Ewe Body Condition Determines Oestrus Response to Hormonal Oestrus Synchronization in Smallholders Village Flocks

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Abstract

The objective of this study was to investigate the effects of ewe associated factors on hormonal oestrus synchronization in village sheep flocks in Sidama zone, Southern Ethiopia. Initially, for synchronization fifty-five Sidama ewes were selected and checked for pregnancy status using pregnancy diagnosis device (Preg-Tone). The ewes were injected with a single shot of $PGF_2\alpha$ (Lutalyse®) hormone at the rate of 2.5 ml per ewe. Thirty-eight of the 55 ewes treated with hormone showed oestrous signs. The ewes were then joined with active selected four breeding rams for four consecutive days. Oestrous response and conception rates were analyzed using multinomial logistic regression model. The overall oestrous response rate and conception rate were 69.1% and 89.2%, respectively. The average time to onset of oestrus was 54.1 hrs, ranging from 19.1 to 97.5 hrs. Neither ewe body weight (P = 0.902), age (P = 0.127) nor parity (P = 0.968-0.084) had significant effect on the oestrus response rate of ewes to hormonal oestrus synchronization. The only significant factor determining oestrus response was ewe body condition. Ewes with body condition score of 2.5 and below were significantly more likely not to respond to hormonal treatment (odds ratio = 2.15E-09, P = 0.000) compared to ewes with body condition score of 3.0. However, none of the factors studied (body condition, body weight, age and parity of the ewe) affected the time of onset of estrus after hormone administration and conception rate. It could be concluded that body condition, regardless of the other ewe associated factors (i.e. body weight, age and parity), dictates oestrus response of ewes to hormonal treatment in synchronization of oestrous cycles in village ewe flocks. It is thus imperative to pay attention to nutrition of ewes for successful synchronized breeding in villages where supplementary feeding is rarely practiced.

Key words: *Synchronization, oestrous response, body condition, sheep, Sidama*

Introduction

In traditional uncontrolled continuous mating systems under smallholder small ruminant farming systems, lambing is commonly distributed throughout the year, with only a small proportion (13% to 15%) of the lambings occurring in a peak lambing season during the favorable rainy season in Ethiopia (Legesse, 2008) and elsewhere (Setiadi *et al*., 1995). Flock performance is negatively affected if lambing/kidding do not match with appropriate seasons in terms of feed availability and disease load. Year-round dispersed lambings has also been found to limit village-based genetic improvement efforts since only a few selection candidates would be available in each round of selection resulting in low selection intensity (Gizaw *et al*., 2014).

Hormonal oestrus synchronization has been introduced in Ethiopia to accelerate delivery of improved dairy genetics (Tegegne *et al*., 2012) and its application in small ruminant breeding has been under investigation (Zeleke, 2009; Zelelke *et al*., 2016). However, Oestrus responses to hormonal synchronization ranging from 65 to 100% have been reported for Ethiopian sheep breeds (Zeleke 2009; Zeleke *et al*. 2016) and from 4.3– 100% for village flocks elsewhere depending on the synchronization protocol (Omontese *et al*. 2016). Oestrus response is also affected by various ewe associated factors such as body condition, age, body weight and parity and as well as environmental stresses (Santoralia *et al*., 2011). These factors could be confounded and there is a need to single out the predominant factor determining the success of oestrus synchronization under village conditions. This study investigates the effects of ewe-associated factors on hormonal oestrus synchronization and to introduce pregnancy diagnosis device (Preg-Tone) for early stage of pregnancy in village sheep flocks in Sidama zone of Southern Region, Ethiopia.

Materials and Methods

Study area

The study was conducted at Bensa woreda of Sidama zone, Ethiopia. Sidama is one of the zones in Southern Nations and Nationalities and Peoples' Region (SNNPR). The capital is Hawass town located 275 km south of Addis Abeba. Sidama zone is located at $5^0$45' and $6^0$45' N latitude and $38^0$39' and $38^0$29' E longitude. It has highlands, midlands and semi-dry lowlands agro-ecologies accounting for 30%, 60% and 10% of the area, respectively. The farming system of the zone is

characterized as mixed farming system. Among the three agro-ecological zones, this study was conducted only in high land parts of Bensa *woreda*[1].

