

# A survey of management practices and major diseases of dairy cattle in smallholdings in selected towns of Jimma zone, south-western Ethiopia

Belay Duguma

Department of Animal Sciences, College of Agriculture and Veterinary Medicine, Jimma University,  
PO Box 307, Jimma, Ethiopia. Email: [duguma2012@gmail.com](mailto:duguma2012@gmail.com)

## Abstract

**Context.** Smallholder dairy farming is becoming an important source of food, income and employment for many urban dwellers in Ethiopia. However, suboptimal productivity is a major constraint due to diseases and poor management practices.

**Aims.** The present work aimed at assessing management practices, dairy cattle diseases, and methods used by farmers to identify diseases on smallholdings in selected towns of Jimma zone, south-western Ethiopia.

**Methods.** Data for the study were obtained by surveying 52 dairy-keeping farmers by using a semi-structured questionnaire and personal observations.

**Key results.** The mean herd size of indigenous and crossbred cattle was  $5 \pm 0.04$  and  $2 \pm 0.4$  respectively. Natural pasture was the main source of feed with supplementation, mainly with agro-industrial by-products, concentrate mixes, non-conventional feeds and crop residues. In total, 75% of the respondents practiced a free-grazing system. Most (64%) of the respondents used natural service for breeding. In all, 64% and 35% of the respondents washed their hands and the teats respectively, before milking. In the order of decreasing percentage of respondents, the most frequently reported dairy cattle health problems were tick infestation, mastitis, lumpy skin disease, blackleg, heart water, fascioliasis, trypanosomiasis, foot-and-mouth disease, pasteurellosis, brucellosis and anthrax. Repeated breeding, retained fetal membranes, abortion, stillbirths and dystocia were the common reproductive health problems, in a decreasing order of the reported percentage. Lumpy skin disease was reported as a major cause of calf and lactating-cow deaths. A total of 89% of the respondents used veterinary medicines to treat their sick animals. About 24% of the respondents stated culling of their animals due to old age, lack of space, infertility, feed shortage, need for cash and low production, in a decreasing order of importance.

**Conclusions.** The results showed farmers are well knowledgeable in cattle production practices and are actually mitigating effects of most disease challenges in their farms, which may have resulted in low milk productivity.

**Implications.** The farmers in the current study had some knowledge of milk production activities that may be recommended for similar settings, especially on how to manage dairy cattle production under smallholder farms, obviously including the occurrence of diseases, which they are managing appropriately with available technologies including vaccines and treatment. These could be used as baseline data by dairy stakeholders and policy makers during the formulation and implementation of policies for sustainable growth and development of smallholder dairy for similar settings.

**Additional keywords:** culling, grazing system, parasite, reproductive health problems.

Received 11 February 2019, accepted 13 April 2020, published online 4 June 2020

## Introduction

Ethiopia is endowed with the largest livestock population in Africa (Solomon *et al.* 2003; CSA 2013) and the sector contributes ~17% to the gross domestic product (GDP) and ~36% to the agricultural GDP (Metaferia *et al.* 2011), and provides a livelihood for 65% of the population. The cattle population of Ethiopia is estimated at 57.83 million head, of which 55.48% are females, and ~98.66% are of traditional Zebu breed (CSA 2016). In Ethiopia, smallholder dairying

contributes about 16.5% of the national Gross Domestic Product (GDP) and 35.6% of the agricultural GDP (Metaferia *et al.* 2011). It also contributes 15% of export earnings and 30% of agricultural employment (Behnke 2010).

Despite the large dairy cattle population, its economic benefit and productivity have remained low due to several constraints such as the shortage of feed both in quantity and quality, poor genetic potential of the traditional animals, prevalent diseases and parasites, inadequate management

practices, lack of appropriate health services and technological support (CSA 2008; Belay *et al.* 2011). Among these constraints, disease is the most important, and responsible for reducing both numbers and productivity of animals (Solomon *et al.* 2003; Negassa *et al.* 2011).

Diseases have many negative impacts on production and productivity of dairy cattle, imposing significant economic losses resulting from mortality, morbidity, loss of weight, poor growth rate, and poor fertility and reduced animal draft power. In Ethiopia, an estimated loss due to animal diseases for the 2014–2015 fiscal year was 3.23 million cattle, 4.37 million sheep, 4.90 million goats, 18 231 camels and 41 195 chickens (CSA 2016). In Africa, Ethiopia ranks second only to Nigeria in the health burden of zoonotic diseases (Grace *et al.* 2012).

Among the most common diseases affecting cattle production and productivity in Ethiopia are anthrax, blackleg, brucellosis, contagious bovine pleuropneumonia, cowdriosis, foot-and-mouth disease, internal and external parasites, mastitis, pasteurellosis and trypanosomiasis, and reproductive health problems are widely distributed in different regions of the country, and are major constraints to livestock production in general, and dairy farming in particular (Ashenafi 2016; Dereje *et al.* 2018; Welay *et al.* 2018; Mebrahtu *et al.* 2018; Tedla and Gebreselassie 2018). Poor nutritional status, inadequate management practices, livestock movement and climatic conditions have been identified as reasons for a high prevalence of cattle diseases in Ethiopia (Berhanu 2002). A mortality of 8–10% has been reported for the indigenous cattle in Ethiopia (MoARD 2007).

Determination of farm management practices is of paramount importance when evaluating the epidemiology of livestock diseases (Thrusfield 1996) and farm profitability (Simianer *et al.* 1991). It is also reported that considerable financial losses in the livestock sector are associated with diseases and inefficient management (Simianer *et al.* 1991). Poor hygiene of the animals and the environment is considered one of the leading predisposing factors for infectious diseases in dairy farms (Bramley and McKinnon 1990). According to Sharma and Baldock (1999), infectious diseases in dairy animals lead to reduced animal productivity, food insecurity, and loss of trade and decreased economic gains from the enterprises.

Research that can elucidate major animal health problems is a central issue for further epidemiological studies on livestock diseases (Damte 2003) and knowing the common and/or the major health problems is essential to dairy cattle owners, researchers and veterinarians, and can assist in the development of herd health strategies and the selection of possible interventions (Radostits *et al.* 1994). This task involves identifying major cattle diseases, existing traditional knowledge and traditional medicines and health interventions (Benin *et al.* 2002).

Inefficient management practices and diseases cause considerable economic losses in livestock farming. Animal health management, including provision of good quality nutritious feed, clean water, comfortable clean environment and reliable veterinary services, is essential for increased animal productivity because it reduces animal morbidity and mortality, and for safeguarding public health by reducing

exposure to zoonotic pathogens (Hardarson 2002). However, current information on dairy cattle diseases and management practices in the present study area are scarce. The findings will help address the current information gap, so as to design and implement appropriate disease prevention and control strategies and improve management practices to enhance health and productivity of dairy cattle. The aim of the present study was to assess management practices and the main dairy cattle health problems in smallholdings in selected towns of Jimma zone, south-western Ethiopia.

## Materials and methods

### Study site

The present survey was conducted in the capital towns (namely, Agaro, Seka, Sheki, Serbo and Yebu) of the five districts of the Jimma zone, Oromia Regional State, Ethiopia. Jimma zone is 352 km south-west of Addis Ababa, the capital of Ethiopia. The locations of the towns are as follows: Agaro, 7°40'N–8°04'N, 36°17'E–36°46'E; Seka, 7°17'N–7°44'N, 36°17'–36°42'E; Sheki, 7°13'N–8°39'N, 36°43'E–37°12'E; Serbo, 7°35'N–8°00'N, 36°46'E–37°14'E; and Yebu, 7°38'N–7°54'N, 36°38'E–36°53'E. The altitude of the areas ranges from 880 to 2660 m above sea level. The Agaro, Seka, Sheki, Serbo and Yebu towns are located ~45, 18, 23, 23 and 22 km from the Jimma town, capital of the Jimma zone. The average annual rainfall ranges from 1400 to 1900 mm. The average annual minimum and maximum temperatures are 7°C and 31°C (Alemu *et al.* 2011). Mixed crop–livestock is the predominant production system in Jimma zone. In Jimma zone, the main livestock species include local Zebu cattle, goats, sheep, equines and poultry, with cattle being the predominant species, and the main crop types include maize, sorghum, teff (*Eragrostis teff*), barley, wheat and pulses, while coffee is the major cash crop.

