Report on the rapid integrated assessment of nutrition and health risks in small ruminant value chains in Ethiopia

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January 2014

RESEARCH PROGRAM ON Agriculture for Nutrition and Health
CGIAR
Led by IFPRI

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Federal Ministry for Economic Cooperation and Development

This report is a product of the Safe Food, Fair Food project supported by the German Ministry for Economic Cooperation and the German Agency for International Cooperation.

Citation: Dewé, T. 2014. Report on the rapid integrated assessment of nutrition and health risks in small ruminant value chains in Ethiopia. Nairobi, Kenya: ILRI.

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Author's note

This report was written by TD. The results section is reliant on the reports produced by TA and DG (Abergelle); FD and AH (Atsbi); BA and HA (Borena); MYZ and SMH (Doyogena); BS and LT (Horro); SG, LT and SA (Menz); and MM and GG (Shinelle) from the participatory activities they conducted in the field. BS completed the literature review and KR read and commented on the manuscript.

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Many thanks are due to my Ethiopian colleagues, without whose skills in translation and facilitation this study would not have been completed. It could not have commenced without the efforts of Getachew Legese, Kristina Roesel and Delia Grace from ILRI, and Aynalem Haile and Barbara Rischkowsky from ICARDA, for whose assistance, organisation, leadership and advice I am most grateful. Finally, every acknowledgement is due to the participants in this study, and to whom this report is dedicated – your enthusiasm and insight were inspiring.

The study was carried out with the financial support from the CGIAR Research Program on Agriculture for Nutrition and Health (A4NH), led by IFPRI, and the Safe Food, Fair Food project funded by the Federal Ministry for Economic Cooperation and Development, Germany.

Executive summary

Smallholder farmers produce the majority of animal-source foods in sub-Saharan Africa. These foods are of high nutritional value but are also an important cause of food-borne disease. Whereas traditional food safety approaches tend to ban any product containing hazards, new risk-based approaches try to assess whether there is a genuine threat to human health, and if so, how to mitigate it. The ILRI-led and BMZ-funded Safe Food, Fair Food project applies risk-based decision-making to improve food safety and nutrition within selected livestock value chains.

In Ethiopia, the focus is on the small ruminant sector, which involves around 48 million animals, and is dominated by smallholder and pastoral production. Over 80% of the human population lives in rural areas, and diarrhoea and nutritional deficiencies account for almost 15% of the national disease burden. The objectives of this study were to perform a rapid integrated assessment of food safety risks and nutritional benefits within the Ethiopian small ruminant value chain, and to identify areas for further research and interventions.

Participatory techniques allow efficient procurement of information in a data-scarce environment, while engaging communities in risk management and communication. Participatory rural appraisals (PRAs) and focus-group discussions (FGDs) were conducted with groups of rural producers and consumers at seven representative study areas in agricultural and pastoral regions of Ethiopia. The PRAs involved the use of visual aids to gain information on topics such as seasonal production and consumption patterns, animal health and zoonoses, food safety awareness, and cultural practices. The FGDs were held with mothers of young children, and concentrated on food preparation and children's diets.

Consumption of small ruminant meat by rural people was often limited to 2-5 occasions per year, although pastoraliss, Muslims, and more affluent urban consumers ate meat more frequently – up to several times a week. Consumption was limited by economic factors as well as frequent religious fasting for Ethiopian Orthodox Christians. Production and consumption peaked at times of major religious and national festivals and non-producers usually purchased live animals for backyard slaughter at these times. Risky meat-handling practices included eating raw meat or offal, eating sick animals, and potential cross-contamination during food preparation. Risk-mitigating practices included careful butchering, minimal or no storage of fresh or cooked meat, and thorough cooking of meat before eating.

Milk production was associated with lambing/kidding periods, but volume was limited by feed availability at these times. Peak consumption occurred after the rainy season, when feed was abundant, and the needs of the producer's household and extended family were prioritised. Small ruminant milk did not appear readily available in towns and cities. Consumption of raw milk was the major risk to food safety, although risk-mitigating techniques such as boiling and fermentation were also reported.

Increasing production and consumption of small ruminant meat and milk in Ethiopia, while minimizing the associated risks of foodborne disease, is a complex task that requires an integrated, multidisciplinary approach. In many rural communities in Ethiopia, small ruminant meat is consumed rarely, which reduces exposure to meat-borne pathogens. However, in pastoral areas, risky practices such as consumption of raw meat, or meat from diseased animals, overlap with year-round meat consumption. Small ruminant milk also presents a risk of foodborne disease, but is under-utilised as a food source in some areas. Future work should focus on increasing intake of animal-source foods, as nutrient deficiencies are likely to represent a risk to the overall health status of many rural communities. At some sites, further research into hazard identification and potential food safety interventions is also warranted.

Acronyms

ACIAR	Australian Centre for International Agricultural Research
ASF	animal-source foods
CRP L&F	CGIAR Research Program on Livestock and Fish
CRP A4NH	CGIAR Research Program on Agriculture for Nutrition and Health
DCSI	Debit Credit and Savings Institute, Tigray
ETB	Ethiopian birr
FAO	Food and Agriculture Organisation of the United Nations
FFGD	focus group discussion
FMD	foot and mouth disease
ICARDA	International Centre for Agricultural Research in the Dry Areas
ILRI	International Livestock Research Institute
MoARD	Ministry of Agriculture and Rural Development, Ethiopia
MoH	Ministry of Health, Ethiopia
NGO	non-governmental organisation
PPR	peste de petits ruminants
PRA	participatory rural appraisal
QSAE	Quality and Standardization Authority of Ethiopia
RVF	Rift Valley fever
SFFF	Safe Food, Fair Food
USAID	US Agency for International Development
VCA	value chain analysis
WHO	World Health Organisation

Contents

1 Background

1.1 **Small ruminant production in Ethiopia**

Ethiopia is home to almost 92 million people, of which over 60 million (66%) live on less than US$2 per day; approximately 28 million (31%) live on less than US$1.25 per day[1]. The country boasts over 48 million head of small ruminants (sheep and goats) - one of the largest populations of these animals in sub-Saharan Africa[2]. Small ruminants are kept mostly by smallholder farmers[3], and have an important role to play in security and investment for the rural poor[4]. They function as walking liquid assets that can be exchanged for cash during times of financial strain or when their owners are faced with unexpected expenses. They are also kept for their meat and milk, and for non-food products such as manure or skin, which can be utilised within the household or as a source of income4.

The average livestock holding in smallholder mixed crop-livestock systems in the Ethiopian highlands has less than four head each of cattle and small ruminants[5]. Pastoralist flocks are larger and constitute 40% of the total livestock population in Ethiopia, although pastoralists themselves make up only 12 to 15% of the human population4. Small ruminant production consists almost exclusively of extensive, low-input systems, and productivity remains low: the sector is burdened by low birth and growth rates, and high mortality[4]. The average carcass weight is 10.0 and 8.5 kg for sheep and goats, respectively[6]. Average gross off-take rates for small ruminant flocks in the highlands has been reported to range between 19% and 34% (sheep) and 15% and 30% (goats)4,[7]; in pastoral areas, these figures are as low as 10% of sheep and 11% of goats[7]. Average daily milk production by indigenous goat breeds receiving supplementary feeds was reported to be approximately 1kg/female/day[8]. However, under natural conditions, milk production in pastoral flocks has been reported to be as low as 0.24kg/female/day for indigenous goat breeds in the dry season, and on average 0.40kg/female/day for sheep and goats in the same flocks in the wet season[9]. Reasons for this low productivity include feed shortages, lack of appropriate breeding programs, a high disease burden, and market difficulties3. These production limitations are particularly pressing, as demand for small ruminant meat, both domestically and from the Middle Eastern market, is increasing steadily – a trend which is expected to continue3.

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[1] World Bank, 2013. Ethiopia: data. The World Bank Group, USA. http://data.worldbank.org/country/ethiopia [Accessed online 6th November 2013]

[2] FAOSTAT, 2013. Production: live animals [sheep and goats, Ethiopia, 2011]. Food and Agriculture Organisation of the United Nations, Italy. http://faostat3.fao.org/faostat-gateway/go/to/download/Q/QA/E [Accessed online 6th November 2013]

[3] ILRI, 2011. Sheep meat value chain in Ethiopia: background proposals for the CGIAR Research Program on Livestock and Fish. International Livestock Research Institute (ILRI), Kenya.

[4] Gizaw S, Tegegne A, Gebremedhin B, Hoekstra D, 2010. Sheep and goat production and marketing systems in Ethiopia: characteristics and strategies for improvement. Working paper no. 23, Improving Productivity and Market Success of Ethiopian Farmers (IPMS), International Livestock Research Institute (ILRI), Kenya.

[5] Jabbar MA, Grace D, 2012. Regulations for safety of animal source foods in selected Sub-Saharan African countries: Current status and their implications. SFFF, ILRI, Kenya.

[6] FAOSTAT, 2013. Production: livestock primary [sheep and goats, Ethiopia, 2011]. Food and Agriculture Organisation of the United Nations, Italy. http://faostat3.fao.org/faostat-gateway/go/to/download/Q/QL/E [Accessed online 6th November 2013]

[7] Negassa A, Rashid S, Gebremedhin B, 2011. Livestock production and marketing. Working paper no. 26, Ethiopia Stratey Support Program II (ESSP II), International Food Policy Research Institute (IFPRI), Ethiopia.

[8] Mestawet TA, Girma A, Ådnøy T, Devold TG, Narvhus JA, Vegarud GE, 2012. Milk production, composition and variation at different lactation stages of four goat breeds in Ethiopia. Small Ruminant Research 105:176-181

[9] Degen AA, 2007. Sheep and goat milk in pastoral societies. *Small Ruminant Research* 68:7-19.

Figure 1. Small ruminant production in Ethiopia: Menz

1.2 CGIAR Research Program on Livestock and Fish and Safe Food, Fair Food

The CGIAR Research Program on Livestock and Fish (CRP L&F) aims to improve meat, milk and fish production and consumption by the poor, by the development of existing livestock and fish value chains. This program has identified several chains in Africa, Asia and South America to undergo value chain analysis (VCA) and testing of best-bet interventions to improve livelihoods of actors within these chains.

Safe Food, Fair Food (SFFF), led by the International Livestock Research Institute (ILRI), runs in parallel with CRP L&F and focuses on identifying and managing the food safety and nutrition risks within the selected value chains – mostly in informal markets. Animal-source foods (ASF) are an important route of transmission for foodborne diseases, which have a significant impact on human health in the developing world[10]. Paradoxically, ASF are highly nutritious and energy-rich, and inadequate consumption of them leads to a host of dietary and developmental deficiencies[11,12].

See additional information to better explain the complex context (because CRP A4NH must be mentioned here as well):

- CGIAR Research Program on Livestock & Fish = CRP L&F = led by ILRI but with partners like ICARDA, CIAT, WorldFish… "More milk, meat and fish by and for the poor": focus on improved value chain productivity.
- CGIAR Research Program on Agriculture for Nutrition and Health = CRP A4NH = led by IFPRI; program has 4 components and one of them is led by ILRI (prevention and control of agriculture-associated diseases). https://aghealth.wordpress.com/
- ILRI-led ACIAR-funded project developed generic toolkit for "Rapid Integrated Assessment (RIA) of food safety and nutrition". The project countries are: Egypt, Tanzania, Vietnam. It was a project under CRP A4NH (2012-2013).

ILRI-led BMZ-funded project (SFFF) in Ethiopia, Senegal, Tanzania, Uganda (2012-2015). SFFF aligned with CRP L&F (livestock value chain = food chain) but under CRP A4NH. Use the tools developed by RIA.

[10] Grace D, Gilbert J, Randolph T, Kang'ethe E. The multiple burdens of zoonotic disease and an ecohealth approach to their assessment. *Trop Anim Health Pro* 44:67-73

[11] Speedy W, 2003. Global production and consumption of animal source foods. *J Nutr* 133:4048S-4053S

[12] Leroy JL, Frongillo EA, 2007. Can interventions to promote animal production ameliorate undernutrition? *J Nutr* 137: 2311-2316

Traditional food safety approaches are not necessarily appropriate to the developing world, as they tend to ban any product containing hazards, without concern for the impact on other factors – such as nutrition – within the value chain. As expressed in a SFFF strategic document:

'This is both inequitable and inefficient. It is inequitable because the interests of poor, small-scale farmers are not considered and inefficient because the great majority of the risk management in informal markets is done by the value chain actors themselves. Marginalizing them from food-safety decision making decreases the likelihood of their participation in high value markets'[5].

Thus, the new risk-based approaches to food safety try to assess whether there is a genuine threat to human health, and if so, how to mitigate it while involving all stakeholders, and taking into account other pro-poor objectives such as income generation, nutrition and empowerment of women.

The objectives of this study were to use participatory techniques to rapidly identify risks to food safety and nutrition within the Ethiopian small ruminant value chain, thereby engaging value chain actors in communication and management of those risks, and to recommend areas for further research and possible interventions.

1.3 Selection of value chain

The increasing demand for Ethiopian small ruminant meat, at least, provides an opportunity to increase small ruminant production via research into, and development of, the small ruminant value chain. The criteria for the L&F/SFFF research program and the rationale for including the Ethiopian small ruminant value chain within this program were identified in the L&F background proposal3 (**Table 1**).

Table 1. Criteria for L&F/SFFF research program and rationale for including the Ethiopian small ruminant value chain

Criteria	Rationale
Growth and market opportunity	- Huge and increasing demand for small ruminant meat within and outside the country, reflected in increasing prices - Ethiopia's strategic location promoting exports to Middle East markets - Current annual livestock and meat export potential is estimated at USD 136 million however, the realized export earning over the past 15 years to 2003 averaged only to USD 2.5 million - Abattoirs in Ethiopia operate only at 40% of their capacity - High potential to raise the low flock productivity and off-take rate in smallholder flocks
Pro-poor potential	- The majority of rural poor in Ethiopia depend on small ruminant production - Both men and women are involved in sheep production with different tasks and decision-making power; also a good income opportunity for women-headed households - Many market agents along the value chain (input/livestock traders, meat processors and transporters etc.) provide potential for benefit as well as challenge for cooperation

Criteria	Rationale
Researchable supply constraints	- Negative selection of breeding rams for lamb growth as fast-growing lambs are sold first; inbreeding due to small flock sizes - Shortage and fluctuation in quantity and quality of feed supply - Poor animal hygiene and high disease burden - Lack of business enterprise production strategy - Lack of sustainable organizational structures for breeder and producer groups in order to facilitate their access to affordable breeding animals, animal health care and efficient market services - Poor market infrastructure and institutional arrangements resulting in high price difference between rural and urban markets, high number of middlemen and thus small producer margins - Poor input supply system and limited support services such as extension and credit systems - Insufficient supply of abattoirs with small ruminants of desired number, weigh, age, or body condition
Enabling environment	- Increasing international interest and support from donors for developing the livestock sector in Ethiopia (including a number of livestock development projects funded by USAID) - Various projects/initiatives ongoing or planned by competent organizations/institutions - Commitment by Government of Ethiopia to improve policy environment - Ongoing improvement of paved road network which will enhance market access
Existing momentum	- ILRI and the International Centre for Agricultural Research in the Dry Areas (ICARDA), together with their key partners, bring in a rich combination of technical and practical experiences in developing country and low-input mixed crop–livestock systems, and a history of having successfully worked together in related research - Very few other global organizations combine development with innovative and adaptive research - Both centres have experience with value chain development in small ruminants and other livestock production systems - A number of ILRI and ICARDA partner organizations are already active in Ethiopia or are partners in new project proposals - ILRI provides an excellent infrastructure and is partner in complementary projects

1.4 Selection of study areas

Four criteria were used to identify study areas in Ethiopia for potential inclusion within the small ruminant VCA for L&F, and associated SFFF work. These criteria and the evidence required to meet them are given in Table 2.

Table 2. Criteria for selecting L&F/SFFF study areas in Ethiopia, and the evidence required

Criteria	Evidence required
Growth and market opportunity	Evidence for either the importance of small ruminant products to people's livelihoods in the area, or increased demand for these products, either locally or regionally
Pro-poor potential	Evidence that the poor can play a significant role in increased production, be employed in value chain activities, or are likely to benefit from increased consumption
Researchable supply constraints	The presence of constraints, such as large productivity gaps or transaction costs, for which research may be able to provide solutions, and thereby improve livelihoods
Potential for scaling up interventions and solutions	Agro-ecological conditions are representative of large areas elsewhere in Ethiopia

Identification of study areas, according to these criteria, began with geographical targeting using GIS technology. First, agro-ecological systems for livestock production were mapped (**Figure 2**). The focus was on the three systems classified as: rangeland-based, arid/semi-arid (light yellow); mixed production, arid/semi-arid (light green); and mixed production, temperate/tropical highlands (dark green), which jointly comprise almost 90% of Ethiopia's productive land. Layers for high to medium poverty (people living on less than US$2/day), high sheep and/or goat densities (**Figure 3**) and contrasting market access were then added, and areas of overlap were taken forward for further analysis.

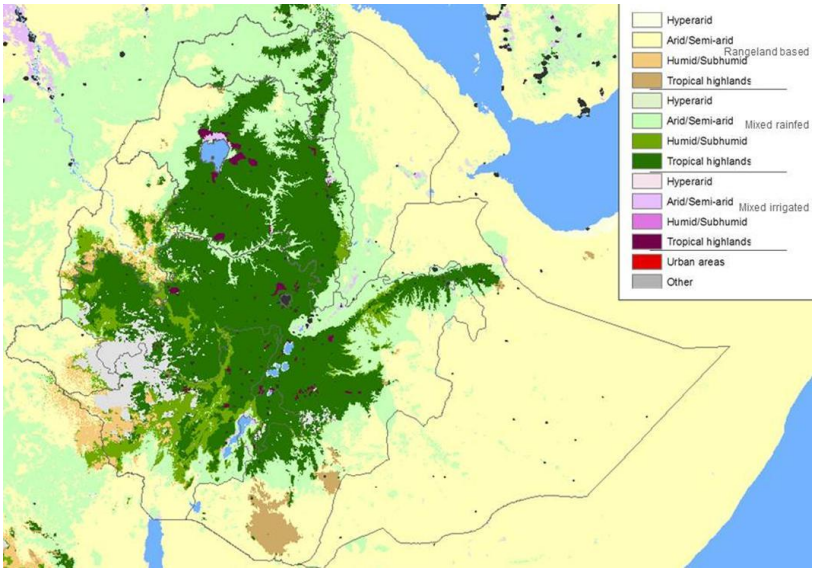

Figure 2: Agro-ecological production systems in Ethiopia[13]

[13] Robinson TP, Thornton PK, Franceschini G, Kruska RL, Chiozza F, Notenbaert A, Cecchi G, Herrero M, Epprecht M, Fritz S, You L, Conchedda G, See L, 2011. Global livestock production systems. Food and Agriculture Organization of the United Nations (FAO) and International Livestock Research Institute (ILRI), Italy.

Next, stakeholder consultations were conducted at national level, to define critical selection criteria. Critical and preferred selection criteria (**Table 3**) for inclusion of individual study areas were developed from the L&F country rationales given in **Section 1.3** above, and adapted according to the Ethiopian context. It was during this stage that lowland areas, with low sheep and goat densities but populated by pastoral people who are wholly dependent on livestock, were included. The criteria were applied to Ethiopia and a shortlist of 14 study areas was created.

Table 3. Critical and preferred criteria for selecting L&F/SFFF study areas in Ethiopia

Critical	Preferred
- Likelihood of success - Market potential - Well known supply areas for sheep or goat meat - Proximity to Addis - Number of sheep and goats per household - Importance of sheep and goats to household livelihoods	- Synergy with on-going research - Government priorities - Potential for success of implementation and impact - Existing links with research and extension system - Regional representation - Availability of secondary data

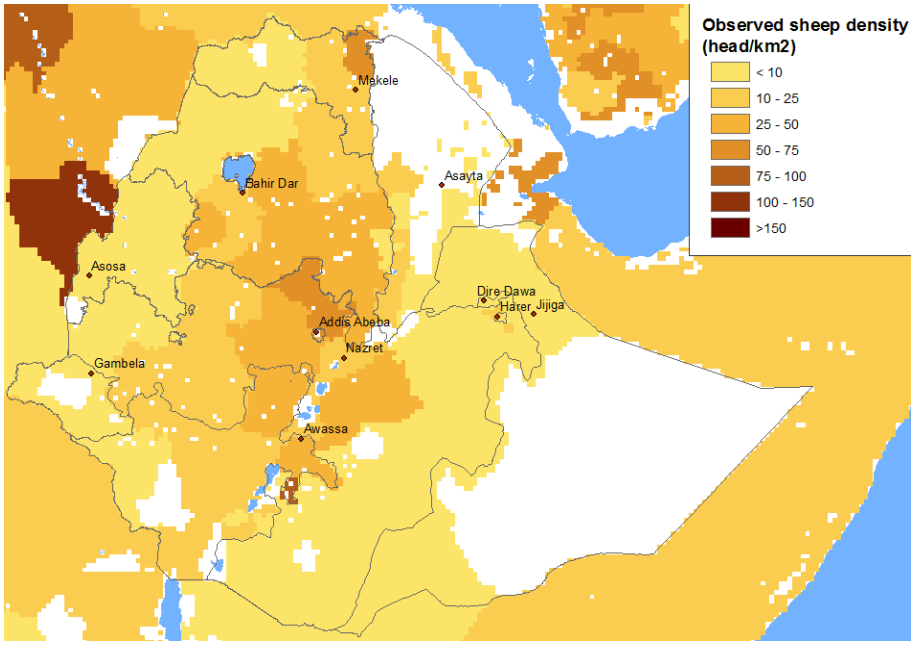

Figure 3: Average sheep densities in Ethiopia[14]

The shortlist of 14 potential study areas was reduced to a final seven during stakeholder consultation. Researchers from each region then visited the study areas with representatives from ILRI/ICARDA and consulted further with research partners and other stakeholders to identify two villages or *kebeles* (the lowest administrative level in Ethiopia) in each study area (

[14] Wint W, Robinson T, 2007. Gridded livestock of the world. Food and Agriculture Organization of the United Nations (FAO), Italy.

Table 4 and **Figure 4**). Criteria used at this stage included willingness of the community to participate in further studies, accessibility to researchers (proximity to roads and to regional research centres), and the site being broadly representative of the selected study area.

Table 4. L&F/SFFF study areas in Ethiopia

No.[a]	Study area	Administrative zone	District	Kebeles	Species	Major product	Production system
1	Atsbi	Eastern Tigray	Atsbi Wenberta	Golgol Ne'ale, Habes	Sheep	Meat	Highlands, mixed crop-livestock
2	Doyogena	Kembata Timbaro	Doyogena	Bekafa, Serera	Sheep	Meat	Highlands, mixed crop-livestock
3	Horro	Horro Gudru Wellega	Horro	Gitlo Doie, Leku Igu	Sheep	Meat	Highlands, mixed crop-livestock
4	Menz	North Shewa	Menz Gera Meder, Menz Mama Mider	Mehal Meda, Molale	Sheep	Meat	Highlands, mixed crop-livestock
5	Abergelle	Wag Himra, Central Tigray	Sekota, Tanqua Abergelle	Sazba, Hadnet	Goats	Meat and milk	Highlands, mixed crop-livestock
6	Borena	Borena	Yabello	Derito, Eloyehe	Goats	Meat and milk	Lowlands, pastoral
7	Shinelle	Somali	Shinille	Degah Jebis, Gad	Sheep and goats	Meat and milk	Lowlands, pastoral

[a] 'No.' refers to number in **Figure 4**

Readers should note that the Abergelle study area is split between two regions: Amhara (Sazba), and Tigray (Tanqua Abergelle). These *kebeles* in this study area shared many cultural similarities; however, there were differences in the timing of their production cycle and other key points. Thus, while 'Abergelle' is the collective term, 'Abergelle Amhara' and 'Abergelle Tigray' will be used throughout this report to describe them separately, where necessary.

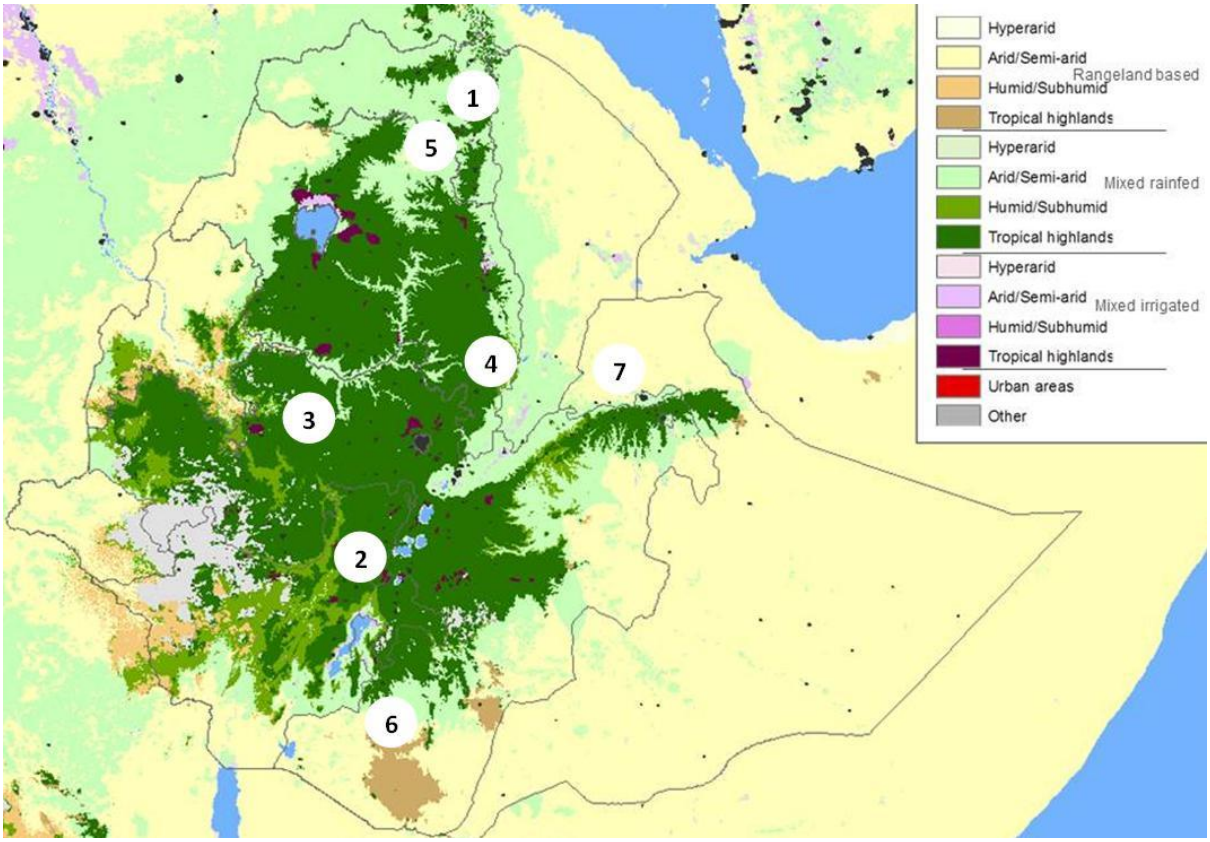

Figure 4. L&F/SFFF study areas in Ethiopia

1.5 Value chain analysis

The results of the ICARDA-led VCA for small ruminants in Ethiopia have been reported in a synthesis paper[15] and in detail in several specific reports[16-23]. This section is a summary of the main findings of these reports and from this SFFF study, and is included here to provide context for the reader. There is some variation between the small ruminant value chains operating in different study areas in Ethiopia. However, some commonalities in the major components of input supply, production, marketing, processing and consumption were identified and are summarised below.

[15] Anon., 2013. Analysis of small ruminant value chains in Ethiopia: a synthesis report (draft). International Centre for Agricultural Research in the Dry Areas (ICARDA), Ethiopia.
[16] Kidanu E, Regassa T, Haile A, Rischkowsky B, Legese G, 2013. Value chain analysis of sheep in Atsbi district of Tigray Region, Ethiopia (draft). Mekele Agricultural Research Centre, ICARDA, ILRI, Ehtiopia.
[17] Ashenafi M, Addisu J, Shimelis M, Haile A, Rischkowsky B, Legesse G, 2013. Assessment of sheep value chain in Doyogena District of SNNPR, Ethiopia (draft). Areka Agricultural Research Centre, ICARDA, ILRI, Ethiopia.
[18] Duguma G, Degefa K, Jembere T, Temesgen W, Haile A, Duncan A, Rischkowsky B, Legese G, 2013. Value chain analysis of sheep in Horro district of Oromia Region, Ethiopia (draft). Bako Agricultural Research Centre, ICARDA, ILRI, Ethiopia.
[19] Beneberu T, Shenkute G, Solomon G, Haile A, Rischkowsky B, Legesse G, 2013. Analysis of sheep value chain in Menz Gera District, North Shewa Zone, Ethiopia. Amhara Agricultural Research Institute (AMARI), Debre Birhan Agricultural Research Centre (DBARC), ICARDA, ILRI, Ethiopia.
[20] Abebaw L, Alemu T, Kassa L, Haile A, Rischkowsky B, Legese G, 2013. Assessment of Abergelle goat value chain in northern Ethiopia (draft). Sekota Dry Land Agricultural Research Centre, ICARDA, ILRI, Ethiopia.
[21] Anon., 2013. Small ruminant value chain analysis in Shinille District of Somali Region. ICARDA, ILRI, Ethiopia.
[22] Desta D, Hagos H, Belay S, Legese G, 2013. Rapid value chain analysis of Tanqua Abergelle goat, Central Zone of Tigray Region, Ethiopia (draft). Abergelle Agricultural Research Centre, ILRI, Ethiopia.
[23] Husen N, Kumsa S, Haile A, Rischkowsky B, Legese G, 2013. Analysis of goats value chain in Yabello District of Borana zone, Southern Oromia, Ethiopia. Yabello Pastoral and Dryland Agricultural Research Centre, ICARDA, ILRI, Ethiopia.

1.5.1 Actors

The main value chain actors – those involved in moving small ruminant products towards the terminal user, by exchanging them for money – in Ethiopia are producers (smallholder farmers and pastoralists), collectors, small- and large-scale traders, brokers, livestock marketing cooperatives, live animal exporters, export abattoirs, butchers, supermarkets, hotels and restaurants, and individual domestic consumers. International consumers have an important role as an end market for meat export in particular, but they were not investigated as part of the VCA.

Components	Input supply	Production	Marketing	Processing	Consumption
Activities	•Supplying breeding stock •Supplying feed •Veterinary services •Credit services	•Feeding •Herding •Housing •Breeding	•Transporting •Buying •Selling •Collecting •Retailing	•Slaughtering •Chilling •Wrapping with fabric for export •Butchering for domestic sale •Cooking	•Eating meat and meat dishes •Eating milk, butter, and cheese
Actors	• Farmers, pastoralists • Research centres • Governmental institutions and NGOs • Public and private vet clinics and pharmacies • Saving cooperatives	• Farmers, pastoralists	• Collectors • Small-scale and large-scale traders • Brokers • Cooperatives • Live animal exporters	• Export abattoirs • Local abattoirs • Butchers • Supermarkets • Hotels/restaurants • Cooperatives • Individual consumers	• Individual consumers, including farmers and pastoralists

Figure 5. Main components, activities and actors within the Ethiopian sheep and goat value chain

Producers include the smallholder farmers in the mixed crop-livestock highlands, and the pastoralists in the lowlands. Producers view small ruminants as saving and investment vehicles, and a source of ready cash when faced with large and/or unexpected expenses (e.g. school fees, food or feed in times of drought). They may or may not generate income from crops or other livestock. Generally, producers have poor to fair access to market information, and do not generally take advantage of times of high demand for their animals. They sell to collectors and traders or to other producers for breeding purposes. In Abergelle, Atsbi, Shinelle and Borena, where milk is produced from goats and/or sheep, it is usually reserved for use by the producer's family. Any excess goat milk can be sold locally as fresh milk (Shinelle), or butter or other products (Abergelle).

Figure 6. Small ruminant producers in Ethiopia: Borena (L) and Menz (R)

Collectors collect animals from villages or remote livestock markets, either on behalf of traders (who provide capital, and from whom they receive a commission), or themselves. Collectors are often also producers, for whom collecting is a sideline. For this reason, they usually have a good relationship with other producers, and can act as a source of market information for the latter, although they can also manipulate this information for their own profit. They generally have good horizontal linkages with traders and local hotels/restaurants and butchers.

Small-scale traders supply hundreds of small ruminants every week to either large-scale traders or to export abattoirs. They purchase animals either from producers or from their own network of collectors, with whom they have verbal agreements. Most use their own capital and trade small ruminants as a sideline activity to trading cattle, or other activities. Large-scale traders supply thousands of animals a week to export abattoirs or live animal exporters on a regular basis. They rely on a network of collectors and small-scale traders and often receive a premium price from the abattoirs, part of which is usually reflected back to their suppliers. Most large-scale traders concentrate on small ruminant trade, although might also trade cattle and/or camel.

Brokers mediate transactions between livestock sellers and buyers in the marketplace. They operate on a commission basis and have been known to manipulate prices. In Shinelle, brokers are particularly important due to clan-based ties. Livestock marketing cooperatives are only reported in Borena. These cooperatives use member donations, with or without start-up contributions by non-governmental organisations (NGOs), to trade small ruminants and other species. They have higher operating costs but fewer market linkages than traders, and are reportedly vulnerable to mismanagement.

Five of Ethiopia's seven export abattoirs are located in Bishoftu and Mojo towns, and receive animals from Borena, Doyogena, Horro, and Menz. The export abattoir in Mekelle is supplied by Abergelle and Atsbi. Export abattoirs usually buy ruminants at the abattoir gate from traders, although in Abergelle, goats are also purchased in the markets. Export abattoirs slaughter on average 2000 small ruminants a day, and export chilled carcasses wrapped in cotton/linen to the Middle East and northern Africa by air. They also process red offal for export in refrigerated containers as sea cargo. Export abattoirs have a preference for young, entire males of 14-27kg liveweight, and provide their suppliers with transport (open-bodied trucks) for these animals. A new export market has recently developed for highland sheep, in addition to the pre-existing markets for goats and lowland sheep.

Butchers are becoming increasingly important in small ruminant value chains in Ethiopia. They buy animals from markets, have them slaughtered at municipal abattoirs or slaughter in-house, then either retail fresh meat for the consumer to take home and cook, or offer meat dishes cooked and served on-site. Preference for a specific type of animal varies between sites: in large towns and cities, butchers avoid mature females. This is because customers in this area have a preference for young, tender sheep and goat meat; also, the meat from mature fattened animals is less profitable on a per-kilogram basis. In contrast, in Horro, butchers prefer mature female sheep, due to their lower price in the markets and the greater carcass weight compared to younger animals.

Figure 7. Butcher's shop in Shinelle (L) and goat meat *tibs* (R)

Supermarkets operate in cities and large towns. They purchase animals from small traders or within the marketplace, or might be supplied by retailing middle-men. Slaughtering occurs in the municipal abattoir and processing is completed within their own premises. Hygiene standards tend to be higher than butchers', and they offer pre-packaged meat to the domestic consumer. They can also act as carcass suppliers to hotels and restaurants. Supermarkets prefer adult males of 40-45 kg liveweight.

Hotels and restaurants operate in towns and cities and buy live animals from producers or collectors in the market, or from small traders who have agreed to supply a certain number of animals per week. They slaughter small ruminants in-house and then prepare and sell a variety of dishes. These include *tibs* (fried meat), *wat* (stew), and *dulet* (raw, partly-cooked or cooked offal). Hotels prefer mature female or castrated male sheep and goats, in the region of 28kg liveweight.

Individual domestic consumers purchase live animals directly from producers in rural areas, or from collectors or traders at markets, and slaughter and butcher them at home for special occasions. Fattened entire male goats are often preferred, and there is a bias against black animals. In towns and cities, fresh or cooked meat can be purchased more frequently from hotels/restaurants, butchers, or supermarkets. Goat milk or milk products can sometimes be purchased in local markets. Consumption of small ruminant products, particularly in rural areas, is further explored in the SFFF analysis below.

1.5.2 Input supply

The major inputs into the small ruminant value chain are breeding stock, animal feed, veterinary services, and credit.

In all study areas, breeding stock are overwhelmingly provided by other farmers, or are obtained in the market. There is an absence of operational breeding centres, whether government- or privately-owned. However, a joint ILRI-ICARDA community-based breeding program has been established in conjunction with regional research centres in Horro and Menz, and some regional governments had plans to scale this up. Breeding animals are also provided by NGOs, either as revolving foundation stock, or by purchase and donation of new animals. Pastoralists in Borena also report a community-based restocking program, *busa gonofa,* where families who have lost their stock to drought are compensated with donated animals from other members of the community.

