On-Farm and On-Station Comparison of Early Growth and Survival Performances of Horro Sheep in Western Ethiopia

Kasahun Bekana [1], Temesgen Jembere [2]* and Gemeda Duguma [3]

[1]Ambo University, Ethiopia P O Box 19, Ambo; [2]Bako Agricultural Research Center, P O Box 03, Bako; [3]Wollega University, P O Box 395, Nekemte; * Corresponding author: *tjbakara@yahoo.co.uk*

ABSTRACT

Even though sheep is one of the most important species of livestock with estimated population size was about 52.5 million heads, the genetic improvement made to this species was not encouraging. On station small ruminant research was reported for being inefficient and Community Based Breeding Program (CBBP) has emerged as alternative. However, empirical evidences were not available which presented performance evaluation results of Horro sheep under on station and on farm conditions. Hence, the objective of the current study was to compare early growth and survival performance of Horro sheep breed managed under on-farm conditions with those managed under on-station condition. The on-farm and on-station data for this study was collected from two Kebeles in Horro district namely Gitilo and Laku Igu and at Bako Agricultural Research Center (BARC). The effect of fixed factors including location (on farm and on station), parity, type, sex, season and year of births of lambs were investigated on early growth traits including birth weight (BWT), three-month weight (3MW), six-month weight (6MW) and survival to three months of age using data collected from 2009 through 2018 at BARC and CBBP of sheep in Horro district. The overall means (kg) for BWT, 3MW and 6MW, in respective order, was 2.80±0.70, 12.27±3.27 and 16.31±2.86. The location of birth, year of birth, and type of birth of lambs had highly significant effect (p<0.0001) on the early growth traits where the early growth traits from on-farm (from the CBBP in this context) and single birth were heavier. Regarding the year of births, the growth performance of the lambs had shown an improving trend from 2009 to 2013 and declined thereafter. However, the trend BWT was almost constant across years compared 3MW and 6MW. The place of birth (being on farm or on station), type of birth (being born single or twin) and the magnitude of birth weight had highly significant effect (p<0.0001) on Horro lambs' odds ratio of survival to three months of age. Sex of lambs also had significant effect (p=0.0313) on Horro lambs' odds ratio of survival to three months. It was concluded that unless full commitment, at government and technical staff level, is ensured neither genetic improvement nor conservation of Horro sheep breed could be realized under on-station condition. The genetic improvement of Horro sheep at village level, under on-farm condition was confirmed to be better alternative as health interventions and use of selected rams for breeding backstopped the traditional raising practices of sheep owners in Horro district.

Keywords: Early growth; fixed factors; on farm sheep research; survival.

INTRODUCTION

Sheep production is one of the most important agricultural activities in Ethiopia. Sheep is the second most important species of livestock next to cattle in the country where about 99.6% are indigenous breeds (CSA, 2020) where estimated population size was about 52.5 million heads (CSA, 2020). Duguma (2010) reported that different indigenous sheep breeds are owned and managed by resource poor smallholder farmers and pastoralists under traditional and extensive production systems. There are nine identified and characterized sheep breeds through phenotypic and molecular methods in Ethiopia (Gizaw, 2008).

Even though sheep plays important roles in the country's economic development and livelihoods of farmers and pastoralists, their productivity remains low due to several reasons. Some of the major

problems were weak genetic improvement efforts associated with absence of planned breeding programs and breeding policies, diseases and parasites, feed shortage, inadequate extension service delivery or lack of improved technologies, poor infrastructure and lack of market information (Duguma, 2010; Mirkena, 2010; Gizaw et al., 2013).

In fact, many efforts have been conducted on genetic improvement for improving production and productivity of sheep but the success was limited. Characterization of the indigenous sheep breeds, genetic improvement via crossbreeding using exotic breeds and genetic improvement using open nucleus breeding systems were some of the efforts that have been undertaken indicating that Ethiopia is a country where different livestock breeding programs have been practiced for a long period of time. However, the country has not succeeded with sheep genetic improvements due to lack of clear and documented breeding and distribution strategies, very little consideration of farmers' needs and indigenous practices and unsuitability of the environment (Tibbo, 2006; Duguma, 2010; Haile et al., 2011).

