International Journal of
Life Sciences
International Peer Reviewed Open Access Refereed Journal

Int. J. of Life Sciences, 2022; 10 (1):21-32
ISSN:2320-7817(p) | 2320-964X(o)

Research Article Open Access

Productive and Reproductive Performances of Arab Goats in the Western Lowlands of Ethiopia

Befikadu Zewdie[1*], Mengistu Urge[2], Yosef Tadesse[3], Arvind Chavhan[4] and Solomon Gizaw[5]

[1]Departement of Animal Sciences, Assosa University, P.O.Box 18, Ethiopia;
ORCID ID:https://orcid.org/0000-0002-6861-133X
[2,3] School of Animal and Range Sciences, Haramaya University, P.O. Box 138, Dire Dawa, Ethiopia;
[2]E-mail: urgeletta@yahoo.com | [3]E-mail: yosef.tadesse@gmail.com
[4]Department of Zoology, Digambarrao Bindu College, Bhokar, Nanded, MS, India
[5]LIVES project, International Livestock Research Institute (ILRI), P.O.Box 5689, Addis Ababa, Ethiopia;
E-mail: s.gizaw@cgiar.org.
. *Corresponding Author E-mail: zewdienati@gmail.com

Manuscript details:
Received: 02.02.2022
Accepted: 10.02.2022
Published: 21.02.2022

Cite this article as:
Befikadu Zewdie, Mengistu Urge, Yosef Tadesse, Arvind Chavhan and Solomon Gizaw (2022) Productive and Reproductive Performances of Arab Goats in the Western Lowlands of Ethiopia, *Int. J. of Life Sciences*, 10 (1): XX-XX

Available online on http://www.ijlsci.in
ISSN: 2320-964X (Online)
ISSN: 2320-7817 (Print)

ABSTRACT

Assessment of performance of goats under farmers'management condition is necessary to design appropriate strategy for sustainable goat improvement. Accordingly, the present study was conducted to estimate growth, reproductive performance, and milk yield of Arab goats as a step towards designing sustainable goat genetic improvement and conservation strategy. Flocks of 40 households having 61 does were monitored for a period of 15 months. The overall mean for birth weight (BW), weaning weight (WW), six-month weight (6MW), and yearling weight (YW) were 2.56±0.61, 8.47±2.09, 11.82±2.41, and 16.17±1.62 kg, respectively. The result showed that BW was significantly affected by sex and parity of does. Weaning weight and YW were significantly affected by sex and parity, respectively. Season of birth and parity significantly affected 6MW. Age at first kidding (AFK) and kidding interval (KI) were 354.55±83.78 days and 7.97±1.14 months, respectively. Does kidded during the wet season had short AFK and KI than those kidded during the cool season or dry season. Does which kidded at third parity had shorter KI ($P<0.001$) than other parities. The overall milk yield per day (DMY), lactation total milk yield (TLMY), and lactation length (LL) were 0.36±0.28 litters, 14.14±4.20 litters, and 39.25±10.20 days, respectively. Seasons of birth and parities affected TLMY and LL ($P<0.001$). The study revealed improving the non-genetic factors that affect productivity and appropriate selection strategy can increase the productivity of Arab goat breed.

Keywords: Arab goat, Conservation, Genetic improvement, Monitoring study.

INTRODUCTION

Ethiopia, a country of diverse agro-ecology, owns the third and sixth largest goat population in Africa and the world, accounting for 9% and 3% of the populations, respectively (FAOSTAT, 2016). The goat population of the country is estimated at 30.2 million heads (CSA, 2016). In Ethiopia, goats are reared under the mixed crop livestock, pastoral, agro-pastoral and extensive traditional systems. Although the purpose of keeping goats varies across different economical, cultural, and ecological settings (Getahun, 2008), in general goats are reared for fulfilling multiple roles, such as socio-cultural purposes to provide meat, milk, and manure. Flock sizes are larger in the lowland mixed crop-livestock and pastoral and agro-pastoral systems (Solomon *et al.* 2010). In the highlands, because of shrinking agricultural land per household, reduced feed availability and land degradation, goats are kept in a small flock.

.

Despite the large resource base and significant role of goat production in the national and household economy, the slow growth rate, high mortality rate, and low commercial off-take rate challenged the productivity of smallholder goat production in Ethiopia (Deribe *et al.* 2014, Solomon *et al.* 2014). Hence in order to effectively utilize their potential, it is vital to understand the growth performance and carcass characteristics, the response to different feeding regimes and the possible integrations of the animals into various production systems.

Arab goat is one among the goat breeds of Ethiopia that have been traditionally kept by local farmers in the arid environment of Assosa and Kurmuk districts under mixed crop-livestock farming systems of Western Ethiopia. Good performance and ability to adapt, survive, produce, and reproduce in arid environment and tsetse infested areas are peculiar characteristics of the breed. The breed has some level of trypano-tolerance feature (Getenet *et al.* 2005). Nevertheles, Arab goat faces a number of different threats such as free animals' movement in the border areas of Ethio-Sudan, changes in producer preference because of socio-economic factors, and recurrent drought and disease epidemics. This indicates the need for urgent genetic improvement and conservation, which requires detailed and up-to-date information on productive and reproductive traits of the breed. Hence, identifying impacts of non-genetic factors affecting the performances of the flocks would be useful for implementation of sustainable breed improvement and conservation. Unfortunately, this information was not readily available to develop breeding strategy for improvement and conservation of the breed. Previousely available data were collected through farmers recall method (Getinet *et al.* 2005). Thus, monitoring of growth, reproductive, and productive performance of the breed in their habitat and under smallholder farmer's condition would enable us to understand the potential of the breed for sustainable improvent, utilization, and conservation. Therefore, the objective of this study was to estimate growth, reproductive, and milk production performances of Arab goat breed through flock monitoring studies and to identify factors affecting these parameters.