Feed for small ruminants includes grazing, native browse, crop residues, cultivated forage, concentrate feeds, and industrial by-products. It has been estimated that natural pasture and browse provides 80-90%, and crop

residues 10-15%, of total livestock feed intake in Ethiopia[24]. Crop residues are an important and increasing source of supplementary feed, particularly in the highland areas, although pastoralists will also utilise this feed source during the drought. Farmers in the crop-producing highlands might retain residues for their own use, or sell to other farmers or traders, some of whom store the product for later sale in the dry season. Forage crops are not well-adopted in Ethiopia, due to competition with food crops, lack of market channels, and drought in some areas. Concentrate feeds utilised by farmers in some areas (chiefly Doyogena) include wheat bran and oilseed cake; feed materials tend to be purchased directly from the factory, or from traders. Liquid by-products from breweries were also reported in small towns and villages as a supplementary feed for small ruminants.

Animal health inputs in Ethiopia are largely dependent on government-backed veterinary services, which are pyramidal in design. In theory, each regional state has its own veterinary diagnostic laboratory, each district has an animal health clinic, and every three *kebeles* are served by an animal health post. The animal health posts are staffed by veterinary technicians and are designed to provide basic services; more advanced veterinary care should be provided by veterinarians at the district animal health clinics. However, at some sites, animal health posts or clinics are non-operational. In most cases, the technicians staffing the animal health posts have insufficient transportation and/or funding to enable travelling to the different *kebeles*. Shortage of appropriate veterinary medications, vaccines, equipment, further education and administrative assistance are commonly reported by veterinary personnel. In a previous study, 3% of goat-owning and 14% of sheep-owning households in Atsbi received vaccination services for their animals[4]. Private 'drug shops' selling veterinary drugs are also reported, but vary in reliability, and are believed to charge higher prices. Informal drug sellers are also active, especially in the pastoral areas, and are considered a concern due to poor knowledge of appropriate drug handling and administration.

Three major sources of credit for small ruminant producers exist: rural microfinance institutions, household asset building programs, and rural savings and credit cooperatives. Microfinance is supplied by regional state institutions in all study areas except Shinelle, at which a single credit scheme operated by Oxfam, an NGO, was available. Uptake of microfinance loans by small ruminant producers appears to be low, and rural savings and credit cooperatives are reportedly limited by financial capacity, due to the low value of member deposits.

1.5.3 Production

Several elements of small ruminant production were investigated during the VCA: breeding and feeding practices, housing and shelter, and veterinary care. Discussion of the latter is excluded from this section, as animal health is addressed at length in **Section 3.4.1**, and veterinary care has been explored in **Section 1.5.2**.

Production in each of the VCA study areas in Ethiopia is dominated by a single local breed that is well-adapted to the agro-ecological conditions of the area. Crossing with exotic breeds such as Dorper sheep and Boer goats has been attempted throughout the country, although have not delivered any lasting success. Selection of breeding stock does not occur in any real way, except at Horro and Menz, where farmers have been involved in a community breeding program. Elsewhere, the same ram or buck might be retained within a flock for up to five years. Negative selection occurs when superior male specimens are sold out of the flock, due to the higher price they attract in the market, and not retained for breeding purposes. Mature ewes are also sold for meat, particularly to hotels and restaurants. Many of these are pregnant at the time of slaughter, thereby incurring wastage not only of the offspring, but of the reproductive potential of the ewe. Controlled mating was only reported for sheep, at Shinelle, where farmers seek to avoid lambing during the dry season.

[24] Alemayehu M, 2003. Country pasture/forage resources profiles: Ethiopia. FAO, Italy. Cited by Gizaw et al., 2010[4]

Figure 8. Small ruminant production in Ethiopia: Atsbi

Feeding practices for small ruminants are dominated by the crop cultivation cycle in the highlands. Here, sheep are free-roaming and have ample access to grazing during the dry season, when crops are not in the ground. The exception is Atsbi, which practices a cut-and-carry system, where livestock are excluded from designated areas; instead, farmers harvest the forage from these areas and feed it directly to their animals. During the rainy season (June to September), when crops are growing, sheep at Doyogena are tethered or corralled, and similarly fed cut forage. Those undergoing fattening, which is a process almost exclusive to this study area, are usually housed and fed concentrates and higher-quality forage. In Horro and Menz at this time, grazing animals are restricted to fallow and marginal lands, or within the homestead. Highland animals also receive household scraps and crop residues. Goats in Abergelle have access to ample browse, although might be moved to the lowlands during drought or when crops are growing in the wet season. In pastoral areas, cropping does not occur, and animals are moved according to feed and water availability. Supplementary feed is provided to large ruminants during times of severe drought, but not to small ruminants.

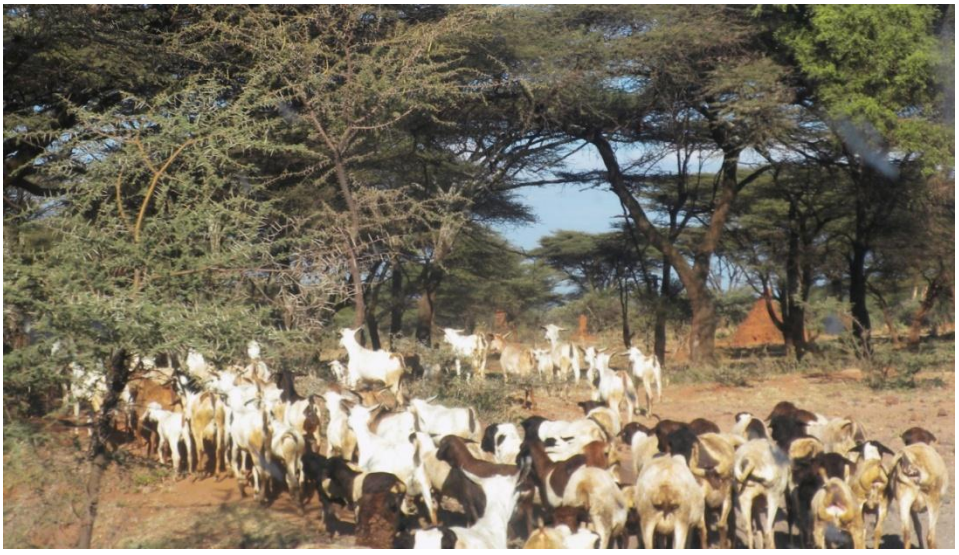

Figure 9. Small ruminant production in Ethiopia: Borena

Small ruminants are housed with large ruminants at all study areas, and in Doyogena, Horro and Menz, within the house with the family. Sharing the indoor living space is also reported in Abergelle Tigray and Borena, if flocks are small. In Atsbi and Abergelle, open-top fences are used to confine animals during the dry season; during the wet season, they are housed in roofed barns or caves. Open-top fences are also used for all

livestock in the pastoral areas. Kids and lambs are separated from their dams overnight in Abergelle, Borena and Shinelle, in order to milk the dams in the morning. Rams are kept separate in Shinelle, and lambs and fattening sheep are restrained and fed separately in Doyogena. Herding of animals is performed by men and boys at all study areas; in female-headed households, shepflocks are employed where necessary. This is reportedly for safety reasons and because of the domestic commitments of women and girls.

Figure 10. Examples of housing in Abergelle: fences made of wood or cacti, and traditional dwellings within which small ruminants might be housed together with the producer's family

1.5.4 Marketing

Producers preferentially buy breeding stock from other producers (an exception to this occurs in Abergelle Amhara, where farmers consider it bad luck to sell breeding stock to neighbouring farmers), although they will also purchase from collectors and small traders in the marketplace. Purchase of animals is most likely to occur immediately after harvest time in the highland areas, when farmers have ready cash, and grazing and crop residues are in abundance. In contrast, pastoralists sell animals at the end of the dry season, in order to fully utilise grasses and browse.

The majority of small ruminant sales by farmers occur in the marketplace (approximately 70%); the remainder are sold in the villages or on the road to market. Producers might sell to other producers, collectors, traders, processors, or even individual consumers. They do not seem to cultivate relationships with any particular buyer. The majority of marketed animals in Borena are entire male yearlings (40%), followed by mature females (24%) and young females (20%)[25]. As stated above, market supply of small ruminants in Ethiopia is usually driven by the producer's requirement for cash. However, animals will be sold at times of highest demand (major religious festivals) if possible. Pastoralists seem to be more sensitive to (lack of) feed supply and presence of demand from export abattoirs.

[25] Borena Pastoral Development Office, 2006. Cited by Anon., 2013[15]

Figure 11. Small ruminant market in Abergelle

Eighteen major marketing channels were identified for sheep and goat meat in Ethiopia. These ranged from producers → local hotels through to producers → collectors → small-scale traders → large-scale traders → retailers → supermarkets → individual consumers for the domestic market, and from producers → collectors → live exporters to producers → collectors → small-scale traders → large-scale traders → export abattoirs or live animal exporters for the export market. It is clear that, in many instances, the marketing channels for small ruminants and their meat can be long, with up to five intermediaries handling animals between the producer and the individual domestic consumer. This increases the price of the end product to the consumer, while reducing the producer's share of the final price of the animal. For example, when animals are sold directly from the farm gate to a local hotel, the producer receives 100% of the estimated price of approximately 850 Ethiopian birr (ETB); by contrast, when animals are sold via a long marketing channel to butchers, the producer's share represents 53% of the ETB 1600 final price[15]. The price fetched by individual animals is usually based on a visual estimation of its body weight, which is vulnerable to subjectivity. Prices fetched by animals sold in the market tend to be higher than those sold at the farm gate.

Transportation of small ruminants from the farm to primary markets is predominantly done by trekking, and can take up to three hours. They might be transferred to secondary markets by trekking or trucking. Transport from secondary markets to terminal markets or abattoirs occurs in open-bodied trucks, which have not been adapted to loading or transport of live animals. Three routes of small ruminant flow were identified: the northern route, which collects animals from Abergelle and Atsbi and funnels them towards Mekele for domestic consumption or meat export; the southern route, which absorbs animals from Doyogena, Horro, Menz and Borena, mostly to large meat export abattoirs or to domestic markets in Addis Ababa, and partly to live animal export markets in Dire Dawa; and the eastern route, which collects animals from Shinelle and the surrounding areas and delivers them to the live animal export or domestic markets in Dire Dawa, or via informal channels across the Somalian border. According to the VCA, significant meeting of these routes occurs only in terminal meat export markets (northern and southern) or terminal live animal export markets (southern and eastern). The majority of small ruminants produced in Doyogena, Horro and Menz end up in domestic markets, although a sizeable proportion of Doyogena sheep (34%) are destined for export. Abergelle goats and Atsbi sheep end up on the domestic market or in export abattoirs. Approximately 90% of small ruminants coming out of Borena flow towards meat export abattoirs, and perhaps 60% of those produced in Shinelle undergo informal cross-border trade into Somalia and Djibouti.

Figure 12. Goats in an ISUZU truck (L) and being loaded for transport (R) in Abergelle

There are clear differences in the domestic and export end markets for small ruminant meat. Domestic consumers generally prefer mature, fattened female or castrated male animals, although urban Muslim consumers in this study reported a preference for young lean meat. The multiplication of small ruminant butchers in cities and towns indicates increasing demand for smaller portions of meat, and perhaps more frequent consumption, than the traditional pattern (still practiced in rural areas) of a whole animal being shared within or between households. The increasing popularity of butchers is interesting in light of the higher prices offered by these vendors (up to twice the price per kilogram of meat obtained in supermarkets). An import recent trend in the domestic market is the introduction of goat meat to butcheries and supermarkets in the highland areas; previously, it had been limited to lowland areas. In 2004, average annual consumption of sheep meat in urban areas was almost three times that of goat meat[26].

Chilled small ruminant meat exports from Ethiopia have increased rapidly over the last ten years. The primary targets are the United Arab Emirates (UAE) and Saudi Arabia. Export to India has also been reported, and Turkey and Vietnam are important destinations for offal. These countries prefer entire male animals, aged between one and two years, with a liveweight of 13-30kg. This lean meat is destined for the lower end of the market (possibly expatriates), as higher-income Middle Eastern consumers prefer imported live animals that have been freshly slaughtered.

[26] Asfaw N, Jabbar M, 2008. Livestock ownership, commercial off-take rates and their determinants in Ethiopia. Research Report 9. ILRI, Kenya

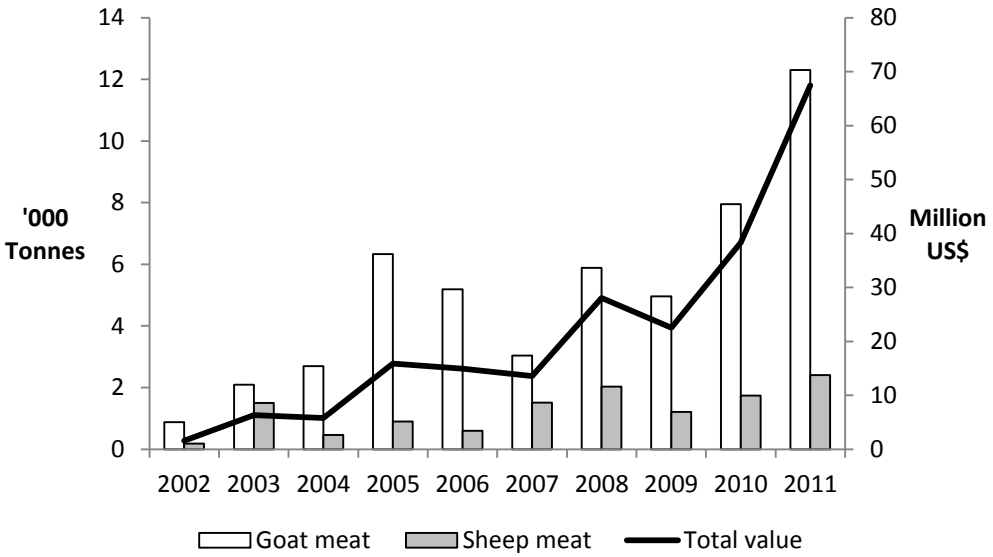

Figure 13. Trends in small ruminant meat exports[27]. Volume is shown on the left y-axis; total value on the right.

Marketing of goat milk and milk products such as butter or cheese is restricted to local villages and towns near to the producer. These activities are exclusively the domain of women.

Figure 14. Amhara woman selling butter in a market in Abergelle (L), and butter patties in a traditional container (R)

1.5.5 Processing

Meat processing is undertaken by butchers, hotels/restaurants, supermarkets and export abattoirs as described in **Section 1.5.1**. Processing also occurs in the homes of individuals, when meat is intended for consumption by the family, and is described in the results (**Section 3.12.1**). Processing of milk is done at home by the females of the household, and involves smoking containers and/or fermenting milk to prolong the shelf life, and processing it into butter, cheese or yoghurt; this is also described in the results (**Section 3.12.2**).

[27] FAOSTAT, 2013. Trade: crops and livestock products [sheep and goat meat, Ethiopia, 2002-2011]. Food and Agriculture Organisation of the United Nations, Italy. http://faostat3.fao.org/faostat-gateway/go/to/download/T/TP/E [Accessed online 6th November 2013]

1.5.6 Consumption

Measures and practices relating to consumption of small ruminant meat and milk in Ethiopia is explored at length in **Sections 3.6** and **3.12**.

The movement of animals within the small ruminant value chain in Ethiopia is shown in **Figure 15**.

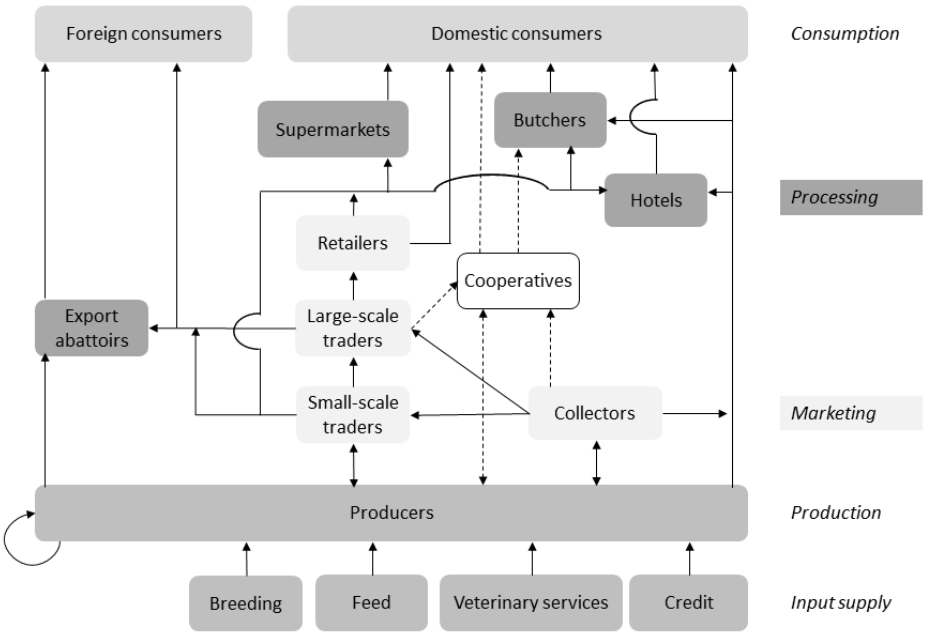

Figure 15. Small ruminant value chain in Ethiopia (adapted from the VCA synthesis report[15]). Cooperatives were found only in Borena study area, and thus represent a minor part of the overall value chain (black outline, dotted arrows).

1.6 Situational analysis of regulatory frameworks

This section contains edited excerpts from a SFFF report on food safety regulations in sub-Saharan Africa[28].

The main government organs responsible for food safety in Ethiopia are the Ministry of Health (MoH), Ministry of Agriculture and Rural Development (MoARD) and the Quality and Standardization Authority of Ethiopia (QSAE). These institutes have different and overlapping mandates. The MoARD is empowered to control animal diseases, including zoonoses, through inspection of premises where animals (or their products or by-products) are kept. This can include taking samples from animal products and by-products for the identification of disease or disease-causing agents. The Ministry is also empowered to establish quarantine stations and entrance and exit posts to control the safety of animal-source food that is being imported and exported. It can also issue international sanitary certificates for exported food or require the same for imported food products.

The MoARD drafted a number of regulations in 2010 to enforce these powers. The Regulation on Prevention and Control of Animal Diseases describes the procedures for prevention and containment of animal and zoonotic disease, notification of livestock disease outbreaks, testing and quarantine procedures, and the creation of disease-free zones. The proposed Regulation on Animal Identification and Movement Control outlines the procedures for registration of premises and the identification, recording and tracking of food animals. The Regulation on Animals, Animal Products and By-Products describes the procedures of quarantine,

[28] Jabbar MA, Grace D, 2012. Regulations for safety of animal source foods in selected Sub-Saharan African countries: Current status and their implications. SFFF, ILRI, Kenya.

vaccination, and other actions to be taken in the face of disease occurrence, and lists the requirements to be met for import and export of animal-source foods.

The MOARD is also empowered to carry out meat inspection in local and export abattoirs. Regulation 428 of 1972 describes in detail the facilities required to undertake *ante mortem* inspection, and the required procedures of *post mortem* inspection. The ministry has submitted a new Meat Inspection and Hygiene Proclamation to be endorsed by the parliament. This proposed act requires the registration of abattoirs and slaughterhouses and defines the duties and responsibilities of meat inspectors, and it explicitly states that meat should display stamps attesting that the carcass has been passed as fit for human consumption. In 45% of the cases, stamps are laid by the meat inspection service. No inspection of food is carried out at wet markets and private butcheries. No chilling or cooling facilities exist in butcheries, although all small ruminant meat is sold within a day of slaughter.

The MoH has recently enacted Proclamation No. 661/2009, which enables it to control the safety and quality of food. The new act entitles the Ministry to: set food standards; issue licenses to trans-regional food companies; control the import, export, distribution, and storage of food; and control the quality of food laboratories. It can also issue, renew, suspend and revoke licenses of food processing plants and food importers or exporters. The Ministry can initiate policies and legislations, undertake post-market surveys, dispose of expired foods and control illegal trade, wherever necessary, in order to strengthen food safety in the country. The act prohibits the production, sale, or distribution of food without a permit; no raw food materials, additives, or packaging can be used unless it complies with national and international food safety standards. The law also prohibits people infected with communicable diseases from working in food plants or catering establishments. The MoH has appointed inspectors who are empowered to enter any food establishment and inspect its compliance with these laws, and has published manuals and guidelines on food hygiene and safety. Imported and exported food items are also required to be accompanied by a food safety certificate.

The QSAE is also empowered to set food standards. The QSAE has developed a number of standards related to quality assurance and the safety of animal-source food, which are supposed to be followed by all stakeholders - the implementing authorities as well as producers, traders and other middle-men, processors and retailers.

In conclusion, there are few acts with a sufficiently wide scope to deal with food safety issues. The actual number of implementing agencies for each act is unclear, as each ministry can control several agencies, each of which has separate (but often overlapping) mandates to enforce the legislation. There is also overlap of the responsibilities and mandates of the MoH and QSAE. There is little close cooperation or co-ordination between the three institutions, which has resulted in duplication of work and wastage of their already-scarce human and financial resources. An unsuccessful attempt was made to establish a Technical Committee to coordinate the food safety activities carried out by different ministries and agencies, and to liaise between them. A National Food Safety Council was also established, with members drawn from the public and private sectors. Its roles and responsibilities are ambitious and include the following:

- establish and coordinate an effective food safety assurance system;
- formulate effective food safety policy and strategy and follow up their approval and implementation;
- establish and strengthen food safely information, education, communication, training among regulatory bodies, inspection authorities, institutions, producers and consumers;
- strengthen the food safety inspection, monitoring and epidemiological studies;
- establish food laws and update food safety regulations and establish food safety fund;
- harmonize the national food safety system with international requirements;
- establish intuitional arrangements for effective food safety management;
- establish and strengthen risk assessment capacity and research in food safety.

The council is yet to be implemented but its complex structure and multiplicity of membership and objectives may keep it on paper with little practical application

1.7 **Previous interventions**

Previous interventions reported by VCA respondents were concerned with breeding, feed management, animal health, credit, marketing, and drought relief. Interventions tended to be project-based and were not necessarily continued or expanded after the conclusion of the project. This is consistent with the findings of Tegegne, Gebremedhin and Hoekstra in their comprehensive summary of development in the livestock sector – they criticise the majority of interventions in Ethiopia because they are "either location-specific, species-specific or breed-specific, and have failed to be sustainable"[29].

The community-based sheep breeding programs established at Horro and Menz study areas were reported to be of benefit to farmers and have attracted the attention of regional governments, who are planning to introduce similar measures elsewhere. Breeding improvement programs are, however, still limited to specific local sheep breeds at this time. There also seems to be a lack of cohesiveness between breeding programs generally, and inadequate information on animal husbandry and management to accompany them[29]. Attempts to cross-breed native goats with exotic animals in order to increase milk production produced no additional net benefits than indigenous breed goats in one study[30].

Several collaborations have focussed on developing feed and water resources; however, according to Tegegne and co-authors, the success of these programs remains to be determined[29]. The cut-and-carry system of feeding livestock that was established in Atsbi was reported to have become a major feed source in this area[16]. Controlled grazing programs (Menz) and supply of emergency feeds (Borena) during drought were also reported.

A constraint repeatedly reported by farmers during the VCA was inadequate veterinary services, which are largely government-provided. The lack of government resources has already been recognised, as has the limited involvement of the private sector and NGOs[29]. Previous interventions include government-run vaccination drives and provision of veterinary services, drugs or vaccinations by NGOs (e.g. World Vision at Atsbi[16]; USAID at Abergelle Tigray[22]), although these are no longer operational. Increasing privatisation of veterinary services has not materialised, due to a number of challenges (lack of capital, unwillingness of producers to pay for services, affordability of drugs and disposables, poor accessibility and high transportation costs, and competition from informal drug suppliers)[29].

Credit supplied by microfinance institutions was often poorly taken up by producers, as described in **Section 1.5.2**, although some NGO credit programs remain functional, such as the Oxfam loan program for female small ruminant producers in Shinelle[21]. However, marketing cooperatives developed during interventions in Borena, previously described by researchers as successful[31], were reported as suboptimal by farmers and other actors during the VCA[23]. Livestock marketing is generally underdeveloped in Ethiopia, due to traditional management systems, lack of market-oriented production, poor infrastructure and financing, and cross-border trade[29]. Drought relief as reported in the VCA varied throughout the country, and could take the form of food aid or donations of live animals or supplementary feeds; as this type of intervention involves emergency relief rather than development *per se,* it will not be discussed further.

Some broad-based interventions that include targeting of other development areas, as well as livestock, have been successful. Promotion of collective action by Boran women's groups across the Ethiopia-Kenya border was found to improve participation in livestock trade and increase savings, among other benefits[32]. Another integrated project, this time focussed on improving productivity of women-managed dairy goats through

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[29] Tegegne A, Gebremedhin B, Hoekstra D, 2006. Input supply system and services for market-oriented livestock production in Ethiopia. In: Proceedings of the 14th Annual Conference of the Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia.

[30] Ayalew W, RIschkowsky B, King JM, Bruns E, 2003. Crossbreds did not generate more net benefits than indigenous goats in Ethiopian smallholdings. *Agricultural Systems* 76:1137-1156.

[31] Desta S, Gebru G, Tezera S, Coppock DL, 2006. Linking small-ruminant producers to markets: a case study from the sourthern Ethiopian rangelands. In: Regional Consultation on Linking Farmers to markets: Lessons Learned and Successful Practices, USAID, Cairo, Egypt. http://globalfoodchainpartnerships.org/cairo/papers/SolomonDestaEthiopia.pdf [Accessed online 17th November 2013]

[32] Coppock SL, Desta S, Tezera S, Gebru G, 2009. An innovation system in the rangelands: using collective action to diversify livelihoods among settled pastoralists in Ethiopia. In: Sanginga PC, Waters-Bayer A, Kaaria S, Njuki J, Wettasinha C (eds*). Innovation Africa: Enriching Farmers' Livelihoods*. Earthscan, London, UK, pp104-119.

better management, genetic input and education, resulted in improvement in a number of development parameters[33]. These included proportion of households with access to ASF, proportion of households consuming goat milk or meat, proportion of children drinking milk and the total amount consumed by each individual, and micronutrient intake of participants. Crucially, the dairy goat project was integrated with a range of other interventions, including support for live animal credit schemes, animal health training, forage development, breeding programs, and a poultry development project.

Legislation has been passed to enforce interventions intended to improve food safety (see **Section 1.6**), although in practice, they are restricted to formal, urban environments. Studies on food safety in Ethiopia have, until now, been limited to microbiological sampling and research into knowledge, attitudes and practices of abattoir workers and other processors[34,35]. There seems to have been very little work done on food safety interventions in this country.

[33] Ayele Z, Peacock C. Improving access to and consumption of animal source foods in rural households: the experiences of a women-focused development program in the highlands of Ethiopia. *J Nutr* 133:3981S-3986S

[34] Haileselassie M, Taddele H, Adhana K, Kalayou S, Tadesse G, 2013. Food safety knowledge and practices of abattoir and butchery shops and the microbial profile of meat in Mekele City, Ethiopia. *Asian Pac J Trop Biomed* 3:407-412

[35] Woldemariam E, Molla B, Alemayehu D, Muckle A, 2005. Prevalence and distribution of Salmonella in apparently healthy slaughtered sheep and goats in Debre Zeit, Ethiopia. *Small Ruminant Research*, 58:19-24

2 Methods

2.1 **Study design**

The 14 sites selected as described in **Section 0** were considered to be broadly representative of each study area. It was initially anticipated that participatory rural appraisals (PRAs) and focus group discussions (FGDs) would be conducted with equal numbers of producers and consumers, along with interviews with key informants and observations of processing facilities and other infrastructure. However, due to the extremely rural nature of the sites, and the high penetrance of small ruminant owning, most consumers were also producers. Due to time and logistical restraints, and respondent sensitivity, interviews and inspections were also not completed during this rapid appraisal – it is hoped that they will be performed in the next stage of the project.

2.2 **Compliance**

The protocols were submitted to the ILRI Institutional Research Ethics Committee (IREC) in Jan 2013 and approved in June 2013. Because no samples were taken from living animals or exported to another country, no further approvals or permits were needed.

2.3 **Sampling strategy**

Once *kebeles* and villages had been identified as per the site selection procedures described in **Section 0**, local co-ordinators were nominated by scientists at the regional research centres with which CRP L&F and SFFF are collaborating. These co-ordinators were usually part-time employees of the research centres and local residents who helped liaise with communities during scientific studies. The intention was for the co-ordinators to facilitate meetings with community stakeholders and the research centre scientists in order to introduce the project and its aims, and to answer any preliminary questions.

Selection of participants for the SFFF exercises was non-discriminatory. The local co-ordinator, perhaps with the involvement of the local head man or community elders, asked for producer and consumer volunteers to contribute to the study. It was made clear that approximately 2-3 hours of time would be required for participation in the PRAs and that lunch and refreshments, but no remuneration, would be provided. Between 6 and 10 people were requested for each PRA, and attempts were made to include a reasonably representative cross-section of volunteers.

FGDs were also conducted with mothers of young children (less than 5 years old). The local co-ordinator requested 5-10 volunteers for this exercise; mothers were told that the FGD would take up approximately 1 hour of their time, and similarly, food and drink would be provided. Every effort was made to structure the research activities over the day such that the FGDs could be conducted during the times of least inconvenience to the mothers, who had the most household commitments.

2.4 **Tools used**

A rapid assessment of the food safety risks, and nutritional benefits, within the selected small ruminant value chains was conducted using participatory epidemiology techniques. Different tools were designed by SFFF to answer a set of key research questions, which fall under different topics and described in

Table 5. These research questions were answered through a series of exercises that addressed the detailed sub-questions shown in this table.

Table 5. Key research questions addressed in this study, and the specific sub-questions used within the tools

Topic	Key research questions	Sub-questions
Food and nutrition security	What is the role of the ASF food in question in diets of poor producers and consumers?	- How does small ruminant production vary by season? - What are the constraints to producing larger amounts of small ruminant meat and milk? - What is the role of small ruminant products in the diet by season? - What is the role of small ruminant foods in nutrition of young children?
	What is the relationship between livestock keeping and livestock eating?	- To what extent are livestock keepers also livestock eaters? - Where are small ruminant meat and milk obtained?
Food safety	What are the main hazards likely to be present in the ASF food value chain?	- How do producers perceive quality and safety? - How do consumers perceive quality and safety?
	What risks do these hazards pose to value chain actors?	- What are the attitudes towards consumption of sick or dead animals?
Combined nutritional and food safety issues	How does nutritional quality and food safety change along the value chain?	- How do conditions between purchase and consumption affect nutritional quality and food safety?
	What are the nutrition and food safety trade-offs?	- What are the attitudes towards consumption of sick or dead animals? - What is the role of waste in loss of nutrients? - Are there trade-offs or synergies between feeds and foods?
	How is value chain development likely to affect nutrition and food safety?	
Social and gender determinants of nutrition and health	Who gets the nutritional benefits and bears the health risks of the ASF?	- How do consumers perceive quality and safety?
	How do gender roles and poverty influence health and nutrition risks?	- How does gender affect preparation and consumption? - What is the role of small ruminant products in the diet by season?
	How do cultural practices affect health and nutrition risks?	- How do conditions between purchase and consumption affect nutritional quality and food safety?
Trends and possible interventions	How could investments enhance consumption of nutrients and decrease risks?	

The PRAs and FGDs were facilitated by a regional research centre scientist, with the assistance of a veterinary MSc student from the University of Addis Ababa, both of whom spoke the local language of the particular study area. The full tools are provided in **Annexes 1-3**, and are summarised as follows:

2.4.1 Producer PRAs

These were conducted with groups of 6-10 producers and contained the following activities:

1. Seasonal calendar, where counters were used to indicate the small ruminant production cycle, milk/ meat production and consumption, rainfall, and times of general food shortage during the year.
2. Pair-wise matrix, for which producers listed constraints on increasing volume or quality of small ruminant production. These constraints were then entered along two sides of a matrix and respondents were asked to identify the most important constraint from each column-row pairing (**Table 6**). The total number of times each constraint was listed as the most important of a pair was used to allocate an overall ranking for the whole matrix.
3. Problem-opportunity matrix, in which previous and potential interventions for the major constraints on production were discussed.
4. Proportional piling (**Figure 16**), which was used to demonstrate:
   a. the proportion of animals entering and leaving the flock for different reasons (e.g. death, sale, gift) throughout the year;
   b. the proportion of deaths attributed by farmers to different causes; and
   c. the proportion of animals affected by different diseases.
5. Knowledge, attitudes and practices (KAP) surrounding food quality and safety.

Table 6. Example of a pair-wise matrix: identifying the most important of a pair of production constraints

Constraint	Disease	Breeding	Predators	Owners	Feed shortage	Count	Rank
Disease		Disease	Disease	Disease	Disease	4	1
Breeding			Breeding	Owners	Feed shortage	1	4
Predators				Owners	Feed shortage	0	5
Owners					Owners	3	2
Feed shortage						2	3

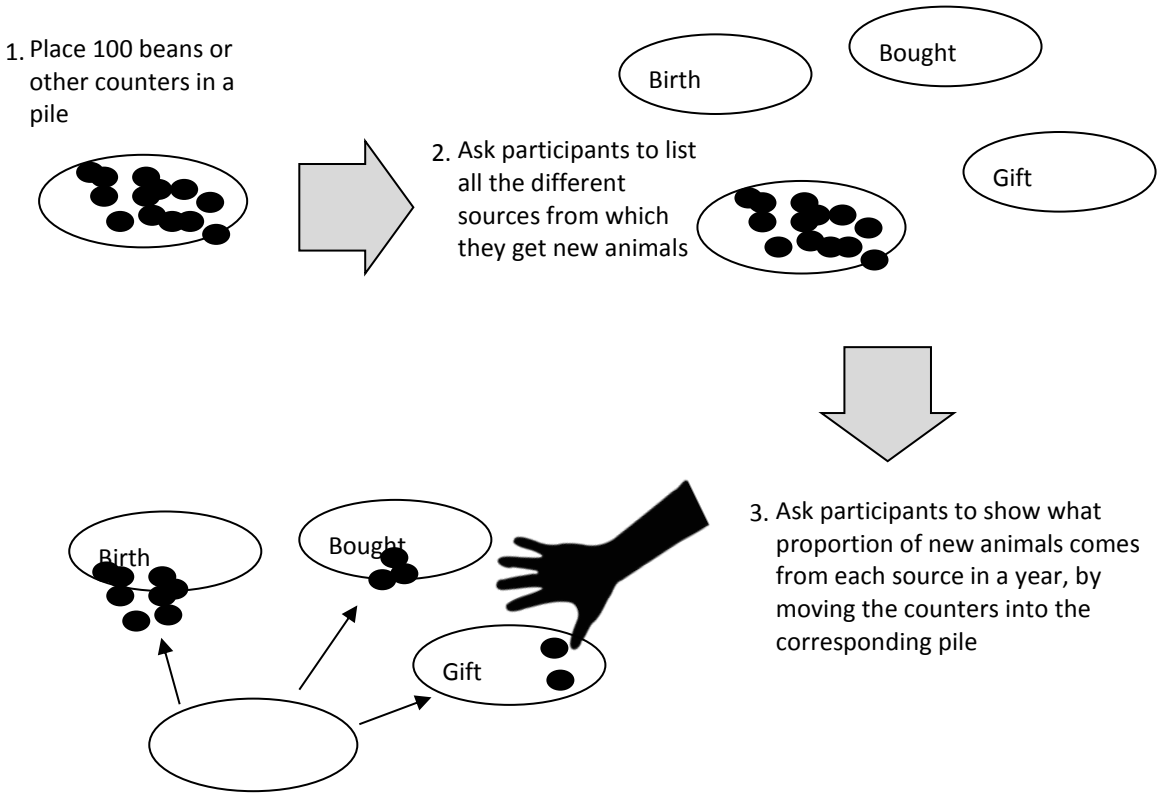

Figure 16. The process of proportional piling, here used to show the proportion of animals entering the flock from different sources

2.4.2 Consumer PRAs

The consumer PRAs also included seasonal calendars and KAP investigation. Additional tools were:

1. Listing, rating and ranking of the role of all animal source foods (ASF) in the diet.
2. Venn diagram to indicate proximity and importance of different sources of small ruminant meat and milk.
3. Flow charts, to demonstrate the typical pathway of food preparation and handling between purchase/harvest of small ruminant products, and consumption.
4. Listing and elaboration of the role of animal-source foods in diets of young children.

2.4.3 FGDs

Focus group discussions were also conducted with mothers of young children, and included questions on food preparation practices, consumption of food products by different members of the community, possible associations between food and health problems, and the importance of food waste or animal feeds competing with food for people.