Government station based open nucleus breeding programs of small ruminants were blamed for not yielding significant improvement in Ethiopia; hence community based breeding programs has become as alternative to the station based breeding programs in developing countries. However, it was not proofed whether community based breeding programs, commonly implemented under on-farm condition, of small ruminants could be better option than the on-station breeding programs with the help of empirical evidences.

On-station research was started on Horro sheep at Bako Agricultural Research Center (BARC) in 1977 but there was an argument regarding the Horro sheep flock maintained there in relation to adaptation to hot and humid climate of the center. Horro highland, where the current CBBP of Horro sheep was implemented, was believed to be the natural ecological niche of Horro sheep breed. Hence, there is a need to compare the on-farm productivity performances (i.e. from Horro highland) with the on-station performances from BARC.

In the current study, the early growth and survival performances of Horro sheep under on-farm conditions were compared with the on-station conditions using data collected from 2009 through 2018. The data collected from the CBBP of Horro sheep at Horro district, Horro Guduru Wollega zone, Ethiopia was used as on-farm data and data collected during the same period at BARC represented the on-station condition. Therefore, the objective of the current study was to compare early growth and survival performance of Horro sheep breed managed under on-farm conditions with those managed under on-station condition.

MATERIALS AND METHODS

Description of the Study Areas

The map of the study areas is presented in Figure 1. The on-farm and on-station data for this study was collected from two Kebeles in Horro district namely Gitilo and Laku Igu and at BARC. Horro district is located at about 315 km from Addis Ababa ($9^0 34´$N and $37^0 06´$ E) in Oromia Regional State in Western Ethiopia. Mixed crop-livestock production system is common farming practice in Horro district. The area has one long rainy period extending from March to mid-October with mean annual precipitation of about 1800 mm and maximum and minimum temperatures of about 22.67 and 11.750C, respectively. Gitilo and Laku Igu were where Community based sheep genetic improvement program was implemented since 2009. Among the kebeles of Horro district, Gitilo and Laku Igu had the highest sheep population and they

were accessible. They are situated at about 12 km and 7 km, respectively, to the west of Shambu town, the capital of Horro district and Horro Guduru Wollega zone. The altitude of both kebeles ranges from 2170 to 2853 m.a.s.l.

BARC is located in Oromia Regional State at about 258 km from Addis Ababa to the west on the main road to Nekemte and it is about 8 km away from Bako town. It lies between $9^0$6'N latitude and $37^0$9'E longitude at an altitude range of 1579 to 1789 m.a.s.l. The BARC area receives an annual average rainfall of about 1238 mm and the area experiences a hot humid weather of minimum temperature of 13.3^0C and a maximum of 34^0C.

Flock Management

On-farm flock management

In the two kebeles of Horro district namely Gitlo and Laku Igu, farmers keep their sheep flock together (in group) in a communal grazing land during daytime and depart during night time. Most of the farmers prepared flock house enclosed to kitchen house for night time. However, some farmers who own only small flock do tie their sheep to a peg together with calves. The main feed sources in the study area were natural pasture and aftermaths. Sometimes, few farmers prepare supplemental feeds (local brewery by-product called 'atela', and salt) for the pregnant, breeding rams and castrated rams. As reported by Tufa (2019) sheep flocks were de-wormed against internal parasites four times per year. They were also vaccinated against different diseases including bacterial and viral causes.
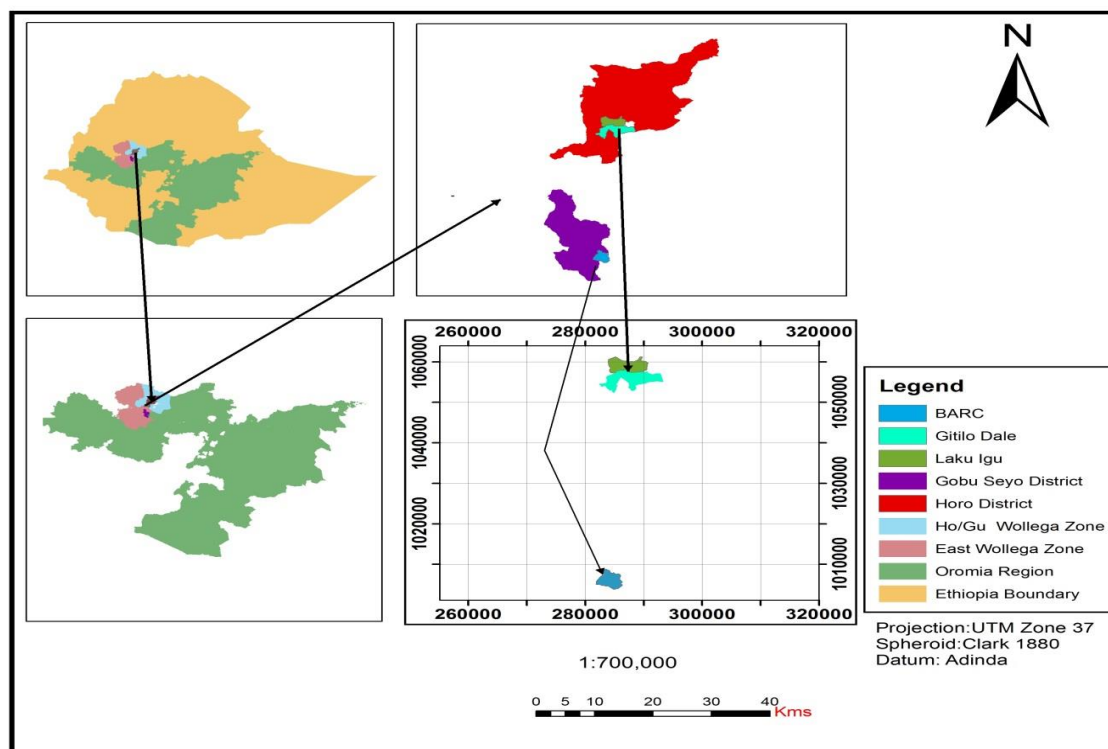

