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Research article

Husbandry practices and constraints of smallholder dairy production in Dilla Zuriya district, Gedeo Zone, Ethiopia

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ABSTRACT

The study assessed dairy cattle management practices and identified constraints at smallholder dairy farms in Dilla-Zuriya District. A cross-sectional survey was undertaken on 120 purposely selected smallholder dairy farmers from three potential kebeles (Chichu, Andida and Gola). A Structured questionnaire was developed and applied to collect data. Descriptive statistics procedures of SPSS were followed to analyse the collected data. The result showed that most farmers (70.9%) produce milk primarily for income generation under a mixed crop-livestock production system. The herds mean of the local and cross breeds cattle in the study area were 5.23 and 2.41, respectively. Banana and Enset leaves and stems were the primary feed resources of the study area. Besides, farmers use natural grazing pasture and home fruit and vegetable leftovers as animal feed. The watering frequency was twice a day, either from river or pipe. Traditional houses made from locally available construction materials like mud and wood are the typical dairy cattle housing system. Except for calves, all types of dairy cattle were kept together in the same house. Feed shortage, limited access to, and the high purchasing cost of improved dairy heifers were the top two pressing constraints of dairy production in the study area. Therefore, enhancing the quality and accessibility of feed and applying breed improvement technologies are highly recommended to support dairy production.

1. Introduction

Milk production remained stable in Africa with 49 million tonnes. However, Ethiopia, Kenya and South Africa, among others, registered declines (FAO, 2021). The dairy sector contributes 12–16% to the national Gross Domestic Product (GDP) and 40% to the agricultural GDP of Ethiopia (Zijlstra et al., 2015). Ethiopia's total annual milk production comes from 7.5 million milking cows and is estimated to be 4.96 billion litres, that is, 1.48 L per cow per day on average (CSA, 2021). From the total milk production, 98% is contributed by smallholder dairy farmers, representing about 85% of milk producers (Mebrate et al., 2019).

Dairy cows have biologically the most efficient system that converts roughages feeds into milk. Milk is a highly nutritious food for human beings and is universally recognised as nature's nearly complete diet since it meets the nutritional requirements of the neonates (Benta and Habtamu, 2011). As milk products play a vital role in human nutrition throughout the world, the products must be of high quality. In less developed areas and especially in hot tropics, high quality of safe products is most important but not easily accomplished (Mirkena, 2009).

Cows are housed and handled under various management systems (Adams, 2012). Control of animal health, adherence to good milking practices, and control over milking parlour hygiene are essential in reducing the microbial load in raw milk (Bekuma and Galmessa, 2018). Proper housing, feeding, and equipment help ensure that the animals are taken care of appropriately and that adequate facilities can manage the cows effectively (Adams, 2012).

Dilla Zuriya district is one of the potential milk producing areas in the Gedeo Zone, found in the country's southern region. However, limited research and no scientific documentation on smallholder dairy farms' management, constraints, and opportunities. Description of management characteristics, including identifying constraints in the area, is the relevant step to plan and implement dairy cattle development strategies (Tsegay et al., 2015). The lack of up-to-date and location-specific information on dairy cattle management systems and constraints is often a major bottleneck to Ethiopia's productivity and product improvement endeavours (Ayele et al., 2003). Thus, this research work is initiated to bridge the documentation gap and forward baseline information for further development of dairy improvement strategies to assess dairy

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cattle management practice, constraints, and opportunities at smallholder dairy in Dilla Zuriya district Gedeo Zone.

