# Review of goat research and development projects in Ethiopia

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ILRI PROJECT REPORT

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# Acronyms

| | |
|---|---|
| AFK | Age at first kidding |
| CCPP | Contagious caprine leuropneumonia |
| CSA | Central Statistical Authority |
| DNA | Deoxyribonucleic Acid |
| EIAR | Ethiopian Institute of Agricultural Research |
| IAR | Institute of Agricultural Research |
| IBC | Institute of Biodiversity Conservation |
| ESGPIP | Ethiopia Sheep and Goat Productivity Improvement Program |
| FAO | Food and Agriculture Organization of the United Nations |
| ICARDA | International Center for Agricultural Research in the Dry Areas |
| ILCA | International Livestock Center for Africa |
| ILRI | International Livestock Research Institute |
| KI | Kidding interval |
| LSB | Litter size at birth |
| LSW | Litter size at weaning |
| LWB | Litter weight at birth |
| LWW | Litter weight at weaning |
| PPR | Pest des petit ruminants |
| SNPs | Single Nucleotide Polymorphisms |
| SSR | Simple Sequence Repeat |

# Executive summary

Goat production in Ethiopia contributes significantly to national export earnings and the livelihoods of producers, especially poor rural households. Across the whole country, goats provide meat, milk, cash, skins, manure and security (insurance), as well as banking and gifts (Adane and Girma 2008).

The total goat population of Ethiopia has increased by 30% in the last 12 years. Goats comprise 5.32% of the total tropical livestock units of Ethiopia, contribute an estimated 12 to 14% of meat products, 10.5% of milk production and 6% of all animals exported (http://borlaug.tamu.edu/2011/08/22/ethiopias-meat-and-live-animal-export-sps-lmm/).

While the socio-economic importance of goats is widely recognized, their full potential contribution to poverty reduction and food security is constrained by inefficiencies at all levels of the production process.

The input side is constrained by poor feeds, animal health and inferior genotypes, while the lack of standardized marketing systems and infrastructure to access markets impede the output side.

Priority areas of research attention include improving product quality for export and domestic markets, supporting commercialization of production, improving our understanding of goat genetic resources, improving the efficiency of procurement and utilization of feeds, reducing kid mortality rates, and developing standardized marketing systems.

# Introduction

Ethiopia is home, excluding some pastoral areas of Afar and Somali regions, to approximately 24 million goats (CSA 2013). Though the population density of goats in mid- and low-altitude areas is high, they are produced across the country from the arid lowlands to the coolest highland areas.

Goats are amongst the commonest farm animal species which sustain the livelihoods of smallholder farmers, pastoralists and agropastoralists alike. They fulfil various functions such as generating cash income, serving as household security, accumulating capital, and fulfilling cultural obligations (Workneh and Peacock 1993; Workneh 2000; Grum 2010; Dhaba et al. 2012; Feki 2013).

Compared to other ruminants, goats possess unique abilities to adapt to harsh tropical environments and are closely associated with resource-poor households often found in marginal and harsh environments. As such, investments in improving goat productivity can contribute to livelihood systems and the food security of producers in equitable ways (poor rural households also benefit).

Goats are also a source of other non-food products such as skin and manure. No recognized use of fibre has been reported from Ethiopian goats though some goat breeds (e.g. Arsi-Bale goats of Bale highlands) are known to have long hair. Goats also significantly contribute to the live animal and meat export trade.

Total goat numbers have continued to increase over the past 12 years. They play an important role in smallholder mixed, agropastoral and pastoral production systems due to their low initial capital investment, ability to produce multiple products (meat, milk, skin, manure etc.) at low input costs, high rates of reproduction (multiple births are not uncommon), and high turnover rates due to the short time they take to attain maturity.

In the arid lowlands where nomadic pastoralism predominates, goats are among the main livestock species produced. Goats are also an integral part of highland farming systems. The growing demand for meat from small ruminants, improving infrastructure (transport and information technology), and improvement in small ruminant husbandry techniques among producers provide opportunities to enhance the contribution of goats (and sheep), to smallholder farmers' livelihoods (Getahun 2008).

The current contribution of goats to the country's economy and producers' livelihoods is however still below the total potential production capacity (Girma et al. 2000). Given the large population size with diverse breeds and their wide distribution across various agro-ecological zones and production systems, there is a huge potential to utilize goats to raise the socio-economic status of producers by improving goat productivity. First however, some key limiting constraints need to be tackled through various research and development interventions.

This report reviews past and present goat research and development activities in Ethiopia, drawing key lessons, identifying key constraints and opportunities, and suggesting research and development interventions to improve goat production and productivity.

