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Research Article

Traditional dairy production and milk handling practices in Mareka district, Dawuro Zone, Southwestern Ethiopia

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Abstract

This study aimed to assess traditional dairy production, management, and milk handling practices in the Mareka district of the Dawuro zone in southwestern Ethiopia. Samples included 96 dairy cattle-producing households across three agroecological zones. Data collection methods were structured questionnaires, observations, and discussions with key informants. Statistical analysis was performed using the Statistical Package for the Social Sciences. According to the study's findings, lactating cows constituted 28% of the overall herd population in the highlands and lowlands and 27% in the midlands. While 83% of households kept animals in the same house as their family, 15% housed them in the kitchen. Notably, cows in the highlands had a significantly shorter calving interval (17.3±0.78 months) compared to the midland (24.5±1.46 months) and lowlands (23.2±1.58 months). Average lactation lasted 229.3±6.69 days, with milking starting 51.6 days after calving. During peak periods, daily milk production per cow varied from 1.22±0.06 liters in the lowland and midland to 1.63±0.10 liters in the highlands. The average lactation yield per cow was 198.82 liters, with higher yields observed in highland cows, followed by midland and lowland cows. The study emphasizes the importance of empowering farmers and improving management practices to enhance the impact of traditional dairy practices on human nutrition and community livelihoods.

Keywords: Calving interval; Lactation length; Traditional dairy production

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1. Introduction

Ethiopia's traditional dairy farming sector benefits from favorable climate conditions, diverse native cattle breeds, and varied agroecological settings. The development of this sector holds significant potential for poverty alleviation and community nutrition enhancement in the country (Minten et al., 2020). Specifically, dairy development, particularly at the smallholder

level, can positively impact nutritional outcomes by increasing accessibility to milk and boosting household income (Randolph et al., 2007).

The dairy sector plays a crucial role in achieving two of the Sustainable Development Goals (SDGs), namely poverty reduction (SDG 1) and hunger eradication (SDG 2) (FAO et al., 2018). Rural women particularly benefit from dairy production as it generates cash and helps fulfill social obligations (Edemo, 2017).

The connection between livestock and nutrition, especially for children, is significant (Delay et al., 2020). Smallholder dairy farming households often exhibit better nutritional status, benefiting both mothers and school-aged children (Hoorweg et al., 2000; Walton et al., 2012). Moreover, women's ownership of livestock correlates positively with children's weight-for-age Z scores (Jin & Iannotti, 2014).

The characteristics of traditional dairy production serve as crucial indicators for the growth of the dairy sector in Ethiopia. The United Nations' SDGs underscore poverty eradication, hunger reduction, and sustainable resource management, aligning with the goals of dairy development.

While the challenges related to low cow productivity in Ethiopia are well-documented, there remains a gap in understanding the decision-making behavior and efficient resource utilization to enhance cattle production and reduce calving intervals. Despite the widely recognized importance of cattle in Ethiopia, system-specific data on cattle productivity and value are lacking, hindering our comprehensive analysis of these systems (Li et al., 2023). Additionally, the long-term impact of animal reproduction on human nutrition downstream is either underrepresented or concentrated in specific areas. This study aims to examine the causal relationship between dairy production, management techniques, and milk and milk product handling in Mareka district, Dawuro zone, southwestern Ethiopia.

2. Materials and Methods

2.1 Description of the study area

This research was conducted in Mareka District, located within the Dawuro Zone of the Southern Western Region of Ethiopia. The Dawuro Zone is bordered by the Woliyta Zone to the east, the Gamo, Gofa, and Basketo Zones to the south, the Konta Zone to the west, the Oromiya Region to the north, and the Kembata and Tembaro Zones to the northeast. Mareka District occupies a central position within the Dawuro Zone. The administrative capital, Tercha, is

situated at coordinates 7°09'N and 37°30'E, approximately 500 kilometers southwest of Addis Ababa.

The Dawuro Zone encompasses a total land area of 446,082 hectares and is characterized by rugged, hilly, and mountainous terrain. Its primary forest cover, the Kechi-Yama-Dode-Kella natural forest, spans approximately 32,000 hectares. The Chebera Churchura National Park, located between the Dawuro and Konta Zones, enhances the region's biodiversity. The zone is intersected by several perennial rivers, all of which are tributaries of the Gojeb and Omo Rivers. Elevation within the zone varies significantly, ranging from 500 meters above sea level in the lower Omo Valley to 2,800 meters at the Tocha Tuta Ridge. The climate is marked by a mean annual rainfall of 1,500 mm and an average temperature of 20°C, with a bimodal rainfall distribution pattern.

