Livestock type	Herd size	Agro-ecological zones		*P*- Value
	LL Mean ± SE	ML Mean ± SE	Overall Mean ± SE	
Cattle	2.06 ± 0.15	2.24 ± 0.14	2.15 ± 0.11	0.384
Sheep	0.12 ± 0.01[b]	0.17 ± 0.02[a]	0.14 ± 0.01	0.040
Goat	0.43 ± 0.19	0.20 ± 0.03	0.31 ± 0.09	0. 202
Donkey	0.08 ± 0.02	0.12 ± 0.02	0.10 ± 0.02	0. 335
Mule	0.00 ± 0.00	0.07 ± 0.007	0.03 ± 0.00	0. 353
Chicken	0.24 ± 0.11	0.25 ± 0.10	0.24 ± 0.02	0.987
Horse	0.09 ± 0.03	0.18 ± 0.03	0.13 ± 0.02	0. 059
Total	3.02 ± 0.51	3.23 ± 0.34	3.12 ± 0.27	

SE, standard error; [a, b] Means in the same row with different superscripts are significantly different ($P < 0.05$).

chickens, with an overall mean of 3.12 ± 0.27. All of the respondents across the AEZs maintained indigenous genotypes of livestock.

3.3. Purposes of keeping livestock

Table 3 presents the main reasons for keeping livestock in the study area. In both AEZs, cattle are kept mainly as a source of milk, savings, cash income, manure, draught power and meat, in descending order. Goats were kept as sources of meat, income, savings and manure in that order. Similarly, sheep are kept for cash income, meat, savings and manure in that order, and equines are kept as important means of transporting goods and humans from place to place, cash income, and manure in that order. Chickens/poultry are kept to provide meat, savings, cash income and manure. Overall, the most important reasons for keeping cattle, goats, sheep, equines and poultry were milk (27.4 %), meat (33.9 %), cash income (33.3 %), transport (85.1 %), and meat (72 %), respectively. The reasons for keeping livestock were similar between the two AEZS, but with varying proportions of the reasons for keeping livestock.

3.4. Available feed resources and feeding system

Table 4 summarizes the major sources of feed available in the dry and wet seasons and livestock feeding system in the study area. Overall, the main feed resources for livestock in the wet season were natural pasture (82.1 %), IFTSs (59.5 %), NCFRs (45.6 %, improved forages (30.3 %), crop residues (25.6 %), and stubble grazing (18.4 %), whereas during the dry season, natural pasture (82.1 %), crop residues (57.7 %), IFTSs (51.8 %), NCFRs (29.2 %), stubble grazing (28.6 %) and improved forages (22.0 %) constituted the main feed resources. Among these, natural water constituted the major feed resource for livestock during both the wet season (82.1 %) and dry season (82.1 %). The major livestock feeding systems practiced by the respondents were free grazing (60.1 %), both free and zero grazing (18.5 %), tethering (13.7 %) and zero grazing (7.7 %).

3.5. Practice of supplementary feeding

Table 5 presents the types of local supplementary feeds offered to livestock in the study area. It was reported that NCFRs (*atella,* local brewing byproduct), sugarcane, enset (*Ensete ventricosum*), and maize and sorghum grain were the most commonly used supplementary feeds whenever available. The results revealed that cattle, small ruminants and equines were primarily supplemented with *atella* (57.7 % of respondents), grain (70.2 %) and grain (69.6 %), respectively.

Table 3
Frequency (%) of reasons for keeping livestock as described by respondents in two agro-ecological zones of the study area.

Types of Livestock	Agro-ecological zones				Overall (N = 168)	
	LL (N = 78)		ML (N = 90)			
	N	%	N	%	N	%
Cattle						
Milk	21	26.9	25	27.8	46	27.4
Savings	20	25.6	22	24.4	42	25.0
Income	10	12.8	13	14.4	23	13.7
Manure	12	15.4	10	11.1	22	13.1
Draught power	8	10.2	10	11.1	18	10.7
Meat	7	9.0	10	11.1	17	10.1
Goats						
Meat	25	32.0	32	35.5	57	33.9
Income	27	34.6	29	32.2	56	33.3
Saving	24	30.8	25	27.8	49	29.2
Manure	2	2.6	4	4.4	6	3.6
Sheep						
Income	28	35.9	28	31.1	56	33.3
Meat	24	30.8	30	33.3	54	32.1
Saving	20	25.6	24	26.7	44	26.2
Manure	6	7.7	8	8.9	14	8.3
Equine						
Transport	70	89.7	73	81.1	143	85.1
Income	5	6.4	10	11.1	15	8.9
Manure	3	3.8	7	7.8	10	6.0
Chicken[a]						
Meat	58	74.3	63	70.0	121	72.0
Saving	10	12.8	12	13.3	22	13.1
Income	8	10.3	10	11.1	18	10.7
Manure	2	2.6	5	5.6	7	4.2

[a] Only local chickens are raised by the interviewed farmers.