Figure 1. Map of the study areas

In these two kebeles, breeding was uncontrolled (year-round); breeding rams were selected by researchers, CBBP representatives and development workers (two times: screening at six-month age and selection at 12 month age) for mating based on their conformation (body size, color and appearance) and based on maternal history (Mirkena et al., 2011). Selected breeding rams were mixed with flocks for mating purpose. Scholars stated that the selected breeding rams give service for two years after selection. After two years of breeding services, the selected breeding rams were sold or castrated. As CBBP regulation, ram lambs born in the flock and not selected for breeding should be sold or castrated before reaching mating age. Enumerators were hired and data were being collected rounding on farm gate of the participating farmers. The CBBP of the sheep at Horro was started with about 120 farmers in the 2009 and the number had increased gradually. The CBBP of sheep at Horro district was first implemented by collaborating research institutions including the Austrian university of life sciences (BOKU), International center for agricultural research in dry areas (ICARDA) and Oromia Agricultural Research Institute. Horro district is found at about 70 km north of Bako and the research team from BARC was making a frequent monitoring of the implementation.

On-station flock management

Horro sheep flocks at BARC were kept under semi-intensive production system. Flocks houses were constructed from bamboo and corrugated iron sheet separately for different ages and sexes. Feed sources for sheep at on-station were natural pasture, aftermaths, hay and concentrate feed. During daytime (8:00 AM- 5:00 PM) sheep flock freely graze from natural pasture by separating mature females from mature males (Abegaz, 2002) (however, the sheep flock were allowed to graze for shorter time due to various reasons since recently). However, concentrate feed was given in the morning before letting the flock to grazing land and afternoon when the flock were back to their house according to necessitated for different categories of sheep. For instance, breeding ram and breeding ewes during breeding season (for 42 days) fed higher amount of concentrate feed (about 300 g) than other categories of flock. However, during the last one and half decade, the management level allotted to the flock was reduced because of various factors. In BARC, controlled breeding is practiced (two times per year that takes place during November and during June; for long period of times, mating was taking place only once in a year); rams and breeding ewes were screened by researchers. During breeding season both breeding ram and screened ewes were not allowed to graze in the field and they were confined in separate houses in a male to female ratio of 1:20 at daytime (8:30 AM- 5:30 PM) and adjoin during night time. All the breeding activities were recorded during this time by trained enumerator.

Data Analyses

For the analysis of early growth traits, *general linear model* procedure of SAS (2002) was used. The influences of class variables like location of births as on farm and on station (where on farm is the CBBP in Horro district and on station was the flocks at BARC), sex of lambs, type of births, parity of births, season and year of births on the early growth traits of Horro lambs (birth weight, three months' weight and six months weight) were investigated. The least squares mean of early growth variables were compared and separated by *pdiff* procedure of SAS (2002).