The predominant agricultural system in the rural areas of the Dawuro Zone is mixed crop-livestock production. Key annual crops include maize, teff, sorghum, beans, peas, wheat, barley, haricot beans, sesame, taro, potatoes, and sweet potatoes, while perennial crops such as coffee, sugar cane, bananas, mangoes, and avocados are also cultivated. Enset (*Ensete ventricosum*) plays a pivotal role in the region's agriculture, supporting high population densities by providing substantial yields from small landholdings. It serves as a staple food source, particularly during periods when other crops are not yet mature or available in storage. Among tree species, eucalyptus has recently become invasive, affecting both arable and non-arable lands in the highland areas. Livestock production includes cattle, sheep, goats, equines, and poultry, with cattle serving as the primary source of milk. Dawuro kibe (butter) holds significant cultural value as an indigenous product. Mareka District was selected for this study due to its status as a commercial and agricultural hub within the Dawuro Zone, representing a significant portion of the zone's dairy production and marketing activities.

2.2 Sample size and sampling technique

Three kebeles (farmer's associations) were purposefully selected from the Mareka district to collect household data. These kebeles are named Waka, Gozoshasho, and Tarcha. Before selecting the kebeles, the district was stratified into three altitudinal categories such as highland, midland and lowland. From each agroecological zone, one kebele was randomly sampled (Table 1). The goal was to ensure representation from different ecological contexts. The percentage area coverage of the kebeles in agroecology was roughly similar throughout the district. Next,

households were randomly picked from each kebele based on their level of involvement in milk production, as well as the number and type of dairy animals they possessed.

Table 1. Proportion sample size in each unit (kebele) in the Mareka district

Agro-ecology	Altitude (m)	Kebele	Number of households
Highland	>2200	Waka	32
Midland	1650-1900	Gozoshasho	32
Lowland	< 1450	Tercha	32
Total		3	96

2.3 Method of data collection

During the survey, both primary and secondary data were collected. Structured and pre-tested questionnaires were used to gather information directly from sampled households. The questionnaires were administered through house-to-house visits, involving direct interviews with farm families. Researchers conducted personal observations and engaged in discussions with key informants. Women, particularly those involved in dairying and having close interactions with cows, were specifically interviewed. Secondary data were obtained from relevant governmental and non-governmental organizations. These sources provided additional context and background information. The survey covered various aspects, including family sizes, dairy cow holdings, cows' production and reproduction performance, handling practices exercised by the family, milking utensils, and local herbs used for milk preservation and flavoring.

2.4 Data analysis

The data from the survey was analyzed using various descriptive statistics such as means, percent and frequency. The percentage of farmers (respondents) who had given similar responses to the questionnaire was calculated out of the total number of respondents who responded to each questionnaire. Those who did not respond to certain questions were excluded from the calculation.

Results of the statistical summary were presented in Tables. Some of the variables analyzed using the mentioned descriptive procedures include, household size, and reasons for the non-availability of cattle barns for farm households, and the population that utilizes warm water to make hygienic practices were summarized. The Statistical Package for the Social Sciences (SPSS) was used for data analysis.

3. Results and Discussion

3.1 Demographic characteristics

In the study area, the average family size was 7.29 members with minimum and maximum of 2 and 13, respectively. The average number of males and females per household under 15 years was 1.66 and 1.84; between 15 to 64 years was 1.83 and 1.84, respectively. The average number of females was slightly greater than males and the female-to-male ratio was 1.05: 1. The old age, above 64 years was very few in both genders. This study's average family size was comparable to those reported by Amejo et al. (2018) in the same locality (6.9 (SE=0.2)) and in the Alaba special districts of the SNNP region (6.7±0.18) (Kocho, 2007). However, it exceeds the national (5.2) and SNNP (5.1) area averages (CACC, 2003).

3.2 Agricultural features and dairy husbandry

Household holdings of the different categories of cattle were comparable in the three agroecologies (Table 2). The average number of lactating cows from the total herd population was 28% in the highlands and lowlands and 27% in the midlands, which exceeded all other herd structures included in the area, except for calf holding. Yoseph et al. (2003) reported the proportion of cows in urban and peri-urban dairy herd was higher than other cattle groups. It is unavoidable for a family to own at least one milking cow. Respondents stressed the importance of a dairy cow in the family as a breeding stock, nutritional source, and source of income for many small producers, particularly women.

According to FAO et al. (2018), dairy cow ownership and/or production improvement consistently had a substantial positive and nearly always statistically significant influence on a variety of parameters. Several research, countries, and indices give compelling evidence that dairying was the cause, not the effect, of increased household welfare. Whalen, (1984) stated that in the Ethiopian highlands, revenue from the sale of butter and cheese is the main source of income for women. In most traditional dairy production practices women are responsible for milk allocation and use part or all of the income from the sale of dairy products to purchase goods for the family.