Table 1. Goat production systems in Ethiopia

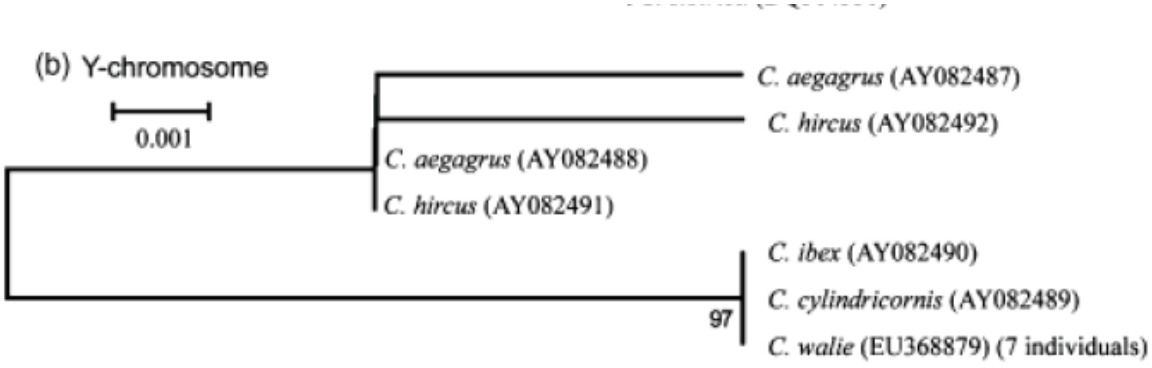
| Production system | Description | Distribution |
|---|---|---|
| Mixed crop and livestock | Crop-based mixed farming systems often comprise some goats, with very small flock sizes, as a way to generate cash and produce meat (Tesfaye 2004). With increases in human population, declining land holdings and shrinking grazing land, the relative importance and population of goat in these systems is increasing (Workneh 2000). Milk production from goats is important in some mixed crop–livestock and pastoral areas (Takyi 2008) along with kid growth which increases income from sale of animals<br><br>Major feed sources include natural pastures, crop residues, industrial by-products, and tree legumes in cut and carry system (Kidus 2010, Dereje 2011; Dhaba et al. 2012; Tegegne 2012). In some areas, grazing is under tethering (Workneh 2000; Kidus 2010) while in others it is either free or herded and goats graze and browse on communal land (Deribe 2009; Tegegne 2012). Water availability doesn't appear to limit production in most areas under this production system<br><br>In most cases, goats are housed with the family (Endeshaw 2007; Deribe 2009; Kidus 2010) or in separate housing (Belete 2009; Kidus 2010; Dhaba et al. 2012) | Highlands and mid-altitude areas |
| Pastoral and agropastoral | Most goats are kept under extensive systems in the Ethiopian lowlands where the main production system is pastoral or agropastoral. Here, goats, with camels, are important to the livelihoods of their keepers. Flock sizes can be very large (>150 in some pastoral and agropastoral areas (Workneh and Peacock 1993; Grum 2010; Feki 2013). Feeding is predominantly on rangeland-based pastoral systems, with periodic use of crop residues in agropastoral areas. Water availability is usually a limiting factor (Grum 2010), with more adapted breeds such as the Short and long-eared Somali breeds requiring less frequent watering. Thorny enclosures are common in pastoral areas with pens made for the kids (Grum 2010). There are growing opportunities to increase production and productivity driven by expanding live animal and meat export markets and demand from the Middle East<br><br>Lowland and some mid-altitude areas | |
| Urban and peri-urban | Despite there being goat production in towns all over the country this system has received little research attention. No reliable quantitative data is available on urban and peri-urban goat production but it is not uncommon to observe sheep and goats in urban areas including the capital Addis Ababa (Solomon et al. 2008). With the expansion of khat (*Cata edulis*) in almost all parts of the country, goats frequently serve as 'cleaners' of the left overs<br><br>The population and contribution of goats in urban and peri-urban areas needs to be quantified and associated value chains studied. The environmental impacts of these production systems also need to be investigated | Urban and peri-urban areas |

# Origin of goats in Ethiopia

Archaeological evidence shows that goats were one of the first animals to be domesticated, around 10,000 years ago, most probably in both the Southern Zagros /Central Iranian Plateau, and in Eastern Anatolia (Naderi et al. 2007). It is unclear when goats were first introduced to Ethiopia; they appeared in East Africa by 4000–3500 years BP (Marshall 2000).

The origin of Ethiopian goats has not been investigated. However, it is likely that their origin is similar to goats found elsewhere in the world, for which archaeological studies suggest that the domestic goat (*Capra hircus*) was domesticated from the Bezoar, *C. aegagrus* (Naderi et al. 2007). This origin was confirmed by genetic studies based on mitochondrial (Takada et al. 1997; Manceau et al. 1999) and nuclear DNA (Pidancier et al. 2006). Despite anecdotal information, there is no scientific evidence of any genetic introgression or reproductive compatibility with *C. walie* (walia ibex) which is endemic in the northern Ethiopian highlands.

Figure 1. Position of *Capra hircus* in relation to *C. aegagrus* and other related species.




Source: Gebremedihin et al. (2009).

# Goat research activities in Ethiopia

In Ethiopia, research on goats was started in the mid-1970s as part of the small ruminant research program (Aschalew et al. 2000) implemented nationally by the Institute of Agricultural Research (IAR; now the Ethiopian Institute of Agricultural Research, EIAR).

Since 1988, some research projects were also undertaken at Haramaya and Hawassa universities with the Ministry of Agriculture (MoA) and various non-governmental organizations like FARM Africa and Agri-service Ethiopia. Between 2006 and 2011, a nationwide project was implemented by several institutions (higher learning institutions, research institutions and agricultural development offices) as part of the Ethiopian Sheep and Goat Productivity and Improvement Program (ESGPIP) with USAID funding. Most research in the early years aimed to characterize and evaluate the performance of a limited number of indigenous breeds (Appendix 1).

Research on Arsi-Bale and Boran goats at the Adami Tulu Research Center was the longest-running project on goats in Ethiopia, running for more than 15 years from 1992. Phenotypic characterization of Ethiopian and Eritrean goats was a major output of Farm Africa's Dairy Goat Development Project (FARM Africa 1996). The comprehensive approach of the study, the robustness of the analytical methodology and the dissemination of the findings has since been a benchmark for similar studies in other livestock species (e.g. Workneh et al. 2003).

Compared to sheep, very few management (mainly nutrition) and production related research projects have been undertaken with goats. However, several on-farm research studies describing production systems have been undertaken (Tolera 1998; Endeshaw 2007; Getahun 2008; Belete 2009; Dereje 2011; Gurmesa et al. 2011; Assen and Aklilu 2012; Dhaba et al. 2012). In addition to production systems, other studies (Workneh 1992; Alemayehu 1993; Nigatu 1994; Getnet 2001; Tegegne 2012) also phenotypically characterized goat populations in their study areas.

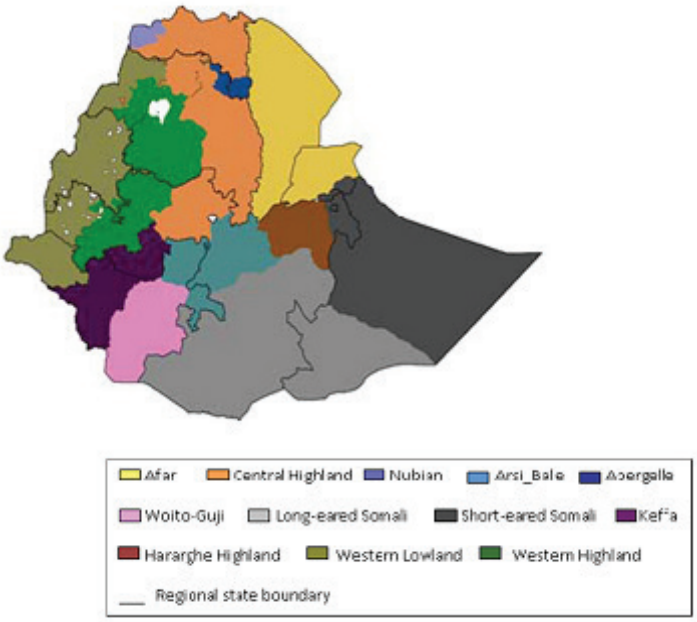
## Phenotypic characterization

Indigenous goat breeds/types are widely distributed and are found in all agro-ecologies of Ethiopia and it appears they have evolved through a process of natural selection (Galal 2005) that favoured adaptation and survival rather than production.

