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On-farm performance evaluation of Maale goats under agro-pastoral management in Southwest Ethiopia

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A B S T R A C T

This study was conducted in Maale district Southwest Ethiopia with the objective of evaluating the productive and reproductive performance of Maale goats under agro-pastoral management conditions. Thirty households that have flocks numbers of more than ten were purposely selected and monitored from July 2018 to July 2019. Growth data of birth weight, three month, six month, nine month and yearly weight; birth type and parity were collected. The data were analyzed using the General Linear Model (GLM) procedure of SPSS (21). The overall mean birth weight of the kids was 2.57±0.05 kg (males 2.68±0.07 and females 2.47±0.07 kg). The weaning and six months weight of kids was significantly different ($p<0.05$) between sexes of kids with 7.66±0.25 and 6.90±0.23 kg for male and female kids, respectively. The average body weight of males and females for six months; nine months and yearly were 11.57±0.30, 10.42±0.28; 15.42±0.27, 14.69±0.25 and 19.03±0.28, 18.43±0.25 kg, respectively. The birth type showed a significant ($p<0.05$) difference in birth weight. The result further indicated that the weaning weight of single and twin kids was highly significant ($p< 0.001$) and recorded as 7.66±0.25 and 6.90±0.23 kg, respectively. The overall pre-weaning average daily gain was 51.64±1.89 g day^{-1} (54.47±2.81 male and 48.93±2.53 g day^{-1} female). The birth type was significantly ($p=0.01$) different in pre-weaning growth rate and recorded 57.24±1.63 and 45.24±3.59 g day^{-1} for single and twin kids, respectively. Twins had higher post-weaning average daily gain than single and recorded as 43.61±1.48 and 40.76 ±0.70 g day^{-1}, respectively. It was concluded that, along with other management interventions, the reproduction and growth performance of Maale goats is reasonably good and suited for community-based breeding strategies and higher performance could be expected.

Keywords: Ethiopia, Maale Goats, Performance, Productive, Reproductive, South Omo

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Introduction

Livestock production is one of the primary agrarian activities which directly or indirectly employ a large section of the society especially those residing in the rural areas (Belay and Meseretu, 2018; CSA, 2021). Several studies have indicated that the overall productivity of the livestock does not commensurate with their population (Aberra, 2018). Results of the latest livestock census showed that there is huge number of goats, which estimated in 52.5 million, which are reared across the diverse agro-ecological zones and production system of the country (CSA, 2021). Despite huge number and genetically diverse, Ethiopian indigenous goats are genetically less productive as compared to temperate breeds (Mohammed *et al*. 2012).

Goats are deeply embedded in almost every African culture and are true friends to rural people of Sub Saharan Africa in particular (FARM Africa, 2005). Goats can play a vital role in ensuring the food security of a household, often being the only asset possessed by a poor family. In time of trouble, such as crop failure or family illness, goats can be sold and food or medicine purchased (FARM Africa, 2005). Goats also provide their owners with a broad range of products and socio-economic services and have played an important role in the social life of many African people, being used as gifts, dowry, in religious rituals and rites of passage (Peacock, 1996).

Based on phenotypic characterization, the country is endowed with 15 goat populations (IBC, 2004), even though, the recent molecular study regrouped in to seven genetic entities (Mekuriaw, 2016). Goats are the significant species for the rural communities that reared in large flock since they are adaptive to harsh environment than sheep and cattle species (Birhanie *et al.*, 2018). Goats are provided 3.4 and 1.6 times higher gross margin than sheep and cattle, respectively in dry area of the country (Woldu *et al.*, 2016).

Goat production has become very popular in recent years as a path way out of poverty (Ahuya *et al.*, 2003) and has been regarded as a feasible means to improve the income and nutrition of rural communities and to bring these communities into commercial marketing systems (Braker *et al.*, 2002). However while the wide spread cultural acceptance of goat and goat products for development there are many physical, economic, social and political constraints to developing goats in Sub-Saharan Africa (FARM Africa, 2005). Attempts to document indigenous goat breeds of Ethiopia and their performance using different methods have been conducted since long (Deribe, 2009; Hassen *et al.*, 2012; Dereje *et al.*, 2013). However, studies of on-farm performances of a goat breed at community level are quite limited.

