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# Feed the Future Innovation Lab for Livestock Systems

# Ethiopia:
# Livestock Disease Management and Food Safety Brief

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## 1. Introduction

Livestock provides a livelihood for 65% of the Ethiopian population (Solomon, 2003). According to recent estimates, Ethiopia has 56.71 million cattle, 29.33 million sheep, 29.11 million goats, 1.16 million camels and 56.87 million poultry (CSA, 2015). These estimates do not include livestock populations in the nonsedentary (nomadic) areas of the Afar and Somali regional states.
The predominant livestock production system in Ethiopia is extensive, where indigenous breeds are kept under low-input/low-output husbandry practices. The productivity of this sector is constrained by several factors and livestock mortality rates are high: death estimates for 2014/2015 fiscal year were 3.23 million cattle, 4.37 million sheep, 4.90 million goats, 18,231 camels, and 41,195 chickens (CSA, 2015). Ethiopia ranks highest in Africa in the health burden of zoonotic diseases (Grace et al., 2012).

To fully utilize the untapped livestock potential and address food safety issues, the government has created the Ethiopia Livestock Master Plan (ELMP, 2015). The animal health part of the plan calls for establishment of a robust animal health information system; reduced production losses by controlling prioritized diseases; increased export earnings by reinforcing the quarantine, inspection and certification system; decreased impact of zoonotic diseases on public health by controlling them and ensuring safety of animal products, improved infrastructure, and addressing policy issues.

## 2. Major Animal Diseases

**Prevalence by species, trends**
In Ethiopia, there are several endemic animal diseases caused by bacteria, viruses, protozoa, and parasites that compromise the productivity of the livestock sector. The most important diseases are:

- **Foot and Mouth Disease (FMD)** – FMD is endemic in Ethiopia and outbreaks occur in cattle throughout the country, with the highest incidence in central Ethiopia (Ayelet et al., 2009). The overall herd- and animal-level prevalence is 57.6% and 11.9%, respectively (Gulima, 2011 cited in EAHYB, 2015). Among the seven globally known serotypes of FMD virus, serotypes O, A, C, SAT1, and SAT2 have been identified in the country (Ayelet et al., 2009). There are no published data on the trend of the prevalence of FMD in Ethiopia; however, the number of outbreaks does not seem to show a decreasing trend (Ayelet et al., 2012; Jemberu et al., 2015).
- **Lumpy Skin Disease (LSD)** – LSD is an endemic viral disease of cattle in Ethiopia. Herd-level prevalence of LSD has been reported to be 44% (38-50%), with the highest prevalence in the mid-highlands (64%), followed by the lowlands (50%). Animal-level prevalence in infected herds is 27% (22-32%), with 31% in the mid-highlands, 24% in the highlands, and 23% in the lowlands (Gari et al., 2012). According to the report of the Ministry of Agriculture, LSD is showing an increasing trend, but sufficient data to fully understand LSD in the country is lacking (EAHYB, 2012).
- **Contagious Bovine Pleuropneumonia (CBPP)** – CBPP is an endemic bacterial disease of cattle in Ethiopia. Its overall animal-level prevalence is reported to be 5.6%, varying from 0.9% in the Somali region to 19.7% in the Gambella region. Compared with the number of outbreaks before 2002, CBPP has shown a declining trend (EAHYB, 2012). More recently, the following prevalence rates were reported: in Adama export quarantine farms 4% in 2011 (Kassaye & Molla, 2012) and 7.8% in 2015 and in two abattoirs in Bishoftu 5.9% in 2015 (Atnafie et al., 2015).
- **Bovine Tuberculosis (BTB)** – BTB is endemic in Ethiopia, with low prevalence in the extensive system, varying from 0.3% to 5.5% at animal level (Gumi et al., 2011; Gumi et al., 2012b; Tschopp et al., 2013); and high prevalence in urban and peri-urban dairy farms, 55% at herd-level and 32.3% at animal level (Firdessa et al., 2012). BTB has also been reported in camels (Beyi et

al., 2014, Gumi et al., 2012b), and sheep and goats (Gumi et al., 2012b; Kassa et al., 2012). The trend of BTB prevalence appears to increase with intensification of husbandry and proportion of high-yielding exotic lines in farms (Firdessa et al., 2012). The prevalence of bovine tuberculosis in Ethiopia is summarized in Table 1.

Table 1. Prevalence of bovine tuberculosis in cattle, camels and small ruminants in Ethiopia

| **Animals** | **Prevalence (%)** | | **Study sites** | **Source** |
|---|---|---|---|---|
| | **Animal level** | **Herd level** | | |
| Cattle | 5.5 | 41.9 | South | Gumi et al., 2011 |
| | 2.0 | 14.3 | Somali region, East | Gumi et al., 2012b |
| | 0.3 | NA | Arsi zone, Central | Tschopp et al., 2013 |
| | 32.3 | 55 | Addis Ababa | Firdessa et al., 2012 |
| Camel | 6.0% | NA | East | Beyi et al., 2014 |
| | 0.4 | 3.1 | Southeast | Gumi et al., 2012b |
| Sheep & | 0.2 (goats) | 3.1 (goats) | Southeast | Gumi et al., 2012b |
| Goats | 1.44 (sheep<br>4.3 (goats) | 20 (sheep & goats) | Afar region, North | Kassa et al., 2012 |

NA – not available

- **Brucellosis** – The herd- and animal-level prevalence of bovine brucellosis in southern and eastern Ethiopia, including indigenous cattle from crop-livestock mixed and pastoral production systems, are 26.1% and 3.5%, respectively (Megersa et al., 2011a). Tschopp et al. (2013) reported a relatively low animal-level prevalence in Arsi, central Ethiopia, a mixed farming area (i.e., 1.7%). The estimates for commercially oriented urban and peri-urban dairy and breeding farms are 10.6% at herd level and 1.9% at the animal level (Asmare et al., 2013). The animal-level prevalence of brucellosis in sheep and goats ranges from 1.1% to 3.2% and 1.9% to 9.6%, respectively (Ashenafi et al., 2007; Gumi et al., 2013; Megersa et al., 2011a; Teshale et al.; 2006). In camels, the animal-level prevalence of brucellosis is reported to be in the range of 0.9% to 3.4% (Gumi et al., 2013; Habtamu et al., 2015; Megersa et al., 2011a).
- **Contagious Caprine Pleuropneumonia (CCPP)** – CCPP is mainly a bacterial disease of goats, but outbreaks also occur in sheep (Shiferaw et al., 2006). Its prevalence is 32.7% in goats and 18.3% in sheep in the Tigray and Afar regions (Abera et al., 2011); 15.5% in goats in Hamar and Bena-Tsamai districts, South Omo zone, Southern Nations, Nationalities, and Peoples' Region (SNNPR) (Mekuria et al., 2008); and 13.2% in goats in Borena and Guji zones, Oromia region (Bekele et al., 2011).
- **Peste des Petits Ruminant (PPR)** – PPR is a viral disease of sheep and goats. In a countrywide study that covered 43 districts, the prevalence of PPR in sheep and goats was 6.4%, with the lowest prevalence in Oromia region (1.7%) and the highest in Somali region (21.3%) (Waret-Szkuta et al., 2008). In camels and cattle, the prevalence of PPR was 3% and 9%, respectively (Abraham et al., 2005). Based on three studies conducted in Afar and Gambella regions at different times, the prevalence of PPR appears to be increasing in both sheep and goats (Abraham

et al., 2005; Megersa et al., 2011b; Waret-Szkuta et al., 2008). The prevalence of PPR was 15.3% in 1999 (Waret-Szkuta et al., 2008), 16% in 2001 (Abraham et al., 2005), and 38.3% in 2010 in Afar (Megersa et al., 2011b). Similarly, it was 23% in sheep and 22% in goats in 2001 (Abraham et al., 2005), and 31.0% in sheep and 26.3% in goats in 2010 in Gambella (Megersa et al., 2011b).

- **Pox** – There is no literature on the prevalence and trends of caprine and ovine pox in Ethiopia. However, 893 pox outbreaks were reported to the Ministry of Agriculture in 2007/08 fiscal year (ESGPIP, 2009) and 1,234 outbreaks happened between 2008 and 2012 (Gelaye et al., 2015). In Borena (the southernmost zone of Oromia region), based on clinical diagnosis, the prevalence of camel pox was 0% during dry season, 0.3% during major wet season, and 14.2% during minor wet season (Megersa, 2010).
- **Trypanosomiasis** – Trypanosomiasis is endemic in Ethiopia, particularly in southwest, west, and northwest areas. A recent estimate of the prevalence of trypanosomiasis in southwestern Ethiopia is 9.61%, and it is showing a declining trend (Duguma et al., 2015). Camels are affected by *Trypanosomiasis evansi*; its prevalence ranges from 2% to 10.9% in Afar and southern Oromia (Fikru et al., 2015, Tekle and Abebe, 2001).
- **Endoparasites** – Based on small-scale assessments conducted in different parts of the country, the prevalence of gastrointestinal parasites is 14.8-61% in cattle (Duguma et al., 2012; Emiru et al., 2013; Regassa et al., 2006); 47.7-100% in sheep and goats (Dagnachew et al., 2011; Emiru et al., 2013; Kumsa et al., 2010; Kumsa et al., 2011; Kumsa & Wossene, 2007; Regassa et al., 2006), 55.5-96.9% in camels (Birhanu et al., 2014; Demelash et al., 2014; Tekle & Abebe, 2001); and ranging from 75.8% (*Nematoda*) to 86.3% (*Cestoda*) in chickens (Ashenafi & Eshetu, 2004).
- **Ectoparasites** – National surveys on ectoparasites are lacking. Prevalence rates ranging from 15.4%-40.2% were reported from various parts of the country (Onu et al., 2013; Yacob et al., 2008a; Yacob et al., 2008b). In central Ethiopia, the overall prevalence of ectoparasites in sheep is 48.1% (Kumsa et al., 2012). In the Tigray region of northern Ethiopia, the prevalence rates of mange mites, lice, and sheep keds were 4.4% in both sheep and goats, 6% in both sheep and goats, and 11.67% in sheep, respectively (Kassayeq & Kebede, 2010). In the Borena lowlands, depending on the season of the year, 29.0-34.0% and 56.4-85.4% of camels were found to be infested by mange mites and ticks, respectively (Megersa, 2010). Ectoparasite control programs have been running in selected regions for a couple of years; nevertheless, the trend does not appear to be declining (Tolossa, 2014).
- **Newcastle disease (NCD)** – NCD is an endemic viral fowl disease in Ethiopia. Fragmented studies conducted on village or backyard chickens have shown seroprevalence varying from 5.6-19.78% (Chaka et al., 2012; Getachew et al., 2014; Zeleke et al., 2005).
- **Infectious Bursal Disease (IBD)** – The overall prevalence of IBD in Ethiopian chickens is 77.48% (EAHYB, 2012). In backyard chickens sampled at markets in central Ethiopia, the prevalence was 91.9% in the dry season and 96.3% in the wet season (Chaka et al., 2012).
- **Emerging diseases** – While outbreaks of Rift Valley Fever (RVF) occasionally occur in neighboring countries, it is not clinically reported in Ethiopia (EAHYB, 2012). Southern Ethiopia has the highest risk for RVF (Anyamba et al., 2009). Similarly, East Coast Fever (ECF) is not found in Ethiopia despite its endemic status in Kenya. The vector of ECF (*Rhipicephalus appendiculatus*) is not reported from Ethiopia; however, the climate of central and southern parts of the country is favorable for this tick, and its introduction to the country could be disastrous to the cattle industry (Leta et al., 2013).

