WHY WE KEEP BIRTH WEIGHT RECORDS IN THE COMMUNITY BASED GENETIC IMPROVEMENT PROGRAMS OF SMALL RUMINANTS?

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Abstract

The present study was conducted to justify that keeping birth weight (BWT) records have little or no significance in genetic improvements of market or adult weights of small ruminants while implementation of community based breeding program (CBBP). Analysis of Pearson correlation (r) between BWT and six month (6MW), BWT and nine month weight (9MW), three month weight (3MW) and 6MW and 3MW and 9MW was conducted for three indigenous Ethiopian goat breeds, namely Abergelle (AB), Central Highland (CH) and Woyto-Guji (WG). The records used for the trait combination ranged from 365 to 715 for BWT and 6MW, 271 to 543 for BWT and 9MW, 362 to 715 for 3MW and 6MW and 269 to 543 for 3MW and 9MW. The 6MW and 9MW were also regressed on BWT and 3MW for the three indigenous goat breeds. The r between BWT and 6MW, BWT and 9MW, 3MW and 6MW and 3MW and 9MW ranged from 0.099 to 0.176, 0.051 to 0.163, 0.598 to 0.706 and 0.370 to 0.546, respectively. The regression coefficients ("b") of 6MW on BWT, 9MW on BWT, 6MW on 3MW and 9MW on 3MW ranged from 0.494 to 0.999, 0.311 to 0.996, 0.706 to 0.927 and 0.415 to 0.669, respectively. In general, BWT had weak r with 6MW and 9MW in three indigenous goat breeds of Ethiopia. The adjusted R-squared (R^2) for regressing 6MW and 9MW on BWT was less than three percent whereas the R^2 was in the range of 13 to 50% for the regression of the traits on 3MW. Literature reports also indicated weak r and genetic correlation (r_g) between BWT and adult or market weight in small ruminants. In addition, the direct heritability is smaller for BWT, compared to adult weights. For these factual, BWT could not be targeted for direct genetic improvement through selection and indirect improvement of other traits. Yet, recording BWT in the CBBP remained compulsory. We conclude that keeping BWT records in the village based breeding program of small ruminants has little or no significance.

Key words: Birth weight; Correlation; Market weight; Heritability

Introduction

Community based breeding program (CBBP) is said to be suitable for small stock keepers of small ruminants in developing countries (Mueller et al., 2015a). It is presented as an alternative to the station or government based breeding program. These days, the CBBP is being implemented in many developing countries including Ethiopia (Duguma, 2010; Duguma et al., 2011; Aynalem et al., 2011; Abegaz et al., 2014; Wurzinger et al., 2013; Mueller et al., 2015b).

The approach required record keeping, among others, for which hiring enumerators is mandatory. Recording formats that enumerators use have been developed by breeders for the implemented CBBP in Ethiopia. For instance, detailed recording formats were developed sheep (Duguma, 2010) and goat (Alemu, 2015) in Ethiopia. Growth traits at different ages including birth weight (BWT), three month weight (3MW), six month weight (6MW) and 12 month weight (12MW) in the CBBP of sheep (Duguma 2010) and BWT, 3MW, 6MW, nine month weight (9MW) and 12MW in the CBBP of goats (Alubel, 2015) are being kept in Ethiopia.

Among the growth traits, we observed that keeping accurate BWT was not easy. Under, station based breeding program, birth weights could be easily recorded within 24 hours after birth which is not the case in CBBP. Recording the BWT in CBBP rather depends on the feedback owners provide to enumerators or the activeness of the enumerators to round on all the member farmers participating in the CBBP and record new births. Unless special focus is given, for instance hiring as many enumerators as possible, accurate birth weight could not be recorded in the CBBP of small ruminants. Hiring numerous enumerators, on the other hand, could be associated with high variable costs leading to low discounted profitability of a breeding activity (Gizaw et al., 2014; Mirkena et al., 2012).

The paradox is embarking in keeping of BWT records under village breeding program where it has little or no implication for the genetic improvement programs. Meta-analysis of literature review in sheep (Safari et al., 2005) and in goats (Jembere et al., in press) showed that birth weight had weak phenotypic and genetic correlations with adult or market weights. On top, the BWT had smaller direct additive heritability and higher ratio of common environmental variances compared to the adult or market weights; which means it could not be a selection criteria. We wanted to argue the importance of recording birth weight versus its significance in the CBBP of small ruminants. To reveal that, we analyzed correlation and regression coefficients of BWT with adult or market weights. Growth data generated from three indigenous Ethiopian goat breeds namely, Abergelle (AB), Central Highland (CH) and Woyto-Guji (WG) were used. The work was also backstopped by reliable literature parameter estimates.

