Productivity of Abergelle, Central Highland and Woyto-Guji goat breeds in Ethiopia

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Abstract

The objective of this paper was to evaluate the productivity of three indigenous goat breeds from Ethiopia namely Abergelle (AB), Central Highland (CH) and Woyto-Guji (WG) based on their kids' total live weight at three months (LWW), survival rate to three months (S3M) and average daily milk yield (ADM, for AB only). The LWW were standardized by year and post partum weight (ppw) of does. In addition, productivities expressed as the body weight of three months old kids produced per doe per year (index I) and per kg ppw per year (Index II) were also assessed. The overall least squares means of LWW for AB, CH and WG were 7.6, 15.3 and 10.2 kg, respectively. The overall mean of the ADM for AB was 367.10±139.79 ml. The S3M was 76.30%, 78.50% and 77.70%, for AB, CH and WG, respectively. Overall means of index I and index II were 14.7 kg and 0.50, respectively. Year of birth affected (p<0.05) LWW and S3M of AB, CH and WG as well as the indices. The ADM and S3M of AB and LWW of WG were also influenced (p<0.001) by village of kidding. The LWW and S3M of the three breeds were not influenced (p>0.05) by sex of lambs. On the other hand parity of birth had clear influence (p<0.05) on ADM and S3M of AB and index I. Season of birth also had influence (p <0.001) on LWW of AB only. The CH does produce about 200% LWW of AB does and about 150% LWW of WG does. The CH was found to be the most productive breed in terms of all assessed parameters followed by WG. The AB was best suited for dual services (meat and milk). Hence, goat meat investment priorities in Ethiopia could target Central

Highland goats. However, the productivity of these goat breeds should be improved in their respective localities by minimizing possible factors hampering their productivity.

Keywords: *goat, indices, milk, productivity, survival, total kid weight*

Introduction

Ethiopia is believed to have the largest ruminant population in Africa; the country owns 60.4 million cattle, 31.3 million sheep and 32.7 million goats (CSA 2018). The annual goats' population reports of Ethiopia, before this report, were considerably smaller than that of sheep population. However, since very recently, the ratio of goat to sheep population showed increasing trend amounting 0.93 (CSA 2012), 0.99 (CSA 2015), 0.98 (CSA 2017) and 1.05 (CSA 2018); this could be an indication that goats are becoming as important as sheep in Ethiopia. The increasing trend of goat population in Ethiopia was in line with prevailing situation in the world. Skapetas and Bampidis (2016) reported that the goat number in the world increased by 33.8% during the years 2000 – 2013. The increasing trend of goats' population could be associated with development of market for products from goats, changes of customers' attitude towards products from goats and the ability of these animals to adapt to a wide range of environmental conditions (Rodica et al 2013). Increasing population pressure, land scarcity and diminishing production resources could be also promoters of goat in the tropics (Bett et al 2009).

In developing countries, indigenous goats make valuable contribution, especially to livelihoods of the poor in the rural areas. They are important sources of meat, milk, manure, fibers and skins, and satisfy various cultural and religious functions (Tesfaye 2004; Kosgey and Okeyo 2007; Kanani 2009; Aziz 2010; Devendra 2012). The importance of this valuable genetic resource is, however, underestimated and their contribution to the livelihood of the poor was inadequately understood (Kosgey et al 2006; Kanani 2009; Aziz 2010).

With the help of a project funded by SIDA (Swedish) and implemented by Biosciences for eastern and central Africa and International Livestock Research Institute (BecA-ILRI), a community based breeding programs (CBBP) on three indigenous goat breeds in Ethiopia was implemented in six villages in 2013 (Alubel 2015; Tatek et al 2016; Zergaw et al 2016; Jembere et al 2019). The purpose of the project was improving goats' productivity in Ethiopia through efficient understanding of the indigenous goat genetic resources, genetic improvement, and enhanced individual and institutional capacity building. The goat breeds included Abergelle (AB), Central Highland (CH) and Woyto-Guji (WG). The CH inhabits the mid altitude or highland areas of the country where the annual rainfall is reasonably good

while the AB and WG inhabited either arid or semi-arid agro-ecologies of the country. The CH, as the name indicates, is found in central highlands of the Ethiopia while AB and WG are found in the northern and south western parts, in respective order, of the country. Currently, CBBP of small ruminants are promoted and being implemented in almost all regional states of Ethiopia.