### Study design and sampling procedures

A cross-sectional survey design was employed for the study. The five study towns were purposely selected on the basis of their high potential for dairy production. The study population was all households in the five towns who keep dairy cattle. A list of all households keeping dairy cattle was obtained from the Livestock and Fisheries Resources Development Agency Offices (LFRDAO) of the respective districts. Thus, the dairy cattle producers in the five towns were 151 households in total. The study units for this study were dairy farmers who owned one or more indigenous (*Bos indicus*), crossbred (indigenous × Holstein–Friesian) or both breeds of cattle during the study. Finally, 52 households (respondents), in total, were randomly selected, proportionally for the sampling frame of each district, by using a simple random-sampling method. Accordingly, 18 households in Agaro, six in Yebu, four in Sheki, 12 in Serbo and 12 in Seka town were selected for the interview. Before the interview, respondents who were willing to participate were informed of the content and purpose of the study and assured that their participation was voluntary and their identity would be kept confidential and a verbal consent was obtained from each respondent.

### Methods of data collection

Data were collected through face-to-face interviews by using semi-structured questionnaires. The questionnaire was developed in English and translated by the author into the local language (Afaan Oromo) and the interviews were conducted in the local language. The translated questionnaire was pre-tested on 15 respondents from within the five towns, but who were not included within the final study. The pre-tested questionnaires were reviewed and modified accordingly for the actual data collection. Those questions that were not clear to the farmers were restructured and restated. To avoid bias among interviews and to validate the accuracy of the information, the questionnaires were administered by the author who spoke and understood the language of respondents, with support from staff of veterinary and livestock production of the respective districts. To understand farmers' traditional knowledge of diseases, the farmers were asked to list the names of dairy cattle diseases in the local language (Afaan Oromo). The names were then translated into English with the help of either the local veterinarian or animal health assistant who were fluent in the local language and knowledgeable about the epidemiology of diseases in the area and their identification. A comprehensive probing of the farmers on the local names, symptoms and time of the year when disease is common was listed in 'Afaan Oromo' before final translation into English names was undertaken. Local veterinary personnel at a district level were present throughout the interviews to assist in the verification of disease translation and occurrence of the diseases mentioned in the area. The questionnaire gathered

information on demographic data of respondents (age, sex, marital status, educational level, main occupation, farming experience and family size), cattle breed and herd sizes, the most common dairy cattle diseases, management practices (feeding, breeding, housing, water sources), calf-rearing practices, animals died in the past 12 months before the interview date, causes of cattle deaths, reasons for culling, milking procedures and pre-milking hygienic practices, access to animal health services, disease treatment options, sources of labour, distance to river point, record keeping, and farmers' knowledge of disease identification. Cattle housing condition on all farms was visually inspected with the aid of a checklist to assess the drainage (present or not), hygiene (accumulation of slurry, animals soiled with dung), ventilation (present or not), and space (adequate or small for easily lying down, rising or movement) categorised as good, satisfactory and poor.

### Statistical analyses

Questionnaire data were coded and analysed using SPSS software (Statistical Package for Social Sciences for Windows, version 16; BI Survey Tips, Chicago, IL, USA) to generate descriptive statistics for the variables. Descriptive statistics, such as means, percentages and standard errors of the mean were used to present the results.

## Results

### Demographic characteristics of respondents

Table 1 shows the demographic data of the respondents. All the selected respondents took part in the study. Of these, 87%

**Table 1. Demographic characteristics of 52 dairy cattle owners who participated in a survey on management practices and dairy cattle diseases in selected towns of Jimma zone, south-western Ethiopia (% of responses in each town and overall)**

Variable	Study town					Overall
	Agaro (n = 18)	Yebu (n = 6)	Sheki (n = 4)	Serbo (n = 12)	Seka (n = 12)	
Age (mean ± s.e.)	54.28 ± 2.91	41.50 ± 4.74	40.24 ± 4.17	47.17 ± 2.33	42.83 ± 3.85	47.44 ± 1.70
Family size (mean ± s.e.)	6.11 ± 2.35	4.33 ± 1.37	6.75 ± 2.63	6.50 ± 3.15	5.33 ± 2.84	5.86 ± 0.36
<i>Gender (%)</i>						
Male	77.8	100	100	83.3	75.0	87.2
Female	22.2	0.0	0.0	16.7	25.0	12.8
<i>Education level (%)</i>						
Illiterate	27.8	16.7	0.0	16.7	16.7	15.5
Primary school	38.9	16.7	50.0	25.0	16.7	29.5
Junior secondary school	16.7	50.0	50.0	16.7	25.0	31.7
Senior secondary school	11.1	16.7	0.0	16.7	41.7	17.2
College	5.5	0.0	0.0	16.7	0.0	4.4
University	0.0	0.0	0.0	8.3	0.0	1.7
<i>Main occupation (%)</i>						
Trade	22.2	16.7	25.0	16.7	16.7	19.4
Civil servant	16.7	0.0	0.0	25.0	16.7	11.7
Retired officer	5.5	0.0	0.0	8.3	0.0	2.8
Only dairying	33.3	16.7	0.0	0.0	8.3	11.7
Mixed farming	22.2	50.0	50.0	8.3	33.3	32.7
Housewife	0.0	0.0	0.0	0.0	25	5.0
Student	0.0	16.7	25.0	0.0	41.7	16.7
<i>Dairy farming experience (%)</i>						
<5 years	0.0	16.7	0.0	8.3	0.0	5.0
6–10 years	0.0	0.0	0.0	0.0	8.33	1.7
>10 years	100	83.3	100	91.7	91.7	93.3

were male and 13% were female. The mean age and family size of the respondents was  $47 \pm 1.70$  years and  $6 \pm 0.36$  persons respectively. The majority (55%) of the respondents had above primary school education, whereas 15% were illiterate. About 12% of the respondents were engaged in dairying on a full-time basis, while 88% of the farmers were engaged in various livelihood activities besides dairying. The majority (93%) of the respondents had more than 10 years of experience in dairy farming.

#### *Herd size, feed resources and feeding practices*

Indigenous zebu cattle were the predominant breed kept for milk production by the respondents, along with a few crossbred (Holstein–Friesian  $\times$  indigenous zebu) cattle. The average herd size of the indigenous and crossbred cattle per household was  $5.0 \pm 0.04$  and  $2.0 \pm 0.4$  respectively. Milk production was mainly for home consumption, followed by a source of income from milk sales.

Multiple responses were assumed, 92% of the respondents reported that natural pasture was the major dairy cattle feed resource, followed by hay (36%), crop residue (32%) and cut-and-carry grass (29%). According to the respondents, although natural pasture was the main source of feed used all year-round, its availability and quality declined in the dry season, resulting in poor performance and loss of animal condition. Hay and crop residues were mainly used during the dry season as a coping strategy to the low availability of natural pasture. Multiple answers were assumed, with commercial concentrate mix (18% of the respondents), nougseed cake (5%), wheat bran (24%), brewery spent (2%) and non-conventional feeds (4%) all being used to supplement lactating cows. The majority (82%) of respondents mentioned that lack of capital prevented them from feeding concentrates to their lactating cows. The only mineral supplement used was common salt (100%), which respondents perceived to increase milk yield. It was observed that 74%, 12%, 12% and 2% of the respondents practiced free grazing, zero-grazing, partial grazing and a combination of zero- and free grazing respectively. Under the free-grazing system, animals were released for grazing about 0800 hours after morning milking and brought back to the sheds about 1700–1800 hours local time.

#### *Housing management*

In the present study, all respondents provided permanent closed housing for their animals. The roofs of the housing were made of corrugated iron sheet (85%) and grass thatch (15%), while walls were made of wood plastered with mud (100%). Overall, 59%, 17%, 12%, 9% 2% of the cattle sheds had wooden, earthen, concrete, stone and brick floors respectively. In all, 78% of the farmers housed their animals only at night; the remaining 22% housed their crossbred animals all the time. None of the respondents used bedding for either calves or adult animals. All of the animals were housed together, except calves, which were housed in the family dwelling. On the basis of visual observations, the cattle houses were assessed to be

suboptimal with poor ventilation, poor hygiene and drainage facility, and inadequate space. Most of the farmers (88%) reported that removal of dung and cleaning of the cattle housing was undertaken once a day, but our observational findings proved that the majority of cattle houses were of poor hygiene (dirty). The remaining respondents (9%) indicated that they cleaned cattle sheds more than twice a day. On the basis of the observational findings and subjective scoring, cattle housing hygiene was judged to be good in 24% of houses, satisfactory in 15% and poor in 61%. With regard to space, 23%, 14% and 63% were assessed as adequate, satisfactory and inadequate respectively. About 4%, 6% and 90% of the housing drainages were rated as good, satisfactory and poor respectively.