Performance recording is an important tool to suggest for the breeding policy for a given area. However, recording in general is hardly practiced in many livestock species in the country, to identify the performance and management gaps (Tibbo, 2006). Reproductive and productive performances are important indicators of adaptability and management suitability (Abegaz *et al.*, 2002; Getahun *et al.*, 2008). Birth weight, birth type, pre and post-weaning, parity of doe and season of birth are important traits that can affect the profitability of the goat enterprise (Zeleke *et al.*, 2017). These important traits are affected by a number of factors. Genetically and environmental factors are dramatically affect the goat production. Among these factors, pre-weaning mortality of young kids is the essential problem for the breeders. Mortality is documented as the main factor adversely affecting goat production in the tropics (Zeleke *et al.*, 2017). It needs a strategic post-survey recording and documentation of the performances of the animals in their native environment under farmer's condition.

Very often, the results obtained from on-station research are of little relevance to traditional production systems and may not contribute much towards understanding of the specific adaptation of animals to farmer's conditions (Rey *et al.*, 1992). Documentations of important productive and reproductive traits related to the Woyto-Guji (locally known as Woyto, Guji or Konso) goat breed at on farm level are very little. However, information is lacking in this regard, and no study has yet been conducted to identify such factors. Therefore, this study was aimed to evaluate and measure on-farm productive and reproductive performances of Woyto-Guji goats in their breeding tract under agro-pastoral management conditions.

Materials and Methods

The study area

Maale woreda is one of the ten woreda's found in South OmoZone, which covers an area of 1432 km^2 and has human population estimated 102,870. The population density of the woreda is 66 persons per km^2. The woreda is divided in to 23 rural and 1 urban PA. The altitude of the woreda ranges between 600-1500 m.a.s.l. Its astronomical locations are 5.08^{o}N - 6.01^{o}N latitudinally and 36.3^{o}E - 37^{o}E longitudinally. There are two major agro ecologies found in the woreda namely kola and woynadega, which account 85% and 15%, respectively. The mean annual RF ranges between 800-1200 mm and the mean annual temperature ranges between18-35^{o}c. The woreda has animal resources with an estimated amount of 324,652 cattle, 81,181 sheep, 452,943 goats, 213,456 local and improved poultry, 12,256 equines, 2870 dogs, 3028 cats and 267,216 bee colonies. The average land holding of the woreda ranges from 0.15-2.10 hectare. There is only one ethnic group/Maale/ found in the woreda and their farming system is mixed crop livestock production system (Bizuayehu *et al.*, 2016).

Data source and management

All collected data were coded and recorded in excel sheet. On farm flock, monitoring was carried out in three kebele's of the woreda. The kebele's were selected purposively based on the goat population and access for infrastructure. Accordingly, thirty households with flocks numbers more than 10 were selected, and a total of 30 Flocks were monitored from July 2018 to July 2019. At the beginning of the study, all flocks were ear tagged. The age of the goats and parity were identified with dentition and information from the rearers.

Data was collected by trained enumerated in the selected kebele's and supervised by researchers in a monthly interval. Data collected on growth include birth weight, three months weight, six months weight, nine and twelve month's weight. In addition, season of birth, type of birth, does parity also taken. Body weight was taken every month using hanging scale balance (50 kg capacity with 200 g precision) for kids until six months of age and with three months interval thereafter.

Growth rate (Average Daily Gain, ADG) was computed as:

Pre-weaning ADG (g day^{-1}) = (3 MWt – Birth Wt)/90
Post-weaning ADG (g day^{-1}) = (Yearly wt – three months weight)/275.

Milk yield data

Data on milk yield was taken from 61 doe's. After parturition, dam milk production was measured once in a week to 3 month postpartum. Dam was separated from their progeny in the late afternoon when they came in from grazing. Early next morning one-half of the udder was milked out by hand and kids then allowed to suck to satiety and again separated. In the afternoon, 24 hr after the initial separation on the day, half of the udder was again milked out. Total milk recorded at the morning and afternoon milking was doubled to give an estimate of daily milk production.

