

Project Report

Integrated interventions for the Small Ruminants value chain transformation in Ethiopia (SmaRT Pack): Community-based small ruminants herd health interventions

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Contents

Tables	iv
Acknowledgements	v
Executive summary	vi
Project background	1
The project areas	2
Herd health interventions	3
Impacts and outcomes of herd health interventions	13
Morbidity and mortality	13
Deworming	13
Ovine pasteurellosis	14
Medical treatments	14
Outputs of the project	16
Key success factors	16
Scalability of herd health interventions	16
Lessons learned	17
Constraints and challenges	17
References	18
List of partners	19

Tables

Table 1. The project sites	2
Table 2. The number of farmers for which the follow up of disease cases at household level was done	3
Table 3. Number of small ruminants vaccinated against ovine pasteurellosis in years	6
Table 4. Number of small ruminants vaccinated against PPR in years	7
Table 5. Number of small ruminants vaccinated against sheep and goat pox in years	7
Table 6. The number of farmers that participated in trainings on the prevention and control of respiratory diseases	8
Table 7. The number of animals dewormed against gastro-intestinal parasites and lung worm per year per site	8
Table 8. The number of farmers trained on the community-based gastro-intestinal parasite and coenurosis control	10
Table 9. The number of men and women farmers trained about the small ruminants' reproductive health management	10

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Executive summary

A three year project named the 'Small Ruminants value chain transformation in Ethiopia' or 'SmaRT Pack' was launched in 2019 to pilot integrated interventions containing animal health, genetics, feed and forage, marketing, environmental management and gender. The planned activities were built on previous intervention packages with a focus on integration of activities. The project was implemented in four CGIAR Research Program on Livestock sites; Bonga, Menz, Abergelle and Doyogena. The herd health management component of the project was led by the International Livestock Research Institute (ILRI) and implemented by national partner agricultural research institutes, namely, Amhara Region Agricultural Research Institute (ARARI) and Southern Agricultural Research Institute (SARI). Different herd health activities were conducted in the sites comprising a herd health approach to reducing the incidence of respiratory disease, community-based gastro-intestinal parasite and coenurosis control, enhancing small ruminant reproductive performance, health certification of breeding rams and targeted feeding of pregnant ewes.

To apply the herd health activities, an intervention calendar was developed at the beginning of the project and implementing activities was supported by community conversations, multi stakeholders platforms (MSP) and community of practice (CoP). In the project period, implementing animal health activities motivated the farmers to apply the other activities of SmaRT Pack (e.g. genetics, feed and forage, marketing, environmental management and gender).

Morbidity reduced from year to year and as did burden of gastro-intestinal parasites in project sites. The impact of this approach in preventing and controlling of small ruminant diseases in project sites is reflected in the vastly lower mortality and morbidity rates seen in the study sites (4.35 and 0.85%, respectively) compared to figures for such systems elsewhere in Ethiopia where mortality typically ranges from around 12 to 14% for sheep and 11 to 13% for goats (MoA and ILRI 2013). The calendar based herd health approach is a routine and essential aspect of flock management in much of the world but is seldom applied in rural Ethiopia. The efficacy of its components are well established and monitoring showed this efficacy in the field sites, although issues such as emergence of parasite resistance to worm medicines needs to be managed, and data on whether the respiratory vaccine available matched the major circulating strains was not available.

Key messages

- The calendar based herd health intervention is important in the management of small ruminant health reducing morbidity and mortality.
- The data from our intervention based study showed that there was a decrease in the morbidity of animals in study sites from year to year, and overall mortality is very much lower than typically found in equivalent small ruminant systems in Ethiopia.
- Failing to control worms in small ruminants causes massive morbidity and reduces productivity. In this project deworming reduced the burden of gastro-intestinal parasites such as liver fluke (*Fasciola*) and round worms, such as strongyles, and the mean egg count reduced to more than 90% after deworming.

- There were some signs of emergence of resistance to deworming medicines and more nuanced strategies need to be applied to manage this. Such strategies are well established elsewhere.
- Respiratory disease had been previously identified as a major problem in the highland agro-ecology and mixed crop–livestock production system (Alemu et al. 2019) and the herd health approach applied reduced this burden, not only through vaccine but also through improved provision of medicines and advice for treating sick animals. Vaccinating sheep and goats against the major respiratory disease, ovine pasteurellosis, were shown to stimulate a good level of population immunity.
- In the future, more detailed investigations could be performed to confirm the vaccines used remain well matched to the circulating pathogens, as new threats will emerge.
- Improved treatment of sick animals reduced mortality of animals in general.
- The community conversations and trainings on different animal health related activities improved the knowledge and skill of the farmers.
- In general, the herd health package consisted of establishing proven health practices for sheep and goats, and as would be expected deworming reduced worm burden, vaccinating delivered immunity and treating sick animals reduced mortality and aided recovery. We also revealed key aspects needed for farmer education around these practices, required to obtain good uptake and correct application.
- Further analysis will be done to assess the economic returns on these practices in this setting as although economic case for routine deworming and treating sick animals is well established and self evident, quantified evidence of this will be more compelling to all stakeholders, farmers, government, donors, etc.
- Further work is also needed to establish these approaches as self funded sustainable, routine management practices within small ruminant systems in Ethiopia.