With regard to manure disposal and utilisation, all respondents removed manure by hand. Majority (71%) of the respondents indicated that they piled the manure at the residential backyard, whereas 18%, 6%, 3% and 2% disposed of the manure on open fields (environment), piled it near cattle shed, stored it in pit and both at open field and backyard respectively. About 41%, 27%, 18% and 2% of the respondents indicated that they used manure as a fertiliser, fuel and fertiliser, fuel, and for biogas production respectively, while the remaining respondents (12%) indicated that they did not use manure at all.

#### *Breeding practices*

With regard to the breeding method, 64%, 11% and 25% of the respondents indicated that they used natural service, artificial insemination (AI) and both AI and natural services respectively. The AI service was provided only by the government. All bull mating of cows (100%) was uncontrolled, and none of the respondent selected the best bull for breeding purpose.

#### *Calf rearing practices*

All respondents (100%) reported that calves fed colostrum within 1–2 h after birth by suckling (100%) their dam freely. All of the respondents reported that they did not milk cows until 2 weeks after parturition and allowed calves to freely suckle their dam to ensure that the calves get sufficient milk for increased growth. A total of 86% of the respondents indicated that after 2 weeks after birth, calves were separated from their dams and subjected to partial suckling twice a day before and after milking until they were weaned, while the remaining 5% and 9% indicated that they practiced only partial suckling before milking and bucket feeding respectively. All respondents indicated that calves fed milk twice daily. Natural grass was offered to the calves from about the third week after birth. Concentrate supplementation and vaccination of calves was not practiced by any of the respondents. In total, 93% and 7% of the respondents used natural and forced separation to wean calves respectively. The respondents indicated that calves were weaned at  $\sim 8.40 \pm 0.34$  months of age due to the fact that they are used to stimulate milk letdown until cessation of lactation.

### Milking procedures and hygienic practices

All respondents (100%) indicated that lactating cows were milked by hand, twice a day, in the morning and evening. With respect to pre-milking hygiene, 64%, 35% and 100% of the respondents indicated that they washed their hands, the teats and milking containers respectively, before milking. The respondents who did not clean the teats before milking believed (perceived) that the calves cleaned the teat during suckling for stimulation of milk letdown before milking. None of the respondents practiced pre- and post-milking teat dipping into anti-germ solution, fore-milking quarters to check for milk abnormalities and the use of towel for udder drying after washing.

### Sources of water

Rivers (43% of the respondents), hand-dug wells (28%), tap (11%), tap and rivers (11%), rivers and wells (7%) and tap and wells (1.0%) were the sources of drinking water for the animals, whereas calves were watered at home. All respondents (100%) indicated that the frequency of watering cattle was once and twice a day during the rainy and dry seasons respectively. The mean distance to rivers from the homesteads was indicated to be  $\sim 0.89 \pm 0.07$  km.

### Record keeping and farm labour

Written farm records were not kept by 95% of the respondents, while very few (5%) indicated that they kept written record of daily milk yields. Despite the lack of written records, the respondents reported that they kept a mental record of their farm. The majority of respondents (85%) indicated that they depended on family labour to perform all farm activities, while 6% and 9% reported that they used hired labour and both family and hired labour respectively. Respondents who used hired labour indicated that herding (44%), watering animals

(43%), cleaning of sheds (25%), collecting fodder (23%), feeding animals (17%), washing animals (8%), collecting water (8%), milking (8%), selling of milk (6%) and taking care of sick animals (6%) were performed by hired labour, while the remaining percentages of these activities were performed by members of the household.

### Common diseases of dairy cattle

Table 2 presents the results of dairy cattle health problems as reported by respondents in the study area. According to the respondents, next to feed shortage, diseases and parasites were the most important constraints to dairy production and productivity in the area. The most common dairy cattle diseases and parasites as reported by the respondents (multiple responses were allowed) were tick infestations (79% of the respondents), mastitis (52%), lumpy skin disease (LSD, 38%), blackleg (35%), heart water (23%), facioliasis (22%), trypanosomiasis (8%), foot-and-mouth disease (6%), bovine pasteurellosis, (5%), brucellosis (2%) and anthrax (2%), in that order of importance. Repeated breeder (14%), retained fetal membrane (12%), abortion (11%), stillbirths (8%) and dystocia (6%) were reported as the major reproductive health problems.

### Dairy cattle deaths

On average,  $0.31 \pm 0.10$  calves,  $1.0 \pm 0.05$  heifers,  $0.13 \pm 0.05$  milking cows,  $0.02 \pm 0.02$  dry cows and  $0.02 \pm 0.02$  bulls had died per household in the 12 months before the present survey. The total number of calves, lactating cows, heifers, dry cows and bulls that had died in the past year was 13, 8, 5, 1 and 1 respectively.

### Causes of cattle death

The study showed that LSD (18.3% of respondents), unknown reasons (8%), heart water (3%) and ingesting plastic bags (1%)

**Table 2.** Common dairy cattle diseases as reported by 52 dairy cattle owners participating in a survey on management practices and dairy cattle diseases in selected towns of Jimma zone, south-western Ethiopia (% of responses in each town and overall)

Scientific name of the disease <sup>A</sup>	Local name of the disease (in Afaan Oromo)	Study town					Overall
		Agaro	Yebu	Sheki	Serbo	Seka	
Tick infestation	Silmii	88.9	66.7	75.0	75.0	91.7	79.5
Mastitis	Dhukkuba Muchaa	44.4	16.7	100	33.3	75.0	53.8
Lumpy skin disease	Cittoo	16.7	100	25.0	25.0	25.0	38.3
Blackleg	Abbaa Gorbaa	0.0	26.8	25.0	66.7	58.3	35.4
Heart water	–	50.0	16.7	25.0	50.0	25.0	23.3
Faciolosis	Raammoo Tiruu	0.0	0.0	25.0	66.7	16.7	21.7
Trypanosomiasis	Sinchii	5.5	0.0	0.0	8.3	25.0	7.8
Foot-and-mouth disease	Maasaa	22.2	0.0	0.0	0.0	8.3	6.1
Pasteurellosis	Gororsaa	0.0	0.0	0.0	16.7	8.3	5.0
Brucellosis	Gatachisaa	11.1	0.0	0.0	0.0	0.0	2.2
Anthrax	Abbaa Sangaa	0.0	0.0	0.0	0.0	8.3	1.7
Reproductive health problems							
Repeated breeder	–	5.5	16.7	50.0	0.0	0.0	14.4
Retained fetal membrane	–	0.0	0.0	50.0	8.3	0.0	11.7
Abortion	Gatachiisaa	11.1	16.7	0	16.7	8.3	10.6
Stillbirth	Jabbii du'aa dhaluu	5.5	0.0	25.0	0.0	8.3	7.8
Dystocia	–	11.1	16.7	0.0	0.0	0.0	5.6

<sup>A</sup>Multiple responses possible.

were the most common reasons of death of calves in the previous year. Lumpy skin disease, unknown reasons and milk fever were the main causes of death of lactating cows, accounting for 13%, 4% and 1% respectively. About 18% and 13% of the respondents reported that LSD was the most common cause of calf and lactating-cow losses respectively. Blackleg (2%), unknown reasons (5%) and plastic ingestion (1%) were indicated as the most common causes of death of heifers, whereas heart water (2%) and plastic ingestion (1%) were the main causes of mortality of dry cow and bull.

#### Reasons for culling

Over all respondents interviewed, 24% reported culling of one or more of their animals in the 12 months before the survey, with an overall average culling being  $2.0 \pm 0.31$  animals per household. The main reasons given for culling were old age (6%), lack of space (6%), infertility (2%), feed shortage (3%), need for cash (5%), and low milk production (2%).

#### Access of veterinary services and disease treatment options

All respondents (100%) reported that animal health services were exclusively provided by the government animal health centres located in the respective towns. The main services provided were diagnosis, treatment, vaccination and veterinary drugs. The services were provided by government veterinarians, animal-health assistants and veterinary technicians. Farmers also reported purchasing veterinary drugs not prescribed by veterinarian, from private veterinary pharmacies.