Table 4
Available feed resources in the wet and dry seasons and livestock feeding system in the study area.

Feed types	Agro-ecological zones				**Overall[a] (N = 168)**	
	LL (N = 78)		ML (N = 90)			
	N	%	N	%	N	%
Wet season[a]						
Natural pasture	70	89.7	68	75.5	138	82.1
IFTSs	49	62.8	51	56.7	100	59.5
NCFRs	34	43.6	41	45.6	75	45.6
Improved forage	22	28.2	29	32.2	51	30.3
Crop-residues	18	23.1	25	27.8	43	25.6
Stubble grazing	12	15.4	19	21.1	31	18.4
Dry season[a]						
Natural pasture	68	87.2	70	77.8	138	82.1
Crop-residues	43	55.1	54	60.0	97	57.7
IFTSs	35	44.9	52	57.8	87	51.8
NCFRs	21	26.9	28	31.1	49	29.2
Stubble grazing	23	29.5	25	27.8	48	28.6
Improved forage	17	21.8	20	22.2	37	22.0
Feeding system						
Free grazing	51	65.4	50	55.5	101	60.1
Both free- and zero-grazing	11	14.1	20	22.2	31	18.5
Tethering	10	12.8	13	14.4	23	13.7
Zero-grazing	6	7.7	7	7.8	13	7.7

[a] Multiple answers were possible; thus, percentages were summed to more than 100 %.

Table 5
Main types of feed supplements commonly utilized by respondents in the study area.

Livestock species	Types of supplements	Agro-ecological zones				Overall	
		LL		ML			
		N	%	N	%	N	%
Cattle	Atella	41	52.6	56	62.2	97	57.7
	Grain	11	14.1	15	16.7	26	15.5
	Sugarcane	26	33.3	8	8.9	34	20.2
	Enset	–	–	11	12.2	11	6.5
Sheep and goat	Grain	57	73.1	61	67.8	118	70.2
	Sugarcane	21	26.9	20	22.2	41	24.4
	Enset	–	–	9	10	9	5.3
Equine	Grain	54	69.2	63	70	117	69.6
	Sugarcane	24	30.8	27	30	51	30.4

3.6. Indigenous fodder trees and shrubs

Table 6 shows the major indigenous fodder trees and shrubs available for livestock feeding in the study area. According to the respondents in both study AEZs, naturally occurring IFTSs or browse species make a significant contribution to the diet of their ruminants, particularly during the dry season. Surveyed farmers were familiar with the species consumed by their animals. Fruits, leaves and twigs are the plant parts utilized by ruminants either by cutting/lopping their branches or by direct browsing by animals. However, the leaves of these browses are the most utilized plant portion by animals.

3.7. Livestock housing system

Table 7 summarizes the livestock housing system in the study area. Across both AEZs, approximately 65.5 %, 64.3 %, 53 %, 48.2 % and 18 % of the respondents housed cattle, small ruminants, calves, chickens and equines, respectively, in separate sheds at night. Approximately 47.02 % and 30.4 % of the HHs housed calves and poultry in family dwellings, respectively. Equines were housed mainly in kraals/fences (35.1 %) and house verandas (38.7 %).

3.8. Access to water sources and watering frequency

In the ML AEZ, water sources for livestock included rivers (79.4 %), tap (10.3 %), and ponds (10.3 %), whereas in the LL AEZ were rivers (78.9 %), tap (6.7 %), and ponds (14.4 %). During the dry season, approximately 70.5 % and 47.8 %, 19.2 % and 42.2 %, and 10.3 % and 10%of the HHs in the LL and ML AEZs watered their animals twice a day, once a day and once every two days, respectively. Whereas, about 57.7 % and 65.6 %, 21.8 % and 21.1 %, and 20.5 % and 13.3 % of the HHs in the LL and ML AEZ watered their animals

Table 6
Common indigenous fodder trees and shrub species available for livestock feeding in the study area (N = 168).

