

Comparative Evaluation of On-Farm Growth Performance of Local Gamo Highland and Gamo X Bonga F1 Crossbred Sheep in Chencha District, South Ethiopia

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Abstract: *The study was conducted to compare the on-farm growth performance of local Gamo highland and Gamo x Bonga first filial generation (F1) crossbred sheep in Chencha district. A total of 93 local Gamo highland and 125 Gamo x Bonga F1 crossbred sheep were used for data analysis. The study revealed that the overall mean growth performance of local Gamo highland sheep for birth, weaning, six-month, nine-month and yearling weights were 2.12 ± 2.20 , 8.84 ± 1.38 , 14.40 ± 1.73 , 19.17 ± 0.99 and 22.95 ± 1.20 kg, respectively. The corresponding parameters up to six-month weight for Gamo x Bonga F1 crossbred were 2.77 ± 0.65 , 15.01 ± 2.39 and 22.75 ± 2.08 kg, respectively. Crossbred sheep performed better than local Gamo highland sheep at respective growth stages and attained early at six-month weight the yearling weight of local Gamo highland sheep's market weight. Males showed higher values than females at all growth stages in general. The overall mean daily weight gain (g day^{-1}) of pre and post-weaning for local Gamo highland sheep were 74.7 ± 9.1 and 52.3 ± 0.7 , respectively. The corresponding values (g day^{-1}) for Gamo x Bonga crossbred were 136.0 ± 19.3 and 86.0 ± 3.4 , respectively. The growth rate of Gamo x Bonga F1 crossbred sheep were faster at both pre and post-weaning than local Gamo highland sheep. Hence, it is possible to conclude that crossbreeding of local Gamo highland sheep has improved sheep productivity in the study area.*

Keywords: Birth weight, Chencha, crossbred sheep, local Gamo highland sheep, weight gain



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1. Background and Justification

There are about 14 traditionally recognized sheep populations in Ethiopia, which are classified into nine genetically distinct breeds (Gizaw, 2008). The country has about 30.7 million heads of sheep, of which about 75% is found in the highlands where mixed crop-livestock production systems dominate (DAGRIS, 2006; CSA, 2017). Sheep production is among the most important agricultural activities in the mixed perennial crop (*Enset*; *Ensete ventricosum*) like Gamo highland areas and providing cash income from the sale of live animals, as insurance during crop failure, source of meat, and manure in Southern Ethiopia (Kocho, 2007).

However, sheep genetic improvement programs for local sheep breeds by crossbreeding with exotic breeds in developing countries like Ethiopia have not been very successful due to unsuitability of the exotic breeds with the breeding objectives and management approaches in low-input and low-output production

systems (Workneh *et al.*, 2003; Kosgey *et al.*, 2006). In addition, poor performance of imported breeds from the temperate regions to tropical region with sub-optimal management conditions and high importation cost has created a negative image for genetic improvement programs (Workneh *et al.*, 2003). Further, crossbreeds with exotics in Ethiopia were rejected by farmers upon dissemination because of sustainability of parent stock, high management and phenotypic unlikeness like Dorper sheep to the indigenous ones (Markos, 2006; Getachew *et al.*, 2016). In Ethiopia, past failures in sheep genetic improvement have led to new research design of breeding programs like community-based breeding program. It properly considers the farmers' breeding objectives, infrastructure and ownership and active participation from inception through implementation in situations where livestock keepers already run their animals together, such as in communal grazing areas (Sölkner-Rollefson, 2003; Solomon *et al.*, 2009; Solomon *et al.*, 2010; Gameda, 2011; Solomon *et al.*,

2011; Tadele, 2011). This program has a potential to produce improved indigenous sheep breeds so that local animals can replace the genetic potential of exotic breeds for tropical environments like Ethiopia.