MATERIAL AND METHOD

The study area and flock sampling

The study was undertaken in two warm-humid lowland districts, namely Assosa and Kurmuk, in Assosa zone of Benishangul-Gumz Region of western Ethiopia. Assosa district is located between 10° 02.922'N L and 34° 33.868'E longitude. It is characterized by diverse topography with altitudinal range of 580-1544 m.a.s.l. Mono-modal rainfall pattern during April-September with average annual rainfall of 1316 mm, temperature of 11 to 30°C with the hottest months of March and May are the feature of the district (Assefa *et al.* 2015). Kumuruk district is located between 10°32′N latitude and 34°17′E Longitude. The altitude ranges from 500 to 1200 m a.s.l. The temperature ranges from 25 to 33^{o}C and the hottest months of the area are March and May. The district is characterized by mono-modal rainfall with mean annual rainfall of 800 to1200 mm (AsARC, 2011).

Two kebeles (the lower administrative unit of the country) from each district (Baro and Tsentshalu for Assosa and Abadi and Horazehab for Kumruk) were purposively selected based on their representative-ness with respect to goat population, accessibility to market, road, and regular visiting, flock size, and willingness of the farmers to participate in the study. Ten households from each rural kebele (forty in total) were selected randomly. Sixty-one pregnant does owned by the selected households were taken purposively and used for the monitoring study.

Animal management

As per the tradition of the study areas, goats are kept under shelter during the nighttime, whereas, newborn kids and their dams are kept together in the main family house for about a week. The does are released for grazing after a week but the kids remain in the house for a month and join their dam in the evening. However, some farmers let the kids to follow their dams after just one week. Goats graze crop aftermaths starting from November to January and on open grazing lands from Febraury to April when fields are free from crops. On the contrary, during the cropping season or in rainy season, goats are herded around the homesteads. Most of the farmers do not provide supplementary feed to does, except some grains to the lactating ones. The major feed sources are free grazing on pastureland, which is far from the homestead and crop residues that are in short supply. During the dry season, animals suffer from shortage of feed and are moved to the nearest forest and riverbanks where they can get adequate pasture and water. Breeding is uncontrolled in the area because bucks run with does throughout the year.

Method of data collection and data type

Data were collected through long period flock monitoring approch. The monitoring period started in November 2015 and ended in February 2017. Each experimental animal was identified with a numbered ear tag. The doe lifetime information such as animal identification (date of birth, parental detail), birth type (single, twin, triplet), abortion cases, offspring information (sex, birth weight), and health information (vaccinations, treatments) were recorded. Seasons were catagorized in to wet season [June to September], Cool season [October to January], and Dry hot season [February to May]. Data were collected every day by trained enumerators who were supervised for four days per week by the senior researcher.

The growth traits recorded during monitoring periods were birth weight (BW), weaning weight (WW) at three months of age, sixmonth weight (6MW), and yearling weight (YW). Weights of kids were taken using suspended spring balance. The reproduction traits of does recorded were first kidding date, number of kiddings (parity), and birth date and birth type (single or multiple) of kids. Data recorded includes growth performance of 88 kids, reproductive performance traits of 61 does (Age at first kidding, kidding interval, litter size, and survival rate), and 709 milk records (daily milk yield, total lactation milk yield, and lactation length). Mean number of parturitions recorded by doe was 44. The fixed effects considered were sex of the kids, birth type (single and multiple), doe parity (1-5) and season of birth. Based on growth traits, average pre-weaning daily weight gain (PrWDG) and post weaning daily weight gain (PoWDG) were computed as $ADG_{t3-t1} = (W_{t3}-W_{t1})/t3-t1$, where ADG_{t3-t1} is the weight gain between periods t1 and t3, W_{t3} the weight at age t3, W_{t1} the weight at age t1, and t3-t1 is the number of days between ages t1 and t3 (adapted from Belay *et al.* 2013 and Gebretnsae *et al.* 2018). Annual reproductive rate (ARR) was calculated for each doe using the formula described by Ibrahim (1998): $ARR = S\ (1-M)/I$; Where S is litter size, M is the rate of kid pre-weaning mortality and KI is kidding interval in doe in years.

Data Analysis

In the present study, GLM of SAS (2011) was used to determine the influence of season of birth on AFK. Effect of season of birth, parity and birth type on kidding interval (KI), and effects of sex, season of birth, parity, and birth type on growth traits were analysed. Binary logistic regression procedure in SPSS (2011) was used to determine the influence of parity and season of birth on the litter size of does. Effects of season of kidding, does' parity, sex of kid and birth type on survival rate of kids were also studied. The two-way interactions effects were also fitted in the models and retained in the final model when found significant ($P<0.05$) in the preliminary analysis.

RESULTS and DISCUSSION

Growth performance

The overall least squares mean of birth weight (BW) for Arab goat was 2.56±0.61 kg (Table 1). Male kids were significantly ($p<0.05$) heavier by 0.34 kg at birth (BW) and 0.07 kg/day at weaning (WW) than females (Table 1). Cool season born kids were significantly ($P<0.05$) heavier at six month (6MW) than those born during wet and dry season. Kids born to first parity dam have lower weight at 6 and 12 month than the other parities and second parity kids recorded higher 6MW ($p<0.01$) and yearling weight (YW) ($P<0.05$) than kids born to does in other parities. The result indicated that birth type and sex were not significantly affected by PrWDG. Birth type affected ($p<0.05$) post weaning daily weight gain, and single born kids gained 1.93 gm/day, which is greater than multiple born kids (Table 1).

Table 1: Overall Least square means (±SE) for effects of nongenetic factors on growth parameters