Project background

A three year (2019–2021) project funded by the CGIAR Research Program on Livestock was proposed to pilot integrated interventions with a focus on better integration of different activities such as genetics, feed and forage, animal health, environment, marketing and gender. The proposed country project was aimed at improving the livelihoods of male and female farmers through consolidating, testing and promoting of integrated interventions at producer level while facilitating equitable access to input supplies and services through community action and partnership development. The overall objective of the project was to consolidate, implement, evaluate and promote integration of interventions (SmaRT Pack) at producer level while ensuring equitable access to input supplies and services and developing partnerships.

In sheep and goat producing areas of Ethiopia, the gaps in disease control were resulting in high morbidity and mortality of young and adult animals were identified as a major constraint to improving small ruminant productivity. Impact of small ruminant diseases were described in a participatory epidemiology and gender survey which was conducted in 2015/2016 by ILRI with the support of the CGIAR Research Program on Livestock and Fish. According to the survey, the impacts of animal diseases included economic and financial loss, loss of productivity, impact on human health, migration to other jobs and wastage of time treating the animals. According to the results of the survey, the farmers had limited knowledge about best practices in husbandry, preventing and controlling disease, poor access to quality veterinary inputs (including use of antimicrobials) and limited access to advisory services.

Based on the findings of the participatory epidemiology, literature reviews and serosurveys, respiratory diseases were rated as the highest priority among small ruminant diseases. Gastro-intestinal parasites and coenurosis were also ranked as major health constraints in producing sheep and goats. This led to defining appropriate control measures with the aim to reduce the socio-economic impact of these major diseases. Best bet interventions on parasite control (gastro-intestinal tract parasites and coenurosis), reproductive and respiratory diseases were designed and tested.

Integrated herd health intervention (i.e. vaccinating, deworming, health follow up and treatments and awareness creation campaigns) is preferable to reduce the impact of disease since fragmented individual interventions for animal health may not be able to generate sufficient benefits to increase production and productivity. Furthermore, this preventive approach is needed to maintain productivity, as opposed to reacting to failures in animal health, which will impact on short- and long-term productivity even if the animals recover. Dealing with individual problems not only has a limited impact it can also be more expensive to implement.

When farmers consider approaches for the control and prevention of small ruminant diseases, they draw on their own experiences. Our rationale was that if farmers could see the benefits of such an approach it would lead to long-term adoption of these approaches and lasting behavioural change. Therefore, the herd health interventions under SmaRT Pack project focused on smallholder farmers who use communal grazing lands and watering points, and the activities were intended to be undertaken with the full engagement of farmers and other stakeholders (partner national research institutes and agricultural development offices) with a vision of ensuring that interventions continue beyond the duration of the project.

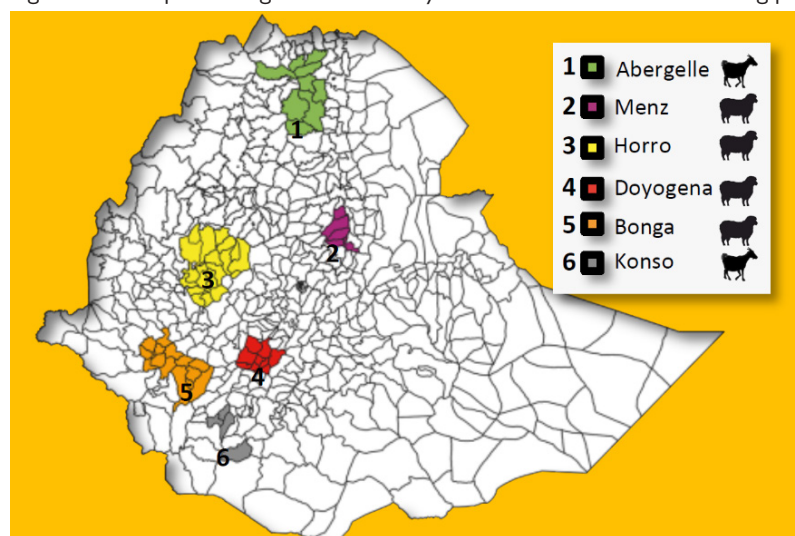
The project areas

The integrated intervention (SmaRT Pack) activities were conducted in four small ruminant community-based breeding sites in Ethiopia (Table I and Figure I). In the new intervention villages, the full implementation of intervention was started in 2020.

Table I. The project sites

Region	Districts/CBBP sites	Villages	Intervention status
Southern Nations, Nationalities and Peoples region	Adiyo	Boka	Old intervention village
		Shuta	Old intervention village
		Shena	New intervention village
		Kochiyo	Control village
	Doyogena	Ancha Sadicho	Old intervention village
		Hawara Arara	Old intervention village
		Lemi-Suticho	New intervention village
		Bakafa	Control village
Amhara region	Menz	Sinamba Boda	Old intervention village
		Key Afer	Old intervention village
		Zeram	New intervention village
		Emegua	Control village
	Abergelle	Bilaque/Saka	Old intervention village
		Sasba	Old intervention village
		Sikala	New intervention village
		Niraque	Control village

Figure I. A map showing the community-based small ruminant breeding program sites in Ethiopia.