Regarding disease treatment options, 89% and 11% of the respondents used veterinary medicines and a combination of traditional and veterinary medicines respectively, for the treatment of their sick animals. Eleven per cent of the respondents indicated that high cost of veterinary drugs and financial limitations were the main reasons for using herbal remedies versus veterinary medications. Isolating sick

animals from healthy herds, using disinfectant to clean cattle sheds and written health and treatment records were not reported by any of the respondents.

#### Farmers' knowledge of diseases

Table 3 summarises farmers' knowledge of common dairy cattle diseases. The results of the study showed that majority of the respondents had good knowledge of common diseases, and were able to describe diseases by their vernacular name, clinical signs and parts of the body affected. They mentioned that the observation of distinct clinical signs was the primary method used to identify a particular disease of dairy cattle. For example, respondents identified clinical mastitis (*Dhukkuba muchaa*) by visual observations of swollen quarter(s), pain when touched, decreased milk yield, abnormal milk and decreased appetite, while anthrax was recognised by the sudden death of the animal and dark blood (*dhiigaa gurraachaa*) from body orifices. As for trypanosomiasis (*sinchii*), respondents stated that it was caused by biting flies (*Titiisaa gammoojii*), that is, tsetse fly. Farmers recognised it by symptoms of emaciation (loss of condition), reduced milk production and draught power and death. No local name was mentioned for heart water, but farmers described it by its particular clinical sign, *lafaan mara* (move in circling).

#### Discussion

The present study is the first to assess the management practices and dairy cattle diseases among the smallholdings in the selected towns of Jimma zone, south-western Ethiopia. It has provided valuable insight and baseline data to better understand the management practices and dairy cattle diseases for conducting priority-based research that enhances smallholder dairy production in the study area. The results would also be vital in formulating policies for implementing dairy cattle development interventions. The study was conducted using data-collection instruments, such as a questionnaire and

**Table 3. Farmers' knowledge of disease identification as reported by 52 dairy cattle owners participating in a survey on dairy cattle diseases and management practices in selected towns of Jimma zone, south-western Ethiopia**

English name	Local name (in Afaan Oromoo)	Symptoms reported by the farmer
Anthrax	Abba Sangaa	Suddenddeath, dark blood ( <i>dhiigaa gurraachaa</i> ) oozes from body orifices
Brucellosis	Gatachiisaa	Abortion
Blackleg	Abbaa Gorbaa	Swelling of limbs ( <i>miilla dhiiteessa</i> ), loss of appetite, lameness ( <i>ni okolsisa</i> )
Foot-and-mouth disease	Maasaa	Rapid breathing ( <i>hargansiisa</i> ), sores ( <i>madaa</i> ) between the hooves, in the mouth on the lips and tongue, lameness ( <i>okolsiisa</i> ), salivation ( <i>gorora yaasa</i> ), spreads fast
Heartwater	Bishaan onnee	Reduced appetite, moves in circles ( <i>lafaan mara</i> ) or difficulty standing, white foam from mouth, and tears from eyes, bloody diarrhoea, and moving tongue in and out
Lumpy skin disease	Citteessa	Multiple lumps and nodules ( <i>cittoo</i> ) on skin, eye and nasal discharge, fatal ( <i>ni ajjeesa</i> ), rapid spread, affects both young and adult animals
Mastitis	Dhukkuba muchaa	Swollen quarter (s) ( <i>muchaa dhiiteessa</i> ), milk with blood ( <i>aannan dhiigaa makata</i> ), pain when touched, causes blind teats, reduced milk yield
Pasteurellosis	Gororsaa	Salivation ( <i>gororsiisa</i> ), cough, eye and nasal discharge, rapid breathing ( <i>argansiisa</i> , <i>afuura kuta</i> ), kills within one week
Facioliasis	RaamooTtiruu	Loss of appetite, emaciation ( <i>ni huuqata</i> ), white worms in faeces, cough ( <i>ni qufaasisa</i> )
Tick	Silmii	Emaciation ( <i>ni huuqisa</i> ), anaemia ( <i>dhiiga xuuxa</i> )
Trypanosomiasis	Sinchii	Caused by tsetse flies ( <i>titiisa gammoojii</i> ), emaciation (loss of condition), anaemia ( <i>dhiiga xuuxa</i> ), fatal ( <i>ni ajjeesa</i> )

personal observations. Thus, the study has some limitations in its data-collection tools as the used tools have limitations of their own. Many of the data reported here relied on farmer recall and perception, used a low sample size, and the use of household questionnaire alone; so, caution should be applied in interpreting the results, because it is possible that farmers could have either under- or over-reported, which are, of course, common limitations for a survey of this type.

#### *Respondents' demographic characteristics*

The respondents engaged in dairy farming most likely were not youths due to resource limitations. Belay *et al.* (2011) reported an average age of  $51.26 \pm 10.99$  years for smallholder dairy producers in Jimma town, Ethiopia, which is higher than the findings in our survey. The average family size reported in the current study was lower than was observed by Haile *et al.* (2012) who reported  $7.1 \pm 0.22$  persons per household among smallholder dairy producers in Hawassa town. In the present study, the fact that the majority of the respondents were male is consistent with what has been previously reported (Yitaye *et al.* 2007). In the present study, the small proportion of women involved in dairy farming suggests resource limitations as men tend to have the primary decision power in Ethiopian households.

The fact that the majority of the respondents had higher than primary school education corroborates earlier findings (Gillah *et al.* 2013). Indeed, education is an important factor for improving the adoption rate of new technologies that can positively affect the future improvement of dairy production, and has been shown to increase the rate of adoption of new technology in farming households (Umoh 2006). The main occupation of the respondents was in agreement with the findings of Haile *et al.* (2012), who indicated that most dairy producers in Hawassa town had other occupations besides dairy farming. The study showed that people with different occupational and economic background undertook dairy farming for home consumption of milk and as source of supplementary income from milk sales that were used to meet costs of various expenses. This implies that smallholder dairy farming in the study area has a potential for improving the welfare of respondents and could contribute towards poverty alleviation.

#### *Breed of cattle, herd size and feeding management*

Respondents in the present study kept both indigenous and crossbred (indigenous  $\times$  Holstein–Friesian of unknown percentage of genetic composition) cattle for milk production. This agrees with the results of previous studies (Ngongoni *et al.* 2006; Yilma *et al.* 2006). The average herd size of local breed in the current study was lower than that reported by Asaminew and Eyasu (2009). However, the average herd size of crossbred cattle was higher (Ngongoni *et al.* 2006; Yilma *et al.* 2006) or lower (Haile *et al.* 2012; Fon Tebug *et al.* 2012; Gillah *et al.* 2013) than what has been reported previously. The major reasons for keeping more local breed than crossbred cattle in the present study was the lack of and/or inadequate AI services, high cost of improved breeds and shortage of feed. This requires due attention to improve

access to AI for crossbreeding of local breed and to alleviate the shortage of breeding bulls. The average herd size per household was found to be rather high in relation to the space available for housing due to lack of space for any further expansion. From our observations, the trend of the current herd size will likely tend to decrease due to the diminishing area of communal grazing lands as more land is used for housing and public infrastructure development across the towns, exacerbating feed scarcity due to difficulties of feed availability. Consequentially, this is of great concern for sustainable dairy production and development in the area.

The fact that natural pasture formed the major feed resource for dairy cattle in the present study is consistent with what has been previously reported (Asaminew and Eyasu 2009; Haile *et al.* 2012; Gillah *et al.* 2013). However, the major challenge in depending on natural pasture is its seasonal variation in quality and quantity (Okello and Sabiiti 2006), particularly in the dry season. This could result in low productivity, deterioration in body condition and susceptibility to diseases. The finding of the present study that common salt was the only mineral supplement used concurs with the observation of Diriba *et al.* (2014) among smallholder urban dairy farmers in Bako and Nekemte towns in Ethiopia.