Previous studies did not focus on assessments of does' productivity in terms of total weight of kids at three months per doe, survival of kids to three months of age and three month weight of kids per doe per year. Focuses were characterization of growth and reproduction traits from offspring's perspective. On the other hand, it was demonstrated that the indices focusing on weaning weights (three month weight in our case) per individual doe or ewe are superior for measuring the reproductive potential of meat breeds (Bosman et al 1997). For instance, such studies were available for Horro sheep (Duguma et al 2002), Djallonke sheep (Gbangboche et al 2006) and Nagerian goats (Bosman et al 1997). However, similar information are lacking for any of indigenous goat breeds in Ethiopia. Jembere et al (2019) reported the overall productivity index of the same goat breeds but productivity indices at individual doe level. Therefore, using data collected during the implementation phase of BecA-ILRI project, the objectives of this paper was to assess the productivity of Abergelle, Central Highland and Woyto-Guji does based on kids' total live weight and survival at three months of age. The total live weights of kids at three months were standardized by year and post partum weight of does and factors affecting these parameters were investigated. Factors influencing the average daily milk yields of AB were also assessed.

Materials and methods

General description of data collection sites

Data used in the present study were collected from six villages located in five different districts in Ethiopia. The districts included Tanqua Abergelle of Central Tigray zone, Ziqual of the Wag-Himra zone, Lay Armachiho of North Gonder zone, Meta-Robi (now divided into two districts: Meta-Robi and Meta-Walkite) of West Shoa zone and Konso Special district of Segen zoria zone in Ethiopia.

Abergelle goats were reared where the rainfall was uni-modal, short and erratic that extends for not more than two months per year, usually from end of June to the end of August. Crop production usually fails due to low soil fertility and high moisture stress, almost every year (Alubel 2015) signifying the importance of livestock in general and that goats in particular. About 50% of the land mass of Lay Armachiho

district, one of the sites for the CH, lies between 1000 and 2300 meters above sea level (masl) and the other half lies between 2000 and 3000 masl (Kahsay 2013). In Lay Armachiho district, the rain fall is uni-modal and usually runs from May to September. Meta-Robi district, in which the other village for CH was located, lies in a hilly land scope at elevations from 1,200 to 2,900 masl. Precipitation of this district was relatively low and mainly occurs during two seasons: the small rainfall, locally called *belg* rain, between March and April, and the big rain called *meher* rain between June and September. The rainfall pattern of Konso district, where WG was raised, follows a bi-modal pattern. There are two rainy seasons, i.e. *Belg* : big rains with the period starting mid February and lasts to April and the small rain period *Meher* occurring around October and November (Cheung 2008); the agro-ecological zones of Konso special district were 30% dry semi-arid and 70% arid. The temperature of the area mostly experienced hot and warm that ranges between 12 to 33 degrees centigrade (Tesfaye 2003).

Goat breeds and specific villages

Abergelle goat breed had medium size (65-75 cm) height but stocky (28–34 kg); are mostly reddish brown in colour; males have magnificent spiral horns; the hair is short and smooth; all males have ruffs, and 94% of males have beards (FARM-Africa 1996). The CH had predominantly had straight facial profile. All male goats have curved or straight horns which are oriented backwards. The coat colour of the breed is variable where the predominant colour being red-brown with smooth hair. The mean height at the shoulders is 76.3 cm for adult bucks and 67.9 cm for does. Their mature body weight ranges from 30-43 kg (DAGRIS 2007). According to Biruh (2013) the WG had their first kidding at about 22 months and 6.8 months of kidding interval. Zergaw et al (2016) also reported a kidding interval of about 5.5 months for this breed.