2.5 **Data collection and analysis**

Data was collected during the PRAs and FGDs by the facilitator's assistant and additional notes were taken by the facilitator and this author; photographs of the activities were also taken by the latter. Qualitative data was recorded as-is, with the assistance of photographs for further documentation. Semi-quantitative data was cleaned and entered into an Excel spreadsheet. Averages were calculated for each individual study area, and from which overall average values for Ethiopia were determined, such that data from each study area made an equal contribution to the overall results.

Ranking of constraints from the pair-wise matrix was converted to a numerical score to allow comparison between study areas. To do this, the rank *r* of a particular constraint at each site was converted to a rank-score *s,* such that the highest-ranked constraint received the highest rank-score of the *n* constraints reported at that site:

$$s = n + 1 - r \qquad [1]$$

The average rank-score in each study area, $\bar{s}$, was then calculated from the rank-score from each site within that study area. The overall score for each listed constraint was generated by summing the average rank-score for each study area. Results were expressed as a percentage of the total rank-score over all constraints.

Data on specific animal diseases was expressed both as the absolute proportion of sick or dead animals, and as the proportion of the whole flock at each site.

3 Results

In this section, following a brief description of the study areas and the completed fieldwork, the results are addressed according to the research questions contained within the tools.

3.1 **Study area characteristics**

As stated above, five of the study areas were based on smallholder mixed livestock/crop production systems (Abergelle, Atsbi, Doyogena, Horro, Menz), and two were pastoralist areas (Borena, Shinelle). The (overwhelmingly) majority religious group was Ethiopian Orthodox Christian at Abergelle, Atsbi, Horro and Menz; Protestant at Doyogena; and Muslim at Shinelle. A mix of Ethiopian Orthodox, Islam and traditional beliefs were reportedly practiced at Borena. PRA groups consisted of even numbers of both genders, or were mostly men.

While Atsbi was considered a sheep meat-producing study area, sheep and goat milk was also reported to form part of the diet, especially for children. Similarly, in Borena, sheep meat and milk also formed a minor part of the diet. Thus, while not all research questions were fully addressed for these additional products, some details were provided incidentally during fieldwork and have been included here where relevant.

3.2 **Completed tools**

A total of 23 PRAs were conducted across the sites: 11 with producers and 12 with consumers. Of the consumer groups, nine contained producers, one was a mixed group of producers and non-producers (Atsbi) and two were made up of town-dwellers (Borena, Doyogena). At most sites, around 10 people participated in the PRA, although this sometimes reduced as people left the group before the exercise was completed. Eleven FGDs were also conducted: six within rural villages; one at *kebele* level that included a mix of producers and non-producers (Atsbi); three in towns (Abergelle, Borena, Doyogena); and one in an urban centre (Dire Dawa, close to Shinelle). Occasionally, a FGD was conducted with 4 rather than 5-10 mothers.

Figure 17. Producers completing the seasonal calendar in Atsbi (L) and Shinelle (R)

3.3 How does small ruminant production vary by season?

3.3.1 Production cycle

In Ethiopia, births supply the majority of new animals entering small ruminant flocks each year: 52% of flock entries, on average [range: 35-76%] (**Figure 19**). The greatest proportional contribution of births occurs at Shinelle, whereas the lowest proportions of births were reported at Abergelle Tigray (37%) and Borena (35%). Other main sources of small ruminants were purchases (on average 18% [range: 7-24%]), gifts (15% [5-53%]), and the share-loan system (10% [0-27%]). Known as *ribi* in some areas, the share-loan system involves one farmer loaning small ruminants to another; the loan is repaid with the offspring of these animals, although the exact terms varied between study areas. In study areas where it is practiced (Abergelle, Horro, Menz), it contributes 22-25% of the annual flock intake. Both gifts and share-loans were considered to play an important role in community activity and social connectivity. Government or NGO donation was a large source of small ruminants in Atsbi only (20%).

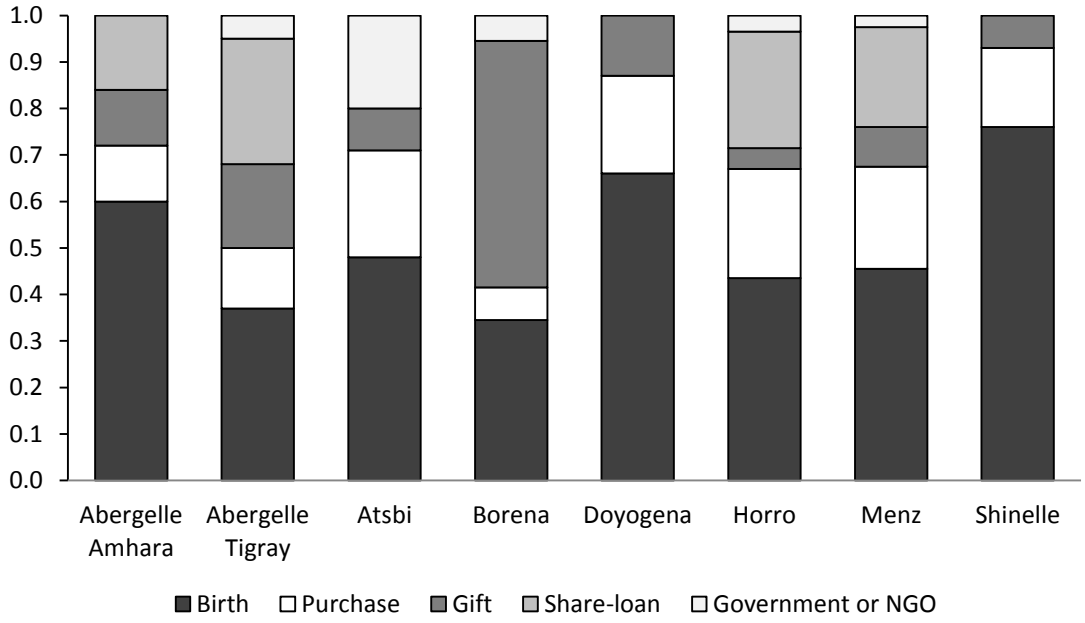

Figure 18. Average proportion of small ruminants entering flocks each year from different sources at several study areas in Ethiopia

The timing of the production cycle in Ethiopia varies according to climate and production system. In the sheep-producing central highlands (Doyogena, Horro, and Menz), seasonal reproduction is reasonably similar across study areas. In these areas, there are three main lambing periods: December-January, April-June, and September, although lambing does occur at lower levels for the remainder of the year (**Figure 19**). Main lambing periods are associated with breeding seasons of July-August (during the rainy season), November-January (dry season), and April (just before the rainy season), respectively. Outside the central highlands, lambing is much more seasonal. Greater peaks are reported in December-January, March-April, and July-August, and relatively fewer (if any) births occur in the intervening months. This is particularly interesting at Atsbi, as although this study area is in the north of the country, it is at high altitude, and shares the timing of the main rainy season with the central highlands. In Shinelle, farmers reported separating rams from ewes at specific times of the year, to ensure that lambing does not occur in seasons when feed is limited.

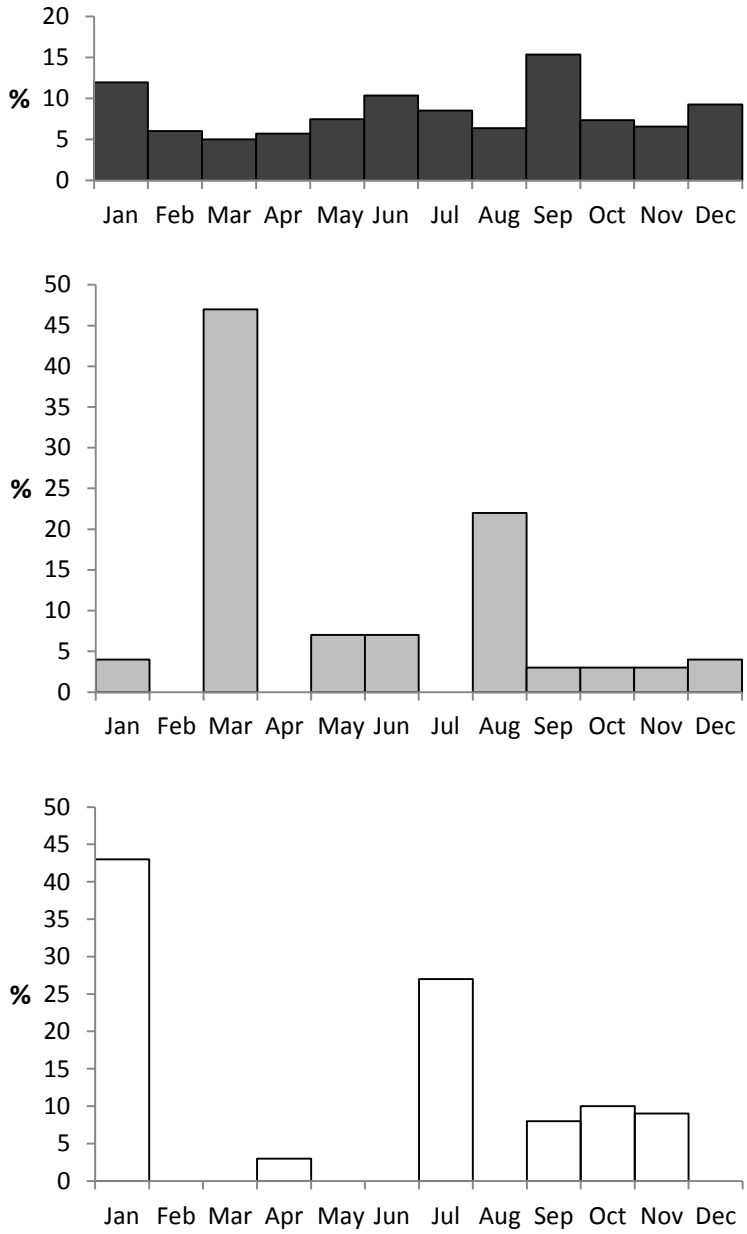

Figure 19. Average percentage of annual lambing occurring per month in three areas in the highlands? of Ethiopia: top, central highlands (Doyogena, Horro and Menz); middle, Atsbi; bottom, Shinelle. Main rainy season in Atsbi and the central highlands is July-September; in Shinelle, it is June-August

The goat production cycle is also highly seasonal. Peak kidding was reported during November-December in all study areas (Abergelle, Borena, and Shinelle), which was approximately five months after the rainy season (**Figure 20**). Additional birth peaks were reported in April and August (Borena) and June (Shinelle), which indicate breeding during the dry season. Farmers in Shinelle did not control the breeding periods for goats, unlike for sheep, as they considered goats hardy enough to withstand drought.

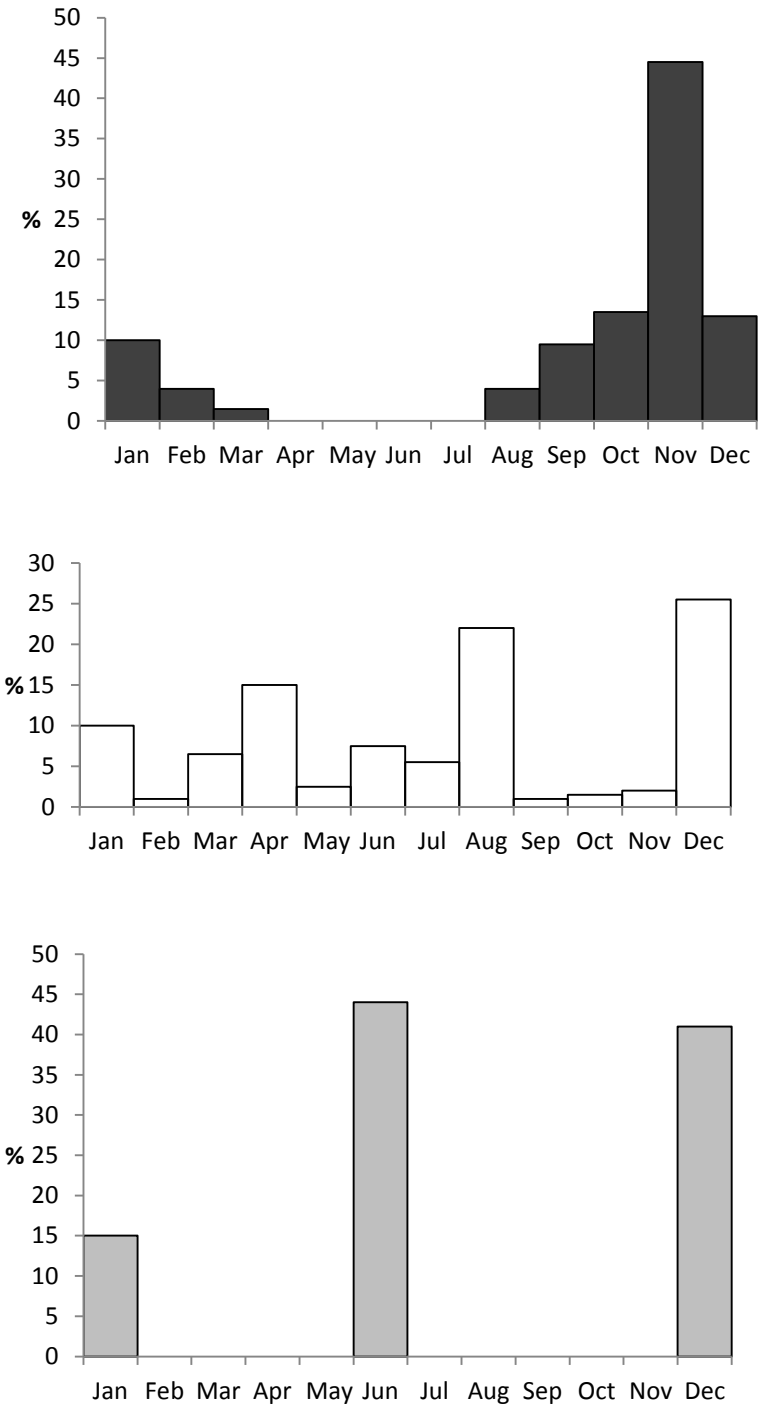

Figure 20. Average percentage of annual kidding occurring per month in three study areas in the lowlands? Ethiopia: top, Abergelle; middle, Borena; bottom, Shinelle. Main rainy season in Abergelle is May-August; in Borena, March-May; and in Shinelle, it is June-August

3.3.2 Meat production

Meat production *per se* does not occur at farm level in Ethiopia. Rather, producers measured production in terms of sale or slaughter of live animals. Production of both sheep and goats were similar throughout the country, and were generally aligned with consumption patterns (largely influenced by religious and cultural festivals), with some notable exceptions.

Small ruminant production in all study areas peaked at three major time points throughout the year (**Figure 21**), all associated with major national or religious holidays: April (Ethiopian Easter); September (Ethiopian New Year, *Meskel, Eid al-Fitr,* and *Arafa*); and December-January (Ethiopian Christmas, Muslim *Mawlid,* and *Timkat*). Additional celebrations such as *Sene Michael*, observed in June by Horro's Orthodox Christians, were associated with smaller localised increases in production. The 2-3 month period from April/May until the onset of the rainy season is the time of generalised feed shortage. The high average production in October is not proportional to domestic meat consumption, which is low at this time (**Figure 32**); instead, it is influenced by reports of high production in Abergelle, Borena and Shinelle only. These three study areas are largely goat-producing and between 26 and 31% of their annual yearly production of small ruminants occurs in October. This is probably due to increased demand from the Middle East at this time.

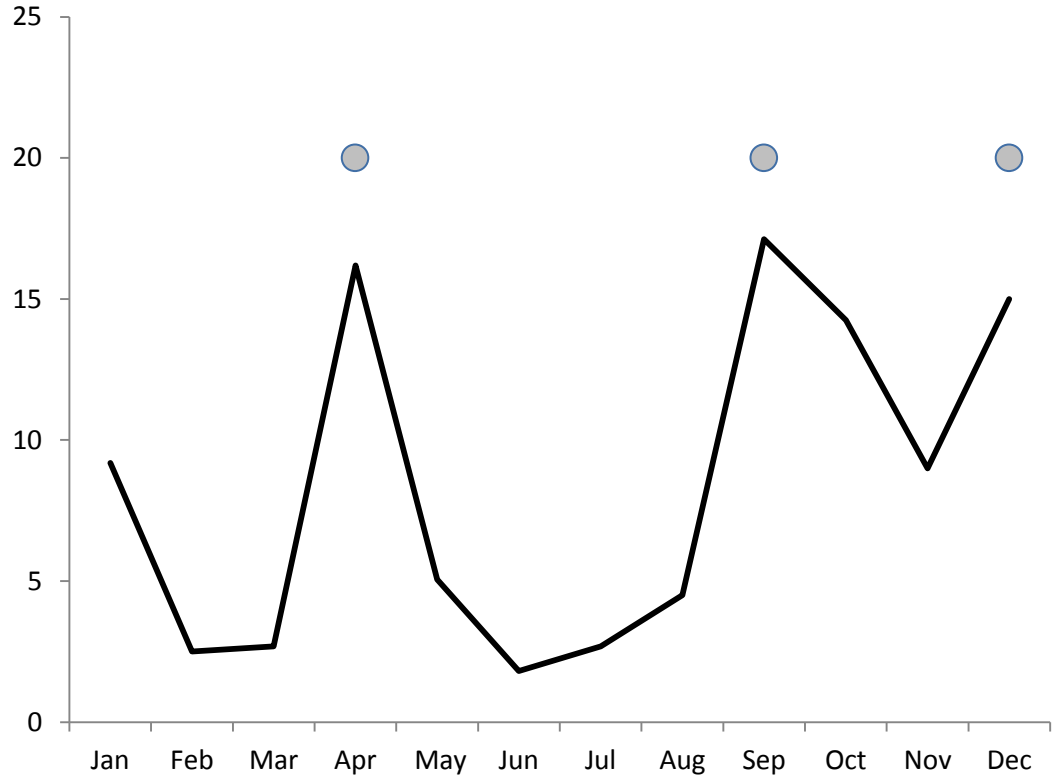

Figure 21. Percentage of annual small ruminant meat production occurring per month in Ethiopia. Results are averaged over seven study areas. Circles represent timing of major religious festivals

Goat production at one *kebele* in Borena (Derito), where a mixture of traditional beliefs and religions are observed, was more consistent throughout the year. Producers at this site prioritised the role of red meat in their own diets, which was reflected by their much higher rates of consumption (see later). By contrast, in other study areas such as Abergelle and Shinelle, farmers reported selling sheep and goats during times of food shortage, in order to generate cash to purchase grains and other staples. Under these circumstances, animals were usually in poor condition and thus unable to fetch good prices: one farmer in Shinelle described the process as "throwing my animals away" in the market, rather than selling them.

3.3.3 Milk production

As expected, seasons of milk production were strongly associated with the reproductive cycle. However, the proportion of milk produced during each month of the year did not necessarily parallel the proportion of births occurring in the preceding months. This was chiefly a result of feed availability. For example, in Borena, peak kidding occurred in August and December. Kidding in August was followed by a relatively high proportion of milk production, while December births were associated with almost no milk production. This was ascribed to

feed shortages during this time. On average, 40% of yearly milk production occurred during August and September (**Figure 22**).

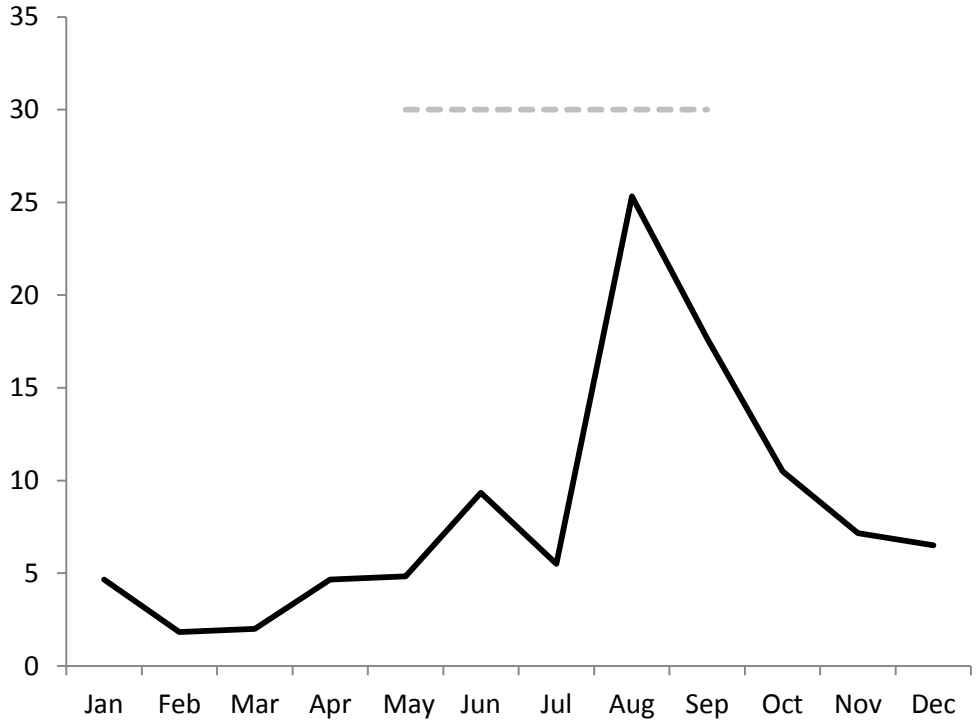

Figure 22. Percentage of annual goat milk production occurring per month in Ethiopia. Results are averaged over three study areas. Dotted line indicates timing of major rainy season

3.4 What are the constraints to producing larger amounts of small ruminant meat and milk?

The constraints to producing larger amounts of meat and milk from sheep and goats, from most-reported to least-reported by producers, are as follows:

1. Disease, feed shortage;
2. Lack of breeding program and/or improved genotypes;
3. Lack of market access, predation;
4. Land shortage, lack of finance;
5. Water shortage;
6. Lack of supplementary feed, lack of housing, poor management, and a large consumption requirement.

The constraints faced at each site were ranked by respondents. The final score for each constraint was presented as a percentage of the sum of the average rank-score for each study area. The five most highly-scored constraints are feed shortage, disease, lack of a breeding program or improved genotypes, land shortage, and lack of adequate finance, in that order. Of these, feed shortage and disease are by far the most important, with scores approximately 10 percentage points higher than the next-most important constraint (**Figure 23**).

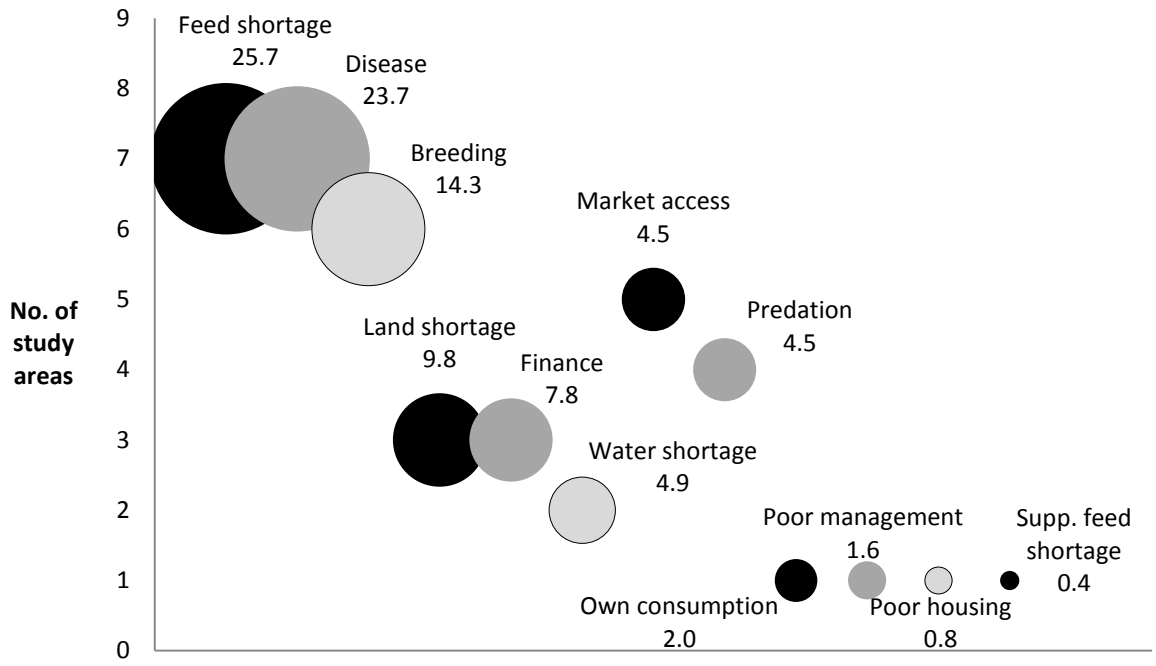

Figure 23. Constraints on small ruminant production in Ethiopia. Constraints are ordered along the x-axis by decreasing percentage rank-score (indicated by size of circle and in data label). Y-axis indicates number of study areas reporting that constraint. 'Supp.' = supplementary

This finding is consistent with data provided on reasons for animals leaving the flock (flock exits) (**Figure 24**). On average, 46% of animals – between 32% and 75% in individual study areas – left flocks in the last year. Of these, an average of 36% [range: 26-53% in individual study areas] occurred due to death; the highest proportion of deaths were reported in Borena (53%), and the lowest in Doyogena (28%) and Atsbi (26%). This represents an overall annual mortality rate as a percentage of the total flock of 16%: 12% [10-18%] of sheep, and 20% [10-27%] of goats. Death contributed to a greater percentage of flock exits than the reported average due to sale, which was on average 27% [11- 55%] of exits. Here, Atsbi is again an outlier, with a much higher proportion of small ruminants leaving flocks due to sale (55%) than in the study area with the next-highest proportion (Doyogena, 33%). Sales in Abergelle and Borena account for only 18% and 11%, respectively, of the flock exits in these areas.

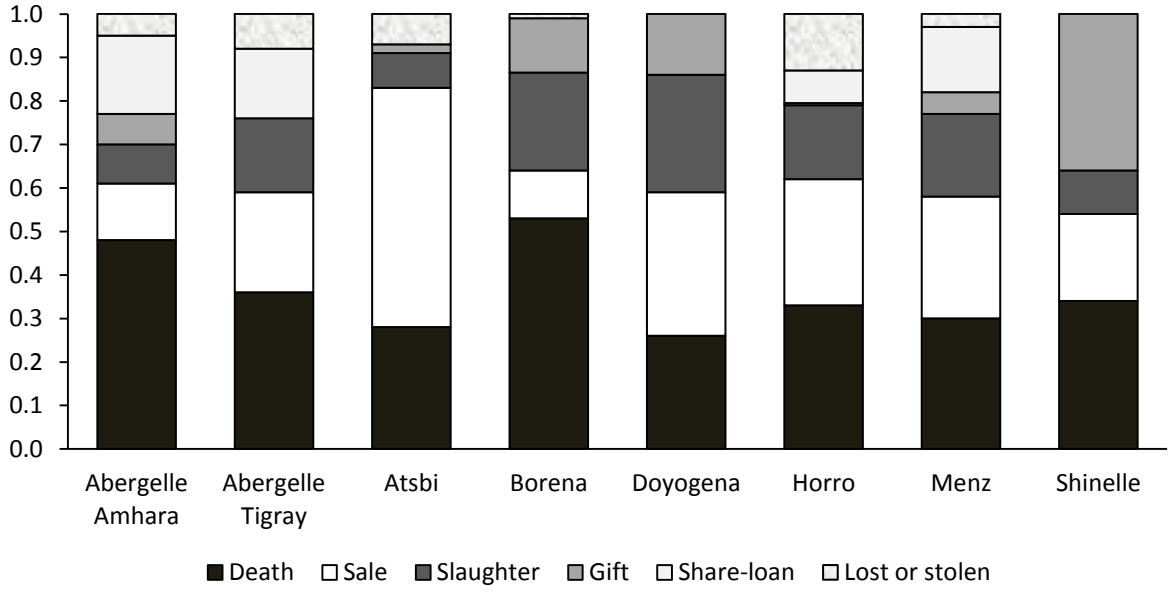

Figure 24. Average proportion of small ruminants leaving flocks each year for different reasons at several study areas in Ethiopia

Figure 25. Proportional piling being used to show flock exits and deaths in Menz. Labels are written in both English and Amharic (Ge'ez script)

Of the deaths, an average of 53% [range: 28-92%] were attributed to disease and 23% [0-64%] to starvation, which equates to an overall average annual mortality of 9% and 4% due to these causes, respectively. Study areas with the largest percentage of deaths due to disease were Borena, Doyogena, Horro and Menz (66-87%), whereas producers in Atsbi and Shinelle reported the highest percentage of losses due to starvation (64% and 43%, respectively). Predation was one of the third-most frequently reported constraints, although it did not score highly compared to other constraints at individual sites. However, it had an estimated average total mortality of 3% and was considered an important cause of death in Abergelle, Horro and Shinelle, accounting for an average of 20-41% of deaths at individual sites within these study areas.

3.4.1 Disease

Extensive information was gathered on animal health, due to its association with zoonoses and foodborne disease. The five major causes of sheep deaths were respiratory disease (3% overall mortality, on average), starvation (2%), predation (1%), liver disease (1%), and diarrhoea (1%). Goats were most likely to succumb to starvation (5%), predation (4%), coenurosis (3%), diarrhoea (2%), and respiratory disease (1%). 'Respiratory disease' includes pasteurellosis, and 'liver disease' is most likely fascioliasis. The proportions of total mortality attributed to the different diseases (and starvation, predation and accidents) is shown in **Figure 27** and **Figure 28**, and the difference between the study areas are indicated in **Annexes 4** and **5**.

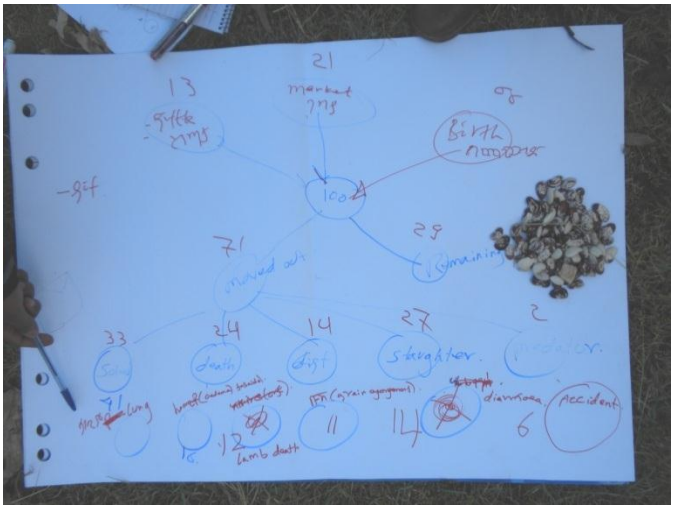

Figure 26. Proportional piling being used to show flock mortality and disease burden in Doyogena. Labels are written in both English and Amharic (Ge'ez script)

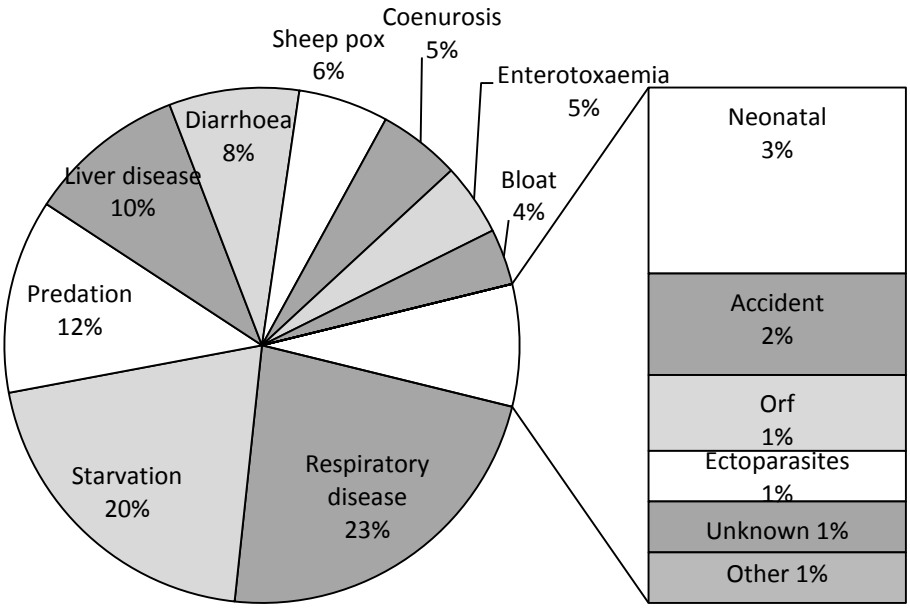

Figure 27. Percentage of annual sheep mortality attributed to different causes in Ethiopia. 'Bloat' includes grain overload

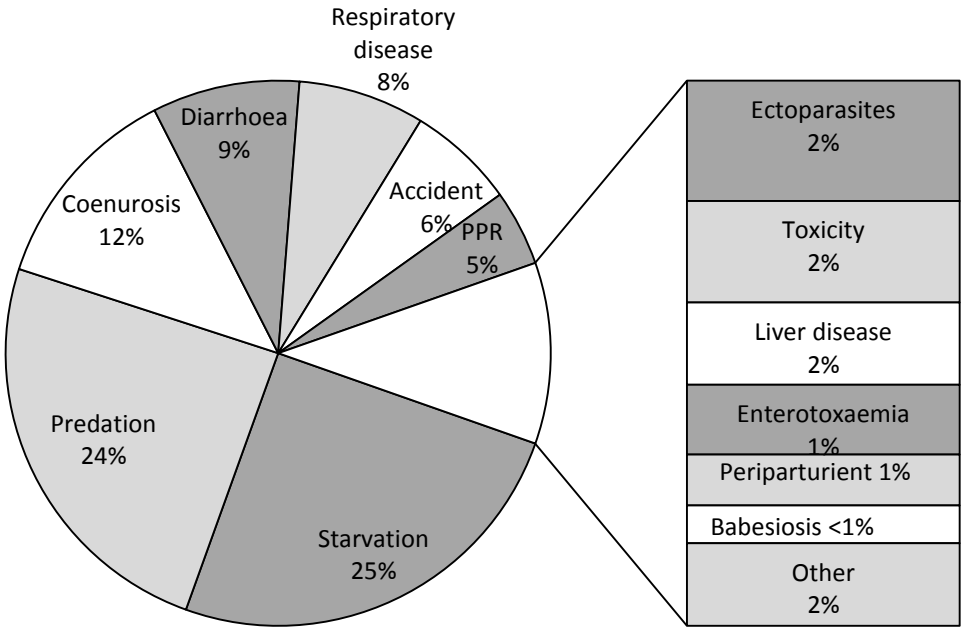

Figure 28. Percentage of annual goat mortality attributed to different causes in Ethiopia

On average, 42% of small ruminants in Ethiopia were reportedly diseased each year; this figure ranged from 25% in Atsbi to 62% in Shinelle, although it was as reportedly as high as 82% at one site in Borena (Derito). Average annual morbidity was 36% [range: 25-42% in individual study areas] of sheep and 49% [38-62%] of goats. The top five diseases for both species were unchanged whether the results were expressed as a proportion of diseased animals, or as the morbidity rates for the whole flock. The five major causes of morbidity in sheep flocks were respiratory disease, liver disease (identified variously by submandibular oedema, enlarged livers, and jaundice), diarrhoea, coenurosis, and sheep pox (**Figure 29**). The overall average annual morbidity rates, as a percentage of the whole flock per year, were 9%, 6%, 5%, 3% and 2% respectively, for these diseases. Thus, an estimated 25% of Ethiopian sheep were afflicted by these five diseases in the preceding year. Neonatal problems were reported at Doyogena, however, they were not 'counted' as a disease by farmers elsewhere. In goat flocks, the five major causes of disease were coenurosis, respiratory disease, ectoparasites, peste de petits ruminants (PPR), and diarrhoea (**Figure 30**). The overall average annual morbidity rates for these diseases were 10%, 9%, 8%, 7%, and 5%, respectively: a total of 39% morbidity. Breakdowns of the proportional morbidity in each study area are shown in **Annexes 6** and **7.**

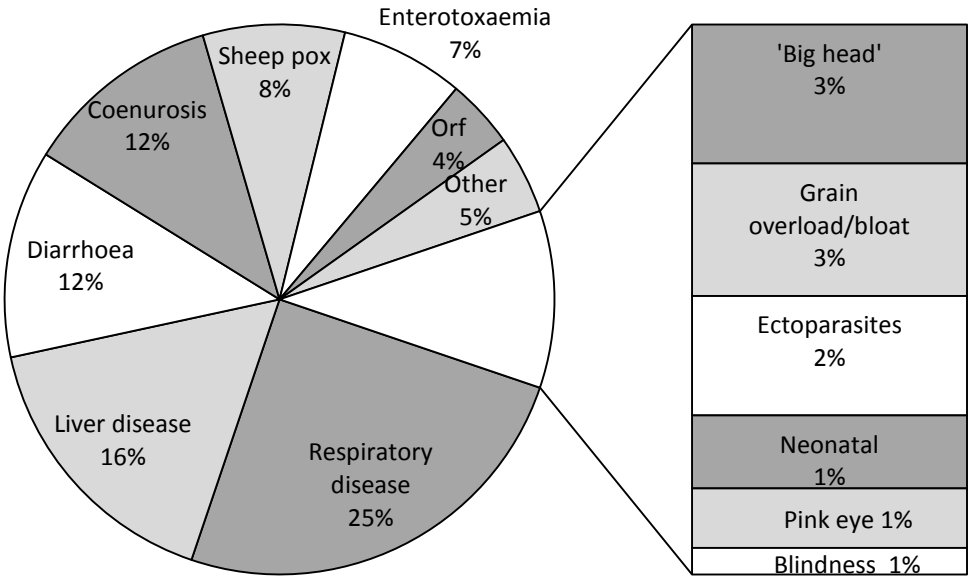

Figure 29. Percentage of annual sheep morbidity attributed to different diseases in Ethiopia[36]

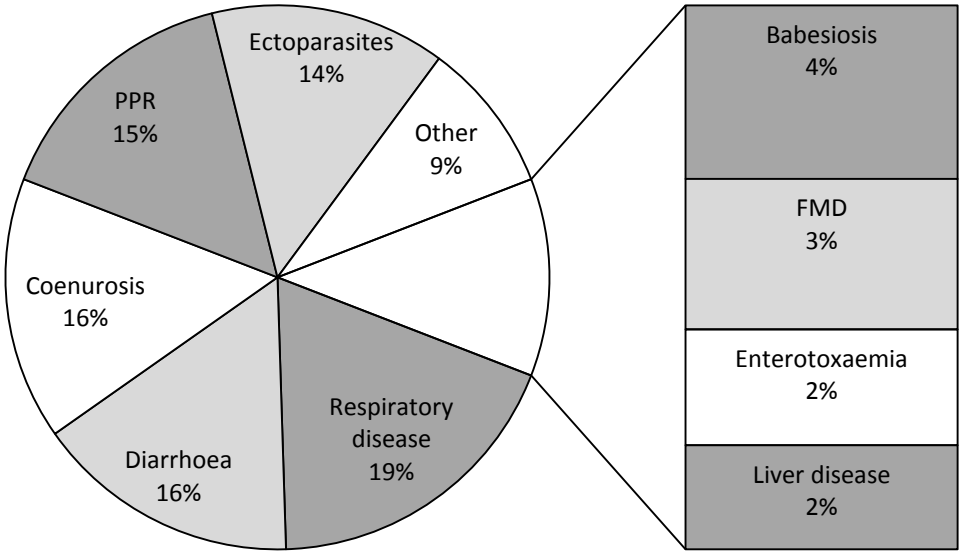

Figure 30. Percentage of annual goat morbidity attributed to different diseases in Ethiopia. FMD = foot and mouth disease; PPR = peste des petits ruminants

[36] 'Big head' was reported as having a large burden at one site in Doyogena only. It was described as a clinical syndrome distinct from bottle jaw, although we were unable to ascertain which disease farmers were referring to. Possibilities include bluetongue.