According to Coppock (1994), Borana women in southern Ethiopia are responsible for milking animals, selling milk, and purchasing family necessities. Women's dairy product sales generate 20% of Borana's annual household income in southern Ethiopia (Holden & Coppock 1992). The Borana men in northern Kenya own and are responsible for the livestock. According

to FAO (1979), women are responsible for caring for calves and small ruminants, milking cows, processing milk, and using the revenues as needed. Similarly, Whalen (1984) reported that in the Ethiopian highland mixed crop-livestock production system, women are responsible for decision-making concerning dairy management such as watering, feeding, milking, cleaning animals and preparing beds, assigning young children to different activities, selling milk and using dairy income for household needs.

Table 2. Mean (±S.E) cattle holding of households in three agroecologies of Mareka district

Group of cattle	Agroecology			Total
	Highland	Midland	Lowland	
Calves	1.6(0.10)	1.7(0.10)	1.4(0 .12)	1.6(0.06)
N	30	32	32	94
Heifers	1.3(0.13)	1.6(0.17)	1.4(0.15)	1.4(0.09)
N	13	20	17	50
Bulls	1.1(0.10)	1.3(0.12)	1.6(0.2)	1.4(0.09)
N	14	21	14	49
Dry cows	1.3(0.1)	1.3(0.16)	1.4(0.12)	1.3(0.07)
N	19	14	18	51
Lactating cows	1.6(0.1)	1.7(0.10)	1.4(0.12)	1.6(0.06)
N	30	32	32	94

Furthermore, the community's nutritional needs necessitate the presence of at least one milking cow in the herd to supplement the family diet. A bread loaf prepared from enset (*Ensete ventricosum*), a commonly grown crop, or other cereal grains found in the research area is extremely difficult to make without milk and milk products. This type of cuisine demands an additional nourishing diet or recipe.

3.3 Cattle housing

Of the total respondents, 83% kept their animals in the same house where the family lived 15% kept them in the kitchen and only 2% housed them in a separate barn (roofed house) (Table 3). According to the respondents, the cattle herd is confined at night in the following order: oxen, bulls, heifers, dry cows, lactating cows, and calves, left to right. This setting facilitates indoor action and night milking. Calves are separately kept until the dam dries off to protect unwanted calf suckling.

There are several reasons for the respondents not to keep their animals in separate houses. The most important ones they claimed include, separately housing animals is not a cultural practice (22%), separately housing for animals is uneconomical (19%), keeping animals in the same house as humans protect animals from theft and/or wild animals (17%) or it protects animals from theft alone (13%). The other important attributes of the respondents such early

identification of diseased animals when entering and living in the house, protecting animals from cold stress and disease, making animals docile, facilitating immediate aid if they are sustained, getting personal satisfaction and protecting them and the owners from various types of harmful conditions accounts 12%.

According to Croney & Botheras (2010), the strength of the human-animal bond is likely to influence people's thought processes about how animals should be treated, because people form close emotional connections to animals they consider companions, and those relationships are likely to influence how they think about, view, and value other animals, including those used for food. Concerns about livestock animal welfare may stem from attitudes about companion animals (Croney & Botheras, 2010).

Table 2. Livestock housing in three agro-ecologies of Mareka district

Barn type	Agroecology [Frequency (%)]			Total
	Highland	Midland	Lowland	
Common house (human and animals)	19(60)	31(97)	30(94)	80(83)
Separate barn	2(6)	0(0)	0(0)	2(2)
Kitchen	11(34)	1(3)	2(6)	14(15)

3.4 Reproductive and productive performance of cattle

Cows in the three agroecological patterns were significantly different ($p \leq 0.001$) in the mean calving interval (Table 4). The overall mean calving interval of cows in the study area was 21.8 months, but cows in the highland had significantly shorter calving interval (17.3±0.78 months) than those in the midland (24.5±1.46 months) and in lowlands (23.2±1.58 months). This may be due to a relatively better feeding condition in the highland areas. Highland cows may receive better feeding from residue and other supplemental feeds while lactating and thus may induce them to become in heat and conceive while they are still lactating. On the other hand, under range management conditions, especially when the nutrition is marginal, cows do not conceive while lactating and hence calving interval is extended (Mukasa-Mugerwa, 1989, Tegegne, 1981, Ash, 1991). Thus, the latter situation may be reflected in midland and lowland areas of Mareka district, Dawuro zone. Similarly, many studies showed prolonged calving intervals to cause significant problems in Ethiopia. For example, a study in Belesa, Northern Amhara region indicated that calving intervals of cows ranged from 2 to 4 years (Tessema et al., 2003).