Study animals

The study animal belonged to a cooperative village sheep breeding groups. Through discussion with the farmers, 55 ewes were selected for the study. Prior to synchronization the ewe flocks were checked for their pregnancy status using an ultrasound pregnancy diagnosis device (Preg-Tone®). The selected ewes were 16 to 36 months of age with 1-3 parity level and weighing 18-34 kg. The ewes were scored for their body condition on a 1-5 scale (1=thin/emaciated; 2= thin/poor; 3= acceptable; 4= fat; 5=very fat) following Srinivas (2013). Experimental breeding ewes and rams were used from the same location. A total of four mature active rams with similar age and BCS and which has higher body weight were subjected for 38 ewes which have responded oestrus. Thus, the two rams were allocated for 19 ewes and the rest two rams were used for 19 ewes.

Oestrous synchronization and mating

A single shot of $PGF_2\alpha$ (Lutalyse®) hormone was administered at the rate of 2.5 ml per ewe. Synchronization was carried out in to two cluster (FTC and village level), but mating was made at their nearest village where rams are placed. Following synchronization, the ewes were then joined with active selected mature and similar age group rams for four consecutive days from 8:00 am to 6:00 pm. After 6:00 pm the ewes were returned back to their home. Mating time (estrus) of each ewe was observed by the sheepherders and rams also detect ewes heat. When the rams are mounting the ewe doesn't move, indicating ewe's status of heat. The breeding rams were flushed 400 gm of concentrate feed once daily for a month so as to increase libido. Selected ewes were managed according to the farmers' practice with no special feeding or any other management intervention throughout the study period. Preventive treatment was administrated against internal parasites. Sixty days post-joining ewe pregnancy status was diagnosed using Preg-Tone®.

[1] *woreda* is the lowest administrative level equivalent to district.

Statistical analysis

Oestrous response and conception rates were analyzed using multinomial logistic regression analysis and SPSS version 20 (2011) was employed for the analysis. Oestrous response and conception rates were modeled as dependent variable. Parity as categorical and body condition score, body weight and age were considered as as continuous independent variables. For the dependent variables, there exist two continuous variables Z_k (Z_1 and Z_2) each of which can be thought of as the likelihood of oestrus response and conception, with larger values of Z_k corresponding to greater probabilities of oestrous response or conception. Mathematically, the relationship between the Z's and the probability of a particular outcome is described in the formula: $\pi_{ik} = (ez_{ik}) / (ez_{i1} + ez_{i2} + ... + ez_{ik})$, where π_{ik} is the probability the i_{th} ewe falls in category k and z_{ik} is the value of the k_{th} unobserved continuous variable for the i_{th} ewe. Time of onset of response was analyzed fitting body condition score and parity as categorical and body weight and age as continuous independent variables in a general linear model.

Results and Discussion

Oestrus response and conception rate

Thirty-eight of the 55 ewes treated with hormone showed oestrous signs, resulting in oestrous response rate of 69.1% (Table 1). This could be considered a moderate response compared to oestrous an average response rate of 76.5% achieved in four local breeds (Gizaw *et al*., 2016), ranging from 93.2% in the Horro type sheep to 57.5% in the Atsbi sheep type. Similarly, Zeleke (2016) reported 55–65% oestrous response rate for the local Ethiopian Menz and Awassi-Menz crossbred sheep. Oestrous response varies significantly across experiments due to variation in ewe factors, breed differences, age, environments and managements. Omontese *et al* (2016) reported response rates ranging between 20 and 100% for Nigerian goat breeds. The average time of onset of oestrus after hormone administration in the current study was 54.1 hrs ranging from 19.1 to 97.5 hrs (Table 1). The percentage of ewes showing oestrus within 72 hrs was 74.5% (Fig. 1), which was close to the average 76.5% reported for four Ethiopian sheep breeds (Gizaw *et al*., 2016).

Table 1. Estrus response, onset of response and conception rate of ewes treated with Lutylaze hormone

Variables	No. of ewes synchronized	No. of ewes responded	Oestrus response (%)	Time to onset of oestrus (hrs.)	Conception (%)
Overall	55	38	69.1	54.1±3.5	89.2
Parity					
First	18	16	88.89	59.7±5.7	87.50
Second	23	13	56.52	50.1±4.9	92.85
Third	14	9	64.28	49.5±7.9	77.78
Body condition score					
2.0	23	12	56.5	53.3±6.8	75.0
2.5	18	11	61.1	57.6±4.5	90.9
3.0	14	14	100	52.1±6.6	100.0

Pregnancy diagnosis using ultra sound detector confirmed that 34 (89.4%) of the 38 ewes that showed oestrus signs and joined with rams were pregnant. This conception rate could be considered high given conception rates following artificially induced oestrus is usually reported to be low. For instance, Kumar *et al*. (2016) reported low conception rates in three hormonal oestrus induction protocols (37.5%, 53.3 and 56.3%) compared to the oestrus response achieved (81.3%, 100%, and 93.7%). On the other hand, Cairoli *et al*., (2006) reported similar conception rates between cows inseminated after induced-oestrus and spontaneous oestrus (59% vs 54.5%).