Scientific name of IFTSs	Common name	N (%)	Species of livestock feeding	Edible part
In ML				
Cordia africana	Dampe (M), Wanza (A)	30 (17.8)	Cattle and Goat	Leaves
Albizia gummifera	Sesa (A)	10 (5.9)	Goat	Leaves
Trichilia dregeana	Bonga abeba (A)	40 (23.8)	goat	Twigs and Leaves
Acalypha fruticosa. Forssk.	Kerchan	15 (8.9)	Cattle and small ruminant	Leaves
Vernonia jugalis	seyoma	40 (23.8)	Goat	Leaves
Vernonia amygdalina	Grawa		Goat	Leaves
Cape fig	Shola	35 (20.8)	Cattle and goat	fruits and Leaves
Justcia Schimperiana	Sensel	20 (11.9)	Goat	Leaves
Croton macrostachyus	Bisana	15 (8.9)	Goat	Leaves
Zanthoxylum leprieurii Guill & Sschinz	Dedoy	25 (14.9)	Cattle and small ruminant	Twigs and Leaves
In LL				
Cordia africana	Dampe (M), Wanza (A)	35 (20.8)	Small ruminant	Leaves
Albizia gummifera	Sasi (M), Sesa (A)	20 (11.9)	Goat	Leaves
Acalypha fruticosa. Forssk	Kerchan (M)	15 (8.9)	Cattle and small ruminant	Leaves
Vernonia amygdalina	Grawa (A)	25 (14.9)	Goat	Leaves
Ricinus Communis	Gulo (A)	20 (11.9)	Goat	Leaves
Allophylus macrobotrys Gilg	Beni (M)	10 (5.9)	Small ruminant	Leaves
Vepris daniellii	Walalo (M)	20 (11.9)	Goat	Leaves
Zanthoxylum leprieurii Guill & Sschinz	Dedoy (M)		Cattle and small ruminant	Twigs and leaves
Trilepisium madagascariense	Goboy (M)	30 (17.8)	Goat	Leaves

N, number of respondents; A, Amharic; M, Majangir; Multiple answers were possible; thus, the frequency (%) was increased to more than 100.

Table 7
Types of livestock housing systems practiced by respondents in the study area.

Type of housing	Agro-ecological zones				Overall	
	LL		ML			
	N	%	N	%	N	%
In separate shed						
Mature cattle	43	55.1	67	74.4	110	65.5
Small ruminants	39	50	69	76.4	108	64.3
Calves	40	51.3	49	54.4	89	53.0
Poultry	35	44.9	46	51.1	81	48.2
Equine	10	12.8	20	22.2	30	17.8
In family dwelling						
Calves	38	48.7	41	45.6	79	47.0
Poultry	23	29.5	28	31.1	51	30.3
Small ruminants	13	16.7	10	11.1	23	13.7
Mature cattle	2	2.6	7	7.8	9	5.3
Kraal						
Equine	31	39.7	28	12.2	59	35.1
Mature cattle	27	34.6	11	12.2	38	22.6
Small ruminants	18	23.1	5	5.5	21	12.5
Shed without complete wall						
Poultry	9	11.5	13	14.4	22	13.1
House veranda						
Equine	37	47.4	28	31.1	65	38.7
Small ruminants	8	10.3	6	6.7	14	8.3
Poultry	11	14.1	3	3.8	14	8.3
Mature cattle	6	7.7	5	5.6	11	6.5

N, number of respondents.

twice a day, once a day and once every two days, respectively.

3.9. Diseases of livestock

Table 8 shows that farmers reported disease/health problems related to livestock in the study area. Trypanosomiasis, Pasteurellosis, foot-and-mouth disease; blackleg, mastitis, lumpy skin disease, ticks, brucellosis, rabies and fascioliasis were reported as the common diseases in ruminants in order of occurrence. Health problems of equines in order of occurrence included African horse sickness, wounds and lameness. Newcastle disease, fowl typhoid and Coccidiosis were the major diseases of poultry in order of occurrence. These diseases of livestock were reported with varying proportions of occurrence between the ML and LL AEZs. According to the respondents, Trypanosomiasis was the most economically important disease and impediment to the development of livestock due to its

Table 8
Common livestock health problems encountered by respondents in the study area.

Common diseases/health problems	Agro-ecological zones				Overall	
	LL		ML			
	N	%	N	%	N	%
Ruminant diseases						
Trypanosomiasis	19	24.4	12	13.3	31	18.45
Bovine Pasteurellosis	8	10.3	20	22.2	28	16.66
Foot-and-mouth disease	13	16.7	10	11.1	23	13.69
Blackleg	11	14.1	11	12.2	22	13.09
Mastitis	9	11.5	9	10.0	18	10.71
Lumpy skin disease	6	7.7	8	8.9	14	8.33
Ticks	4	5.1	7	7.8	11	6.54
Brucellosis	5	6.4	6	6.7	11	6.54
Rabies	2	2.6	5	5.6	7	4.16
Fascioliasis	1	1.3	2	2.2	3	1.78
Equine diseases						
African horse sickness	52	66.6	59	65.6	111	66.07
Wounds	21	26.9	22	24.4	43	25.6
Lameness	5	6.4	9	10.0	14	8.33
Poultry diseases						
Newcastle disease	38	48.7	41	45.6	79	47.02
Fowl typhoid	26	33.3	20	22.2	46	27.38
Coccidiosis	14	17.9	29	32.2	43	25.59

N, number of respondents; shoats, sheep and goats.

high morbidity and mortality, particularly in the LL AEZ.