The disease burden was uniformly attributed by farmers to the absence of adequate veterinary services. In all study areas except Borena, this was reported as a combination of:

- lack of access to veterinarians and/or technicians – unstaffed animal health posts were commonly reported. In Atsbi, for example, farmers had contact with veterinary personnel perhaps once a year;
- inadequate transport for veterinary technicians and community animal health workers, which led to farmers having to travel long distances with sick animals to obtain treatment;
- no diagnostic services, such as laboratory facilities;
- insufficient knowledge and/or abilities of the veterinary service providers, and absence of further education.

Drug shortages were specifically reported at Abergelle Amhara, Doyogena, Horro and Menz; at Atsbi, Borena, Doyogena and Shinelle, informal drug suppliers were used to fill the gap. Farmers in Doyogena also mentioned reliance on informal drug suppliers or unqualified animal health workers as having a negative effect on flock health. Farmers in Abergelle Tigray, Atsbi, Borena and Shinelle regarded vaccine shortages as a root cause of this constraint on production; in Abergelle and Borena, vaccines were reported as being 'faulty'. It was unclear whether a lack of vaccine efficacy was attributable to incomplete coverage, inappropriate dosage and/or administration, an inappropriate vaccine, a break in the cold chain, or to deficiencies of the vaccine itself.

Additional root causes of the disease constraint on small ruminant production included lack of education on disease control (Horro), "abusing use of drugs" (Doyogena), shared grazing (Doyogena), grazing on swampy ground (Horro), poor nutrition (Menz, Shinelle), and environmental factors such as climate variability (Horro, Menz).

Previous interventions, as mentioned in **Section 0**, included vaccination campaigns by government and/or NGO providers, or in one case (Atsbi), and NGO-run animal health service. These interventions tended to be intermittent. Farmers considered improving animal health to be the responsibility of the government, but would welcome contributions from any other stakeholders, including NGOs. Paying for private veterinary services was considered an expensive and less effective alternative. Their main requests were for timely and efficacious vaccination (Abergelle Amhara, Borena), access to a qualified veterinarian (Abergelle Tigray), and provision of diagnostic services (Abergelle Tigray).

3.4.2 Feed shortage

Feed shortage was most commonly attributed to shortages of land and/or water. In Shinelle in particular, farmers reported a shortening of the rainy season in recent years. Grazing land was reported to be under pressure from population growth and expansion of croplands in the highland areas, and by encroachment of bush in the pastoral areas, although this provides browse for goats.

Other root causes associated with feed shortage, according to responses to the problem-opportunity matrix, included climate change (Doyogena, Horro, Menz), deforestation and erosion (Abergelle Tigray, Atsbi, Shinelle), high density of animals (Menz), increased enclosure of grazing lands for individual use (Abergelle Amhara), and even, in Borena, "God's will". In the crop-producing highlands, lack of storage for crop residues also contributed to shortages. Feeding of concentrates did not play a significant role in small ruminant production, except in some fattening operations in Doyogena. Here, concentrate feeds were reported to have drastically increased in price in recent years, subsequent to a 2011 government imposition of price-fixing for wheat flour and other major commodities. By-products such as wheat bran are exempt from price-fixing, and accordingly, prices of these materials have doubled as processors attempt to make up the shortfall on the products for human consumption[15].

In Abergelle Amhara, no interventions to improve feed supply were reported. A cut-and-carry system was reported exclusively in Atsbi, where livestock were excluded from designated areas from which forage was harvested. Irrigation was occurring in Atsbi in addition to the cut-and-carry system of feeding, although it was thought that water storage could be increased in this area, and in Borena. In Atsbi and Doyogena, there had been some supply of crop and forage seeds from the government. Producers in Doyogena practiced supplementary feeding and had also adapted their sheep production cycle to align better with rainfall occurring over the year. Farmers in Horro and Menz reported planting suitable forage crops and feeding livestock with crop residues; in Menz, attempts were being made to avoid free grazing.

Farmers requested improved seeds for crops and forage in Abergelle. Producers at multiple sites also implored training to improve their crop and forage production, and to learn more about feed management and supplementation options, particularly in the highland areas. Pastoralists were more inclined to request government- or NGO-backed support in the form of supplementary feed donations during the dry season.

3.4.3 Lack of breeding program and/or improved genotypes

Breeding-related constraints on small ruminant production ranged from a lack of selective breeding programs to an absence of improved genotypes, whether exotic or from elsewhere in Ethiopia. In Atsbi, farmers attempted to combat this by practicing selective breeding and cross-breeding local ewes with higher quality rams (e.g. from Afar). Conversely, in Borena, introduction of exotic breeds by NGOs was reported to cause problems with disease and drought resistance, due to dilution of the hardy local goat breed. In Horro and Menz, farmers had been exposed to selective breeding programs, and were anxious for scaling up of these programs, as they considered their own lack of knowledge a major root cause of the lack of selection in their flocks. They were also aware of causes of negative selection such as in-breeding or retaining poor quality animals within the flock, and reported some selective culling, selection of ewes and rams, and exchange of rams with other farms.

Producers in Atsbi suggested improvements via collaborative work with the agricultural office, possible provision of improved breeds, and government intervention in selective breeding. Horro producers requested stronger collaboration with government and other professionals, in order to provide more specialised breeding knowledge and make further progress in this area. In Menz, farmers felt that they could strengthen their own farmers' association to support this work.

3.4.4 Land shortage

Land shortage was reported as a production constraint in Atsbi, Doyogena, and Menz. Despite being less frequently reported than lack of market access and predation, this constraint scored more highly overall, as it was considered one of the major constraints at Doyogena and Menz, and of moderate importance in Atsbi. By contrast, market access and predation were the least-important or second-least-important constraint in all study areas where they were mentioned, with the exception of Abergelle Amhara, where predation was considered of moderate importance.

Despite farmers reporting land shortage as a separate constraint to feed shortage, the two constraints are inextricably linked, and it was difficult to discuss them separately. 'Land shortage' was used to refer to a lack of grazing space, and so, many of the issues discussed in **Section 3.4.2** apply.

3.4.5 Lack of appropriate finance

While options for financial support did exist in most study areas, many producers were discouraged from utilising them. Firstly, loan conditions varied between providers. The regional Debit Credit and Savings Institute (DCSI) of Tigray was the sole provider reported to offer individual loans; all others required group collateral. This was considered problematic by many farmers, who preferred to conduct business independently, as they preferred to shoulder their own risk. DCSI also allowed loans of up to ETB 35,000, provided credit history was good, although other providers limited loans to a fraction of this. Secondly, in most study areas, loans were not considered appropriate to livestock production cycles, with repayments commencing from the start date of the loan. This is likely to be significant, given the periods of time required for gestation, growth and fattening of small ruminants. Thirdly, farmers felt unsure of the terms and conditions associated with microfinance loans, and reported a lack of staff available to create awareness of these financial products.

Multiple contributing root causes of the financial constraint on small ruminant production were given at Atsbi. These included a reluctance to take out group loans, increased interest on financial products that were available, increasing living expenses, increasing family size, lack of business knowledge or a savings culture, and lack of job opportunities. According to producers, various projects were being undertaken in the area to create financial awareness, build capacity, encourage saving, and increase farm income through irrigation. The NGO World Vision had previously provided financial assistance and restocking. The producers we spoke to in this study area also suggested that not only financial products and access should be improved, but other wider-reaching interventions, such as quality education and thus increased job prospects for youth, building infrastructure to encourage investment, and family planning.

In Doyogena, producers mentioned that finance was limited as traditional banks, similar to co-operatives, were their only source of funds.

3.5 Where are sheep and goat meat and milk obtained?

Most consumers in our PRAs were also producers. Thus, the vast majority of small ruminant meat and milk in all study areas came from within the household/home farm.

3.5.1 Meat

The second-most important source of small ruminant meat for farmers was the community (within the village). This was relevant in areas like Abergelle and Horro where 3-4 families would either pool money, or simply take turns slaughtering one of their own animals, before sharing the meat. The distances between community members ranged from immediate neighbours to 1-2 km away in Menz. A very minor source of meat for farmers in Horro, Menz and one *kebele* in Shinelle were butchers in nearby towns, which were estimated to be 5-6 km away in Horro and Menz, and 14 km away from the Shinelle *kebele*. These were used only in "emergency situations", for example, an unexpected visit from a relative, or a sick child (Shinelle). Three live animal markets in Abergelle were 3, 4 and 5 hours walk away from the villages - at a walking speed of 3-5km/hr, this could represent distances of between 9 and 25 km. However, it seemed that these markets were used as a source of live animals with which to replenish the flock, rather than to provide animals for immediate slaughter and consumption.

For non-producer consumers at Atsbi and Doyogena, both the household and markets were considered to be the most important sources of meat. This is because live animals were bought from markets and brought back for home slaughter. In Atsbi, the closest markets were 2-3 hours away by foot: this could represent distances of 6-15km. In Doyogena, the market was located within the town in which the PRA took place. In the town in Borena, and urban Dire Dawa near Shinelle, the most important source of meat was local butcher shops or meat markets. For all consumer groups, ceremonies and visits to relatives both inside and outside the community acted as a minor source of meat, although the frequency of this occurring was reportedly very low.

Figure 31. A small ruminant market in Abergelle (L) and a butcher shop in Dire Dawa, near Shinelle (R)

3.5.2 Milk

The only sources of small ruminant milk available to most farmers were the home farm (most important), and occasionally the community (Atsbi, Shinelle), which was of low to minor importance. In Atsbi, children reportedly obtained milk from neighbours, or drank it directly from the animal. In Shinelle, people in need (again, perhaps with a sick child) might purchase milk from a neighbour, or be loaned a lactating female.

For non-producer consumers in Atsbi and Shinelle, the community again provided the major source of small ruminant milk, either by purchase or shared feeding. In Borena, milk was mostly supplied by pastoralists living outside the town. Very rarely, it was obtained with tea in coffee shops outside the community, when travelling. Respondents in Dire Dawa, near Shinelle, did not purchase small ruminant milk.

3.6 What is the role of small ruminant products in the diet by season?

Consumption patterns were very similar to production patterns (**Figure 32**). It is important to note that the role of small ruminant meat and milk - and in fact all animal-source foods - in the diet of Ethiopian Orthodox Christians is limited by the fasting days required by that religion. Orthodox Christians comprise approximately 45% of the population[37] and were the majority religious group in Abergelle, Atsbi, Horro and Menz. Fasting should be observed by anyone over the age of 13 years, and involves complete abstention from all animal products. All Wednesdays and Fridays (except for the 50 days after Easter) are fasting days. Four extended fasts are observed each year: Great Lent (55 days leading up to Easter), Apostles' Fast (14-40 days in June-July), the Assumption of Virgin Mariam (15 days in August) and the Fast of the Prophets (43 days over November-January), as well as several additional short fasts. Overall, fasting occurs over almost 70% of the year.

3.6.1 Meat

Small ruminant meat consumption by rural Ethiopians (including those in small country towns) was almost overwhelmingly governed by the timing of religious and cultural festivals, and did not differ noticeably between producers and non-producers (**Figure 32**). Meat consumption during the intervening months appeared largely unaffected by periods of general food shortage; instead, it was limited by religious requirements and financial/economic restrictions. Consumers explained that these restrictions are related to accessibility: in rural areas where people do not have access to fresh meat markets, whole animals must be purchased or selected from the producer's own flock, and slaughtered. This is represents a considerable cost to the consumer - especially compared to other foods, such as cereals, that could be bought with the proceeds of a live animal sale - and one that can't be justified by poor people, except on special occasions. At these times, due to the large amount of meat available at one time, sharing with family and others in the community was commonly reported.

[37] CIA, 2013. The world factbook: Ethiopia. Central Intelligence Agency, USA. https://www.cia.gov/library/publications/the-world-factbook/geos/et.html [Accessed online 2nd March 2013]

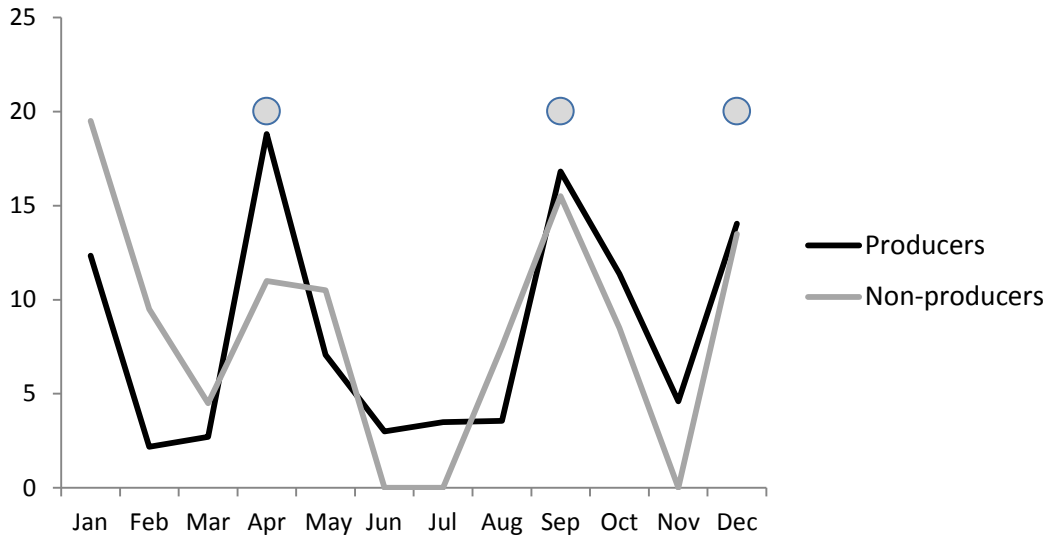

Figure 32. Percentage of annual small ruminant meat consumption occurring per month in rural Ethiopia. Results are averaged over seven study areas and are shown for producers and non-producers. Circles represent timing of major religious festivals

There were some exceptions to this rule. In Borena, pastoralists with large small ruminant flocks were more frequent consumers of meat – they considered meat an important part of their diet, and less costly than the alternatives. In one *kebele* in the Shinelle study area, where residents were within a few kilometres of the Shinelle meat market, producers reported purchasing small amounts of meat when necessary – for example, to feed a sick child.

Urban Muslims in Dire Dawa, close to our Shinelle study area, reported much more frequent consumption of sheep and goat meat. Proportional consumption across the year was not captured, although in general, these consumers reported eating meat one to six times a week. This is considerably more than people in the rural areas. Meat consumption in Dire Dawa also seemed unaffected by general food shortages, but if a household experienced financial difficulty, consumption of meat and other animal-source foods was reduced.

3.6.2 Milk

Small ruminant milk consumption was dependent on a combination of the small ruminant production cycle and feed availability, and in Abergelle, religious fasting. Producers reported that proportional consumption of goat milk over the year matched milk production (**Figure 22**); consumption of sheep milk, while mentioned at Atsbi, was not quantified. Peak milk consumption in all milk-producing study areas occurred after the rainy season, when feed was abundant. Butter, yoghurt and raw or boiled-milk cheese were also produced at these times. During the dry season, ewes and does produced less milk, which was consumed entirely by their own offspring. General food shortage was reported in the months preceding the rainy season (Borena, Shinelle), or during the rainy season (Abergelle, Atsbi). Thus, lack of milk availability coincided with general hungry periods. Unfortunately, some of the extended religious fasts observed in Abergelle overlapped with periods of peak production (August in Abergelle Amhara, November-December in Abergelle Tigray). During this time, excess milk was given to young children or pets, or processed into butter.

Sheep milk was drunk only by children in Atsbi. Elsewhere, small ruminant milk was usually consumed by the farmer's household and/or relatives or neighbours, although it was also sold to local customers in Shinelle (historically, goat milk was also sold in Borena, but in recent years, pastoralists had retained milk for their own use). In Abergelle, women were forbidden from consuming whole milk, although milk products were permitted. Household consumption of milk tended to be prioritised, so milk available for sale was usually surplus to the family's daily requirements. This meant that the effects of feed shortages were magnified for non-producers, particularly those in towns with less access to local sources of milk. In Borena, town-dwellers reported a recent complete cessation of milk supply, and small ruminant milk was reportedly not available at all in urban markets in Dire Dawa, near Shinelle.

Butter could be stored in smoked pots for several months, after being "purified" with special plants and spices. This could enable very low levels of consumption of milk products during non-fasting periods and when little or no production was occurring, although in Abergelle and Shinelle, butter was reportedly only available for 3-6 months of the year.

3.6.3 Other ASF

Other ASF that were consumed in most study areas included chicken, beef, cow's milk and dairy products, eggs and honey. In the pastoral areas (Borena, Shinelle), camel meat and milk was also consumed, and chicken was avoided. In Borena, it was explained that all chicken was produced for sale rather than own consumption; in Shinelle, chicken was not eaten due to religious beliefs that, as chickens act as scavengers, their meat was impure. Generally speaking, meat was consumed infrequently: in Abergelle, Atsbi and Shinelle, meat of any kind was eaten only 3-5 times per year. In the central highlands (Doyogena, Horro, Menz), consumers reported eating small ruminant meat 2-3 times/year, beef 2-4 times/year, and chicken 2-5 times/year, although it appears that the occasions (i.e. festivals and celebrations) for eating meat of different kinds overlapped with each other – meaning that meat consumption was clustered around major holidays, rather than spread out over the year. In Borena, year-round meat consumption was reported, although respondents did not want to specify exact amounts, as meat consumption is an indicator of financial status.

Cow's milk and dairy products were consumed frequently in Atsbi, Borena, Doyogena, Horro and Menz (except during fasting times in Atsbi, Horro and Menz). Estimated consumption was 1 cup per person per day. Amounts were not quantified in Borena and Shinelle, where camel milk was also consumed. In Abergelle, milk of any kind was only consumed over 3-6 months of the year, although respondents did not distinguish between milk from cows and small ruminants. In Abergelle, cultural taboos prevented the consumption of whole milk of any kind by women. Consumption of small amounts of butter from cow's milk was reported in all study areas, although the frequency varied widely: in Menz, it was consumed during festivals only, in Doyogena, it was eaten several times a month, and in Horro, consumers reported eating butter daily (except during fasting periods). In Abergelle and Shinelle, butter was only available for 3-6 months of the year, although it was unclear whether this was made from cow's milk or goat's milk. Yoghurt was also part of the diet in several study areas.

Approximately 1-3 eggs were consumed per week in the non-pastoral areas, although it was difficult to determine whether this was household or individual consumption. Honey was available twice a year in Abergelle and Atsbi, although we were unable to determine over what time period a jar of honey would last.

3.7 What is the role of small ruminant foods in nutrition of young children?

ASF were a valued part of children's diet in all seven study areas. They were given to children to increase growth and "power", prevent disease, improve mental development (Horro, Menz), and increase happiness (Atsbi). Mothers reported the possibility of abdominal discomfort and/or diarrhoea if large amounts of different ASF were fed together. Children started eating food other than breast milk at six months of age at all sites, except in one *kebele* in Borena (Eloheye), where it was introduced at two months.

3.7.1 Meat

Small ruminant meat was generally included in the children's diet from the age of one year. For children aged up to two years, cooked liver and kidney was served in Abergelle, and sheep meat soup in Doyogena; in other study areas, children of this age were served meat along with the rest of the family. Tail fat was considered an important addition to the diet for children of all ages in Shinelle. From the age of two years, children usually ate with the family, and did not receive specially prepared meat, with the exception of Doyogena, where sheep meat soup continued to be provided until children were five years old.

Sheep and goat meat was particularly given to sick children in Horro, Menz, and Shinelle, although health problems associated with meat consumption were also reported. Diarrhoea and stomach pains were attributed to fatty meat at Abergelle, Atsbi and Borena, and to raw meat at Doyogena and Horro.

3.7.2 Milk

Sheep and goat milk was a daily part of the diet of children less than one year old in Abergelle, Atsbi, Borena and Shinelle, but only during productive periods. A typical daily serving was one cup (250ml). It was consumed in decreasing amounts as children got older. Milk was usually boiled at Abergelle and Atsbi and Yabello town in Borena; it was consumed raw elsewhere in Borena and one *kebele* in Shinelle (Degah Jebis). However, older children (two to five years) were reported to drink directly from the sheep or goat at Atsbi. It is not known whether this occurs in other areas.

Milk was the most commonly-used ASF for sick children, and was utilised during illness in all study areas. Health problems associated with milk consumption were diarrhoea, particularly if fed along with meat (Abergelle, Shinelle), and earlier onset of puberty in girls (Abergelle Tigray). No problems were reported at other sites.

3.7.3 Other ASF

Cooked egg was reported to be a feature of the diets of children up to two years of age in all study areas except Abergelle and Shinelle. It was given daily in Doyogena, Horro and Menz, less frequently in Atsbi due to concerns about digestibility, and rarely in Borena. Eggs were also especially given to sick children in the central highlands (Doyogena, Horro, and Menz). Beef meat was introduced at the one to two year mark in all study areas, and was fed interchangeably with small ruminant meat, according to which (if any) was available to the household.

On occasions when small ruminant milk was not available, and in non-milk producing areas, cow's milk was used instead. This tended to be boiled, except at Eloheye *kebele* in Borena, and like small ruminant milk was served daily to the very young (up to one year), and with decreasing frequency as children got older.

Figure 33. Young children with their mothers in Atsbi

3.8 Are there trade-offs or synergies between feeds and foods?

Some crossover between animal feed and human food was reported, although livestock usually received the by-products or leftovers from human consumption, rather than diverting potential foods. In Atsbi, livestock were fed the by-products from production of the local alcohol, and in Horro and Shinelle, they received vegetarian leftovers from family meals. At Doyogena, ruminants were fed crop residues and the by-products from false banana and sugar cane production during the fattening process. Women in Shinelle also reported sparing some *injera* from the morning meals to give to lactating does during times of feed shortage.

3.9 **What is the role of waste in loss of nutrients?**

Most small ruminant products were consumed within a short period of time, and spoilage was rarely reported, if at all. Meat and milk that was not consumed within a day of production was processed to extend its shelf life (for example, by curing and drying meat, or processing milk into butter). Both producers and non-producer consumers reported discarding food that was considered unsafe to eat, if necessary, but this occurred rarely: respondents were more likely to try to mitigate the perceived risk through various techniques (**Section 3.11**) than discard food – especially meat – in entirety.

3.9.1 Meat

Parts of the healthy animal that were not consumed differed between study areas and are summarised in **Table 7**. Results were similar for both producers and non-producer consumers who purchased live animals, then slaughtered them at home.

Table 7. Small ruminant body parts that are not used for human consumption in Ethiopia.

	Small ruminant body parts that are discarded in each study area						
Body part	Abergelle	Atsbi	Borena	Doyogena	Horro	Menz	Shinelle
Blood	■						■
Brain	■	■	■	■			
Eye					■	■	
Tongue					+/-		
Lung	■	■	■	■	■		■
Spleen	■	■		■	■		■
Thymus	■						■
Small intestine						■	
Large intestine	■		+/-				
Pancreas				■			
Reproductive organs			■	■		■	
Feet	■	■	■		■	■	

Shading indicates that the body part was consistently reported to be discarded in that study area. +/- indicates that the body part was discarded by some people, but was consumed by others.

Parts that were not consumed were either given to dogs and cats, or discarded in the open. By contrast, butchers in Dire Dawa discarded gut content and blood from animals they slaughtered, but sold the entire carcass and offal to consumers of different economic groups.

3.9.2 Milk

Milk generally was discarded if it contained blood or pus, but was given to dogs or cats if it separated after boiling (town consumers, Borena), or if excess was produced during fasting periods (Abergelle). Butter seemed to be used equally for cosmetics as for food, which is a missed nutritional opportunity, particularly for women in Abergelle who are reliant on butter and other milk products for their dairy intake.

3.10 **How do producers perceive quality and safety?**

producers' perceptions of quality and safety related to their own preferences as consumers. They considered people who bought their animals to have similar preferences, and often found it difficult to distinguish between quality and safety attributes – for them, the two parameters were inter-dependent.

3.10.1 Meat

The main meat attributes that producers used to assess quality and safety were colour, smell, and consistency. Of these, dark colour and foul smell were the most commonly–reported ways to detect meat that might be unsafe to eat. Another important quality attribute was fat content, with a strong preference for fatty animals and meat at all but one study area (Abergelle Tigray). This was considered an indication of a well-fed and healthy animal.

The quality attributes reported in each study area, and the safety issues associated with them, are summarised in **Table 8**.

Table 8. Ethiopian producers' perceptions of small ruminant meat quality and safety.

	Safety issues associated with quality attribute in each study area						
Quality attribute	Abergelle	Atsbi	Borena	Doyogena	Horro	Menz	Shinelle
Red colour indicates good quality	Dark colour indicates that animal might have been diseased at time of slaughter	Red colour indicates meat was bled properly after slaughter, and is fresh	Dark, yellow or green meat indicates animal was diseased at time of slaughter, which might be a health risk	-	Dark meat has been stored for a long time, and might be a health risk	Dark colour indicates the animal was diseased at slaughter, or bleeding was incomplete. Indicates a health risk	Meat that darkens quickly after slaughter indicates animal was diseased. Indicates a health risk
"Good smell" indicates freshness	Foul smell indicates meat is unsafe to eat. Animal might have been diseased at time of slaughter.	Foul smell indicates meat is unsafe to eat	Foul smell indicates contamination by flies, or the presence of "wounds", which might be a health risk	-	Foul smell indicates animal was diseased at slaughter, or meat is contaminated. Indicates a health risk	Foul smell indicates meat has been stored incorrectly, and may have been contaminated. Indicates a health risk	Unusual smell indicates animal was diseased at slaughter. Indicates a health risk
Consistent, "normal" texture indicates good quality	"Hard substances" and pus in the meat indicates a health risk	None specified	Pus is avoided (unclear if this is considered safety issue, or just against their own preferences as a consumer)	Abscesses or "cancer" in the meat are removed. (Unclear whether this is due to awareness of health risks, or due to consumer preferences)	"Frothy or jelly-like" substance on meat indicates animal was diseased at time of slaughter. Might be a health risk	"Jelly-like" substance on meat indicates animal might have been diseased. Might be a health risk	-

High fat content is preferred	-	Animal is good quality (less likely to be diseased)	-	Animal is good quality (less likely to be diseased)	-	-	Animal is good quality (less likely to be diseased)
Lean meat preferred	High fat content is a health risk			-		-	-
Presence of a small amount of dark blood is preferred	None specified	-	-	-	-	-	-
Chemical-free taste	-	-	-	Change in taste indicates anthelmintics used during finishing. Associated with a health risk (hypersensitivity)	-	-	-

A dash (-) indicates that the quality attribute was not reported by producers in that study area. 'None specified' indicates that the quality attribute was reported, but an associated safety issue was not identified.

Producers had a reasonable awareness of safe slaughter and handling practices. Their strategies to improve quality and safety of small ruminant meat varied between study areas, and are summarised in **Table 9**.

Table 9. Practices reported by Ethiopian producers to improve quality and safety of small ruminant meat.

	Presence of handling practice in each study area						
Slaughter practice	Abergelle	Atsbi	Borena	Doyogena	Horro	Menz	Shinelle
Slaughtering healthy animals in good body condition		■			■		■
Ensuring animals are not stressed at time of slaughter				■	■		
Ensuring complete bleeding at slaughter		■			■	■	
Avoiding contamination during skinning and butchering	■	■		■			
Separation of gut and gut contents, carcass and offal		■		■	■		
Washing the carcass				■			
Preservation of meat by salting and smoking to prevent spoilage	■			■	■	■	

Shading indicates that the slaughter practice was reported

The responses to the problem-opportunity matrix indicated that deficits in animal health, hygienic slaughter practices, and producers' knowledge of safe meat storage and handling were the main root causes of quality and safety issues. Producers in Doyogena also reported the misuse of albendazole during the fattening period, which resulted in detectable changes to the taste of the meat, and potential health issues for consumers.

3.10.2 Milk

Producers seemed to be reasonably sensitive to abnormal milk and milk products (

Table 10). The smell and visual appearance of the milk were considered the most important methods by which to assess quality and safety.

Table 10. Ethiopian producers' perceptions of quality and safety of small ruminant milk and milk products

	Safety issues associated with quality attribute in each study area		
Quality attribute	Abergelle	Borena	Shinelle
Milk should be from female that has not been recently bred	-	-	Milk from recently-bred females has an abnormal smell and is considered unsafe
Milk from mid- or late-lactation is of better quality	-	-	None specified
Milk should be free from dirt and hair	-	None specified	-
Normal appearance indicates good quality	Watery milk is of low quality, and can be associated with disease. Off-white colour, or the presence of blood or pus, is a disease risk	The presence of blood or pus is a disease risk	Blood in the milk is associated with risk of disease after consumption
Normal smell indicates freshness	Sour-smelling butter is not fresh, and can be associated with disease	Sour-smelling milk can be associated with disease	-
Taste indicates freshness and quality	Sour milk has been stored for long periods of time, and might be contaminated, which can be associated with disease	-	None specified
Milk should appear uniform after boiling	-	Inconsistent milk has been stored a long time after boiling, and can be associated with disease	-

A dash (-) indicates that the quality attribute was not reported by producers in that study area. 'None specified' indicates that the quality attribute was reported, but an associated safety issue was not identified.

Methods used by producers to improve the quality and safety of small ruminant milk and milk products at three study areas are recorded in

Table 11. Producers in Shinelle were particular about washing their hands before milking sheep or goats. Whole milk was always boiled before drinking in Abergelle and in one *kebele* in Shinelle (Gad), although it was consumed raw in Borena and in Degah Jebis *kebele* in Shinelle. It did not tend to be boiled if it was going to be used for butter or yoghurt, although in Abergelle, women reported boiling buttermilk (the by-product of butter production) before using this to make buttermilk cheese.

Other risk-mitigating methods included the use of medicinal or preservative plants to treat milk and butter containers. In Abergelle, the plants used for smoking were identified as *hafaflo* and *hanse* in the local language, Tigrinya, although the English equivalent could not be determined. Calabashes used for carrying and storing milk and milk products were similarly identified as *kil.* Spices called *abish* were added to milk in Abergelle, and spices/preservatives were reportedly used in butter in this study area, although it was not clear whether these were the same.

Table 11. Practices reported by Ethiopian producers to improve quality and safety of small ruminant milk and milk products

	Presence of handling practice in each study area		
Handling practice	Abergelle	Borena	Shinelle
Milk from animal that has been recently mated is avoided			
Washing hands before milking			
Smoking milk containers with medicinal plants			
Sieving of milk through fabric			
Boiling milk before drinking			+/-
Processing milk into yoghurt and butter quickly			
Using preservatives and spices in the preparation of butter			
Lining butter container with preservative plants			

Shading indicates that the handling practice was consistently reported in that study area. +/- indicates that the technique was practiced by some people, but not others, within the study area.

The root causes of milk-related quality and safety issues were reported to be lack of disease control (most study areas), or failure of women to sieve the milk for impurities (Borena). Producers at both Abergelle sites also reported an association between drinking milk and developing symptoms of malaria, although they did not consider this a food safety issue *per se*.

3.11 **How do consumers perceive quality and safety?**

The majority of consumers involved in the PRAs were also producers, due to the very rural location of most sites, and the high penetrance of sheep and goat ownership. Thus, their perceptions of quality and safety include those given above. Additional information gleaned during the consumer PRAs is summarised below.

3.11.1 Meat

Perceptions of quality were impacted by consumer awareness regarding health and nutritional benefits, and taste preferences. Small ruminant meat was considered of high nutritional value in all study areas. When asked to rank different animal-source foods for health and nutritional benefits, consumers consistently placed it in the top third. It was considered the most nutritious meat at all sites, and the most important ASF for this criterion in Abergelle and Doyogena; elsewhere, it was ranked after dairy products and egg.Consumers in Borena did not particularly value meat from sheep, and considered it to be of much lower nutritional quality than that from goats. Conversely, in Shinelle, sheep meat was considered more nutritious than goat meat, due to its high fat content, and was believed to be an essential part of children's diets. Soft organs such as liver and kidney were also considered to be highly nutritious. Both sheep meat in Shinelle and goat meat in Abergelle were considered to have medicinal or prophylactic properties, in addition to a high nutritional value, and were preferentially given to sick people or those trying to prevent disease.

In terms of taste, sheep meat was ranked highly in Abergelle, Atsbi, Borena, Menz and Shinelle, where it was again preferred to goat. It was considered mid-range in Doyogena and Horro, where dairy products, eggs, and at the latter, chicken, were preferred. Goat meat ranked poorly for taste in Abergelle and one village in Borena.

Safety perceptions varied between study areas. Small ruminant meat was considered very safe in Abergelle, Atsbi, Doyogena, Menz and Shinelle, but was considered mid-range in Horro. Generally, only honey, egg and dairy products (if anything) were considered safer. Again, in Borena, distinction was made between meat from sheep and goats, with goat meat clearly outranking sheep meat in this category.

Producers seemed to have a reasonable awareness of potential risks to food safety, however, as mentioned previously, this did not always preclude them consuming suspect meat. Rather than avoiding the risk altogether, they tended to adopt habits as consumers that allowed them to reduce the perceived risk. These practices are summarised in **Table 12**.