The ideal calving interval for milk production in a dairy herd is 12 months (Peters, 1984; Gaines and Palfrey, 1931; Fetrow et al., 2007; DeLay et al., 2020). To achieve this target the

management aspect must be very good; estrus detection must be in the best condition; and depend on the cattle breed. Mekonnen & Goshu (1987) reported an average calving interval of 453 ± 106 days for indigenous Fogera cows in Gonder, which is shorter than the present study. On the other hand, the average calving interval of cows in the Dawuro zone was roughly comparable to 25 months reported by (Yilma & Ledin, 2000) for local cows in central highland mixed smallholder.

Table 4. Mean (±S.E) reproductive and productive performances of cattle in three agroecological areas of Mareka district

Cows performance	Agroecology			Total
	Highland	Midland	Lowland	
Calving interval (months)	17.3 (0.78)[a]	24.5 (1.46)[b]	23.2 (1.58)[b]	21.8(0.83)
N	30	32	32	94
Milking start after calving (day)	50.0 (1.81)	53.91 (2.00)	50.8 (1.83)	51.6(1.09)
N	30	32	32	94
Lactation length (day)	243.0 (12.42)	233.4 (13.52)	211.9 (8.19)	229.3(6.69)
N	30	32	32	94
Peak milk yield period (day)	144.0 (8.56)[b]	113.4 (6.83)[a]	106.9 (6.99)[a]	121.0(4.57)
N	30	32	32	94
Lean milk yield period (day)	49 (8.6)[a]	65.2 (10.1)[b]	54.7 (5.5)[ab]	56.3(8.2)
N	30	32	32	94
Peak milk yield lit/cow/day	1.63 (0.10)[b]	1.22 (0.06)[a]	1.22 (0.06)[a]	1.35(0.05)
N	30	32	32	94
Lean milk yield lit/cow/day	0.76 (0.05)[b]	0.63 (0.02)[a]	0.62 (0.03)[a]	0.67(0.02)
N	30	32	32	94
Lactation milk yield/liters/cow*	271.96[b]	179.5[a]	164.3[a]	201.07
N	30	32	32	94

*=Does not include calf off-take at either period, Row means with different superscripts are significantly different at P< 0.05.

In general, it is believed that calving rates and intervals in eastern Africa remain inefficient when compared to those obtained in the United States, Europe, and other countries with well-developed dairy businesses (DeLay et al., 2020). Many studies (Dahl & Hjort, 1976) discovered that normal calving rates were between 25 and 60%, with calving intervals of up to four years in many East African countries. While observed differences in the calving interval between cattle of Dawuro zone and the other stocks may be attributed to differences in management conditions and genotype of the cow. The mean lactation length in the study area was about 229.3±6.69 days (Table 4). In most modern dairy farms, a lactation length of 305 days is commonly accepted as a standard. However, such a standard lactation length might not work for smallholder dairy cows in which the lactation length is considerably shorter in most cases (Masama et al., 2003; Teodoro & Madalena, 2003; Msangi et al., 2005). The study conducted by Alemu & Zinash, (2002) showed the average lactation length of a zebu cow to be 150-200 days. Probably farmers in

Dawuro milk cows until they are quite dry. However, this milking practice harms the calving interval, next-season milk and productive efficiency of the cow. Some scholars, however, argue that such an extended lactation period has practical significance for the smallholder dairy farmer as it provides compensation for the usually extended calving interval (Tanner et al., 1998). However, sometimes the profitability of short or extended lactation length gets the interest of the farm family in different ways. Men like cows dry off shortly and enter into the next gestation, whereas women need extended lactation. The former harvests calf crops from successive births while the latter needs to precede the ongoing lactation to fulfill the milk demand of the family. Numerous studies have documented that additional days in which cows are not pregnant beyond the optimal time post-calving are costly (Groenendaal et al., 2004; Meadows et al., 2005).

The average time lapse between calving and starting milking was comparable in the three agroecological levels (Table 4). On average farmers in Dawuro commence milking their cows after 51.6 days, which is a typical feature in the study area. Normally in most areas, cows are left not milked during the first week after parturition and in some cases, milking can be delayed at most until the middle of the second week. In Dawuro, farmers believe that allowing such an extended period of suckling improves calf growth and health. However, such a practice results in inefficient use of milk, and possibly the nutrition of the calf can be topped up using milk replacer and the milk can be made available for human use. Cows in the three agroecological areas of Dawuro significantly differed ($p<0.01$) in the average length of peak milk yield period (Table 4). The mean length of the peak milk yield period in the highlands (144±8.16 days) was significantly longer than in the lowlands (106.9± 6.99 days) and in the midlands (113.4 ± 6.83 days). Conversely, the average length of the lean milking period was shorter in the highlands than in the lowland and midland areas. The milking frequency was twice per day in all parts of the studied area mainly early morning and evening. Mean daily milk production per cow during the peak period was 1.35 liters with variation from (1.22±0.06) liters in lowland and midland areas to (1.63±0.10) liters in the highland and differences were significant ($p<0.01$). Yilma & Ledin (2000) reported that indigenous cows' average daily milk yield of 1 to 1.5 liters in the central highland of Ethiopia. Similarly, daily mean milk/cow during the lean period was significantly higher ($p<0.01$) in the highland (0.76±0.05 liters) than in the midland (0.63±0.02 liters) and lowland (0.62±0.03 liters) (Table 4).