A comprehensive phenotypic characterization of Ethiopian goats was done by Farm Africa (FARM Africa 1996) classifying indigenous goats based on their geographic location and the ethnic communities who keep them. Based on the analysis of morphological data (Workneh 1992; Alemayehu 1993; Nigatu 1994) along with geographic distribution, fourteen distinct goat populations were identified across Ethiopia and Eritrea (FARM Africa 1996).

These were categorized into four major families including the Nubian (Nubian, Barka), Rift valley (Worre, Afar, Abergelle, Arsi-Bale, Woyto-Guji), Somali (Hararghe highland, short-eared Somali, long-eared Somali) and the small East African (central highland, western Highland, western lowland, Keffa) goat families. Figure 2 shows the distribution of 12 Ethiopian goat populations (excluding Barka and Worre) which were defined based on morphological data.

Figure 2. Geographical distribution of goat types of Ethiopia.




Source: ESGPIP (2009).

Barka and Worre goats occur in Eritrea and their related ecotypes (e.g. Begait and Abergelle goats) are found in adjoining areas of Ethiopia.

Additional phenotypic characterization has been done for goats found in Benishangul Gumuz national regional state, Getnet et al. (2005), in Amhara region, Halima et al. (2012a) and in Bench Maji zone in southwestern Ethiopia, Tegegne (2012).

Getnet et al. (2005) identified five morphologically different goat types, namely: Felata, Arab, Gumuz, Oromo and Agew. Felata, Arab and Gumuz goats predominate in semi-arid zones while Agew and Oromo goats are found in subhumid zones of the region.

Halima et al. (2012a) identified six morphologically distinct indigenous goat populations in the Amhara region, namely: Gumuz, Begia-Medir, Agew, Bati, Central Abergelle and Abergelle. Gumuz and Agew were distributed in both Amhara and Benishangul Gumuz regions. The authors indicated the presence of clear morphological variations between and within these goat ecotypes in terms of coat colour, head profile, horn orientation, ear form and head shape. However, molecular characterization on the same six goat populations (Halima et al. 2012b) shows that about 95% of the variation is represented within populations indicating the presence of low genetic sub-differentiation among the goat populations.

In the southwestern part of Ethiopia, Tegegne (2012) defined two goat ecotypes: Meanit and Sheko which are most likely ecotypes of Keffa goats previously characterized in the adjoining area.

In summary, different researchers have used different terms (breed, population, ecotypes, type) to describe different phenotypic variants of goats, leading to a lack of clarity in the distinctions between breeds, populations and ecotypes.

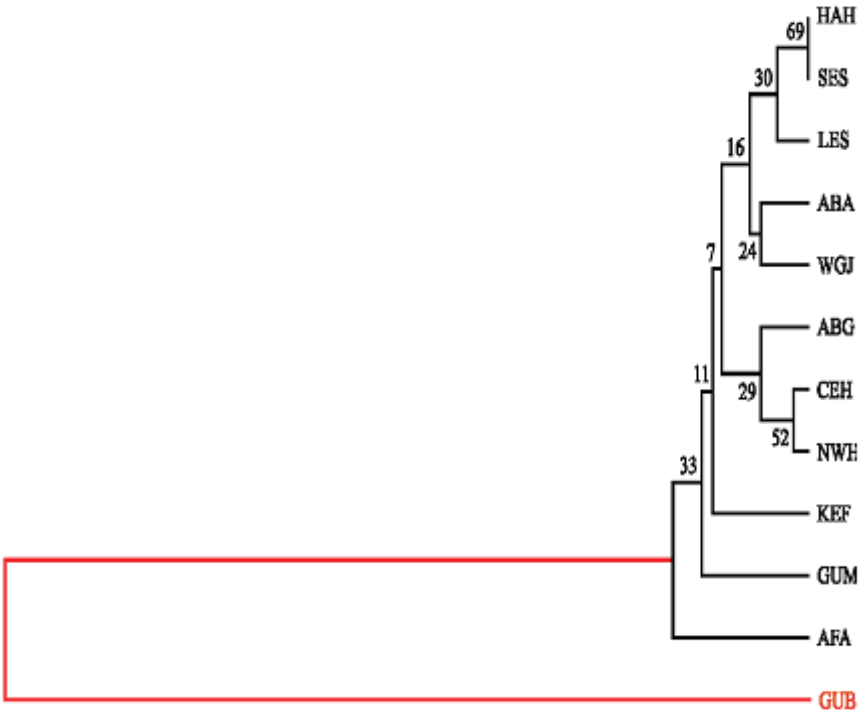
# Molecular characterization

Ethiopian indigenous goats have also been characterized using protein polymorphisms (Addisu et al. 2002) and microsatellite genetic markers (Tesfaye 2004; Halima et al. 2012b).

In the study by Addisu et al. (2002) four indigenous (Afar, Hararghe highland, western highland and western lowland), two exotic breeds (Toggenburg and Anglo-Nubian) and three crossbred populations (crosses between the exotic breeds and Hararghe highland and Somali goat types) were studied. The study revealed high genetic variation between populations and close genetic relationship (low genetic variation) within populations.

In the study by Tesfaye (2004), 11 goat populations were characterized using 15 microsatellite markers. These were categorized into 8 genetic clusters namely: Arsi-Bale, Gumuz (Gumuz), Keffa, Woyto-Guji, Abergelle, Afar, highland (previously classified as Central and Northwest Highland by Farm Africa), and eastern and southeastern goats (previously classified as Hararghe Highland, short-eared Somali, long-eared Somali by Farm Africa)—see Figure 3. The study also showed that about 75% of the total genetic diversity of Ethiopian goats is present in four breeds: Afar (24.32%), Abergelle (19.22%), Gumuz (16.59%) and Keffa (12.99%).

Figure 3. UPGMA tree representing the genetic relationship between the 11 Ethiopian populations with GUB as an out-group population.




Note: ABG: Abergelle, ABA: Arsi-Bale, AFA: Afar, CEH: Central Highland, GUM: Gumuz, HAH: Hararghe highland, KEF: Keffa, LES: Long-eared Somali, NWH: North-West highland, SES: Short-eared Somali, WGJ: Woito-Guji, GUB: Guinea Bissau.