The survival analyses of Horro lambs up to three months of age were also conducted. The influences of location, birth type, sex, parity, birth year, season of birth and birth weight itself were investigated by the *logistic regression* procedure of SAS (2002). Lambs that died before three months of

age because of infectious diseases only were considered as lambs that not survived; based on information from owners and attendants, lambs that were eaten by predators, died of mechanical accidents, and metabolic disorders were before three months of age were added to lambs that survived up to three months of age. This was done by assuming that had the animals get chance of surviving, they would have survived. In the case of on station condition, survival data of lambs was collected from flock record book at BARC. Odd ratio survival of lambs up to three months of age was then compared for the factors including for the on farm and on station conditions.

RESULTS AND DISCUSSION

Early Growth Performances of Horro Sheep On-farm and On-station

The least square means and standard errors of birth weight, three and six months of Horro sheep are given in Table 1. The overall means (kg) for the traits, in respective order, was 2.80 ± 0.70, 12.27 ± 3.27 and 16.31 ± 2.86. The location of birth, year of birth, and type of birth of lambs had highly significant effect ($p<0.0001$) on the early growth traits where the early growth traits from on-farm (from the CBBP in this context) and single birth were heavier. On the other hand, sex of lambs, season of birth of lambs and parity of birth of lambs had highly significant effect ($p<0.0001$) on the birth weight and did not significantly ($p>0.05$) affected 3MW and 6MW.

Table 1. Least squares means of birth weight, three-month weight and six-month weight of Horro sheep by different production conditions, sex, birth type, season and parity of births in Western Oromia, Ethiopia during 2009 to 2018.

Factors *	Birth weight		Three month weight		Six month weight	
	N	LSmean ± SE	N	LSmean ± SE	N	LSmean ± SE
Overall	3710	2.80±0.70	1525	12.27±3.27	987	16.31±2.86
Site	***		***		***	
On farm	1305	2.69±0.03	1261	12.78±0.35	862	18.92±0.50
On station	405	2.45±0.04	264	10.26±0.35	125	14.00±0.48
Sex	***		NS		NS	
Male	1853	2.64±0.03	765	11.58±0.24	471	16.98±0.42
Female	1857	2.51±0.03	760	11.46±0.24	516	15.94±0.44
Type of birth	***		***		***	
Single	2479	2.68±0.03	1058	12.30±0.24	693	16.98±0.42
Twin	1231	2.46±0.03	467	10.73±0.26	294	15.95±0.44
Season¥	***		NS		NS	
1	1143	2.63±0.03	411	11.56±0.28	267	16.88±0.44
2	394	2.44±0.04	345	11.31±0.29	303	16.21±0.45
3	968	2.68±0.03	308	11.85±0.29	212	16.38±0.46
4	1205	2.54±0.03	461	11.36±0.25	205	16.39±0.45
Parity	***		NS		NS	
1	736	2.45±0.03	333	11.33±0.27	209	16.27±0.46
2	835	2.57±0.03	411	11.50±0.26	265	16.68±0.44
3	718	2.61±0.04	314	11.61±0.26	195	16.71±0.45
4	644	2.64±0.04	254	11.57±0.29	167	16.33±0.47
5	777	2.57±0.04	213	11.68±0.31	151	16.33±0.47

N=number of observations; LSmean=least squares means, SE=standard error, ***=p<0.0001, NS=p>0.05, ¥ means 1=December, January and February; 2=March, April, May; 3=June, July, August; 4=September, October, November.

The BWT, 3MW and 6MW of Horro lambs under the on farmer condition were heavier (kg) by 0.24, 2.52, and 4.92 than the respective values of the traits under on-station condition. Single born Horro lambs were also heavier (kg) by 0.22, 1.57 and 0.93 than twin born lambs for BWT, 3MW and 6MW, respectively during the study periods. The BWT of male Horro lambs was heavier by about 0.13 kg than the BWT of female Horro lambs during the study period. Regarding the season of birth, Horro lambs born during the second season (in March, April and May) had lighter birth weights (2.44 kg) compared to the rest seasons of births (greater than 2.54 kg). BWT of Horro lambs from the first parity was also lighter (2.45 kg) than the subsequent parities (where the BWT of Horro lambs was at least 2.57 and above).