2. Materials and methods

2.1. Description of the study area

The study was conducted in Dilla-Zuriya district, Gedeo Zone of South Nation Nationalities and Peoples Regional State. The district is 90 km and 360 km away from Hawassa (regional city) and Addis Ababa (capital city). The district surrounds Dilla town, the administrative town of Gedeo Zone. Geographically the Dilla Zuriya district is located in longitudes of $38^0 17'14''$ to $38^0 24'14''$ East and latitude of $6^0 15'4''$ to $6^0 25'7''$ North (Figure 1). The district's total area is about 13,965 ha, of which 13,442 ha are cultivated. The area receives an annual maximum, mean and minimum rainfall of 1400, 1150 and 900 mm, respectively. The mean annual temperature of the woreda ranges between 18-27 °C. The altitude ranges from 1,350 to 2,600 m. a.s.l. The information obtained from Gedeo Zone agricultural office indicates that agroforestry accounts for 83% of the total study area. In comparison, 13% was cultivable land and the rest land patricians according to different land-use practices. The land use practice is a multipurpose agroforestry ecosystem. Trees are arranged in a relatively high degree of species diversity (trees, crops and animals) integrating densely (Negash and Achalu, 2008).

2.2. Sampling techniques and sample size

The survey was conducted from November 2019 to March 2020. A two-stage purposive and random sampling technique was implemented to select research units. First, after taking preliminary survey on production potentials of all kebeles from the Dilla Zuriya district, three kebeles were chosen purposively based on their potential in dairy cattle production and minimum holding of at least one local or crossbred milking cow. Secondly the sampled households were selected using simple random sampling techniques from each kebele. From the selected Kebeles, the researchers drew a total of 120 Dairy cattle owners (2) (forty smallholder dairy farmers from each kebeles). The total sample size of the study is determined by using sample size determination formula (1) (Yamane, 1967).

$$n = \frac{N}{1 + N(e)^2} \tag{1}$$

Where n is the sample size, N is the population size, and e is the level of precision. The total dairy cattle producers in the district were 290, and 7% precision was used.

$$n = \frac{290}{1 + 290(0.07)^2} = 120 \tag{2}$$

2.3. Method of data collection

A cross-sectional survey was undertaken on 120 purposely selected smallholder dairy farmers from three potential kebeles (Chichu, Andida and Gola). Structured questionnaire was designed to collect general household information, herd composition, dairy cattle management practice and constraints. The questionnaire was pre-tested before the actual data collection started to verify that all of the study's objectives were met and respondents understood and answered the questions correctly. After that, the amended questionnaire was given out. Secondary data were collected from the district's livestock and fisheries office documents and other related articles. Focus group discussions with farmers were held to acquire a deeper understanding of dairy production challenges and triangulate the data collected through a questionnaire. The pairwise ranking tool was used in focus group discussions to prioritise the major constraints.

2.4. Data analysis

Data collected from the survey were summarised on Microsoft excel 2019, and descriptive statics were generated after analysis using SPSS