Though maintained by the Agew and Tigray ethnic groups of northern Ethiopia, the AB were distributed along the *Tekeze* river in the provinces of southern *Tigray* (*Tembien and Inderta*), north*Wollo* (*Wag* and *Raya-Azabo*) and eastern *Gonder*; the climate is semi-arid to sub-humid with altitude above 1000 masl; the production systems are mixed as well as agro-pastoral (FARM-Africa 1996). WG inhabits the regions of north and south *Omo* as well as parts of southern *Sidamo* and *Wolayta* in the southern Ethiopia; they were mainly kept by pastoralists ethnic groups (*Tsemay, Malie, Hamer, Benna, Dasenatch, Bumie* and *Guji*) and by a few agricultural societies (*Konso* ans *Gardula*); less distinct types of this goat are also kept by the *Wolayta, Gofa* and Gamo people in North Omo; the climate is semi-arid and arid (FARM-Africa 1996). According to the Awgichew

and Abegaz (2009) the CH are mainly found in the central highlands, west of the Rift Valley, *Wollo*, *Gondar* and *Shoa*.

The villages for AB, CH and WG are located in *Tigray* and *Amhara, Amhara* and *Oromia* in and *SNNP's* (Southern Nations, Nationalities, and People's) region, respectively. Specific names for the villages were *Dingur* (*Tigray* region) and *Blaku* (*Amahara* region) for AB,*Waykaw* (*Amahara* region) and *Tatessa* (*Oromia* region) for CH and *Messale* and *Arkisha* (SNNP's) for WG. Study sites' identification was guided by the respective district agriculturalists. The location of these villages is detailed in Table 1.

Table 1. Latitude, longitude, altitude and rainfall of the study villages

Parameters	**Dingur**	**Blaku**	**Waykaw**	**Tatessa**	**Massale**	**Arkisha**
Latitude	13° 22´	12°81´	12°86´	9°54´	5°21´	5°26´
Longitude	38° 98´	38°76´	37°35´	38°23´	37°26´	37°34´
Altitude[#]	1731	1405	1192	2176	1383	1326
Rainfall (ml)*	710.65	546.95	1879.3	910.85	510.75	510.75

**=average rainfall of 2013 and 2014 (national Meteorology agency of Ethiopia) and meteorology stations for rainfall were Abi Adi, Sekota, Tikil Dingay, Ambo Agriculture, and Konso, from left to right, respectively; #=meters above sea level*

Data collection

Ad hoc enumerators were hired to collect data of doe productivity traits. All does and kids of participating farmers were ear tagged with permanent plastic marker during mid July, 2013 to August, 2013 at all the study sites; the data collection continued up to Mid April, 2015. Growth, mortality and flock dynamics data were recorded. The growth traits being recorded were birth weight, three month weight, six month weight, nine month weigh and yearling weights. While recording the mortality data, disease symptoms on a given animal and treatments provided with the dates and status (whether recovered or dead) were recorded. Data related to three month weight and mortality to three months of age only were used in the present study. Other parameters including kidding interval (KI), litter size at birth (LSB) and productivity indices (index I and index II) (detailed below) were derived from the already collected data.

Studied traits

In the present study five parameters, that could explain the performance of a doe, including total litter weight at three months (weight of single born kids), average daily milk yield (ADM), and three month weigh doe productivity indices (index I and index II) and survival rates to three months were investigated.