The early growth performance of Horro lambs was also given in Figure 1 for various years of study. The growth performance of the lambs had shown an improving trend from 2009 to 2013 and declined thereafter. However, the trend BWT was almost constant across years compared 3MW and 6MW (Figure 1).
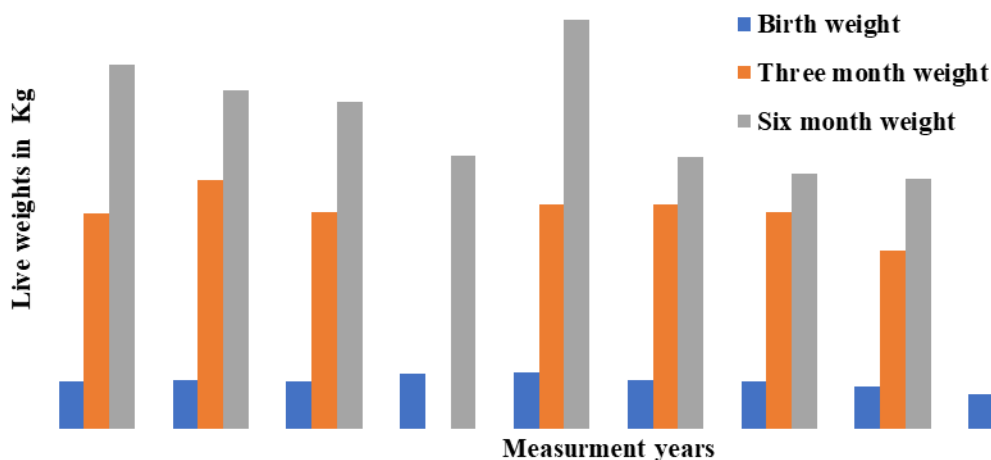

Figure 1. Early growth performances by year of births for Horro sheep from Bako Agricultural Research Center and fro CBBP of Horro district

Survival analysis Horro lambs up to three months of age

The odds ratio of survival of Horro lambs to three months of age is given in Table 2. The place of birth (being on farm and on station), type of birth (being born single or twin) and the magnitude of birth weight had highly significant effect (p<0.0001) on Horro lambs' odds ratio of survival to three months of age. Sex of lambs also had significant effect (p=0.0313) on Horro lambs' odds ratio of survival to three months. The odds ratio of survival to three months under the on farm condition (the community based breeding program in this case) was about 36 times the odds ratio of survival to three months under on

station condition (Table 2). Similarly, single born lambs had about 1.5 times odds ratio of survival to three month of twin born lambs. The odds ratio of survival to three months for male lambs was 0.76 times the odds ratio of survival of female Horro lambs during the study period. Regarding the influence of birth weight, there was about 1.36 increment of odds ratio of survival to three months for a unit increase of birth weight of Horro lambs (0.5 to 4.5 kg).

Table 2. The odd ratio estimates of survival of Horro lambs up three months as affected by various fixed factors in western Oromia, Ethiopia during 2009 to 2018.

Factors	Odds ratio of survival to three months	p-value
On farm births versus On station births	36.25	<0.0001
Single birth versus multiple births	1.49	0.001
Male lambs versus female lambs	0.76	0.0313
Birth weight	1.36	0.0009

In developing countries, research performances on animals are becoming inferior under on-station because of various reasons. The poorer early growth and survival performances of Horro sheep under on-station conditions could be due to (1) the management level the animals received, (2) the environmental factors, (3) combination of both. The management levels could include the feeding, health and housing. Under on-station conditions of BARC, sheep flock graze for about 9:00 hrs (8:00 to 17:00) during day times. Sometimes, the sheep flock were taken to grazing after 8:00 and brought back to their pens before 17:00 which lessens the time of grazing and hence contributed in poor growth performances. On top of this, the preset or recommended amount of concentrate supplementations and basal hay supplementations for different categories of sheep under the on-station conditions during controlled breeding and the rest parts of the year were hardly fulfilled owing to the fluctuating annual government budget dedicated to the sheep research at BARC. The shortage of hay at the farm level again contributed to the shortage of beddings to newly born and young lambs. The night time housings were also those constructed in the late 1970s with wood called bamboo tree and roofed corrugated iron sheet. These all could have contributed to the poorer early growth performances of Horro sheep at BARC.