Adopted from the map by ICARDA (the SmaRT Pack project sites are 1, 2, 4 and 5 only).

All flocks in the villages were able to receive the vaccination and treatments included in the herd health approach. This was done to achieve herd immunity and village level control to reduce the circulation and hence, exposure to these pathogens. Follow up at selected households was done in each village (Table 2).

Table 2. The number of farmers for which the follow up of disease cases at household level was done

Sites	Adiyo (Bonga)		Menz			Doyogena				Abergelle		
	Boka	Shuta	Shena	Sinamba Boda	Key Afer	Zeram	Hawara Arara	Ancha Sadicho	Lemi Suticho	Bilaque/Saka	Sasba	Sikala
Number of participating households	179	184	50	69	63	83	128	150	51	35	19	55

In the households selected for the follow up, the health parameters such as disease incidences and mortality were collected and analysed to monitor disease incidence and impact of the interventions. Serum antibody titration tests were done for the herd to see the effect of vaccinating against ovine pasteurellosis to confirm if herd level immunity was developed after vaccinating and to measure the efficacy of the vaccine. Fecal egg count data were collected before and after deworming campaigns for small ruminants (gastro-intestinal parasites) and dogs (coenurosis) to test the reduction in fecal egg count for the herd.

Herd health interventions

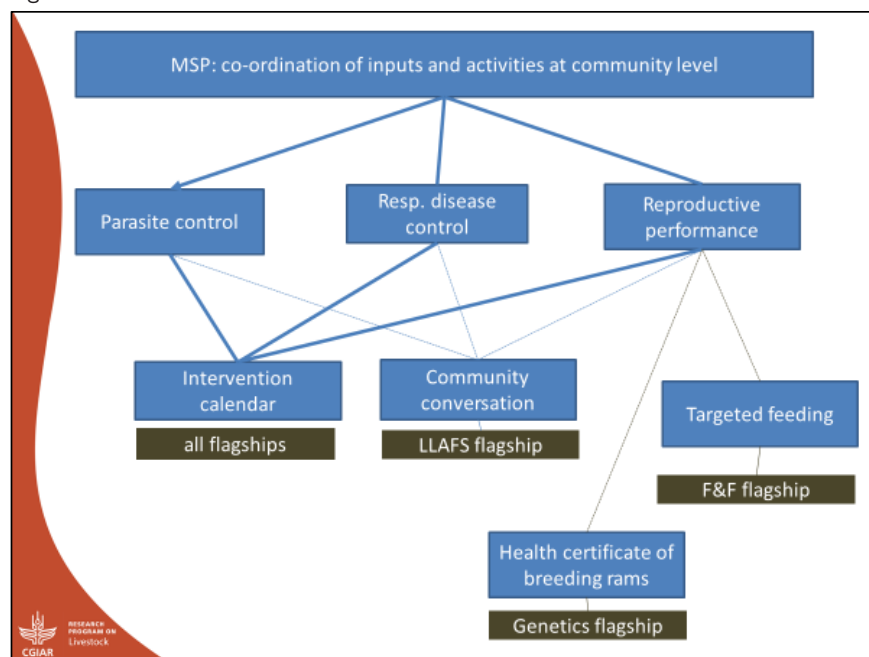
Herd health is a planned animal health and production management program that uses a combination of regularly scheduled veterinary activities and good herd management designed to optimize animal health and productivity (Blood, 1979). It is a continuous process with a mutual commitment from the animal health professional and the farmer working together.

The objectives of the herd health activities in the integrated intervention project were to:

- work closely with service providers such as development agents and private veterinarians to ensure sustainability of the project
- increase the productivity of small ruminants at individual animal farm level and
- assess the impact of integrated intervention packages addressing animal health constraints.

Eight herd health activities (shown in Figure 2) were planned by CGIAR scientists in collaboration with national and regional research and development partners. All the planned activities were linked with each other and with activities from other livestock CGIAR flagships (Figure 2).

Figure 2. Herd health activities and their interconnection.



A. Community level multistakeholders platform (MSP) for the community-based prevention and control of small ruminant diseases

Village level multistakeholder platforms (MSP) are very important since they operate at the grassroots level and can bring all the actors together. Therefore, this activity was conducted with the objective of establishing the MSP in the villages of CGIAR Research Program on Livestock sites to apply the concept of community-based prevention and control of diseases with all the stakeholders.

Achievements

- The MSP established in Doyogena community-based breed improvement site where the members of the MSP conducted meetings and discussed animal health challenges in the area such as disease occurrences, infrastructure of animal health services, awareness and behaviour of farmers towards diseases and control measures, opinions on the herd health interventions, cooperation of villagers for interventions and linkages among stakeholders to prevent and control livestock diseases.
- Additionally, after discussions, they developed a work plan for all stakeholders on animal health activities, which included a timeline of actions.
- For more information, please visit our report on MSP <https://cgspace.cgiar.org/handle/10568/107000>

Even though the MSP was established and functioned in Doyogena community-based breeding program (CBBP) site, later the CGIAR research team decided to change the MSP into community of practice (CoP) in which all the stakeholders of small ruminant interventions are included.