  An epidemic wave of an acute and contagious unknown camel syndrome, which is commonly called "Camel Sudden Death" (CSD), has occurred in the last decade in Ethiopia. It was first reported in Afar in 2005, and it has spread to the southern parts of Ethiopia and into Somalia and North Kenya in the subsequent years. This disease is not known to the local people, and the causative agent could not be identified (Dawo, 2010, Megersa et al., 2012).

  Serological testing was recently carried on 188 camels from Afar, Somali; and Borena for

detection of antibodies against Middle East Respiratory Syndrome Corona Virus (MERS-CoV): 93% of young and 97% adult camels were positive (Reusken et al., 2014).
Highly Pathogenic Avian Influenza virus (HPAI) has not been detected in Ethiopia. However, there is high risk of introduction of this virus because of the millions of birds migrating to East Africa from Europe and Asia each year to reach the lakes and wetlands in the Great Rift Valley. Given the risk posed by HPAI, a multidisciplinary national committee was established in 2005 and has been carrying out vigilance through active surveillance with the concerned bodies of the government (EAHYB, 2012; Berhane, 2005).

**Documented impacts**

- **Foot and Mouth Disease** – The estimated economic losses of FMD outbreak in cattle, arising from milk loss, mortality, and draft power loss, average US$76 per affected herd, US$9.8 per head in crop-livestock mixed system, and US$174 per affected herd and US$5.3 per head in the pastoral system (Jemberu et al. 2015). In another study, the overall short-term farm level direct loss due to FMD outbreak in an urban dairy farm was estimated at ETB45,131, equivalent to €1962 (Beyi, 2012). Data on national level economic impact of FMD is lacking.
- **Contagious Bovine Pleuropneumonia** – A study shows that Ethiopia loses over ETB205.6 million per year due to CBPP (Laval, 1999). The case fatality rate of CBPP is estimated at 16% (Gulima, 2011, cited in EAHYB, 2012).
- **Bovine Tuberculosis** (BTB) – BTB has both public health and economic impacts. The prevalence of BTB in cattle slaughtered in abattoirs has been 0.83-5.2% (Mengistu & Enquselassie, 2014; Shitaye et al., 2007), and the carcasses of 0.024-0.03% of cattle slaughtered in some abattoirs were completely condemned (Asseged et al., 2004; Mummed & Webb, 2015). There is no data on production losses, but the prediction of economic losses based on current BTB prevalence in the country and loss of weight reported by farmers implies that it causes substantial losses to the producers and the livestock sector (Tschopp et al., 2013). *Mycobacterium bovis*, the cause of BTB, is frequently isolated from human TB patients, which confirms the public health significance of this disease in a country where consumption of raw milk and meat, and close contact with animals is very common (Firdessa et al., 2013; Gumi et al., 2012a).
- **Brucellosis** – Brucellosis has both public health and economic impacts. There is no data on the economic impacts of brucellosis on livestock production in Ethiopia; however, Megersa et al. (2011a) report a significant association between seropositivity and a history of spontaneous abortion in cattle herds.
- **Lump Skin Disease** – An LSD outbreak investigation report shows that 108 of 296 affected cattle in one area (13.61% of all animals) died in two outbreaks, which was roughly equivalent to ETB972,000 (US$51,590, where US$1 = ETB18.84) direct financial loss, and additional expense of ETB16.50 per animal for treatment (Ayelet et al., 2013). Furthermore, annual financial costs of LSD were estimated by summing up the average production losses stemming from morbidity and mortality (i.e., milk, beef, and traction power losses) plus the treatment and vaccination expenses: the economic cost in infected herds was US$6.43 (5.12-8) per head of local breed and US$58 (42-73) per head of Holstein-Friesian/crossbred cattle (Gari et al., 2012).
- **Contagious Caprine Pleuropneumonia and Peste des Petits Ruminant** – Literature on the economic impacts of these two diseases is absent.
- **Caprine/ovine pox** – In 2007/2008 fiscal year, out of 57,638 goats and sheep that contracted the disease, 6,401 (11.1%) died (ESGPIP, 2009).
- **Endoparasites** – According to Biff et al. (2006) Ethiopia is reported to be losing US$81.8 million per year due to mortality caused by endoparasites. Fromsa and Jobre (2012), based on a retrospective study of data collected over 15 years (1985-1999), estimate that the annual financial loss due to bovine hydatidosis (*Echinococcus* disease) arising from condemned organs, decreased carcass weight, and decreased milk yield was ETB1.691 billion (US$101.20 million). This is

equivalent to ETB475.40 (US$28.45) per every infected slaughtered bovine and ETB249.00 (US$14.90) per every infected milking cow (Fromsa & Jobre, 2012). In Sodo municipal slaughterhouse, the annual loss implicated to bovine liver condemnation due to *Fasciola* was US$4000 (Abunna et al., 2010).

- **Ectoparasites** – Ectoparasites are attributed as major causes of skin rejection at tanneries (Tolossa, 2014). The annual financial loss in a single tannery due to quality deterioration of exported skins was estimated at US$778,199.41 for pickled sheep skins and US$247,677.61 for wet blue goat skins (Ashenafi et al., 2014).
- **Infectious Bursal Disease** – A follow-up study conducted for six months in two districts in northwest Ethiopia revealed cumulative incidence rates of 17.40% and 38.39% and case fatality rates of 77.73% and 98.56% in village chickens of Farta and Bahir Dar Zuriya districts, respectively (Mazengia et al., 2009). In an outbreak occurring in commercial poultry farms in Bishoftu, central Ethiopia, a mortality rate of 49.89% was reported (Zeleke et al., 2005).

**Variation by region and system**

- **Foot and Mouth Disease** – It appears that the prevalence of FMD is highest in intensive production systems, somewhat lower in mixed farming systems, and lower still in pastoral systems. For instance, animal level prevalence in Borena (pastoralism) (Rufael et al., 2008), Bahir Dar (mixed farming) and Haramaya (intensive production), East Hararge zone (Negusssie et al., 2011) were 21%, 38.4%, and 80%, respectively.
- **Contagious Bovine Pleuropneumonia (CBP)** – CBP is endemic in western and southern parts of Ethiopia and in the Afar region. Based on a 2004 serosurveillance survey by the National Animal Health Diagnostics and Investigation Center (NAHDIC), high prevalence was observed in Gambella and Benishangul-Gumuz regions (EAHYB, 2012).
- **Bovine Tuberculosis (BTB)** – A higher prevalence of BTB was documented in Holstein and Holstein cross breeds than in local zebu cattle, and in animals kept in the intensive production systems than in the extensive system (Firdessa et al., 2012; Tschopp et al., 2013). Firdessa et al. (2012) reported prevalence rates of 61.8% in Holstein-Friesian cattle, 37.2% in Holstein crosses with local cattle, and 0.3% in zebu.
- **Brucellosis** – Unlike BTB, the prevalence of brucellosis was found to be lower in intensive production systems than in the extensive system (Asmare et al., 2013; Megersa et al., 2011a; Tschopp et al., 2013). Husbandry practices of commingling animals from different herds together, such as aggregation of animals in watering points in pastoral areas, favors the occurrence of brucellosis (Megersa et al., 2011a; Yohannes et al., 2013; Jergefa, 2009).
- **Lumpy Skin Disease (LSD)** – Based on outbreak reports to the Ministry of Agriculture from 2007 to 2011, LSD outbreaks have occurred in all regions except Harari and Dire Dawa, with the highest records in the central and southwest parts of the country (Ayelet, 2014). The same authors also documented higher number of outbreaks in feedlot cattle than in those kept under extensive management, and a higher number of outbreaks in mid-highlands zone than in other agro-climatic zones. Gari et al. (2011) reported higher LSD annual cumulative incidence and annual mortality rates in Holstein-Friesian and their cross breeds (33.93 and 7.43%) than in local zebu cattle (13.41 and 1.25%).
- **Contagious Caprine Pleuropneumonia** (**CCPP)** – CCPP has been reported from all over the country, with the highest prevalence in the lowlands, where 70% of Ethiopian goat population exist (Gedlu, 2004).
- **Peste des Petits Ruminant (PPR)** – The highest prevalence of PPR was observed in the Somali region (21.3%), followed by the Afar and Tigray (15.3%) regions. PPR is more common in the lowlands and in pastoralism-dominated livestock production systems (Waret-Szkuta et al., 2008).

- **Trypanosomiasis** – Trypanosomiasis occurs in the southwestern, western, and northwestern parts of Ethiopia, in the regions Oromia, Amhara, Benishangul-Gumuz, Gambella, and Southern SNNPR (Duguma et al., 2015).
- **Endoparasites** – The challenge of endoparasites is higher in the extensive production systems than in the intensive systems (Duguma et al., 2012; Emiru et al., 2013; Regassa et al., 2006).
- **Ectoparasites** – Mange mites and tick infestations of small ruminants are more common in the lowlands than in the highlands (Kassayeq & Kebede, 2010; Kumsa et al., 2012).

**Factors impacting incidence**

- **Management** – Management factors that increase the incidence of animal diseases in Ethiopia include mixing different species, commingling at watering points, and lack of knowledge on disease management practices (e.g., segregating sick animals, avoiding immediate mixing of newly purchased animals with the existing ones, replacement practices, seeking traditional healers or doing nothing when animal becomes sick, not burning or burying dead animals) (Hailu et al., 2014; Megersa et al., 2009; Tschopp et al., 2009).
- **Feed quantity and quality** – Encroachment of crop cultivation and urbanization on grazing or range lands is dramatically increasing in Ethiopia. As a result, the feed resource available for livestock in terms of both quality and quantity is declining, which in turn leads to susceptibility of animals to various infectious pathogens and parasite challenges. Recurrent drought also exacerbates the occurrence of diseases (Addis et al., 2014; Catley et al., 2014).
- **Unrestricted movement** - Cross-border movement, lack of quarantine, and unrestricted animal movement in the country are factors in disease incidence (Megersa et al., 2009).
- **Intensification and introduction of susceptible animals/breeds** – Intensification of production and the distribution of improved breeds of chickens, or of chickens infected at breeding or multiplication centers, are claimed to be factors in the increased dissemination and incidence of chicken diseases (Mazengia, 2012; Mazengia et al., 2009). These factors also hold true for large animal diseases, such as BTB (Ameni et al., 2007; Vordermeier et al., 2012); FMD (in Borena, Negusssie et al., 2011; Rufael et al., 2008); LSD (Gari et al., 2011); and brucellosis (Firdessa et al., 2012; Tschopp et al., 2013).
- **Change of climate and micro-climate** – Global warming and micro-agro-climatic change induced by the development of a number of hydroelectric dams and irrigation schemes in Ethiopia favor changes in the incidence patterns of vector-borne diseases, the incidence patterns of external and internal parasites, and the spread of diseases to new areas (Alemayehu & Fantahun, 2012).