Adapted from Tesfaye (2004).

The study by Halima et al. (2012b) focused on six goat ecotypes (Gumuz, Begia-Medir, Agew, Bati, Central Abergelle and Abergelle) found in the northern and northwestern regions. These were clustered into two genetic groups using molecular characterization. The Tesfaye (2004) and Halima et al. (2012b) studies were based on 15 microsatellite markers, from the 30 markers recommended by the FAO/ISAG working group on livestock genetic diversity for use in goats.

If all 30 markers were used, this would not only yield more accurate data, but also offers opportunity for comparative analysis with other studies that have used similar set of markers (FAO 2011). Additionally mitochondrial DNA, Y-chromosome haplotypes, or dense marker panels of single nucleotide polymorphisms (SNPs) can provide additional information on genetic distance and phylogenetics. Such information can be important input to decisions on conservation (e.g. priority setting based on marginal loss of diversity) and cataloguing (important in cases of biopiracy).

# Genetic parameter estimates

Genetic improvement of any livestock species requires an accurate estimation of inherent phenotypic and additive genetic variability within and between populations/breeds. The magnitude of variations within and between populations and levels of expected heterosis determine whether selection or crossbreeding would be the method of choice for genetic improvement. Decisions with regard to methods of genetic improvement are required in designing and implementing genetic improvement programs (e.g. setting breeding objectives and defining goals, and deciding on the breeding strategies).

Compared to sheep, genetic parameter estimates for most Ethiopian goat breeds/populations are lacking, due to the absence of pedigree and performance data. The only exception is Arsi-Bale goats whose genetic parameters have been estimated mainly for reproductive and milk production traits (Table 2). For reproductive traits, maternal heritability estimates were close to zero and had very high standard error.

Table 2. Genetic parameter estimates for various traits in Arsi-Bale goats

| Trait | Direct heritability | Maternal heritability | Sources |
|---|---|---|---|
| Age at first kidding | 0.245 ± 0.19 | – | Tesfaye et al. (2012) |
| Kidding interval | 0.245 ± 0.19 | – | Tesfaye et al. (2012) |
| Litter size at birth | 0.074 ± 0.05 | – | Tesfaye et al. (2012) |
| Litter size at weaning | 0.006 ± 0.05 | – | Tesfaye et al. (2012) |
| Litter weight at birth | 0.125 ± 0.05, | – | Tesfaye et al. (2012) |
| Litter weight at weaning | 0.053 ± 0.07 | – | Tesfaye et al. (2012) |
| Survival to weaning | 0.08 ± 0.05 | – | Tesfaye et al. (2012) |
| Lactation length | 0.00 to 0.03 | 0.03 ± 0.15 | Mohammed et al. (2012) |
| Lactation milk yield | 0.00 to 0.069 | 0.22 ± 0.12 | Mohammed et al. (2012) |
| Daily milk yield | 0.02 to 0.071 | 0.26 ± 0.12 | Mohammed et al. (2012) |

Genetic correlation estimates varied from –0.43 ± 0.11 between age at first kidding (AFK) and kidding interval (KI) to 0.99 ± 0.09 between litter size at weaning (LSW) and litter weight at weaning (LWW). Some of the heritability estimates and the genetic and phenotypic correlations between the traits were medium and with low standard errors and can therefore be used in selective breeding (e.g. litter weight at birth). In the other cases, estimates were low and had high standard error so are of little practical value.

# Goat development activities in Ethiopia

Goat development work has also been limited in scope, although some of the research mentioned above does involve some development work. These include the distribution of pure indigenous or crossbred does or bucks to rural women and households, establishment of marketing infrastructure in some pastoral areas that supply goats for export or to abattoirs, and the Boer goat breeding program of ESGPIP which distributed crossbred Boer bucks in Afar, Amhara, Oromia, Southern, Somali and Tigray regions. The socio-economic impact of pure and crossbred goats in the Hararghe highlands was subject of study in several research projects (Habtemariam et al. 2000; Workneh 2000; Teressa 2004).

Development interventions were mainly focused on improving milk production and growth rates through crossbreeding. However, despite better performance of crossbreds over the indigenous breeds under on-station conditions, such superiority was not replicated under village conditions. The adoption rates of crossbred genotypes by farmers was found to be very low, in some cases as low as 20% with most of the adopters being better-off households rather than poor farmers (see Teressa 2004).

Most of the implemented projects lacked functional institutional synergies and exit strategies. In comparison to indigenous breeds, the crossbreds were not profitable, under village conditions especially, when returns per unit liveweight or metabolic weight were taken into account (Workneh 2000).

Some of the projects lacked clear targets aligned to the production environments and farmers objectives, for example the IAR-led goat crossbreeding projects at Werer and Holetta research centres. The crossbreeding at Werer was between the Afar goats (local) and Saanen goats (exotic) while at Holetta, highland goats were crossed with Saanen animals. At Werer, arid and semi-arid environments were targeted which resulted in poor adaptation of the crossbreds to the environment. On the other hand, Holetta is a cool highland where goats are not an important livestock species, hence focusing on goat development was ill-conceived.

As in many other crossbreeding projects in Africa, the difficulty of maintaining a constant supply of purebred exotic breeds and shortages of improved stock (Tefera 2000) impinged on the long-term sustainability of the various projects. No attempts were made to develop stable synthetic breeds.

# Research on traditional goat breeding practices

Several studies have shown that goat keepers have developed their own breeding practices which include selection of bucks (Grum 2010) or does (Tegegne 2012) that are used either in controlled (Grum 2010) or uncontrolled (Tesfaye et al. 2012) mating systems. Some studies, however, indicated absence of selection in these approaches (Samuel 2005; Tsedeke 2007; Dereje 2011).

Where selection is practiced, the criteria used are based on maternal (ancestral) history, production performance appraisal and some other traditional systems (Table 3). About 90.8% of Short-eared Somali goat keepers in Dire Dawa select their breeding stock based on maternal history (Grum 2010; Feki 2013). In the Central Rift Valley area however, both subjective and objective selection criteria are used with more emphasis placed on morphological traits of bucks (Tesfaye et al. 2012a).