Table 12. Actions taken by rural Ethiopian consumers to mitigate risks to safety of small ruminant meat

	Actions taken to improve safety of small ruminant meat in each study area						
Quality attribute or safety issue	Abergelle	Atsbi	Borena	Doyogena	Horro	Menz	Shinelle
Dark meat	Boiled or cooked thoroughly	Cooked thoroughly	None taken, or cooked thoroughly	None specified	Not consumed if alternative; otherwise cooked thoroughly	Not consumed	Not consumed
Foul-smelling meat	Not consumed	Not consumed	Cooked, before or after trimming	None specified	Not consumed if alternative; otherwise cooked thoroughly	Not consumed	Not consumed
Pus present	Trimmed, remainder cooked	-	-	Trimmed, remainder cooked	-	-	-
Lesions present	Trimmed, remainder cooked	-	-	Trimmed, remainder cooked	-	-	-
Frothy or gelatinous coating	-	-	-	-	Not consumed if alternative; otherwise cooked thoroughly	Not consumed if alternative; otherwise cooked thoroughly	
Fatty meat	None specified	None specified	-	None specified	-	-	None specified

A dash (-) indicates that the quality attribute or safety issue was not reported by producers in that study area. 'None specified' indicates that no mitigating action was described.

At some sites, bile (Abergelle) or lemon juice (Atsbi) was added to all food before consumption, as a means of ensuring safety. For the same reason, women in Atsbi who ate raw meat reported consuming a local alcoholic beverage, *areki,* immediately afterwards.

Non-producer consumers in a nearby town at Borena, and in the city of Dire Dawa, near Shinelle, had similar perceptions of food quality and safety attributes, including smell, colour, tenderness, and a preference for high fat content. Consumers in Borena did not purchase meat they considered of poor quality or representing a health risk – except when there was no alternative. In Dire Dawa, where women were able to visit meat markets daily, meat considered unsafe was not purchased.

3.11.2 Milk

Goat milk was ranked very highly for nutritional value at Abergelle and Borena. It was also ranked highly in Shinelle, although not as highly as sheep milk. Milk in general was also considered of high nutritional quality in Atsbi. Regarding taste, small ruminant milk was the highest-ranked ASF at Abergelle, Atsbi, and Shinelle, although was poorly regarded in Borena.

Milk from sheep and goats was considered very safe at Abergelle, Shinelle, and by villagers in Borena. It was ranked poorly for safety by Borena town-dwellers, who considered it less safe than butter, beef, sheep and goat meat, and egg. It was also ranked least safe in Atsbi. Despite these lower rankings, producers seemed less aware of the risks of milk-borne, compared to meat-borne, disease. For example, while aversion to mastitic milk was high, boiling of outwardly-normal milk before consumption was not consistently reported. Risk-mitigating practices that were reported by rural consumers (chiefly producers) are summarised in **Table 13**.

Table 13. Actions taken by rural Ethiopian consumers to mitigate risks to food safety of small ruminant milk

	Actions taken to improve safety of small ruminant milk in each study area		
Quality attribute or safety issue	Abergelle	Borena	Shinelle
Hair or dirt present	-	Sieving through fabric	-
Watery	None specified	-	-
Discoloured	Not consumed	Not consumed	-
Pus present	Not consumed	Not consumed	-
Blood present	Not consumed	-	Not consumed
Abnormal smell	Boiling	None specified	Not consumed if associated with mating
Sour taste	Boiling	None specified	Rarely occurs due to speed of consumption
Separates after boiling	-	None specified	-

A dash (-) indicates that the quality attribute or safety issue was not reported by producers in that study area. 'None specified' indicates that no mitigating action was described.

Non-producer consumers in Yabello town in Borena had similar opinions as producers regarding milk quality and safety: white colour, fresh smell, and a uniform consistency after boiling were all valued. However, similar to meat buyers, the ability to choose which milk to purchase seemed to increase risk-averse behaviour. Consumers reported that discoloured milk, milk containing pus or blood, or with an abnormal smell, were simply not purchased; and milk that separated after boiling was not consumed. Town-dwellers in Borena had also historically boiled all purchased milk.

In this study area, goat milk and butter were the most highly-ranked milk products for taste and nutritional value. Here, sour smell was an indicator of rancidity and yellow butter was considered to be of low quality, although this did not necessarily preclude consumption. No butter-related quality or safety issues were identified by producers in Borena or Shinelle, although butter of any kind was ranked most highly out of all foodstuffs for taste, nutritional quality and safety by town-dwellers in Borena.

3.12 How do conditions between purchase and consumption affect nutritional quality and food safety?

Rural people in all study areas did not have access to modern food preservation methods such as refrigeration. In Yabello town in Borena study area, electricity was accessible to consumers; however, none of the respondents used refrigerators due to economic reasons. In urban Dire Dawa, near Shinelle, refrigeration was also available, although its use again depended on the economic standing of the household.

3.12.1 Meat

A surprisingly uniform picture of conditions between purchase and consumption throughout Ethiopia emerged. **Figure 34** shows a generalisation of the process followed by both producers and consumers who purchased live animals then slaughtered them at home. Differences specific to study area are highlighted.

Generally, the time from slaughter to first consumption was short – perhaps one hour. Consumption of lightly-cooked or raw meat and/or offal was reported in Borena, Doyogena, Horro, and Menz, although it was forbidden to Muslim consumers, who only ate well-done meat. Meat eaten for subsequent meals was reheated over an extended period (1-2 hours) and cooked thoroughly. Pots, usually clay, were used for cooking meat, which was never prepared over an open flame. Meat was stored in special dry or smoked containers and clay pots, and stored in a cool area. All non-preserved meat, except in Doyogena, was reported to be consumed on the same day as slaughter or purchase. Meat that was preserved by salting then drying or smoking could last longer and was cooked for 1-2 hours before consumption.

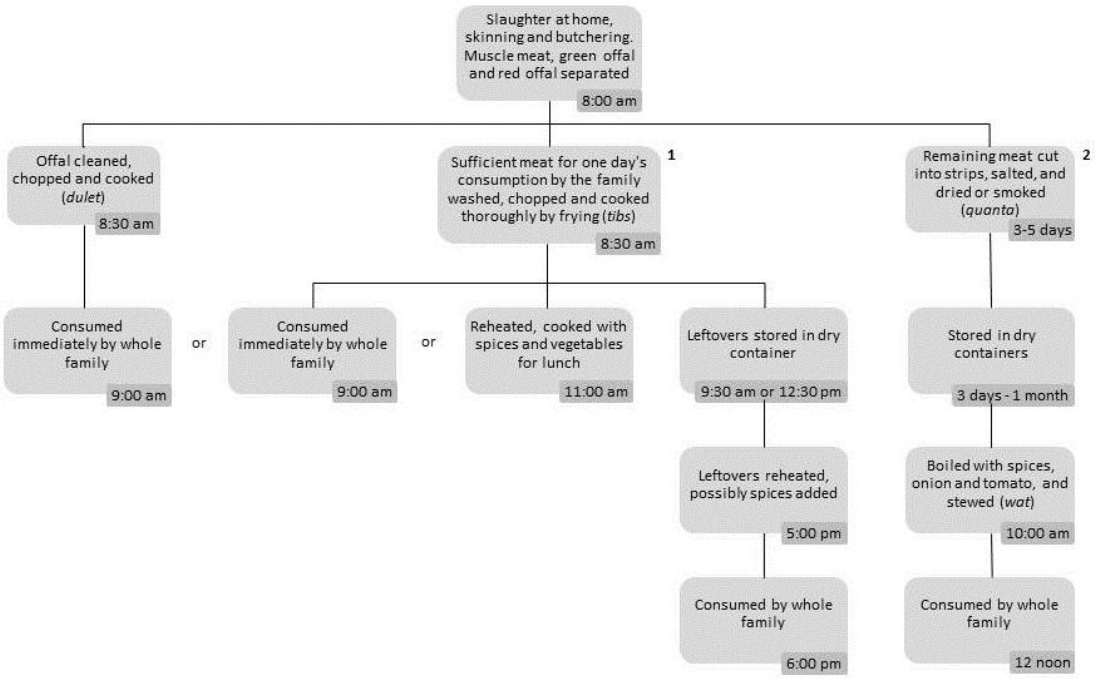

Figure 34. Typical pattern of small ruminant meat preparation in Ethiopia. 1: In Doyogena, fresh meat is set aside and stored until cooking at lunchtime, or the next day; in Horro, and Menz, the meat is only lightly cooked; and in Horro, the offal is stored and then cooked and eaten at lunchtime. 2: In Shinelle, the meat is deep fried in fat (*lamqat*) instead of being dried and salted or smoked.

Consumers who purchased fresh meat directly (Borena and Shinelle) also reported washing the meat, chopping it, then cooking it and consuming immediately. Leftovers were reheated and eaten for dinner, with nothing retained until the next day.

Spices were used heavily in meat dishes. Onions and tomatoes were the most commonly used vegetables, and were used mostly for stews, to which other vegetables such as carrot and potatoes were added when available. Green pepper was used particularly in *tibs.* Consumption of raw vegetables was generally rare, except in Horro and Shinelle, where this practice was commonly reported. Women reported using the same utensils for vegetables and meat in most study areas, although separate ones were used at Doyogena, Yabello town and Horro. Meat dishes were usually accompanied by *injera,* a tef-based fermented pancake, and in urban areas, rice or pasta.

3.12.2 Milk

Small ruminant milk preparation was also reasonably uniform across all milk-producing sites. The typical process is summarised in **Figure 35**. The major differences between sites involved boiling of milk before consumption – which could vary even within the one study area - and the processing of milk into different products.

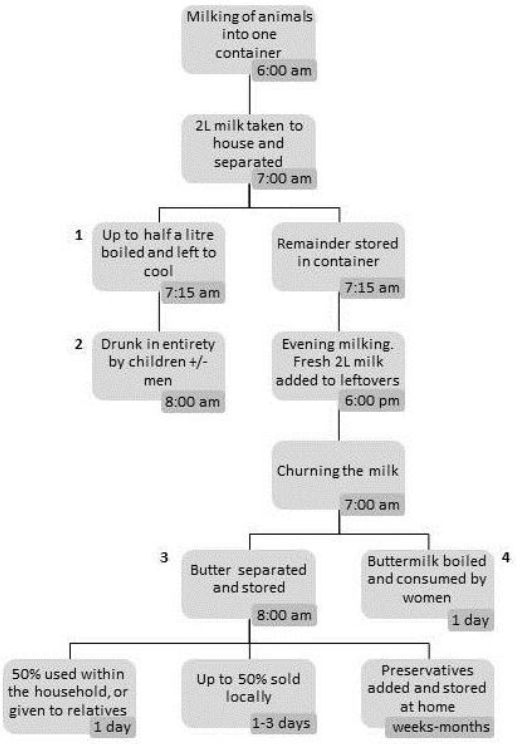

Figure 35. Typical pattern of small ruminant milk preparation in Ethiopia. 1: In one *kebele* in each of Borena (Eloyehe) and Shinelle (Degah Jebis), milk was never boiled before consuming. **2:** In Borena and Shinelle, milk was consumed by the whole family, including women. **3:** In Borena, butter-making was not reported. **4:** In Abergelle, buttermilk was also boiled and used to make cottage cheese, which was consumed within a few days.

At all sites, the use of medicinal or preservative plants to smoke or line the containers used for milk collection and processing seemed to be well established, and as mentioned previously 3.10.2), was considered important to preserve shelf life and safety of the products.

Figure 36. Traditional container for storing milk

Butter was prepared from naturally-fermented raw milk. Fresh butter was consumed or used as a cosmetic within a few days by the household or relatives. With the addition of preservatives (likely to be salt, although other products could also be used), butter was reported to last for extended periods of time (months),

although in Abergelle, it was usually consumed once fasting ceased. Buttermilk was boiled and consumed or used to make cheese.

Non-producer consumers did not process small ruminant milk into butter or other products, but instead used it for drinking only. Generally, these consumers would purchase non-refrigerated milk, boil it immediately, then either drink all of it, or store some for re-boiling at consumption later that day.

3.13 **How does gender affect food preparation and consumption?**

3.13.1 Meat

Decisions that preceded meat preparation at all study areas were shared between men and women. As women in Shinelle put it, generally "the father is the president, but the mother is the prime minister". The decision to purchase or slaughter live animals was made by men in Abergelle, Borena, Doyogena, and by men and women in Atsbi, Horro, Menz and Shinelle. Men selected the animal for slaughter in Atsbi; men and women jointly selected animals in Abergelle, Horro, and Shinelle; and women chose the animal in Borena and Doyogena. In all study areas, choosing an animal to buy in the market was the responsibility of men only; this was because men were believed to be better negotiators, but also for safety reasons, and because women tended to have responsibilities in the home that precluded them travelling long distances to market.

Buying meat from butchers or hotels/restaurants outside the community, as occurs occasionally in Horro and Menz, was also considered the sole domain of men. In Yabello town in Borena, the decision to purchase meat from butchers or markets within the community was made by men; in Dire Dawa, this decision was made by women. In both cases, actual selection of the meat was performed by women.

There were gender differences in small ruminant meat consumption, which varied between study area; these are summarised in **Table 14**. In Abergelle, the best quality muscle meat was given to men, due to their greater daily caloric requirement and more physical workload. In many study areas, women – especially while pregnant – expressed a preference for liver and kidney as well as muscle meat.

Table 14. Gender differences in consumption of small ruminant meat in each study area

Study area						
Abergelle	Atsbi	Borena	Doyogena	Horro	Menz	Shinelle
Men preferentially given high-quality cuts	Collection of small pieces from each part of the animal given to women for health	Pregnant women prefer red meat and liver	Pregnant women prefer liver or *dulet*	Either no difference between the genders, or women prefer red meat, liver and intestines	Women prefer to avoid fat	-
Pregnant women prefer liver and kidney						

3.13.2 Milk

Decisions regarding small ruminant milk, and selection of milk to buy were solely made by women, with two exceptions: men drinking tea while travelling, and town-dwellers in Borena, who reported that these decisions were shared between men and women.

However, there were some differences in milk consumption between the genders. Most notably, in Abergelle, women were forbidden from consuming whole milk, as it was thought to make them too strong, as well as to hasten the onset of puberty in girls. In Abergelle, Atsbi and Shinelle, butter was an important food for women as well as a cosmetic for hair and skin.

Table 15. Gender differences in consumption of small ruminant milk and associated products in each study area

Study area			
Abergelle	Atsbi	Borena	Shinelle
Women more likely to consume butter, which is also used externally for hair and skin	Women use butter as cosmetic	-	Women use butter as cosmetic
	Women do not consume whole milk		Pregnant women prefer sheep and goat milk

4 Discussion

4.1 **Comments on tools**

The tools worked well in the Ethiopian context, although it was evident that the planned preparatory discussions among local partners and group participants had not always taken place. Engagement with and enjoyment of the participatory methods was universally noted by respondents, and helped counteract 'research fatigue', which was explicitly raised by respondents at every site. The level of engagement was particularly notable in pastoral areas, where experienced researchers were expecting disengagement and even abandonment of the exercises by the pastoralists after one and a half hours. In our hands, the PRAs took 3-4 hours to complete; the FGDs took approximately 1 hour. The proportional piling for flock entry, exit, and disease burden was especially popular with producers, and animal health issues generated the most impassioned discussions. Tools that were unpopular with participants were the chapatti diagram (most consumers relied on one or two sources of small ruminant products, and thought it much more efficient to just tell us the details, rather than use cards and diagrams) and the quality and safety problem-opportunity matrix.

There were three general problems in utilising the tools, which may or may not be particular to Ethiopia. The first was the high penetrance of sheep and goat owning, which meant that information on consumption by non-producers was limited – it was only available in study areas where towns or cities were nearby (Borena, Doyogena, Shinelle). The second was the cultural value placed on considered discussion in this country, which could have contributed to the extended length of time required to complete the PRAs. The third was due to farmers' misunderstanding of the concept of production – they had a tendency to view small ruminants as a liquid asset, rather than a 'product', which caused some difficulties with the seasonal calendar.

The reliance on participatory techniques in this study means that some bias is present in the results. This includes selection bias (where respondents interested in a particular topic self-select by volunteering for the PRA), reporting bias (where respondents accidentally or intentionally report inaccuracies), or detection bias (the SFFF tool has a strong focus on animal health, zoonoses and food safety, which could make it more likely to detect or elicit comment on these issues) are all possibilities. The influence of particular individuals (e.g. authority figures) or subgroups (e.g. men) on the answers given by the group of respondents should also not be disregarded.

Bias could be particularly pertinent with respect to animal health: we noted that during the SFFF fieldwork, which was conducted by veterinarians and animal health researchers, disease was rated highly in all study areas during the pair-wise ranking of production constraints, whereas market-related issues were ranked lower; however, the economist-led VCA teams, who were simultaneously completing PRAs with similar groups of producers, found that economic/market-related constraints were more likely to be ranked highly in some study areas. This tendency could reflect genuine, random differences of opinion between individuals in the SFFF and VCA PRAs, or it could be the result of bias. For example, producers might focus on animal health-related constraints in the SFFF work, perhaps because they think that the researchers are more interested in these issues and/or are more likely to promote interventions related to them. Despite these reservations, the SFFF finding that animal health and feed constraints as the two most important constraints on small ruminant production in Ethiopia is consistent with other reports[4], as was the average estimated contribution of deaths to flock outflows[7]. Interestingly, the estimated proportion of inflows attributable to births was lower – at the expense of gifts and donations – in this study. Again, this difference could be the result of bias, or genuine changes in productivity and/or social customs.

Bias could also lead to under- or over-estimation of the burdens of individual diseases. Exaggeration by producers of the impact of specific animal health problems, in the hope of prompting interventions, is a possibility. The misdiagnosis or non-specific diagnosis of diseases can also result in inaccurate estimates. Fascioliasis could be particularly susceptible to over-estimation, as it was predominantly identified by "bottle jaw", or submandibular oedema, which can have a range of causes. Classifying diseases according to syndromes such as diarrhoea, respiratory disease or lamb mortality can also obscure the true disease burden. In some cases, the mortality rates of diseases (e.g. coenurosis in Atsbi) were underestimated, as producers would slaughter affected animals. Despite these limitations, the most significant diseases identified by producers in this study were almost identical to those reported in other participatory studies (pasteurellosis,

fascioliasis, coenurosis, orf, sheep pox, ectoparasites, and diarrhoea)[4], which indicates a consistency in at least the *perceived* disease burden. In some cases, we were unable to identify the English equivalent of diseases known locally; trypanosomiasis was not mentioned, and nor were clostridial diseases, except for enterotoxaemia.

The fieldwork was conducted by male researchers, which could also result in reporting bias, particularly with respect to food preparation and cooking practices. These activities were the responsibility of women and it is possible to conceive of a lack of understanding of the researchers of the processes involved, thereby precluding full exploration of these practices; it is also possible that culturally sensitive elements may have been concealed by the female respondents. While some sensitive information was obtained, for example that women are forbidden to drink whole milk in Abergelle, gender barriers seemed to prevent detailed discussion of this issue, and perhaps others. This could be circumvented by recruiting a balance of male and female researchers for future work; however, at this time, female researchers were not available at the regional research centres which were the project partners. It is also possible that gender differences in small ruminant –related decision-making and consumption were downplayed by the mixed male-female participant groups (perhaps due to a focus on gender-related issues by other researchers, or the relatively recent legislation requiring girls to be educated as well as boys). Ethiopia is still a very gender-divided country, particularly in the rural areas, so the effect of these influences should not be overlooked.

A final consideration was the sensitivity of some respondents to answering wealth-related questions. This was particularly evident in Borena, where non-producer consumers in Yabello town did not want to specify the frequency with which they consume ASF, as this was an indicator of wealth, and might have had less obvious effects elsewhere.

4.2 What is the role of the food in question in the diets of poor producers and consumers?

Animal-source foods are considered an important component of a nutritious and balanced diet. Meat and milk contain high levels of energy, readily-digestible protein and bioavailable micronutrients such as zinc, iron, calcium, Vitamin B_{12}, Vitamin B_2 (riboflavin) and Vitamin A[38]. Inadequate intake of ASF may be a major contributing factor to high infant mortality rates, delayed growth and development, and other broad-based nutritional problems[11].

Typically, animal-source foods make up only 5-10% of the total daily energy intake in sub-Saharan Africa[39], including Ethiopia[33], whereas in developed countries, this is over 25%[40]. In Ethiopia, over 80% of the human population lives in rural areas, where subsistence farming is common[1], and yet, 40% of Ethiopians exist on less than the minimal daily energy requirements specified by the World Health Organisation (WHO)[41]. Adult female malnutrition has been estimated at 27%, and child malnutrition, although decreasing, was still at 44% in 2011. The relative role of both meat and milk is limited by the fasting days observed by Ethiopian Orthodox Christians, who were the dominant religious group at four of our study areas (Abergelle, Atsbi, Horro and Menz). Fasting days require complete abstention from ASF of any kind, and can take up 70% of the year (see **Section 3.6**).

4.2.1 Meat

In rural Ethiopia, meat consumption is restricted by economic and religious factors, and is under-utilised as a dietary component. This is true for both producers and non-producers in these areas: consumers slaughter live animals - either from their own flock, if they are producers, or purchased for the occasion - in order to eat

[38] Neumann C, Harris D, Rogers L, 2002. Contribution of animal source foods in improving diet quality and function in children in the developing world. *Nutrition Research* 222:193-220.
[39] Dror DA, Allen LH, 2011. The importance of milk and other animal-source foods for children in low-income countries. *Food and Nutrition* 32:227-243.
[40] Gerosa S, Skoet J, 2012. Milk availability: trends in production and demand and medium-term outlook. Food and Agriculture Organisation of the United Nations, Italy.
[41] World Health Organisation, 2013. Nutrition landscape information system: Ethiopia. http://apps.who.int/nutrition/landscape/report.aspx?iso=eth [Accessed online 27th December 2013]

meat, as they do not have access to small amounts from butchers or other processors. Consumption is centred on the major Christian or Muslim religious festivals and many of the consumers (including producers) we interviewed ate sheep or goat meat only 2-5 times a year. This is consistent with estimations that meat consists of approximately 2% of the total caloric intake of the average Ethiopian[42]. Average yearly per capita consumption of meat from any species was 10.5 kg/capita/year in 2003[11], of which small ruminant meat was second to beef[33,41].

Muscle meat is an important source of high quality protein, iron, zinc, and B vitamins except folic acid; liver and kidney contain high levels of iron, B vitamins including folic acid, and vitamin A[11]. Deficiencies in these micronutrients can result in anaemia, immunosuppression, developmental disorders, and blindness, among others[11,43]. While the preferential consumption of liver and kidney by pregnant women as reported in this study is likely to be an important source of these micronutrients for the developing foetus, it is unlikely that consumption occurs regularly enough to reach minimum recommended levels.

Exceptions were found amongst the pastoralists, who have large flocks and lead semi-nomadic lifestyles, and urban consumers. In Borena, producers consume sheep and goat meat more consistently throughout the year, and have a strong preference for consuming this ASF. The village of Derito in Borena was the sole location where the producers' own preferences as consumers were considered a constraint on production of animals for sale.

Only one study area, Shinelle, was geographically close to a major urban centre: the town of Dire Dawa. Here, consumption of sheep and goat meat was much more frequent, with fresh meat reportedly purchased by the predominantly Muslim population from informal Halal markets 1-5 times a week. Urban consumption was limited chiefly by economic concerns, and was reported to have reduced in recent years, due to a marked increase in the price of sheep and goat products. Nonetheless, end users here and in other major cities (Addis Ababa, Mekele) enjoy a more ASF-rich diet than poor producers: annual small ruminant meat consumption in urban Ethiopia has been estimated at 31.5kg/person; in rural areas, it is 6.4 kg[26].

4.2.2 Milk

According to the Food and Agriculture Organisation of the United Nations (FAO), the importance of milk in the Ethiopian diet "cannot be understated"[44]. Milk is a nutritious ASF and contains high levels of many of the same micronutrients as meat. Consumption of milk (from any species) has been estimated at 14.6 kg/capita/year in Ethiopia, which represents one tenth of the average in countries such as Cyprus, Mongolia and Somalia[11], and equates to an average of 40ml per day, or for Orthodox Christians, approximately half a cup of milk on every non-fasting day.

Consumption of small ruminant milk was reported in four study areas during this investigation: Abergelle (goat), Atsbi (sheep and goat), Borena (goat) and Shinelle (sheep and goat). At all of these, consumption at all levels was heavily dependent on the pattern of milk production. This was highly seasonal, and influenced by both the proportion of births and the availability of feed during the year. Small ruminant milk was much more accessible to producers than non-producers, and was consumed more frequently than meat. Goat's milk contains higher levels of calcium, phosphorus and potassium than cow or human milk, and is more readily digested than cow's milk[45]. Goat milk is likely to play a particularly important role in the pastoral areas – due to the drought-resistant qualities of these animals - and in Abergelle, where dairy milk production is low. Goat milk could be purchased by non-producers in small rural towns but it was not accessible to consumers in larger towns and cities.

Milk products such as butter and cheese contain high proportions of fat and protein, which are severely lacking in the Ethiopian diet[33]. Their production is also highly seasonal, although as they are able to be stored, they are available for longer periods of time than fresh milk. Small ruminant milk products therefore have an important but still under-utilised role in the diet, especially for women and children.

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[42] Anon., 2012. Targeting animal production value chains for Ethiopia. L&F/SFFF, ILRI, Kenya.
[43] Craig WJ, 2009. Health effects of vegan diets. *Am J Clin Nutr* 89(suppl):1627S-1633S
[44] FAO, 1990. The technology of traditional milk products in developing countries. Food and Agriculture Organisation of the United Nations, Italy.
[45] Silankove N, Leitner G, Merin U, Prosser CG, 2010. Recent advances in exploiting goat's milk: wuality, safety and production aspects. *Small Rum Res* 89:110-124

4.2.3 Other ASF

As explained above, the frequency of consumption of all ASF is restricted in most of our study areas. Other products that are consumed are beef, cow's milk, chicken, and eggs. In the pastoral areas, camel meat and milk also form part of the diet. In general, meat of any kind is consumed between 2 and 10 times a year in rural areas, except in Borena. Small ruminants seem to be an equally important meat source as cattle, which differs from previous findings[11,33].

Consumption of dairy milk varied: typically, one cup of cow's milk a day could be consumed in the central highlands when not fasting, and much lower quantities in areas like Abergelle. While non-producers have much less access to small ruminant milk (particularly in towns and cities), they are more likely to purchase cow's milk, which is the most important dairy product in their diet. Cow's milk and goat milk have many similarities in composition, but notably, goat milk contains readily digestible casein and fat globules, higher levels of available Vitamin A, and lower levels of Vitamins B_6 and B_{12}. Eggs are eaten a few times a week in the central highlands and in Atsbi; less frequently in Abergelle; and not at all in Borena – rather, poultry owners produce eggs and chickens solely for sale.

4.3 What is the relationship between livestock keeping and livestock eating?

Keeping small ruminants did not seem to be associated with meat consumption; in fact, consumption was likely to be greater amongst non-producers. It was, however, associated with milk consumption. Small ruminant milk was preferentially consumed by the household, with only excess volumes being made available for sale, either as whole milk (only in Borena and Shinelle) or butter. Despite this, total milk consumption in Ethiopia remains low, and malnutrition rates are high despite a large proportion of the human population being involved in agriculture.

In most of our study areas, which are extremely rural, consumers who were not also producers were rare: we were unable to find non-producers at *kebele* level. Some sites (Abergelle Tigray, Atsbi, and Doyogena) were close to small towns, where non-producer consumers could be found. Here, consumers seem to function as pseudo-producers in terms of their relationship with the animals and their meat: animals are purchased live, slaughtered at home, and consumed according to practices and patterns that are essentially the same as those of the producers at that site.

4.4 What are the main hazards likely to be present in the ASF food value chain?

Pathogens likely to be present in small ruminant food products include faecal bacteria such as *Salmonella spp.*, toxigenic *Escherichia coli* and *Campylobacter,* and *Giardia duodenalis* and *Cryptosporidium* protozoa. These can be ingested after contamination of meat, milk, or due to poor hygiene. *Staphylococcus aureus* and *Listeria monocytogenes* can be transmitted in milk. *Bacillus anthracis* can be transmitted by eating infected meat, and both anthrax and Rift Valley fever (RVF) can be contracted when handling meat, blood and organs of infected animals.

Toxoplasma gondii and *Brucella melitensis* are important meat- and milk-borne pathogens, respectively, although human infection can also occur through other transmission pathways (contact with soil contaminated by cat faeces for the former; direct contact with infected small ruminants for the latter). *Mycobacterium bovis*, which causes bovine tuberculosis (TB) and has been reported in small ruminants and people in Ethiopia[46], is transmitted in milk but also by aerosol during close contact. Rabies is most likely to be transmitted via a bite or some other contact with the oral cavity of an infected animal. Other small ruminant-related hazards include *Leptospira spp., Echinococcus granulosus,* and *Coxiella burnetii.* However, the most important routes of infection with these pathogens are not food, but rather urine and contaminated water, contaminated soil, and

[46] Tschopp R, Bobosha K, Aseffa A, Schelling E, Habtamu M, Iwnetu R, Hailu E, Firdessa R, Hussein J, Young D, Zinsstag J, 2011. Bovine tuberculosis at a cattle-small ruminant-human interface in Meskan, Gurage region, Central Ethiopia. *BMC Infect Dis* 11:318

contaminated dust particles, respectively. *Fasciola spp.* are also likely to be prevalent in small ruminant-producing areas, particularly the moist highlands, although again, infection with this parasite occurs via environmental exposure.

Potential non-biological hazards include the presence of heavy metals, due to the use of particular cooking utensils, and carcinogens produced during cooking or preservation of meat. The presence of drug residues, particularly in internal organs like liver and kidney or in milk, and aflatoxins in meat and dairy products should also be considered.

4.5 What risks do these hazards pose to value chain actors?

Hazards in the small ruminant value chain can be transmitted by a number of routes. These are summarised in **Figure 37**.

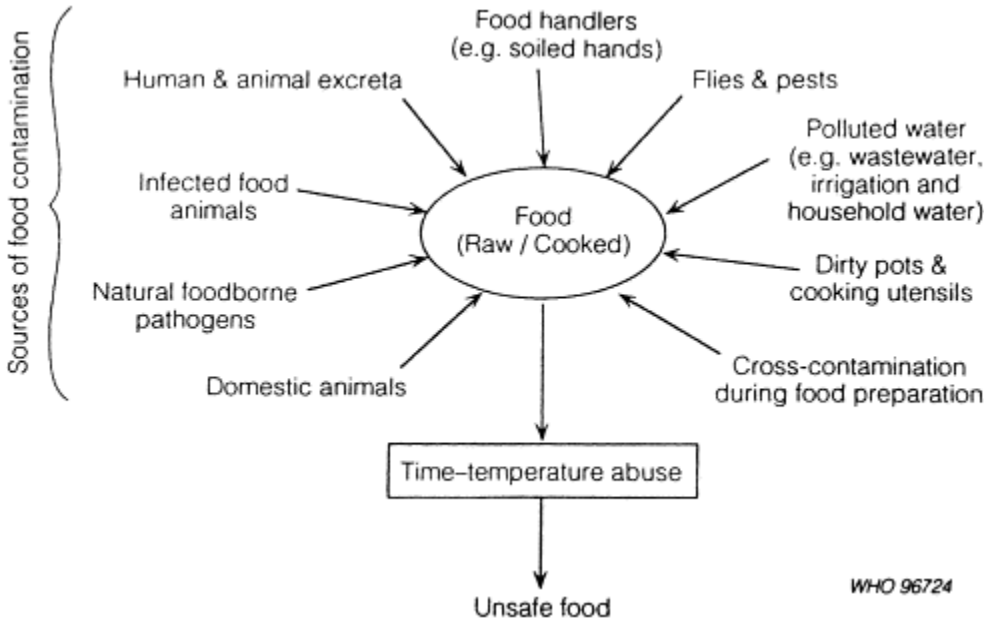

Figure 37. Sources of food contamination during food preparation[47]

Increasing contact with small ruminants increases the risks of exposure to hazards that are directly transmissible between livestock and people, such as *C. burnetii, B. melitensis and M. bovis,* and faecal-borne bacteria and parasites. The consequences of human exposure to these hazards can range from nil, through to subclinical infection, a host of clinical syndromes - such as flu-like illness (e.g. Q fever), muscle pain and fatigue (e.g. brucellosis), diarrhoea (e.g. caused by *E. coli*), pneumonia (e.g. zoonotic TB), abortion and other reproductive problems (e.g. listeriosis), encephalitis and blindness (e.g. toxoplasmosis) - to death (e.g. anthrax, RVF). Producers who have close contact with animals and animal faeces are at greater risk of contracting direct zoonoses than value chain actors such as large-scale traders, who might have much less exposure to small ruminants. Producers are also more likely to consume diseased or dead animals. Other actors at increased risk of directly transmissible zoonoses such as anthrax, brucellosis or RVF include veterinary service providers and people involved in slaughtering and butchering small ruminants[48-50]. By contrast, people with regular exposure

[47] Mortarjemi Y, Nout MJR, 1996. Food fermentation, a safety and nutritional assessment. *Bull World Health Org* 74:553-559

[48] Mwenye KS, Siziya S, Peterson D, 1996. Factors associated with human anthrax outbreak in the Chikupo and Ngandu villages of Murewa district in Mashonaland East Province, Zimbabwe. *Cent Afr J Med* 42:312-5.

[49] Godfroid J, Cloeckaert A, Liautard J-P, Kohler S, Fretin D, Walravens K, Garin-Bastuji B, Letesson J-J, 2005. From the discovery of the Malta fever's agent to the discovery of a marine mammal reservoir, brucellosis has continuously been a re-emerging zoonosis. *Vet Res* 36:313-326.

to animals are more likely to develop some immunity to certain pathogens (e.g. *C. Burnetii*), although it is not known whether this outweighs the risks of this exposure.

The risks posed by foodborne hazards in the Ethiopian small ruminant value chain differ from those presented by direct zoonoses. According to work by Grace et al., gastrointestinal diseases – including foodborne disease - are the most important zoonoses in the developing world[51]. Foodborne disease is not restricted to ASF but can be contracted from vegetables, cereals and other food groups: diarrhoeal diseases account for over 12% of deaths in Ethiopia each year[52], and lack of water, sanitation and hygiene is thought to account for 11% of total deaths[53]. The risk of developing foodborne disease is dose-dependent, which means it increases when any or all of the following are true:

- there is an increased prevalence of the hazard, either *in vivo* or in food products;
- pathogen growth or toxin production occurs in or on the food (usually due to suboptimal conditions of time and temperature);
- there is failure to inactivate the hazard by cooking or other processing techniques, or contamination of the food occurs afterwards; and
- there is increased consumption of the food in question.

The results of this study indicate that time-temperature abuse and a failure to cook small ruminant meat or milk adequately, as is shown to occur at a number of study areas in Ethiopia, could present the greatest risks of foodborne disease.

Importantly, behaviour that eliminated the risk of foodborne disease (i.e. by not consuming the food in question) was much more likely to be applied to small ruminant milk than to meat in Ethiopia. It was clear that producers were much more prepared to incur the nutrient losses and safety benefits of discarding suspect milk than meat; non-producers would not purchase products they considered unsafe in the first place, or would discard purchased milk if it appeared abnormal at the time of consumption.

People who consume greater amounts of ASF – some pastoralists, and affluent, urban consumers – could be at increased risk of meat-borne disease than producers. The risk could be increased further by substandard slaughter and food handling practices in butcher shops and hotels/restaurants[34]. By contrast, most producers in this study were found to consume small ruminant meat very rarely – 2-5 times a year – which drastically reduces the risk of disease via this foodstuff. This is important in the context of Ethiopian livestock production practices, which involve close contact with live animals, and the lack of adequate sanitation and disease control in rural areas. Diarrhoeal diseases can result from contamination of a number of food sources – not just meat and milk - with pathogens. Thus, while *E. coli* and other foodborne gastrointestinal pathogens are likely to be important hazards within the small ruminant value chain, in rural areas exposure to these hazards via meat is likely to make a relatively small contribution to the overall risk. For rural producers in Ethiopia, zoonoses resulting from direct contact with small ruminants, or exposure to contaminated food and water could well be more important.