Effects/ levels	BW (kg)	WW (kg)	6MW (kg)	YW (kg)	PrWDG (g)	PoWDG (g)
Overall	2.56±0.61	8.48±2.13	11.82±2.41	16.17±1.62	65.83±23.24	28.51±8.75
N	88	88	88	88	88	88
CV %	17.16	24.10	20.35	10.00	15.30	10.68
Sex						
Male	2.66±0.07^{a}	8.90±0.34^{a}	11.69±0.37	16.82±0.31	69.48±3.78	29.31±1.42
Female	2.32±0.09^{b}	8.83±0.41^{b}	11.22±0.53	15.88±0.34	61.10±4.51	27.20±1.70
	*	*	NS	NS	NS	NS
Season						
Wet	2.53±0.13	8.77±0.62	11.61±0.75^{b}	16.00±0.48	69.29±6.92	26.79±2.61
Cool	2.50±0.07	8.36±0.34	11.88±0.40^{a}	15.82±0.26	65.30±3.83	27.62±1.44
Dry	2.45±0.09	7.97±0.41	10.87±0.47^{c}	16.17±0.32	61.28±4.53	30.36±1.71
	NS	NS	**	NS	NS	NS
Parity						
1st	2.44±0.13^{c}	8.27±0.61	12.31±0.69^{b}	16.25±0.47^{b}	64.79±6.78	29.58±2.55
2nd	2.52±0.12^{bc}	8.52±0.60	13.06±0.61^{a}	17.22±0.46^{a}	66.43±6.10	32.25±2.49
3rd	2.74±0.09^{a}	8.73±0.44	11.18±0.54^{bc}	15.85±0.34^{b}	66.92±4.91	26.35±1.85
4th	2.50±0.10^{bc}	8.41±0.50	11.89±0.59^{b}	16.34±0.39^{b}	65.60±5.55	29.38±2.09
5th	2.27±0.15^{c}	7.92±0.71	8.84±0.81^{c}	14.32±0.55^{c}	62.73±7.84	23.73±2.95
	*	NS	**	*	NS	NS
Birth						
Single	2.55±0.09^{a}	8.42± 0.42	11.15 ± 0.50	16.31± 0.32	65.06±4.62	29.22±1.74^{a}
Multiple	2.43±0.07^{b}	8.32± 0.32	11.75 ± 0.38	15.69±0.25	65.52±3.53	27.29±1.34^{b}
	*	NS	NS	NS	NS	*

Means within a column group and under the same parameter with the same letter are not significantly different (P>0.05); BW: birth weight; 6MW:6-months weight; WW: weaning weight; YW: yearling weight; PrWDG: pre weaning (birth to weaning) weight; PoWDG: post weaning (weaning to 12 months) weight. N: Number of observations; NS: non-significant; SE: mean standard error; *P<0.05; **P<0.01.

Table 2: Overall Least square means (±SE) for effects of season, birth, and parity on AFK, KI and ARR

Fixed factor and levels	AFK (days)	KI (months)	ARR
Overall	354.55±83.78	7.94±1.14	1.22±0.62
N	44	61	61
CV%	23.62	14.31	25.94
Season of birth	**	***	**
Wet	286.00±37.47^{a}	6.97±0.24^{a}	1.65±0.17^{b}
Cool	340.00±15.56^{b}	8.07±0.13^{b}	1.10±0.10^{a}
Dry	431.00±26.49^{c}	8.15±0.16^{c}	1.04±0.13^{a}
Parity	-	**	*
1st	-	8.34±0.23^{c}	1.12±0.2^{bc}
2nd	-	7.73±0.04^{ab}	1.66±0.18^{a}
3rd	-	7.24±0.17^{a}	1.27±0.12^{bc}
4th	-	7.41±0.19^{ab}	1.39±0.14^{ab}
5th	-	7.93±0.27^{bc}	0.87±0.19^{c}
Birth type	-	***	-
Single	-	7.20±0.16^{a}	-
Twin	-	8.27±0.12^{b}	-

Means with different superscript within column and under the same factor are significantly (P < 0.05) different; AFK: Age at first kidding; KI: Kidding Interval; ARR: Annual Reproduction Rate. N: Number of observations; *P<0.05; **P<0.01; ***P<0.001.

Reproductive performance

The average kidding Interval (KI) of Arab goat was 7.94 months. Does kidding in the wet season had significantly (P<0.001) shorter KI than those kidding in cool and dry seasons. Parity and type of birth also had significant effects on KI of Arab goats and does in their 2nd, 3rd, and 4th parities had lower KI than 1st parity and single kidding has shorter KI than twins. Kids born in the wet season had significantly shorter AFK (P<0.01). The effects of season of birth and parity were significant on ARR. Doe kidding in wet season and during their second parity had higher ARR (Table 2).

The odds ratio and p-value of dry season compared to wet season (ODD=15.79; P=0.02; Table 3) showed that litter size was 15.79 times more likely higher in dry than in wet season.

Single born kids survival rate up to weaning age was higher (P<0.05) than multiple born kids (Table 4). Compared to multiple births, kids born single had 1.248 times more likely higher pre-weaning survival rate. Single born kids had also significantly (P<0.01) higher survival rate up to six-month and yearling age than multiple born kids. Wet season born kids had higher pre-weaning survival rate (P<0.01) than those born during cool and dry season.

Milk production performance

Cool season kidding does recorded significantly (P<0.05) longer lactation length (LL) than wet and dry seasons kidding does. Does in their fourth parity have significantly longer lactation length than the other parities (P<0.05). Single kidding does had significantly (P<0.01) longer LL than does having multiple birth (Table 5).

Table 3: Binary logistic regression results for the effect of parity and season of birth on litter size

Variables	B	Standard error	Significance (P value)	Odds Ratio
intercept	-0.689	0.82	0.40	0.502
Parity				
1st	0.24	0.96	0.80	1.27
2nd	-0.16	0.97	0.86	0.84
3rd	0.69	0.89	0.43	2.00
4th	1.26	0.94	0.18	3.54
5th*	0	-	-	1
Season of birth				
Wet season*	0	-	-	1
Cool season	0.68	0.53	0.19	1.98
Dry season	2.76	1.14	0.02	15.79

*5th parity was considered as the reference category for effect of parity, and wet season for effect of seasons.

Table 4: Binary logistic regression results for survival rates in Western lowland Arab goat

	Pre-weaning survival		Survival up to six months		Survival to yearling age	
Variables	Significance (P)	Odds ratio	Significance (P)	Odds ratio	Significance (P)	Odds ratio
Intercept	0.534	1.850	0.574	1.726	0.029	23.490
parity1	-	1	-	1	0.877	0.776
parity2	0.942	0.931	0.379	2.195	0.154	0.212
parity3	0.550	1.750	0.072	4.896	0.948	1.072
parity4	0.454	0.499		1	-	1
parity5*	-	1	-	1	-	1
sx1	0.422	0.596	0.656	.699	0.182	0.218
sx2*	-	1		1	-	1
Ws	0.022	8.161	0.114	5.762	0.386	3.083
Cs	0.107	3.514	0.133	4.301	0.085	8.498
ds*	-	1	-	1	-	1
Single births	0.028	1.248	0.012	1.131	0.026	1.110
Multiple births*	-	1	-	1	-	1

*omitted since this category was the reference category, sx1: male; sx2: Female; ws: wet season; cs: cool season; ds: dry season.