Statistical analysis

The collected data was analysed using the General Linear Model (GLM) procedure of SPSS (21). Dependent or response variables in the analysis were birth weight, weight at different ages and pre and post weaning and average daily weight gains. The fixed effects considered were sex of the kid, parity of the doe, birth type and season of birth.

The model used to analyse growth traits was:

$$Yijkl= \mu + Si + Pj + Bk + Tl\varepsilon ijkln$$

Where,

Yijkl = observed live weight and weight gain ($Yijkl^{th}$ individual)
μ = overall mean
Si= the effect of the i^{th} sex (i = 1, 2)
Pj = the effect of the j^{th} parity (j = 1, 2, 3, 4, 5, ≥6)
Bk= the effect of the k^{th} type of birth (k = single, twin)
Tl= the effect of the l^{th} season (l = wet, dry)
εijkln = random residual error associated to $Yijkln^{th}$ observation

Results and Discussion

Flock monitored

From the studied thirty agro-pastorals in the beginning, there have been 750 goats and after one year, the goat number reached 875. The flock number was increased by 17% in one year. A total of 343 (male 167 and female 176) kids birth data were recorded during the flock monitoring period. Male to female ratio of the new births were 0.95:10. The result indicated that sex categories did not appear differently from the expected ratio of 50:50. The mean number of flock at the end of the study period was 29.17±12.76 (Mean±SD) with the range of 14-70 goats per HH.

Growth performances

Birth weight, three month, six month, nine month and yearly weight of goats in the studied district was presented in table1.

The result in Table 1 showed that sex had a significant effect ($P<0.05$) on birth weight, weaning weight and six months weight of the kids. The birth weight of males and female kids were 2.68±0.07 and 2.47±0.07 kg, respectively with the overall mean birth weight of 2.57±0.05 kg. The present result was higher than studied by (Alemu, 2015; Belay and Mengistie, 2013) which was reported 1.98±0.06 and 1.91±0.04 kg, respectively for Abergalle goats and comparable with the study of Deribe (2009) for Alaba goats. The type of birth, sex, parity, the development and age of dam, length of pregnancy, feeding, season of kidding, parity and health condition (Mioč *et al.*, 2011) may acclimatize these variations of birth weight.

The sex of the kids had statistically significant ($p<0.05$) effect on birth weight. Male had a heavier weight as compared to the female kids; this may be due to the effects of sexual-size dimorphism (Liao *et al.*, 2013). The birth weight obtained in the present study was comparable with reports of Mehlet (2008) for Arsi-Bale goats at on-station and Tatek *et al.* (2004) for Arsi-Bale goats under traditional management conditions. Birth weight is an economic trait, which has a positive relation with kid survival and overall post-natal development.

The effect of the type of birth on kids' birth weight clearly demonstrated that in this study single kids were significantly ($p<0.05$) heavier than twin kids. According to the result, single and twin kid's birth weight was 2.67±0.04 and 2.46±0.09 kg, respectively. The differences in birth weight in different litter size may be due to the small size and weight of the twin in the uterus (Bushara *et al.*, 2013; Zeleke *et al.*, 2017). Kugonza *et al.* (2014), confirms these results that birth weight decreased as litter size increased with single kids growing much faster than twins do at all ages. It is probable that single kids consume more colostrum and hence more immunoglobulins than twins or triplets. This means that resistance to disease is stronger in singles and hence the higher possibility of a better growth rate and live body weight (Kugonza *et al.*, 2014). It also means that the higher birth weight of single born kids than those of multiple births is probably due to the sharing of uterine space and uterine nutrient by the fetus of multiple births leading to lowered birth weight (Soundararajan and Sivakumar, 2011). Weaning weight of single and twin kids was highly significant ($p<0.001$) and was 7.86±0.15 and 6.60±0.32 kg, respectively.