All respondents who kept local lactating cows indicated that they do not give conventional concentrate as a supplement to their lactating cows due to lack of capital. However, they used non-conventional feeds such as *atela* and *bulule* to compensate for conventional-concentrate supplementation. Mtengeti *et al.* (2008) also indicated that lack of protein supplement could be due to scarcity and/or high price. According to Asaminew and Eyasu (2009), in view of the high costs of concentrates, use of *atela* might be a viable alternative; however, its effect on milk yield and composition deserves investigation. In general, scarcity of natural pasture in quality and quantity, especially in the dry season, high cost of concentrates, lack of knowledge and skill on how best to utilise locally available feed sources and lack of land for forage production are the major constraints observed with regard to feed in the study area. Therefore, so as to ensure stable milk production, farmers should ensure year-round feed availability through adopting alternative supplementary-feeding strategies, such as using urea molasses mineral blocks, and efficient utilisation of the locally available cheap feed resources such as crop residues and potential non-conventional feed resources, particularly, *atela*, enset leaf and khat (*Catha edulis*) leftovers as a supplementary feeds to natural pasture. The crude protein contents of *atela*, enset leaf and khat leftovers is 21.4%, 13.12% and 12.6% respectively, as reported by Ajebu *et al.* (2012) and Mekasha *et al.* (2007). Thus, these unconventional feeds could be used as a good source of protein for improving health and productivity of dairy cattle in the study area. The fact that free-grazing was the most common management system practiced among the respondents is inconsistent with earlier observations (Gillah *et al.* 2013). However, the practice of year-round free-grazing could lead to overgrazing of the natural pasture, poor productivity of cattle and transmission of infectious diseases due to a greater chance of contact between sick and healthy herds. This

requires serious attention in terms of cattle health and sustainability of grazing lands.

#### *Housing management*

Cattle sheds are, in general, poorly and improperly constructed. From the observational assessment, majority of cattle sheds had inadequate space compared with the 6.7-m<sup>2</sup> standard space required per dairy animal (FAO 1998). From our observational subjective assessment, the size of the floor did not match the number of animals housed for sleeping, rising and movement. Similarly, high stocking densities in urban dairy farms in Nairobi, Kenya (Aleri *et al.* 2011), has been reported, where two or three cattle are housed in 4 m<sup>2</sup>. The drainage, space and hygienic conditions of cattle houses in the present study were, in general, found to be poor on many cattle sheds, particularly in zero-grazing systems for cleaning and manure handling. These findings concur with the results of previous observations (Kivaria *et al.* 2006; Mekonnen *et al.* 2006; Mureda and Zeleke 2008; Gillah *et al.* 2012), namely, lack of well-designed cattle sheds in urban and peri-urban dairy farms in East Africa. Generally, the housing structures in the majority of the farms were not ideal and could affect the health and welfare of the animals. Therefore, dairy farmers should be educated on the importance of having properly constructed cattle sheds using locally available low-cost materials to allow free resting, rising and movement of animals with no or minimum negative effects. Poor cattle-shed design decreases the productivity of the dairy cow (Kassa 2003) and predisposes them to various body injuries and diseases (Aleri *et al.* 2011).

The study observed that a lack of poor drainage system (gutter), high stocking density (overcrowding), earthen and flat floor, and a lack of bedding materials were the main factors that attributed to the problem of maintaining good hygienic condition of the floors. None of the respondents reported using disinfectant for cleaning floors. Lack of proper manure disposal was also one of the major problems for the poor hygiene of floors. Lupindu *et al.* (2012), in their study, claimed that there is a high risk of contracting zoonotic diseases as a result of improper handling of animal manure. Thus, providing technical support to the farmers on the efficient use of manure would be of valuable importance. In the present study, the housing of animals in a group could increase the transmission of infectious diseases because respondents did not practice separation of sick animals due to a lack of separate sheds, and this would deserve attention.

#### *Breeding practices*

The predominant use of the natural service for breeding reported here is consistent with the findings of Gillah *et al.* (2012). Even though natural mating was the common method of breeding, the majority of the respondents had no breeding bull within their own herd, and relied on any bull available for mating when their cows were on heat. The main reason for relying only on natural service in Seka and Sheki towns was the lack of access to AI service. Thus, there is a need to improve access to AI service by the government or to encourage private sector engagement in AI service to

improve fertility of breeding cows. Those respondents who used AI service complained about its lower conception rates. The respondents did not have a specific season set for breeding their cows and calving occurred throughout the year due to uncontrolled mating that took place during communal grazing. Thus, parturition during the critical periods of feed shortage could affect the performance of the calf and the dam.

#### *Calf-rearing practices*

In the present study, calves were fed colostrum within a stipulated time after birth. Kehoe *et al.* (2007) indicated that the time from calving to the intake of colostrum is a factor that correlates negatively with the transfer of passive immunity for calves, because the greater the time interval, the lower the efficiency of the absorption of immunoglobulin. In the first 6 h of life, the macromolecules that arrive in the intestine are absorbed intact without undergoing denaturation. However, with an increasing age, the efficiency of absorption decreases, being greatly reduced 16–18 h after calving, with no absorption occurring after 24 h (Johnson *et al.* 2007; Godden 2008). The practice of feeding calves reported in the present study is in agreement with the results of previous studies (Asaminew and Eyasu 2009; Chang'a *et al.* 2010). The majority of the respondents practiced restricted suckling of calf feeding of milk before and after milking until weaning. Residual calf suckling has the advantage of reducing contamination, feeding of cold milk to the calf and incidence of mastitis (Mdegela *et al.* 2004), and suckling exploits the maximum milk potential of the cows, increases milk yield, and results in good calf growth, low mastitis incidence and low calf mortality (Mejia *et al.* 1998; Yilma *et al.* 2006).

#### *Milking procedures and hygienic practices*

The milking procedure and hygienic practices reported in the current study are in agreement with the findings of previous studies (Asaminew and Eyasu 2009; Belay and Geert 2015). In the current study, hygiene around milking varied among respondents, whereby 35.6% and 64.6% did not practice washing their hands and teats before milking. Thus, promoting hand washing and teat cleaning before milking, together with other good hygienic practices, would be important to ensure good milk quality. The lack of practice of teat dipping after milking to avoid infection reported in the present study is consistent with the findings of Lencho and Seblewongel (2018). Getachew (2003) reported that the production of milk of good quality requires good hygienic practices, such as clean milking utensils, washing hands, cleaning the udder and the use of individual towels and good handling before delivery to consumers or processors.

#### *Farmers' reported diseases of dairy cattle*

Irrespective of the town, respondents reported a wide range of dairy cattle diseases such as infectious diseases (bacterial, protozoal and viral) and parasitic infestations to be endemic in the area. This finding is in agreement with the results of previous cross-sectional studies of cattle diseases (Zelalem *et al.* 2017; Dereje *et al.* 2018; Welay *et al.* 2018; Mebrahtu

*et al.* 2018) in different regions of Ethiopia, but with varying frequency of occurrence of the reported diseases. This variation could be attributed to the difference in the environment, level of husbandry and management practices and animal health services. Tick infestation, mastitis and LSD were mentioned as the three most important health problems frequently prevailing in the area. The high prevalence of ticks could be due to the warm and humid amiable climatic condition of the area, which favours the growth, survival and multiplication of ticks, and the lack of preventive measures and the practice of communal grazing practice on natural pasture, where the parasite can complete its cycle and poses a risk of transmission. Thus, effective preventive measures that farmers could apply are needed to mitigate tick infestations. During the farm visits, we observed that some farmers hand-picked ticks from their infested animals, while others smeared the infested body part of the animal with Malathion, cattle dung and kerosene oil as traditional preventive measure to ticks. This use of Malathion and kerosene oil could cause additional damage to hide or predispose the animals to infections, and thus deserves attention to reduce economic losses resulting from reduction of hide quality.

The high occurrence of mastitis reported in the present study is likely to be related to the poor standard of management practices such as poor housing hygiene, milking hygiene and veterinary care services (Blowey and Edmondson 2000; Tadele *et al.* 2015). During farm visits, the majority of the cattle sheds had inadequate space, poor hygiene, no drainage and concrete floors. This highlights the need for training farmers on best health-management practices that are simple, easily adoptable and economically rewarding, such as cow, housing, personal and milking hygiene, proper waste management, good biosecurity practices and provision of effective veterinary services to prevent and control mastitis, which, in turn, maintains good udder health, and improves milk yield and quality, and consumer health.

Lumpy skin disease (LSD) as being one of the most prevailing diseases of dairy cattle reported in the present survey corresponds to the results of previous studies (Oladele and Antwi 2013; Fasil and Juta 2016). The respondents indicated that LSD caused economic losses through morbidity and mortality, reduced milk yield, and the high cost of the treatment. The high occurrence of LSD in the current study might be attributed to the lack of regular vaccination and the practice of free-grazing on communal lands, resulting in a high contact rate of sick animals with healthy herds.