Litter weight at three months (LWW)

Weights of kids born at given parturition (number of parturitions are indicated in Table 2) per doe and that reached three months after birth were considered. If multiple born kids survived up to three months, then the weight of all kids at this age points were summed up; otherwise, weight of single kid surviving to three months of age was recorded. In general, if there is no multiple births and no deaths, litter weight at three months is equal to weight of single born kids. If kid(s) born from a given doe could not survive until three months of age, then the value for LWW was zero, which was about 24% of the total kids in AB, 22% of the total kids born in CH and about 23% of the total kids born in villages for WG goat breed. Kids that did not survive until three months of age were ignored from the calculation of litter weight at three months.

Productivity indices

Based on LWW and other literature estimates, two productivity indices were investigated at individual does level. These included productivity expressed as the body weight of 90 days old kids produced per doe per year (index I) and per kg ppw per year (Index II). The influences of breed, year of birth and parity of birth were investigated for the indices using General linear model procedure of SAS (2004).

(Bosman et al 1997; Peacock 1987) (1)

(Gbangboche et al 2006) (2)

(where y=live weight production per parturition in kg, standardized per year, LW3M = Litter weight at three months after birth; KI=subsequent kidding interval).

Milk productivity of Abergelle does

Average daily milk yield (ADM, ml) was collected from about 1150 Abergelle does for 12 weeks after kidding/parturition. A doe was milked once in a week starting a week from kidding/parturition date. Milking was twice per day: in the evening and in the morning. Kids were separately housed during night; farmers use traditional practice of tying teat with barks of shrubs and lubricating the teats with dung to prevent kid suckling during day times. When milk measurements were taken from a doe, her kid(s) was (were) assigned to another doe to ensure complete milking as well as to take care of the kids that were prevented from suckling their dams.

Survival rates to three months of age

The survival rates of kids born to a doe were analyzed using a logistic regression procedure in SAS (2004). Kids that exited due to reasons other than deaths were considered as kids that survived. This was because had the reasons (other than deaths due to diseases) were avoided, the kids could have survived.

Fixed factors investigated

Fixed effects of villages, year, season, type, sex, and parity of kids' birth were investigated in the analysis of the studied traits where inclusion of the fixed effects was found to be important. Data were collected from two villages per breed and the effects of respective villages were investigated on the studied traits. Parity of breeding female goats was known from owners during initial recording of flock at household level based on which subsequent parities were determined from the continuous data monitoring via enumerators. Parameters with unknown parities were ignored from the evaluations of does' productivity.

Seasons were categorized into 'dry' and 'wet' based on 2013 and 2014 rain fall data obtained from the national meteorology agency of Ethiopia and from previous experiences in the literature. Accordingly, 'wet' months were July, August and October in *Dingur* village; July, August and September in *Blaku* village; June, August, September, October and November in *Waykaw* village; April – October in *Tatessa* village; and January, March, June, August, September, October and November in *Massale* and *Arkisha* villages. The rest months in the respective villages were categorized as 'dry' season.

Numbers of records were found to be unbalanced across year, type and parity of births; for instance, records from triplets, parity ≥ seven and in the year 2015 were found to be small at all the study sites. Due to these reasons, small records in 2015 were merged to data recorded in 2014; small triplet records (majorly for Central Highland goats) were merged to twin born ones and all parities greater or equal to parity six were considered as the sixth parity.

Data analysis and models fitted

General linear and logistic regression procedures of SAS (2004) were used for the analysis of the current data. Parameters including LWW, index I, index II, and ADM were analyzed using general linear model and survival rate of kids to three months of age was analyzed using logistic regression model. The analysis of LWW, ADM, and survival of kids to three months (S3M) were made separately for the breeds whereas, in the analysis of index I and index II, data from the three breeds were combined and

investigated since standardization was made per ppw and per year. For the analysis of index I and index II, fixed effects of breed, year of birth and parity of birth were fitted in the model. On the other hand, the model fitted for the analysis of LWW and S3M contained fixed effects of villages, sex, year, type of birth, season of birth, and parity of birth; the model for the analysis of ADM contained fixed effects of villages, year of parturition, season of parturition and parity. For the analysis of S3M the logit model below was fitted:

Where p=kids' survival to three months; X_1, X_2, X_3, X_4, X_5, X_6, and X_7 were predictor variables of birth weight, post-partum weight, village, year, sex, birth type and parity, respectively.