The effect of season of birth on body weight was statistically significant ($P<0.05$). The kids born during dry season (2.67±0.07 kg) weighed heavier than wet season (2.47±0.06 kg). The result was in agreement with Deribe (2009) for

Alaba goats and Zeleke *et al.* (2017) for Central Highland x Boer crossbred goats. This could be due to the availability of better nutrition (grass and browsing tree) in the later stage of pregnancy i.e. during end of wet season. Besides the same, the doe/kids may not be able to go for browsing due to heavy rains and the only option to feed such doe/kids is through cut and carry system. Zeleke *et al.* (2017) also explained that, the effect of season might be partly by the climatic conditions and feed availability during mating and pregnancy of dam. The lowest birth weight during wet season may be due to that goats in wet season do not graze well due to the dew and wetness of the environment, which consecutively affect the foetus at pregnancy. According to Deribe (2009), the higher birth weight in kids born in the dry season is related to the better body condition of the dams due to good body reserves during the early dry season. Furthermore, goats were in a better body condition irrespective of feed availability when they were free wandering during the dry season, having chance for feed selection. Weaning weight and six months weight of kids was significantly different ($p<0.05$) between sex of kids. Accordingly, weaning weight of male and female kids was 7.66±0.25 and 6.90±0.23 kg, respectively.

Six months weight of male and female kids was 11.57±0.30 and 10.42±0.28 kg, respectively. The least square mean of nine months weight of male kids was 15.42±0.27 kg and female goats was 14.69±0.25 kg, average yearly weight of male and female goats at Maale woreda was 19.03±0.28 and 18.43±0.25 kg, respectively. The result was higher than the reports of Abergalle goats at Sekota area (Belay and Mengistie, 2013).

Table 1. Least square means and standard errors for weights from birth to yearly age of Malle goats.

Factor	Birth Wt (kg)		3mon Wt (kg)		6mon Wt (kg)		9mon Wt (kg)		Yearly Wt (kg)	
	N	LSM(±SE)	N	LSM(±SE)	N	LSM(±SE)	N	LSM(±SE)	N	LSM(±SE)
Overall	343	2.57±0.05	304	7.27±0.17	275	10.97±0.21	259	15.04±0.18	252	18.72±0.19
Sex of kid		*		*		*		NS		NS
Male	167	2.68±0.07	147	7.66±0.25	132	11.57±0.30	125	15.42±0.27	120	19.03±0.28
Female	176	2.47±0.07	157	6.90±0.23	143	10.42±0.28	134	14.69±0.25	132	18.43±0.25
Birth type		*		***		NS		NS		NS
Single	276	2.67±0.04	244	7.86±0.15	223	11.32±0.19	208	14.97±0.17	203	18.89±0.17
Twin	67	2.46±0.09	60	6.60±0.32	52	10.50±0.41	51	15.13±0.36	49	18.48±0.37
Season of birth		*		NS		NS		NS		NS
Wet season	202	2.47±0.06	179	7.32±0.24	161	11.21±0.28	153	15.18±0.25	149	18.88±0.25
Dry season	141	2.67±0.07	125	7.22±0.25	114	10.75±0.30	106	14.91±0.27	103	18.56±0.27
Parity of doe		NS		NS		NS		NS		NS
1	46	2.51±0.15	38	6.87±0.51	35	10.68±0.55	34	14.49±0.49	34	18.17±0.48
2	74	2.61±0.10	66	7.32±0.41	56	11.09±0.53	53	15.54±0.48	52	19.02±0.47
3	63	2.49±0.10	55	7.82±0.41	47	11.34±0.47	44	14.63±0.42	42	18.38±0.44
4	50	2.53±0.17	45	7.18±0.55	41	10.44±0.67	36	15.05±0.61	35	18.90±0.61
5	38	2.57±0.11	37	6.87±0.36	37	10.90±0.45	36	14.98±0.40	36	18.95±0.40
>6	72	2.71±0.09	63	7.46±0.29	59	11.16±0.37	56	15.30±0.34	53	18.68±0.36

**p < 0.05, ** p< 0.01, *** p< 0.001; Means with different letters within the same column are significantly different at the indicated level. NS: Not Significant; N: number of observations.*

According to the studied result, the birth weight of the kids in the parity of the first, second, third, fourth, fifth and more than six were, 2.51±0.15, 2.61±0.10, 2.49±0.10, 2.53±0.17, 2.57±0.11 and 2.71±0.09 kg, respectively (Table 1). Although, the weight of the kids through all parities statistically insignificant there were plenty and visual difference in the birth and three months weight. This may be attributed with the advancement of the animal age or it may due to physiological stress experienced by goats. According to study of Deribe (2009), there was non- consistent increment of birth weight as parity advanced. The decline of dam's productivity soon after reaching certain level of threshold, as it was observed from the sharp decrement in fifth parity, might partly be due to the management and aging effect at higher parties (Deribe, 2009).