Table 5: Overall Least squares means (± SE) for effects of parity, season and birth type on milk production traits

Effects and levels	DMY (lt)	LMY (lt)	LL (days)
Overall	0.36±0.28	14.14±4.20	39.25±10.20
N	709	709	709
R^2	0.17	0.51	0.50
CV %			
Season	NS	***	***
Wet	0.40±0.04	13.70±0.63^b	35.05±1.52^b
Cool	0.34±0.02	14.89±0.26^a	41.94±0.62^a
Dry	0.36±0.05	0.40±0.73^c	4.13±1.76^c
Parity	NS	***	***
1st	0.32 ± 0.06	3.71±0.88^c	15.29±2.14^c
2nd	0. 37± 0.03	7. 62±0.41^b	22.03±1.00^{bc}
3rd	0.35 ± 0.03	8.99±0.46^b	27.07±1.11^b
4th	0.40 ± 0.03	21.47±0.46^a	53.91±1.12^a
5th	0.39 ± 0.05	6.53±0.71^c	16.91±1.72^c
Birth type	NS	NS	**
Single births	0.39±0.03	9.48±0.43	25.08±1.05^b
Multiple births	0.35±0.03	9.84±0.42	29.01±1.01^a

Means within a column group with the same letter are not significantly different (P>0.05); DMY: daily milk yield; LTMY: lactation total milk yield, and LL: lactation length; N: Number of records; Se: Standard error; NS: Not significant;*P<0.05; **P<0.01; ***P<0.001.

DISCUSSION

The BW of Arab goat was within the medium range of BW of Ethiopian and tropical goat breeds. This implies that the growth performance of goats under smallholder management system faces multiple stresses (nutrition,heat, parasites, disease, and poor management) resulting into lower growth performance. Increased performance could be achieved through improving management and feeding conditions and through genetic improvement by selecting genetically superior animals (Kosgey *et al.* 2004). Genetic improvement would enhance the effects of management interventions by improving growth performance.

The mean birth weight (BW) of Arab goat (2.56±0.61 kg) was consistent with the study of Tesfaye (2009) that observed body weight range of 2.2 to 2.9 kg for indigenous goats managed under traditional system. The wide variation in birth weight among breeds and within breed could be partly attributed to year and season of kidding, age and body weight of dam and parity. Moreover, earlier studies (Sen *et al.* 2013, Ocak *et al*. 2014) noted that the exchange capacity of caprine placenta between maternal and fetal systems depends on placental size and number of placentomes. Hence, size, which is related to the nutrient transfer capacity of the placenta, plays useful role in determining the prenatal growth trajectory of the fetus and hence birth weight. However, the higher or lower birth weight may not be related with weaning and yearling weight. In relation to this, earlier study by Safari *et al.* (2005) from Australia on sheep and later work of Jembere *et al*. (2016) from Ethiopia in goat noted weak correlation (r) of BW with 6MW, 9MW, market, and adult weights. This may indicate that even though there are multiple stresses on the performance of goat in the study area, growth performance could be enhanced after birth through improved management and selection of genetically superior animals at weaning, 6-months, and yearling age. In support of this, study by Eyob *et al.* (2017) displayed that good mothering ability and lactation potential of ewes have significant effects on weaning weight of lambs. Regarding environmental factors, recent study of Atoui *et al.* 2017) showed that birth weight is significantly affected by environmental factors, particularly in arid regions.

Greater BW in male than female is attributed to the competition for nutrients in the uterus due to the presence of dimorphism in the two sexes. In addition, the effect of male sex hormones on the physiological function contributes to greater birth weight in male. The current result was supported by different studies (Mekete *et al.* 2016, Zeleke *et al*. 2017).

The result indicates that single born kids were heavier than multiple-born kids. Hagan *et al.* (2014) reported that as the number of foetus increases, the number of caruncles attached to each foetus decreases, thus reducing the feed supply to the foetus and consequently resulting into lower birth weight. In a comprehensive analysis of factors associated with low lamb birth weight, Gardner *et al.* (2007) identified that litter size has the greatest single influence on birth weight, while year of birth, maternal birth weight, maternal nutrition, lamb sex, and maternal body composition at mating were also important.

Heavier birth weight at third parity than the rest could be an attribute of more competition between growth of the young doe and the fetus for the available nutrients at parity 1 and 2. Although mature does provide a good maternal environment to the developing fetus, doe productivity declines after reaching certain level of threshold due to management and aging effect of the does at higher parities as it was observed in the fifth parity in the present study.

The superiority of males to female at WW could be due to the higher BW of males and higher efficiency of weight gain, which is due to hormonal differences that enhance growth. Goat belongs to the most dimorphic mammals and other domestic animals, which exist along the life of animals from fertility until adult age. Rensch (1960) described that in many taxa, sexual size dimorphism (SSD) varies with body size and larger species generally exhibits higher male to female body size ratio, which is known as "Ranch's rule". The cause of sexual dimorphism is described by the study of Vitousek *et al.* (2007) and they stated that resource availability may influence the body size of one sex to a greater degree than the other when relative energy expenditure on mating and reproduction is greater for that sex. In addition, ecological factors may select for small body size in both sexes but female body size may be constrained by fecundity selection. Earlier study by Ugur *et al.* (2004) also noted that the difference in weight between the sexes may be due to usually longer male carrying than female fetus by the does during pregnancy period (1–2 days more) . In the present study, male kids were 0.07 kg/day heavier than female kids at WW and recorded greater daily gain than female kids reflecting effect of sex in favor of males than females in body growth and weight gain. Similar sex effects were also reported in previous studies (Yaekob *et al*. 2015, Hamzo *et al.* 2016).

Cool season born kids were heavier at six month (6MW) than wet season and dry season born kids. This may be because of less environmental stress during cool season. The succulent character of forage with low dry matter content in wet season may also contribute to the lower six-month weight of kids than in the cool dry season. The management practice of tethering small ruminant during wet season to prevent crop damage limits selective grazing and intake of sufficient dry matter in the absence of an appropriate supplementation resulting in reduced growth rate. However, previous studies (Zinat et al. 2013, Alemu, 2015) reported heavier six-month weight in wet than those born during dry season in highland parts of Ethiopia, which could be an attribute of differences in management and of disease burden. The lower performance of kids born in the dry season needs special attention since it delays pubertal time and thus affects life time productivity of the animal.