3.10. Access to veterinary services and disease control method

Table 9 presents access to veterinary services and drugss and disease treatment options. The majority of the respondents (47.6 %) had access to veterinary services from private providers and government (34.5 %). Whereas, 17.9 % of the interviewees practiced traditional medicines due to limited financial resources and access to veterinary services. To treat their sick animals 45.8 %, 17.9 % and 42.8 % of respondents used veterinary medicines, traditional medicines, and a combination of both veterinary and traditional medicines, respectively. Overall, respondents had access to veterinary drugs from private veterinary pharmacy (39.3 %), government veterinary pharmacy (34.5 %) and both private and government veterinary pharmacy (26.2 %) to control the diseases.

3.11. Management of newborn calves

Table 10 shows the rearing practices used for newborn calves in the study area. The results revealed that the majority (64.9 %) of the respondents did not practice cleaning mucus, disinfecting the navel cord (100 %) or separating the calf from the dam (53.0 %) after birth. Most of the respondents (86.9 %) indicated that colostrum should be fed to newborn calves within 1 and 2 h after birth by allowing the calf to suckle its dam (100 %). The majority (82.1 %) of interviewees fed milk to calves by partial suckling of their dams before and after milking. A majority (53.4 %) of HHs offered drinking water to calves starting at 15 days of age. Approximately 61.3 % of the respondents reported feeding green grasses to calves starting from one month of age after birth. Most (63.7 %) of the respondents weaned calves at eight months of age; that is, the calves suckled their dams up to 8 months of age. The majority of respondents (66.1 %)

Table 9
Access to veterinary services and drugs and disease control options as mentioned by respondents in the study area.

Service provider		Agro-ecological zones				Overall	
		LL		ML			
		N	%	N	%	N	%
Access to veterinary services	Government	26	33.3	32	35.6	58	34.5
	Private	39	50.0	41	45.6	80	47.6
	Traditional medication	13	16.7	17	18.8	30	17.9
Access to veterinary drugs	Government	25	32.1	33	36.7	58	34.5
	Private	27	34.6	39	43.3	66	39.3
	Both	26	33.3	18	20.0	44	26.2
Disease control options	Veterinary medicine	36	46.2	41	45.6	77	45.8
	Traditional medicine	21	26.9	21	23.3	42	25.0
	Both	21	26.9	28	31.1	49	29.2

N, number of respondents.

Table 10
Newborn calf management practices as reported by respondents in the study area.

Variables		Agro-ecological zones					
		ML		LL		Overall	
		N	%	N	%	N	%
Cleaning of calf after birth	Yes	29	17.3	30	17.9	59	35.1
	No	61	36.3	48	28.6	109	64.9
Time of feeding colostrum to calf after birth	1–2 h.	78	46.4	68	40.5	146	86.9
	One hr.	12	7.1	10	6.0	22	13.1
Navel cord disinfection	No	90	100	78	100	168	100
Separation of calf from dam after birth	Yes	43	25.6	36	21.4	79	47.0
	No	47	28.0	42	25.0	89	53.0
Method of colostrum feeding	By suckling dam	90	100	78	100	168	100
Method feeding milk	Suckling	75	83.3	63	80.8	138	82.1
	Bottle	6	3.6	10	6.0	16	9.5
	Bucket	9	5.4	5	3.0	14	8.3
Offering water to calf after birth	From 10 days	49	29.2	31	18.5	80	47.6
	From 15 days	41	24.4	47	28.0	88	52.4
Offering green grass to calf after birth	2 Weeks	38	22.6	27	16.1	65	38.7
	1month	52	31.0	51	30.4	103	61.3
Offering concentrate feed to calf after birth	3 Weeks	65	38.7	53	31.5	118	70.2
	1 month	25	14.9	25	14.9	50	29.8
Calf weaning age (months)	7	11	6.5	12	7.1	23	13.7
	8	16	9.5	22	13.1	38	22.6
	>8	63	37.5	44	26.2	107	63.7
Calf weaning method	Natural	58	34.5	53	31.5	111	66.1
	Forced	32	19.0	25	14.9	57	33.9

N, number of respondents.

used the natural method to wean calves, whereas 33.9 % used the forced/separation method. Natural weaning is a gradual process in which the cow gradually reduces the calf's access to the suckle and eventually rejects the calf, whereas forced weaning is performed by separating the calf from the dam or using traditional anti-suckling methods, such as smearing the udder with cattle dung or putting a thorny ring on the calf's muzzle to prevent suckling. None of the respondents in the present study indicated receiving a vaccination for calves after birth.