Weight Gain (ADG) performance of the kids

The overall pre-weaning average daily gain for the studied goats was 51.64±1.89 g (Table 2). The pre-weaning average daily gain obtained in this study was comparable with Abergalle goats (Belay and Mengistie, 2013). Pre-weaning ADG of male and female kids was 54.47±2.81 and 48.93±2.53 g, respectively. However, there was no significant difference in average daily weight gain between male and female kids. Similar result was also observed by Zeleke *et al.* (2017), sex of kids had no influence on pre weaning and post weaning kid survival rates for Central Highland x Boer crossbred goats. The present study disagreed with the study by Gatew *et al.* (2019) who reported that sex of kids affected significantly by total daily weight gain in Bati goats. Sex of kids, season of birth and parity of doe were non-significant ($p > 0.05$) on the average daily weight gain of Maale goats and similar results was reported by Gatew *et al.* (2019) in Bati goat.

The result further indicated that, birth type was significantly ($p<0.01$) different in pre-weaning ADG and recorded as 57.24±1.63 and 45.24±3.59 g for single and twin kids, respectively. Kids born as single were higher in pre weaning daily body weight gain than twins; this result was in agreement with (Zeleke *et al.*, 2017; Bushara *et al.*, 2013). According to those authors, this difference is probably due to the intrauterine environment where a higher availability of nutrients to the single kid, lack of competition as well as more space may facilitate growth. The uterine space and available nutrient shared by more than one kid may be responsible for the reduced birth weight with increasing litter size. However, the pre-weaning ADG was not affected by season of birth in this study, many researchers, indicated that there have been factors of birth season on ADG (Zeleke *et al.*, 2017; Gatew *et al.*, 2019). The overall Post-weaning ADG was 41.98±0.75 g day^{-1}. Post-weaning ADG was non-significant for the studied fixed effects. However, twins have higher post-weaning ADG than singles and recorded as 43.61±1.48 and 40.76±0.70 g day^{-1}, respectively. According to the current result wet and dry season birth post weaning weight ADG was recorded as 42.30±1.02 and 41.69±1.10 g day^{-1}, respectively.

Table 2. Least square means and standard errors for pre and post average daily gain from birth to yearly age of Maale goats.

Factors	Pre-weaning ADG (g day^{-1})		Post-weaning ADG (g day^{-1})	
	N	LSM(±SE)	N	LSM(±SE)
Overall	305	51.64±1.89	252	41.98±0.75
Sex of kid		NS		NS
Male	147	54.47±2.81	120	42.28 ±1.11
Female	158	48.93±2.53	132	41.71±1.01
Birth type		**		NS
Single	245	57.24±1.63	203	40.76 ±0.70
Twin	60	45.24±3.59	49	43.61±1.48
Season of birth		NS		NS
Wet season	180	52.96 ±2.60	149	42.30 ±1.02
Dry season	125	50.38±2.73	103	41.69±1.10
Parity of doe		NS		NS
1	38	48.07 ±5.61	34	40.39 ±1.95
2	67	50.07±4.51	52	42.87 ±1.91
3	55	58.85±4.48	42	40.33±1.76
4	45	51.68±6.10	35	42.05±2.43
5	37	47.75±4.01	36	44.21±1.60
>6	63	52.55±3.18	53	41.27±1.44

*** p< 0.01, Means with different letters within the same column are significantly different at the indicated level. NS: Not Significant; N: number of observations; ADG = Average Daily Gain; g day^{-1}= gram per day.*