Small ruminant producers - who have preferential access to milk and milk products - are at increased risk of exposure to milk-borne diseases compared to other value chain actors. One study in Abergelle detected subclinical mastitis in 18% of goats and isolated *S. aureus* and *E. coli* from 28% and 17%, respectively, of milk samples from 47 sheep and goats[54]. However, most risks posed by milk-borne hazards are greatly reduced during boiling, so those who boil milk before consumption (Abergelle, Atsbi, and Gad *kebele* in Shinelle) are protected to a large extent from milk-borne disease transmission. *S. aureus* toxins are an exception, as they

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[50] Swanepoel R, Paweska JT, 2011. Rift Valley fever. In: Palmer SR, Soulsby L, Torgerson P, Brown DWG (eds), 2011. *Oxford Textbook of Zoonoses: Biology, Clinical Practice, and Public Health Control.* Oxford University Press, Oxford, UK, pp 423-431.
[51] ILRI, 2012. Mapping of poverty and likely zoonoses hotspots. Department for International Development, UK.
[52] WHO, 2008. Burden of disease – death estimates by cause. World Health Organisation, Switzerland. http://www.who.int/healthinfo/global_burden_disease/estimates_country/en/index.html [Accessed online 11th February 2013]
[53] WHO, 2009. Ethiopia: country profiles – environmental burden of disease. World Health Organisation, Switzerland. http://www.who.int/gho/countries/eth/country_profiles/en/index.html [Accessed online 10th Marcy 2013]
[54] Gebrewahid TT, Abera BH, Menghistu HT, 2012. Prevalence and etiology of subclinical mastitis in small ruminants of Tigray regional state, north Ethiopia. *Vet World* 5: 103-109.

are heat-stable[55]. Producers in Borena and Shinelle who drink raw goat's milk are therefore at greater risk of being exposed to hazards via this route – as are children in Atsbi and potentially, other study areas, who drink milk directly from the doe or ewe. A time delay between milking and consumption, such as might occur when milk is sold, can also increase the risk of bacterial growth and toxin production (for example, by *Staphylococcus spp.*).

Interestingly, there was a perceived association between drinking milk in Abergelle – where it was reportedly boiled – and malaria. It was unclear whether this association might be attributable to synchronicity of peak milk production and therefore consumption with the onset of the malaria season, or to acquisition of zoonoses (e.g. brucellosis or Q fever) and misinterpretation of the symptoms. In the latter case, the seasonal association could be explained by acquisition of zoonoses either via milk (in which case boiling was not complete, or was inconsistently practiced) or via direct or indirect contact with parturient animals and potentially infective tissues.

Traditional milk fermentation was reported by farmers and pastoralists at all three goat-producing study areas (Abergelle, Borena and Shinelle). Milk fermentation by lactic-acid producing bacteria, which is part of traditional sour milk, yoghurt and cheese production in Ethiopia, causes a drop in pH and other antimicrobial changes that inhibit bacterial growth, survival and toxin production[54,56]. Under Ethiopian conditions, fermentation has been shown to inhibit growth of *E. coli* O157:H7, *S. enteritidis* and *L. monocytogenes* in cow's milk, although it takes several days for these microbes to die off completely[57-59]. Very little data are available on the persistence of pathogens in traditional goat's milk products, but it can be assumed that milk processing will reduce food safety risks to some degree – although the extent to which this occurs is time- and pathogen-dependent. Enterohaemorrhagic *E. coli*, for example, may be able to survive some fermentation processes, as can rotavirus[54].

Aflatoxins and other mycotoxins are produced by moulds growing on crops, and have been identified in barley, sorghum, wheat and tef in Ethiopia[60]. Aflatoxins are metabolised in the liver and can be excreted in milk, although it is not known how relevant this is to Ethiopian small ruminant production systems. Aflatoxin is not produced on pasture, on which the majority of Ethiopian ruminants are fed. It may be that the low level of supplementary feeding with aflatoxin-vulnerable crops that occurs in the small ruminant value chain - with the notable exception of the Doyogena study area - prevents exposure of sheep and goats to sufficiently high levels of the toxin for it to be excreted in milk or persist in the liver in amounts that present a human health risk.

In terms of non-biological hazards within the small ruminant value chain, cooking indoors could pose an increased risk of respiratory disease or cancer, due to exposure to toxic compounds. This risk is likely to be higher for women and perhaps children, although the degree of risk could depend on the type of wood used, the housing/ventilation arrangement, and other factors. Very little information is available on drug residues in small ruminant meat and milk in Ethiopia, so it is difficult to assess the degree of risk presented by antimicrobial and other drugs. However, studies of baked and fried beef showed that no significant losses in the amount of ivermectin and albendazole, as well as other anthelmintics, were observed in meat after cooking[61]. This could perhaps present an opportunity for further research - particularly in areas like Doyogena where producers reported residue issues, and Borena, where antimicrobials and anthelmintics are enthusiastically administered. The overall risk to the consumer of subtherapeutic levels of these drugs is

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[55] Motarjemi Y, 2002. Impact of small scale fermentation technology on food safety in developing countries. *Int J Food Microbiol* 75:213-229

[56] Adams MR, Nicolaides L, 1997. Review of the sensitivity of different foodborne pathogens to fermentation. *Food Control* 8: 227-239

[57] Tsegaye M, Ashenafi M, 2005. Fate of Escherichia coli O157:H7 during the processing and storage of Ergo and Ayib, traditional Ethiopian dairy products. *Int Journal Food Microbiol*, 103:11-21

[58] Ashenafi M, 1993. Fate of *Salmonella enteritidis* and *Salmonella typhimurium* during the fermentation of 'ergo', a traditional Ethiopian sour milk. *Ethiopian Med J* 31:91-98

[59] Ashenafi M, 1994. Fate of Listeria monocytogenes during the souring of Ergo, a traditional Ethiopian fermented milk. *J Dairy Sci* 77:696-702.

[60] Ayalew A, Fehrmann H, Lepschy J, Beck R, Abate D, 2006. Natural occurrence of mycotoxins in staple cereals from Ethiopia. *Mycopathologia* 162:57-63

[61] Cooper KM, Whelan M, Danaher M, Kennedy DG, 2011. Stability during cooking of anthelmintic veterinary drug residues in beef. *Food Addit Contam Part A Chem Anal Control Expo Risk Assess* 28:155-65.

thought to be low, at least in terms of hypersensitivity and other adverse effects[62], but the contribution to antimicrobial resistance in Ethiopia is unknown.

4.6 What are the risks of small ruminant foods in the diet of young children?

Generally speaking, risks within the small ruminant value chain are likely to be higher for children than adults under the same circumstances. Children are exempt from Orthodox fasting but are more likely to be malnourished or lack immunity. Mothers were aware of gastrointestinal discomfort and diarrhoea in children fed ASF. They usually ascribed this to an intolerance brought on by consuming large amounts of different ASF (as might occur during festivals), although it could also be an indicator of foodborne disease. Children who have begun to consume foods other than breast milk have been shown to be at increased risk of diarrhoea from these foods, and subsequent malnutrition[63]. For these children, the three pathologies of foodborne disease, malnutrition and immunosuppression form a vicious cycle that magnifies the effects of each, and from which it is difficult to escape. Early cessation of exclusive breastfeeding, poor hygiene, and feeding raw milk or meat to children is therefore particularly risky.

On the other hand, inadequate consumption of ASF – including small ruminant meat and milk – also contributes to micronutrient deficiencies, which have been implicated in a range of developmental problems in children, including poor growth and poor mental function[11]. The high (albeit declining) rates of malnutrition in Ethiopian children indicate that there is still much to be done in this area.

4.7 What are the health risks associated with excessive consumption?

4.7.1 Meat

Vegetarian or vegan diets have been associated with lower cholesterol levels and lower blood pressure than diets containing meat[42]. There is good evidence to associate an increased risk of colorectal cancer with increased frequency (by times per week) and increased volume (by 100g per day) of red meat consumption[64]. Links between red meat consumption and other cancers have been postulated but not proven[64]. According to this rapid assessment, excessive consumption of small ruminant meat by most rural Ethiopians is highly unlikely although some groups with more frequent consumption, such as pastoralists in Borena, could be at greater risk of colorectal cancer. It should also be kept in mind that increased meat consumption in the developed West – where most cancer risk factor studies have been performed - is usually associated with diets consisting of greater amounts of processed foods, and smaller amounts of dietary fibre, which is probably protective against colorectal cancer[64]. By contrast, the traditional Ethiopian diet is dominated by fibre-rich unprocessed cereals, roots and tubers[41], and it is unclear what the effects are of more frequent meat consumption within this context.

Affluent (especially urban) consumers, who might eat meat regularly and in larger amounts, could be at increased risk of colorectal cancer and other diseases associated with excessive consumption of fresh red or processed meats, such as cardiovascular disease, obesity and diabetes[65-68]. However, these associations have

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[62] Waltner-Toews D, McEwen SA, 1994. Residues of antibacterial and antiparasitic drugs in foods of animal origin: a risk assessment. *Prev Vet Med* 20: 219-234

[63] Motarjemi Y, Käferstein F, Moy G, Quevedo F, 1993. Contaminated weaning food: a major risk factor for diarrhoea and associated malnutrition. *Bull World Health Organ* 71: 79-92

[64] World Cancer Research Fund / American Institute for Cancer Research, 2007. *Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective*. AICR, Washington DC, USA http://www.dietandcancerreport.org/cancer_resource_center/downloads/Second_Expert_Report_full.pdf [Accessed online 27th December 2013]

[65] McAfee AJ, McSorley EM, Cuskelly GJ, Moss BW, Wallace JMW, Bonham MP, Fearon AM, 2010. Red meat consumption: an overview of the risks and benefits. *Meat Sci* 84:1-13

[66] Wang Y, Beydoun MA, 2009. Meat consumption is associated with obesity and central obesity among US adults. *Int J Obesity* 33:621-628

[67] Song Y, Manson JE, Buring JE, Liu S, 2004. A prospective study of red meat consumption and Type 2 diabetes in middle-aged and elderly women: the Women's Health Study *Diabetes Care* 27:2108-2115

not been fully explored, particularly in the context of the Ethiopian diet; furthermore, affluent consumer groups were not examined in this study.

4.7.2 Milk

There seems to be no evidence regarding health risks associated with excessive consumption of small ruminant milk. In any case, excessive consumption is extremely unlikely in Ethiopia, but for different reasons than for meat: small ruminant milk production in this country is highly seasonal, and productivity is low, meaning much smaller amounts are available than for cow's milk. Milk is also shared within the whole family, meaning that the quantities consumed by individuals are not excessive. Access to this product by affluent urban consumers also seems to be low.

4.8 How does nutritional quality and food safety change along the value chain?

4.8.1 Meat

Nutritional quality can increase during the fattening process that takes place in study areas like Doyogena. Elsewhere, it could potentially decrease along the chain, due to stress and trauma incurred during long transports. It can also be decreased during prolonged cooking, although this reduction is not likely to be significant.

Food safety could decrease *in vivo* if antimicrobials and other drugs were used without observing proper withdrawal times, or if animals become diseased or increase shedding of pathogenic gastrointestinal bacteria during transport, as has been shown in cattle[69]. Food safety could also potentially decrease through contamination with faecal and other bacteria during slaughter and butchering[69], as well as during storage and preparation, particularly if time-temperature abuses occur[54]. The latter is especially true when meat is eaten raw or only lightly cooked, and might be more significant in hotels and restaurants (rather than home consumption), or when vegetables and other ingredients are added, depending on food hygiene and handling practices.

Conversely, safety of small ruminant meat improves during cooking, particularly when this is done for extended periods of time and/or to high temperatures, and during preservation. The practice of deep-frying meat and storing it, coated in fat, for extended periods of time (*lamqat*) in Shinelle is known as fat-embedding and is a less effective means of killing pathogens than other preservation methods[10].

4.8.2 Milk

The nutritional quality of milk is likely to change along the value chain, particularly if it is processed into butter and cheese. These products contain higher proportions of fat and protein than whole milk, although the volumes produced are much less.

The safety of small ruminant milk can also change along the value chain. Food safety is reduced if contamination of milk with pathogenic bacteria occurs, for example, during milking or storage. However, safety of milk can be improved by boiling, traditional fermentation, and potentially, processing into cheese and butter. Conversely, inappropriate storage of these products can also cause them to become unsafe.

Adulteration of small ruminant milk for sale was not reported in this study; at times of lower milk production or higher demand by the producers themselves, milk was simply not made available for sale. This could have been influenced by the short milk value chains and local sales, which might create community-based pressure to avoid adulteration.

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[68] Van Dam RM, Willett WX, Rimm EB, Stampfer MJ, Hu FB, 2002. Dietary fat and meat intake in relation to risk of type 2 diabestes in men. *Diabetes Care* 25:417-424

[69] Adam K, Brüsilauer, 2010. The application of food safety interventions in primary production of beef and lamb: a review. *Int J Food Microbiol* 141:S43-S52

4.9 What are the trade-offs between safety and nutrition?

Raw meat and milk presents an increased health risk, with a negligible reduction in nutritional value, compared to when it is cooked or boiled.

4.9.1 Meat

Thorough cooking of meat, and especially boiling, is likely to lower its nutritional content by reducing the availability of the essential amino acids, lysine and methionine, and the non-essential amino acid cysteine[70]. However, this loss is thought to be "of little practical significance"[10].

Cooking meat with a high fat content results in higher levels of oxidisation products, which can be carcinogenic. Preservation decreases the nutritional quality of meat to a variable extent and curing or smoking, while likely to result in a reduced risk of infectious meat-borne disease, could increase risks of cancer due to development of polycyclic hydrocarbons and nitrosamines[10]. However, the amount of polycyclic hydrocarbons in Ethiopian sheep and goat meat should be low, due to it not coming into contact with a direct flame; the effect of nitrosamines is only relevant if nitrates or nitrites are used in the curing process. Furthermore, the effect of these compounds on human health has still yet to be fully quantified.

In general, while thorough cooking or preservation of meat involves some trade-off between reduced exposure to pathogens, and increased exposure to potentially harmful chemical compounds as well as a lower nutritional value, the former is likely to outweigh the latter in terms of the overall health benefit – particularly in the Ethiopian context.

Other trade-offs between safety and nutrition involve the consumption of diseased or dead animals, and discarding certain parts of the carcass. By consuming unhealthy or dead animals, producers expose themselves to a greater risk of foodborne disease – but also take advantage of an opportunity to benefit nutritionally. The overall impact of this practice on producer livelihoods has not been examined. Conversely, discarding body parts such as lung (which could contain TB abscesses), or spleen (which might be contaminated with gut content) according to tradition is likely to reduce the risk of direct disease transmission to people, but can contribute to zoonotic pathogen life cycles (e.g. *E. granulosus*) – it also reduces the total amount of ASF available for consumption. Again, the overall impact on livelihoods of these practices has not been explored.

4.9.2 Milk

Boiling milk is an important way to improve its safety, although not if contaminated with heat-stable toxins, and the effect on nutritional quality is thought to be minimal. The production of milk products, particularly butter, which can be stored for extended periods of time, could also be important in ensuring more consistent intake of ASF over the year. Butter and yoghurt are higher in protein and fat than whole milk, although it is not known what the net benefit of consuming these products is, compared to consuming the volume of milk required to produce them. Fermentation is likely to reduce the risk of foodborne disease in raw goat milk, as well as change the nutritional content, although this is dependent on the conditions. Fermentation of cow's milk for one to three days has been reported as reducing the coliform load while still retaining nutritional value[71]. Cheese produced from boiled milk is safer than raw milk, provided contamination does not occur. Unfortunately, very little data is available on the effect of fermentation on products made from goat's milk, particularly in comparison to boiled milk. A potential trade-off could be an increased opportunity for contamination and bacterial growth, and perhaps a loss of nutrients.

[70] Bender, A, 1992. Meat and meat products in human nutrition in developing countries. Food and Agriculture Organisation of the United Nations, Italy. http://www.fao.org/docrep/t0562e/T0562E00.htm#Contents [Accessed online 11th March 2013]

[71] Gonfa, A, Foster, HA, Holzapfel, WH, 2001. Field survey and literature review on traditional fermented milk products of Ethiopia. *International Journal of Food Microbiology,* 68: 173-186.

4.10 **Who gets the nutritional benefits and bears the health risks?**

Producers were at greater risk of zoonotic disease, due to their increased contact with live small ruminants and their waste. Otherwise, the nutritional benefits and health risks of small ruminant products were generally evenly borne by those who consumed them. This means that poor people (including producers), especially if restricted by religious requirements, were less likely to enjoy the nutritional benefits – or suffer the food safety risks – of small ruminant meat consumption. Conversely, subsistence farmers and pastoralists were more likely to face the nutritional benefits and health risks associated with small ruminant milk than urban consumers (although the latter consume more ASF in total).

There was some imbalance in nutritional benefits and health risks faced by some groups. For example, preferential feeding of high-quality meat cuts to men in Abergelle is likely to have a positive effect on the nutritional benefits for them, without an increase in risk. Muslims, who do not observe regular fasting like Ethiopian Orthodox Christians, and are forbidden from consuming bloody (i.e. undercooked) meat, get greater nutritional benefits from these foods, with a relatively lower increase in health risks.

By contrast, the health risks of raw meat or milk consumption are increased relative to the nutritional benefits for any consumer, particularly for vulnerable groups such as the young and immunosuppressed. This is especially relevant for diseases such as toxoplasmosis, cryptosporidiosis and listeriosis. There may also be an increased health risk to the foetus *in utero* if raw or contaminated meat or milk, or tissues containing toxic compounds, is consumed by the mother. Additionally, producers who consume sick or dead animals are likely to face relatively increased risks of foodborne disease and zoonoses (e.g. anthrax), disproportionate to the nutritional benefits.

There is also an imbalance between the nutritional benefits and health risks of meat and milk that is prepared or processed in different ways, which might expose certain groups of consumers to varying risks. Liver, which is higher in iron, Vitamin A, and folic acid than muscle meat, has its own nutritional benefits but may also represent an increased risk of exposure to toxic residues, for example; this could be important to pregnant women, who were reported to preferentially consume liver. Nutritional and safety differences between different milk products could have particular importance in Abergelle, where women do not consume whole milk, but do have access to buttermilk, cheese and butter; and for children.

4.11 **How do gender roles and poverty influence nutrition and health risks?**

4.11.1 Gender roles

Gender roles seemed to have little influence on nutrition and health risks, with two important exceptions: the cultural taboo against women drinking whole milk in Abergelle, and the preparation of food exclusively by women.

The rationale behind the taboo was reported first as an essential demonstration of a wife's trustworthiness, then after further discussion, as a means to prevent women becoming "too difficult for their husbands to manage", due to the increased energy, strength, and sexual desire associated with milk consumption. Whole milk was also withheld from older female children at the two sites in Abergelle, as it was associated with earlier onset of puberty. Men were also preferentially given the choicest meat cuts in this study area, in order to give them more energy for laborious tasks. The restrictions on whole milk consumption seemed to apply to cow's milk as well as goat milk. This taboo was counter-acted to a small degree by the preferential consumption of butter by women, which was used to "increase shining and beauty" by improving skin and hair quality (butter was also used externally for the same purpose). However, the amounts consumed appeared much lower than the volumes of milk available.

In Abergelle, choice red meat cuts were preferentially given to men rather than women, which puts women at an increased risk of nutritional deficiency. This practice might also occur – and just not be reported – in other areas. However, total meat consumption is generally so low for both genders that this probably has a relatively small impact.

Cooking indoors over a fire, as seems to be the norm, can expose individuals to carcinogens and other toxic by-products. Women, who were solely responsible for food preparation in all study areas, are thus likely to have increased exposure to these chemicals. Children were also likely to be exposed, particularly girls helping their

mothers; men probably were not present during times of food preparation, and thus could be at a decreased risk of health problems associated with air pollution. Cooking and handling food may also increase the risk of women either becoming exposed to pathogens, or transferring them onto food.

Not quite a result of gender roles, but rather biological ones, was the preferential feeding of red meat and liver to pregnant women in Borena, Doyogena and Horro. This was reported to be a preventative measure against anaemia and nutritional deficiency. Consumption of raw or lightly-cooked meat or *dulet* represents a particular risk for this group; it may also increase exposure to drug residues. Consumption of raw small ruminant milk was also reported by pregnant women in Borena and Shinelle, which can increase the risk to the foetus.

4.11.2 Poverty

In Ethiopia, poverty restricted the nutritional benefits, but increased the relative health risks of consuming small ruminant products. Meat consumption was limited by economic factors, and in rural areas, occurred only during major ceremonial occasions. Farmers preferred to sell a live animal, and distribute the proceeds for other purposes - such as buying grain – rather than slaughter and consume it themselves. When an animal was slaughtered, and farmers had concerns about the safety of the meat, they were more likely try to mitigate the risk (for example, by boiling the meat thoroughly) rather than avoiding consumption altogether.

Compared to farmers or those who purchase a whole animal and slaughter it at home, town-dwelling consumers were often able to choose which meat to consume. In the town at Borena, consumers did not purchase meat they considered of poor quality, or representing a health risk, unless there was no alternative. In Dire Dawa, where women were able to visit meat markets daily, meat considered unsafe was simply not purchased – or it was purchased at a discount by poorer individuals. Offal too was purchased by those of lower economic status. The more affluent consumers, such as those we met with in Dire Dawa, also had a more frequent intake of meat.

In Ethiopia, milk consumption did not seem to be affected by poverty, but rather by availability. There was a hierarchy of consumption such that the lamb or kid at foot had priority access to milk, followed by the producer's household, then by relatives or neighbours in need. Only then was the surplus made available in the market.

4.12 **What are the cultural practices affecting nutrition and health risks?**

Cultural practices affecting health and nutrition risks within the sheep and goat value chains varied between the different study areas.

4.12.1 Meat

The chief nutritional risk within sheep and goat value chains is deficiency, and is partly affected by cultural practices. Limited consumption was attributable to a mix of cultural/religious and economic reasons. The risk of nutritional deficiencies was perhaps alleviated to a small degree by the preferential feeding of energy- and nutrient-dense ASF during times of increased metabolic requirements (pregnancy, lactation, illness); however, it is unlikely that the absolute amounts consumed are able to reach recommended minimal levels.

Ethiopian traditional practices that mitigated the health risks of small ruminant meat consumption were minimal storage of unpreserved meat, and thorough cooking of most meat dishes. These practices were reported by different classes of consumer and across all study areas, and are likely to reduce pathogen load by decreasing contamination and increasing neutralisation of pathogens. Other potentially risk-mitigating practices reported in specific areas, or by specific consumer groups, were the use of fresh bile as a bactericide (Abergelle), and preservation of meat by salting and drying (Abergelle, Doyogena, Horro and Menz).

Practices likely to increase health risks included the consumption of *dulet,* an offal mixture than can be served as a raw, lightly cooked, or thoroughly cooked dish, according to consumer preferences, and *kitfo,* which is raw or lightly cooked minced meat. Raw meat and/or offal were reportedly consumed at Borena, Doyogena, Horro and Menz and increased the risk of infection with food-borne pathogens. Raw meat consumption was forbidden to Muslims, which reduces the risk of exposure of this group to meat-borne pathogens.

Another cultural practice that could increase health risks for women was the preparation of food almost exclusively by this group. This is likely to increase the risk of exposure to air pollutants for this group, as discussed in **Section 4.11.1**.

4.12.2 Milk

Preparation of traditional Ethiopian milk products, particular butter, was reported at all milk-producing sites and helps nutritional benefits from milk consumption to be spread out over (part of) the year. Processing could decrease health risks by neutralising bacteria through fermentation, whereas prolonged storage of such products could increase pathogen loads.

Cultural practices to reduce the health risks associated with small ruminant milk consumption also varied across Ethiopia. Sheep and goat milk or milk products were not traditionally part of the diet in the central highlands (Doyogena, Horro, and Menz). Adult women were forbidden from drinking whole milk at both Abergelle locations, thereby sparing them the health risks, but also the nutritional benefits of this product. In Atsbi, consumers were very particular about always boiling milk, which could be attributable to local tradition or more recent health education by extension workers.

Customs likely to increase the health risk included the consumption of raw milk, particularly by children. This was reported in several study areas (Abergelle Tigray, Borena, and Shinelle). In Atsbi, raw milk was not intentionally given to children but rather, they were seen drinking directly from sheep and goat udders. This is likely to increase the health risks associated with this product, specifically by increased likelihood of exposure to faecal and soil-borne contaminants.

4.13 How is value chain development likely to affect nutrition and food safety?

Multiple recommendations have been made by the VCA team as to how the Ethiopian small ruminant value chain can be developed[15]. These include improvements to input supply (particularly with respect to animal health and feed supply) and production systems, such that greater numbers of higher quality animals, targeted towards a specific end market – whether domestic or for export – can be produced. For pastoralists such as those in Borena, who already consume ASF more frequently, investments to secure feed supply and mitigate the risks of drought and climate change, as well as improve animal health, could be crucial to improving their livelihoods. The reported animal health burden warrants special attention, as veterinary services are poor throughout the country, and specific diseases are over-represented in some areas. Breeding programs could help increase productivity, although the relative benefits of introducing exotic bloodlines (which are more productive but also, less resilient to local conditions) should be carefully considered. Sale of pregnant ewes and does for slaughter, which is surprisingly common, should also be discouraged. These changes could result in the production of more nutritious and safer small ruminant meat in addition to the obvious financial advantages to producers; larger numbers of animals could also lead to increased risk of zoonotic disease.

Other developments likely to directly impact producers include improving horizontal linkages between themselves and vertical linkages with buyers/collectors, as well as improving information flow, market access and participation. Knowledge of the opportunities for profit from animal by-products such as skin could also be transferred. Commercialisation and stratification of production systems with specialisation as appropriate to different agro-ecological zones has also been recommended[4]. All of these could potentially lead to better educated, better informed producers with increased bargaining power and a more consistent supply of income from small ruminants. However, improving production, cash flow and total household income of producers will not necessarily result in increased intake of small ruminant meat by this group[12,72].

The small ruminant value chain could be further developed by shortening marketing chains. In some areas, small ruminants are bought and sold by multiple actors – all of whom seek a profit but, as found during the VCA, do not necessarily add value[15] - before being slaughtered and processed. This results in an increased price

[72] Berti PR, Krasevec J, FitzGerald S, 2004. A review of the effectiveness of agriculture interventions in improving nutrition outcomes. *Pub Health Nutr* 7:599-609

to the end consumer and is exacerbated by taxation when animals are moved across regional boundaries. Reducing the role of middlemen would however have a negative impact on their livelihoods, although this could be mitigated by increasing their involvement in other sectors. There are also opportunities to develop the transport sector, particularly in terms of efficiency and animal welfare. Shortening marketing chains and reducing animal losses incurred during transport could therefore result in a lower price of small ruminant meat, thus increasing consumption by non-producer consumers, particularly those outside rural areas. Increased consumption in turn results in improved nutrition but also an increased risk to health if proper meat hygiene and handling practices are not observed. This could prove critical if trends of increasing urbanisation and meat consumption continue, particularly if the small ruminant value chain develops rapidly without appropriate risk mitigation.

Another opportunity for value chain development that could be considered, and which could impact on nutrition as well as food safety, is improved accessibility to small ruminant foods. At *kebele* level in rural areas, consumers are forced to purchase and slaughter a whole animal if they wish to eat meat, as other options do not exist. This is illustrated by the differences in consumption patterns reported by respondents in the two *kebeles* in Shinelle. In Degah Jebis, meat consumption was limited to the major Islamic festivals. Here, like in the highland areas, farmers preferred to sell a live animal and use the proceeds to purchase grain and other staples, than to slaughter and consume the animals themselves. However, in Gad *kebele*, producers reported similar consumption peaks in April and September, but with lower but consistent levels of consumption for the rest of the year. This is perhaps due to their ability to access to a large fresh meat market in Shinelle town (still 14 km away), which enabled farmers to purchase smaller amounts of meat at a time when necessary – for example, to feed a sick child - thus avoiding the loss of one of their own animals. Enabling the purchase of small amounts of meat at a time, rather than being forced to sacrifice or purchase a whole animal, or being dependent on sharing a carcass with neighbours, could help reduce these economic limitations and increase the frequency of consumption. Development of the processing sector, with improved penetrance of butchers and other meat sellers, as well as hotels/restaurants that serve meat dishes, could thus increase meat consumption.

Increased production of goat milk is more likely to result in increased consumption by producers, and therefore improved nutrition, as there is already a strong prioritisation of consumption by the producer's household – particularly by children - above sale of this food. Local development of the small ruminant milk value chain, while not explored in the VCA reports, could also provide an additional source of income for producers with excess milk, although it could increase the safety risks of this product. It is unclear whether there are genuine opportunities for development of this section of the value chain in urban areas, due to readily available cow's milk.

4.14 **How could investments enhance consumption of nutrients?**

Generalised investments to improve nutritional status should be considered across all study areas. Basic services such as electricity and with it, modern methods of food storage (particularly freezing), could enhance consumption of small ruminant foods and other ASF by facilitating an increase in the total amount of ASF consumed by individuals, and/or ensuring more even distribution of consumption over the year. This should largely be the responsibility of the government, although roles for other stakeholders and even private investment could be conceived.

Investments that target women could play a role in improving their social standing, which could in turn result in improved nutrition. This could be especially critical in Abergelle, where women were particularly nutritionally disadvantaged compared to men. It is also important to consider that increased consumption of small ruminant foods is likely to be associated with an increased risk to food safety. The indirect effects of enhanced nutrient consumption - such as hastening the onset of puberty in girls, or increased fecundity – that might have important negative impacts on overall livelihoods should also be carefully explored.

As mentioned previously, many of the rural poor in Ethiopia face religious restrictions on the consumption of ASF. The rigidity of Ethiopian Orthodox fasting requirements could be assessed, particularly in terms of trends in religious observance, in case there are opportunities for religious restrictions on ASF consumption to be reduced in the future. explore local preservation methods for fresh produce for consumption between fasting seasons?

4.14.1 Meat

Consumption of sheep and goat meat by Ethiopians is restricted by religious fasting periods as well as by economic factors. The latter might well have the greater impact: Protestant Christians in Doyogena and Horro, who do not observe religious fasting, reported similar consumption patterns to their Orthodox Christian neighbours. Poverty is widespread in Ethiopia and investments to enhance the consumption of meat should focus on improving the overall economic status of producers and poor consumers. While increasing household income and cash flow might not be *sufficient* to increase household intake of meat[73], it does appear necessary: the poorest Ethiopians do not consume ASF at all[74]. There is however, likely to be a difference between rural and urban consumers in the threshold level of household income required to increase ASF consumption.

For producers, there is a complex relationship between livestock keeping and their own nutrition and health, on which increased small ruminant production could even have a negative impact (for example, by increasing human exposure to zoonotic pathogens) (**Figure 38**). The outputs of the CRP L&F VCA detail the potential for increased productivity and income generation via development of the small ruminant value chains[15-23], and are summarized in **Section 4.13**. Of particular interest to the SFFF work is the high burden of small ruminant disease in some areas: control of specific diseases could be targeted by study area (e.g. coenurosis in Borena or enterotoxaemia in Atsbi - see **Annexes 4-7**). However, we should be mindful that increased animal production and even wealth will not necessary increase consumption of small ruminant foods by producers - although it could potentially improve overall nutrition.

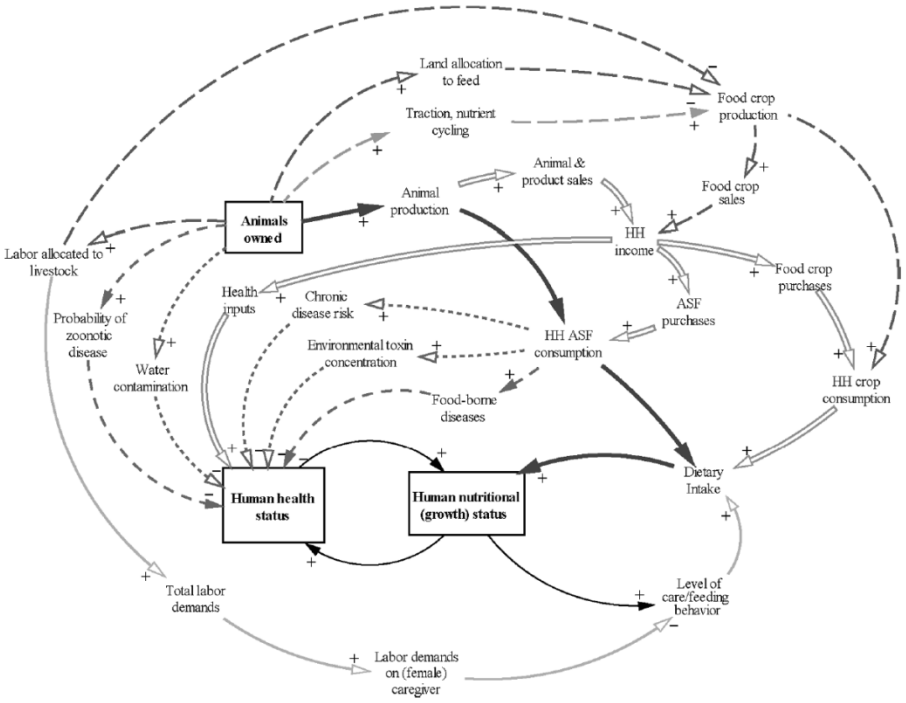


Figure 38. Hypothesized causal linkages between livestock keeping and human nutrition and health outcomes among the poor[72]. HH = household; arrows indicate causal linkages and '+' or '-' indicates the direction of the effect. Thick solid arrows indicate increased ASF consumption due to owning animals; thick open arrows indicate increased household income. Dashed arrows with open arrowheads indicate the effects on consumption of other foods; dashed arrows with solid arrowheads indicate the relationship with zoonotic disease. Indirect effects on health are indicated by dotted arrows (environmental factors) and thin arrows (household labour demands).

[73] Randolph, TF, Schelling, E, Grace, D, Nicholson, CF, Leroy, JL, Cole, DC, Demment, MW, Omore, A, Zinsstag, J, Ruel, M, 2007. Role of livestock in human nutrition and health for poverty reduction in developing countries. *Journal of Animal Science* 85:2788-2800.

[74] Aklilu HA, Udo HMJ, Almedinders CJM, Van der Zijp AJ, 2008. How resource poor households value and access poulutry: village poultry keeping in Tigray, Ethiopia. *Agr Syst* 96:175-183

In rural areas, the absence of meat processors means that investments that increase income will not necessarily increase consumption of small ruminant meat. Income could be diverted to meet more pressing household needs, such as the purchase of cereals or payment of school fees, rather than the perceived luxury of meat consumption. Considering the large unit size and value of sheep and goats, and their importance as walking liquid assets, overall nutrient intake of poor value chain actors might be most successfully improved through the diversion of increased income generated from small ruminants towards more accessible ASF, such as milk, eggs or chicken[75]. It is also possible that improvements in nutritional parameters might unevenly fall to certain individuals within the household. Reviews of this subject suggest that broad-based interventions that include promotion of women's involvement and/or nutrition education are more likely to succeed in these respects[12,71]. Investments to improve accessibility to meat - as discussed above; also, perhaps facilitating linkages between rural consumers would enable more meat to be shared - could be investigated as part of an integrated program to increase meat consumption in the long term, although other factors (e.g. affordability, proximity) would need to be favorable. There are opportunities here for both governmental and NGO involvement, and for innovative solutions involving stakeholder consultation and perhaps the private sector.

For urban consumers, for whom many more food options are available, increasing income and/or reducing the cost of small ruminant meat are likely to have more direct effects on consumption rates. Improving the efficiency of small ruminant value chains, as previously explored, could help reduce the costs to the consumer. However, it is probable that ASF consumption by urban consumers will continue to increase, even without investment, as has been shown throughout the developing world[11].

4.14.2 Milk

Increasing intake of sheep and goat milk and milk products is potentially more achievable in rural areas than increasing intake of meat, as the former does not require sacrifice of a valuable asset. Unlike meat consumption, milk consumption by producers' own households is likely to be prioritised in Ethiopia, due to its flexible unit size and widespread recognition in all study areas of the nutritional value of this class of food. Consumption of nutrients in small ruminant milk and milk products would be enhanced by increasing milk production, thus resulting in an increase in the amount of excess milk available for human consumption. This could benefit producers by increasing their intake and/or increasing their income through the sale of processed milk products, as has been shown in previous dairy goat interventions in Ethiopia[33], although further work to see which of these results would be prioritised by producers, and which has the greatest overall impact on livelihoods, is justified. Goat's milk is likely to be a particularly important pathway to improved nutrition in Abergelle, where dairy milk production is limited, and in the diets of children.

Specific investments to improve production could address the feasibility of integrating feeding and breeding programs, with the aim of improving the alignment of the major lambing/kidding season with times of maximum feed availability. Improving feed supply and availability is crucial, and selective breeding programs could also be used to increase milk productivity. Other mechanisms to improve productivity could also be addressed, such as increasing flock off-take or reducing the age at off-take. This could result in an increase in the amount of feed available to lactating animals, as well as a decrease in the amount of milk consumed by offspring. Again, an integrated approach to interventions is necessary. Non-producer consumers might not benefit from increased production to the same degree although, in conjunction with milk value chain development, it could eventually result in increased consumption by these people. Again, the opportunities within this section of the value chain could be worth investigating.

The cultural hurdle to consumption of whole milk by women in Abergelle, and other regions of Ethiopia, is difficult to address. This is a missed opportunity for women to obtain important vitamins and minerals, particularly calcium; but it seems to be a sensitive and private issue, enmeshed in gender relations, traditional roles, fecundity and sexuality. Thus, communities are likely to resist interventions in this area. While female empowerment should form part of long-term plans for value chain development, a more practical approach in the short- to medium-term might be to instigate further research into the role of milk products in women's diets, with the intention of establishing whether a nutritional gap exists; and if so, whether production and consumption of processed products (butter, cheese, yoghurt) could be enhanced to fill that gap.