**Priorities for disease control**

In Ethiopia, priority is given to decreasing the morbidity and the mortality of production related diseases (mainly external and internal parasites); to trade-limiting diseases (FMD, ovine/caprine pox, LSD, PPR, CBPP); and to the prevention of highly pathogenic emerging diseases (RVF, HPAI/NCD complex, ECF). In the Ethiopia Livestock Master Plan (ELMP, 2015), diseases have been prioritized based on their impacts on rural households, impacts on market and value chains, and possibilities for intensification pathways for control schemes. Accordingly, the diseases with the top priority ranks are FMD, CBPP, brucellosis, and tuberculosis for cattle; PPR, ovine/caprine pox, and CCPP for small ruminants; surra (trypanosomiasis) for camels; and NCD for chickens. In addition, trypanosomiasis and external parasites are included in the priority list.

**Impact on access to local and regional markets**

In Ethiopia, several diseases (mainly transboundary diseases, such as FMD, CBPP, CCPP, PPR, brucellosis, and LSD) affect access to international trade. Because of these diseases, Ethiopia is denied exportation of live animals or meat to the lucrative European market. Furthermore, trade with Middle East

countries is frequently hampered and embargo is sometimes imposed due to such diseases (AGP-LMD, 2013b). Depending on the importing country's requirements, animals are screened and/or vaccinated for specific diseases during a quarantine period. For instances, United Arab Emirates (UAE) requires sheep and goats be screened for brucellosis and RVF, while Egypt wants animals screened for FMD, CBPP, and brucellosis.

- **Foot and Mouth Disease (FMD)** – FMD impedes export of livestock and meat to international markets. Ethiopia lost more than US$14 million in consequence of the Egyptian trade ban in 2005/2006 (Leforban, 2005).
- **Brucellosis** – Some countries that import live animals from Ethiopia request brucellosis-free animals. Random tests for *Brucella* antibodies are conducted for sheep and goats exported to the UAE (AGP-LMD, 2013a; AGP-LMD, 2013b).
- **Lumpy Skin Disease (LSD)** – Feedlot animals recovered from LSD are not fit for export purposes and thus must be sold on the local market for lower prices (Ayelet, 2014).
- **Rift Valley Fever (RVF)** – A clinical case of RVF has not been reported in Ethiopia, despite occasional outbreaks in the neighboring countries (EAHYB, 2012). Nevertheless, live-animal importing countries like UAE request sheep and goats that are serologically negative for antibodies against RVF virus (AGP-LMD, 2013a; AGP-LMD, 2013b).

## 3 Foodborne and Zoonotic Diseases

In Ethiopia, data are lacking on the burden of foodborne diseases. However, various fragmented studies show high prevalence of pathogens in foods of animal origin, in animals, and in humans. The overall prevalence of *Salmonella* in raw meat samples (beef, goat meat, mutton, pork, and camel) collected from abattoirs and markets was 5.6% and 11.7% respectively; and 10.8% of milk samples from farms were positive. *Salmonella dublin*, *S. anatum*, *S. saintpaul*, *S. newport*, *S. typhimurium*, *S. infantis*, *S. mishmarhaemek*, *S. braenderup*, and *S. muenchen* have been isolated from these samples (Tadesse & Gebremedhin, 2015). Similarly, the pooled prevalence estimates of *Salmonella* in humans were 8.7% in diarrheic children, 5.7% in diarrheic adults, and 1.1% in carriers; 57.9% of the isolates were nontyphoidal *Salmonella*. Two of nontyphoidal *Salmonella* serotypes (*S. concord* and *S. paratyphi*) and two typhoidal serotypes (*S. typhimurium* and *S. typhi*) account 82.1% of the isolated major serotypes that cause human infections (Tadesse, 2014). *Salmonella* was also isolated from 3.1% of food handlers in Gonder (Garedew-Kifelew et al., 2014).

Nearly one-third (103 out of 316 or 32.6%) of samples of retail meat and milk products in Addis Ababa were found to be contaminated with *Listeria* species, and 5.1% of the samples had *L. monocytogenes* (Molla, 2004). In another study, ready-to-eat food items (pasteurized milk, cheese, ice cream, and cakes) and raw meat products (minced beef, pork, and chicken carcasses) in Addis Ababa had *Listeria* species (26.6%) and *L. monocytogenes* (4.8%, Mengesha et al., 2009).

Thermophilic *Campylobacter* species were identified from 9.3% of meat samples (Dadi & Asrat, 2008) and 10.1% of sheep and goat carcasses (Woldemariam et al., 2009) in Debre Zeit and Addis Ababa, and in 72.7% of chickens in Bahir Dar (Ewnetu & Mihret, 2010). *Campylobacter* species (specifically *C. jejuni* and *C. coli*) were also identified from 16.7% of diarrheic children under five years old in Jimma (Tafa, 2014) and in 8% of the general public in Bahir Dar (Ewnetu & Mihret, 2010).

The prevalence of the virulent *Escherichia coli* O157:H7 in various samples taken from Modjo export abattoir was 4.2-8.7% (Mersha et al., 2010). In another study, 4.2% of samples of beef, mutton, and goat meat from abattoirs were positive for *Escherichia coli* O157 (Hiko et al., 2008). More recently, a

prevalence of 2.5% was reported in goat carcasses and other environmental samples from Somali region (Dulo et al., 2015).

Food handlers in Gonder (29.1%, Andargie et al., 2008) and Bahir Dar (41.1%, Abera et al., 2010) were positive for intestinal parasites such as *Entamoeba histolytica*, *Giardia lamblia*, and helminths. The overall prevalence of *Shigella* species in a hospital in Harar was 14.6%, with higher prevalence in children under 15 years (17.7%) and adults above 45 years (16.7%), as compared to adults between 15 and 45 (11.0%) (Mekonnen et al., 2014).

Zoonotic diseases (infectious diseases of animals that can be transmitted to humans) are rampant in Ethiopia. Based on a systematic review of studies done between 2002 and 2011, *Mycobacterium bovis* was isolated from 23 of 342 milk samples (6.7%) collected from farms (Mengistu & Enquselassie, 2014). *M. bovis* was also detected in 21 of 449 samples taken from human tuberculosis (4.7%), and accounted for 7.24% of the total species of *Mycobacterium* isolated from human cases (i.e., total = 290). A seroprevalence study among human patients with febrile illness conducted in pastoral areas for *Brucella abortus* antibodies showed that 34.9% of patients in Borena zone, 29.4% of patients in Hamar district, South Omo zone, and 3% of patients in Metema district, North Gonder zone, were seropositive (Regassa et al., 2009b). It was also reported that 4.8% of abattoir personnel and dairy farmers in Addis Ababa were seropositive (Kassahun et al., 2006).

In Ethiopia, based on retrospective data, 35.2% of cattle, 11.8% of sheep, 4.9% of goats, and 16.8% of camels slaughtered in 21 different abattoirs were observed to harbor hydatid cyst (*Echinococcus*; Fromsa & Jobre, 2012). In dogs, the prevalence of Echinococcosis varies 20-50%; however, this estimate was based on a small sample size (Koskei et al., 2014). In humans, an incidence of 2.3 cases of Echinococcosis per 100,000 per year was estimated based on a review of 36,402 patients admitted for an ultrasound examination (Kebede et al., 2010).

The prevalence of bovine tapeworm (*Taenia saginata*) in cattle was 2.9% in a Jimma abattoir (Megersa et al., 2010); 7.5% in an Addis Ababa abattoir (Kebede et al., 2009); 11.3% in a Wolaita Sodo abattoir (Regassa et al., 2009a); and 19.7% in a Harar abattoir (Terefe et al., 2014). The same studies assessed the exposure of people to taeniasis at least once in the year preceding the study time and the results showed the following percentage of infestation from *T. saginata*: 50.6% of the respondents in Wolaita Sodo (Regassa et al., 2009a); 55.1% in Jimma (Megersa et al., 2010); 60.7% in Harar (Terefe et al., 2014); and 64.2% in Hawassa (Abunna, 2008).

Rabies is an endemic disease in dogs in Ethiopia (Ali et al., 2010). Based on two studies done in Gonder, North Ethiopia, the annual incidence of human rabies case was 1.27-4.6 per 100,000 people (Deressa et al., 2010; Yibrah, 2015). Between 2001 and 2009, 386 fatal human cases of rabies were recorded by the Ethiopian Public Health Institute (Deressa et al., 2010).

Anthrax is another endemic animal disease in Ethiopia. Its cutaneous form is occasionally reported in humans; having contact with an open cadaver is reported to be the main contributing factor (Seboxa & Goldhagen, 1989; Shiferaw, 2004).

There are no recent reports of leptospirosis in Ethiopia; however, leptospiral antibodies were detected four decades ago in horses (91.3%), cattle (70.7%), pigs (57.1%), goats (47.3%), sheep (43.4%), camels (15.4%), and dogs (8.3%) using a microscopic agglutination test (Moch et al., 1975). The first human leptospirosis in Ethiopia was reported from Wonji hospital, central Ethiopia, where 47.5% of febrile patients of unknown causes (n = 59) were positive for leptospiral infection using Lepto Dri-Dot card agglutination test (Yimer et al., 2004).

The existence of *Coxiella burnetii* in Ethiopia, the cause of Q fever, was first reported in 1966 (Philip et al., 1966). In 1988, 6.5% of 465 sera collected from people in Addis Ababa were positive for Q fever using a complement fixation test (Abebe, 1990). More recently, Gumi et al. (2013) used an ELISA test to report a seroprevalence *Coxiella* of 31.6% in cattle, 90.0% in camels, and 54.2% in goats from southeast pastoral parts of Ethiopia.

Toxoplasmosis is highly prevalent in both animals and humans in Ethiopia (Dubey, 2013). Based on a meta-analysis, the prevalence of toxoplasmosis was 87.72% (95% CI = 78.63, 93.28) in cats; 34.59% (95% CI = 21.08, 51.12) in small ruminants; and 74.73% (95% CI = 61.85, 84.36) in cattle (Gebremedhin & Tadesse, 2015). The prevalence in humans was 74.73%, with significantly higher odds of seroprevalence in pregnant women (3.96, 95% CI = 3.15 - 4.97) than in nonpregnant women. However, there is no data on congenital toxoplasmosis in children, despite the fact that a prevalence up to 41% was reported in children one to five years of age (Dubey, 2012).

Cutaneous and visceral leishmaniasis (VL) are endemic and growing health problems in Ethiopia (Gadisa et al., 2015; Negera et al., 2008). VL is endemic in the lowlands, but its spread to neighboring highlands areas has been recently reported. More than 3.2 million people are at risk of infection and 2,500-4,000 new cases annually occur in the country (Gadisa et al., 2015; Tsegaw et al., 2013).