Bonga sheep breed is one of the known Ethiopian indigenous sheep breeds produces at (1800 – 2835 m.a.s.l) and developed by community-based sheep breeding program initiated by International Center for Agricultural Research in the Dry Areas (ICARDA) project (Gizaw, *et al.*, 2013) and strengthening now by the government support. Sheep populations around Gamo highland are relatively characterized lighter and dwarf and with short tail (Abera *et al.*, 2013) than Bonga (Zewdu, 2008). However, its productivity in other similar agro-ecologies like Gamo highland areas was not well documented to replace the exotic genotypes. There is an uncontrolled dissemination trend of unknown rams like sheep from Dawuro Zone in south Ethiopia by different aid organizations for crossbreeding in the current study areas. However, the on-farm performance of the existing sheep ecotype and Bonga F1 crossbreds was not done and recorded. Thus, the current research was prepared to evaluate the comparative on-farm growth performance of both local Gamo highland and their F1 crossbred lambs with Bonga rams and to devise possible breeding intervention options in the study area.

2. Material and Method

2.1 Study area

The study was conducted in Chencha district, Gamo zone. Chencha is bordered on the south by Arba Minch Zuria, on the west by Dita, on the north by Kucha and on the east by Ego districts. It is located 37 kilometers north of Arba Minch. Chencha has a longitude and latitude of 6°15'N, 37°34'E, respectively and an elevation of 2732 meters above sea level. The average annual temperature is 16°C. The area is characterized by mixed farming system. The major crop types produced include inset, barley, wheat, bean, pea and potatoes.

2.2. Sampling method

Chencha district was selected purposively among Gamo highland areas for its high population of sheep (10,760 head) as indicated by Office of Livestock and Fishery (unpublished). Sheep keeping trend is

decreasing due to pastureland shortage. Based on farmers' requirement to improve the productivity of the local sheep, crossbreeding of the local sheep with other productive breeds was thought to be a solution. Hence, Bonga sheep breed was also purposively selected for crossbreeding for its big body size and fast growth rate than local Gamo highland sheep population. Accordingly, volunteer nearby households those who have ewes were established as ram user groups.

2.3 Sheep management

About 10 yearling improved Bonga rams were distributed for ram user groups. Sheep in the study areas depend largely on communal grazing by tethering. The disseminated rams were supplemented with locally available feed sources (barley, inset and home leftovers) along with grazing by tethering.



Figure 1: Local Gamo highland sheep eco-type grazing by tethering.

2.4. Mating method

Bonga rams improved by community-based breeding program through paternal line selection from Bonga agricultural research center (village cooperatives) were introduced for crossbreeding with local ewes by natural mating based on 1:25-30 male to female mating ratio. Ram user groups were well trained to keep ewes separately only to mate with improved Bonga rams and bring their breeding ewes when they show heat sign at any day time. Then, ewes were allowed for hand mating with improved Bonga rams at mating station.

2.5 Data collection procedure

Data collected were lamb breed, sex and weight (from birth to yearling every three months interval) for both breeds (local Gamo highland sheep and Bonga x Gamo F1 crossbred sheep). The effect of birth type and parity were not considered in the current study due to almost all the lambs born were single (small breeds are less prolific than the very large breeds (Gizaw *et al.*, 2013)) and sheep owners were not sure for their ewe parity, respectively. Sheep owners were trained to report to the trained data collector on daily basis in order to weigh the lambs and record all necessary parameters.

2.6 Data analysis

The lamb data were analyzed only for available data due to the high off-take rate to the market and some mortality. The collected data were analyzed using SPSS software (version 16.0). The response variables in the analysis were weights at different age categories and pre- and post-weaning growth rates. The fixed effects considered were the breed and sex of the lambs.

The model used to analyze the data is indicated below.

$$Y_{ij} = \mu + B_i + S_j + \epsilon_{ij} \quad [1]$$

Where

Y_{ij} = the responses of birth, weaning, six-month, nine-month, and yearling weights

μ = the overall mean

B_i = fixed effect of i^{th} breed (1= local Gamo highland sheep, Bonga x Gamo F1 crossbred sheep)

S_j = fixed effect of j^{th} sex (1 = male, 2 = female)

ϵ_{ij} = random error

3. Results and Discussion

3.1 On-farm growth performance

The on-farm growth performance of local Gamo highland sheep and Gamo x Bonga F1 crossbred sheep is presented in Table 1. The overall growth performance of local Gamo highland sheep for birth, weaning, six-month, nine-month and yearling weights were 2.12 ± 2.20 , 14.40 ± 1.73 , 19.17 ± 0.99 and 22.95 ± 1.20 kg, respectively.