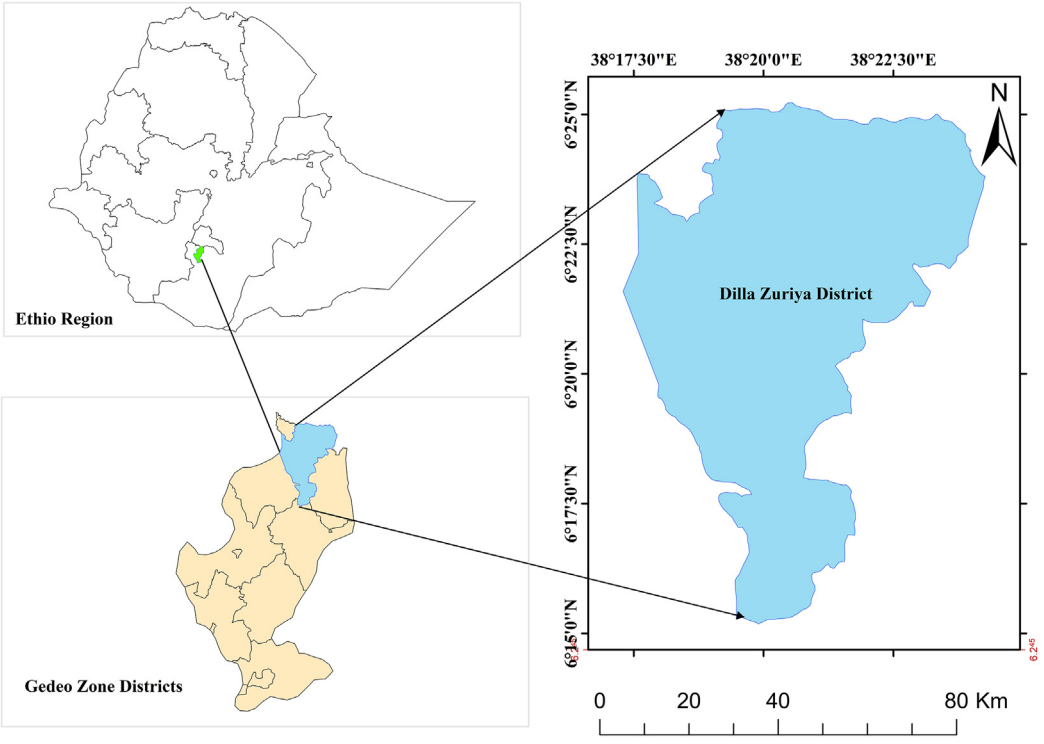

Figure 1. Study area map.

(statistical package for social science, version 26). A chi-square test was calculated using SAS (Statistical Analysis System) version 9.4) to see if the proportions of the different categorical variables are significantly different or not. Major smallholder dairy producers' constraints were analysed using indices (weighted averages) formula (3) to obtain the aggregate ranking and calculated as

Index = sum of [(3 × number of responses for 1st rank +2 × number of responses for 2nd rank + 1 × number of responses for 3rd rank)]/(3 × total responses for 1st rank +2 × total responses for 2nd rank + 1 × total responses for 3rd rank). (3)

2.5. Ethical clearance

All the data collection instruments (household survey questionnaire and FGD checklists) were reviewed for ethical clearance and approved by the Dilla University, College of Agriculture and Natural Resources. Moreover, informed consent was obtained from all surveyed households and FGD participants of this research.

3. Results and discussions

3.1. Socioeconomic characteristics of respondents

The significant difference in socioeconomic characteristics of respondents (sex, age, and education) was tested at 5% probability (Table 1). Both male and female-led dairy farms were randomly included in the survey. However, a majority (60.8%) of the dairy farms were run by females (Table 1). Thus, the involvement of female farmers in the smallholder dairy sector was significant (X^2 = 5.63; P < 0.0176). The majority of the respondents (70 %) were found in the productive working-age category of 26–50 years. This finding agrees with (Yohanis and Tilahun, 2021), which showed 82 % of dairy producers are up to age of 50. This implies that young farmers have been attracted to the dairy sector; good opportunity to intensify, modernise and optimise economic use.

The respondent's educational background is significant (X^2 = 135.67; P < 0.0001). Nearly half of the dairy farmers (44.1%) in the current area has no educational exposure. The illiteracy level of smallholder dairy farmers under the present study area was considerably higher than a central Zone of Tigray, which is 16.25%, as reported by (Gebrekidan et al., 2012). Illiteracy negatively affects dairy improvement efforts by slowing the rate of intensification and hindering the adoption of new technology. The mean family size per household of the recent study (8.79) was higher than the finding of Bereda et al. (2012); Belay et al. (2012) and Bernabas et al. (2018). They reported an average of 6 persons living per household in Jimma, Ezha and Quara. The largest family size is expected since the area is recognised with high population density, up to 1300 persons per km2, the highest rural population density in Africa (Mulugeta and Mabrate, 2017).

Table 1. Socioeconomic characteristics of smallholders in the study area.

Parameter	Variables	% (N = 120)	X^2	P-value
Sex of farm leader	Female	60.8	5.63*	0.0176
	Male	39.1		
Age category	<25	14.1	135.67*	0.0001
	26–50	70		
	46–65	15		
	>65	0.83		
Educational background	Illiterates	44.1	56.33*	0.0001
	Grade 1st -4th	39.1		
	Grade 5th -8th	13.3		
	Grade 9th -12th	3.3		
Total Family size mean)/HH		8.79		

χ2 = Chi-square; * = significant if p < 0.05 level of significance.