B. Developing vaccination and treatment calendar for common small ruminant diseases

To achieve cost-effective livestock management, packaging health and management interventions at appropriate seasons considering the production cycle of various classes of animals, reproduction cycles, and seasonality of pathogens is a prerequisite. For this a custom designed calendar at community level is an excellent way to ensure the health of sheep and goats. In Ethiopia, the key components of a herd health program for small ruminants included: strategic vaccination against different respiratory diseases and

reproductive animal health, deworming against gastro-intestinal parasites and prevention of coenurosis transmission from dogs.

Objectives

- developing the vaccination calendar for common infectious diseases
- developing deworming calendar for internal parasites and
- capturing other health related activities in the calendar.

Achievements

- In 2019, researchers and veterinarians in project sites discussed with CGIAR researchers and developed the tentative small ruminant health intervention calendar for the intervention sites. The full calendar can be accessed through: <https://cgspace.cgiar.org/handle/10568/107144>.
- The calendar was also updated at the beginning of 2021. The calendar includes vaccination against the different small ruminant diseases and deworming of GI parasites and deworming of dogs for coenurosis. The updated version of the calendar can be accessed through: <https://repo.mel.cgiar.org/handle/20.500.11766/12558>.

C. Implementing integrated herd health approach to reduce the impact of respiratory disease in small ruminants

Research in Ethiopia over the last 15 years highlighted the importance of different respiratory pathogens among small ruminants. Studies conducted on disease priorities in project sites of the CGIAR Research Program on Livestock provided further evidence that respiratory diseases are a top priority for livestock keepers (Alemu et al. 2019).

The respiratory disease complex, clinically manifested mainly in the form of pneumonia, was found to be the most important infectious cause of morbidity and mortality in Ethiopian sheep. However, the coverage and quality of veterinary services to alleviate this prevalent animal health problem is insufficient across the different livestock production systems in the country (Gizaw et al. 2021). This is further exacerbated by the limited knowledge among small ruminant livestock keepers on the causes, transmission and control and prevention of respiratory diseases.

- Therefore, ILRI in collaboration with national agricultural research institutes have developed a herd health approach to control and prevent respiratory diseases in small ruminants with the following objectives:
- Rolling out a gender sensitive herd health packages around systematic vaccination to the incidence and impact of respiratory disease in small ruminants.
- Improving the awareness of farmers about respiratory disease and increasing their capacity to recognize disease situations and giving appropriate information/animal disease data.
- Implementing calendar based vaccination against ovine pasteurellosis, PPR, sheep and goat pox and contagious caprine pleuropneumonia (CCPP).
- Following up the incidence of respiratory diseases (longitudinal follow up) for databased decision-making.

Achievements

Vaccination of small ruminants against ovine pasteurellosis, PPR, sheep and goat pox were conducted in Menz, Doyogena and Bonga CBBP sites whereas vaccination against ovine pasteurellosis, PPR, sheep and goat pox and CCPP were conducted in Sekota site (Tables 3–6).

Follow-up and treating of sick animals were conducted in all sites and a total of 1,331 respiratory case data was registered by enumerators from 2018–2021.

On the other hand, deworming of small ruminants against lung worms was conducted within an annual deworming calendar against other gastro-intestinal parasites (refer the report on parasite control).

i. Vaccinating against ovine pasteurellosis

The ovine pasteurellosis vaccine was administered twice a year with a six month interval between treatments.

Table 3. Number of small ruminants vaccinated against ovine pasteurellosis in years

Year	Number of small ruminants vaccinated per site				Total
	Doyogena	Bonga	Menz	Abergelle	
2019	2,355	9,201	4,108	2,292	17,956
2020	2,320	9,499	7,014	3,508	22,341
2021	2,531	11,232	7,628	3,800	25,191

Figure 3. Animal health assistant vaccinating sheep against ovine pasteurellosis.



ii. Vaccinating against PPR and sheep and goat pox

The vaccination of PPR, a highly contagious viral disease of small ruminants, was given a great attention to reduce the burden of the disease in small ruminants producing sites and to meet the global target of eradicating the disease by 2030. Since the disease has also no specific treatment, focus was given to prevent with vaccination. The sheep and goats in intervention sites were also vaccinated against sheep and goat pox (Table 4).

Table 4. Number of small ruminants vaccinated against PPR in years

Year	Number of small ruminants vaccinated per site				
	Doyogena	Bonga	Menz	Abergelle	Total
2019	2,130	8,716	3,520	2,120	16,486
2020	1,875	8,312	5,282	2,911	18,380
2021	2,315	9,120	5,628	3,215	20,278

iii. Vaccinating against anthrax

Anthrax is an endemic and very important disease affecting domestic and wild animals in Ethiopia. It is also one of the top prioritized zoonotic diseases in Ethiopia. The calendar based vaccination was conducted to control and prevent the production and zoonotic impact of the disease in sheep and goat rearing areas (Table 5).