The average lactation yield across the study area is approximately 198.82 liters per cow. Highland cows produce significantly more milk, averaging 271.6 liters per lactation, followed by

midland cows at 179.5 liters, and lowland cows at 164.3 liters. These figures exclude milk consumed by calves during the initial two-month suckling period or during milking.

Various studies have shown that calves on average consume 32% of the total milk produced in rural small-scale production systems (Gebrewold et al., 2000; Feleke & Geda, 2001; Redda, 2001). As a result, the average lactation yield of cows in Dawuro obtained in this study could underestimate the true performance of the cows as they abstained from milking for quite an extended period (nearly 2 months) after calving. Thus, this may explain the low average lactation yield estimated in the present study compared to average values commonly reported for indigenous zebu cattle under a smallholder production system.

For instance, Ahmed et al. (2003) reported the average lactation yield for zebu cows to be range between 400 to 680 kg of milk/cow. On the other hand, the average yield estimated in the present study for highland cows in Dawuro (271.96 lit/lactation) was found to be on the upper range of the lactation yield reported by Alemu & Zinash (2002) in Ethiopia (200-250 lit/lactation/cow). However, the estimated average for the lowland and midland cows is still lower reflecting twofold effects of trypanosomes as well as the extended period of abstaining cows from milking, management and genotype effect.

3.4 Milking, milk handling and processing

3.4.1 Milking and milk handling practices

Cows are milked twice a day, in the early morning before breakfast and in the evening before dinner, across all three agroecologies (highland, midland, and lowland). Farmers noted that milking twice daily is a recent change because cows are producing less milk than before. In the past, cows were milked three times a day.

During milking, calves are allowed to suckle briefly to encourage milk flow and soften the teat. After this, calves are moved away and tied in front of their mother, where they can lick and sniff her, which helps keep the cow calm. If the cow becomes agitated, it may need to be tied to a pole. Calves are allowed to suckle again during milking to further stimulate milk flow. After milking, calves can continue suckling until the herd goes out to graze or the family starts other activities.

Cows are always milked indoors, either in the same area where they are housed with the family or in the kitchen where food is prepared. Farmers avoid milking cows outside, believing that moving them from their usual place can disrupt milk flow. Indoor milking is also considered

cleaner, as outdoor environments may expose milk to dirt or other contaminants. Additionally, insects or other disturbances outside can make cows nervous, which can reduce milk production. However, the milking areas were often muddy and unclean, and the cows' bodies were also dirty.

The prevalence of traditional hygienic methods during milking and milk handling is displayed in Table 5. Before milking, the majority of farmers (97 percent in the highlands, 100 percent in the midlands, and 100 percent in the lowlands) wash their hands and milking implements. However, washing the cow's udder before milking is less common: 72% of highland farmers, 41% of midland farmers, and 50% of lowland farmers do this. Many farmers believe the calf cleans the teat by suckling, so they skip washing the udder. Washing the udder after milking is rare, practiced by only 9% of highland farmers, 6% of midland farmers, and none in the lowland. Typically, calves are allowed to suckle any remaining milk and clean the teat.

Table 5. Frequency in traditional hygienic practice during milk product handling in three agroecologies of Mareka district

Hygienic practices	Agroecology [Frequency (%)]			Total (n=96)
	Highland (n=32)	Midland (n=32)	Lowland (n=32)	
WH/WUBM/WE	22(69)	12(38)	16(50)	50(52)
WH/WE	7(22)	17(53)	14(44)	38(40)
WH/WUBMI/WE	0(0)	1(3)	2 (6)	3(3)
WH/WUBMI/WUAM	1(3)	0(0)	0(0)	1(1)
All*	1(3)	1(3)	0(0)	2(2)
All except WUBM	1(3)	1(3)	0(0)	2(2)

WH=Washing hand, WUBM =Washing udder before milking, WUAM=Washing udder after milking, WUBMI=Washing udder before milking if dirty, WE=Washing equipment, *= WH/WUBM/WUAM/WUBMI/WE

None of the farmers filter the milk after milking. Instead, they mix it directly with previously collected milk in a container or use it for other purposes. Some farmers (13% in the highland, 3% in the midland, and 9% in the lowland) use warm water to wash the udder before milking. Additionally, 38% of highland households use warm water to clean milking equipment. Farmers cited lack of time, labor shortages, limited equipment, and the cow's habits as reasons for not using warm water to wash udders. Smoking dairy equipment is not a common practice in the study area. Ashenafi & Fekadu (1993) however indicated that smoked containers tend to lower the microbial load of milk contained therein as compared to unsmoked containers.