Materials and Methods

Description Of The Study Sites And Breeds

The data used for the correlation and regression analysis in the present work were generated from CBBPs established for AB, CH and WG. There were two villages per breed. The data were pooled from the two villages and analysed by breed. The villages were where the joint project of Biosciences for eastern and central Africa and International Livestock Research Institute (BecA-ILRI) goat project was implemented. Detailed information of the study sites were given in Table 1.

Table 1. Description of the study sites by breeds

	Abergelle		Central highland		Woyto-Guji
District	Tanqua Abergelle	Ziquala	Lay Armachiho	Meta-Robi	Konso
District's zone	Centeral Tigray	Wag-Himra	North Gonder	West shoa	Segen Zuria

District's city*	Yechila	Tsitsika	Tikil Dingay	Shino	Karat
Distance (km)	893	784	758	100	595
Village(s)	Dingur	Blaku	Waykaw	Tatessa	Messale and Arkisha
Altitude (m.a.s.l.)	1574	1462	2052	1200-2900	500-2200
Latitude (North)	13^{o}22'	12^{o}48'	12^{o}58'	9^{o}20'	5^{o}17'
Longitude (East)	38^{o}99'	38^{o}47'	37^{o}04'	38^{o}10'	37^{o}29'
Temperature (^{0}C)**	20-28	22	17-24	23-31	12- 30
Rainfall (annual, ml)	539	255	840-1200	750-110	400-1000

*m.a.s.l. = meters above sea level; *= altitude ranges for Meta-Robi and Konso were given for the district as a whole; **= mean daily temperature.*

Description of the indigenous goat breeds

The AB is kept in arid production system whereas the WG goat breed is kept in the semi-arid production system. CH is suited to crop-livestock mixed production system (Tatek et al., 2016). The description of indigenous goat breeds is given in Table 2.

Table 2. Description of the indigenous Ethiopian goat breeds

Parameters	Abergelle	Central Highland	Woyto-Guji
Distribution	South Tigray, North Wollo, eastern Gonder	Centeral highlands, West of the Rift-valley, Wollo, Gonder and Shoa	North and south Omo, Sidamo, and Wolyta
Production system	Arid	Crop-livestock	Semi- arid
Use	Meat, milk and skin	Meat and skin	Meat and skin
Coat color	Plain and patchy	Reddish-brown	
Facial profile	Straight to concave	Straight	Straight to concave
Horn	All horned	All horned	Most horned; there are some polled
Height at wither (cm)			
Male	71.4	76.3	72.9
Female	65	67.9	66.4

Phenotypic Correlation and Regression

Pearson correlation among growth traits in three indigenous goat breeds was made. Regression of adult or market weights on BWT and 3MW was also analyzed. The CORR and REG procedures in the SAS (2004) were used to calculate the correlation and regression coefficients, respectively. The statistical significances were tested for the coefficients. The phenotypic correlation of BWT & 3MW, BWT & 6MW, BWT & 9MW, 3MW & 6MW and 3MW and 9MW were investigated. In addition, 6mw & 9mw were regressed on BWT and 3MW and presented.

The present data analyses were reinforced by referring to the available weighted average genetic parameter estimates. The weighted average estimates included phenotypic and genetic correlations and direct genetic and direct maternal heritability estimates. The weighted average estimates are considered to be reliable and were presented based on pooled literature parameter estimates.

Results and Discussion

The present study revealed that phenotypic correlation ***(r)*** of BWT with the market or adult weights were small or even equal to zero in some cases. The ***r*** between BWT and 6MW for WG and between BWT and 9MW for CH were not different from zero (Table 3). In general, ***r*** of BWT with both 6MW and 9MW from the three breeds were in the range of 0.051 to 0.176 and the ***r*** of 3MW with both 6MW and 9MW were in the range of 0.370 to 0.706 (Table 3).

Hither ***r*** between 3MW and 6MW was observed compared to the ***r*** between BWT and 6MW (Table 3). The ***r*** of 3MW and 6MW was higher than ***r*** of BWT and 6MW by more than three, five and six folds in the cases of CH, AB and WG, respectively. In the same fashion, the 3MW and 9MW had higher r than BWT and 9MW where the superiority was by more than three, eight and two folds, for AB, CH and WG, respectively.

Adjacent weights had higher r than distant age weights. For instance, the r of 3MW and 6MW compared to r between 3MW and 9MW was higher for all the three breeds, the magnitude of superiority being 1.29, 1.40 and 1.86 folds for AB, CH and WG, respectively.