Table 5. Number of small ruminants vaccinated against sheep and goat pox in years

Year	Number of small ruminants vaccinated per site				
	Doyogena	Bonga	Menz	Abergelle	Total
2019	2,355	9,201	4,108	2,292	17,956
2020	2,320	9,499	7,014	3,508	22,341
2021	2,531	11,232	7,628	3,800	25,191

iv. Vaccinating against CCPP

Vaccinating against CCPP was conducted in Abergelle goat site. A total of 2,320, 3,214 and 1,650 animals were vaccinated in 2019, 2020 and 2021, respectively, i.e. a total of 9,600 animals vaccinated in three years.

v. Training of men and women farmers on control and prevention of respiratory diseases

Men and women farmers were trained on the control and prevention of respiratory diseases by good herd health management even though COVID-19 pandemic has disrupted the delivery of trainings and community conversations starting from mid-2020 (Table 6).

Figure 4. The picture from training of farmers in Adiyo district on preventing and control of respiratory diseases.



In the trainings the farmers learned about the causes, clinical signs, transmission, predisposing factors, control and prevention of respiratory diseases of small ruminants; and they discussed seasonal calendars for

vaccination and treatment for respiratory diseases (Table 7). The farmers also learned about good husbandry and feeding systems to prevent or reduce the incidence of respiratory diseases.

Table 6. The number of farmers that participated in trainings on the prevention and control of respiratory diseases

Year	Number of farmers trained per site												Total
	Doyogena			Bonga			Menz			Abergelle			
	M	F	T	M	F	T	M	W	T	M	W	T	
2019	195	83	278	243	120	363	97	35	132	43	11	54	827
2020	86	32	118	112	52	164	85	28	113	73	31	104	499
2021	236	93	329	271	142	413	162	53	215	—	—	—	957

D. Parasite control activities

i. Community-based strategic gastro-intestinal parasite control in small ruminants in Ethiopia

Gastro-intestinal tract (GIT) parasites are a major cause of livestock diseases that can have devastating socio-economic impacts in smallholder livestock keeping communities. Various studies in the Ethiopian highlands have generated evidence of the occurrence of gastro-intestinal tract (GIT) parasites in small ruminants and the resulting impact on production. Studies showed the average nematode infection rate in sheep and goat is 75.6% (Asmare et al. 2016).

The parasites cause disease when present in large numbers in the host animal or when the animal is weakened by another disease or poor nutrition. Infections can lead to reduced appetite in sheep and goats, impaired the ability to absorb nutrients and anaemia, which contribute to poor growth rates, lower milk yields, poor condition of hair/fleece coat or even the death of the animal. To quantify the real impacts of these parasites further studies are needed.

In a communal animal management system where animals graze in the same areas and share watering holes, transmission can occur easily. A community-based approach to GIT parasite control interventions is therefore key to long-term sustainable outcomes. This activity was conducted in three community-based breeding sites, i.e. Bonga, Menz and Doyogena.

Objectives

- setting up a timetable for strategic interventions to control internal parasites
- introducing the concept of community-based anthelmintic treatment practice
- demonstrating performance measurement scoring to farmer to identify the presence of parasite infection that allows farmers to monitor their herds.

Achievements

Deworming campaigns were conducted at the beginning of the two rainy seasons, i.e. twice a year (Table 7).

Table 7. The number of animals dewormed against gastro-intestinal parasites and lung worm per year per site

Year	Number of small ruminants dewormed per site			
	Doyogena	Bonga	Menz	Total
2019	1,865	8,213	3,915	13,993
2020	1,020	9,140	6,320	16,480
2021	2,171	10,032	5,628	17,831

Since parasite control needs community action, the community conversation module on gastro-intestinal parasite control was developed. Community conversation is a participatory training and extension approach adopted for herd health interventions. On the other hand, for the follow up of the effectiveness of deworming programs, the pre and post deworming fecal samples were collected from the sites. A total of 1,928 and 735 fecal samples were collected pre and post deworming through 2018–2021 and analysed.

Figure 5. Deworming, sample and data collection.



ILRI in collaboration with Addis Ababa University, College of Agriculture and Veterinary Medicine at Bishoftu delivered training to eight researchers and laboratory technicians to build the capacity of researchers and laboratory technicians on the diagnosis and control of gastro-intestinal parasites and coenurosis by (<https://cgspace.cgiar.org/handle/10568/116291>).

ii. Community-based coenurosis control

Coenurosis (gid or sturdy), a parasitic and fatal disease, is widespread in the highlands of Amhara, Tigray, Oromia and Southern Nations, Nationalities and Peoples Regions of Ethiopia where 75% of the country's sheep population are found (Adane et al. 2015). The disease accounts for 5% of the annual mortality of sheep and goats (Njau et al. 1988).

Coenurosis was identified as one of the major small ruminant disease constraints in sites under the CGIAR Research Program on Livestock (Alemu et al. 2019). The clinical sign of the disease—circling of animals—is often confused with other nervous diseases. To bring the disease under control, SmaRT Pack project have implemented the community-based control with the following objectives:

- improving the overall health of dogs in the area by reducing the parasitic burden by deworming them with praziquantel
- determining the effect of anthelmintic medication on taenia spp and other intestinal parasite with zoonotic importance
- controlling and preventing the incidence of coenurosis in the study area
- raising the community awareness about the cause, transmission, prevention and control option of the disease.