Table 6 shows households within and across the three agroecologies that used different types of milking equipment. Highlanders mostly used plastic containers for milking (41%) or clay pot (22%) or both clay pot and gourd (25%). In the midland, the majority used clay pots (56%) or both clay pots and gourd (25%) for milking, whereas in the lowlands, clay pots were

exclusively used for milking by most households (82%) and usage of other types of equipment for milking was fairly uncommon. In general, the use of plastic containers for milking was fairly common in the highlands than clay pots alone or together with gourd, whereas the reverse was true in midland and lowland areas. Early urbanization in the highlands and therefore availability of plastic containers has allowed the use of such equipment commonly by the highlanders. Gourd fruit plant grows and mixed social (such as potter maker) group inhabitants may provide the opportunity to frequently use gourd and clay pots in the midland and lowland areas.

Clay pot and gourd were most frequently used for the storage and fermentation of milk, however, variations were observed among the three agroecologies regarding the preference between the two types of equipment for storage and fermentation purposes. Households in highland and midland most frequently used clay pots to ferment milk (41% and 56%, respectively) followed by both clay pots and gourd (25% each) or gourd alone (16% each). Whereas in the lowlands, either clay pot or gourd alone was used for milk fermentation (40% and 47%, respectively) and households that used both equipment interchangeably were relatively few.

According to the key informants, the size of the clay pot and gourd used for milking, storage or fermentation, process, and churning varied greatly in size. For example, clay pots used for milking are locally called *butia* and in similar categories, equipment used for storage or fermentation and cheese making is locally known as *xarowa*. The size of these two equipment ranges from 1 to 3 liters. Most of the respondents said that they do not like to store or ferment milk in extra-large-sized clay pot. This is probably related to problems encountered during handling because of its large size and its sensitivity to easily damage. On the other hand, the gourd used for milking is locally called *bacha,* which is the smallest in volume. *Qaraba* is the respective name of the gourd in the area and is commonly used for storage and/or fermentation. *Qaraba* also used milk drinking purposes. The churn equipment locally called *Ma'nachia* is the largest in volume of all.

In all parts of the study area, *Ma'nachia* (churning gourd) is exclusively used for churning purposes. *Ma'nachia* with appropriate volume and wider mouth was selected for churning. Selected *Ma'nachia* is placed on the ceiling of the roof; dried for several days by the smoke and the vent is opened at one side of the neck, which is later used as a gas outlet. During churning, the mouth of *Ma'nachia* is packed tight with dried enset leaf. Churning is performed

by women or female children sitting on a flat floor, stretching both legs one over the other, and gently rocking the Ma'nachia back and forth over the knee.

Table 6. Equipment used for milking, storage and processing of milk and milk products in three agro-ecologies of Mareka district

Equipment and their purpose	Agroecology [Frequency (%)]			Total
	Highland	Midland	Lowland	
Milking	**n=32**	**n=32**	**n=32**	**n=96**
Clay pot	7(22)	18(56)	26(82)	51(53)
Gourd	0(0)	3(9)	1(3)	4(4)
Plastic	13(41)	3(9)	2(6)	18(19)
Clay pot/ Gourd	8(25)	8(25)	2(6)	18(19)
Gourd/Plastic	3(9)	0(0)	1(3)	4(4)
Clay Pot/Gourd/Plastic	1(3)	0(0)	0(0)	1(1)
Fermentation	**n=32**	**n=32**	**n=32**	**n=96**
Clay pot	13(41)	18(56)	15(47)	46(48)
Gourd	5(16)	6(19)	13(40)	24(25)
Plastics	3(9)	0(0)	0(0)	3(3)
Metals	2(6)	0(0)	0(0)	2(2)
Clay Pot/ Gourd	8(25)	8(25)	4(13)	20(21)
Gourd/Plastic	1(3)	0(0)	0(0)	1(1)
Churning	**n=27**	**n=28**	**n=30**	**n=85**
Gourd	27(100)	28(100)	30(100)	85(100)
Cheese processing	**n=27**	**n=28**	**n=30**	**n=85**
Clay pot	27(100)	28(100)	30(100)	85(100)
Cheese storage	**n=27**	**n=28**	**n=30**	**n=87**
Clay pot	7(26)	11(32)	16(53)	34(39)
Plastics	1(4)	1(4)	3(10)	5(6)
Metals	3(11)	0(0)	0(0)	3(3)
Enset leaf	7(26)	0(0)	0(0)	7(8)
Clay Pot /*Eenset* leaf	7(26)	18(64)	11(37)	36(41)
Clay Pot/Plastic	2(7)	0(0)	0(0)	2(2)