3.2. Characterisation of a production system

A majority (70.9%) of sampled smallholder dairy farmers practised mixed crop-livestock farming, similar to Horoguduru Wollega Zone of Western Ethiopia (Belay et al., 2012). As depicted in Table 2, almost half of smallholder dairy farmers produced milk primarily for income generation. Sara (2018) and Fissha & Deng (2021) also mentioned milk production as a major production purpose in the Ziway-Hawassa milk shed and Gambella. Secondly, dairy farmers produced milk targeting income generation and home consumption. Dairy farming experience is significantly different (X^2 = 95.2; P < 0.0001), and only 4 % of the respondent have less than 6 years of experience (Table 2). However, there was little tendency to formulate and apply experiences to improve milk production systematically.

3.3. Cattle herd compositions

The average herd composition of the assessed farms in the area is summarised in Table 3. On average, the lactating cows were higher (2.92 and 1.60) in the local breed and crossbred, respectively. Similarly (Bereda et al., 2014) also found lactating cows with the highest proportion in the Gurage Zone. Keeping the largest proportion of cows may be advantageous because of their multifunctional usage in milk production, replacement stock, and manure. Whereas the respondents rarely kept local and crossbred bulls. In the present study, this lower average of bulls could be attributed to a significant land constraint on providing sufficient feed for their animals. In general, more local breeds were kept in the herd than crossbreds. The proportion of cattle herd mean obtained in this finding was less than that reported by Beriso (2015) and Tesfaye & Wondossen (2019) in Aleta Chuko and Gurage Zone.

3.4. Dairy cattle management practices

3.4.1. Feed sources used for dairy cattle

According to the study, smallholder dairy farmers supply their dairy cattle with different feed resources based on availability and feed price. Banana and Enset leaves and stems (80.3%) were the dominant feed source for the dairy cattle (Table 4). In Gedeo agroforest, crops such as Enset and banana are the dominant perennial plants used as food for society (Alemu et al., 2013), creating an excellent opportunity to use these plant leftovers to feed cattle. Enset is also one of the non-convention feed sources for dairy cattle in Jimma (Duguma and Janssens, 2016).

The study also showed that smallholder dairy farmers used fruit and vegetable leftovers, crop residues, and natural pasture to feed dairy cattle. Natural pasture and crop residues were also identified as dairy cow feed sources in Alefa and Quara district (Ayeneshet et al., 2018), Ada'a and Adama Zuriya district (Bekele et al., 2019), and the southern Ethiopian rift valley (Bedada et al., 2021). Thus, across all the different Ethiopian dairy cattle production systems, major roughage feeds, including natural pasture and crop residues, were used as main feed sources (Ayenew and Tegegne, 2007). Due to high cost, a limited number of smallholder farmers used commercial concentrate feed. Similarly, 80% of dairy farmers in Jimma area didn't used concentrate feed for the same reason (Duguma, 2020).

3.4.2. Feeding system

According to the responses from smallholder farmers, the two types of dairy cattle feeding systems in Dilla Zuriya were free grazing (57.5%) and stall feeding (42.5%) (Table 5). Both feeding strategies have been observed in the periurban areas of Ada'a and Adamazuriya (Bekele et al., 2019), peri-urban Sululta and urban Holetta (Kiros et al., 2018), and the

Table 2. Characterisation of production system.