**Burden by region, gender, age, and ethnic group**

In Africa, Ethiopia ranks second only to Nigeria in the health burden of zoonotic diseases, and stands in first place as a hotspot of leptospirosis in the world (Grace et al., 2012). Diarrheal diseases are the second leading cause of premature death after lower respiratory infections in the country (GBD, 2010). However, there is no literature on distribution of foodborne diseases and zoonotic diseases by region, gender, age, and/or ethnic group. In general, children, the elderly, and immunocompromised people are highly susceptible to foodborne diseases (Lund, 2015).

According to the global report of Foodborne Disease Burden Epidemiology Reference Group (FERG, a World Health Organization external advisory group), Ethiopia is found in a subregion that experiences the second highest foodborne disease burden in the world (Havelaar et al., 2015). Diarrheal disease agents such as *Norovirus*, *Campylobacter* species, *E. coli*, *Salmonella* species, and *Cryptosporidium* species contributed to the largest part of the foodborne disease disability adjusted life years (DALYs) in this region (Table 2).

Table 2. Median rates of Disability Adjusted Life Years (DALYs) per 100,000 Population Due to Foodborne Diseases for Africa Sub-region E, including Ethiopia (with 95% uncertainty intervals), 2010

| **Causes** | **DALYs** | **Causes** | **DALYs** | **Causes** | **DALYs** |
|---|---|---|---|---|---|
| **Diarrheal disease agent** | 824 (447-1,326) | **Invasive infectious disease agents** | 147 (55-343) | **Helminths** | 184 (141-240) |
| ***Viruses*** | 76 (0-225) | ***Viruses*** | | ***Cestodes*** | 178 (136-235) |
| Norovirus | 76 (0-225) | Hepatitis A virus | 18 (3-55) | *E. granulosis* | 0.8 (0.2-16) |

| | | | | | |
|---|---|---|---|---|---|
| ***Bacteria*** | 712 (393-1,160) | ***Bacteria*** | 104 (40-277) | *E. multilocularis* | 0(0-0) |
| Campylobacter spp. | 70 (33-177) | *Brucella* spp. | 0.3 (0.007-18) | *Taenia solium* | 176 (134-229) |
| Enteropathogenic *E. coli* | 138 (6-327) | *L. monocytogenes* | 1 (0-21) | ***Nematodes*** | 5 (1-11) |
| Enterotoxigenic *E. coli* | 105 (17-240) | *M. bovis* | 34 (21-48) | *Ascaris* spp. | 5 (1-11) |
| Shiga toxin-producing *E. coli* | 0.08 (0.02-0.2) | *S. Paratyphi A* | 12 (0-43) | *Trichinella* spp. | 0.001(0-0.002) |
| Non-typhoid *S. enterica* | 193 (44-336) | *S. Typhi* | 52 (0-187) | ***Trematodes*** | 0.02(0.008-0.07) |
| *Vibrio cholera* | 143 (4-383) | ***Protozoa*** | 20 (9-37) | *Clonorchis sinensis* | 0(0-0) |
| ***Protozoa*** | 21 (5-66) | *Toxoplasma gondii* | 20 (9-37) | *Fasciola* spp. | 0.01(0.005-0.04) |
| *Cryptosporidium* spp. | 12 (0-45) | **Chemical and toxins** | 7 (3-21) | Intestinal fluke | 0(0-0) |
| *Entamoeba histolytica* | 5 (0-41) | Aflatoxin | 3 (1-8) | *Opisthorchis* spp. | 0(0-0) |
| *Giardia* spp. | 0.7 (0-3) | Cassava cyanide | 1 (0.3-9) | *Paragonimus* spp | 0.008(0.002-0.02) |
| | | Dioxins | 0.2 (0.09-9) | | |
| **Total DALYs 1,179 (726-1,764)** | | | | | |

Source: Havelaar et al. (2015)

**Disease priorities**

Parallel to the Ethiopian government's plan to increase the number and productivity of livestock in the Second Growth and Transformation Plan (GTP II), a zoonotic disease prioritization workshop was conducted in September 2015 to prepare a national strategy to prevent and control the most important zoonotic diseases in the country (ELMP, 2015). Given the technical and financial limitations to addressing all of the zoonotic diseases in the country, disease prioritization was done based on severity in humans, the proportion of human diseases attributed to animal exposure, the impact of animal disease at household level, the availability of intervention methods, and the existence of inter-sectoral collaboration. The first five selected diseases to be tackled through the establishment of a One Health-focused Zoonotic Disease Unit in the coming five years are rabies, echinococcosis, anthrax, brucellosis, and leptospirosis. The second tier of disease priorities includes Q fever, salmonellosis, BTB (*M. bovis*), leishmaniosis, cysticercosis/taeniasis, toxoplasmosis, and listeriosis (Anonymous, 2015).

**Factors impacting disease incidence**

Several factors have been reported to associate with the incidence of food-borne and zoonotic diseases. These factors include: poor sanitation and open defecation (Amenu et al., 2014; Kebede et al., 2009); backyard slaughter; the tradition of consuming raw milk (Tschopp et al., 2013) and raw or under cooked meat (called "kitfo," "dulet," "kourt"; Kebede et al., 2009; Tadesse & Gebremedhin, 2015); malnutrition and other endemic diseases like HIV-AIDS (Tadesse & Gebremedhin, 2015); poor implementation of food safety regulations and risk-based food safety systems (Jabbar, 2012); poorly equipped food processing plants and slaughterhouses; lack of awareness about foodborne and zoonotic diseases in the society (Amenu et al., 2010); and lack of food storage facilities such as refrigeration, due to poor electricity coverage and unaffordable prices (Tadesse & Gebremedhin, 2015).

**Impact on nutritional status and health**

There are no studies that show the impact of foodborne and zoonotic diseases on nutritional status and health in Ethiopia. However, a recent review and mapping study on zoonotic diseases in developing countries revealed that there is a 99% correlation between national malnutrition, an indicator of poverty, and zoonotic disease burden (Grace et al., 2012). The same study reported that 56 zoonotic diseases cause 2.6 billion cases of human illness and 2.7 million deaths per year globally. In Ethiopia, the estimate of child death due to diarrhea for the year 2010 was 23,700, the major causes of which were linked to foodborne pathogens such as enteropathogenic and enterotoxigenic *E. coli* (Das et al., 2014).

## 4 Recommendations of Assessments Conducted and Follow-up Actions

Upon the request of the Ethiopian government, the World Organization for Animal Health (OIE) carried out a Performance of Veterinary Services (PVS) evaluation in 2011 (Samuel Mulat, personal communication). The assessment had four components: human, physical and financial resources; technical authority and capability; interaction with stakeholders; and access to markets. This evaluation was followed by a gap analysis using the PVS Gap Analysis Tool, looking at competencies, strategies, resources, and activities. Following the OIE analyses, the Ministry of Livestock and Fisheries (MoLF) prepared an animal health strategy, putting into consideration the outcomes of the analyses and the given recommendations. In line with the country's gender mainstreaming program, attention has been given to promote women's participation in the strategy (Samuel Mulat, personal communication).

## 5 On-going Disease Control Programs and Their Impact

In Ethiopia, very few national disease control programs are underway and the livestock disease control process is mainly dominated by prophylaxis. A 42-month control program for PPR in pastoral areas was launched in February 2015 with funds secured from the European Union. A five-year national sheep and goat ectoparasite control project was started in January 2012. Since 1997, eradication of the tsetse fly, the

vector of the protozoa *Trypanosoma*, has been carried out in the southern Great Rift Valley of Ethiopia with the support of the International Atomic Energy Agency (EAHYB, 2012).

**Current surveillance activities**

Livestock disease surveillance is carried out at both federal and regional levels in Ethiopia. At the federal level, the Animal and Plant Diseases/Pest Risk Analysis Administration Case team (now the Epidemiology Directorate under MoLF) guides overall surveillance activities and central animal health data collection, collation, analysis, and dissemination. The National Animal Health Diagnostics and Investigation Center (NAHDIC) also conducts and coordinates surveillance activities, besides serving as a referral diagnostic center and guiding Regional Veterinary Laboratories (RVLs). The National Veterinary Institute (NVI) provides diagnostic and surveillance service for emergency preparedness, in addition to its main mandate of vaccine production. The National Tsetse and Trypanosomiasis Investigation and Control Center (NTTICC) and the South Tsetse Eradication Project carry out surveillance of tsetse-borne and non-tsetse trypanosomiasis.

At the regional level, RVLs conduct surveillance and diagnoses in their respective regions. Slaughterhouses, disease control and eradication projects, quarantine stations, check points, and international entry and exit ports are also involved in active and/or passive surveillance activities (EAHYB, 2012).

The Veterinary Public Health Directorate of MoLF is responsible for inspection of meat, milk, and farms for food-borne and zoonotic diseases. The surveillance of human disease is conducted by the Ethiopian Public Health Institute (EPHI), which is under the Ministry of Health (MoH). In EPHI, the department of Public Health Emergency Management (PHEM) is responsible for human diseases/health surveillance, the department of Nutrition and Food Science is responsible for inspection of hotels and other food catering firms, and the Department of Zoonoses carries out surveillance of zoonotic diseases.

There is one national referral diagnostic center at NAHDIC that provides, among other services, diagnostic services for all export animals and animal products, along with capacity building for the 14 RVLs (Retrieved from http://nahdic.gov.et/node/2 January 13, 2016). The RVLs are mandated to conduct surveillance and diagnostic activities in their respective regions. Besides the routine bacteriological, serological, and parasitological procedures that are being conducted in NAHDIC and RVLs, diagnosis and investigation of highly pathogenic agents like HPAI and other zoonotic diseases are carried out at NAHDIC, and cell culture and feed analysis is carried out at NVI (Retrieved from http://www.nvi.com.et/index.html# January 13, 2016).

The data collected for surveillance includes outbreak investigations, data from abattoirs and quarantine stations, and disease reports from districts. NAHDIC carries out active surveillance for diseases of national and transboundary concern, such as PPR, FMD, RVF, CBPP, BTB, HPAI, and IBD (EAHYB, 2012). The Epidemiology Directorate in the MoLF is responsible for collection, analysis and dissemination of information about animal health in the country (EAHYB, 2012). Data collection, analysis, and dissemination of information about human diseases is carried out by EPHI.

The surveillance information is used to understand the overall situation and trends of animal health, to promptly take action if exotic diseases are introduced, to work toward freedom from diseases, to prioritize interventions, and to monitor effectiveness of disease under control and eradication programs (EAHYB, 2012).

**Structure of animal health and food safety management**

Actors for animal health are: MoFL; regional and district animal health bureaus; Veterinary Drugs and Feed Administration and Control Authority (VDFACA); veterinary drug and input importers, distributers,

and dispensers; the Ethiopian Veterinary Association; and farmers/pastoralists. Actors for food safety are MoLF, MoH, slaughterhouses, food manufacturers, food traders, food inspectors, animal and human health experts, producers such as farmers or pastoralists, consumers, and professional associations such as the Ethiopian Veterinary Association (EVA), the Ethiopian Public Health Association (EPHA), EPHI, and the Ethiopian Standards Agency (ESA, under the Ministry of Science and Technology/MoST).