Results

Total Litter weight three months (LWW)

The least squares means and standard errors of LWW for AB, CH and WG are given in Table 2. The overall least squares means of LWW (kg) for AB, CH and WG was 7.6, 15.3 and 10.2, respectively. Fixed effects of type and year of birth had clear effects (p<0.001) on LWW of all the three breeds. Multiple births resulted in higher LWW compared to single births in all the cases. The LWW from multiple births were about double of LWW from single births (12.5 vs 7.8 for AB; 19.4 vs 11.6 for CH; 17.4 vs 9.2 for WG) (Table 2). The effect of year of birth on LWW was not constant for the three breeds; for instance, higher LWW were from births in 2013 for AB (10.6 kg in 2013 and 9.6 kg in 2014) and WG (13.6 kg in 2013 and 12.9 kg in 2014), whereas, in the case of CH, higher LWW was from kids born in 2014 (16.1 kg) compared to that of 2013 (14.8 kg). Regarding the effect of WG villages on LWW *Arkisha* (14.9 kg) resulted in higher LWW than *Massale* (11.6 kg). Likewise, season of birth affected (p <0.05) the LWW of AB only (10.6 kg in wet season and 9.7 kg in dry season). The LWW was not affected by villages of birth in the cases of AB and CH. The effect of sex and parity of birth on LWW was not seen in all the three breeds. The effect of post partum weight on the LWW was found to be important in all the three breeds.

Average daily milk yield (ADM)

Least squares means of ADM is given in Table 3 for Abergelle breed. The overall mean of the trait was 367±139 ml. Villages in which does kidded and milked had

visible effect (p<0.001) on ADM where does kidded and milked in *Dingur* had higher ADM (453 ml) compared to the other village (308 ml). Year and season of kidding did not influence (p>0.05) ADM. On the other hand, parity of does (p<0.05) affected ADM where ADM from the first parity was smaller (354 ml) than ADM from the latter parties (378 ml to 390 ml).

Table 2. The effect of investigated fixed factors on total litter weight at three months of age (LWW, kg) for Abergelle, Central highlan and Woyto-Guji goat breeds

Parity	Abergelle		Central Highland		Woyto-Guji	
	N	LSmean±SE	N	LSmean±SE	N	LSmean±SE
Overall LWW	875	7.6±1.54	567	15.3±4.0	464	10.2±1.86
Village		p >0.05		p >0.05		p <0.001
1	339	10.2±0.18	246	15.2±0.29	187	11.6±0.19
2	536	10.1±0.19	320	15.8±0.30	277	14.9±0.18
Year		p <0.001		p <0.01		p <0.001
2013	536	10.6±0.19	158	14.8±0.36	146	13.6±.21
2014	339	9.6±0.19	408	16.1±0.22	318	12.9±0.17
Sex		p >0.05		p >0.05		p >0.05
Male	441	10.2±0.18	326	15.7±0.26	264	13.4±0.17
Female	434	10.1±0.19	240	15.3±0.29	200	13.2±0.19
Season		p <0.001		p >0.05		p >0.05
Dry	813	9.7±0.15	159	15.4±0.35	226	13.1±0.19
Wet	62	10.6±0.25	407	15.5±0.22	238	13.4±0.17
Birth type		p <0.001		p <0.001		p <0.001
Single	848	7.8±0.10	323	11.6±0.30	419	9.2±0.11
Multiple	27	12.5±0.31	243	19.4±0.30	45	17.4±0.29
Parity		p >0.05		p >0.05		p >0.05
1	190	10.1±0.21	111	15.2±0.45a	111	13.3±0.23
2	110	10.2±0.23	109	15.6±0.41a	98	13.4±0.24
3	170	10.2±0.21	109	15.8±0.40a	84	13.3±0.24
4	167	10.3±0.21	92	15.7±0.45a	77	13.3±0.24
5	144	10.1±0.21	65	15.6±0.52a	54	12.9±0.28
6	94	9.9±0.23	80	15.1±0.48b	40	13.6±0.32