Description		Chichu	Andida	Gola	Overall	X^2	P-value
		N (%)	N (%)	N (%)	N (%)		
Production system	Livestock production	10 (25)	12 (30)	13 (43.3)	35 (29.2)	20.83*	0.0001
	Mixed crop-livestock farming	30 (75)	28 (70)	27 (90)	85 (70.9)		
Purpose of milk production	Income generation/sale	10 (25)	32 (80)	17 (56.7)	59 (49.2)	34.55*	0.0001
	Home consumption	3 (7.5)	1 (2.5)	6 (20)	10 (8.3)		
	Both	27 (67.5)	7 (17.5)	17 (56.7)	51 (42.5)		
Experience in dairy farm	1–5 years	-	1 (2.5)	3 (10)	4 (3.3)	95.20*	0.0001
	6–10years	4 (10)	1 (2.5)	5 (16.7)	10 (8.3)		
	11–15 years	11 (27.5)	8 (20)	15 (50)	34 (28.3)		
	>15 years	25 (62.5)	30 (75)	17 (56.7)	72 (60.0)		

$\chi 2$ = Chi-square; * = significant if $p < 0.05$ level of significance.

Table 3. Cattle herd structure in Dilla Zuriya district.

Category	Local breeds (mean ± SE)	Cross breeds (mean ± SE)
Lactating cows	2.92 ± 1.18	1.60 ± 0.04
Dry cows	0.57 ± 0.12	0.21 ± 0.09
Heifer	0.86 ± 0.08	0.11 ± 0.06
Calves	0.75 ± 0.51	0.46 ± 0.21
Bull	0.13 ± 0.04	0.03 ± 0.02

Amhara and Tigray areas of Ethiopia (Makkar et al., 2018) In the current study, stall feeding practices were lower than in North Shoa's urban and peri-urban production contexts, where around 77 % of smallholder dairy farmers practiced it (Lakew et al., 2019). Smallholder dairy producers in Dilla Zuriya feed their dairy cattle either collectively or individually.

3.4.3. Water source and watering practice

Dairy farmers used two sources to water their cattle (Table 5); either from the river (54.3%) or from pipe (45.8%). (Tesfaye and Wondossen, 2019) for Gurage Zone, (Bekuma and Addisu, 2021) for Buno Bedele Zone, and Hosanna town have all indicated such water sources. Similar to the Alefa district of North Gondar Zone (Ayeneshet et al., 2018), near half of (44.1 %) of dairy producers in Dilla Zuriya provided water twice a day. Although farmers in Jimma and Gurage areas use similar water sources to the present area, the frequency of watering in those areas has been affected by seasonal changes (Tesfaye and Wondossen, 2019; Duguma, 2020).

3.4.4. Housing management system

Good housing conditions can improve milk production by reducing environmental stress (Broucek et al., 2017). The majority (56.7 %) of dairy farmers in Dilla Zuriya district built a separate dairy cattle house from the main dwelling home. On all studied dairy farms in the Oromiya

Table 4. Available feed resources in the study district.

Feed resource	Chichu	Andida	Gola	Overall
	%	%	%	%
Natural pasture grazing	12.08	12.66	13.20	12.65
Enset leaves and steams	13.42	12.99	13.20	13.20
Banana leaves and steams	13.42	12.99	13.20	13.20
Crop residue	12.75	11.69	11.55	11.99
Local brewery waste (Atella)	8.39	9.09	9.57	9.02
Wheat bran	9.73	10.06	9.90	9.90
Commercial concentrate	5.70	4.87	3.96	4.84
Fruit leftovers (avocado, mango, banana)	12.42	12.66	13.20	12.76
home vegetable leftovers	12.08	12.99	12.21	12.43

Table 5. Feeding and Watering system of dairy cattle.

Description		Chichu	Andida	Gola	Overall %
		N (%)	N (%)	N (%)	
Feeding system	Free grazing system	23 (57.5)	20 (50)	26 (65)	57.5
	Stall feeding	17 (42.5)	20 (50)	14 (35)	42.5
Feed provision	Group feeding	21 (52.5)	20 (50)	22 (55)	52.5
	Individual feeding	19 (47.5)	20 (50)	18 (45)	47.5
Source of water	River	18 (45)	27 (67.5)	20 (50)	54.2
	Pipe water	22 (55)	13 (32.5)	20 (50)	45.8
Frequency of water provision	Once day	3 (7.5)	10 (25)	8 (20)	17.5
	Twice a day	22 (55)	17 (42.5)	14 (35)	44.2
	Three times a day	10 (25)	12 (30)	16 (40)	31.7
	Ad libitum	5 (12.5)	1 (2.5)	2 (5)	6.7

Table 6. Housing system of the study area.