The lower weight at 6 and 12 month in Kids born to first parity dam than those born to the other parities and higher 6MW and yearling weight (YW) recorded by kids born to second parity dams may be attributed to the efficiency of nutrient utilization by kids after weaning. Belay and Mengestie (2013) however, noted increasing trend of 6MW and yearling weights in kids born to first to third parities dams.

The absences of effect of sex and seasons on yearling weight in the current study were different from the study of Belay and Mengestie (2013) who noted that sex and seasons of birth had significantly affected by yearling weight in Sekota district, northern Ethiopia. The non-significant effect of season of birth obtained in the current study was in agreement with that of Mabrouk *et al.* (2010). Similarly, Dadi *et al.* (2008) observed no effect of season of birth on body weights at 12-months of age in Boar and Aris Bale goats.

As observed in the current study, sex and birth type significantly affected birth weight. However, both variables did not have impact on pre-weaning daily weight gain. This indicates that maternal environment has no greater influence on the efficiency of kids PrWDG. In addition, absence of effect of sex on average daily gain was reported by Deriba *et al*. (2011).

Single born kids gain heavier than multiple born kids, which is ascribed to the scarcity of nutrients for the twins or triplets than single fetous at pre-natal stage which in turn affects growth at later stage. In relation to this, study by Reed *et al.* (2014) indicated that maternal restricted nutrition has negative consequences on the number of muscle fiber and altering regulators of muscle growth. Meyer *et al.* (2013) also noted that restricted feeding during gestation has immediate and long-term impacts on growth and development of offspring. Single born kids grew approximately 42.66, 19.84, and 37.50% faster than multiple born kids from birth to weaning age, weaning age to 6-months, and 6-months to 12-months, respectively. The lower growth rate from weaning to 6- months of age is due to weaning shock, and insufficient development of digestive system for effective roughage digestion and nutrient utilization.

The average Kiding Interval (KI) obtained in the present study was higher than 5.94 and 6.34 months reported by Hassen *et al.* (2015) under semi-intensive and extensive systems, respectively in Bangladesh but it was lower than 11 months recorded for Abergelle goat of northern Ethiopia (Belay *et al*. 2014). The kidding interval recorded in the current study lies with in the interval of 7.86-8.83 months reported for most Small East African goats' (Wilson and Durkin, 1988). In general, the quality of nutrition, body condition score of breeding male (Polak *et al.* 2015), and breeding male to breeding female ratio are among the determinants of KI in goats.The KI can be lowered through enhancing the recovery of uterus after parturition, which could be achieved through provision of good quality and appropriate amount of nutrition to the does. Robinson *et al.* (2006) noted that early development of the foetal ovary is remarkably sensitive to maternal nutrition with subsequent lifetime effects on ovulation rate. Other ealier study (Boland *et al*. 2000) explained that under nutrition results in increased post-partum interval to conception, interferes with normal ovarian cyclicity by decreasing gonadotropin secretion, and increases infertility. The mean value of AFK (354.55 days) in the current study was relatively good and at the lower range (12 to 18 months) of values reported by Payne and Wilson (1989) for goats in the tropics, and lower than 407.9 days reported by Mengiste *et al.* (2013) for central highland goat of Ethiopia. This may indicate the potential of the Arab goats for higher lifetime production. The AFK (28 months) reported for station managed Arsi-Bale goats is exceptionally higher (Dadi *et al*. 2008) when compared to other indigenous goats in Ethiopia. This might be due to controlled breeding practiced in the research station, which indicates that the existing uncontrolled breeding practice in this system is in favour of early kidding of indigenous goats than the controlled breeding practices in the improved system.

Does kidding in the wet season have shorter KI than those kidding in cool and dry seasons, which is in line with earlier studies in southern Ethiopia (Mengistie *et al.* 2013, Deribe *et al.* 2014). This is generally attributed to feeds availablity in the wet season, which helps the uterus to recover quickly for conception. The longer KI in first parity was due to utilization of feed for growth, as these does are still growing, limiting the nutrient available to uterus to recover for early onset of post-delivery heat. In the traditional goat production system, female goat that give single kid and female with twins receive same amount of feed and this could delay the uterine recovery time for female goat with twins due to insufficiency of nutrients for both milk production and onset of reproduction. Bushara *et al.* (2013) reported similar effects of birth type on KI for Central Highland goats. Similarly, kids born in the wet season had shorter AFK, which can be ascribed to feed availability to the doe for good milk production and hence kids grow faster and attain reproductive age at a younger age compared to kids born in dry seasons. Earlier studies (Belay and Mengistie, 2013, Mengistie *et al*. 2013, Hamzo *et al.* 2016) also showed that does kidded during the wet season had shorter AFK.

Annual Reproductive Rate (ARR) could be considered as an overall measure of reproductive performance of doe. The average ARR (1.22±0.62) of Arab kids was similar to the value for the local central high land goat (Menigistei *et al.* 2013). Doe kidding in wet season and during their second parity had higher ARR. Due to the higher effect of environment than genetic, the reproductive performance traits can be improved through better management, and hence the impact of season, birth type, parity and other non-genetic factors can be reduced through appropriate management. The increase in mortality rate in the dry season is due to shortage of green feed. This implies that improvement in reproductive performance can be realized by improving feed availability and through selection of adaptive Arab goat to feed and water scarcity.

The variation in litter size in tropical goats have great advantage as reproductive performance could be improved by selection without affecting their potential adaptive characteristics to hot and harsh environment (Hamzo *et al.* 2016). Litter size was more likely higher in dry season which implies that does ovulate more eggs in cool and wet seasons. This is due to high plane of nutrition in the cool and wet seasons. In agreement with the current finding, Mengiste *et al.* (2013) obtained higher litter size during hot dry season as compared to other seasons (wet and cool dry seasons). In addition, the study of Hagan *et al.* (2014) noted that conception rate is high when mating is accompanied by high plane of nutrition; especially two months prior to mating. Heavier and good conditioned does could also give larger litter than lighter does Hamzo *et al.* 2016). Baiden (2007) has also reported that significantly higher litter size was obtained during the dry season.