N=number of observations (observations in LW3M were equal to observations in LSB in respective breeds and factors); z=least squa means with different letters are significantly different; LSMEANS=least squares means; SE=standard error; ¥=1=Dingur, Waykaw a Massale for AB, CH and WG breeds, respectively and 2=Blaku, Tatessa and Arkisha for AB, CH and WG, respectively

Table 3. Least squares means of average daily milk yield (ml) in Abergelle goat breed, in Ethiopia

Factors	Abergelle	
	N	X ±SE
Overall	1150	367.1±139.78

Village		p <0.001
Dingur	519	453.4±7.17a
Bilaku	631	308.1±8.22b
Year		S
2013	556	377.9±8.20
2014	594	383.6±7.01
Season		p >0.05
Dry	999	374.4±4.61
Wet	151	387.1±12.03
Parity		p <0.05
1	243	354.1±10.33b
2	166	394.3±12.06a
3	199	386.0±11.02a
4	219	381.0±11.34a
5	191	378.4±11.34a
≥6	132	390.7±12.86a

(X is least squares mean; SE= standard error; N=number)

Survival to three month (S3M)

Survival rate to three months (S3M), likelihood ratio of the overall model and individual predictors for the three indigenous Ethiopian goat breeds is given in Table 4. The S3M was 76.30, 78.50% and 77.70%, for AB, CH and WG, respectively. The significant effect (p<0.001) of the likelihood ratio for the three breeds indicate that the fitted model was better than empty model. Intercepts were important (p<0.001) in AB indicating that the logistic regression model could contain the constant, whereas model without constant can be constructed in the other two breeds. Village, parity, year and covariate ppw (p<0.05) improved the fitted model for the analysis of S3M in AB. In the case of CH and WG, year of birth only (p<0.05) improved the fitted model for the analysis of the S3M. Concerning the individual predictors including sex and type of birth did not (p>0.05) improve the model for the analysis of S3M in all the three breeds. In addition, village, parity and constant ppw did not significantly (p>0.05) improve the fitted model for the analysis of S3M in CH and WG breeds.

Log odds of S3M and odds ratio of survival to death of S3M for factors having effect in at least one breed is given in Table 5. Log odds and odd ratios for S3M were 0.15 and 1.16, respectively for ppw in the case of AB. The log odds and odds ratios for the trait in AB were -1.60 & 0.20 and 1.86 & 6.43 for *Dingur* compared to *Blaku* and for 2013 compared to 2014, respectively. The range of log odds and odds ratio for parity 1 to 5 compared to parity 6 was 0.38 – 0.96 and 1.47 to 2.60, respectively for AB. Log odds and odds ratio of S3M for the year 2013 compared to 2014 were -0.20 & 0.82 and 0.81 &2.24 for CH and WG, in respective order.

Table 4. Survival rate at three months of age, significance of likelihood ratio and individual predictors in the logit model for three indigenous Ethiopian goat breeds under farmers' production practices

	n	S3M	LLR	INT	Ppw	vil	Year	Sex	btype	Parity
AB	1152	0.763	p <0.001	-3.82	p <0.001	p <0.001	p <0.001	p >0.05	p >0.05	p <0.05

CH	991	0.785	p <0.001	0.47	p >0.05	p >0.05	p <0.001	p >0.05	p >0.05	p >0.05
WG	649	0.777	p <0.05	1.38	p >0.05	p >0.05	p <0.01	p >0.05	p >0.05	p >0.05