The anestrous ewes that did not respond to hormone treatment were also run with the ewes that showed oestrous during the mating period. The percentage of the anoestrus ewes that started to cycle and conceived during the mating period was only 5.9%. Effect of ram exposure is known to affect oestrus behavior (Nugent *et al*., 1988), but the ram effect is more effective with sudden introduction of rams and when ewes have had no contact with rams for a period of time, which was not the case in the current study.

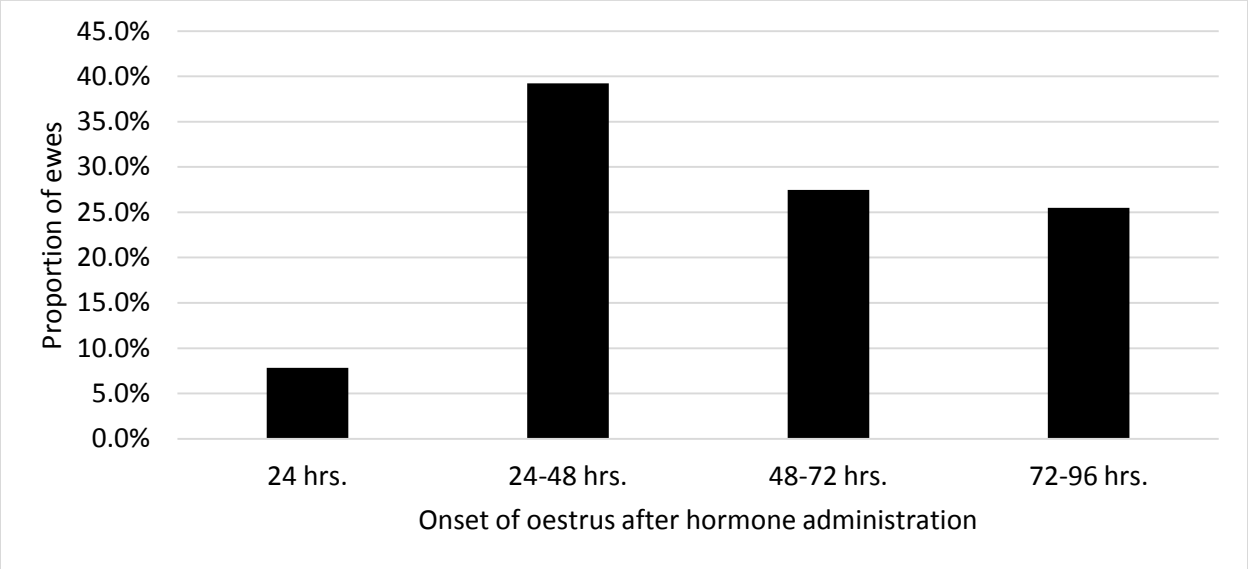

Fig. 1 Distribution of onset of oestrus in hours after Lutylaze hormone administration

Determinants of oestrous response, onset of oestrus and conception rate

Neither ewe body weight (P = 0.902), age (P = 0.127) nor parity (P = 0.968-0.084) had significant effect on the oestrus response rate of ewes to hormonal oestrus synchronization (Table 2). However, there are some reports (Véliz *et al*., 2009; Ungerfeld and Sanchez-Davila, 2012) where parity showed significant influence on oestrus response, though not on pregnancy rate, a unit increase in body weight resulted in an increase of 14.7% in oestrus response (Gizaw *et al*., 2016), and heavier goats showed more oestrus response and shorter time to onset of oestrus than lighter goats (Véliz *et al*., 2006).

However, the studies reporting significant effects of parity and body weight (Véliz *et al*., 2006; Véliz *et al*., 2009; Ungerfeld and Sanchez-Davila, 2012) did not include the effects of body condition in their analysis models. In the current study the effects of ewe parity, body weight, age and body conditions were investigated in a multivariate model. The results showed that the only significant factor determining oestrus response was ewe body condition (Table 2). Ewes with body condition score of 2.5 and below were significantly more likely not to respond to hormonal treatment (odds ratio = 2.15E-09, P = 0.000) compared to ewes with body condition score of 3.0. This is in agreement with other studies in which the analyses models included body condition together with other ewe associated factors such as parity and body weight. In these studies, neither body weight nor age of ewes significantly influenced their fertility (Aliyari *et al*., 2012) and estrus responses were not significantly different between nulliparous, primiparous and multiparous does (Mat *et al*., 2015), whereas body condition had significant influence on oestrous

responses. A similar result was reported for cattle where body condition rather than parity and age had a significant effect on oestrous response and conception (Gebrehiwot *et al*., 2015). These findings indicate that body condition is the overriding determinant of oestrous response to hormonal oestrus synchronization in ewes.