[75] Smith J, Sones K, Grace D, MacMillan S, Tarawali S, Herrero M, 2013. Beyond milk, meat and eggs: role of livestock in food and nutrition security. *Animal Frontiers* 3:6-13

4.15 **How could investments decrease food safety risks?**

The provision of basic services such as electricity, a clean, reliable water source, and appropriate sanitation could all aid in a generalised reduction in risks associated with small ruminants and their products. Investments to increase food choices – either within or between food categories – through improved access should also be considered, as this could increase risk mitigating behaviour from consumers (including producers themselves). This was demonstrated by the more risk-averse behaviour of those who had access to fresh meat markets.

Care should be taken to consider the closeness of the relationship producers have with their livestock when planning food safety interventions. In cropping areas of Ethiopia, small and large ruminants are kept inside and can share living space with the human members of the household. Close contact with livestock during herding, milking or treatment is likely in all study areas. This proximity to live animals and their waste could be a greater source of exposure to faecal pathogens than contamination during slaughter, for example. Close contact with aborted or parturient females is another possible risk factor for transmission of both brucellosis and Q fever; and in the latter case, certainly a more important one than consumption of unpasteurised milk products[76]. Thus, further work into the importance of different transmission pathways is needed.

Indirect methods of improving food safety include reducing the prevalence of zoonotic disease in small ruminants, and reducing the exposure of value chain actors (particularly producers) to faecal and soil-borne pathogens. A functional animal health system is desperately needed, both to increase productivity and to reduce zoonoses. Producers listed very few zoonotic diseases when discussing animal health problems, which could be due to lack of awareness, or genuine lack of concern about these diseases. Providing explanations of pathogen transmission cycles and education about zoonoses could help rural communities reduce the prevalence of specific diseases. Investigation of the impact of consuming dead or diseased animals should be explored, and interventions made where appropriate (e.g. training on how to identify a suspected anthrax case, and why not to eat it). Examination of traditional slaughter practices and identification of risks could lead to meat hygiene training, although it is questionable whether this is an efficient use of resources – given the low levels of consumption – at producer level. Another concern is the possible presence of drug residues or aflatoxins in small ruminant meat, or the development of antimicrobial resistance. Further research into these effects, and education about responsible drug use, could be incorporated as part of improvements to the animal health services.

At producer level, specific mechanisms to decrease food safety risks should be targeted by study area. It is difficult to recommend spending resources on specific interventions to improve the safety of small ruminant foods in study areas where the frequency of consumption – and therefore, relative risk of disease - is very low. The justifications for inclusion or exclusion of each study area in further work, and the overall recommendation, is summarised in

[76] Dewé TCM, Nigsch A, Stärk KDC, 2013. *Coxiella burnetii* in small ruminants: assessing the public health risk. Proceedings of the Society for Veterinary Epidemiology and Preventative Medicine (SVEPM) Annual Meeting, Madrid, Spain

Table 16.

Table 16. Food-safety related reasons for and against inclusion in further food safety research and interventions at producer level in each study area, and the resulting recommendation

Study area	Reasons for inclusion	Reasons for exclusion	Included?
Abergelle	- Heavy reliance on small ruminants as sources of income and nutrients - Potential for improving milk production - Consumption of sick animals - Consumption of raw milk (frequency unknown) - Perceived association between drinking milk and disease - Gender-based imbalance in consumption	- Limited consumption of small ruminant meat - Boiling of milk already reported (frequency unknown)	Yes (milk)
Atsbi	- Consumption of sick animals - Consumption of raw meat varies by village - Sheep milk consumed by children (including directly from animal), and goat milk by whole family	- Infrequent consumption of small ruminant meat - Small ruminant milk minor part of diet - Boiling of milk always occurs	Perhaps (milk)
Borena	- Increased intake of small ruminant meat compared to other study areas - Consumption of dead and sick animals - Consumption of raw milk and meat - Early cessation of exclusive breastfeeding - Possible role of drug residues in meat	- Very little consumption of small ruminant products in neighbouring town	Yes (meat and milk)
Doyogena	- Consumption of raw or lightly cooked offal - More intensive production (fattening) - Possible role of drug residues in meat	- Limited consumption of small ruminant meat - No consumption of small ruminant milk - Little consumption of sick animals	Perhaps (meat)
Horro	- Consumption of raw or lightly cooked meat and offal - Some access to butcher shops - Some consumption of sick animals	- Limited consumption of small ruminant meat - No consumption of small ruminant milk	No
Menz	- Consumption of raw and lightly cooked meat and offal - Some consumption of sick animals	- Limited consumption of small ruminant meat - No consumption of small ruminant milk	No
Shinelle	- Consumption of raw milk - Access to meat markets in Shinelle and Dire Dawa - High frequency of meat consumption by urban Muslims	- Limited consumption of small ruminant meat in villages - No consumption of raw meat by Muslims	Yes (meat and milk)

For consumers who purchase small ruminant meat, zoonotic diseases are less likely to be contracted directly, but the opportunities for contamination and bacterial growth might be higher. Some microbiological sampling of meat in processing establishments has been done in Ethiopia, although it might be worthwhile to expand on this in order to better determine the prevalence and impact of hazards in the informal market. Consumers further down the value chain might also be at greater risk of exposure to drug residues. Relevant investments could include investigation of risky practices and providing education and training in abattoirs, butchers, hotels/restaurants and supermarkets, as well as better implementation of food safety regulations and inspections. More research is needed to determine the overall impact on livelihoods – both of consumers and

of producers – of food safety risks to consumers, as a reduction in these risks might not necessarily correspond to increased demand for the product, or development of the small ruminant value chain.

Further work could be done to investigate the prevalence of raw milk consumption, and interventions to ensure boiling of milk could be implemented. While some communities (such as Shinelle, where goat's milk is highly valued for its medicinal properties) might be resistant to boiling small ruminant milk, it has been easily adopted in at least one study area (Atsbi). Additionally, studies on the changes to safety and nutritional quality of goat's milk – as opposed to cow's milk – undergoing traditional fermentation are sorely lacking. It is possible that in Ethiopia, fermented goat's milk products are consumed before sufficient time has passed to kill all pathogenic bacteria. For this reason, the use of starter cultures to hasten fermentation could also be investigated[54].

Other food safety interventions applicable to both producers and non-producers include the promotion of exclusive breastfeeding until infants are six months of age, and food safety education. Training about meat hygiene, hand-washing and safe food preparation, for example, could reduce health risks associated with a range of foods and activities. It is critical that such education includes women, who traditionally do all the cooking and childcare in Ethiopia.

5 Conclusions and recommendations

The small ruminant value chain in Ethiopia presents multiple opportunities for value chain development. These include, but are not limited to, improved input supply (e.g. especially animal health services and feed supply, but including credit provision and other financial assistance), improved production practices (e.g. producer education, feed management, breeding programs), better market linkages (particularly between producers and other actors), better infrastructure (e.g. transport), improved information flow (especially to producers) and shortening of marketing chains. These issues are complex and despite some regional variation, are generally widespread. An integrated, broad-based approach to interventions could result in increased income of actors within the value chain, although further research and testing is needed to identify which interventions are most achievable and efficient - and have the greatest impact on the livelihoods of the poor.

Food insecurity and dietary inadequacy present a major nutritional risk to Ethiopians. Increasing income of value chain actors through value chain development will not necessarily lead to improved food security, although it is probably required. Due to the high opportunity cost of slaughtering animals, ways to improve access to fresh or preserved meat portions – particularly in rural areas – should be investigated. Meat seems to be more important to food security in pastoral areas than elsewhere, so further work on feed availability, drought resistance and disease control could be particularly beneficial to these communities. For town- and city-dwellers, a reduction in the price of small ruminant meat could increase consumption, and could be achieved by optimising the efficiency of the value chain. Small ruminant milk probably has greater potential than meat to improve food security for the rural poor in Ethiopia and seems to be underutilised - thus, research into improving milk production and availability, and optimising processing and storage of milk products, could be warranted. This is particularly true for the effects of traditional fermentation on goat's milk, on which information is scarce. The cultural objection to women drinking whole milk in Abergelle should also be explored, particularly with the intention of investigating alternative foods. Improving access to small ruminant milk in towns and cities could also be considered, although might well be unnecessary if cow's milk already occupies the dairy-based dietary niche in these areas.

While research and interventions to improve nutrition within small ruminant value chains could be applied across much of Ethiopia, further work on food safety should be prioritised by study area. With the view to prioritising intervention strategies, research to investigate pathogen prevalence and load in small ruminants and the production environment, and the relative importance of different transmission pathways of zoonotic and foodborne diseases, could help ensure that funding and other resources are most effectively allocated. A better understanding of producers' knowledge of zoonotic diseases and drug usage is also needed. Reports on the effect of traditional fermentation and processing techniques on goat milk are also sorely lacking.

This study was rural in focus, and much more work is needed on the consumption habits of urban and more affluent consumers, and on the food safety risks of small ruminant products purchased from various processors or prepared at home. This should include more detailed investigation of the prevalence and impact of food safety issues. Toxicological sampling could also be relevant in Doyogena and elsewhere where meat from fattened animals is sold, as the possibility it could contain drug residues or aflatoxins is worth investigating. It would also be interesting to explore whether improving safety of small ruminant foods in the urban environment would make an appreciable difference to livelihoods of consumers and other value chain actors – or indeed to the demand for the product.

While problems at producer level are complex, and additional research is needed before interventions to improve food safety in the small ruminant value chain can be implemented, some simple messages should be conveyed to consumers in the meantime. Chief amongst these is the importance of adequate cooking of meat and boiling milk before consumption, as well as safe food handling practices, to reduce the risk of foodborne diseases - particularly pertinent when disease control is otherwise poor. In this regard, the involvement of women is critical, as they are traditionally responsible for food preparation in Ethiopia. Additionally, risk-mitigating behaviour of consumers can be promoted by increasing food choices – either within or between food categories – through better access, increased income, and less cultural/religious restrictions.

Finally, it is worth noting that any increase in consumption frequency or volume is likely to precipitate an increase in food safety risks, in parallel with nutritional benefits. Anticipating these risks, and considering appropriate interventions as part of a long-term view, would be prudent.

6 Annexes

Annex 1: PRA with small ruminant producers in Ethiopia

NB. Blank line _____ should be filled in with the value chain of interest

Participants: _____ farm owners Site:_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ Date:_ _ _ _ _ _ _ _ _ _ _ _

Welcome and Introduction

Good morning/afternoon. My name is _ _ ____ _ _ _ _ _ and my assistant is _ _ _ _ _ _ _ _ _ _ __ . Over the next few weeks, our research team from _ _ _ _ _ _ _ _ _ _ _ _ will be visiting groups of men and women in the community as part of a project on agriculture and diets in your community. We want to meet with you today because we feel that projects that help make food safe and nutritious can do a better job if we talk to men and women about their opinions and experiences. We want to learn especially about how _____ is farmed, sold, and consumed by people in the community and how this relates to things like nutrition and health. Before we begin, we would like to tell you a little more about how the session will go and ask your permission to participate.

Consent

You are being asked to be in a research study. It is entirely your choice. If you decide to take part, you can change your mind later on and withdraw from the research study. The decision to join or not to talk with us today will not cause you to lose any benefits. Your participation is not paid but we brought some refreshments. Your participation in the group discussion is completely voluntary, so if at any time you no longer want to participate, you are free to leave.

There are no foreseeable risks or discomforts associated with this study; we don't expect anything that we discuss here to be controversial. The research team promises to respect your privacy and confidentiality. We will not tell anyone that you participated in this group discussion and your identity will not be linked back to what you said. However, we cannot guarantee other people in the discussion will not repeat what is said outside of this room. Everyone here must agree not to talk to other people about any specific person in the group or what they said during our discussion today. This information we talk about will be shared with the research team, but we will remove all names so they will not be able to tell who said what in the discussion. A study number rather than your name will be used on study records. Your name and other facts that might point to you will not appear when we tell other people what we talked about today.

What questions do you have about confidentiality?

Certain offices and people other than the researchers may look at the study records. Government agencies and university employees overseeing proper study conduct may look at your study records. We will keep any research records we produce private to the extent we are required to do so by law.We will pass a participation list now for you to sign, which also confirms that you agree to participate in this study. [*For illiterate groups, consent will be obtained verbally.]*

Our assistant, _ _ _ _ _ _ _ _ _ __ , will be taking some notes, but he/she will not be able to write down every word that is said, so we would like to tape-record our conversation so we can listen to it later and make sure we understand everything you told us. The recording will be stored in a secure location and will not be accessible to anyone outside of the research team. We will also be taking some photos of the posters made. The notes won't have anyone's name, and we will leave a copy with anyone who wants. Is it alright with everyone if we use a tape-recorder? Thank you for your willingness to be recorded.

Ground rules for the PRA

- All the views that we give are very important so what we would like to ask is when one is speaking please let us give her time to speak until when she is finished then another one can speak.
- Please feel free to speak your opinion. We don't all have to agree but need to respect each other's opinion during the discussion.
- We would like it if all of us can participate and speak. We would like to have the opinions of everyone so for the sake of this discussion, we are all equal, and no one knows more than the other.

- We are going to use a lot of pictures and diagrams in this discussion. This makes it easy for everyone to see the information and check if it makes sense. It also means we can take pictures of the diagrams
- We would like to discuss for around one hour. We will also be making some posters to show the information. We will be providing tea and snacks.

More information

We are giving everyone a card with the name of someone from the research team. If you would like any more information later, please contact them. *[Prepare these cards beforehand; give the name of someone at the office].*

Once our study is complete (in around 12 months) someone will come back to the community to share the results with you.

A. How does _____ production vary during the year (availability)

Activity: Seasonal calendar *[about 30 minutes]*

Materials:

- A large sheet of paper with the months and any major festivals written in. Start with the month preferred by producers.
- Beans or counters to indicate _____ consumption [This is better than drawing as it is much easier to change.]
- Coloured markers.

Research questions addressed:

How does _____ production vary by season? What is the role of _____in the diet by season? And with respect to seasons where there is less food available?

Facilitator: We'd like to talk about when _____is available throughout the year. We are going to create a calendar that represents the past year. Please note where these events fall on the calendar.

- High/low rainfall
- Seasons where there is less food available in the community
- _____cycle (grow, harvest, or varying yield). [Probe for start of school year, festivals, times when people get sick as animals are often harvested then]
- Production of _____ (quantity represented by sticks or counters)
- Household consumption

Data capture:

_____ production cycle												
Times of general food shortage												
_____ production												
_____ consumption												
	j	f	m	a	m	j	j	a	s	o	n	d

[Enter the number of counters used and take a picture of the calendar.]

B. What are farmers' perceptions to the main constraints to production of _____ (availability)

Activity: Matrix/pair wise comparison *[about 20 minutes]*

Materials:

- A large sheet of paper.
- Pictures to indicate various potential constraints.
- Coloured markers.

Research questions addressed:

What are the constraints to producing larger amounts of _____]? Among these constraints which are most important?

Facilitator: We'd like to talk about the different problems that affect your ability to produce _____in greater quantities.

- brainstorm on the constraints to animal/fish keeping. [Consider but do not suggest: feed, disease, markets, improved breeds, low production, insecurity etc.].
- rank the top five constraints
- develop a matrix with constraints along the top and side: use picture cards
- go cell-by-cell and ask farmers to compare the top and side to say which is most important
- the result of the comparison is written in the cell
- At the end, count the number of times each constraint was selected. The constraint that was selected the most times is ranked highest.

Data capture

	Disease	Lack of feed	Lack of markets	D	E	F	G	Number of preferences
Disease								
Lack of feed								
Lack of markets								
D								
E								
F								
G								

Activity: Problem-opportunity matrix

Materials:

- A large sheet of paper.
- Coloured markers.

Research questions addressed:

How do producers perceive quality and safety?

Facilitator: We would like to hear your ideas about what could be done to increase _____production. To organize our ideas, let's focus on the top 3 production issues. Let's identify the root causes these issues are related to and we'll write them on the poster. *[Keep asking 'why' questions to get to root causes. For example, if the constraint is disease, ask "why do you think your animals are so prone to disease?" Continue to probe deeper to get further reasons/factors influencing the constraint.]*

[Go through each issue one-by-one following this order.] Starting with this first problem, what solutions do you have that could improve the situation, including what should be done, who should do it, and how it could get done? Finally, what initiatives are you aware of that have already been done to address this issue? What was the level of success/failure of the initiative?

Data capture

	Production constraint		
	problem 1	problem 2	Problem 3
Root cause (what is the problem related to?)			
What is already being done			
What more can be done			
Who has to do it			
How it can be done			
What has been done before?			
Was it successful or not?			

C. Animal production, morbidity and mortality and uses (availability & risk)

C.1 Community (herd) entry/exit *[about 40 minutes]*

Activity: Proportional piling, listing

Materials:

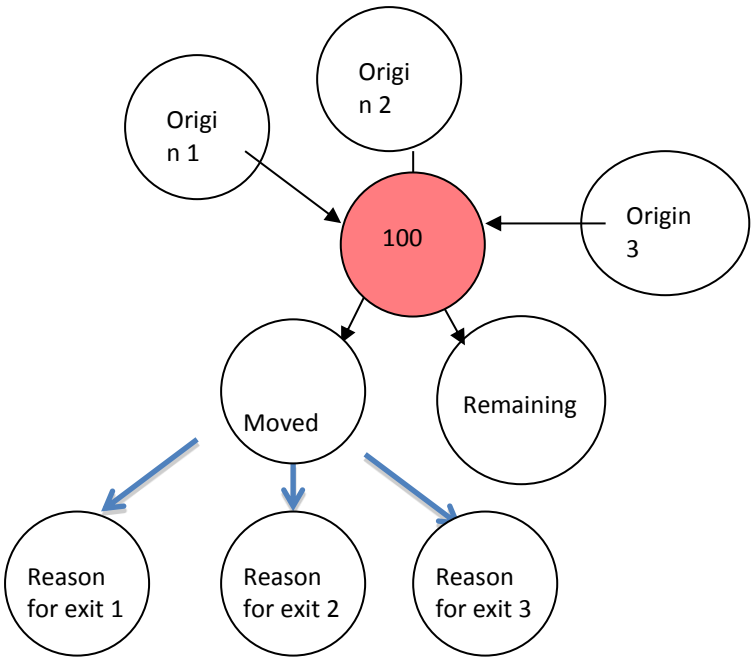
- A large sheet of paper.
- Counters.
- Coloured markers.

Research questions addressed

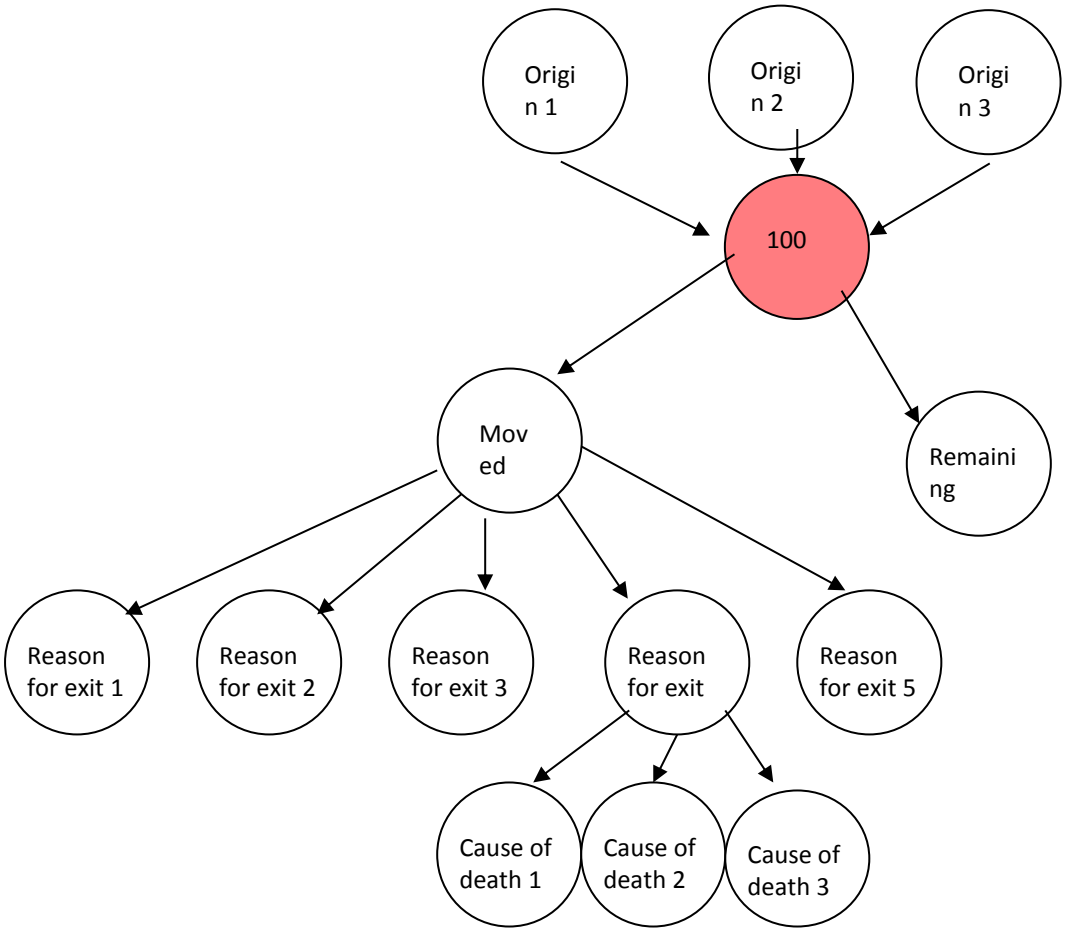
What are constraints in terms of producing enough _____? To what extent are livestock keepers livestock eaters? Health risks vs. nutrition benefits around consumption of sick/dead animals.

Facilitator: We would like to understand what happens to _____ in the community over the course of year. The stones/beans/counters in this circle represent all the stock present in the village or community at the start of the year. First we want to look at the proportion which enters the herd. How do they obtain their animals during the course of the year *[e.g. purchase, gift, government program, birth…]***.**

Secondly, we want to look at the proportion which leaves the herd. What are the different reasons a _____ there at the beginning of the year might not be at the end? *[Probe: sold, gifted, consumed, died, stolen, lost…]*



Among those that died, what were the different causes *[probe: starvation, predation etc]*



C.2 List of most common diseases *[about 35 minutes]*

Tool: simple ranking

Materials:

- A large sheet of paper.
- Coloured markers.

Facilitator: We would like to find out more about the most important diseases that affect your _____ in this area.

Data capture

Characteristics	[Disease1]	[Disease2]	[Disease3]	[Disease4]	[Disease5]
Local name					
Clinical signs					
Probable western name or names					
What kind of _____ is affected *[e.g. young, castrated etc]*					
Does it occur seasonally or throughout the year (If seasonal specify which season)					
Does it affect local, improved or both equally					
What is the main effect of the disease on _____ *[e.g. death, weight loss – ask further questions]*					
What causes it					
What is the treatment or prevention					
Is the treatment/prevention effective? (score *=a little bit effective,**=,***= very effective					
Additional remarks					

C.3 Herd morbidity and mortality *[about 30 minutes]*

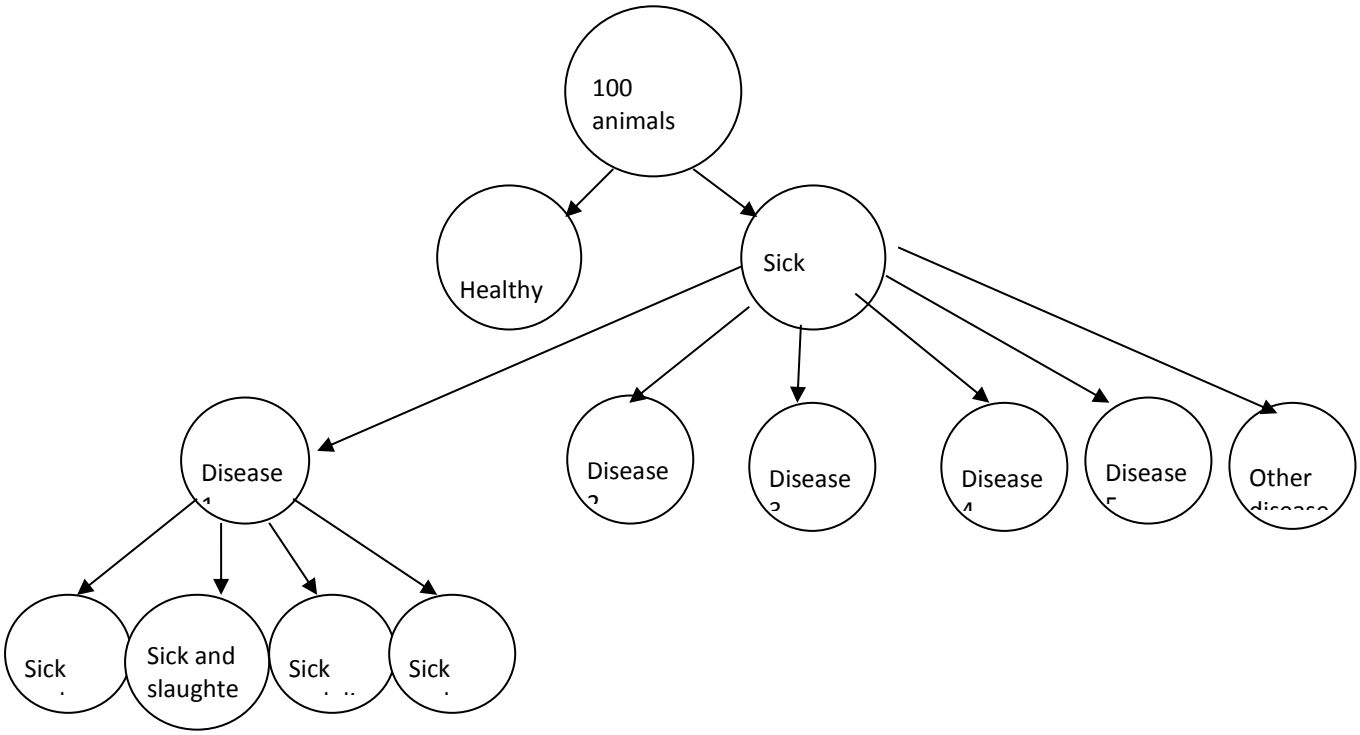
Tool: Proportional pilling for Herd Morbidity and Mortality (PPM)

Facilitator

- A circle is drawn on the ground to represent the herd.
- A pile of similar sized stones/beans/counters is put in the circle to represent all the animals in the herd (use 100).

- The facilitator again divides the herd into two groups: those that were sick during the last year and those that were never sick.
- Those that were sick are divided according to the most common diseases (4 to 5).
- The rest of the diseases/conditions will be grouped under the category of OTHERS.
- For each category of sick animals divide the counters into sick and sold; sick and slaughtered for consumption (emergency slaughter); sick and died; sick and recovered.

Data capture



Record proportion of herd that gets sick (eg. 30/100), and numbers/proportion for each disease:

Disease name	Proportion of sick animals with this disease	Outcome				Comments/root causes/reasons why
		Die	Emergency slaughter	Sale	Recover	

1. What can people do with sick _____ that die or are emergency-slaughtered?
2. In what types of situations would people eat sick _____?
3. In what types of situations would people eat meat/milk from _____ which have died?
4. What types of people in the community are more or less likely to eat sick _____? *[Probes: the poor, elderly]*
5. If people do consume _____ from sick or dead _____, whatmeasures do they take?

D. _____ quality and safety issues (KAP)

Activity: Listing, ranking, scoring *[about 30 minutes]*

Materials:

- A large sheet of paper
- Coloured markers.

Research questions addressed:

How do producers perceive quality including safety?

Facilitator: Now we would like to understand some of the main issues around _____ quality you face as farmers.

How many of you eat _____ ? *[note the number of women/men]*

Do your children eat _____ too? *[note the group consensus]*

First, let's start by discussing quality of [ASF]. What are some of the attributes you look for to determine the quality of _____? *[On the poster, make a note of qualities mentioned in one column. Prompt for nutritional quality, size, yield, appearance, smell, taste.]*

What aspects of quality are you most concerned with and why? *{Rrank.]* What can compromise this quality aspect (safety issue)? Can any of these make _____ less safe to eat? Would you eat them anyway?

Data capture

Quality attribute	Importance (rank after all attributes been listed)	Reasons for selecting food with this attribute	Safety issue associated with absence of quality attribute	Can any of these make _____ less safe to eat?	Would you eat it anyway?	How often do you find this safety issue? +++ often ++ sometimes + never
e.g. colour of fish	1	Pale colour is a sign of poor quality fish; this associated with the quality of the water				
e.g. smell	2					

What could be a reason for you not to buy/eat the _____? *[list, rank, score]*

Data capture

Reason not to buy/eat	Why?	Do you find this often? +++ often ++ sometimes + never	Remarks
e.g. Dark meat	Might have been stored too long or animal sick when slaughtered	++	Will not buy/eat if there is a choice, but if we have no choice, we boil it

How do the people who buy/eat your _____ judge quality?

What measures do you take when/after you slaughter/harvest/milk an animal to ensure better quality/safety, and why?

Measure	Reason
Slaughter animal quickly, after it has been resting	Meat tastes better

E. Producers' suggestions for improving quality

Activity: Problem-opportunity matrix

Materials:

- A large sheet of paper.
- Coloured markers.

Research questions addressed:

How do producers perceive quality and safety? [What solutions do producers consider appropriate to the major food quality constraints?]

Facilitator: We would like to hear your ideas about what could be done to improve the safety of _____ To organize our ideas, let's focus on the top 2 quality attributes we identified earlier. Let's create general categories to describe the problem these issues are related to and we'll write them on the poster. *[Get to root cause by probing deeper, asking further 'why' questions, like for production constraints.]*

[Go through each issue one-by-one following this order.] Starting with this first problem, what constraints do you face as farmers? What solutions do you have that could improve the situation, including what should be done, who should do it, and how it could get done? Finally, what initiatives are you aware of that have already been done to address this issue? What was the level of success/failure of the initiative?

Data capture

	Food quality constraints	
	Problem 1	Problem 2
Root cause (WHAT IS THE PROBLEM RELATED TO?)		
What is already being done		
What more can be done		
Who has to do it		
How it can be done		

Thank you for your time and cooperation. This is useful for our understanding of _____ farming.

Now do you have questions for us?*[Record questions and response]*

Annex 2: PRA with small ruminant consumers in Ethiopia

NB. Blank line _____ should be filled in with the value chain of interest

Participants: _____ consumers Site:_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ Date:_ _ _ _ _ _ _ _ _ _ _ _

Welcome and Introduction

Good morning/afternoon. My name is _ _ _ _ _ _ _ _ _ _ _ _and my assistant is_ _ _ _ _ _ _ _ _ _ _ . Over the next few weeks, our research team from _ _ _ _ _ _ _ _ _ _ _ _ _ _will be visiting groups of men and women in the community as part of a project on agriculture and diets in your community. We want to talk with you today because we feel that projects that help make food safe and nutritious can do a better job if we talk to men and women about their opinions and experiences. We want to learn especially about how _____ is farmed, sold, and consumed by people in the community and how this relates to things like nutrition and health. Before we begin, we would like to tell you a little more about how the discussion will go and ask your permission to participate.

Consent

You are being asked to be in a research study. It is entirely your choice. If you decide to take part, you can change your mind later on and withdraw from the research study. The decision to join or not to talk with us today will not cause you to lose any benefits. Your participation is not paid but we brought some refreshments. Your participation in the group discussion is completely voluntary, so if at any time you no longer want to participate, you are free to leave.

There are no foreseeable risks or discomforts associated with this study; we don't expect anything that we discuss here to be controversial. The research team promises to respect your privacy and confidentiality. We will not tell anyone that you participated in this group discussion and your identity will not be linked back to what you said. However, we cannot guarantee other people in the discussion will not repeat what is said outside of this room. Everyone here must agree not to talk to other people about any specific person in the group or what they said during our discussion today. This information we talk about will be shared with the research team, but we will remove all names so they will not be able to tell who said what in the discussion. A study number rather than your name will be used on study records. Your name and other facts that might point to you will not appear when we tell other people what we talked about today.

What questions do you have about confidentiality?

Certain offices and people other than the researchers may look at the study records. Government agencies and university employees overseeing proper study conduct may look at your study records. We will keep any research records we produce private to the extent we are required to do so by law. We will pass a participation list now for you to sign, which also confirms that you agree to participate in this study. *[For illiterate groups, consent will be obtained verbally.]*

Our assistant, __ _ _ _ _ _ _ _ ___ , will be taking some notes, but he/she will not be able to write down every word that is said, so we would like to tape-record our conversation so we can listen to it later and make sure we understand everything you told us. The recording will be stored in a secure location and will not be accessible to anyone outside of the research team. We will also be taking some photos of the posters made. The notes won't have anyone's name, and we will leave a copy with anyone who wants. Is it alright with everyone if we use a tape-recorder? Thank you for your willingness to be recorded.

Once our study is complete (in around 12 months) someone will come back to the community to share the results with you.

Ground rules for the PRA

- All the views that we give are very important so what we would like to ask is when one is speaking please let us give them time to speak until they finished then another one can speak.
- Please feel free to speak your opinion. We don't all have to agree but need to respect each other's opinion during the discussion.
- We would like it if all of us can participate and speak. We would like to have the opinions of everyone so for the sake of this discussion, we are all equal, and no one knows more than the other.

- We are going to use a lot of pictures and diagrams in this discussion. This makes it easy for everyone to see the information and check if it makes sense. It also means we can take pictures of the diagrams.
- We would like to discuss for around one- two hours. We will also be making some posters to show the information. We will be providing tea and snacks (in the middle/ at the end?)

More information

We are giving everyone a card with the name of someone from the research team. If you would like any more information later, please contact them. *[Prepare these cards beforehand; give the name of someone at the office]*

A. Animal source foods (all) availability and use

Activity: Listing, rating and ranking

Materials:

- Flip chart paper.
- Pictures of different foods.
- Different coloured markers.

Research questions addressed:

What is the role of the food in question in diet quality? Relationship between livestock keeping and livestock eating.

Facilitator: We'd like to start by talking about the types of animal-source foods people in your community produce and consume. When we say animal-source foods today, we mean any kind of foods that come from animals. This could include chicken or _____, or animal products such as milk or eggs. Let's start by making a list of the types of animal-source foods people in your community eat. [Note responses on the poster*. [Probe for species and type.]*

Let's go through each food one-by-one.

- Is this food kept at home in order to sell?
- Is this food kept at home in order for the household to eat?
- How often do people eat these types of foods?
- When people eat these foods, how much do they eat at a single time/meal?

Data capture

Types of ASF	Kept at home for sale (y/n)	Kept at home for HH consumption (y/n)	Frequency	Quantity

Facilitator: Of all these foods listed, let's rank them in the order of best to worst considering different factors we make when deciding what foods to eat. We will consider taste, safety, health/nutrition benefits, and price. **What other factors should we add to the list?** *[Add 1-2 other factors the group mentions. Go through each category one-by-one and ask the group to rank them best to worst for their taste, safety, health/nutrition benefits, and on. Ask them to rank these goods from best to worst for different groups of people.]*

Data capture

ASF	Taste rank	Safety rank	Health/nutrition benefits rank	Children <5 rank	Children 5-12 yo rank	Pregnant women rank	Elderly rank	Sick rank

B How does the _____consumption vary during the year (availability)

Activity: Seasonal calendar

Materials:

- A large sheet of paper with the months and any major festivals written in. Start with the month preferred by consumers.
- Beans or counters.
- Coloured markers.

Research questions addressed:

What is the role of this _____ in the diet by season? And with respect to times of food shortage?

Facilitator: We'd like to talk about when _____ is available throughout the year. We are going to create a calendar that **represents the past year**. Please note where these events fall on the calendar.

- _____ cycle (breeding, growing, harvesting, yield etc.)
- Seasons where food is less available in the community
- _____ consumption. [Can use different colours if different products (e.g. poultry meat and eggs)]

Data capture:

_____ cycle												
Times of food shortage												
_____ consumption												
	j	f	m	a	m	j	j	a	s	o	n	d

Count the number of counters and take a picture of the calendar.

C. Where is the _____ obtained (access)?

Activity: Chapati diagram

Materials:

- A large sheet of paper.
- Different diameter circles (three) of paper in different colours.
- Weights or masking tape to help stick circles to poster.
- Measuring tape.

Research questions addressed:

What is the relation between livestock keeping and livestock eating?

How accessible is the _____?