Description		Chichu	Andida	Gola	Overall %
		N (%)	N (%)	N (%)	
Separate house from family house	Yes	27 (67.5)	19 (47.5)	22 (55)	56.7
	No	13 (32.5)	21 (52.5)	18 (45)	35.0
Types of house	Made from local material	39 (97.5)	36 (90)	37 (92.5)	93.3
	Concrete house	1 (2.5)	4 (10)	3 (7.5)	6.7
How confined	All cattle together	4 (10)	-	1 (2.5)	4.2
	separating calves only	31 (77.5)	40 (100)	39 (97.5)	91.7
	All kept separately	5 (12.5)	-	-	4.2

Table 7. Major constraints of dairy production.

Constraints	Index
Feed shortage & high cost of commercial concentrate	0.29
Limited Access and High Cost of Dairy Heifers/cow	0.28
Poor breed improvement practice	0.2
Disease	0.15
Limited credit access	0.01
Limited Market access	0.07

special Zone, similar separated dairy cattle houses were observed (Jalel et al., 2020). In Dilla Zuriya district, traditional housing types were common, and majority (93.3%) of dairy farmers construct dairy barns from locally available construction materials like mud and wood (Table 6). Different types of housing systems have been reported for Horoguduru Wellega Zone; 77% of dairy farmers construct fence barns without shade for dairy cattle (Beyene et al., 2015). Furthermore, 76.11% of smallholder dairy farmers in the Gurage Zone confine their dairy cattle in the family house (Tesfaye and Wondossen, 2019).

The majority (91.7%) of smallholder dairy farmers confine all classes of dairy animals together while separating calves only. Thus, houses were not separately constructed for different categories of dairy cattle.

3.5. Major challenges of dairy production

Several factors constrain dairy cattle production in Dilla Zuriya district. Feed shortage (Index = 0.29) and limited access to dairy heifers (Index = 0.28) associated with high purchasing costs were the most hitting constraints, as prioritized by dairy farmers (Table 7). Shortage of quality feed supply has been reported as the priority problem in Alefa and Quara districts (Ayeneshet et al., 2018) and West Hararghe (Musa and Mummed, 2020). Besides, Lombebo & Wosoro (2019) stated that Hosanna town's urban dairy farmers encountered a challenge due to the increased feed prices. Poor breed improvement practice and disease prevalence, ranked 3rd and 4th, were the most severe constraints to improve dairying in Dilla Zuriya district. Disease and parasite infestation were among the restrictions impeding dairy production in Telo District (Gebremichael and Hailemariam, 2019) and Alefa and Quara Districts (Ayeneshet et al., 2018). Furthermore, insufficient artificial insemination service, shortage of semen, and shortage of AI professionals have been recognized as factors leading to poor breed improvement in most parts of Ethiopia (Lombebo and Wosoro, 2019; Mebrate et al., 2019).

4. Conclusion

Smallholder dairy farmers in Dilla Zuriya district produce milk mainly from local cows under a mixed crop-livestock production system primarily for income generation. Fruit and vegetable leftovers were used as feeds for dairy cattle in addition to leaves and stems of Enset and Banana. Dairy cattle are collectively or individually allowed to graze natural pasture freely. Farmers provide water for dairy cattle mostly twice a day from rivers or pipes. Except for calves, different classes of dairy cattle were confined in traditional houses made from mud and wood. Feed shortage and limited access to improved dairy heifers associated with high purchasing costs were the two major constraints of dairy production in Dilla Zuriya district. Enhancing the quality of locally available feed resources and applying dairy cattle breed improvement technologies such as Artificial insemination are highly recommended to improve the dairy production potential.

Declarations

Author contribution statement

Sara Endale Hailemariam: Conceived and designed the experiments; Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Biruh Tesfahun Tezera; Demeke Haile Engidashet: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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