Table 2. Likelihood of oestrus response following treatment with Lutylaze hormone in ewes differing in age, body weight, body condition and parity

Variable name	Estimated coefficient (β)	Std. error	P value	Odds ratio (exp *B*)
Intercept	23.734	3.119	0.000	
Age (months)	-0.104	0.068	0.127	0.902
Weight (kg)	0.012	0.095	0.902	1.012
Body condition score 2.0	-19.957	0.764	0.000	2.15E-09
Body condition score 2.5	-19.635	0	.	2.97E-09
Body condition score 3.0	0[b]	.	.	.
Parity 1	-0.047	1.19	0.968	0.954
Parity 2	-1.565	0.905	0.084	0.209
Parity 3	0 [b]	.	.	.

a. The reference category is 'no oestrous response'. b. This parameter is set to zero because it is redundant.

Both the current and previous findings indicate that a body condition score of 3.0 results in maximum oestrous response to hormonal oestrous synchronization. Mat *et al.* (2015) found oestrous response rates of 0%, 77.8% and 0% in ewes with body condition scores of <2.0, 2.5-4.0 and >4.0, respectively. Aliyari *et al.* (2012) reported a normal oestrous cycle in ewes with body condition score of 3, whereas ewes with body condition score of 2 and 2.5 showed shorter and irregular oestrous cycle duration. Body condition scores of 2.5 to 3.0 have been recommended by some authors (Husein & Ababneh, 2008; Contreras-Solis, *et al*., 2009).

Body condition directly affects hypothalamic activity and GnRH secretion and effects on reproductive performance are mediated through changes in ovarian hormones or in hypothalamo-pituitary sensitivity to ovarian hormones (Rhind, *et al*., 1989) and the impact of body condition was quantified to reach as high as a 2.4-fold increase in pregnancy loss for a unit reduction in condition score (López-Gatius *et al*., 2002).

None of the factors studied in the present study (body condition, body weight, age or parity of the ewe) affected the time of onset of estrus after hormone administration and conception rate (Table 3). Similarly, Mat *et al*. (2015) reported a non-significant influence of body condition on pregnancy rate and time of onset of oestrus. However, in some cases the effect of body condition could be expressed in lower pregnancy rate (Maqhashu *et al.*, 2016) and feed restriction, through its effect on body condition, could delay onset of oestrus (Mani *et al.*, 1992). These difference among different studies could be the availability of flush feeding for ewes response in synchronization and conception; age of ewe, body condition, parity, breed type, ewe factors and environmental conditions.

Table 3 Likelihood of conception of hormonally-induced ewes differing in age, body weight, body condition, parity and differences in time of onset of oestrus after hormone treatment.

	Conception rate			Onset of oestrus (hr)		
	B	Sig.	Exp(*B*)	*B*	Sig.	Exp(*B*)
Intercept	221.71	0.977		28.35	0.467	
Age (months)	-5.628	.	0.004	0.868	0.263	2.383
Weight (kg)	-0.062	0.780	0.940	-0.401	0.675	0.67
Body condition score 2.0	-18.177	0.998	1.28E-08	-0.596	0.943	0.551
Body condition score 2.5	0.496	1.000	1.642	7.966	0.362	2881.99
Body condition score 3.0	0 [b]	.	.	0 [b]	.	1.000
Parity 1	-47.791	0.995	1.76E-21	18.734	0.115	1.37E+08
Parity 2	6.973	0.999	1067.764	5.327	0.625	205.744
Parity 3	0 [b]	.	.	0 [b]	.	1.000

a. The reference category is no conception, b. This parameter is set to zero because it is redundant.

Conclusion

It could be concluded that body condition, regardless of the other ewe associated factors (i.e. body weight, age and parity), dictates oestrus response of ewes to hormonal treatment in synchronization of oestrous cycles in village ewe flocks. It is thus imperative to pay attention to nutrition of ewes for successful synchronized breeding in villages where supplementary feeding is rarely practiced.

Acknowledgement

This study was financially and technically supported by the Livestock and Irrigation Value Chains for Ethiopian Smallholders (LIVES) project of the International Livestock Research Institute (ILRI). LIVES project is financed by Global Affairs Canada (GAC). Hawassa Agricultural Research Center and Bensa woreda Livestock and Fishery Development Office are duly acknowledged for their facilitation and support during the field work.

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