Achievements

The activities were started in Bonga and Menz CBBP sites. The survey to access pre-intervention knowledge, attitude and practice of farmers about the disease was conducted in two sites. Additionally, the post intervention survey was conducted in Bonga CBBP site.

Registration of dogs and deworming with praziquantel was done in Bonga and Menz sites and a total of 368 and 300 dogs were registered and treated with praziquantel. The pre and post deworming samples were also collected and analysed from dogs. This activity is still in progress since it started late in Menz site.

iii. Training of men and women farmers on the control of gastro-intestinal parasites and coenurosis

Awareness of the farmers is very important to apply a community-based gastro-intestinal parasites and coenurosis control program. Therefore, experts from ILRI partner research centres and livestock and fish development offices trained farmers (Table 8) on the following topics:

- Cause, clinical signs, predisposing factors, treatment, control and prevention methods of internal parasite and coenurosis. For coenurosis training material developed previously was used.
- Pictorial demonstration of different methods that are commonly applied to determine the presence of helminth infection.
- Seasonal deworming calendar.
- How to improve small ruminant husbandry and feeding to prevent/reduce internal parasite
- Concept of community-based internal parasite control
- Concept of 'Five Point Check', which deals with targeted selective treatment of internal parasites and the need for deworming small ruminants. The five checkpoints are: eye (eyelid colour), jaw (oedema), back (body condition score), tail (diarrhoea) and nose (nasal discharge).

Table 8. The number of farmers trained on the community-based gastro-intestinal parasite and coenurosis control

Year	Number of farmers trained per site									Total
	Doyogena			Bonga			Menz			
	M	W	T	M	W	T	M	W	T	
2019	195	83	278	243	120	363	97	35	132	773
2020	86	32	118	112	52	164	85	28	113	395
2021	236	93	329	271	142	413	162	53	215	975

E. Enhancing the reproductive performance of small ruminants

To control the reproductive failure in small ruminants, the farmers (Table 9) were trained on the cause, control and prevention methods for reproductive health problems in small ruminants. The trainings also covered healthcare around reproduction and handling of new born animals, and youngstock.

Table 9. The number of men and women farmers trained about the small ruminants' reproductive health management

Year	Number of farmers trained per site												Total
	Doyogena			Bonga			Menz			Abergelle			
	M	F	T	M	F	T	M	W	T	M	W	T	
2019	195	83	278	243	120	363	97	35	132	43	11	54	827
2020	86	32	118	112	52	164	85	28	113	73	31	104	499
2021	236	93	329	271	142	413	162	53	215	—	—	—	957

On the other hand, regular data recording and follow up for the occurrence of abortion related illness were conducted.

F. Targeted feeding of pregnant ewes and does

Nutrition during late pregnancy (90–145 days) influences lamb birth weight and viability, colostrum supply, lambing difficulty, mothering ability, ewe mortality and subsequent lamb growth rates. Therefore, appropriate feeding during the final 6–8 weeks pre lambing is vital. Thus, targeted feeding of pregnant ewes or does was applied in Abergelle CBBP site for the control of non infectious reproductive diseases. The activity was done with the following objectives:

- ensuring high foetal survival rate and minimizing lamb losses
- improving udder development with plentiful supply of good quality colostrum and milk
- minimizing the death of ewes due to metabolic diseases, prolapse or dystocia.

This activity was conducted in only Abergelle CBBP site in 2019. A total of 133 pregnant does were provided with supplementary feeding. The activity was not done as planned due to the gaps in integration with feed and forage researchers.

G. Vaccination and health certification of breeding rams

This activity involved physical examination of the ram for breeding suitability and laboratory analysis to test for specific reproductive diseases. Certifying a ram also included a standard vaccination record. The activity was conducted in close coordination with the genetics flagship. A total of 530, 591 and 635 first and second ranked rams and bucks were vaccinated and certified in 2019, 2020 and 2021, respectively, in the four community-based breeding sites.

H. Community conversations

Community conversations are an inclusive community engagement approach that promotes behavioural change beyond the individual through facilitated discussion/dialogues and social learning processes, which enable men and women community members and service providers to identify and explore development issues and take actions. It aims to promote coordinated and integrated approach to service delivery, an integrating 'tool' across different sectors and partners. The community conversation modules integrate animal health management, animal welfare, antimicrobial use and resistance and gender and zoonosis and animal feeds and nutrition to facilitate holistic awareness and knowledge both at the farmers and partners level.

Achievements

- Five community conversation modules have been developed on gender and zoonotic diseases, animal welfare and productivity, antimicrobial use and resistance, animal feeds and health management, and community-based gastro-intestinal parasite control.
- Thirty inclusive community conversation sessions have been conducted in five CGIAR Livestock Research Program sites between 2018 and 2021, addressing different livestock development issues (based on modules developed) and engaging over 1,500 (574 women) community members and research and development partners.
- Twelve reports have been produced on community conversations addressing different livestock health and productivity management issues.
- Fourteen blog and outcome stories have been developed that demonstrate changes in gender relations, knowledge and practices of community members, and the capacity of partners for inclusive engagement.