The birth weight of the local sheep recorded in the present study was generally lower than the findings

of different researchers in different parts of the country. Accordingly, Lake *et al.* (2013) in Eastern Amharic, Behan and Anadem (2009) in Western Ethiopia indigenous sheep and Mekuriaw *et al.* (2013) in Farta and Washera recorded the birth weights of 2.36 kg, 2.45 ± 0.40 kg, 2.50 ± 0.02 kg and 2.61 ± 0.0 kg, respectively. The result of three-month weight for local Gamo highland sheep (8.84 ± 1.38) was comparable with reports of Lakew *et al.* (2013) and Zelalem (2018), but lower than that of Hassen *et al.* (2002) for local sheep group. On the other hand, the six-month body weight of local lambs (14.40 ± 1.73 kg) recorded in the present study was higher than the findings of Zelalem (2018) which was 13 ± 0.8 kg for local breed.

The yearling weight of local Gamo highland sheep (22.95 ± 1.20 kg) recorded in the present study was higher than Farta (20.08 ± 0.7) and Menz sheep, which were reported by Shigdaf (2011) and Gizaw *et al.* (2008a). However, the yearling weight observed was lower than the findings of Gizaw *et al.* (2008a) which was recorded by pure Bonga (27.8 ± 1.5) and Washera (23.6 ± 0.7). Similarly, the results were lower than the findings of Abegaz and Gameda (2000) for Horro sheep (23.7 ± 0.04).

The birth, weaning and six-month weights of Gamo x Bonga F1 crossbred sheep were 2.77 ± 0.65 , 15.01 ± 2.39 and 22.75 ± 2.08 kg, respectively as presented in Table 1. The birth weight of Gamo x Bonga F1 crossbred (2.77 ± 0.65 kg) was higher than the findings of other researchers where Derive *et al.* (2017) reported 2.55 ± 0.63 kg for Dorper cross lambs and Mekuriaw *et al.* (2013) found 2.59 ± 0.01 kg for Washera and Farta crossbreed lambs. However, the birth weight of the local Gamo highland sheep was lower compared to the pure Bonga sheep breed (3.42 kg) as reported by Hailed *et al.* (2014). Similar results were also reported by Metsafe (2015) where pure Bonga sheep breed weighed 3.6 kg at birth.

The weaning weight of Gamo x Bonga F1 crossbred (15.01 ± 2.39 kg) was higher than Washera and Farta crosses [11.17 ± 0.49 kg] (Mekuriaw *et al.*, 2013). On the other hand, it has comparable weaning weight with Dorper x local cross [14.95 ± 0.21] (Lakew *et al.*, 2013) and Pure Bonga [14.8 ± 0.2] (Aynalem *et al.*,

2014). The weaning weight of Gamo x Bonga F1 crossbred was however lower than the findings of Metsafe (2015) who reported 15.5 ± 0.08 kg for pure Bonga.

The body weight of Gamo x Bonga F1 crossbred recorded at six-month (22.75 ± 2.08 kg) was generally greater than those reported by Mekuriaw *et al.* (2013), Hassen *et al.* (2002) and Gizaw *et al.* (2013) for Farta x Washera, Awassi x local crosses and Awassi x Menz, respectively.

Generally, the findings of the present study revealed that Gamo x Bonga F1 crossbred performed better than local sheep at respective growth stages. Additionally, crossbred sheep had attained the yearling weight of local Gamo sheep early at six-month growth stage which will be associated with the effect of heterosis. Moreover, on-farm performances of both study sheep were affected by sex. Except for birth and yearling weights, males of local Gamo highland sheep were relatively heavier than the females. On the other hand, in crossbred sheep, males recorded higher weights than females at all growth stages.

Table 1: On-farm growth performances of local Gamo highland and Gamo x BongaF1 crossbred sheep in Chencha district