The reproductive health problem reported here is in agreement with the findings of Adane *et al.* (2014), albeit with varying magnitudes, in Hosanna. The reported occurrence of dystocia is almost similar to that for local and crossbred cows, but lower than that for exotic dairy cows in Jimma (Gashaw *et al.* 2011). Dystocia can cause hypoxia, significant acidosis, interfere with the absorption of colostrum, and reduce the survival of newborns (Lombard *et al.* 2007). The occurrence of abortion reported in the present study was higher than that reported by Degefa *et al.* (2011). This variation might be due to the difference in

management practices, nutritional status and access to animal health services. Mapekula *et al.* (2009) reported that cow abortions were attributed to poor nutrition and old age.

The occurrence of the reported diseases in the present study was expected due to different factors such as a lack of comprehensive prophylactic measures, limited access to veterinary services, high costs of vaccines and drugs, warm and humid climates of the area, and a lack of awareness on good dairy management practices. In addition, inadequate feed resources, and communal-grazing practice where sick and healthy animals graze together and pose risk of disease transmission could be the predisposing factors for the high prevailing disease and parasite incidences in the study area (Tadele *et al.* 2015; Dereje *et al.* 2018; Welay *et al.* 2018; Mebrahtu *et al.* 2018). Therefore, emphasis should be on preventive measures, including appropriate animal management practices, house or shed cleanliness, milking hygiene, comfortable clean environment, securing colostrum immunity for young animals and good-quality feeds (Payne and Wilson 1999; Hardarson 2002; Ezanno 2005; Algers *et al.* 2009). Undernourished animals have weak immunity and are more susceptible to diseases and parasites than are well conditioned animals. Moreover, a persistent need for training programs that promote best practices of disease prevention and control would be essential. To achieve this, an increased involvement of animal health professionals may be one way to improve farmer awareness.

#### *Causes of cattle deaths*

The results of the present study showed that diseases and unknown reasons were the main causes of cattle death. This was a direct reflection of disease management inefficiency and had a significant impact on the profitability of dairy farming. Lumpy skin disease was the most frequently reported cause of death of calves and lactating cows. This was confirmed by our observations during farm visits, of more lactating cows and calves being infected by LSD. Respondents indicated that in addition to loss of animals, LSD caused decreased milk production and a high treatment cost. The high number of deaths caused by LSD might be due to a lack of regular vaccination practices; thus, there is a need to educate farmers on the importance of vaccination against LSD. In the present study, the mortality of dairy cattle due to unknown reasons indicated by the respondents is in agreement with the findings of previous studies (Esslemont and Kossaibati 1997; Thomsen *et al.* 2004). This calls for further investigation of the unknown causes of animals deaths, so as to reduce mortality.

#### *Reasons for culling*

The main reasons for culling reported by respondents are in line with the result of previous studies (Mekonnen *et al.* 2006; Mureda and Zeleke 2008), showing that low production, feed shortage, health problems, financial requirements, space limitations and reproductive problems were the main reasons for culling. Old age was reported as the most common reason for culling, which is inconsistent with the

finding of Maryam *et al.* (2012) that reported infertility as the main reason for culling dairy animals.

#### Access to veterinary services and treatment options

The results of the present survey are in agreement with the observation of Diriba *et al.* (2014), which indicated that dairy producers in Bako and Nekemte towns obtained veterinary services from the government. In contrast, Tariku *et al.* (2015) indicated that 40%, 5% and 43% of clinical treatment, vaccination and drug sales respectively, were provided by private veterinary service providers, in Ada'a district, Ethiopia. This difference might be due to the fact that, in the present study area, there was no private veterinary services provider.

In agreement with the results of the present study, Birhanu *et al.* (2015) reported that most of the smallholder cattle farmers used veterinary medicine for the treatment of diseased animals in Kembata Tembaro, Ethiopia. Respondents who used traditional medicines mentioned that a lack of capital and a high cost of veterinary drugs were the main limiting factors for not using veterinary medicines, despite the fact that the costs of drugs from public veterinary services are subsidised by the government. The present study showed that sick animals were generally not isolated from the herd due to a lack of separate shelter and awareness. This deserves attention towards educating farmers to isolate their sick animals, so as to prevent the spread of infectious diseases. According to the respondents, they did not vaccinate their animals except when animals got sick or there was an outbreak of any infectious diseases in the area that was vaccinated by the government.

#### Farmers' knowledge of disease

In the current study, almost all respondents had a good knowledge of common dairy cattle diseases and parasites prevalent in the study area. All respondents recognised diseases by local name and by observation of clinical signs. This was due to the fact that the reported diseases and parasites are endemic and farmers have lived for a long time with the common cattle diseases in the area. Results of our study showed that the respondents' methods of disease identification through their vernacular language and clinical signs were relatively consistent with the clinical signs that veterinarians identified in disease diagnosis. These findings support those of previous studies (Regassa *et al.* 2006; Sikira *et al.* 2013), namely that farmers used local language names and clinical signs to identify diseases. Respondents indicated that when they noticed the clinical signs of a particular disease, they sought veterinary services or used traditional (herbal) remedies for treating their sick animals. This demonstrates that the interviewees had good traditional knowledge and understanding of common diseases, which is important to involve the community in epidemiological study and research-gap analysis. Hence, when planning disease-control strategies, farmers' traditional knowledge of diseases should be used in conjunction with the scientific methods as an entry point to develop and implement effective disease prevention and control strategies. Birhanu *et al.* (2015) reported that

traditional knowledge, complemented with participatory methods and approaches, allows community and field researchers to jointly study specific livestock problems and helps identify appropriate solutions.

#### Conclusions

It can be concluded from this survey that dairy cattle in the study area were kept under poor management practices and exposed to a wide range of infectious diseases and parasitic infestations. Therefore, the findings of the current study have highlighted the need for improved dairy production and disease management practices to enhance productivity of dairy cattle in the surveyed area. This should be through integrated approach that involves multiple dairy stakeholders, policymakers and, of course, the farmers. Moreover, further in-depth epidemiological studies would be required on the diseases perceived by farmers, so as to design and implement effective preventive and control measures.

#### Conflicts of interest

The author declares no conflicts of interest.

#### Acknowledgements

The author gratefully acknowledges the financial and logistics support from the VLIR-UOS Institutional University Cooperation (IUC-Jimma University). The author is grateful to all the dairy farmers who participated in the study for their valuable time and information. I also extend my gratitude to the animal health and production staff of the respective districts for their support during fieldwork.

#### References

- Adane H, Yisehak T, Niguse T (2014) Assessment of major reproductive disorders of dairy cattle in urban and per urban area of Hosanna, southern Ethiopia. *Animal and Veterinary Sciences* **2**, 135–141. doi:10.11648/j.avs.20140205.11
- Ajebu N, Gashahun B, Girma A (2012) On-farm evaluation of ensen (*Ensete ventricosum*) leaf supplementation on does' milk yield and composition and growth rates of their kids. *Ethiopian Journal of Applied Science and Technology* **3**, 1–8.
- Alemu A, Abebe GW, Golassa L (2011) Climatic variables and malaria transmission dynamics in Jimma town, south west Ethiopia. *Parasites and Vectors* **4**, 1–12. doi:10.1186/1756-3305-4-30
- Aleri JW, Nguhiu-Mwangi J, Mogoia EM (2011) Housing design as a predisposing factor for injuries and welfare in cattle within smallholder units in peri urban areas of Nairobi, Kenya. *Livestock Research for Rural Development* **23**, 53.
- Algers B, Blokhuis HJ, Bøtner A, Broom DM, Costa P, Domingo M, Greiner M, Hartung J, Koenen F, Müller-Graf C, Morton DB, Osterhaus A, Pfeiffer DU, Mohan R, Roberts R, Sanaa M, Salman M, Sharp JM, Vannier P, Wierup M (2009) Scientific opinion of the panel on animal health and welfare on a request from European commission on the overall effects of farming systems on dairy cow welfare and disease. *EFSA Journal* **1143**, 1–38.
- Asaminew T, Eyasu S (2009) Smallholder dairy system and emergency of dairy cooperatives in Bahir dar Zuria and Mecha Woredas, northern, Ethiopia. *World Journal of Dairy and Food Sciences* **4**, 185–192.
- Ashenafi FB (2016) 'Feed the future innovation lab for livestock systems Ethiopia': livestock disease management and food safety brief.' The Management Entity at The University of Florida.