The present work indicated that BWT had weak r with both 6MW (0.099 to 0.176) and 9MW (0.051 to 0.163) based the data generated from the indigenous goat breeds. Rather, 3MW had higher r, compared to BWT, with the 6MW and 9MW traits. The r between 3MW and 6MW (0.598 to 0.706) was, however, higher than r of 3MW and 9MW (0.370 to 0.546). The weak association of birth weight with both 6MW and 9MW could be due to the fact BWT is affected by the maternal environments in the uterus compared to 3MW.

Table 3. Pearson correlation of pre and post weaning growth traits in indigenous goat breeds of Ethiopia

	AB			CH			WG		
Traits	N	R	p	N	r	p	N	r	p
BWT 6MW	715	0.135	0.0003	612	0.176	0.0001	365	0.099	0.0584
BWT 9MW	543	0.144	0.0007	402	0.051	0.3044	271	0.163	0.0073
3MW 6MW	715	0.706	0.0001	605	0.598	0.0001	362	0.690	0.0001
3MW 9MW	543	0.546	0.0001	386	0.427	0.0001	269	0.370	0.0001

AB=Abergelle goat breed; CH=Central highland goat breed; WG = Woyto-Guji goat breed; N= number of observations for the two traits; p= probability value; r = phenotypic correlation; BWT=birth weight; 6MW=six month weight; 9MW= nine month weight; 3MW=three month weight.

The regression of 6MW and 9MW on both BWT and 3MW resulted in high values of regression coefficient (“**b”**) except regression of 9MW on BWT for CH and regression of 6MW on BWT for WG (Table 4). Regardless of their satisfactory “**b”** values (ranging from 0.311 to 0.996), the adjusted R-square for regressing 6MW and 9MW on BWT was considerably low, ranging from 0 % to 3 %. This means some other factors contributed to the magnitude of “**b**” which lessens the reliability of regressing 6MW and 9MW on BWT which could indicate that BWT should not be used to predict both 6MW and 9MW. This does not mean, however, keeping records of birth weight is not important. It is well known that birth weight has higher association with survival. But if accurate birth weight records could not be kept, particularly under the community based breeding programs, planning to keep birth weight records would be rather meaningless. Some other mechanisms including regressing birth weight based on the linear body measurements of kid could be developed. Once such relationship is developed, birth weights of kids, under CBBP could be generated based on the linear body measurements even at the household level of the participating farmers.

The “**b**” of 6MW and 9MW on 3MW were not always higher than the “**b**” of 6MW and 9MW on BWT (Table 4). The adjusted R-Squares for the regression of 6MW and 9MW on 3MW were considerably higher (13 to 50%) than adjusted R-Squares of regressing 6MW and 9MW on BWT.

Table 4. Regression of post-weaning growth traits on pre-weaning growth traits in indigenous goat breeds of Ethiopia

	Parameters	AB		CH		WG	
		6MW	9MW	6MW	9MW	6MW	9MW
BWT	N	715	543	612	402	365	271
	b	0.968	0.996	0.999	0.311	0.497	0.850
	p	0.0003	0.0007	0.0001	0.3044	0.0584	0.0073
	Adj. R^2	0.01	0.02	0.03	0.00	0.01	0.02
	Intercept	7.892	9.953	13.509	18.799	11.83	13.857
3MW	N	715	543	605	386	362	269
	b	0.927	0.669	0.706	0.590	0.811	0.415
	p	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	Adj. R^2	0.50	0.30	0.36	0.18	0.47	0.13
	Intercept	2.921	6.958	8.357	13.271	5.024	11.570

AB= Abergelle goat breed; CH=Central highland goat breed; WG= Woyto-Guji goat breed; N= number of observations for the two traits; b=coefficient of regression;Adj.R^2=Adjusted R-square; p= probability value; **b** *= coefficient of regression; BWT=birth weight; 6MW=six month weight; 9MW= nine month weight; 3MW=three month weight.*

Weighted average r among growth traits in goats, sheep and also in cattle was reported to be higher for adjacent age classes. Jembere et al (in press) reported weighted average r of 0.36 between BWT and 3MW and 0.27 between BWT and 12MW for goats; Safari et al (2005) reported weighted average r of 0.37 and 0.26 between BWT and 3MW and BWT and adult weight, respectively in sheep. Lobo et al (2000) also reported weighted average r of, in cattle, 0.46 and 0.38, between BWT and 3MW and BWT and 12MW, respectively. In all the reports, the r of BWT and 12MW/adult weight was smaller than the r of BWT and 3MW the latter has less practical implication.