- Four extension materials/practice briefs on the community conversation have been produced.
- Two training materials have been developed on the community conversation methodology.
- Three posters/innovation briefs have been developed on the community conversation as a gender transformative approach.
- Training of facilitators of community conversations have been conducted and report produced.
- The trained facilitators also trained district level veterinarians and village level development agents on facilitating community conversations.

Impacts and outcomes of herd health interventions

The integration of small ruminant interventions (health, genetics, feed and forage, environment, marketing and gender) showed positive impact on the transformation of the sector and livelihoods of society. The herd health interventions reduced the morbidity and mortality of small ruminants in project areas and due to this the participating farmers could supply 18 or more sheep or goats to the market per household per year (Kassie et al. 2021).

Evaluating and monitoring of the impact of herd health interventions on the selected animals and farms (households) was conducted: fecal samples were collected before and after every deworming campaign (twice a year) to conduct fecal egg count to compare the outcomes of treatment at animal level. The longitudinal follow up of disease incidence was conducted. Serum samples were also collected from the selected animals before and after vaccination against ovine pasteurellosis to compare serological differences at animal level.

Morbidity and mortality

The data from household level small ruminant morbidity and mortality showed that there was a decrease in morbidity of animals from year to year (the morbidity of 6.31% in 2018 decreased to 3.02% in 2021). The overall annual morbidity and mortality rate in small ruminant populations of the four intervention districts were 4.35% (95% CI: 4.19–4.51) and 0.85 (0.78–0.92), respectively. Eight disease categories (diagnosed tentatively) such as gastro-intestinal parasite, neurological, reproductive, respiratory, skin disease, systemic, other and unknown diseases were identified in the intervention and follow up period. The mortality rates in intervention villages in a follow up period were low as compared to the previous national reports where annual mortality ranges from 12 to 14% for sheep and 11 to 13% for goats (MoA and ILRI 2013). The morbidity and mortality rates varied significantly ($P < 0.001$) between districts and among agro-ecologies and in respect to age groups, an overall morbidity of 7.36 and 3.49% and mortality rate of 2.24 and 0.51% were recorded in young and adult small ruminants, respectively (the full report will be available in a journal paper).

Deworming

Like other aspects of the herd health program, such as vaccination and treatment for common diseases, deworming is well established as a prerequisite for productive livestock farming, yet it is poorly practised in much of Ethiopia. This is likely to significantly contribute to the high morbidity and mortality, and low productivity widely seen. The deworming program within this project reduced the burden of gastro-intestinal parasites significantly over the years. This occurs through keeping on top of the worm burden through regular treatment, which reduces the level of contamination of the pasture with worm eggs, and hence, the exposure of animals to parasitic worms.

A scientific paper is under development that shows the impact of the gastro-intestinal parasite control program. From 1,928 pre treatment and 735 post treatment faecal sample results, the proportion of animals with eggs detected for *Fasciola* (liver fluke), strongyle (a major group of gut round worms) or eggs of any gastro-intestinal tract parasite decreased year on year from 2018 to 2021. In unmanaged worms and fluke cause a massive disease burden in small ruminants, leading to widespread reduction in productivity, ill thrift, death and disease. In most of the sites, the mean egg count reduction after deworming was greater than 90%. This is particularly important as it is fine, and even healthy, to have a low gut worm burden but this must be controlled to prevent production and health effects.

However, there were suggestions of early emergence of resistance to the dewormers used, with slight reductions in the efficacy of the treatments. This is a well established phenomenon, particularly with blanket treatment and in the future deworming strategies will have to be more sophisticated to manage this, applying approaches widely used across the world, e.g. sustainable control of parasites(SCOPs) <https://www.scops.org.uk/>.

Ovine pasteurellosis

According to a laboratory analysis of 302 and 151 pre and post vaccination serum samples done using indirect haemagglutination inhibition test (IHAT), the prevalence of pre and post vaccination antibodies against *Pasteurella Multocida* type A was 83.44 and 93.38%, respectively. The difference between the pre and post vaccination antibody prevalence was statistically significant ($P = 0.003$). This shows that by vaccinating a sheep or a goat with an ovine pasteurellosis, which costs only 0.70 Ethiopian birr (ETB) per dose (ETB 49.1600 = USD 1.00 at 15 December 2021), it is possible to reduce ovine pasteurellosis which causes massive morbidity and mortality of adult and young small ruminants. The cost of replacing a dead small ruminant is approximately ETB 5,000 for an adult and ETB 2,000 for a young animal. So vaccinating adults pays if it prevents more than one death in 7,000 animals (cost of replacement/cost of vaccine dose) and approximately 3,000 for youngstock. The incidence of respiratory disease in this cohort was 54%, of which pasteurella is a major component is far beyond this, with incidence much higher in younger animals. This simple calculation does not account for burden of disease other than death (loss of productivity, treatment costs) or herd immunity effects reducing burden and pathogen exposure in the wider community.

The high pre vaccination seroprevalence may reflect both a high level of pathogen circulation in the population, but through previous vaccination, the two cannot be distinguished in this study. Analysis of seroprevalence by age (to be included in the paper) may provide more insights.