The main stakeholder for animal health is MoLF, and the main stakeholders for food safety and zoonoses include MoLF, MoH, and ESA. Six directorates exist under the State Ministry of Animal Health and Feed (in MoLF): the Epidemiology Directorate, the Disease Prevention and Control Directorate, the Veterinary Public Health Directorate, the Export Abattoirs Inspection and Certification Directorate, the Quarantine Inspection and Certification Directorate, and the Livestock Identification and Traceability Directorate. The Veterinary Public Health Directorate has two case teams: Zoonoses and Food Safety. Other stakeholders for food safety include VDFACA (under MoLF), which has laboratories that test raw animal products for residues and microbes; the Ethiopian Food, Medicine, and Health Care Administration (EFMHCA, under MoH); EPHI; and ESA. The Ministry of Trade and Industry and the Ethiopian Manufacturing Industries Association are also involved in organizing training, setting standards, and drafting regulations with MoH and MoLF, especially for export food items.

**One Health platforms**

In Ethiopia, several institutions have recognized the significance of the One Health approach to tackle animal, environmental, and human problems under one umbrella. Many discussion forums have been held among MoH, the Ministry of Agriculture, the Ministry of Environment, the Ministry of Education, and professional associations, such as EVA and EPHA, to collaborate and create joint ventures. The discussion forums have brought a change of attitude among the participating stakeholders, indicated their interest in promoting this platform; however, a One Health policy has not yet been formulated. There are fragmented efforts in various institutions to practice a One Health approach. For instance, Jimma and Mekelle universities are included in the network of One Health Central and Eastern Africa (OHCEA) (Moti Yohaness, Personal communication), which promotes a One Health approach through multi-disciplinary research, training, and community service (http://ohcea.org accessed January 13, 2016). MoH also uses a One Health approach to address the problems of pastoralists. Moreover, the recent interest of MoLF and MoH to establish a One Health-focused Zoonotic Disease Unit will be a groundbreaking stride toward realizing widely accepted and fully functioning One Health platforms in Ethiopia. The Ethiopian Livestock Master Plan also embraces establishing a One Health Forum at federal and regional levels (ELMP, 2015).

In the realm of gender issues, the Ethiopian government has a gender mainstreaming program where equality of both men and women is generally promoted in all developmental activities, and where women's participation in the agricultural sector is particularly encouraged at all levels. Some NGOs follow as a rule to make at least 30% of their beneficiaries women (Samuel Mulat, personal communication). The gender mainstreaming of the Ministry of Agriculture also includes human resources (staff) balance based on gender at all levels (MoA, 2011).

## Literature Cited

Abebe, A. 1990. Prevalence of Q fever infection in the Addis Ababa abattoir. Ethiopian Medical Journal. 28(3):119-122.

Abera, B., Biadegelgen, F., and Bezabih, B. 2010. Prevalence of *Salmonella typhi* and intestinal parasites among food handlers in Bahir Dar Town, Northwest Ethiopia. Ethiopian Journal of Health Development. 24.

Abera, B. H., Eshetu, L., Mengistu, W., and Hailesilassie, M. 2011. Seroprevalence of contagious caprine pleuropneumonia in Tigray and Afar, northern Ethiopia. In: Animal hygiene and sustainable livestock production. Proceedings of the XVth International Congress of the International Society for Animal Hygiene 3-7 July 2011 2011. Vienna, Austria, 1 (2011). 229-232.

Abraham, G., Sintayehu, A., Libeau, G., Albina, E., Roger, F., Laekemariam, Y., Abayneh, D., and Awoke, K. M. 2005. Antibody seroprevalences against peste des petits ruminants (PPR) virus in camels, cattle, goats and sheep in Ethiopia. Preventive Veterinary Medicine. 70(1-2):51-57.

Abunna, F., Asfaw, L., Megersa, B., and Regassa, A. 2010. Bovine fasciolosis: coprological, abattoir survey and its economic impact due to liver condemnation at Soddo municipal abattoir, southern Ethiopia. Tropical Animal Health and Production. 42(2):289-292. doi: 10.1007/s11250-009-9419-3

Abunna, F., Tilahun, G., Megersa, B., Regassa, A., and Kumsa, B. 2008. Bovine cysticercosis in cattle slaughtered at Awassa municipal abattoir, Ethiopia: Prevalence, cyst viability, distribution and its public health implication. Zoonoses and Public Health. 55(2):82-88. doi: 10.1111/j.1863-2378.2007.01091.x

Addis, B., Tadesse, D., and Mekuriaw, S. 2014. Study on major causes of chicken mortality and associated risk factors in Bahir Dar Zuria District, Ethiopia. African Journal of Agricultural Research. 9(48):3465-3472.

AGP-LMD. 2013a. Agricultural Growth Program - Livestock Market Development. End market analysis for meat/live animals, leather and leather products, dairy products value chains. Cultivating New Frontiers in Agriculture (CNFA). http://www.cnfa.org/program/agricultural-growth-program-livestock-market-development-2/

–. 2013b. Agricultural Growth Project - Livestock Market Development. Value Chain Analysis for Ethiopia: Meat and Live Animals, Hides, Skins and Leather, and Dairy. U.S. Agency for International Development. https://www.usaid.gov/sites/default/files/documents/1860/AGP-LMD%20Value%20Chain%20Analysis.pdf

Alemayehu, K. and Fantahun, T. 2012. The effect of climate change on ruminant livestock population dynamics in Ethiopia. Livestock Research for Rural Development. 24(185). http://www.lrrd.org/lrrd24/10/kefy24185.htm

Ali, A., Mengistu, F., Hussen, K., Getahun, G., Deressa, A., Yimer, E., and Tafese, K. 2010. Overview of Rabies in and around Addis Ababa, in animals examined in EHNRI Zoonoses Laboratory between, 2003 and 2009. Ethiopian Veterinary Journal. 14(2):91-101. doi: 10.4314/evj.v14i2.63927

Ameni, G., Aseffa, A., Engers, H., Young, D., Gordon, S., Hewinson, G., and Vordermeier, M. 2007. High prevalence and increased severity of pathology of bovine tuberculosis in Holsteins compared to zebu breeds under field cattle husbandry in central Ethiopia. Clinical and Vaccine Immunology. 14(10):1356-1361.

Amenu, K., Spengler, M., Markemann, A., and Zarate, A. V. 2014. Microbial quality of water in rural households of Ethiopia: implications for milk safety and public health. Journal of Health, Population, and Nutrition. 32(2):190-197.

Amenu, K., Thys, E., Regassa, A., and Marcotty, T. 2010. Brucellosis and Tuberculosis in Arsi-Negele District, Ethiopia: Prevalence in Ruminants and People's Behaviour towards Zoonoses. Tropicultura. 28(4):205-210.

Andargie, G., Kassu, A., Moges, F., Tiruneh, M., and Huruy, K. 2008. Prevalence of bacteria and intestinal parasites among food-handlers in Gondar town, northwest Ethiopia. Journal of Health, Population, and Nutrition. 26(4):451-455.

Anonymous. 2015. Zoonotic disease prioritization [PA1]for inter-sectoral engagement in Ethiopia. 29-30 2015. Addis Ababa, Ethiopia.

Anyamba, A., Chretien, J. P., Small, J., Tucker, C. J., Formenty, P. B., Richardson, J. H., Britch, S. C., Schnabel, D. C., Erickson, R. L., and Linthicum, K. J. 2009. Prediction of a Rift Valley fever outbreak. Proceedings of the National Academy of Sciences of the United States of America. 106:955-959. doi: 10.1073/pnas.0806490106

Ashenafi, F., Teshale, S., Ejeta, G., Fikru, R., and Laikemariam, Y. 2007. Distribution of brucellosis among small ruminants in the pastoral region of Afar, eastern Ethiopia. Revue scientifique et technique (International Office of Epizootics). 26(3):731-739.

Ashenafi, H. and Eshetu, Y. 2004. Study on Gastrointestinal Helminths of Local Chickens in Central Ethiopia. Revue de Médecine Vétérinaire. 155:504-507.

Ashenafi, H., Tolossa, Y. H., and Yebegaeshet, M. 2014. Impact of sheep and goats ectoparasites on the tanning industry in Tigray region, Ethiopia. Ethiopian Veterinary Journal. 17(2):63-76.

Asmare, K., Sibhat, B., Molla, W., Ayelet, G., Shiferaw, J., Martin, A. D., Skjerve, E., and Godfroid, J. 2013. The status of bovine brucellosis in Ethiopia with special emphasis on exotic and cross bred cattle in dairy and breeding farms. Acta Tropica. 126(3):186-192. doi: 10.1016/j.actatropica.2013.02.015

Asseged, B., Woldesenbet, Z., Yimer, E., and Lemma, E. 2004. Evaluation of abattoir inspection for the diagnosis of *Mycobacterium bovis* infection in cattle at Addis Ababa abattoir. Tropical Animal Health and Production. 36(6):537-546.

Atnafie, B., Goba, H., Sorri, H., and Kasaye, S. 2015. Sero-prevalence of contagious bovine pleuropneumonia in abattoirs at Bishoftu and export oriented feedlots around Adama. Global Veterinaria. 15(3):321-324.

Ayelet, G., Abate, Y., Sisay, T., Nigussie, H., Gelaye, E., Jemberie, S., and Asmare, K. 2013. Lumpy skin disease: preliminary vaccine efficacy assessment and overview on outbreak impact in dairy cattle

at Debre Zeit, central Ethiopia. Antiviral Research. 98(2):261-265. doi: 10.1016/j.antiviral.2013.02.008

Ayelet, G., Gelaye, E., Negussie, H., and Asmare, K. 2012. Study on the epidemiology of foot and mouth disease in Ethiopia. Revue scientifique et technique (International Office of Epizootics). 31(3):789-798.

Ayelet, G., Mahapatra, M., Gelaye, E., Egziabher, B. G., Rufeal, T., Sahle, M., Ferris, N. P., Wadsworth, J., Hutchings, G. H., and Knowles, N. J. 2009. Genetic characterization of foot-and-mouth disease viruses, Ethiopia, 1981-2007. Emerging Infectious Diseases. 15(9):1409-1417.

Ayelet, G. H., R; Jemberie, S; Belay, A; Gelaye, E; Sibhat, B; Skjerve, E; and Asmare, K. 2014. Lumpy skin disease in cattle in central Ethiopia: outbreak investigation and isolation and molecular detection of the virus. Revue scientifique et technique (International Office of Epizootics). 33(3):877-887.

Bekele, T., Asfaw, Y., Gebre-Egziabeher, B., and Abebe, G. 2011. Seroprevalence of contagious caprine pleuropneumonia in Borana and Guji lowlands, Southern Ethiopia. Ethiopian Veterinary Journal. 15(2).