On the other hand, r between 3MW and 12MW was higher by about two folds than r between BWT and 12MW in goat (Jembere et al., in press), sheep (Safari et al., 2005) and cattle (Lobo et al., 2000). This may justify that even based on the meta-analysis results BWT had weak phenotypic correlation with adult age weights or market weights.

The r is an estimate of the association between two visible characteristics and it contains genetic and environmental effects. The r could be similar with the genetic correlation (r_g) when estimates are made within the same environment (if estimates are made in similar environment, then the environmental covariance between the two traits become zero leading to equal genetic correlation with environmental correlation).

Since error variance could not be avoided, judging the genetic association of BWT with different adult weights could be more reliable than the phenotypic association of BWT with the different age weights. The weighted average r_g values in goats were 0.54, 0.32 and 0.31, between BWT and 3MW, BWT and 12MW and 3MW and 12MW, respectively in goats (Jembere et al., in press). These values were 0.47, 0.22 and 0.75, for BWT with 3MW, 6MW, and 12MW in sheep, respectively (Safari et al., 2005). Lobo et al. (2000) reported weighted average r_g values of 0.50, 0.55 and 0.81 between BWT and 3MW, BWT and 12MW and 3MW and 12MW, respectively in cattle.

In all the three reports, high r_g was reported between adjacent age classes; for instance between BWT and 3MW and between 3MW and 12MW. The weighted average r_g between BWT and 12MW or adult age weight was generally smaller than the r_g between 3MW and 12MW. This also, in addition to the r could indicate weak r_g between BWT and BWT.

The BWT of goats, sheep and cattle had smaller direct heritability than 12MW whereas the maternal heritability of BWT for the species was higher than the maternal heritability (it should be noted that maternal heritability could be base of making a trait a selection criteria, but not as important as the direct heritability of a trait) of 12MW (Table 5). Comparing the direct heritability of BWT and 12MW (Table 5), the latter had higher values. In the case of maternal heritability, it was BWT that had higher values compared to 12MW. The lower values of direct heritability of BWT or the higher values of maternal heritability of BWT could indicate the high influence of maternal environment on the trait. From the two heritability estimates, it is the direct heritability estimates that have more implication on genetic improvement through selection. Therefore, it could be concluded that BWT might not be targeted for selection.

Table 5. Weighted direct and maternal heritability estimates of sheep and goat

Species/breed*	Birth weight	Weaning weight	Yearling weight
Direct			
Goat/dual	0.16	0.22	0.31
Sheep/wool	0.21	0.21	0.42
Sheep/dual	0.19	0.16	0.40
Sheep/meat	0.15	0.18	0.29
Cattle1	0.31	0.21	0.33
Tropical cattle	0.34	0.30	0.37
Maternal			
Goat/dual	0.12	0.08	0.05
Sheep/wool	0.21	0.16	0.04
Sheep/dual	0.18	0.10	0.06
Sheep/meat	0.24	0.10	-

**= sources are Jembere et al forthcoming for goat and Safari et al 2005 for sheep*

Endeshaw et al. (2013) said that the market weight of Afar goat was in the range of 25 - 30 kg. According to Shija et al. (2013), slaughter age (years) and weight (kg) of indigenous sheep and goats in East Africa could be in the range 1.5 to 2 years and 20 to 25. Tibbo et al. (2006) suggested market age and market weight for sheep in Ethiopia as 12 months of and 30 kg to be considered in designing the breeding program. The average marketing age (months), for indigenous goats in Ethiopia, was reported to be 11.67 and 12.33 for males and females, respectively (Asefa et al., 2015). In the present study, we could not show favorable correlations between BWT and the market weights or adult weights. The direct heritability estimates from literature, was small.

Conclusion

Birth weight had weak phenotypic correlation with 6MW and 9MW in the three indigenous goat breeds in Ethiopia. The regression of 6MW and 9MW on BWT was not reliable because of low (less than three per cent) adjusted R-square. Literature reports indicate that due to weak phenotypic and genetic correlation between BWT and adult or market weight and low direct heritability, BWT could not be targeted for genetic improvement through selection. Yet, recording BWT in the community based breeding program remained compulsory. We conclude that keeping BWT records under village based breeding program is not only of little or no significance, from field experience, but also hardly practical. Some other mechanisms, however, including regressing birth weight based on the linear body measurements of kid could be developed. Once such relationship is developed, birth weights of kids, under CBBP could be generated based on the linear body measurements even at the household level of the participating farmers.

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