Medical treatments

Additionally, treating animals after the disease was reported also reduced mortality of animals. The treatment data analysis showed that treating infected animals reduced mortality rate significantly. The relative risk of death in treated animals was 0.12 (mortality of 11% in treated and 89% in non treated animals). This means the risk of death of treated animals were 88% less compared to untreated cases (the details, including management of confounding bias will be shown in a scientific journal paper).

The awareness of farmers of the disease prevention and control methods has improved from year to year. The calendar based mass vaccination and deworming program is becoming an accepted animal health management approach in the project areas.

The community conversation on animal health management with other community conversations like antimicrobial use and resistance and animal welfare enabled discussions about animal health and production challenges, and farmers learned from each other.

Even though the impact of single interventions such as animal health activities were visible, it was difficult to analyse the linkages of different interventions such as animal health with genetics, animal health with feeding and forage due to the short duration of the project.

Outputs of the project

Different training materials and community conversation modules on animal health issues were developed. The site specific treatment calendar was developed which will be updated in light of changes in disease epidemiology. Innovation briefs were also developed on the prevention and control of respiratory diseases, coenurosis, gastro-intestinal parasites and reproductive health problems. Additionally, the guide on the implementation and scaling of small ruminant interventions was developed with other flagships such as genetics and feed and forage. With other livestock species such as cattle and camels, herd health management training manuals were developed for the national veterinarians and researchers. Learning modules on transmission and control of coenurosis and anthrax developed earlier were used to train farmers (<https://hdl.handle.net/10568/100524>; <https://hdl.handle.net/10568/100525>).

Field post mortem examination training module was developed for veterinarians and animal health researchers (<https://hdl.handle.net/10568/100526>).

Key success factors

Capacity development of the community on causes, mode of transmission, and prevention and control measures for the disease was one of the key factors for the success of the interventions. The traditional training and the later community conversations helped to identify the gaps and pass knowledge to the small ruminant keepers. This in turn led to community actions on vaccination and deworming of small ruminants and acceptance of the intervention calendars. After building the capacity of our development and national research partners the trainings and community conversations were done. The peer learning and experience sharing between community members by community conversations helped to improve the knowledge, attitude and practices of the participating farmers (<https://hdl.handle.net/10568/114078>). In addition to trainings, the champion farmers who have better knowledge on animal diseases were also selected to report the cases and communicate with enumerators and researchers. This also facilitated the disease reporting system and planning for interventions.

Integrating different interventions also helped to fill the gaps. Communication, ownership and commitment of stakeholders at national, regional and district were also a factor for the success of the program.

Scalability of herd health interventions

The research team believe that the herd health interventions are scalable to the neighbouring farmers, neighbouring villages of the project areas and to the other sheep and goat producing areas of the country given the commitment and ownership of the stakeholders. With the lessons learned in this project, scaling up and implementing the activities in other areas of the country will be feasible.

Innovation briefs of animal health activities and other small ruminant transformation activities such as genetics, marketing and feed will support implementing activities in new areas. The material and modules developed for this project will also allow activities to be scaled.

Lessons learned

In the project period the implementing partners learned the following lessons:

- a. Integrating all small ruminant packages (genetics, feed and forage, marketing) had a significant effect on the impact of the interventions. Therefore, all the packages developed for the transformation of the small ruminants sector should be implemented in integration.
- b. The calendar based interventions helped to implement the activities.
- c. Animal health activities motivated the farmers to implement other activities, therefore, they can be taken as the driving forces of the integrated intervention activities.
- d. The community conversation approach had greatly improved the knowledge, attitude and practice of the community and capacitated partners for inclusive engagement.

Constraints and challenges

Through the project period, we faced different challenges:

- Security situation of the country: In recent years, Ethiopia faced insecurity nationally.
- COVID-19 pandemic: This had a negative impact on implementing activities, which needed people to gather, for example, trainings, community conversations.
- In the beginning, sorting out partner agreements took longer time than anticipated, which delayed the purchase of material and field activities.
- Shortage of vehicles in partner research centres.
- Long distance to some farms disrupted the recording of morbidity and mortality data from some scattered project farmers.
- Shortage and turnover of human resource (animal health researchers and technical assistants) made it difficult to achieve all planned activities according to annual calendar.
- Delayed submission by partner institutes when sending the budget expenditure report delayed some field activities.
- Low participation of private service deliverers. This was due to the undeveloped nature of privatization in Ethiopia and a lack of business/market oriented smallholder farmers who can pay for these services.
- The challenges in timely vaccine production by National Vaccine Institute (NVI): some vaccines were not manufactured on time.

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List of partners

- Amhara Region Agricultural Research Institute (ARARI)
- Debre Birhan Agricultural Research Center (DBARC)
- Sekota Dryland Agricultural Research Center (SDARC)
- Abergelle District Agricultural Development Office
- Ziquala District Agricultural Development Office
- Menz Gera Midr Agricultural Development Office
- Menz Mama Midr Agricultural Development Office
- Southern Agricultural Development Office (SARI)
- Areka Agricultural Research Center (AARC)
- Bonga Agricultural Research Center (BARC)
- Doyogena District Livestock and Fish Development Office
- Adiyo District Livestock and Fish Development Office