- Behnke R (2010) The Contribution of Livestock to the Economies of IGAD Member States: Study Findings, Application of the Methodology in Ethiopia and Recommendations for Further Work. Livestock Policy Initiative (LPI) Working Paper, 45p.
- Belay D, Geert J (2015) Assessment of dairy farmers' hygienic milking practices and awareness of cattle and milk-borne zoonosis in Jimma, Ethiopia. *Food Science and Quality Management* **45**, 1–8.
- Belay D, Yisehak K, Geert J (2011) Analysis of constraints facing urban dairy farmers and gender responsibility in animal management in Jimma Town. *African Journal of Basic and Applied Sciences* **3**, 313–318.
- Benin S, Ehui S, Pender J (2002) 'Policies for livestock development in the Ethiopian Highlands'. Socioeconomic and Policy Research. Livestock Policy Analysis Program. (International Livestock Research Institute (ILRI): Addis Ababa, Ethiopia)
- Berhanu A (2002) Welcome address: animal health and poverty reduction strategies. In: Proceedings of the 16th Annual Conference of the Ethiopian Veterinary Association (EVA), held 5–6 June, 2002, Ghion Hotel, Addis Ababa, Ethiopia, pp: 117–137.
- Birhanu A, Worku T, Benti D (2015) Investigation of major cattle production constraints in Kembata Tambaro zone of southern Ethiopia using participatory epidemiology methods. *Tropical Animal Health and Production* **48**, 109–115.
- Blowey R, Edmondson P (2000) 'Mastitis Control in Dairy Herds (2nd edn)' (Farming Press, United Business Media: Tonbridge, UK)
- Bramley A, McKinnon C (1990) The microbiology of raw milk. *Dairy Microbiology* **1**, 163–208.
- Chang'a JS, Mdegela RH, Ryoba R, Løken T, Reksen O (2010) Calf health and management in smallholder dairy farms in Tanzania. *Tropical Animal Health and Production* **42**, 1669–1676. doi:10.1007/s11250-010-9619-x
- CSA (2008) Agricultural sample survey, 2007/2008 (2000 E.C.), vol. II: report on livestock and livestock characteristics (Private Peasant Holdings). Statistical Bulletin 417. (Central Statistical Agency, Federal Democratic Republic of Ethiopia: Addis Ababa, Ethiopia)
- CSA (2013) Agricultural sample survey 2012/13. Report on livestock and livestock characteristics. Private Peasant Holdings. Statistical Bulletin 570. (Central Statistical Agency, Federal Democratic Republic of Ethiopia: Addis Ababa, Ethiopia)
- CSA (2016) Livestock and Livestock characteristics, Agricultural sample Survey. Federal Democratic 611 Republic of Ethiopia. Livestock and Livestock Characteristics (Private Peasant Holdings). Statistical Bulletin 2, 612 9-13. (Central Statistical Agency, Federal Democratic Republic of Ethiopia: Addis Ababa, Ethiopia)
- Damte D (2003) Major health problems of cattle and camel in the field and abattoir, around Dire Dawa. DVM Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Debre Zeit, Ethiopia.
- Degefa T, Duressa A, Duguma R (2011) Brucellosis and some reproductive problems of traditional Arsi cattle in selected Arsi zones of Oromia regional state, Ethiopia. *Global Veterinaria* **7**, 45–53.
- Dereje T, Gezahegn M, Endale Y, Ararsa B, Melkam A (2018) Study on major health problem of cattle development in Mezhenger, Sheka and Benchi-Maji Zones of south western Ethiopia. *Academic Research Journal of Agricultural Science and Research* **6**, 222–232.
- Diriba G, Mekonnen H, Ashenafi M, Adugna T (2014) Analysis of fluid milk value chains at two peri-urban sites in western Oromia, Ethiopia: current status and suggestions on how they might evolve. *Global Veterinaria* **12**, 104–120.
- Esslemont RJ, Kossaibati MA (1997) Culling in 50 dairy herds in England. *The Veterinary Record* **140**, 36–39. doi:10.1136/vr.140.2.36
- Ezanno P (2005) Dynamics of a tropical cattle herd in a variable environment: a modelling approach in order to identify the target period and animals on which concentrating management efforts to improve productivity. *Ecological Modelling* **188**, 470–482. doi:10.1016/j.ecolmodel.2005.02.016
- FAO (1986) 'Farm structures in tropical climate: a text book for structural engineering and design.' (Eds LP Bengtsson, JH Whitaker) Rome, Italy. 394 pp. Available at <http://www.fao.org/3/s1250e/S1250E00.htm>. [Verified 19 May 2020]
- Fasil N, Juta TS (2016) Major health challenges of dairy cattle in Hawassa town, SNNPRS, Ethiopia. *Journal of Veterinary Science & Technology* **7**, 367. doi:10.4172/2157-7579.1000367
- Fon Tebug S, Kasulo V, Chikagwa-Malunga S, Wiedemann S, Roberts DJ, Chagunda MGG (2012) Smallholder dairy production in northern Malawi: production practices and constraints. *Tropical Animal Production and Health* **44**, 55–62. doi:10.1007/s11250-011-9887-0
- Gashaw A, Worku F, Mulugeta S (2011) Assessment of smallholder dairy production systems and their reproductive health problems in Jimma Town, southwestern Ethiopia. *International Journal of Applied Research in Veterinary Medicine* **9**, 80–86.
- Getachew F (2003) 'Milk and Dairy Products, Postharvest Losses and Food Safety in Sub-Saharan Africa and the Near East. A Review of the Small Dairy Sector – Ethiopia.' FAO Prevention of Food Losses Programme. (FAO: Rome, Italy)
- Gillah KA, Kifaro GC, Madsen J (2012) Urban and peri urban dairy farming in East Africa: a review on production levels and opportunities. *Livestock Research for Rural Development* **24**, 198
- Gillah KA, Kifaro GC, Madsen J (2013) Management and production levels of cross-bred dairy cattle in Dar es Salaam and Morogoro urban and peri urban areas. *Livestock Research for Rural Development* **25**, 165.
- Godden S (2008) Colostrum management for dairy calves. *The Veterinary Clinics of North America. Food Animal Practice* **24**, 19–39. doi:10.1016/j.cvfa.2007.10.005
- Grace D, Mutua F, Ochungo P, Kruska R, Jones K, Brierley L, Lapar L, Said M, Herrero M, Phuc PM (2012) Mapping of poverty and likely zoonoses hotspots. Zoonoses Project 4, report to Department for International Development, UK. International Research Institute. Available at <http://hdl.handle.net/10568/21161> [Verified 19 May 2020]
- Haile W, Zelalem Y, Yosef T (2012) Challenges and opportunities of milk production under different urban dairy farm sizes in Hawassa City, southern Ethiopia. *African Journal of Agricultural Research* **7**, 3860–3866.
- Hardarson GH (2002) Is the modern high potential dairy cow suitable for organic farming conditions? *Acta Veterinaria Scandinavica* **43**, 63. doi:10.1186/1751-0147-43-S1-S63
- Johnson JL, Godden SM, Molitor T, Ames T, Hagman D (2007) Effects of feeding heat-treated colostrum on passive transfer of immune and nutritional parameters in neonatal dairy calves. *Journal of Dairy Science* **90**, 5189–5198. doi:10.3168/jds.2007-0219
- Kassa TM (2003) A study on urban agriculture: the case of small-scale urban dairy farming in selected areas of Addis Ababa. MA Thesis (Geography), School of Graduate Studies, Addis Ababa University, Ethiopia.
- Kehoe SI, Jayarao BM, Heinrichs AJ (2007) A survey of bovine colostrum composition and colostrum management practices on Pennsylvania dairy farms. *Journal of Dairy Science* **90**, 4108–4116. doi:10.3168/jds.2007-0040
- Kivaria MF, Noordhuizen MTPJ, Kapaga MA (2006) Evaluation of the hygienic quality and associated public health hazards of raw milk marketed by smallholder dairy producers in the Dar es Salaam region, Tanzania. *Tropical Animal Health Production* **38**, 185–194.
- Lencho GK, Seblewongel AM (2018) Assessment of dairy farmers' hygienic milking practices and awareness on cattle milk-borne zoonoses in Bishoftu, Ethiopia. *Journal of Veterinary Medicine and Animal Health* **10**, 45–54. doi:10.5897/JVMAH2017.0602
- Lombard JE, Garry FB, Tomlinson SM, Garber LP (2007) Impacts of dystocia on health and survival of dairy calves. *Journal of Dairy Science* **90**, 1751–1760. doi:10.3168/jds.2006-295