Berhane, Y. and Tefera, A. 2005. Avian flu pandemic threat: Why is Ethiopia considered at risk? Ethiopian Journal of Health Development. 19(3):165.

Beyi, A. F. 2012. Costs and benefits of foot and mouth disease vaccination practices in commercial dairy farms in Central Ethiopia. MSc Thesis, Wageningen University, The Netherlands.

Beyi, A. F., Gezahegne, K. Z., Mussa, A., Ameni, G. and Ali, M. S. 2014. Prevalence of bovine tuberculosis in dromedary camels and awareness of pastoralists about its zoonotic importance in Eastern Ethiopia. Journal of Veterinary Medicine and Animal Health. 6(4):109-115. doi: 10.5897/JVMAH2014.0284

Biffa, D., Jobre, Y., and Chakka, H. 2006. Ovine helminthosis, a major health constraint to productivity of sheep in Ethiopia. Animal Health Research Reviews. 7(1-2):107-118.

Birhanu, T., Alebie, A., Giro, B., and Chanie, M. 2014. Prevalence of Gastro Intestinal Nematodes of Camel Slaughtered at Akaki Abattoir, Addis Ababa, Ethiopia. Acta Parasitologica Globalis. 5(3):177-182. doi: 10.5829/idosi.apg.2014.5.3.8535

Catley, A., Admassu, B., Bekele, G., and Abebe, D. 2014. Livestock mortality in pastoralist herds in Ethiopia and implications for drought response. Disasters. 38(3):500-516. doi: 10.1111/disa.12060

Chaka, H., Goutard, F., Bisschop, S. P., and Thompson, P. N. 2012. Seroprevalence of Newcastle disease and other infectious diseases in backyard chickens at markets in eEstern Shewa zone, Ethiopia. Poultry Science. 91(4):862-869. doi: 10.3382/ps.2011-01906

CSA. 2015. Agricultural Sample Survey 2014/15 [2007 E.C.], Volume II. Report on livestock and livestock characteristics (private peasant holdings). Central Statistical Agency (CSA). Addis Ababa.

Dadi, L. and Asrat, D. 2008. Prevalence and antimicrobial susceptibility profiles of thermotolerant Campylobacter strains in retail raw meat products in Ethiopia. Ethiopian Journal of Health Development. 22(2):195-200. doi: 10.4314/ejhd.v22i2.10072

Dagnachew, S., Amamute, A., and Temesgen, W. 2011. Epidemiology of gastrointestinal helminthiasis of small ruminants in selected sites of North Gondar zone, Northwest Ethiopia. Ethiopian Veterinary Journal. 15(2):57-68.

Das, J. K., Salam, R. A., and Bhutta, Z. A. 2014. Global burden of childhood diarrhea and interventions. Current opinion in infectious diseases. 27(5):451-458. doi: 10.1097/QCO.0000000000000096

Dawo, F. 2010. Mysterious mortality in camels (*Camelus dromedarius*) in Borana, Ethiopia: evidence of its association with reproductive age groups. Revue scientifique et technique (International Office of Epizootics). 29(3):621-8.

Demelash, K., Alemu, F., Niguse, A., and Feyera, T. 2014. Prevalence of gastrointestinal Parasites and Efficacy of Anthelmintics Against Nematodes in Camels in Yabello District, Southern Ethiopia. Acta Parasitologica Globalis. 5(3):223-231. doi: 10.5829/idosi.apg.2014.5.3.85129

Deressa, A., Ali, A., Bayene, M., Selassie, B. N., Yimer, E., and Hussen, K. 2010. The status of rabies in Ethiopia: A retrospective record review. Ethiopian Journal of Health Development. 24(2).

Dubey, J., Darrington, C., Tiao, N., Ferreira, L., Choudhary, S., Molla, B., and Gebreyes, W. 2013. Isolation of viable *Toxoplasma gondii* from tissues and feces of cats from Addis Ababa, Ethiopia. The Journal of Parasitology. 99(1):56-58. doi: 10.1645/GE-3229.1

Dubey, J. P., Tiao, N., Gebreyes, W. A., and Jones, J. L. 2012. A review of toxoplasmosis in humans and animals in Ethiopia. Epidemiology and Infection. 140(11):1935-1938.

Duguma, B., Kechero, Y., and Janssens, G. P. J. 2012. Survey of major diseases affecting dairy cattle in Jimma town, Oromia, Ethiopia. Global Veterinaria. 8(1):62-66.

Duguma, R., Tasew, S., Olani, A., Damena, D., Alemu, D., Mulatu, T., Alemayehu, Y., Yohannes, M., Bekana, M., and Hoppenheit, A. 2015. Spatial distribution of *Glossina sp*. and *Trypanosoma sp*. in south-western Ethiopia. Parasites & Vectors. 8:1-10. doi: 10.1186/s13071-015-1041-9

Dulo, F., Feleke, A., Szonyi, B., Fries, R., Baumann, M. P. O., and Grace, D. 2015. Isolation of multidrug-resistant *Escherichia coli* O157 from goats in the Somali region of Ethiopia: a cross-sectional, abattoir-based study. *PloS one*, 10, e0142905. http://dx.doi.org/10.1371/journal.pone.0142905

EAHYB. 2012. Ethiopia Animal Health Yearbook 2011. Addis Ababa, Ethiopia.

ELMP. 2015. Ethiopia Livestock Master Plan. Roadmaps for growth and transformation. A contribution to The Growth and Transformation Plan II (2015-2020). ILRI Editorial and Publishing Services: Addis Ababa, Ethiopia.

Emiru, B., Amede, Y., Tigre, W., Feyera, T., and Deressa, B. 2013. Epidemiology of Gastrointestinal Parasites of Small Ruminants in Gechi District, Southwest Ethiopia. Advances in Biological Research. 7(5):169-174. doi:10.5829/idosi.abr.2013.7.5.74176

ESGPIP. 2009. Sheep and goat pox: Causes, prevention and treatment. Ethiopian Sheep and Goat Productivity Improvement Program (ESGPIP). Technical Bulletin No.29.

Ewnetu, D. and Mihret, A. 2010. Prevalence and antimicrobial resistance of Campylobacter isolates from humans and chickens in Bahir Dar, Ethiopia. Foodborne Pathogens and Disease. 7(6):667-670. doi: 10.1089/fpd.2009.0433

Fikru, R., Andualem, Y., Getachew, T., Menten, J., Hasker, E., Merga, B., Goddeeris, B. M., and Büscher, P. 2015. Trypanosome infection in dromedary camels in Eastern Ethiopia: prevalence, relative performance of diagnostic tools and host related risk factors. Veterinary Parasitology. 211(3-4):175-81. doi: 10.1016/j.vetpar.2015.04.008

Firdessa, R., Berg, S., Hailu, E., Schelling, E., Gumi, B., Erenso, G., Gadisa, E., Kiros, T., Habtamu, M., Hussein, J., Zinsstag, J., Robertson, B. D., Ameni, G., Lohan, A. J., Loftus, B., Comas, I., Gagneux, S., Tschopp, R., Yamuah, L., Hewinson, G., Gordon, S. V., Young, D. B., and Aseffa, A. 2013. Mycobacterial lineages causing pulmonary and extrapulmonary tuberculosis, Ethiopia. Emerging Infectious Diseases. 19(3):460-463. doi: 10.3201/eid1903.120256

Firdessa, R., Tschopp, R., Wubete, A., Sombo, M., Hailu, E., Erenso, G., Kiros, T., Yamuah, L., Vordermeier, M., and Hewinson, R. G. 2012. High prevalence of bovine tuberculosis in dairy cattle in central Ethiopia: implications for the dairy industry and public health. PloS one, 7, e52851. http://dx.doi.org/10.1371/journal.pone.0052851

Fromsa, A. and Jobre, Y. 2012. Estimated annual economic loss from organ condemnation, decreased carcass weight and milk yield due to bovine hydatidosis (*Echinococcus granulosus*, Batsch, 1786) in Ethiopia. Ethiopian Veterinary Journal. 16(2):1-14.

Gadisa, E., Tsegaw, T., Abera, A., Elnaiem, D.-E., Den Boer, M., Aseffa, A., and Jorge, A. 2015. Eco-epidemiology of visceral leishmaniasis in Ethiopia. Parasites & Vectors. 8:381**.** doi: 10.1186/s13071-015-0987-y

Garedew-Kifelew, L., Wondafrash, N., and Feleke, A. 2014. Identification of drug-resistant Salmonella from food handlers at the University of Gondar, Ethiopia. BMC Research Notes. 7:545. doi: 10.1186/1756-0500-7-545

Gari, G., Bonnet, P., Roger, F., and Waret-Szkuta, A. 2011. Epidemiological aspects and financial impact of lumpy skin disease in Ethiopia. Preventive Veterinary Medicine. 102(4):274-283. doi: 10.1016/j.prevetmed.2011.07.003

Gari, G., Grosbois, V., Waret-Szkuta, A., Babiuk, S., Jacquiet, P., and Roger, F. 2012. Lumpy skin disease in Ethiopia: Seroprevalence study across different agro-climate zones. Acta Tropica. 123(2):101-106. doi: 10.1016/j.actatropica.2012.04.009

GBD. 2010. Global burden of diseases, injuries, and risk factors study 2010. GBD profile: Ethiopia. http://www.healthmetricsandevaluation.org (Accessed 24 January 2016.)

Gebremedhin, E. Z. and Tadesse, G. 2015. A meta-analysis of the prevalence of *Toxoplasma gondii* in animals and humans in Ethiopia. Parasites & Vectors. 8:291. doi: 10.1186/s13071-015-0901-7

Gedlu, M. 2004. Serological, clinical and participatory epidemiological survey of contagious bovine pleuropneumonia in Somali region, Ethiopia. AAU. MSc thesis, Addis Ababa University, Ethiopia.

Gelaye, E., Belay, A., Ayelet, G., Jenberie, S., Yami, M., Loitsch, A., Tuppurainen, E., Grabherr, R., Diallo, A., and Lamien, C. E. 2015. Capripox disease in Ethiopia: genetic differences between field isolates and vaccine strain, and implications for vaccination failure. Antiviral Research. 119:28-35. doi: 10.1016/j.antiviral.2015.04.008

Getachew, B., Kyule, M. N., Balcha, M., and Dawo, F. 2014. Seroprevalence of Newcastle disease virus antibodies in village chickens in Kersana-Kondalaity district, Ethiopia. Global Veterinaria. 12(3):426-430. doi: 10.5829/idosi.gv.2014.12.03.8389

Grace, D., Mutua, F., Ochungo, P., Kruska, R., Jones, K., Brierley, L., Lapar, L., Said, M., Herrero, M., and Phuc, P. M. 2012. Mapping of poverty and likely zoonoses hotspots. Zoonoses Project 4, report to Department for International Development, UK. International research Institute, July 2012.