Table 11
Percentages of labor contribution to livestock management tasks by gender among household members as reported by respondents in the study area.

Description	AEZ	Men	Wowen	Girls	Boys	Family	Hired labor
Milking	Lowland	42.3	29.5	10.3	–	6.4	11.5
	Midland	30.0	43.3	8.9	–	7.8	10.0
	Overall	36.1	36.4	9.5	–	7.1	10.7
Milk processing	Lowland	–	73.1	26.9	–	–	–
	Midland	–	76.7	23.3	–	–	–
	Overall	–	75.0	25.0	–	–	–
Marketing of milk and milk products	Lowland	–	82.1	17.9	–	–	–
	Midland	_	81.1	18.9	–	–	–
	Overall	–	81.5	18.5	–	–	–
Herding	Lowland	19.2	6.4	9.0	43.6	12.8	9.0
	Midland	23.3	8.9	5.6	48.9	8.9	4.4
	Overall	21.4	7.7	7.1	46.4	10.7	6.5
Breeding	Lowland	37.2	–	–	42.3	9.0	11.5
	Midland	42.2	–	–	37.8	11.1	8.9
	Overall	39.9	–	–	39.9	10.1	10.1
Watering	Lowland	14.1	6.4	15.4	42.3	14.1	7.7
	Midland	23.3	10.0	12.2	32.2	17.8	4.4
	Overall	19.0	8.3	13.7	36.9	16.1	6.0
Health management	Lowland	21.8	9.0	10.3	21.8	29.5	7.7
	Midland	22.2	7.8	10.0	32.2	22.2	5.6
	Overall	22.0	8.3	10.1	27.4	25.6	6.5
Shed construction	Lowland	55.1	–	–	30.8	–	14.1
	Midland	57.8	–	–	33.3	–	8.9
	Overall	56.5	–	–	32.1	–	11.3
Cleaning sheds	Lowland	–	62.8	23.1	–	–	14.1
	Midland	–	62.2	24.4	–	–	13.3
	Overall	–	62.5	23.8	–	–	13.7

3.12. Utilization of family labour in livestock management activities

Table 11 shows the division of labour among family members with respect to major livestock husbandry tasks in the study area. The results showed that family was the major source of labor for managing livestock rearing operations. Approximately 36.4 %, 76.7 %, 81.1 %, and 62.5 % of the respondents indicated that milking, milk processing, marketing of milk and dairy products, and cleaning of animal sheds were performed mainly by female members of the household, while herding (67.8 %), breeding (79.8 %), watering (55.5 %), health care (49.4 %) and construction of sheds (91.1 %) were predominantly performed by male members of the household. The contribution of hired labour was relatively low. However, they contributed to all livestock husbandry tasks except the selling and processing of milk.

3.13. Major constraints on livestock production

Table 12 shows the major constraints on livestock production in the study area. The most important constraints to livestock production as identified by the respondents included diseases/parasite infestations (35.7 %), lack of access to adequate veterinary services (11.3 %), lack of capital (8.9 %), feed shortages (7.7 %), water shortages during the dry season (6.5 %), low genetic potential of the indigenous stock (6.5 %), poor extension services (6.0 %) and market problems (0.6 %). The majority of the respondents in both AEZs identified diseases as the key challenge to livestock production. Thus, the provision of adequate veterinary services remains imperative for improving overall livestock productivity and welfare, as well as food security and the general livelihoods of farmers.

4. Discussions

This study describes the husbandry and management practices and major constraints of livestock production among smallholder farmers in the Majang zone, southwest Ethiopia.

4.1. Farming system

The results of the study show that the framing system in the present study area is mixed crop-livestock production, in which the livelihood strategies of the respondents are both crop and livestock farming for cash income and household food security. In both of the studied AEZs, livestock keeping is a vital livelihood part of the mixed farming system and represents a viable livelihood alternative. Livestock serve as a source of milk, meat, cash income, manure, draught power and means of transportation. This result is in agreement with reports by Refs. [18,19] elsewhere in Ethiopia. Herrero et al. [1] also reported that mixed crop-livestock farming is the dominant farming system in the developing world. Kosgey and Okeyo [20] also stated that the dependency of rural livelihoods on crop and livestock production is a common phenomenon in developing countries and is also seen as an opportunity for the efficient use of resources.