Facilitator: We are now going to talk about where people in this community obtain the _____ they eat. This circle I've drawn represents your community; the circle inside represents your household and the area outside the circle represents areas outside your community.

First let's come up with a list of the places where you obtain the sheep/goat meat/milk during the year *[brainstorm]*. For each one mentioned, indicate how important the source is by the size of the circle. *['Importance' should indicate relative quantity. Write each source on a circle of appropriate size: large for very important, medium for moderately important, small for not important.]*

Let's note on the poster where consumers obtain _____ by placing these different sized circles on the poster. The distance between the circle and the household circle indicates how far the source is.

[Take a picture of the diagram.]

For each source ask "Who usually makes the decision to obtain _____ from here?" and who obtains it (e.g. who looks at the product and judges quality)?

Data capture

Source	Name	Importance	Distance	Who makes decision to use this source?	Who selects the product?
Home farm					
In community	Vendor				
Outside	Supermarket				

D _____ quality and safety issues

Activity: Listing, ranking, scoring (about 30 minutes)

Materials:

- A large sheet of paper.
- Coloured markers.

Research questions addressed:

How do consumers perceive quality including safety?

Facilitator: Now we would like to understand some of the main issues around _____ quality you face as consumers.

How many of you eat _____? *[note the number of women/men]*

Do your children eat _____ too? *[note the group consensus]*

First, let's start by discussing quality of _____. What are some of the attributes you look for to determine the quality of _____? *[On the poster, make a note of qualities mentioned in one column. Prompt for nutritional quality, size, yield, appearance, smell.]*

What aspects of quality are you most concerned with and why? *[Rank.]* What can compromise this quality aspect (safety issue)? Can any of these make _____ less safe to eat?

Data capture

Quality attribute	Importance [rank after all attributes been listed]	Reasons for selecting food with this attribute	Safety issue associated with absence of quality attribute	Can any of these make _____ less safe to eat?	Would you eat it anyway?	How often do you find this safety issue? +++ often ++ sometimes + never
e.g. colour of fish	1	Pale colour is a sign of poor quality fish; this associated with the quality of the water				
e.g. smell	2					

What could be a reason for you not to buy/eat the _____? *[list, rank, score]*

Data capture

Reason not to buy/eat	Why?	Do you find this often? +++ often ++ sometimes + never	Remarks
e.g. Dark meat	Might have been stored too long or animal sick when slaughtered	++	Will not buy/eat if there is a choice, but if we have no choice, we boil it

NB. The remaining activities are for women only

E. _____ – Preparation and Consumption

Activity: Daily calendar *[about 20 minutes]*

Materials:

- A large sheet of paper.
- Coloured markers.

Research questions addressed:

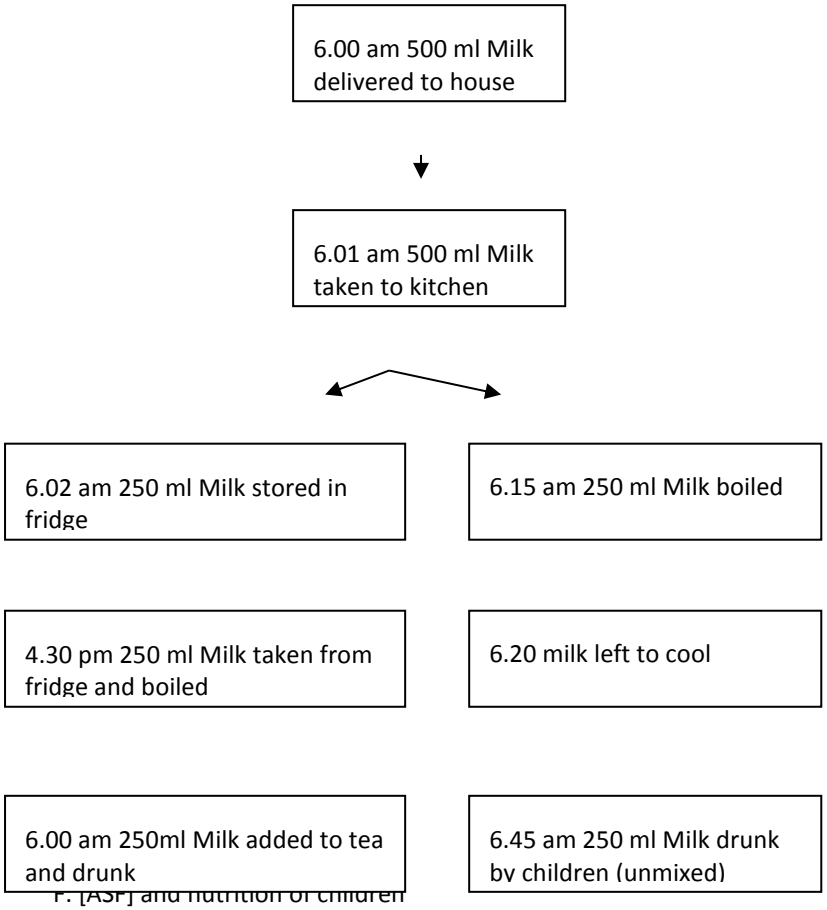
How do conditions between purchase and consumption affect nutritional quality and food safety? How does gender affect preparation and consumption?

Facilitator: Now that we've talked about where you purchase _____, we'd like to ask some questions about how it is typically prepared **at home**. We'd like you to walk us through what happens from when you purchase fresh _____ and the time that passes between each step in the process. Our note taker will be drawing what you tell us on the poster. *[Draw as a sort of timeline/flow diagram.]* Write in different colour pen for male, female and both depending on who is usually involved.

Data capture

Pathway mapping

1. Using cards develop a daily calendar of _____ from purchase to consumption in a typical household.
2. Start with the _____arriving at the household door; record where the _____ came from. Then where it goes to until consumption.
3. Indicate the quantity, time.
4. Indicate the conditions of storage e.g. place; container; whether covered.
5. Note especially if any boiling, chilling, cooking or mixing with other substances takes place.
6. Indicate who consumes _____.
7. Repeat for each possible origin of _____ (hawker, shop, eating out).
8. Rank the importance of each pathway in terms of quantity.



G. Diets of young children

Activity: Listing

Materials:

- Flip chart paper.
- Pictures of different foods.
- Different coloured markers.

Research questions addressed:

What is the role of _____ in nutrition of young children?

Facilitator: Next, we'd like to talk about the diets of young children. For young children, we mean infants up to children who are 5 years old. Before we begin, at how many months do infants typically start eating foods other than breast milk? *[Use this as your cut-off for this activity.]* Next, what types of animal-source foods do young children eat? *[Add this to the list].*

Data capture

Age groups	ASF consumed	Preparation method for each ASF	Amounts in a typical eating occasion – bowl, cup, fist, spoon-full – for each ASF	Frequency of feeding
____ months – 1 year				
1-2 years				
2-5 years old				
Sick child				

- What are some of the reasons why some young children in the community might never eat ASF?
- What are some of the benefits to young children from eating ASF?

Thank you very much for your efforts today – you have helped us understand more about _____ consumption. Any questions about what we have done today?

Annex 3: FGD with mothers of children less than 5 years old

Main research questions

1. Food safety
    a. What risks do hazards pose to children?
2. Food and nutrition security
    a. What is the role of the ASF food in question in diets of young children?
    b. What is the relationship between livestock keeping and livestock eating?
    c. How important is waste as a cause of loss of nutrition?
3. Combined food safety and nutritional issues
    a. How does nutritional quality and food safety change during processing?
    b. What are trade-offs (e.g. boiling, fermenting may increase safety but decrease nutrition)?
    c. Are there trade-offs, synergies, between feeds and foods (especially fishmeal but also fodder, dual purpose crops, sweet potato for pigs and people etc)?
    d. How do the different ASF VC compare in meeting nutrition and safety needs?
4. Social and gender determinants of health and nutrition
    a. Who gets the nutritional benefits and bears the health risks of ASF? How do gender roles and poverty influence health and nutrition risks?
    b. How do cultural practices affecting health and nutrition risks (consumption raw food, withholding food during illness)

Focus group characteristics

- A focus group is a small group of six to ten people, of similar background but who are strangers to each other.
- The format is open discussion is led by a skilled facilitator
- FGD are structured around 5-10 questions related to the study question.
- The discussion should last no more than one hour to get good answers
- 3-5 FGD with the same type of group is needed to arrive at reliable conclusions

Participants: Mothers with children under five;

- Groups should be homogeneous as regards socio-economic status; ethnicity and urban-rural; [ASF] producing or not
- Different FGDs can be conducted with urban consumers and rural consumers; different groups by socio-economic status
- Five to 10 women with young children

Minimum

4 FGD with rural women from [ASF] keeping households and 4 FGD with rural women from non-[ASF] keeping households

Participants: _____-keeping/non-_____ keeping [*select]* mothers of young children

Site:_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ Date:_ _ _ _ _ _ _ _ _ _ _ _

Welcome and Introduction

Good morning/afternoon. My name is _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _and my assistant is _ _ _ _ _ __ _ _ _ _ _ _ _ __. Over the next few weeks, our research team from _ _ _ _ _ _ __ _ _ _ _ _ _ _ _ _ will be visiting groups of men and women in the community as part of a project on agriculture and diets in your community. We want to meet with you today because we feel that projects that help make food safe and nutritious can do a better job if we talk to men and women about their opinions and experiences. We want to learn especially about how [this ASF] is farmed, sold, and consumed by people in the community and how this relates to things like nutrition and health. Before we begin, we would like to tell you a little more about how the session will go and ask your permission to participate.

Consent

You are being asked to be in a research study. It is entirely your choice. If you decide to take part, you can change your mind later on and withdraw from the research study. The decision to join or not to talk with us today will not cause you to lose any benefits. Your participation is not paid but we brought some refreshments. Your participation in the group discussion is completely voluntary, so if at any time you no longer want to participate, you are free to leave.

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We will pass a participation list now for you to sign, which also confirms that you agree to participate in this study. *[For illiterate groups, consent will be obtained verbally.]*

Our assistant, _____, will be taking some notes, but he/she will not be able to write down every word that is said, so we would like to tape-record our conversation so we can listen to it later and make sure we understand everything you told us. The recording will be stored in a secure location and will not be accessible to anyone outside of the research team. We will also be taking some photos of the posters made. The notes won't have anyone's name, and we will leave a copy with anyone who wants.

Is it alright with everyone if we use a tape-recorder? Thank you for your willingness to be recorded.

Ground rules for the FGD

- All the views that we give are very important so what we would like to ask is when one is speaking please let us give her time to speak until when she is finished then another one can speak.
- Please feel free to speak your opinion. We don't all have to agree but need to respect each other's opinion during the discussion.
- We would like it if all of us can participate and speak. We would like to have the opinions of everyone so for the sake of this discussion, we are all equal, and no one knows more than the other.
- We would like to discuss for around one hour. We will also be making some posters to show the information. We will be providing tea and snacks.

More information

We are giving everyone a card with the name of someone from the research team. If you would like any more information later, please contact them. *(Prepare these cards beforehand; give the name of someone at the office)*.Once our study is complete (in around 12 months) someone will come back to the community to share the results with you.

Ice-breaker

Start with an introduction of your name and your favourite food.

A.Who eats _____?

Objective: to assess role of all ASF and _____ in diets; to explore socio-economic and cultural determinants of _____ consumption; to explore relation between keeping livestock/fish and consuming their products (2b) (4a) (4b)

Instructions *(read as written to the group)*: Next, we would like to understand more about the role of livestock and fish foods in the diets of people in your community.

- What kinds of livestock and fish foods do you eat in this community? Which are the most common?
- How common is it to eat _____? [*Probe daily – weekly- monthly*]
- Why might some people eat more _____ than others do? [*Probe: taboos, socio-economic status, producers]*
- Why might some people eat less _____?
- Are there any beliefs or proverbs about eating _____ (e.g. if a child eats an egg it will become bald; a fish rots from the head down)?

Transition: Thank you. Now we want to talk specifically about what food young children typically eat. Think about yesterday…

B. Role of ASF in children's diet

Objective: to assess role of all ASF in children's diets (2a). To assess what potential hazards are present (1a) (4a) (4b) (4d)

Facilitator: Which foods or drinks do your children eat from when they first start to eat, or drink anything that isn't breast milk up to 5 years of age?

- For ASF foods: Why are these given to young children? How are they prepared?
- Are there any ASF that are not good to give to young children? Why is this?

Transition: Thank you. Lots of parts of _____ are good to eat. We would like to talk about which pats are eaten typically in this community…

C. Who eats what parts of the _____?

Objective: different parts of _____ have different nutritional contents and health risks. Parts of _____that may be eaten include: muscle meat, intestines, skin, feet, brain, pluck (heart, lungs, thymus), spleen, liver, kidneys, intestines, reproductive organs, bone marrow, feet, tail. (1a, 4a). To explore waste 2c.

- What parts of the _____are eaten? [*Probe: offal, skin]*
- Are children more likely to eat some parts? Are women more likely to eat some parts? If yes, you could ask why (maybe fertility reasons or others, i.e. raw milk is given to children for strong health)
- Are any parts not used at all? Which parts?
- What is done with them? (Probe: fed to livestock, fed to dogs/cats, thrown away)

Transition: Thank you. Now we want to talk about how you prepare and process and cook and serve _____.

D. Trade offs and synergies

Objective: to explore trade-offs and synergies between nutrition and food safety resulting from cooking, processing, managing food safety (3a) (3b) (3c) (4a) and to assess the importance of waste (2c).

D.1 Cooking, safety, nutrition

- What are the different ways you prepare and cook the _____
    - For stews, do you add vegetables?
    - How long do you cook?
- Do you taste the raw _____?
- Do you eat fresh vegetables (tomatoes, salad, onions etc) with the meal?
- Do you prepare these with the same utensils as you prepare the _____?

D.2 Preservation, safety, nutrition

- What are some of the traditional ways you preserve or keep fresh _____? How common are they?
- Describe the process *[include times*]. Do you think these can have an effect on the goodness of food?

(Probe –around practices that can affect nutrients and safety, eg:

Sun-drying

Smoking

Making cheese

Fermenting

Clay 'fridges')

- What are some of the modern ways you keep fresh _____?
- Is any _____ not eaten because it is spoiled or lost or too much or any other reasons?
- Under what circumstances can this happen?
- How much is lost every week (or month, or year)?

D.3 Trade-offs safety & nutrition

- Do children ever get loose stools, diarrhoea or vomiting from the things they eat?
- What foods can cause this?
- Do you make any changes to diet when children have this problem? (*Probe: stop food; stop water; stop _____ and ASF)*
- What are the things you do to make sure _____ is safe?

(Probes around some of the practices that affect nutrients in food, eg:

Adding baking soda (decrease nutrients)

Cutting into small pieces (decrease nutrients)

Cooking for a long time (decrease nutrients)

Reheating (decrease nutrients)

Leaving skin on (improve nutrients)

Fermenting (improve nutrients))

Transition: Thank you. Now we come to the last topic. Both people and livestock eat food and we would like to talk about both.

D.4 Trade-offs human food and animal food

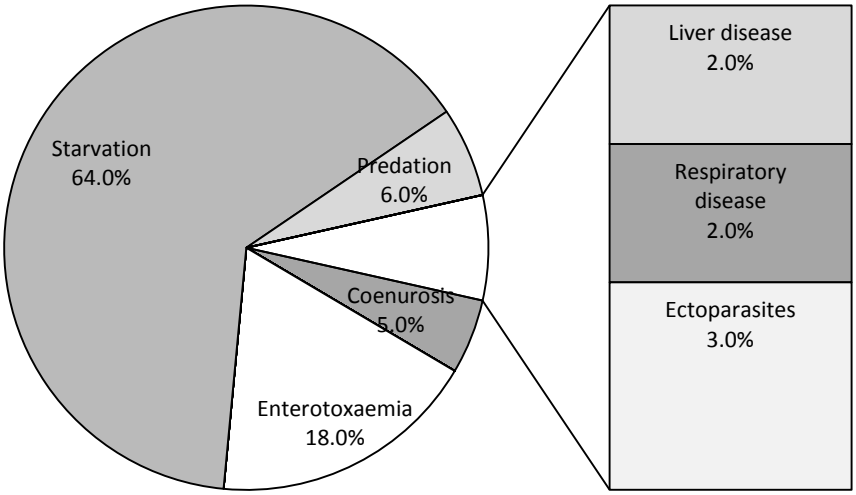
Objective: to explore trade-offs, synergies, between feeds and foods (especially fishmeal but also fodder, dual purpose crops, sweet potato for pigs and people etc)?

- Do you give livestock/fish extra food apart from natural grasses and vegetation?
- Do livestock get food that people could eat?
- If yes, what types of food? Why do you choose to give to livestock?

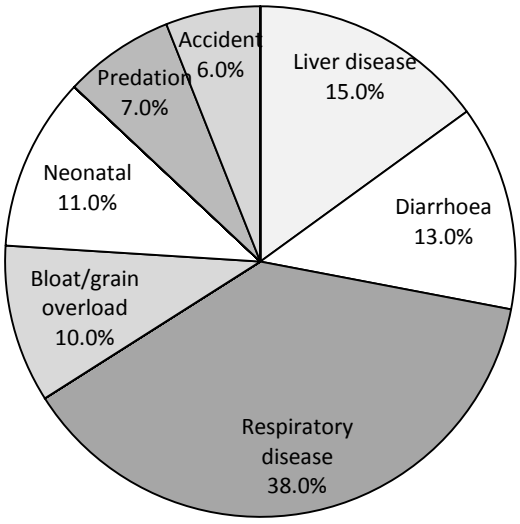
Exit: Thank you for your participation and your contributions. Finally is there anything you would like to add? And do you have any questions for us…

Annex 4: Percentage of annual sheep mortality attributed to different causes at individual study areas

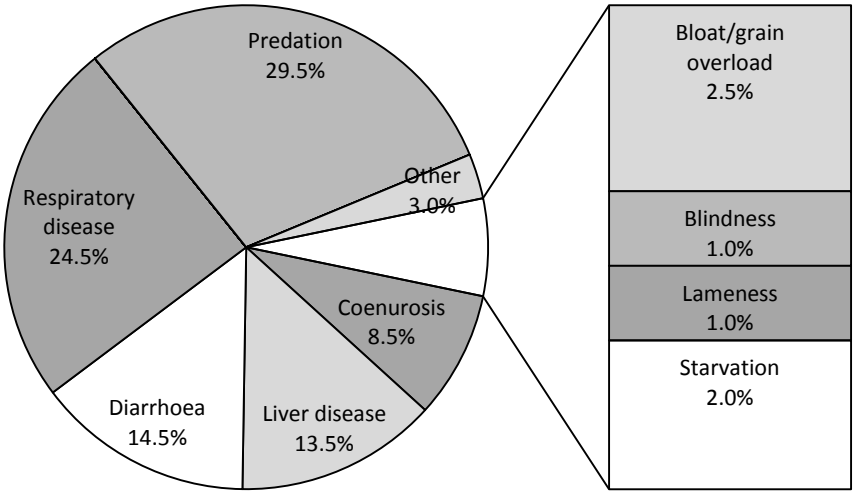
Atsbi



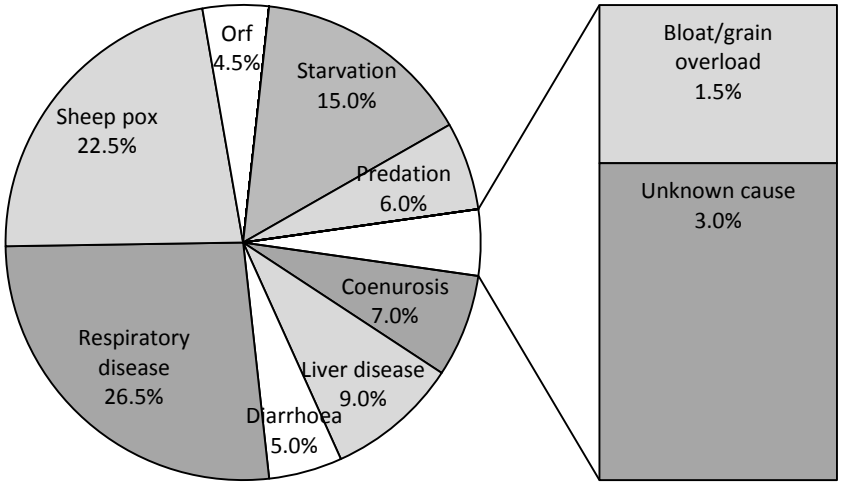
Doyogena



Horro

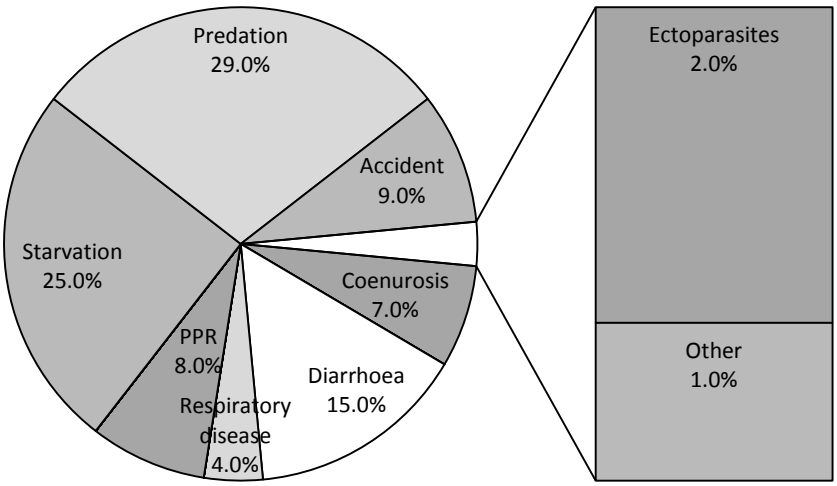

Predation
29.5%
Other
3.0%
Respiratory
disease
24.5%
Coenurosis
8.5%
Diarrhoea
14.5%
Liver disease
13.5%
Bloat/grain
overload
2.5%
Blindness
1.0%
Lameness
1.0%
Starvation
2.0%

Menz

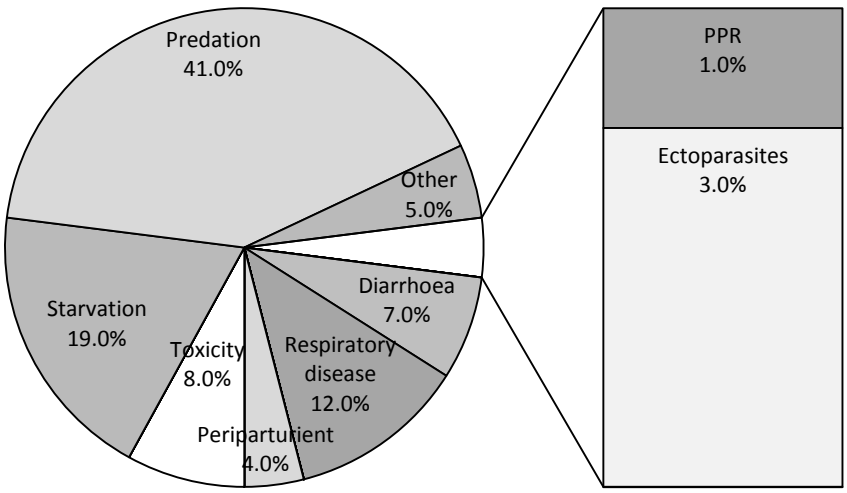

Orf
4.5%
Starvation
15.0%
Sheep pox
22.5%
Predation
6.0%
Coenurosis
7.0%
Respiratory
disease
26.5%
Liver disease
9.0%
Diarrhoea
5.0%
Bloat/grain
overload
1.5%
Unknown cause
3.0%

Annex 5: Percentage of annual goat mortality attributed to different causes at individual study areas

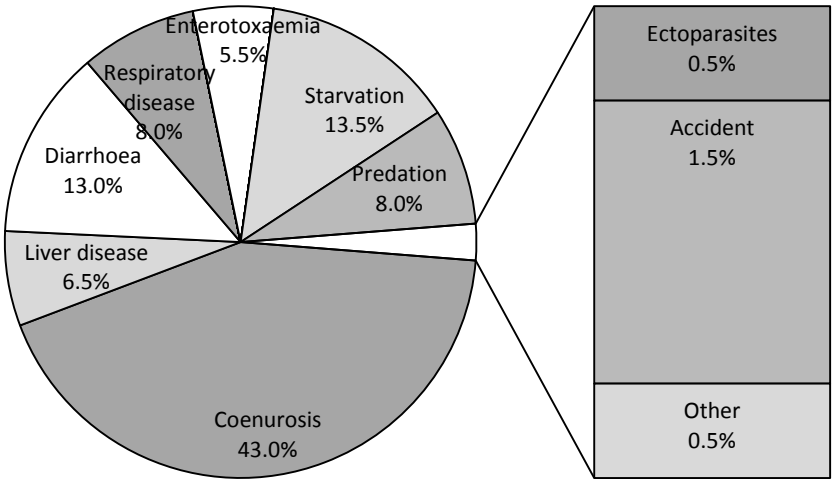
Abergelle Amhara



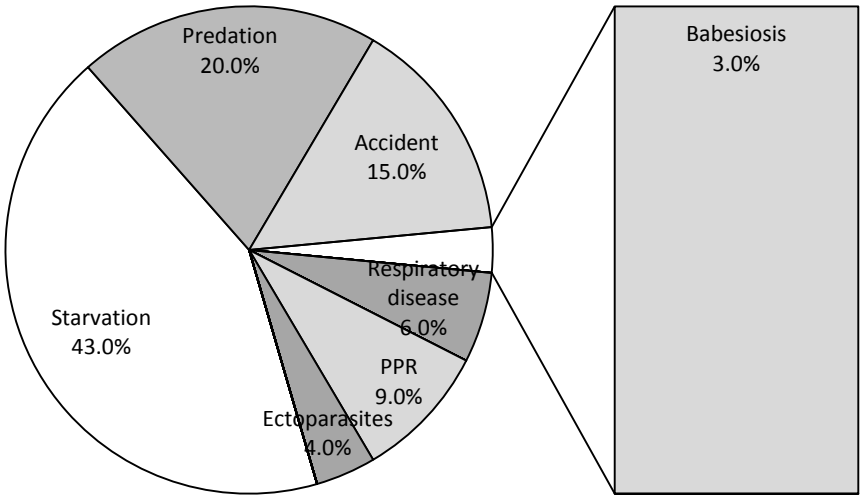
Abergelle Tigray



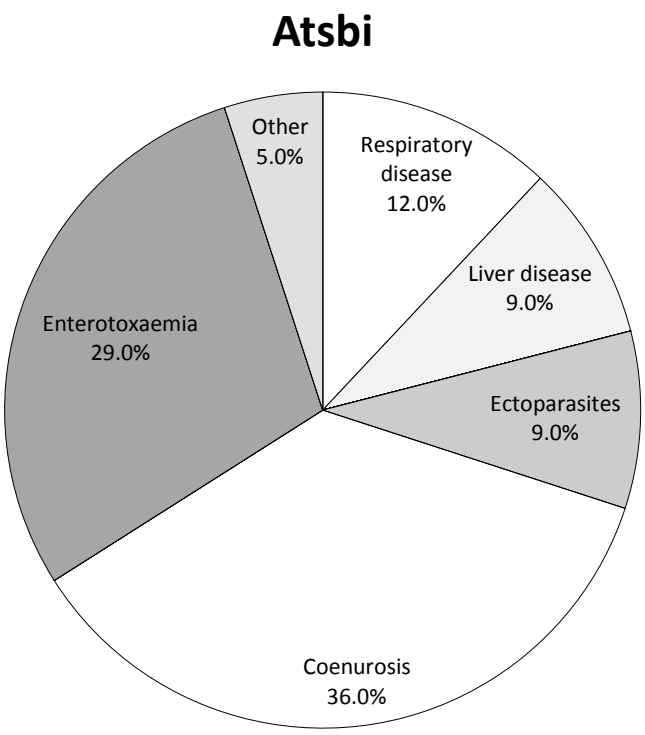
Borena

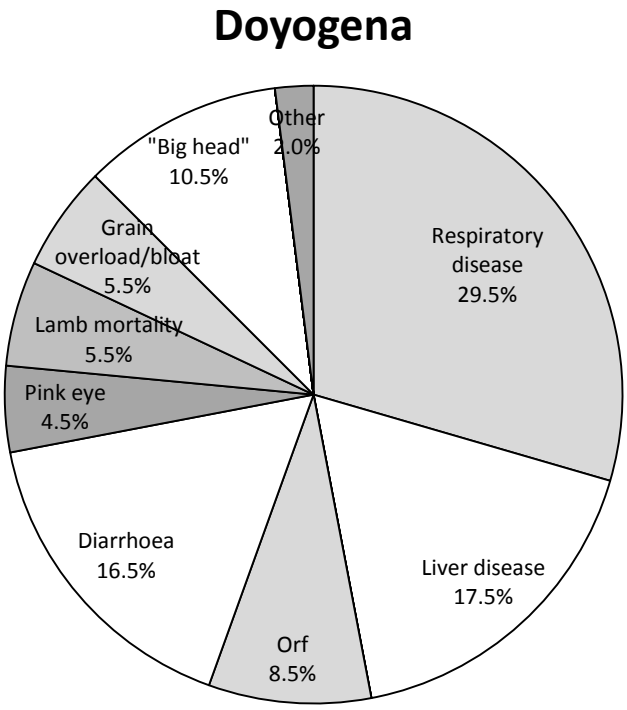


Shinelle

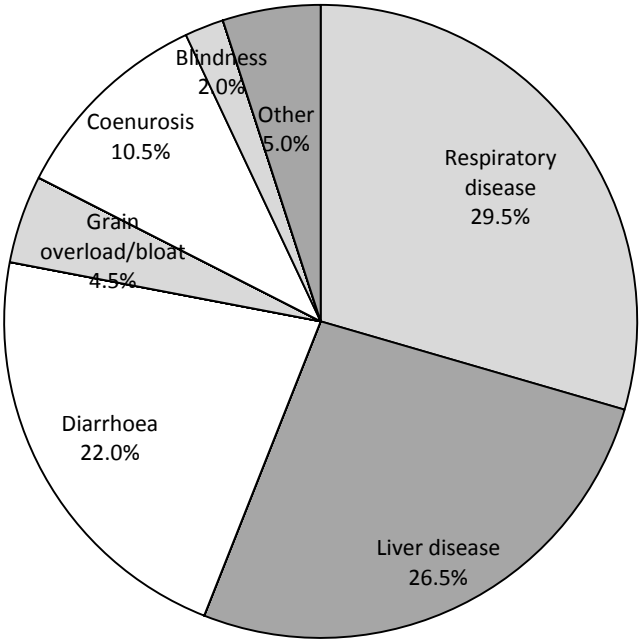


Annex 6: Percentage of annual sheep morbidity attributed to different diseases at individual study areas

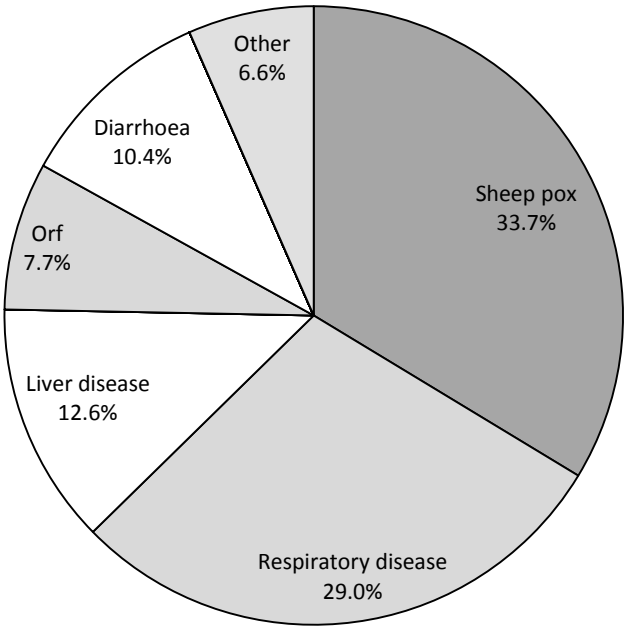




Horro

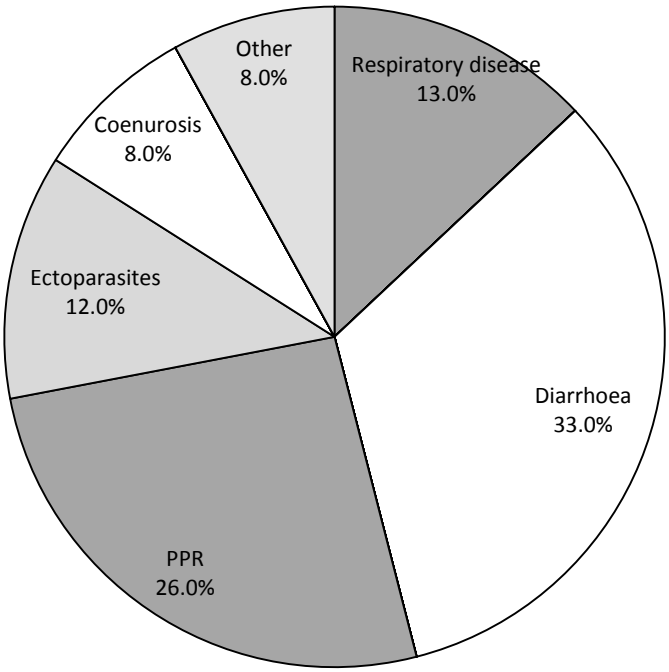

Blindness
2.0%
Other
5.0%
Coenurosis
10.5%
Respiratory
disease
29.5%
Grain
overload/bloat
4.5%
Diarrhoea
22.0%
Liver disease
26.5%

Menz

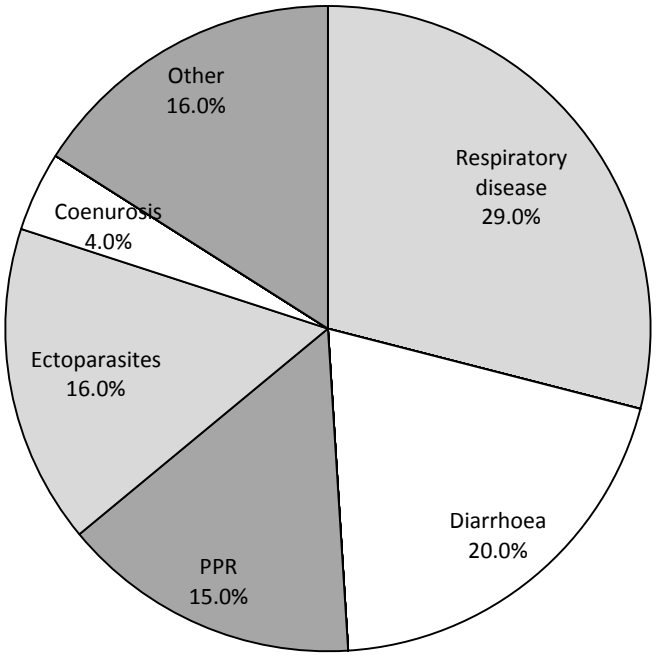

Other
6.6%
Diarrhoea
10.4%
Sheep pox
33.7%
Orf
7.7%
Liver disease
12.6%
Respiratory disease
29.0%

Annex 7: Percentage of annual goat morbidity attributed to different diseases at individual study areas

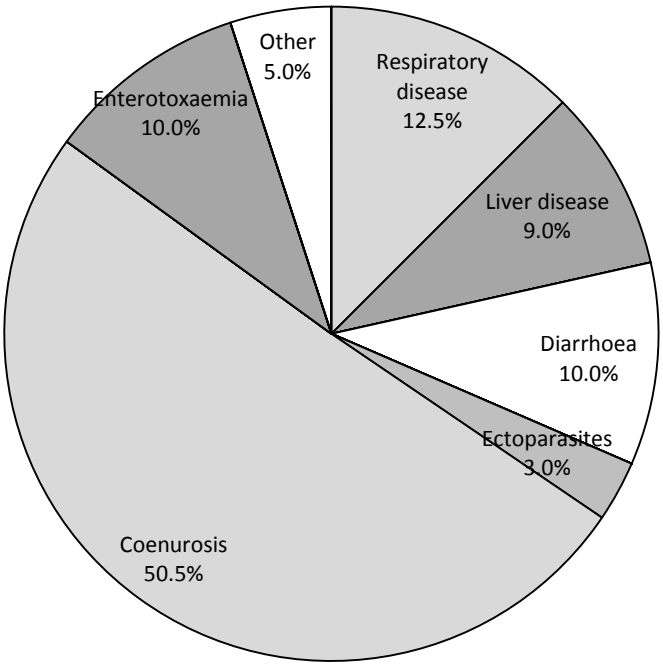
Abergelle Amhara



Abergelle Tigray



Borena



Shinelle