Reproductive losses during pre-weaning period due to poor milking ability of dam, poor management, and pneumonia are very common causes for mortality of kids'. Mortality rate varies among the flocks which could be ascribed to the management difference (Awgichew, 2000). Significant effect of birth type on survival rate up to weaning age was also reported in different studies (Girma *et al.* 2011, Girma *et al.* 2013). The superiority of single born kids to multiple born kids in pre-weaning survival rate is generally credited to lower energy reserves because of the low birth weights in twins and therefore unable to withstand the different environmental effects. Moreover, dam with poor milk yield does not provide adequate nutrition during postnatal periods for twins. Single born kids had also higher survival rate up to six-month and yearling ages than the survival rate o the multiple born kids due to the adequate nutrients they receive during fetal development and postnatal, which aid the animal to build up sufficient body store and immunity. In support of this, earlier study by Devendra and Burns (1983) explained that limited nutrients to fetus and milk consumption after birth are the major reasons associated with high mortality rate of multiple births after weaining. Hence, it is necessary to give attention to feeding and management (breast feeding of colostrum, vaccination at last third of gestation) of multiple born kids during the first few days after birth.

Wet season born kids had higher pre-weaning survival rate (P<0.01) than those born in cool and dry season because of more feed availability in wet and early months of cool-dry seasons to the dam for more milk production. Daily milk yield (0.36 liter) obtained in the present study was within the range of values (0.3-0.5 liters) reported for different goat breeds (Mengistu *et al*. 2007, Islam *et al.* 2009, Paul *et al*. 2013) under grazing condition. But, the result of daily milk yield in the current study was lower than that reported by Mestawet *et al*. (2012) who recorded 1.13 and 0.85 liters for Aris-Bale and Somali goat breeds, respectively under improved management condition implying the potential and the need for improving management for higher milk yield in indigenous breeds of goat. Results of the present study revealed that the Arab goat breed produce more amount of milk as compared to other indigenous breeds.

The Lactation Length (LL) (39.25 days) of Arab goats was higher than LL for Mid-rift valley goat (Tesfaye *et al.* 2000), but it is lower than the value reported for Hararghe High Land goat (Dereje *et al*. 2011), Borena goat (Lemma *et al.* 2003), and Begait goat (104 days; Abreham *et al*. 2017) breeds. These variations in LL among different breeds could be due to differences in management practices and genetic potential of the breeds and could be exploited through selection within breed and crossing among the local genetic resources. The long lactation length in the cool season may be related with the high demand of milk by children and adults to cope up with the cold environment. To obtain milk throughout the season, owners continue milking the goats to get even the smallest amount of milk by extending lactation. Does in their fourth parity have longer lactation length than all other parities, since the family extends the lactation length to exploit more milk at the later parity.

Single kidding does had shorter LL than multiple births. This result was similar from the study by Carnicella *et al.* (2008) who stated that goats that produced twins yielded more milk and had longer lactation period. In this regard, study by Silanikove *et al.* (2006) explained that the increase in milk yield and LL may be related to systemic effects of increased secretion of placental lactogen or the removal of local (mammary gland) negative feedback regulatory inhibition. This is generally explained by the fact that high milk production and lactation length from does with multiple litter size is attributed to high lactogenic activities during prenatal stage and this activity causes greater development of mammary gland, which in turn increases the potential for milk synthesis and milk yield during postnatal period.

CONCLUSION

The result obtained in the current study, in general, showed that the growth performance and milk production of
Arab goats are similar and higher, respectively as compared to local goat breeds. The environmental factors such as sex of kid, seasons, and birth type mainly affected birth weight and reproductive performance. The lower reproductive performance of female does need special attention as they delayed pubertal time and thus affect productivity of the animal. The selection of this goat type should consider as a strategy to 379 increase milk production of the breed

Acknowledgements
I would like to thank Ministry of Education (MOE) for the scholarship and financial support. I am very grateful to all assistances, knowledge and experiences we have received from the farmers in Assosa and Kumuruk districts.

Conflicts of Interest: The authors declare no conflict of interest.

REFERENCES

Abreham H, Gizaw S and Urge M (2017) Milk Production Performance of Begait Goat under Semi intensive and Extensive Management in Western Tigray, North Ethiopia. *Livestock Research for Rural Development*. http://www.lrrd.org/lrrd29/12/hags29240.html.

Alemu A (2015) On-farm phenotypic characterization and performance evaluation of abergelle and central highland goat breeds as an input for designing community-based breeding program. MSc Thesis, Haramaya University, Ethiopia. https://core.ac.uk/download/pdf/132667081.pdf. Accessed August 11, 20/18

AsARC (Assosa Agricultural Research Center) (2011) Results of farming system survey Benshangul-Gumuz Regional State. Assosa Agricultural Research Center.Assosa, (Unpublished, Institute of Agricultural Research, Ethiopian).

Assefa T, Leta S and Derso Samuel (2015) Prevalence of Donkey Trypanosomosis in Assosa District, Benishangul Gumuz Regional State, Northwest Ethiopia. *Global Veterinaria*, 6:147-153.

Atoui A, Hajejji Z, Abdennebi M, Gaddour A and Najari S (2017) Environmental factors affecting birth weight of Tunisian local goat population kids. *Journal of new sciences, Agriculture and Biotechnology*, 38:, 2069-2076.

Awgichew K (2000) Comparative performance evaluation of Horro and Menz sheep of Ethiopia under grazing and intensive feeding conditions. Ph.D. Thesis, Humboldt University, Berlin, Germany.

Baiden RY (2007) Birth weight, birth type and pre-weaning survivability of West African Dwarf goat raised in Dangme West District of the Greater Accra Region of Ghana. *Tropical Animal Health Production*, 39:141 – 147.

Belay D and Mengistie T (2013) Evaluation of Growth Performance of Abergele Goats Under Traditional Management Systems in Sekota District, Ethiopia. *Pakistan Journal of Biological Sciences*. 16 (14): 692-696. http://doi=pjbs.2013.692.696.

Belay S, Berhei G, Godifey G, Brhane M, Zenebe M, Hagos H and Teame T (2014) Reproductive performance of Abergelle goats and growth rate of their crosses with Boer goats. *Livestock Research for Rural Development*, pp: 26.