From the available total milk during the peak lactation period, 89% of household churn ergo to buttermilk and 89% make cheese from buttermilk (Table 6). The other respondents did not produce cheese or churn milk for a variety of reasons, including a lack of milk, the usage of whole liquid milk for household use, and a poor source of milk from a specific breed for cheese-making. Clay pots, enset leaf, and either clay pot or enset leaf made up 26% of cheese storage materials in the highland. In contrast, 37% of households in the midland and 53% of those in the lowland utilized clay pots to store cottage cheese. Furthermore, 64% of households in the midlands and 37% in the lowlands utilized a clay pot or an enset leaf to store homemade cheese. According to the respondents, enset leaf is common packaging material used to transport cheese to the market while clay pot is used for indoor storage purposes. During the wet season, enset leaf is known to host a variety of worms (adult or larvae), including snails, which can have an

influence on both product quality and client health. On the other side, respondents asserted that enset leaf used for cheese handling is wilted with fire or sunlight, which kills or dislodges the worms.

3.4.2 Fermentation

In the study area, fermented milk, called *meo'matha*, is made by adding fresh milk to previously stored milk without using a starter from earlier batches. Fermented milk is used to produce various products like cheese and buttermilk, which play important social roles, such as sharing with neighbors through a practice called *bik'ya*. This involves giving milk or dairy products during times of plenty and receiving them back during scarcity.

Butter, another fermented milk product, is vital in marriage ceremonies, used as cooking oil, food flavoring, hair and body cosmetic, medicine (applied nasally), and a source of income. Whey and other byproducts from churning are consumed by children of both genders. After calving, the cow's first milk, known as *qessa* (similar to colostrum), is collected, mixed with fenugreek, and stored for days before being shared with neighbors.

Table 7. Frequency distribution of factors that affect fermentation time of raw milk to *ergo* in three agro-ecologies of Mareka district

Factors	Agroecology [Frequency (%)]			
	Highland (n =32)	Midland (n=31)	Lowland (n =31)	Total (n=94)
Temperature	10(31)	15(48)	3(10)	28(30)
Cleaning material	0(0)	3(10)	1(3)	4(4)
Cow types	0(0)	2(6)	1(3)	3(3)
Lactation period	1(3)	1(3)	1(3)	3(3)
Disease of cow	0(0)	1(3)	0(0)	1(1)
Temperature/Cleaning material	5(16)	8(26)	8(26)	21(22)
T^0/CM/DC	1(3)	0(0)	0(0)	1(1)
CM/CT/DC	1(3)	0(0)	0(0)	1(1)
T^0/CM/CT/LP	2(6)	0(0)	2(6)	4(4)
T^0/DC	1(3)	1(3)	2(6)	4(4)
T^0/CM/LP	7(22)	0(0)	8(26)	15(16)
CM/CT	1(3)	0(0)	0(0)	1(1)
T^0/CT/LP	1(3)	0(0)	0(0)	1(1)
T^0/CM/CT	1(3)	0(0)	0(0)	1(1)
CM/LP	1(3)	0(0)	2(6)	3(3)
T^0/LP	0(0)	0(0)	3(10)	3(3)

T^0=Temperature, CM= Cleaning material, CT= Cow type, LP=Lactation period, DC=Disease of cow

Factors affecting milk fermentation time include temperature, equipment cleanliness, cow breed, lactation stage, and cow health (Table 7). Cool temperatures in the highlands (31%) and midlands (47%) slow fermentation compared to the warmer lowlands (9%). Unclean equipment can contaminate milk, leading to unwanted souring, but this is rare due to widespread cleaning

practices. About 16% of highland and 25% of midland and lowland farmers noted that high temperatures and dirty equipment together speed up milk souring, especially in the lowlands. Smoking milk containers, believed to reduce microbial growth, is not common, which may contribute to contamination.

The lean lactation period also affects fermentation, as milk has fewer organic components, slowing the pH drop needed for fermentation. This issue is minor, as milk is often used quickly during lean times. However, 22–25% of farmers reported that temperature, unclean equipment, and lean lactation together significantly impact fermentation, increasing milk loss if hygiene is poor. Mastitis, which lowers lactose and alters milk pH, and cow breed differences have minimal impact on fermentation, as noted by few farmers.