S3M= survival rate to three months of age; LLR= log likelihood ratio; INT= intercept; bwt= birth weight; ppw= post-partum weight; vil= village; btype =birth type; n= number of observations; AB= Abergelle; CH= Central highland; WG=Woyto-Guji

Table 5. Changes in Log odds of survival and odds ratios of survival to deaths at three months of age in three Ethiopia indigenous goat breeds under farmers production practices

Predictors		Abergelle		Central Highland		Woyto-Guji	
		Log odds	Odds ratio	Log odds	Odds ratio	Log odds	Odds ratio
Postpartum weight		0.15±0.03	1.16	-0.003±0.02	0.99	0.01±0.03	1.01
Village (1)		-1.60±0.118	0.20	0.06±0.24	1.06	0.006±0.26	1.01
Year (2013)		1.86±0.19	6.43	-0.20±0.19	0.82	0.81±0.25	2.24
	1	0.96±0.29	2.62	-0.002±0.36	0.99	-0.27±0.40	0.76
	2	0.53±0.31	1.69	0.05±0.33	1.05	-0.61±0.40	0.54
Parity	3	0.79±0.31	2.20	0.12±0.32	1.13	0.05±0.40	0.96
	4	0.44±0.29	1.56	-0.28±0.30	0.76	-0.03±0.34	0.97
	5	0.38±0.30	1.47	-0.04±0.33	0.97	0.55±0.47	1.73

Productivity indices

Three month weight productivity per year per doe (index I) and per year per doe ppw (index II) is given in Table 6. Overall means of index I and index II were 14.7 kg and 0.50, respectively. The CH breed had higher index I (22.3 kg) and index II (0.50) (p<0.001) followed by the WG breed (13.1 kg of index I and 0.52 of index II). Index I was higher (p<0.001) for births in 2014 (15.9 kg) than births in 2013(13.2 kg); similarly, index II was smaller (p<0.05) for births in 2013 (0.49) than births in 2014 (0.54). Earlier parities (parity 1 and 2) were characterized by lower (p<0.001) index I (12.2 kg to 13.0 kg) than latter parities (15.2 kg to 16.3 kg). However, there was not sufficient information (p>0.05) to indicate the importance of the effect of parity of birth on index II.

Table 6. The influence of year, parity of previous parturition and breed on least squares (least squares) means of three months weight productivity of does (index I and index II)*

Parameters	Index I		Index II	
	N	LS means ± S.E	N	LS means ± S.E
Overall means	731	14.7±7.32	720	0.50±0.22
Breed	p <0.001		p <0.001	
Abergelle	345	8.4±0.41c	337	0.33±0.01c
Central Highland	295	22.3±0.44a	292	0.69±0.01a

	Woyto-Guji	91	13.1±0.77b	91	0.52±0.02b
Year		p <0.001		p <0.05	
	2013	333	13.2±0.47b	327	0.49±0.01a
	2014	398	15.9±0.42a	393	0.54±0.01b
Parity		p <0.001		p >0.05	
	1	78	12.2±0.85b	78	0.51±0.02
	2	106	13.0±0.72b	104	0.49±0.02
	3	159	15.6±0.59a	158	0.54±0.01
	4	168	15.3±0.58a	164	0.51±0.01
	5	120	16.3±0.69a	117	0.52±0.02
	≥6	100	15.2±0.77a	99	0.49±0.02

**N=number of observations, S.E=Standard error*

Discussion

Twin born kids had heavier (p<0.05) LWW in all the three breeds. Kids born and reared in *Dingur*, *Tatessa* and *Arkisha* villages for Abergelle, Central highland and Woyto-Guji breeds, respectively had heavier LWW. Abergelle and Woyto-Guji kids born in 2013 and Central highland kids born in 2014 had heavier (p <0.05) LWW than kids born in the other year. Similar studies are not available elsewhere for goats but for sheep. The overall mean of total weight of lambs for Horro sheep was about 24.3 kg (Duguma et al 2002) considerably higher than even the LWW for CH goats in the present study. This could be due to the general fact that the three month weight of sheep is greater than the three month weight of goats; in addition the litter size of Horro sheep at three months of age after parturition could be higher than the litter size of goat breeds studied presently.