Boland MP, Lonergan P and O'Callaghanz D (2000) Effect of Nutrition on Endocrine Parameters, Ovarian Physiology, and Oocyte and Embryo Development. Departments of Animal Science & Production, and Animal Husbandry & Production, and Conway Institute of Bimolecular and Biomedical Research, University College Dublin, Beltield, Dublin, Ireland.

Bushara I, Abdelhadi OMA, Mekki DM, Idris AO, Elemam MB, Muna Ahmed MM, Abu Nikhiala AM and Alimon AR (2013) Effect of Sex and Birth Type on Kid Performance of Sudanese Taggar Goats. *Malasia Journal of Animal Science,* 16(1): 107-116.

Carnicella M, Dario M, Consuelo C, Ayres V and Laudadio CD (2008) The effect of diet, parity, year and number of kids on milk yield and milk composition in Maltese goat. *Small Ruminant Research*, 77: 71–74. http://dio.10.1016/2008.02.006.

CSA (Central Statistical Agency) (2016) Federal Democratic Republic of Ethiopia, Agricultural sample survey, 2015/16 report on livestock and livestock characteristics (private peasant holdings). Statistical Bulletin 583 (2), Addis Ababa, Ethiopia.

Dadi H, Duguma G, Shelima B, Fayera T, Tadesse M, Woldu T and Tucho TA (2008) Non-genetic factors influencing post-weaning growth and reproductive performances of Arsi-Bale goats. *Livestock Research for Rural Development*, 20, 7.

Dereje T, Berhanu B and Aynalem H (2011) Herd husbandry and breeding practices of goat in different agro-ecologies of Western Hararghe, Ethiopia. Journal of Animal Production, 13, 1-45.

Deribe GT, Girma A and Azage T (2014) Early Growth of Adilo Kids under Smallholder Management Systems, Southern Ethiopia: Influences of Non–Genetic Factors. *Journal of Advance Animal and Veterinary Science*, 8(2): 470-475. http://dx.doi.org/10.14737/ /2014/2.8.468.476

Devendra C and Burns M. (1983) Goat Production in the Tropics (Commonwealth, Farnham Royal, Slough, UK; Agric. Bureau x Publication.), pp: 183.

https://www.cabdirect.org/cabdirect/abstract/19700104441.

Eyob M, Mestawet T, Girma A, Asirat T and Addisu J (2017) Effect of Non-Genetic Factors on Reproductive and Growth Performance of Abera Sheep under Community Based Breeding Program in SNNPRS Ethiopia. *Journal of Advance Dairy Research*, 5, 4. DOI: 10.4172/2329-888X.1000196

FAOSTAT (2016) Food and Agricultural organization of the United Nations, statistical division. http://faostat3.fao.org/browse/Q/QA/E.

Getahun L (2008) Productive and economic performance of Small ruminants in two production systems of the highlands of Ethiopia. Ph.D. Thesis, Stuttgart-Hohenheim, Germany.

Getinet A, Hegde BP, Bekele T, Enyew N and Workneh A (2005) Phenotypic Characterization of Goat Types in Northwestern Ethiopia. *Ethiopia Journal of Animal Production*, 5(1):13.

Girma D, Misgana D and Feyisa H (2011) Effect of Different Factors on Mortality Rate of Arsi- Bale Kids in Mid Rift Valley of Ethiopia. *Journal of Global Veterinaria*, 6(1): 56-60.

Girma D, Misgana D, Feyisa H, Firhowet M, Tesfaye K and Mohammed N (2013) Study on major causes of kid mortality in Adami Tulu JidoKombolcha District of Oromia, Ethiopia. *Agriculture and Biology Journal of North America*, pp: 2151-7525. Http:// doi:10.5251/abjna.2013.4.2.110.115.

Hagan BA, Nyameasem JK, Asafu-Adjaye A and Duncan JL (2014) Effects of non-genetic factors on the birth weight, litter size and pre-weaning survivability of West African Dwarf goats in the Accra Plains. *Livestock Research for Rural Development*, 26 (13).

Hamzo Khan Kunbhar AA, Memon AL, Bhutto Zahid Iqbal Rajput V, Suthar AM and Leghari RA (2016) Study on female reproductive performance of Kamohri goat managed under traditional management conditions in district Hyderabad, Sindh, Pakistan. *International Journal of Advanced Research Biological Science*, 3(3): 251-260. http://s-o-i.org/1.15/ijarbs-2016-3-3-32.

Hassen MJ, Jalal Uddin Ahmed Md, Mahmudul Alam, ML, Osman, MD and Mhowkat A (2015) Reproductive performance of Black Bengal goat under semi-intensive and extensive condition in Rajshahi district of Bangladesh**.** *Asian Journal of Medical Biology Research*, 1: 22-30.

Ibrahim H (1998) Small Ruminant Productions Techniques. ILRI training manual. ILRI (International Livestock Research Institute), Nairobi, Kenya, 3, 192.

Islam MR, Amin AKM, Kabir A and Ahmed M.U (2009) Comparative study between semi-intensive and scavenging production system on the performances of Black Bengal goat Department of Animal Science, Bangladesh Agricultural University. *Journal of Bangladesh Agricaltural Universty*, 7(1): 79–86.

Jembere T, Kebede K, Rischkowsky B, Haile A, Okeyo Mwai A and Dessie T (2016) Recording birth weight has no significance in village based genetic improvement programs of small ruminants. *Livestock Research for Rural Development.* 28, (135). http://www.lrrd.org/lrrd28/8/teme28135.

Lemma F, Lemma A, Nega T and Tesfaye A (2003) Effect of different legume supplementation on milk production performance of Borana Goats. In the proceeding of the 10th Annual Ethiopian Society of Animal Production, Addis Ababa, Ethiopia, Pp- 21-23.

Mabrouk ON, Sghaier RG, Costa G, Amor B, Amel J and Delgado V (2010) The effect of non-genetic factors on the early body weights of Tunisian local goats. *Revista Brasileira de Zootecnia*, 39(5): 1112-1117.

Mekete G, Senait G, Asrat T, Demerew G and Tekleyohannes B (2016) Participatory on Farm Evaluation and Demonstration of 25% Crossbred (Boer x Woyito-Guji) Goats in Benatsemay District of South Omo Zone, SNNPR, Ethiopia. *Journal of Biology Agriculture and Health care*, 6, 21.