4.2. Livestock composition and herd size

The results of livestock holding revealed that farmers in the study area kept cattle, goats, sheep, donkeys, horses and poultry. The cattle herd size was greater than that of the other livestock species because cattle serve as a source of milk, meat, cash income, savings, manure and draught power. This result concurs with the findings of [16], who reported similar livestock compositions in mixed farming systems. The overall mean livestock herd size per HH (3.12 ± 0.27) observed in the current study is smaller than the findings of [21], who reported a mean value of 9.43 ± 0.73. The overall cattle herd size (2.15 ± 0.11) obtained in this study was lower than the mean of 5.54 ± 0.39 reported by Ref. [22]. These differences could be attributed to variations in feed availability, disease prevalence and the purpose of keeping cattle. The high cattle herd size per HH compared to the other livestock species is due to the multiple roles

Table 12
Major constraints of livestock production as identified by the respondents in the study area.

Constraints	Agro-ecological zones				Overall	
	LL		ML			
	N	%	N	%	N	%
Diseases	28	35.9	32	35.6	60	35.7
Lack of access to AI service	10	12.8	17	18.9	27	16.1
Inadequate veterinary services	8	10.3	11	12.2	19	11.3
Lack of capital	7	9.0	8	8.9	15	8.9
Feed shortage	9	11.5	4	4.4	13	7.7
Water shortage	6	7.7	6	6.7	12	7.1
Low genetic potentials of local animals	4	5.1	7	7.8	11	6.5
Inadequate extension services	5	6.4	5	5.6	10	5.9
Poor access to market	1	1.3	0	0	1	0.6

N, number of respondents.

of cattle as a source of milk, meat, cash income, draught power and manure. The mean herd sizes of sheep (0.15 ± 0.01), goats (0.31 ± 0.09), donkeys (0.10 ± 0.02), horses (0.13 ± 0.02) and chickens (0.24 ± 0.02) observed in our study are smaller than the findings of [23], who reported mean herd sizes of 4.8 for sheep, 5.53 goats, 0.19 donkey, 0.53 horses and 4.83 chickens per household in mixed farming. Belay et al. [16] reported that the average livestock holdings per HH were 4.53 ± 0.4 cattle, 1.08 ± 0.2 sheep, 0.54 ± 0.2 goats, 0.1 ± 0.04 horses, 0.1 ± 0.04 mules, 0.6 ± 0.09 donkeys and 3.04 poultry in mixed farming systems in Ethiopia. The variation in livestock holdings between our findings and those in literature could be due to differences in land holdings, agro-ecology, climatic conditions, disease incidence, labour availability, grazing area and feed availability.

4.3. Purpose of keeping livestock

The results indicated that livestock play multiple and significant roles in the livelihoods of the respondents in the study area. Livestock were kept primarily as a source of milk production, meat, cash income, means of saving, manure, traction and transport. The present findings are in accordance with earlier results reported by Refs. [18,24–26], who also revealed that draught power, income, milk, meat, transport, manure, and social security were the main reasons for keeping livestock. Rewe et al. [27] stated that knowledge of the reasons for keeping livestock is a prerequisite for devising breeding goals.

4.4. Major feed resources and feeding systems

The feeding practices in the current study area were based on locally available feed resources. Natural pasture, crop residues, IFTSs, NCFRs, stubble grazing and improved forages were the major feed resources available for livestock in the dry and wet seasons. The present result is in accordance with the earlier findings of [4,28], who also reported these feeds as major sources of feed for livestock. Natural pasture was observed to be the most important feed resource during both the dry and wet seasons; however, respondents reported its scarcity in the dry season, which reflects seasonal changes in availability between the dry and wet seasons in relation to the availability of rainfall, resulting in reduced livestock performance compared to that in the wet season. Crop residues were indicated to be the second most important source of feed during the dry season following crop harvest, which is in agreement with the findings of [29]. Across the studied AEZs, stover from maize (*Zea mays)* and sorghum (*Sorghum bicolor*) were the major crop residues consumed by livestock during the dry season. These crop residues are used without any treatment due to a lack of awareness about the treatment of poor-quality straw to improve its nutritive value. Kashongwe et al. [17] reported that seasonal fluctuations in feed availability and quality affect the production and reproductive performance of livestock.

The results of this study showed that free grazing, both free and zero grazing, tethering and zero grazing, were the main livestock feeding systems practiced by the respondents in the study area, with free grazing being the predominant feeding system. This finding is consistent with earlier results reported by Refs. [4,18] but contradicts with the findings of Demeke et al. [30] who reported that about 24.6 % of households in the North Achefer district practiced free grazing systems. This difference might be attributed to shortage of communal grazing land in the North Achefer district as compared to the current study area.