Sheep breed	Effect	N	BW (mean \pm SD)	WW (mean \pm SD)	6MW (mean \pm SD)	9MW (mean \pm SD)	Yearling (mean \pm SD)
	Sex		*	*	*		
G	Overall	93	2.12 \pm 2.20	8.84 \pm 1.38	14.40 \pm 1.73	19.17 \pm 0.99	22.95 \pm 1.20
	Male	41	2.44 \pm 3.30	8.72 \pm 1.30	14.33 \pm 1.88	19.16 \pm 0.89	23.03 \pm 1.03
	Female	52	1.87 \pm 0.21	8.96 \pm 1.46	14.45 \pm 1.62	19.18 \pm 1.10	22.91 \pm 1.32
G x B	Overall	125	2.77 \pm 0.65	15.01 \pm 2.39	22.75 \pm 2.08	-	-
	Male	63	2.80 \pm 0.67	14.99 \pm 2.45	24.50 \pm 1.51	-	-
	Female	62	2.72 \pm 0.63	11.06 \pm 2.36	21.35 \pm 1.22	-	-
	Breed		*	*	*		
	G	93	2.12 \pm 2.20	8.84 \pm 1.38	14.40 \pm 1.73	19.17 \pm 0.99	22.95 \pm 1.20
	G x B	125	2.77 \pm 0.65	15.01 \pm 2.39	22.75 \pm 2.08	-	-

*P<0.05, G= Local Gamo highland sheep, B x G= Gamo x BongaF1 crossbred sheep, N=number of observations, BW= birth-weight, WW= weaning-weight, 6MW= six-month weight, 9MW= nine-month weight, SD= standard deviation

3.2. Growth rate

The pre-and post-weaning growth rate of local Gamo highland sheep and their crossbreds with Bonga rams sheep is presented in Table 2. The overall growth rate (g day^{-1}) of pre and post-weaning growth rate of local Gamo highland sheep were 74.7 ± 9.1 g day^{-1} and 52.3 ± 0.7 g day^{-1} , respectively. The current finding of pre-weaning daily average weight gain for local Gamo highland sheep was higher than the report of Zelalem (2018) for local breeds (64.8 ± 5.5 and 63.4 ± 4 g day^{-1}) whereas post-weaning daily average weight gain was lower under similar management conditions. The rate of daily weight gain of Gamo highland sheep at pre-weaning was faster than those at post-weaning. Female sheep (78.8 g day^{-1}) showed faster weight gain during pre-weaning than males (69.8 g day^{-1}), while male sheep (53.0 g day^{-1}) gained

weight rapidly during post-weaning than the females (51.7 g day^{-1}).

The overall growth rate of pre and post-weaning for BongaF1 crossbred sheep was 136.0 ± 19.3 and 86.0 ± 3.4 g day^{-1} , respectively as presented in Table 2. The current findings of pre-weaning daily average weight gains for crossbred was higher than the findings of other researchers (Deribe *et al.*, 2017, Mekuriaw *et al.*, 2013) where Zelalem (2018) reported weight gain of 92.2 ± 5.4 g day^{-1} for local breed. Comparable post-weaning daily average weight gains for crossbred were reported by Zelalem (2018) for local breeds (86 ± 4 g day^{-1}) under similar management conditions. However, lower findings reported beelike *et al.* (201) for Dorper X local crosses and Aynalem *et al.* (2014) for Bonga. Generally, Bonga F1 crossbred sheep pre-weaning

weight gain rate recorded in the present study was faster than the post-weaning rate which could be attributed to weaning shock. Similarly, males (135.4 g day^{-1}) showed faster weight gain during pre-weaning than females (92.7 g day^{-1}), but females (114.3 g day^{-1}) revealed rapid weight gain during post-weaning than males (105.7 g day^{-1}).

The current study revealed that crossbred F1 sheep were faster in weight gain during both pre and post-weaning than local Gamo highland sheep. The possible reason for this may be the hybrid vigor effect of crossbreds. Therefore, the superior daily average body weight gain of Bonga F1 crosses over local sheep attracts farmers in the study area to use Bonga sheep breed as one of the parent stocks.

Table 2: Weight gain of local Gamo highland and Gamo x Bonga F1 crossbred sheep in the study area

Sheep breed	Effect	N	Pre-weaning (mean±SD g day ⁻¹)	Post-weaning (mean±SD g day ⁻¹)
	Sex		*	*
G	Male	41	69.8±22.2 ^b	53.0±1.0 ^a
	Female	52	78.80±13.90 ^a	51.7±0.5 ^b
G x B	Male	63	135.4±19.8 ^a	105.7±10.4 ^b
	Female	62	92.7±19.2 ^b	114.3±12.7 ^a
	Breed		*	*
	G	93	74.7±9.1 ^b	52.3±0.7 ^b
	G x B	125	136.0±19.3 ^a	86.0±3.4 ^a