Mengistu U, Dahlborn K and Olsson K (2007) Effect of intermittent watering on growth, thermoregulation, and behaviour of Ethiopian Somali goat kids. *Small Ruminant Research*, 72: 214-220.

Mengistie T, Belay D and Aussie HM (2013) Reproductive Performance of Central Highland Goats under Traditional Management in Sekota District, Ethiopia. *Asian Journal of Biological Sciences*, 6(5): 271-276.

Mestawet TA, Girma A, Ådnøy T, Devold TG, Narvhus JA and Vegarud GE (2012) Milk production, composition, and variation at different lactation stages of four goat breeds in Ethiopia. Short communication. *Small Ruminant Research*, 105, 176-181. https://doi.org/10.1016/2011.11.014.

Meyer AM, Neville TL, Reed JJ, Taylor JB, Reynolds LP, Redmer DA, Hammer CJ, Vonnahme KA and Caton JS (2013) Maternal nutritional plane and selenium supply during gestation impact visceral organ mass and intestinal growth and vascularity of neonatal lamb offspring. *Journal of Animal Sciences*, pp: 2628–2639.

Ocak S, Ogun S, Gunduz Z and Onder H (2014) Relationship between placental traits and birth related factors in Damascus goats. *Journal of Livestock Science*, pp: 218–223.

Paul RC, Rahman ANMI, Debnath S and Khandoker MAMY (2013) Evaluation of productive and reproductive performance of Black Bengal. *Bangladish Journal of Animal Science.* http://dx.doi.org/10.3329. 20704.

Payne WJ and Wilson RT (1989) Animals Husbandry in the Tropics. 5th Eds., Oxford, UK. Blackwell Science.

Polak J, Mares V, Konrad R and Frynta D (2015) Offspring sex ratio in domestic goats: Trivers-Willard out of natural selection. *Czech Journal of Animal Sciences*, pp: 208–215. http://doi: 10.17221/8170-CJAS.

Reed SA, Joseline S, Raja Maria L, Hoffman S, Zinn A and Kristen EG (2014) Poor maternal nutrition inhibits muscle development in ovine offspring. *Journal of Animal Science and Biotechnology*, 5(43). http://www.jasbsci.com/content/5/1/43.

Rensch B (1960) Evolution above the species level. New York, NY: (Columbia University Press).

Robinson JJ, Ashworth CJ, RookeL JA, Mitchell M and McEvoy TG (2006) Nutrition and fertility in ruminant livestock. *Animal Feed Science and Technology*, pp: 259-276.

Safari E, Fogarty NM and Gilmour AR (2005) A review of genetic parameter estimates for wool, growth, meat and reproduction traits in sheep. *Livestock Production Science*, pp: 271–289.

SAS (2011) SAS/STAT 9.1.3. User's Statistical Analysis System Guide. Cary, NC: SAS Institute Inc.

Sen U, Sirin E and Kuran M (2013) The effect of maternal nutritional status during mid-gestation on placental characteristics in ewes. *Animal Reproduction Sciences*, pp: 31-36.

Silanikove N, Merin U and Leitner G (2006) Physiological role of indigenous milk enzymes: an overview of an evolving picture. *International Dairy Journal*, pp: 533–545. http://doi:10.1016/j.idairyj.2005.08.015

Solomon G, Azage T Berhanu G and Dirk H (2010) Sheep and goat production and marketing systems in Ethiopia: Characteristics and strategies for improvement.IPMS (Improving Productivity and Market Success) of Ethiopian Farmers.Project Working Paper 23. ILRI (International Livestock Research Institute), Nairobi, Kenya, pp: 58.

Solomon AK, Mwai O, Grum G, Haile A, Rischkowsky BA, Solomon G and Dessie T (2014) Review of goat research and development projects in Ethiopia, International Livestock Research Institute (ILRI), Addiss Ababa, Ethiopia, pp: 4-6. http://doi: 10.13140/RG.2.1.4246.3765.

SPSS (2011) Statistical Package for Social Sciences (SPSS) for Windows, Version 20.0. Chicago, SPSS Inc.

Tesfaye A, Alemu R and Lemma F (2000) Preliminary production and reproduction of performance evaluation of Mid Rift Valley and Boran goats. In the proceeding of a conference held at Debub University, Ethiopia. Pp: 10-12.

Tesfaye T (2009) Characterization of Goat Production Systems and On- Farm Evaluation of the Growth Performance of Grazing Goats Supplemented With Different Protein Sources in Metema, Amhara Region, Ethiopia. MSc., Thesis, School of Graduate Studies of Haramaya University, Ethiopia. *Livestock Research and Rural Development*, pp: 1-10.

Ugur F, Savas T and Dosay M (2004) Growth and behavioural traits of Turkish Saanen kids weaned at 45 and 60 days. *Small Ruminant Research,* pp: 179-184.

Vitousek MN, Rubenstein DR and Wikelski M (2007) Lizard ecology: the evolutionary consequences of foraging mode. Cambridge (UK): Cambridge University Press. The Evolution of Foraging Behavior in the Galapagos Marine Iguana: natural and Sexual Selection on Body Size Drives Ecological, Morphological, and Behavioral Specialization, pp: 491–507.

Wilson RT and Durkin JW (1988) Small ruminant production in central Mali: reproductive performance in traditionally managed goats and sheep. *Livestock Production Science*, pp: 523–529.

Yaekob L, Kirman MA and Birhanu B (2015) Morphological Characterization of Indigenous WoytoGuji goat type in Loma district, Southern Ethiopia. *Africa Journal of Agriculture Research*. 10(20): 2141-2151. http://doi: 10.5897/AJAR2015.9626.

Zeleke T, Tilahun M, Deribe B, Lakew M, Belayneh N, Zegeye A and Aychew D (2017) Effect of non-genetic factors on pre-weaning growth, survivability and prolificacy of Central Highland x Boer crossbred goats in North Eastern Ethiopia. *Livestock Research for Rural Development*, pp: 136.

Zinat Mahal MAM, Khandoker Y and Haque MN (2013) Effect of non-genetic factors on productive traits of Black Bengal Goats. *Journal of Bangladesh Agricultural University*, 11(1): 79–86. http://dx.doi.org/10.3329.