Table 3. Farmer election criteria in traditional goat breeding

| Breeds | Major selection criteria/traits of interest | Sex selected | Production system | Sources |
|---|---|---|---|---|
| Afar | Family history (progeny of superior sire and high milk producing doe), large body size, conformation; coat colour | Males and females, with emphasis on males | Pastoral and agropastoral | Feki 2013. |
| Meanit and Sheko (Keffa) goats | Females: Twinning ability, kid growth, mothering ability and body size;<br>Males: body size, pedigree and growth rates | Males and females, with emphasis on females | Mixed crop–livestock and agropastoral | Tegegne 2012 |
| Hararghe highland goats | Males: Body conformation (appearance), coat colour, pedigree of breeding bucks, fast growth and polledness;<br>Females: Body conformation (appearance), milk yield, twinning ability, coat colour, kidding interval and mothering ability | Males and females | Mixed crop–livestock | Dereje 2011 |
| Small-eared Somali (Issa) goats | Females: mothering ability, milk yield, short kidding interval, adaptive traits, grazing ability, drought tolerance, disease resistance and trekking ability;<br>Males: body size, maternal history, coat colour, polledness, body condition and size | Males and females | Pastoral and agropastoral | Grum 2010 |
| Arsi-Bale goats | Females: milk production, family history, twinning ability, dhaaba*, mothering ability, kid growth rate, coat colour and kidding interval;<br>Males: Dhaaba*, coat colour, family history, testicular characteristics, libido, growth rate, prolificacy and disposition/ character | Males and females, with emphasis on males | Mixed crop–livestock | Tesfaye et al. 2012b |

* *Dhaaba* refers to physical characteristics such as size, conformation, leg length, ear and horn which influence prices in traditional markets.

Farmers in Bench Maji zone give more focus to the selection of females (e.g. twinning rate) (Tegegne 2012). In the traditional breeding systems, despite efforts to select superior does and bucks based on pedigree and individual animal performance, it is difficult to realize appreciable genetic gain because of the multiple objectives of farmers, inadequate control of mating and lack of written records to evaluate genetic superiority. It may be important to strengthen such traditional breeding systems with emphasis on a few traits that have been prioritized by farmers coupled with controlled mating and performance recording.

A few studies have revealed slightly higher levels of inbreeding in indigenous Ethiopian goat breeds (Table 4). However, in pastoral and agropastoral areas where flock sizes are large, rates of inbreeding are comparatively low (Grum 2010). Estimates based on molecular genetic data indicated significant levels of inbreeding (though not much higher than the threshold level of 0.063 (Armstrong 2006) even in areas where large flock sizes are common (Tesfaye 2004). However, closed flocks were assumed in all estimates of rate of inbreeding which may not necessarily be the

case since flock mixing is common and therefore the rate of inbreeding may be lower than the magnitude indicated in the reports.

Table 4. Estimated rate of inbreeding in indigenous Ethiopian goat breeds

| Trait | Direct heritability | Maternal heritability | Sources |
|---|---|---|---|
| Age at first kidding | 0.245 ± 0.19 | – | Tesfaye et al. (2012) |
| Kidding interval | 0.245 ± 0.19 | – | Tesfaye et al. (2012) |
| Litter size at birth | 0.074 ± 0.05 | – | Tesfaye et al. (2012) |
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# Performance evaluations

Growth performance, meat production and off-take rates

Substantial information on growth performance of indigenous and crossbred goats has been published and is summarized in Table 5. Meat production and carcass traits have also been studied (Beniam et al. 1983; Addisu 2001; Addisu et al. 2002; Simret 2005; Sebsibie 2006; Ameha et al. 2007).

**Table 5.** Growth performance and meat production of indigenous and crossbred goats

| Breed | Birth weight (kg) | | Weaning weight(kg) | | Yearling weight(kg) | | Type of study | Sources |
|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female | | |
| Boran Somali | 2.28 ± 0.54 (na) | 2.36 ± 0.51 (na) | 7.38 ± 1.8 (na) | 6.89 ± 1.2 (na) | 13.38 ± 3.4 (na) | 12.68 ± 1.9 (na) | On-station | Tesfaye et al. 2000 |
| Mid Rift Valley | 2 | 1 | 7.46 ± 1.85 (na) | 6.32 ± 2.77 (na) | 13.93 ± 2.72(na) | 11.76 ± 1.87(na) | | Tesfaye et al. 2000 |
| Arsi-Bale | 2.32 ± 0.05 (158) | 2.25 ± 0.05 (166) | 8.48 ± 0.26 (158) | 8.08 ± 0.2 (166) | | | On-farm | Tatek et al. 2004 |
| Arsi-Bale | | | 7.8 ± 0.1 (163) | 7.0 ± 0.1 (189) | 15.5 ± 0.3 (92) | 13.2 ± 0.2 (123) | On-station | Takele et al. 2006 |
| Somali × Anglo-Nubian | 3.2 | | | | | | On-station | Neugebauer et al. 1993 |

* Figures in parenthesis indicate the number of observations; (na) = not available.

Generally, the growth rate of goats under traditional management systems is low. However, there is much potential for indigenous goats to be produced for meat with improved nutrition (Ameha et al. 2007). Dressing percentages ranging from 42.5 to 44.6% were reported for Long-eared Somali, Central Highland and Afar goat breeds (Ameha et al. 2007). Preliminary results from on-station research show that crossbreds between indigenous (dam) and Boer (sire) goats grow faster than purebred indigenous goats. However, similar performance evaluation under on-farm conditions has not been undertaken in addition to overall performance of other production and reproductive traits.

Annual goat off-take rates differ depending on the production systems. Off-take rates of 12.8% (Tsedeke 2007) and 35.5% (Belete 2009) have been reported for mixed crop–livestock production systems while off-takes of up to 37% have been reported for pastoral and agropastoral systems (Grum 2010). Much lower (8%) (Workneh 2000) and higher (91%) rates (Getahun 2008) have been reported for mixed production systems.

# Milk production

Goats are also utilized for milk production by many producers in most pastoral and some crop–livestock production system areas. Several studies have sought to quantify the milk production potential of indigenous goats (Galal and Getachew 1977; Workneh and Peacock 1993; Tadelle 2008; Bishaw 2009); the effects of various interventions such as nutrition and crossbreeding on milk production (Kassahun et al. 1989; Fekede and Girma 2000; Lemma et al. 2003; Taye et al. 2009; Dereje 2011; Mestawet et al. 2012), as well as milk keeping quality and processing (Eyasu 1998; Fekadu and Eyasu 2000).

Milk production figures for some goats are summarized in Table 6. Generally, milk production varies within and between breeds. However, most goats produce enough milk for their off-spring with, at times, extra production going to meet household needs, especially consumption by children (Grum 2010).