4.5. Practice of supplementary feeding

The locally available feeds NCFRs (*atella,* local brewing byproduct), sugarcane, enset (*Ensete ventricosum*), and maize and sorghum grains) were the common feeds used to supplement livestock in the current study area. This finding is in agreement with the results of [4], who reported that household leftovers, cereal grains, grain shorts, green grass and salt were the common supplementary feeds offered to livestock by farmers in mixed farming system in Jimma zone.

4.6. Housing system, sources of water and frequency of watering

Separate shed, family dwellings, kraals/fences, verandas, and open-walled sheds are the main types of livestock housing systems used in the present study area. In this study, the animals kept at night in a kraal, veranda or open-walled shed had little protection against extreme weather conditions. Similar results for livestock housing systems were reported in previous studies [31,32]. Mellor [33] stated that housing is one of the most important livestock husbandry activities that protects animals from extreme temperatures, rain, wind, predators, and theft.

The results of this study revealed that rivers (79.2 % of respondents) are the major source of water for livestock in the study area. Supporting the current results, Demeke et al. [30] and Kagira and Kanyari [34] also observed that rivers were the major source of water for livestock. The majority of the farmers in the study area indicated that during the dry season, the watering of livestock is performed twice a day (58.4 %) and once a day during the wet season (58.3 %). Similarly, Demeke et al. [30] reported two-time and one-time-day watering frequencies for livestock during the dry season and wet season, respectively. According to the respondents, some of the temporary water sources that dry during the dry season were forced to travel long distances (6–10 km daily) to be watered at permanent rivers located far from grazing areas, resulting in a decreased grazing period and stress from walking to and from water sources at high temperatures.

4.7. Livestock diseases and access to veterinary services

Livestock diseases and parasites constitute major hurdles to improving the livelihoods of smallholder farmers through the

challenges of loss of productivity, livestock morbidity and mortality, including reproductive losses. The results indicated that trypanosomiasis, Pasteurellosis, foot-and-mouth disease, blackleg, mastitis, lumpy skin disease, ticks, brucellosis, rabies, fascioliasis in ruminants, African horse sickness in equines and Newcastle disease in poultry were the major diseases/health problems in the present study area. These results are in agreement with the earlier results of [10,35–37], who also observed these diseases/health problems of livestock in their study area. The high occurrence of diseases in the current study area could be attributed to the lack of adequate disease prevention measures (vaccination, deworming, and spraying), inadequate access to veterinary services and drugs, high cost of veterinary drugs, lack of finance to invest in animal health, lack of knowledge of disease management, and weak extension services. The interviewees took their animals for diagnosis and treatment to either public or private clinics only when their animals became sick. According to the FAO [38], rural farmers fail to control livestock diseases effectively because of poor knowledge of diseases, inappropriate use of the available control measures, or because the control still needs to be developed and/or is expensive. To address animal health issues**,** there is a need to provide efficient veterinary services to improve overall livestock productivity and welfare. In addition, future detailed epidemiological studies based on laboratory diagnosis are recommended to confirm the existence of specific diseases identified by farmers to design effective prevention and control measures.

In the present study, farmers received access to veterinary services from the private government. This finding is in agreement with the report by Tariku et al. [39]. Approximately 17.9 % of the respondents in the current study relied mainly on traditional medicines due to a lack of financing for the use of veterinary services. Moabiemang et al. [40] also reported that farmers in Botswana used ethno-veterinary medicines and practices to treat diseases of livestock. The main concern regarding the use of traditional medicines is the lack of scientific information on the mechanism underlying the accurate doses and efficacy of these herbal medicines. Thus, further research is needed to determine the appropriate dosage of traditional medicines for their efficient utilization. According to Maposa et al. [41], access to quality veterinary services is essential for the prevention, control, and treatment of animal diseases, ensuring the health and well-being of livestock. Thus, we suggest that the government and other stakeholders should work to expand public veterinary services to help farmers access lower-cost services than private veterinary service providers.

4.8. Management of newborn calves

In our study, approximately 64.9 %, 100 % and 53.0 % of respondents did not clean mucus, disinfect their navels, and separate calf from the dam after birth, respectively. According to the respondents, the dam cleans the mucus by licking the calf after calving. The reason for not disinfecting the navel of the newborn calf might be due to lack of awareness and unavailability of chemicals (tincture of iodine) for disinfection. In contrast [42], reported that approximately 88 % and 59 % of the farmers in Hisar district of Haryana practiced cleaning of the mucus and disinfection of the navel cord of the newborn calf, respectively. According to Vasseur et al. [43], fresh navels may represent a means of entry for pathogens that may cause serious infection and death of newborn calves.