3.4.3 Cleaning and flavoring practices for milk equipment

Table 8 shows the most common plants used for washing milk equipment in the study area. In the highlands, 32% of households use *Ocimum hardiense*, 25% use either *Ocimum hardiense* or *Ruta cynopogan*, and 13% use *Ruta cynopogan* to clean milk utensils.

Table 8. Frequency distributions of plants and local herbs for milk and milk product handling in three agro-ecologies of Mareka district

Purposes and plants/ herbs	Agroecology [Frequency (%)]			Total
	Highland	Midland	Lowland	
Washing	**n=32**	**n=32**	**n=32**	**n=96**
Oh	10(32)	11(34)	8(25)	29(30)
Oh/Cc	1(3)	1(3)	10(31)	12(13)
Oh/Cs	0(0)	9(28)	6(19)	15(16)
Oh/Rc	8(25)	5(16)	2(6)	15(16)
Oh/Cm	1(3)	3(9)	0(0)	4(4)
Cc/Cm	0(0)	0(0)	5(16)	5(5)
Oh/Cyc	2(6)	1(3)	1(3)	4(4)
Oh/Cs/Cyc	2(6)	0(0)	0(0)	2(2)
Oh/Rc/Cyc	2(6)	0(0)	0(0)	2(2)
Cm/Rc	2(6)	0(0)	0(0)	2(2)
Rc	4(13)	2(6)	0(0)	6(6)
Flavour/Taste	**n=24**	**n=23**	**n=29**	**n=76**
Oh/Cs	1(3)	1(3)	1(1)	3(4)
Rg	17(53)	16(50)	28(88)	61(80)
Tfg	2(6)	0(0)	0(0)	2(3)
Oh/Rg	4(13)	0(0)	0(0)	4(5)
Rg/Cs	0(0)	6(19)	0(0)	6(8)

Cs= *Coriand sativum*, Cc= *Chenopodium chenopodiaceae*, Cm= *Cymbopogan martini*, Cyc=*Cymbopogan citralus*, Oh= Ocidinum hardiense, Rg= Ruta graueolens, Rc= *Ruta cynopogan*,Tfg=Trifolium foenum graecum

In the midlands, 34% of households use *Ocimum hardiense*, and in the lowlands, 25% use it for the same purpose. Plant materials for cleaning are more varied in the lowlands, likely due to greater plant diversity in that area. Ayantu (2006) noted that gulowa (*Achyranthes aspera*), tenadam (*Ruta graveolens*), and kosoratya (*Ocimum hardiense*) are used to clean milk vessels for milking, storing, and processing. Most households grow these plants in their backyards or source them from nearby areas, with women primarily handling these tasks.

The survey found that 76% of households use flavoring plants for milk and dairy products. Tenadam (*Ruta graveolens*) is the most common flavoring herb, used by 53% of highland, 47% of midland, and 88% of lowland households. Additionally, 6% of highland households use fenugreek for flavoring. Ayantu (2006) reported that 16.7% of households in Delbo Atwero, 6.1% in Zala Shasha, and 14.1% in Delbo Wegere kebele mix butter with spices. Similarly, tenadam (*Ruta chalepensis*) and garlic (Allium sativum) are commonly used in processing and storing traditional cottage cheese (Aleganesh, 2002).

4. Conclusions

Agriculture, encompassing crop cultivation and livestock production, is vital for livelihoods in rural Dawuro, supporting household income, nutrition, and social well-being. Cattle, particularly lactating cows, are central to these systems, with comparable numbers across highland, midland, and lowland agroecologies. However, reproductive and productive performance varies, with highland cows exhibiting shorter calving intervals and higher lactation yields compared to those in midland and lowland areas. Highland cows also experience longer peak milk yield periods but shorter lean phases. These differences likely result from disease prevalence and suboptimal management practices. Prolonged calf suckling, while beneficial for calf health, may underestimate lactation yields and reduce milk available for human consumption and sale. Reassessing suckling duration is necessary to balance calf welfare with economic outcomes. In order to improve income and dietary diversity, 89% of households turn milk into cottage cheese and butter during periods of high milk output. However, lean periods limit milk availability for processing, constraining economic benefits. Collaborative milk pooling among small-scale producers could ensure sufficient quantities for processing, improving income through stable product sales in distant markets. Regional extension services should prioritize comprehensive dairy management practices to enhance productivity across agroecologies.

Proactive adoption of sustainable practices, rather than reliance on provisional support, will empower farmers and strengthen agricultural systems in Dawuro.

Conflict of Interest

The authors declare no conflict of interest.

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