* P<0.05, G = Local Gamo highland sheep, G x B = Gamo x Bonga F1 crossbred sheep; N= number of observations, SD = standard deviation

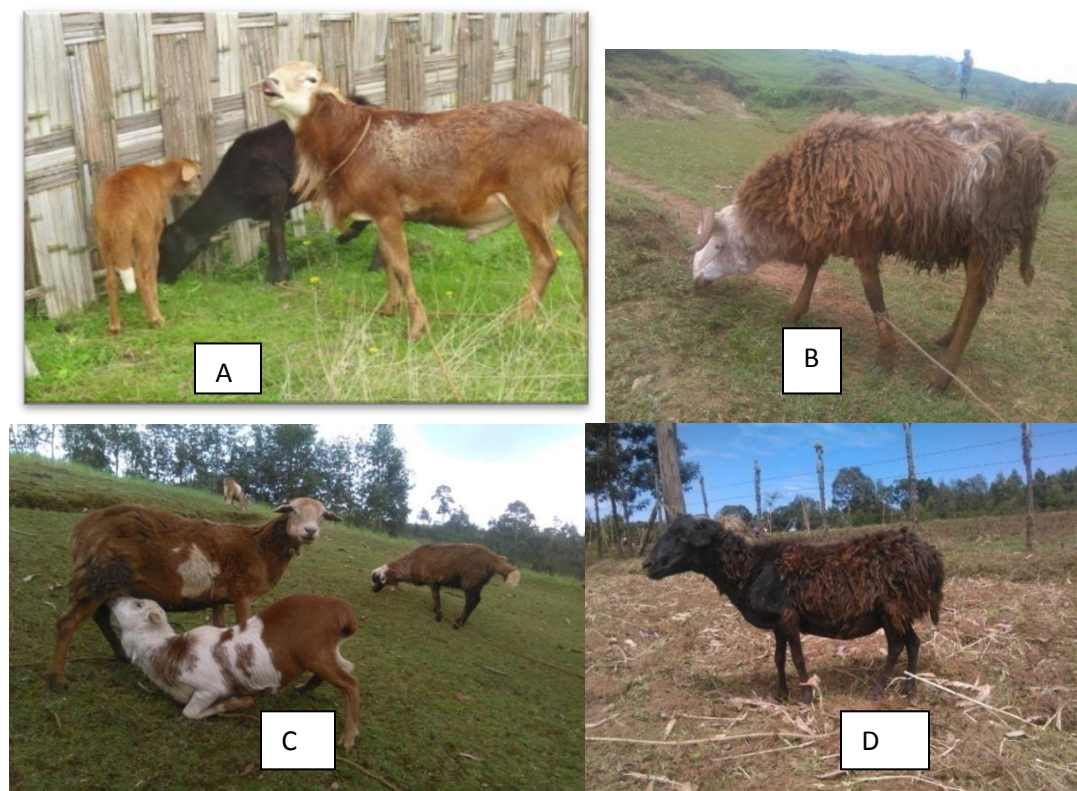


Figure 2: Local Gamo highland sheep and Gamo x Bonga F1 crossbred sheep in the study areas.

A = Improved Bonga ram with FI lamb; B = Typical local Gamo highland ram; C = local Gamo highland ewe with 3 months crossbred FI lamb; D = Typical local Gamo Highland ewe

4. Conclusions and Recommendation

In the current findings, on-farm growth performance of both study sheep was affected by both sex and breed. Males revealed higher values than females at growth stages for both sheep breeds in general. This could be due to sex affected genes for males. Gamo x BongaF1 crossbred sheep breed showed better growth performances than local Gamo highland sheep at birth, weaning and six-month weights.

The weight gain rate for pre-weaning was faster than post-weaning rate. Weaning shock and management could be factors for lower weight gain at post-weaning. The study revealed that Bonga crossbred F1 sheep were faster in weight gain at both pre and post-weaning than local Gamo highland sheep. This could be attributed with genetic effect of Bonga sheepbreed. To improve local Gamo highland sheep productivity in terms of attaining at early market weight, finisher crossbreeding with improved Bonga rams was recommended in the study area.

Conflict of Interest

The authors declared that there is no conflict of interests.

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