Milk production of Maale goats

Milk yield increased gradually with the progress of parity (lactation number) in the present study. Milk yields were 293.5±17.60, 322.4±18.90, 327.6±18.80, 326.1±18.90, 320.8±18, 313.5±16.80, 301.7±16.20, 297.8±16.60 and 289.4±16.2 g from the first to the 9th week of the studied period, respectively. It shows that gradually increased up to week 5 and decreased then afterwards. The yield was also gradually increased with parity number. The present result was comparable with Somali goats, which produce between 0.3 to 0.5 litres of milk per day under grazing condition (Mengistu *et al.*, 2007). The milk production potential of Maale goats was also lower than Begait goats, which are capable of producing 0.55 kg of milk daily without supplementation but 0.7 kg with supplementation (Berhane and Erik, 2006). The results of this study were in agreement with the findings of other studies made in the tropics (Hossain *et al.*, 2004).

Table 3. The result of the daily milk yield of doe's for nine weeks of the monitoring period.

Parity	Mean (±SEM) of milk of doe (ml)								
	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8	Week9
1	261.75 ±34.0	300.0±44.2	301.5±34.5	302.25±32.1	300.0±33.2	287.25±32.6	276.0±29.2	282.0±33.1	273.0±30.5
2	280.20±43.9	300.7±44.3	303.4±40.4	305.70±46.1	296.6±60.3	295.90±40.1	285.7±38.4	268.6±40.3	275.5±38.4
3	286.40±36.8	307.5±42.7	332.7±44.2	315.70±44.5	321.8±40.6	304.10±38.3	304.8±37.2	306.1±36.3	292.5±35.5
4	282.00±42.7	339.8±48.2	321.3±49.5	326.00±52.1	306.0±45.1	316.50±41.8	292.5±40.6	300.8±40.7	287.3±41.9
5	273.30±49.1	295.3±52.7	310.8±56.9	310.00±54.0	305.8±55.9	307.50±50.0	284.2±48.5	285.0±50.1	267.5±48.9
6	377.30±51.2	392.3±52.5	396±54.9	398.30±53.3	395.2±53.1	372.00±49.3	366.8±46.2	345.0±48.9	339.8±47.8
Overall	293.5±17.6	322.4±18.9	327.6±18.8	326.1±18.9	320.8±18.0	313.5±16.8	301.7±16.2	297.8±16.6	289.4±16.2

Summary and Recommendations

Small ruminants have socio-economic and cultural values other than their physical products meat, milk, skin, manure, etc. They are considered as a risk averters for a family through sale for quick and seasonal needs. The objective of the study was to evaluate the productive and reproductive performance of goats in Maale agro-pastoral woreda, Southern Ethiopia. On farm flock monitoring was carried out in three kebele's of the woreda. The kebele's were selected purposively based on the goat population and access for infrastructure. Thirty households with flocks numbers more than ten were selected, and a total of 30 flocks were monitored from July 2018 to July 2019. Data was collected by trained enumerated in the selected kebele's and supervised by researchers in a monthly interval. The mean number of flock at the end of the study period was 29.17±12.76 (mean±SD) with the range of 14-70 goats per HH.

The birth weight of males and female kids was 2.68±0.07 and 2.47±0.07 kg, respectively with the overall mean birth weight of 2.57±0.05 kg. According to the result, single and twin kid's birth weight was 2.67±0.04 and 2.46±0.09 kg, respectively. Weaning weight of single and twin kids was highly significant ($p<0.001$) and was 7.86±0.15 and 6.60±0.32 kg, respectively. These weights and growth rates at specific ages pointed out that goat of the area express better productive capacity. These situations indicate the opportunity for further improvement of the reproductive and growth performances of the animals through appropriate strategies of community based improvement, disease prevention and control, water development, feeding and husbandry practices. The milk production potential of Maale goats was low. However, there is a good potential to increase the DMY to about 1 kg through improved management system. It is concluded that performance level of the goats of Maale area as measured by reproduction and growth parameters is reasonably good and if appropriate community based breeding strategies designed, higher performance could be expected. The contribution of goats to the agro-pastorals enterprise is also satisfactory and could be further improved if modest interventions are undertaken to reduce the barriers.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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