Gumi, B., Firdessa, R., Yamuah, L., Sori, T., Tolosa, T., Aseffa, A., Zinsstag, J., and Schelling, E. 2013. Seroprevalence of brucellosis and Q-Fever in southeast Ethiopian pastoral livestock. Journal of Veterinary Science & Medical Diagnosis. 2(1). doi: 10.4172/2325-9590.1000109

Gumi, B., Schelling, E., Berg, S., Firdessa, R., Erenso, G., Mekonnen, W., Hailu, E., Melese, E., Hussein, J., and Aseffa, A. 2012a. Zoonotic transmission of tuberculosis between pastoralists and their livestock in South-East Ethiopia. EcoHealth. 9(2):139-149. doi: 10.1007/s10393-012-0754-x

Gumi, B., Schelling, E., Firdessa, R., Aseffa, A., Tschopp, R., Yamuah, L., Young, D., and Zinsstag, J. 2011. Prevalence of bovine tuberculosis in pastoral cattle herds in the Oromia region, southern Ethiopia. Tropical Animal Health and Production. 43(6):1081-1087. doi: 10.1007/s11250-010-9777-x

Gumi, B., Schelling, E., Firdessa, R., Erenso, G., Biffa, D., Aseffa, A., Tschopp, R., Yamuah, L., Young, D., and Zinsstag, J. 2012b. Low prevalence of bovine tuberculosis in Somali pastoral livestock, southeast Ethiopia. Tropical Animal Health and Production. 44(7):1445-1450.

Habtamu, T. T., Richard, B., Dana, H., and Kassaw, A. T. 2015. Camel brucellosis: its public health and economic impact in pastoralists, Mehoni district, southeastern Tigray, Ethiopia. Journal of Microbiology Research. 5(5):149-156. doi:10.5923/j.microbiology.20150505.02

Hailu, B., Tolosa, T., Gari, G., Teklue, T., and Beyene, B. 2014. Estimated prevalence and risk factors associated with clinical lumpy skin disease in northeastern Ethiopia. Preventive Veterinary Medicine. 115(1-2):64-68. doi: 10.1016/j.prevetmed.2014.03.013

Havelaar, A. H., Kirk, M. D., Torgerson, P. R., Gibb, H. J., Hald, T., Lake, R. J., and Etal. 2015. World Health Organization global estimates and regional comparisons of the burden of foodborne disease in 2010. PLoS Medicine. 12. http://dx.doi.org/10.1371/journal.pmed.1001923

Hiko, A., Asrat, D., and Zewde, G. 2008. Occurrence of *Escherichia coli* O157: H7 in retail raw meat products in Ethiopia. The Journal of Infection in Developing Countries. 2(5):389-393.

Jabbar, M. A. and Grace, D. 2012. Regulations for safety of animal source foods in selected Sub-Saharan African countries: Current status and their implications. Prepared for The Safe Food, Fair Food Project. International Livestock Research Institute, Nairobi, Kenya. January 2012.

Jemberu, W. T., Mourits, M. C. M., Sahle, M., Siraw, B., Vernooij, J. C. M., and Hogeveen, H. 2015. Epidemiology of foot and mouth disease in Ethiopia: a retrospective analysis of district level outbreaks, 2007–2012. Transboundary and Emerging Diseases. doi: 10.1111/tbed.12338

Jergefa, T., Kelay, B., Bekana, M., Teshale, S., Gustafson, H., and Kindahl, H. 2009. Epidemiological study of bovine brucellosis in three agro-ecological areas of central Oromiya, Ethiopia. Revue Scientifique et Technique (International Office of Epizootics). 28(3):933-943 .

Kassa, G. M., Abebe, F., Worku, Y., Legesse, M., Medhin, G., Bjune, G., and Ameni, G. 2012. Tuberculosis in Goats and Sheep in Afar Pastoral Region of Ethiopia and Isolation of *Mycobacterium tuberculosis* from Goat. Veterinary Medicine International. 869146. doi: 10.1155/2012/869146

Kassahun, J., Yimer, E., Geyid, A., Abebe, P., Newayeselassie, B., Zewdie, B., Beyene, M., and Bekele, A. 2006. Sero-prevalence of brucellosis in occupationally exposed people in Addis Ababa, Ethiopia. Ethiopian Medical Journal. 44(3):245-252.

Kassaye, D. and Molla, W. 2012. Seroprevalence of contagious bovine pleuropneumonia at export quarantine centers in and around Adama, Ethiopia. Tropical Animal Health and Production. 45(1):275-279. doi: 10.1007/s11250-012-0212-3

Kassayeq, E. and Kebede, E. 2010. Epidemiological study on manage mite, lice and sheep keds of small ruminants in Tigray region, northern Ethiopia. Ethiopian Veterinary Journal. 14(2):51-66.

Kebede, N., Mitiku, A., and Tilahun, G. 2010. Retrospective survey of human hydatidosis in Bahir Dar, northwestern Ethiopia. Eastern Mediterranean Health Journal. 16(9):937-41.

Kebede, N., Tilahun, G., and Hailu, A. 2009. Current status of bovine cysticercosis of slaughtered cattle in Addis Ababa Abattoir, Ethiopia. Tropical Animal Health and Production. 41(3):291-294. doi: 10.1007/s11250-008-9188-4

Koskei, P., Janitschke, K., and Feseha, G. 2014. Prevalence of *Echinococcus granulosus* in some selected sites of Ethiopia. East African Journal of Public Health. 8(3):170-175.

Kumsa, B., Beyecha, K., and Geloye, M. 2012. Ectoparasites of sheep in three agro-ecological zones in central Oromia, Ethiopia. Onderstepoort Journal of Veterinary Research. 79(1):1-7. http://www.ojvr.org/index.php/ojvr/article/view/442/719

Kumsa, B., Debela, E., and Megersa, B. 2010. Comparative Efficacy of Albendazole, Tetramisole and Ivermectin Against Gastrointestinal Nematodes in nNaturally Infected Goats in Ziway, Oromia Regional State (Southern Ethiopia). Journal of Animal and Veterinary Advances. 9(23):2905-2911. doi: 10.3923/javaa.2010.2905.2911

Kumsa, B., Tadesse, T., Sori, T., Dugum, R., and Hussen, B. 2011. Helminths of Sheep and Goats in Central Oromia (Ethiopia) During the Dry Season. Journal of Animal and Veterinary Advances. 10(14):1845-1849. doi: 10.3923/javaa.2011.1845.1849

Kumsa, B. and Wossene, A. 2007. Abomasal nematodes of small ruminants of Ogaden region, eastern Ethiopia: prevalence, worm burden and species composition. Revue de Médecine Vétérinaire. 158(1):27-32.

Laval, G. 1999. Cost analysis of contagious bovine pleuropneumonia in Ethiopia. Unpublished.

Leforban, Y. 2005. Report of a mission on foot and mouth disease in Ethiopia. Proposals for a strategic plan for a control program oriented to the export, 10–22 April 2005.

Leta, S., De Clercq, E. M., and Madder, M. 2013. High-resolution predictive mapping for *Rhipicephalus appendiculatus* (Acari: Ixodidae) in the Horn of Africa. Experimental and Applied Acarology. 60(4):531-542. doi: 10.1007/s10493-013-9670-1

Lund, B. M. 2015. Microbiological Food Safety for Vulnerable People. International Journal of Environmental Research and Public Health. 12(8):10117-10132. doi: 10.3390/ijerph120810117

Mazengia, H. 2012. Review on major viral diseases of chickens reported in Ethiopia. Journal of Infectious Diseases and Immunity. 4(1):1-9. doi: 10.5897/JIDIx11.001

Mazengia, H., Bekele, S. T., and Negash, T. 2009. Incidence of infectious bursal disease in village chickens in two districts of Amhara region, northwest Ethiopia. Livestock Research for Rural Development. 21(12):214. http://www.lrrd.org/lrrd21/12/maze21214.htm

Megersa, B. 2010. An epidemiological study of major camel diseases in the Borana lowland, Southern Ethiopia. Drylands Coordination Group (DCG) Report, 2.

Megersa, B., Beyene, B., Abunna, F., Regassa, A., Amenu, K., and Rufael, T. 2009. Risk factors for foot and mouth disease seroprevalence in indigenous cattle in southern Ethiopia: the effect of production system. Tropical Animal Health and Production. 41(6):891-898. doi: 10.1007/s11250-008-9276-5

Megersa, B., Biffa, D., Abunna, F., Regassa, A., Bohlin, J., and Skjerve, E. 2012. Epidemic characterization and modeling within herd transmission dynamics of an "emerging trans-boundary" camel disease epidemic in Ethiopia. Tropical Animal Health and Production. 44(7):1643-1651. doi: 10.1007/s11250-012-0119-z

Megersa, B., Biffa, D., Abunna, F., Regassa, A., Godfroid, J., and Skjerve, E. 2011a. Seroprevalence of brucellosis and its contribution to abortion in cattle, camel, and goat kept under pastoral management in Borana, Ethiopia. Tropical Animal Health and Production. 43(3):651-656. doi: 10.1007/s11250-010-9748-2

Megersa, B., Biffa, D., Belina, T., Debela, E., Regassa, A., Abunna, F., Rufael, T., Stubsjøen, S. M., and Skjerve, E. 2011b. Serological investigation of Peste des Petits Ruminants (PPR) in small ruminants managed under pastoral and agro-pastoral systems in Ethiopia. Small Ruminant Research. 97(1-3):134-138. doi:10.1016/j.smallrumres.2011.03.003

Megersa, B., Tesfaye, E., Regassa, A., Abebe, R., and Abunna, F. 2010. Bovine cysticercosis in cattle slaughtered at Jimma municipal abattoir, southwestern Ethiopia: Prevalence, Cyst viability and its socio-economic importance. Veterinary World. 2(2):257-262. doi: 10.5455/vetworld.2010.257-262

Mekonnen, H., Kebede, A., and Menkir, S. 2014. Isolation rate and drug resistance patterns of Shigella species among diarrheal patients attending at Hiwot Fana hospital, Harar, Ethiopia. Ethiopian Journal of Science and Technology. 7(1):15-25.

Mekuria, S., Zerihun, A., Gebre-Egziabher, B., and Tibbo, M. 2008. Participatory investigation of Contagious Caprine Pleuropneumonia (CCPP) in goats in the Hammer and Benna-Tsemay districts of southern Ethiopia. Tropical Animal Health and Production. 40(8):571-582. doi: 10.1007/s11250-008-9136-3. Epub

Mengesha, D., Molla Zewde, B., Toquin, M.-T., Kleer, J., Hildebrandt, G., and Gebreyes, W. A. 2009. Occurrence and distribution of *Listeria monocytogenes* and other listeria species in ready-to-eat and raw meat products. Vorkommen und Verteilung von *Listeria monocytogenes* und anderen Listeria spp. in verzehrsfertigen Lebensmitteln und rohem Fleisch. Berliner und Münchener Tierärztliche Wochenschrift. 122(1-2):20-4.

Mengistu, A. and Enquselassie, F. 2014. Systematic review on *Mycobacterium bovis* as potential cause of tuberculosis to humans in Ethiopia. Food and Public Health. 4:60-66.