Table 6. Milk production of some indigenous and exotic goats in Ethiopia

| Goat type/breed | Daily milk yield (litres or kg) | Lactation milk yield (litres or kg) | Lactation length | Type of production system | Sources |
|---|---|---|---|---|---|
| Afar | | 24 | 84 days | On-station | Kassahun et al. 1989 |
| Sannen × Afar | | 31 | 84 days | On-station | Kassahun et al. 1989 |
| Highland goats | | 19 | 84 days | On-station | Galal and Getachew 1977 |
| Somali goats | 0.97 (na) | 40.6 (na) | 42 days (na) | On-station | Neugebauer et al. 1993 |
| Anglo-Nubian | 2.98 (na) | 125.3 (na) | 42 days (na) | On-station | Neugebauer et al. 1993 |
| Boran-Somali goats | 0.37 ± 0.2 (na) | 41 (na) | 30.9 ± 8.8 days (na) | On-station (na) | Tesfaye et al. 2000 |
| Mid-rift valley goats | 0.42 ± 0.12 (na) | | 34.9 ± 8.8 days (na) | On-station (na) | Tesfaye et al. 2000 |
| Boer goats | 1.41 (9) | | | On-station | Mestawet et al. 2012 |
| Arsi-Bale | 1.13 (11) | | | On-station | Mestawet et al. 2012 |
| Toggenburg × Arsi-Bale | 0.93 (11) | | | On-station | Mestawet et al. 2012 |
| Somali | 0.85 (17) | | | On-station | Mestawet et al. 2012 |
| Arsi-Bale | 0.21 (227) | 17.73(227) | 86(227) days | On-station | Mohamed et al. 2012 |
| Hararghe highland | 0.4 ± 0.2 (na) | | 3.6 ± 1.4 month (na) | Mixed crop livestock | Dereje 2011 |
| Unidentified | 0.53 ± 0.32 (na) | | 2.7 ± 1.9 month (na) | Pastoral and agropastoral | Tolera and Aster 2007 |
| Unidentified | 0.151 ± 0.056 (257) | | 2.9 month (257) | Mixed crop livestock | Deribe 2009 |
| Boran (long-eared Somali) | 0.37 ± 0.015 (8)–0.48 ± 0.020 (8) | | 84 days | On-station | Lemma et al. 2003 |
| Somali goats | 0.92 ± 0.12 (5)–1.53 ± 0.14 (5) | | | On-station | Getnet et al. 1999 |
| Somali goats | 0.5-0.8 (na) | | 16 weeks | On-station | Fekede and Girma 2000 |
| Arsi-Bale | 0.296 (na) | 21.7 | 83.4 days | Mixed crop livestock | Tatek et al 2004 |

(na) = not available.

# Reproductive performance

One point on-farm surveys (Getnet 2001; Endeshaw 2007; Tsedeke 2007; Tegegne 2012), and long-term monitoring (Tatek et al. 2004; Getahun 2008; Siegmund-Shultze et al. 2009), and on-station research (Galal and Awgichew 1981; Tesfaye et al. 2000; Berhane and Eilk 2006; Yosef 2007; Dadi et al. 2008; Mahlet 2008) have generated a lot of information on the reproductive performance of Ethiopian indigenous goats (Table 7).

Table 7. Reproductive performance of indigenous goats

| Breed | Age at first kidding (AFK) | Kidding interval (KI) | Litter size | Production system | |
|---|---|---|---|---|---|
| Arsi-Bale | | 8.07 (na) months | 1.21 (na) | Mixed crop–livestock | Tatek et al. 2004 |
| Arsi-Bale | 28.46 ± 13 months (203) | 293.18 ± 106 (196) days | 1.64 ± 0.58 (448) | On-station | Dadi et al. 2008 |
| Arsi-Bale | 441.3 ± 4.2 days (542) | 232.2 ± 3 days (1300) | 1.65 ± 0.02 (1837) | Mixed crop–livestock | Tesfaye 2009 |
| Woito-Guji | 14.9 (120) | 8.6 (120) months | 2.07 (120) | Mixed crop–livestock | Endeshaw 2007 |
| Short-eared Somali (Issa) goats | 19.9 ± 7.93 (na) | 6.1 ± 1.09 (na) months | 1.06 (na) | Pastoral; agropastoral; mixed crop–livestock | Grum 2010 |

Figures in parenthesis refer to number of observations. Na = not available.

Age at puberty ranges from 7 to 15 months, while age at first kidding (AFK) ranges between 12 and 20 months. The average number of kids born (NKB) ranges between 1.06 and 1.75 with a kidding interval (KI) between 6 and 8 months. With the exception of KI and average NKB, the highest values for most reproductive traits were observed in goats from arid and semi-arid areas. The low NKB in goats from arid and semi-arid areas (Grum 2010) is likely an adaptation to feed and water scarcity. The reproductive performance of indigenous goats is fairly good and in the short-term, this trait may not be a priority for intervention and efforts at genetic improvement through breeding can be directed to production traits.

# Goat skins

Goat skins are a significant component of the overall value of saleable goat products. With an estimated national annual goat off-take of 35% (Belete 2009) about 8 million goat skins are produced in Ethiopia yearly. Goat skins are raw products for local tanneries and are also traded and exported as raw or tanned leather. Dereje and Tesfaye (2009) indicated that not all goat skins are marketed. Indeed, less than three-quarters of the skins are marketed due to various reasons, including inaccessibility, poor handling and storage (Girma 2003).

Indigenous Ethiopian goats produce quality premium skins. Worldwide, the skin of Bati goats is renowned for its high quality (Mahmud 2000). The skin is thicker, highly flexible and with clean inner surfaces, and excellent for producing high quality suede leather (Mahmud 2000). However, ectoparasite damage, improper flaying and poor preservation lower the quality and value of the skins. Skins from crossbred goats have lower tensile strength, poor tear resistance and percentage elongation capacity (Seid 2011) and are thus of poor quality. Inclusion of skin quality among selection criteria (breeding goal) in goat improvement programs needs to be considered along with other production traits.

# Goat diseases and health service delivery system

Major diseases of goats in Ethiopia include anthrax, sheep (goat) pox, peste des petits ruminants (PPR), fascioliasis, pasteurellosis and other respiratory diseases.