In addition to the poor management levels at BARC, the agro-ecology of BARC is hot and humid and might be less suitable for Horro sheep compared to where the current CBBP of Horro sheep was implemented. The hot and humid weather was said to be convenient for diseases that demanded the highest commitments of animal health workers at the center. Hence, the early growth performances of Horro sheep under the on-station conditions were inferior to that of on-farm.

However, the current early growth traits of Horro sheep under on-station conditions were higher than previous reports for the same breed from on-station. The early growth traits of Horro lambs obtained under the on-farm condition in the current study was higher than values reported under on-station condition for same sheep breed in earlier works (Awgichew, 2000; Tibbo, 2006; Alemayehu et al., 2017).

The odds ratios of survival to three months for Horro lambs during 2010 to 2018 were compared to the odds ratio of survival to three months of age during 2009 (the initial implementation year of the CBBP). The odds ratio of survival for Horro lambs during the 2012 and 2013 were significantly higher (at least p<0.05) than odds ratio of survival during 2009. The odds ratio of survival during 2012 was about 26 times the odds ratio of survival of Horro lambs during 2009 (Table 3). Lamb Survival rate varies from one flock to another depending mostly on management level. Lamb losses also occur during the peri-natal, pre-weaning and post-weaning phases of the reproduction process (Awgichew, 2000). The overall

survival rates (%) to three months of age were about 97 and 59 under on-farm and on-station conditions, respectively.

Table 3. Comparison of odds ratio of survival to three months of age for Horro lambs

Years compared	Odds ratio of survival to 3 months	p –values
2010 vs 2009	0.759	0.4914
2011 vs 2009	0.614	0.2043
2012 vs 2009	26.23	<0.0001
2013 vs 2009	1.697	0.1660
2014 vs 2009	0.429	0.0226
2015 vs 2009	0.557	0.1315
2016 vs 2009	0.688	0.3233
2017 vs 2009	0.566	0.1504
2018 vs 2009	1.761	0.1658

A direct comparison of lamb survival rates could be difficult even within a region as lambs under on-farm and on-station are reared in different management practices and weaned at different ages. In traditionally managed sheep production systems of the tropics, lamb mortality between birth and 150 days of age is estimated to be between 10-30 % (Gatenby, 1986). The major factors affecting lamb survival include age of lamb, litter size, birth weight, and season of birth, nutrition and parity of the ewe (Gatenby et al., 1997; Armbruster et al., 1991; Notter et al., 1991). According to Fitzhugh and Bradford (1983), improvement in ewe nutrition during pregnancy has reduced lamb mortality from 23 % to 11 %. In most cases birth weight has a quadratic relationship with mortality rate whereby mortality tends to increase at extremely low or extremely high birth weights (Mendel et al., 1989; Cooper, 1982). Litter size affects the survival rates of lambs by reducing the birth weight (Awgichew, 2000) and up to 40% pre-weaning mortality rates were reported for multiple births in small ruminants (Gatenby et al., 1997).

The survival value obtained under on-farm condition during the current study was lower than the value reported by Abegaz et al. (2005) who reported that was about 97.3%. Abegaz and Duguma (2000) reported an overall mean of pre-weaning survival rate of 80.5% for the same breed under on-station management based on over data collected for 21. From the above findings it can be observed that on-station pre-weaning survival of Horro sheep maintained at BARC was very low warranting investigation of suitability of the center for the indicated sheep breed or reminding commitment required at higher level. The likely differences in the pre-weaning survival rate between on-station and on-farm flocks of Horro sheep may be mainly due to agro-ecology. Horro sheep breed was believed to be originated from the Horro highland and might be unable to adapt under the hot-humid lowlands of Bako areas. During the beginning of the CBBP, both Duguma (2010) and Mirkena (2010) reported lamb survival rate of 90.5% which was lower by 6.5% than the value reported in the current study. The likely reason may be the health intervention made by the project. According to Tufa et al. (2019), the CBBP sheep producers use anthelmintics (AH) at least four times per year per animal.

CONCLUSION

From the findings of this study, it can be concluded that unless full commitment, at government and technical staff level, is ensured neither genetic improvement nor conservation of Horro sheep breed could be realized under on-station condition at Bako Agricultural Research Center. The genetic improvement of Horro sheep at village level, under on-farm condition was confirmed to be a better alternative as health interventions and use of selected rams for breeding backstopped the traditional raising practices of sheep owners in Horro district.

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