Mersha, G., Asrat, D., Zewde, B. M., and Kyule, M. 2010. Occurrence of *Escherichia coli* O157: H7 in faeces, skin and carcasses from sheep and goats in Ethiopia. Letters in Applied Microbiology. 50(1):71-76. doi: 10.1111/j.1472-765X.2009.02757.x

MOA. 2011. Guidelines for Gender Mainstreaming in Agricultural Sector. Ministry of Agriculture (MOA), Women's Affairs Directorate. October 2011, Addis Ababa, Ethiopia.

Moch, R. W., Ebner, E. E., Barsoum, L. S., and Botros, B. A. 1975. Leptospirosis in Ethiopia: a serological survey in domestic and wild animals. The Journal of Tropical Medicine and Hygiene. 78(2):38-42.

Molla, B., Yilma, R., and Alemayehu, D. 2004. *Listeria monocytogenes* and other listeria species in retail meat and milk products in Addis Ababa, Ethiopia. Ethiopian Journal of Health Development. 18(3):208-212. doi: 10.4314/ejhd.v18i3.9962

Mummed, Y. Y. and Webb, E. C. 2015. Causes of Beef Carcass and Organ Condemnations in Ethiopia. Asian Journal of Animal and Veterinary Advances. 10:147-160.

Negera, E., Gadisa, E., Yamuah, L., Engers, H., Hussein, J., Kuru, T., Hailu, A., Gedamu, L., and Aseffa, A. 2008. Outbreak of cutaneous leishmaniasis in Silti woreda, Ethiopia: risk factor assessment and causative agent identification. Transactions of the Royal Society of Tropical Medicine and Hygiene. 102(9):883-890. doi: 10.1016/j.trstmh.2008.03.021

Negusssie, H., Kyule, M. N., Yami, M., and Ayelet, G. 2011. Outbreak investigations and genetic characterization of foot-and-mouth disease virus in Ethiopia in 2008/2009. Tropical Animal Health and Production. 43(1):235-243. doi: 10.1007/s11250-010-9683-2

Onu, S. H. and Shiferaw, T. Z. 2013. Prevalence of ectoparasite infestations of cattle in Bench Maji zone, southwest Ethiopia. Veterinary World. 6(6):291-294.

Philip, C. B., Hoogstraal, H., Reiss-Gutfreund, R., and Clifford, C. M. 1966. Evidence of rickettsial disease agents in ticks from Ethiopian cattle. Bulletin of the World Health Organization. 35(2):127-131.

Regassa, A., Abunna, F., Mulugeta, A., and Megersa, B. 2009a. Major metacestodes in cattle slaughtered at Wolaita Soddo Municipal Abattoir, Southern Ethiopia: prevalence, cyst viability, organ distribution and socioeconomic implications. Tropical Animal Health and Production. 41(7):1495-1502. doi: 10.1007/s11250-009-9338-3

Regassa, F., Sori, T., Dhuguma, R., and Kiros, Y. 2006. Epidemiology of gastrointestinal parasites of ruminants in western Oromia, Ethiopia. International Journal of Applied Research in Veterinary Medicine. 4:51. doi: 10.5829/idosi.abr.2013.7.5.74176

Regassa, G., Mekonnen, D., Yamuah, L., Tilahun, H., Guta, T., Gebreyohannes, A., Aseffa, A., Abdoel, T. H., and Smits, H. L. 2009b. Human brucellosis in traditional pastoral communities in Ethiopia. International Journal of Tropical Medicine. 4(2):59-64.

Reusken, C. B., Messadi, L., Feyisa, A., Ularamu, H., Godeke, G. J., Danmarwa, A., Dawo, F., Jemli, M., Melaku, S., Shamaki, D., Woma, Y., Wungak, Y., Gebremedhin, E. Z., Zutt, I., Bosch, B. J., Haagmans, B. L., and Koopmans, M. P. 2014. Geographic distribution of MERS coronavirus among dromedary camels, Africa. Emerging Infectious Diseases. 20(8):1370-1374. doi: 10.3201/eid2008.140590

Rufael, T., Catley, A., Bogale, A., Sahle, M., and Shiferaw, Y. 2008. Foot and mouth disease in the Borana pastoral system, southern Ethiopia and implications for livelihoods and international trade. Tropical animal Health and Production. 40(1):29-38.

Seboxa, T. and Goldhagen, J. 1989. Anthrax in Ethiopia. Tropical and Geographical Medicine. 41(2):108-112.

Shiferaw, G. 2004. Anthrax in Wabessa village in the Dessie Zuria district of Ethiopia. Revue scientifique et technique (International Office of Epizootics). 23(3):951-956.

Shiferaw, G., Tariku, S., Ayelet, G., and Abebe, Z. 2006. Contagious caprine pleuropneumonia and Mannheimia haemolytica-associated acute respiratory disease of goats and sheep in Afar region, Ethiopia. Revue scientifique et technique (International Office of Epizootics). 25(3):1153-1163.

Shitaye, J. E., Tsegaye, W., and Pavlik, I. 2007. Bovine tuberculosis infection in animal and human populations in Ethiopia: a review. Veterinarni Medicina. 52:317-332.

Solomon, A., Workalemahu, A., Jabbar, M.A., Ahmed, M.M., and Hurissa, B. 2003. Livestock marketing in Ethiopia: A review of structure, performance, and development initiatives, ILRI (aka ILCA and ILRAD). Socio-economics and Policy Research Working Paper 52. ILRI (International Livestock Research Institute), Nairobi, Kenya. 35pp.

Tadesse, G. 2014. Prevalence of human Salmonellosis in Ethiopia: a systematic review and meta-analysis. BMC Infectious Diseases. 14:88. doi: 10.1186/1471-2334-14-88

Tadesse, G. and Gebremedhin, E. Z. 2015. Prevalence of *Salmonella* in raw animal products in Ethiopia: a meta-analysis. BMC Research Notes. 8:163. doi: 10.1186/s13104-015-1127-7

Tafa, B., Sewunet, T., Tassew, H., and Asrat, D. 2014. Isolation and antimicrobial susceptibility patterns of Campylobacter species among diarrheic children at Jimma, Ethiopia. International Journal of Bacteriology. 2014:7. http://dx.doi.org/10.1155/2014/560617

Tekle, T. and Abebe, G. 2001. Trypanosomosis and helminthoses: major health problems of camels (*Camelus dromedarius*) in the southern rangelands of Borena, Ethiopia. Journal of Camel Practice and Research. 8(1):39-42.

Terefe, Y., Redwan, F., and Zewdu, E. 2014. Bovine cysticercosis and its food safety implications in Harari People's National Regional State, eastern Ethiopia. Onderstepoort Journal of Veterinary Research. 81(1):01-06. doi: 10.4102/ojvr.v81i1.676

Teshale, S., Muhie, Y., Dagne, A., and Kidanemariam, A. 2006. Seroprevalence of small ruminant brucellosis in selected districts of Afar and Somali pastoral areas of Eastern Ethiopia: the impact of husbandry practice. Revue de Médecine Vétérinaire. 157(11):557.

Tolossa, Y. H. 2014. Ectoparasitism: Threat to Ethiopian small ruminant population and tanning industry. Journal of Veterinary Medicine and Animal Health. 6(1):25-33. doi: 10.5897/JVMAH2013.0253

Tschopp, R., Abera, B., Sourou, S. Y., Guerne-Bleich, E., Aseffa, A., Wubete, A., Zinsstag, J., and Young, D. 2013. Bovine tuberculosis and brucellosis prevalence in cattle from selected milk cooperatives in Arsi zone, Oromia region, Ethiopia. BMC Veterinary Research. 9:163-6148-9-163. doi: 10.1186/1746-6148-9-163

Tschopp, R., Schelling, E., Hattendorf, J., Aseffa, A., and Zinsstag, J. 2009. Risk factors of bovine tuberculosis in cattle in rural livestock production systems of Ethiopia. Preventive Veterinary Medicine. 89(3-4):205-211. doi: 10.1016/j.prevetmed.2009.02.006

Tsegaw, T., Gadisa, E., Seid, A., Abera, A., Teshome, A., Mulugeta, A., Herrero, M., Argaw, D., Jorge, A., and Aseffa, A. 2013. Identification of environmental parameters and risk mapping of visceral leishmaniasis in Ethiopia by using geographical information systems and a statistical approach. Geospatial Health. 7(2):299-308.

Vordermeier, M., Ameni, G., Berg, S., Bishop, R., Robertson, B. D., Aseffa, A., Hewinson, R. G., and Young, D. B. 2012. The influence of cattle breed on susceptibility to bovine tuberculosis in Ethiopia. Comparative Immunology, Microbiology and Infectious Diseases. 35:227-232. doi: 10.1016/j.cimid.2012.01.003

Waret-Szkuta, A., Roger, F., Chavernac, D., Yigezu, L., Libeau, G., Pfeiffer, D. U., and Guitian, J. 2008. Peste des petits ruminants (PPR) in Ethiopia: analysis of a national serological survey. BMC Veterinary Research. 4:34. doi: 10.1186/1746-6148-4-34

Woldemariam, T., Asrat, D., and Zewde, G. 2009. Prevalence of thermophilic Campylobacter species in carcasses from sheep and goats in an abattoir in Debre Zeit area, Ethiopia. Ethiopian Journal of Health Development. 23(3):229-233. doi: 10.4314/ejhd.v23i3.53245

Yacob, H. T., Ataklty, H., and Kumsa, B. 2008a. Major ectoparasites of cattle in and around Mekelle, northern Ethiopia. Entomological Research. 38(2):126-130. doi: 10.1111/j.1748-5967.2008.00148.x

Yacob, H. T., Nesanet, B., and Dinka, A. 2008b. Part II: Prevalences of major skin diseases in cattle, sheep and goats at Adama Veterinary Clinic, Oromia regional state, Ethiopia. Revue de Médecine Vétérinaire. 159(8-9):455-461.

Yibrah, M. and Damtie, D. 2015. Incidence of human rabies exposure and associated factors at the Gondar Health Center, Ethiopia: a three-year retrospective study. Infectious Diseases of Poverty. 4 (1):3.

Yimer, E., Koopman, S., Messele, T., Wolday, D., Newayeselassie, B., Gessese, N., Degefe, B., and Sandres, E. J. 2004. Human leptospirosis in Ethiopia: a pilot study in Wonji. Ethiopian Journal of Health Development. 18(1):48-51. doi: 10.4314/ejhd.v18i1.9866

Yohannes, M., Degefu, H., Tolosa, T., Belihu, K., Cutler, R. R., and Cutler, S. J. 2013. Brucellosis in Ethiopia. African Journal of Microbiology Research. 7(14):1150-1157. doi: 10.5897/AJMR12.738

Zeleke, A., Gelaye, E., Sori, T., Ayelet, G., Sirak, A., and Zekarias, B. 2005. Investigation on infectious bursal disease outbreak in Debre Zeit, Ethiopia. International Journal of Poultry Science. 4(7):504-506. doi: 10.3923/ijps.2005.504.506