Typical disease symptoms that have been reported include coughing, sneezing, diarrhoea, bloating, mucus and swollen neck. The most prevalent diseases contributing to heavy mortalities, morbidity wastage and reduced skin quality are respiratory (CCPP), skin (complex skin necrosis, lumpy skin disease) and external parasitic (babesiosis, tick paralysis) diseases (Aklilu 2008; Tesfaye 2009; Grum 2010). In some areas of the South, trypanosomiasis and heart water were identified as important diseases affecting goats (Endeshaw 2007). Internal parasites (e.g. fasciolosis) are also important in humid and subhumid areas or where goats are herded close to wetlands (Endeshaw 2007; Tegegne 2012).

Delivery of animal health services in Ethiopia is mainly through government run clinics distributed across the country. These clinics however lack well-qualified personnel, equipment and drugs.

Efforts are being made to train community animal health workers who, in spite of the shortage of drugs and equipment, are proving to be a sustainable solution to animal health problems (Amare 2004). Animal health service delivery should capitalize on these animal health workers, supporting them with highly trained veterinarians to maintain the quality of service.

Disease surveillance and quarantine should also be strengthened. Mid-level training being provided for agricultural development agents to be placed at grass root level is also a positive development that improves the animal health situation in the country.

# Goat market chains

To stimulate production and productivity, reliable markets are important. Interventions aimed at enhancing the productivity of goats need to also consider market aspects (Andargachew and Brokken 1992).

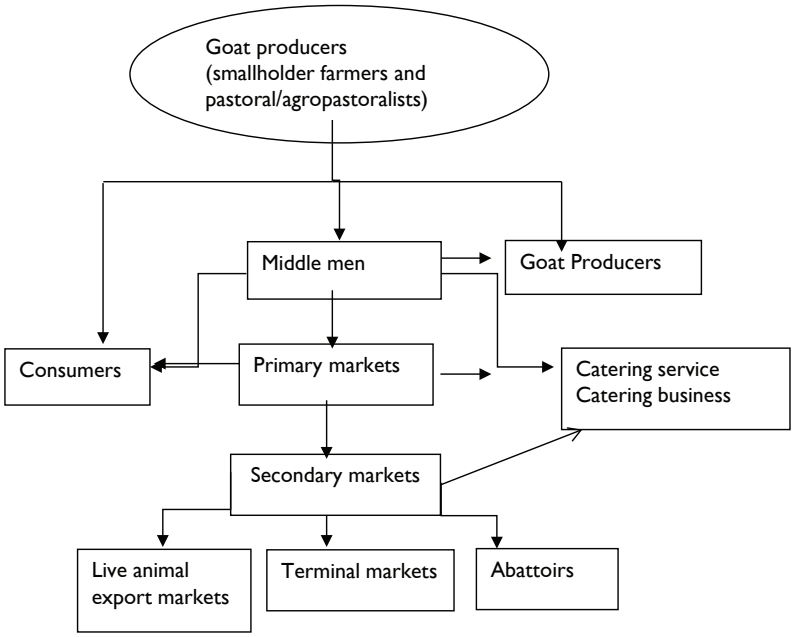
Marketing of goats and their products (e.g. skin, milk) has been the focus of a number of studies (Andargachew and Brokken 1992; Endeshaw 2007; Tsedeke 2007; Asfaw and Jabbar 2008). A high periodic fluctuation in market supply and demand related to periods of religious and public festivals as well as poor access to markets have been identified as the major marketing bottlenecks.

These challenges extend beyond farmers to the national level. The goat value chain has four main tiers (farm gate, local/primary market, secondary market and terminal market—Ayele et al. 2003) with varying actors from one stage to the other (see Figure 4).

Such a system reduces the benefits the primary producers earn. The growing demand for small ruminants in local and international markets (Farmer 2010), improving transportation infrastructure, and the experience of farmers in small ruminant keeping and the potential to grow to market oriented production, are practical opportunities to enhance the contribution of the sector (Getahun 2008). In addition, the increasing number of abattoirs supplying export and domestic markets are expected to play a significant role in improving the market situation (Belete 2009).

Generally the present system of goat production and marketing in Ethiopia is characterized by substantial variations in animal availability, body weights and condition at slaughter, and carcass characteristics. Working towards more market-oriented systems and addressing issues along the whole value chain are receiving attention at both the research and development end.

Figure 4. Goat market chains in Ethiopia.




# Major constraints to goat production

Feed shortage (quantity and quality), diseases, low production/productivity, lack of marketing infrastructure, uncontrolled grazing management, water shortages, and predation have been identified as the major constraints to goat production (Markos 2000; Tsedeke 2007).

Mortality losses are high ranging from an average of 13.3% (Endeshaw 2007) to 14.2% (Belete 2009) and 25.4% (Grum 2010) with the loss exceeding 50% of the flocks in some cases (Grum 2010).

Poor extension support, poor technologies and shortage of inputs, capital and labour are constraints of lesser magnitude (Tsedeke 2007).

For urban and peri-urban production systems, lack of space for housing and feed availability are important constraints (Dinksew and Girma 2000).

Appropriate breeding programs were also lacking limiting long-term genetic improvement of goat production. Interventions targeting these constraints need to be implemented to improve the level of goat productivity both at livestock keepers' and national level.

# Conclusions

Ethiopia possesses a large goat population with diverse breed types that are distributed in all parts of the country.

Albeit to varying degrees, goats are important contributors to the livelihoods of smallholder farmers, pastoralists and agropastoralists. Due to various production constraints, this contribution to livelihoods is not as great as it could be.

As goat production is a largely subsistence occupation of lower-income and food-insecure communities, improved production and associated increases in income and available food (milk and meat) can have a profound impact in reducing poverty and ensuring food security.

This is a compelling reason for goat research and development to get more investment and attention in the development agenda. Additional benefits are the contributions of goats to the export trade (live animal, meat, processed and semiprocessed skin).

Past goat development interventions have been held back by lac of continuity, lack of well-designed and implemented project exit strategies and inadequate positive actions throughout the value chain.

Future efforts need to take these shortcomings into consideration and look to the following.