Breed and year of birth affected index I and Index II. Index I of Nigerian goat reported by Bosman et al (1997) was smaller (8.3 kg – 10.2 kg) than any of the values of index I in the present study (8.4 – 22.3 kg) regardless of their shorter parturition intervals (260 – 279 days) than that of AB and WG of present study (305 – 348 days). This was probably because the weaning weights composing the indices calculation in Bosman et al (1997) (4.7 – 5.8 kg) was smaller than that used in the present study (7.39 – 10.94 kg). As indicated in equation 1, index I was calculated as the ratio of three month weight (3mw) to KI. This means higher 3mw and smaller KI leads to higher index I. In the reports of Gbangboche et al (2006), the weight used as 3mw were about 10.62 kg (higher than almost all of the values in the present work) and lambing intervals of 0.665 years, shorter than the kidding interval values reported in this work, hence, considerably higher values of index I than ours in Gbangboche et al (2006) was reported. In agreement with our report, parity and year of birth had effect (p<0.001) on the index I in Gbangboche et al (2006) where higher values were associated with older parities. The overall mean of index II for Djallonke sheep was

0.56 kg (Gbangboche et al 2006), higher than overall mean value (0.50) in our work. In general, higher index I and index II were associated with heavier 3mw and ppw and shorter KI. These indices showed significant difference for the fixed effect of breed where the highest values were for CH followed by WG. High values from CH breed could be associated with the desired values (higher 3mw and shorter KI were the desired values for instance) of the parameters used to calculate the indices.

The ADM in the present study is lower than values reported by Alsheikh (2013) and comparable with reports of Mahal et al (2013). As in the case of the present study parity had effect on milk production of Black Bengal goat (Goetsch et al 2011). Milk production generally reaches peak in mid parities and decrease thereafter (Goetsch et al 2011). Similar to the present study, season of kidding did not affect milk yield of goat (Mahal et al 2013; Bushara et al 2013). However, amount of daily milk yield was high in the rainy season probably due to the effect of quantity and quality of feedstuff provided by pasture in the rainy season, or due to presumably benefitted nutritionally from leaf development by some browse species (Bushara et al 2013).

The survival rate in the present study was in agreement with reports of Akpa et al (2009), lower than reports of Hailu et al (2006). The survival rates reported in the present study were higher than the survival rate of kids reported by Husain et al (1995). Regarding effects of fixed factors variable reports are available; in the studies of Hailu et al (2006) fixed effects of year, parity, breed type, sex, season of birth, litter size and birth weight influenced ($p<0.05$) survival rate of Borana and Arsi-Bale kids; in reports of Husian et al (1995), fixed effects of birth type and sex were not significant whereas year of birth was significantly influencing survival to weaning of Black Bengal kids; however, in the present study year of birth for all the studied breeds and location and parity of birth for Abergelle breed had influence ($p<0.05$) on survival of kids to three months of age.

Conclusion

- The CH does produced about double LWW of AB does and about 150% LWW of WG does. They also had the highest productivity indices (index I and index II) followed by WG does and the highest survival rates.

- On the other hand, AB does best suited for dual services (producing kids for meat and production of milk).

- Taking the present findings into considerations, investment priorities in Ethiopia focusing on goat meat production could target the CH goats.

- However, as any of the breeds could poorly perform out of their niche, replacing one breed by another should not be an option. Rather, the productivity of the indigenous goat breeds should be optimized in their respective localities by minimizing possible factors hampering their productivity.

- As improving productivity through efficient understanding of the indigenous goat genetic resources is very crucial, knowledge of factors significantly affecting does' productivity is very helpful while implementing the CBBPs of goats.

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