- Lupindu M, Ngowi HA, Dalsgaard A, Olsen J, Msoffe PL (2012) Current manure management practices and hygiene aspects of urban and peri-urban livestock farming in Tanzania. *Livestock Research for Rural Development* **24**, 1–16.
- Mapekula M, Chimonyo M, Mapiye C, Dzama K (2009) Milk production and calf rearing practices in the smallholder areas in the Eastern Cape Province of South Africa. *Tropical Animal Health and Production* **41**, 1475–1485. doi:10.1007/s11250-009-9336-5
- Maryam AL, Mehdi MF, Abbas RG (2012) Causes of culling dairy cows and its relation to age at culling and interval from calving in Shiraz, southern Iran. *Veterinary Research Forum: an International Quarterly Journal* **3**, 233–237.
- Mdegela RH, Kusiluka LJM, Kapaga M, Karimuribo ED, Turuka FM, Bundala A, Kivaria F, Kabula B, Manjurano A, Loken T, Kambarage DM (2004) Prevalence and determinants of mastitis and milk-borne zoonoses in smallholder dairy farming sector in Kibaha and Morogoro districts in eastern Tanzania. *Journal of Veterinary Medicine* **51**, 123–128. doi:10.1111/j.1439-0450.2004.00735.x
- Mebrahtu T, Feven M, Hassen K (2018) A cross-sectional survey and follow up study on major dairy health problems in large and small scale urban farms in Mekelle, Tigray, Ethiopia. *BMC Research Notes* **11**, 236. doi:10.1186/s13104-018-3347-0
- Mejia CE, Preston TR, Fajersson P (1998) Effects of restricted suckling versus artificial rearing on milk production, calf performance and reproductive efficiency of dual purpose Mpwapwa cattle in a semi-arid climate. *Livestock Research for Rural Development* **10**, 1
- Mekasha Y, Tegegne A, Rodriguez-Martinez H (2007) Feed intake and sperm morphology in Ogaden bucks supplemented with either agro-industrial by-products or khat (*Catha edulis*) leftover. *Reproduction in Domestic Animals* **43**, 437–444.
- Mekonnen HM, Asmamaw K, Courreau JF (2006) Husbandry practices and health in smallholder dairy farms near Addis Ababa, Ethiopia. *Preventive Veterinary Medicine* **74**, 99–107. doi:10.1016/j.prevetmed.2005.10.004
- Metaferia F, Cherenet T, Gelan A, Abnet F, Tesfay A, Ali JA, Gulilat W (2011) 'A review to improve estimation of livestock contribution to the national GDP.' (Ministry of Finance and Economic Development and Ministry of Agriculture: Addis Ababa, Ethiopia)
- MOARD (2007) Livestock Development Master Plan Study. Phase I Report – Data Collection and (Analysis. Government of Ethiopia – Ministry of Agriculture and Rural Development: Addis Ababa, Ethiopia)
- Mtengeti E, Phiri E, Urio DG, Mhando Z, Mvena R, Ryoba R, Mdegela R, Singh M, Wetlesen T, Løken T, Reksen O (2008) Forage availability and its quality in the dry season on smallholder dairy farms in Tanzania. *Acta Agriculturae Scandinavica* **58**, 196–204. doi:10.1080/09064700802492362
- Mureda E, Zeleke MZ (2008) Characteristics and constraints of crossbred dairy cattle production in lowland areas of eastern Ethiopia. *Livestock Research for Rural Development* **20**, 57
- Negassa A, Rashid S, Gebremedhin B (2011) 'Livestock production and marketing.' ESSP II working paper 26. (International Food Policy Research Institute/Ethiopia Strategy Support Program II: Addis Ababa, Ethiopia)
- Ngongoni NT, Mapiye C, Mwale M, Mupeta B (2006) Factors affecting milk production in the smallholder dairy sector in Zimbabwe. *Livestock Research for Rural Development* **18**, 5
- Okello S, Sabiiti EN (2006) Milk production of indigenous Ankole cattle in Uganda as influenced by seasonal variations in temperature, rainfall and feed quality. *Makerere University Research Journal* **1**, 73–92.
- Oladele OI, Antwi MA (2013) Incidence and prevalence of livestock diseases along border villages of South Africa and Namibia. *Journal of Animal and Veterinary Advances* **12**, 177–180.
- Payne WJA, Wilson RT (1999) 'An introduction to animal husbandry in the tropics.' 5th edn. (Blackwell Science: Cambridge, UK)
- Radostits DM, Blood DC, Gay CC (1994) 'Veterinary medicine. A textbook of diseases of cattle, sheep, pigs, goats and horses.' 8th edn. (Bailliere Tindal: London)
- Regassa C, Berhanu S, Abdisa A, Fufa D, Hunduma D (2006) Survey of farmers' perception on major health constraints of cattle under smallholder management system in east Shoa zone of Oromia, Ethiopia. In 'Proceedings of the 14th conference of the Ethiopian Society of Animal Production (ESAP)', Tamirat Degefa and Fekede Feyissa (eds). ESAP, Addis Ababa. 230 pp. 5–7 September 2006, Addis Ababa, Ethiopia. pp. 181–190.
- Sharma P, Baldock C (1999) 'Understanding animal health in southeast Asia. Advances in the collection, management and use of animal health information.' (Australian Centre for International Agricultural Research: Canberra)
- Sikira AN, Ndanu H, Laswai G, Nandonde SW (2013) 'Rapid appraisal of dairy value chains in Morogoro and Tanga regions in Tanzania.' (ILRI: Nairobi, Kenya)
- Simianer H, Solbu H, Schaeffer LR (1991) Estimated genetic correlations between disease and yield traits in dairy cattle. *Journal of Dairy Science* **74**, 4358–4365. doi:10.3168/jds.S0022-0302(91)78632-3
- Solomon A, Workalemahu A, Jabbar MA, Ahmed MM, Hurissa B (2003) 'Livestock marketing in Ethiopia: a review of structure, performance and development initiatives.' Socioeconomics and policy research working paper 52, ILRI. (International Livestock Research Institute: Nairobi, Kenya)
- Tadele T, Verbeke J, Ayana Z, Piepers S, Supre K, De Vliegher S (2015) Pathogen group specific risk factors for clinical mastitis, intramammary infection and blind quarters at the herd, cow and quarter level in smallholder dairy farms in Jimma, Ethiopia. *Preventive Veterinary Medicine* **120**, 306–312. doi:10.1016/j.prevetmed.2015.05.001
- Tedla M, Gebreelassie M (2018) Estimating the proportion of clinically diagnosed infectious and non-infectious animal diseases in Ganta Afeshum Woreda, eastern Tigray Zone, Ethiopia. *BMC Research Notes* **11**, 29. doi:10.1186/s13104-018-3158-3
- Thomsen PT, Kjeldsen AM, Sorensen JT, Houe H (2004) Mortality (including euthanasia) among Danish dairy cows (1990–2001). *Preventive Veterinary Medicine* **62**, 19–33. doi:10.1016/j.prevetmed.2003.09.002
- Thrusfield M (1996) 'Veterinary epidemiology.' 2nd edn. (Blackwell Science: London)
- Umoh GS (2006) Resource use efficiency in urban farming: an application of stochastic frontier production function. *International Journal of Agriculture and Biology* **8**, 38–44.
- Welay GM, Tedla DG, Teklu GG, Weldearegay SK, Shibeshi MB, Kidane HH, Gebreziabher BB, Abraha TH (2018) A preliminary survey of major diseases of ruminants and management practices in western Tigray province, northern Ethiopia. *BMC Veterinary Research* **14**, 293. doi:10.1186/s12917-018-1621-y
- Yilma Z, Gojjam Y, Shumye M (2006) Milk production level and calf-rearing system affecting Boran, Ethiopian zebu cattle breed, cow-calf performance. *Livestock Research for Rural Development* **18**, 5
- Yitaye A, Wurziger M, Azage T, Zollitsch W (2007) Urban and peri-urban farming system and utilization of the natural resources in the north Ethiopian highlands. In 'Proceedings of conference on international agricultural research for development', 9–11 October 2007, University of Göttingen, Germany.
- Zelalem A, Yeshwas F, Assemu T (2017) Survey on major diseases affecting dairy cattle in Bahir Dar Dairy farms, north western Ethiopia. *Journal of Entomology and Zoology Studies* **5**, 1121–1124.

Handling editor: Robyn Alders