Most of the respondents (86.9 %) indicated that feeding of colostrum to calves was performed within 1 and 2 h after birth by allowing the calf to suck from the dam (100 %). Godden [44] reported that farmers should feed colostrum to calves within 1–2 h after birth and by 6 h at a maximum, considering that the efficiency of colostral immunoglobulin absorption is 50 % after parturition and 33 % after 8 h and that there is almost no absorption after 24 h. The failure to feed colostrum during the first 6 h after birth increases the risk of failure of passive transfer [45], consequently increasing morbidity and mortality rates. Approximately 61.3 % of the respondents reported offering green grasses to calves starting one month after birth. This is slightly earlier than the findings of [46], who reported that 82.3 % of farmers provided green fodder to calves after two months of age. In the present study, the majority (63.7 %) of the respondents weaned their calves at eight months of age. Another study by Tasew and Seifu [47] reported that calves were weaned on average at 11.8 months of age. The high age of calves at weaning could be because, in indigenous cows, calves are used to initiate milk let-down by restricting suckling before milking throughout the lactation period.

4.9. Source of labour for livestock management tasks

The results of the current study showed that female members of the household were primarily responsible for milking, milk processing, marketing of milk and milk products and cleaning sheds, while the men were responsible mainly for breeding, herding, health care, watering and construction of sheds. The boys contributed more to breeding, herding, health care, watering and the construction of sheds. Similarly [48], reported that livestock husbandry tasks are shared between the men and female members of the household. Paudel et al. [49] reported that in Nepal, women are mainly responsible for forage collection, cleaning the gutter and shed, and feeding animals, whereas milking animals and selling of milk are performed by men. The results of this study indicate that the development of gender-based training that targets men, women, boys and girls is essential for efficient livestock management operations. Additionally, targeting women to acquire livestock and exercise control over these assets will enhance their bargaining power within households so that gender equality can be achieved.

4.10. Major constraints on livestock production

The present study indicated that disease/parasite infestations, inadequate veterinary services, financial limitations, feed shortages, water shortages in the dry season, low genetic potential of the indigenous stock, poor extension services and marketing problems were the major constraints limiting livestock production and productivity reported by farmers across the AEZs. This is consistent with constraints reported elsewhere in Africa [4,19,22,50]. Among the constraints identified by the respondents, disease was the most important problem for livestock production in this study area. This could be attributed to extensive livestock production, the sharing of

communal grazing land and water sources, poor disease control measures and a lack of separation of sick animals from healthy animals, which could predispose animals to disease. Similarly, previous studies [51,52] reported disease as the principal limitation faced by livestock farmers. Mutambara et al. [51] reported that all of the farmers (100 %) in the Gutu district of Masvingo Province in Zimbabwe identified diseases as the most serious constraint to livestock production. The identified constraints will be helpful for designing and implementing appropriate livestock development strategies in the current study area.

4.10.1. Limitations of the study

Although this study provides useful information on livestock husbandry and production constraints in the study area, it is based on qualitative inquiry and livestock farmers' perspectives using a household questionnaire alone. Moreover, the small sample sizes, lack of recorded data, lack of reliance on farmer recall, diseases identified are based on symptoms and farmer experiences rather than confirmatory tests through laboratory diagnostics and lack of application of modelling approaches that can summarize broader production system characterization in data analysis were the limitations of the present study, but these are not uncommon limitations of similar survey studies.

5. Conclusion

The study concluded that livestock were kept in mixed crop-livestock systems in the study area and contributed significantly to the livelihoods of smallholder farmers as a source of milk, draught power, cash income, manure, savings, meat and transport. However, livestock production and productivity are limited by several constraints, such as disease/parasite infestations, inadequate veterinary services, financial limitations, feed shortages, water shortages in the dry season, low genetic potential of the indigenous stock, poor extension services and market problems, and these constraints should be considered by policy makers and other stakeholders when designing and implementing livestock improvement programs. It is recommended that to improve the overall productivity and contribution of livestock to livelihoods and poverty reduction in the study area, there is a need for concerted interventions to address the identified constraints. Such interventions should focus on improved veterinary, artificial insemination, extension and credit services; housing and forage production; conservation and efficient utilization of locally available feed resources; and enhanced capacity of farmers in livestock husbandry and disease prevention measures. The results of this study can serve as baseline information for future studies in similar environments to improve the productivity of livestock in smallholder mixed farming in tropical areas.

Data availability statement

Data will be made available on request to the corresponding author.

Ethics statement

Informed consent was not required for this study because deeply personal or confidential information were not collected from participants.

CRediT authorship contribution statement

Shimelis Assefa: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Belay Duguma:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization. **Zemene Worku:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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