- Improved management (feeding) has been shown to bring sizeable improvement.
- Better growth and milk production in crossbred animals has been observed on-station than with indigenous goats. Developing appropriate goat management packages and further identification of exotic goat germplasm that can successfully be crossed with indigenous goats and fits local production environments need to be given due emphasis.
- In terms of reproduction, indigenous goats show a remarkable performance.
- Indigenous goat skins are of high quality and they are important products both at farm and national levels. Problems related with skin collection, handling and storage are important areas which need to be addressed.
- The export and growing modern domestic markets require a regular supply of standard meat quality and carcass sizes that meet required sanitary standards. This calls for work in all aspects (health, nutrition, breeding and marketing) of goat research and development.
- If goat production intensifies as expected, appropriate animals need to be bred alongside efficient systems to use feed resources, deliver animal health services and provide well-developed market structures.
- Apart from size and quality, maintaining the genetic resource base and increasing supply of animals requires improvement in animal reproduction and survival. Results so far indicate that reproduction levels in most of the indigenous goats are acceptable (e.g. kidding interval, age at first kidding) but kid survival is a serious problem that needs to be addressed.
- There is a complete lack of any selective breeding program on indigenous goats.

- Available information suggests that for some traits exotic goat breeds in pure form or as crossbreeds result in sizeable improvement to production. The choices of types of exotic germplasm and the modalities of its utilization (in pure or crossbred form at certain blood level and in defined niche areas) should be determined to meet different objectives (milk, meat etc.).

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# Appendix 1. Major goat research projects in Ethiopia

| Period | Project | Objectives | Institutions | Study breeds | Geographic coverage | Main activities | Achievements | Remarks | Sources |
|---|---|---|---|---|---|---|---|---|---|
| 1975–82 | Various management, breed evaluation and improvement studies | Study the production performance of Afar and highland goats and their crosses with Saanen breed | Institute of Agricultural Research | Afar goats, Highland goats, Saanen goats, crosses of Afar/ highland goats with Saanen | Melka Werer in Eastern lowlands and Holleta in the Central highlands | Evaluation of growth and milk production performance of Afar and highland goats and their crosses with Saanen | Introduced quarter breed crosses in lowlands and half breed crosses in the highlands of Ethiopia. However, a general loss in productivity was observed with further increase in exotic blood level | Discontinued before any evaluation had been done on-farm on the disseminated genotypes | Kassahun et al. 1989; Aschalew et al. 2000 |
| 1988–97 | Dairy Goat Development Project | Improve the socio-economic and nutritional status of women and children in the highlands of Ethiopia | FARM Africa, Alemaya University, Awassa College of Agriculture, Ministry of Agriculture | Somali; Hararghe highland; Anglo-Nubian goats | Initiated in Eastern Hararghe and later expanded to southern region | Production of crossbred goats and distribution to women in the highlands of Hararghe and areas surrounding Hawassa | Over 2800 indigenous and 900 F1 crossbred goats were distributed on credit. Private commercial dairy goat producers were established. 15 pure Anglo-Nubian buck stations were set up. Crossbreds produced more milk per animal unit but not per unit body or metabolic weight | Lacked efficient exit strategy** | Habte-Mariam et al. 2000; Workneh 2000 |
| 1992–2013 | Performance evaluation of Arsi-Bale and Boran goats | To characterize the production performance of Arsi-Bale and Boran goats | Adamitulu Research Center, Oromia Agricultural Research Institute | Rift valley (Arsi-Bale) and Boran (Somali) goats | On-station at Adami Tulu | Generated baseline information on production and reproduction performance of on-station flocks | Generated data on reproduction and production performance including estimates of genetic parameters for important traits | | Tesfaye et al. 2000; Takele et al. 2006; Dadi et al. 2008 |

| Period | Project | Objectives | Institutions | Study breeds | Geographic coverage | Main activities | Achievements | Remarks | Sources |
|---|---|---|---|---|---|---|---|---|---|
| 1998*- | Goat Project | To improve family welfare in small scale mixed farming systems by improving the productivity of goats managed by women through increased income and milk consumption | FARM Africa, MOA and NGOs | Somali goats; Arsi-Bale goats, Anglo-Nubian goats | 14 districts of Oromia, SNNPR and Amhara | Established women groups; feed development; distributed local goats on credit; produced and distributed crossbred goats; trained development agents, establishment of buck station | 2809 local and 914 crossbred goats were produced, 15 buck stations were established. The extension work has been a success in bringing attitude changes across government agencies, credit institutions and partner NGO | Limited adoption and skewed to better off farmers | Tefera 2000; Takyi 2008 |
| 1998*- | Collaborative project on Institutional Partnership Development | Food security and income generation through improved goat production and extension services involving women's groups | Alemaya University; Awassa College of Agriculture; Langston University, | Arsi-Bale, Somali and Toggenburg goats | Shebedino and Arsi-Negele areas (around Hawassa); Areas around Haramaya University | Training of academic staff; formation of women's groups and distribution of local goats on credit | Women's groups were successfully established and local goats were distributed | | Girma et al. 2000 |
| 2006–2011 | Ethiopian Sheep and Goat Productivity Improvement program | To sustainably increase the productivity of small ruminants in Ethiopia to improve food and economic security | Ethiopian Institute of Agricultural Research, six regional Agricultural Bureaus; six Regional Agricultural Research Institutes; Hawassa University; Haramaya University; Mekelle University | Crosses of Boer goat and Dorper sheep | Amhara, Oromia, Tigray, Afar, Somali and Southern Nation Nationalities People's regions | Training and enhancing technical services; technology transfer; Genotype improvement and animal health interventions | Sheep and Goat Production Handbook for Ethiopia published; centres for animal multiplication to serve as a source of pure genetic material in the country have been established | Lacked implementation of exit strategy | WWW.ESGPIP.org |

| Period | Project | Objectives | Institutions | Study breeds | Geographic coverage | Main activities | Achievements | Remarks | Sources |
|---|---|---|---|---|---|---|---|---|---|
| 2012–(on-going) | Harnessing genetic diversity for improving goat productivity | Explore goat genetic landscape; strengthen national goat breeding programs; Leverage genetic diversity information; capacity building; information gathering and sharing | LRI-BecA hub; Ethiopian NARS; Institute of Biodiversity Conservation (IBC) | Abergelle, Central highland and Woito-Guji goats | Abergelle (Amhara and Tigray) and Tanqu districts; North Gondar Zone of Amhara region, Konso Special District in SNNPR and Ambo area of Oromia region | Baseline data collection and description of the production system; molecular characterization with high density SNP; definition of breeding goals; assessment of alternative breeding strategies and implementation of a breeding program; Design a community based breeding program | On-going | | |
| 2012–(on-going) | Small Ruminant value chains In Ethiopia | Identify and test 'best bet' interventions for different value chains | ICARDA-ILRI | Abergelle, Woito-Guji, Central highlands, Somali goats | | | | | |

* *Report not available.*
** *An exit strategy has been developed but not implemented.*

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