LIVES WORKING PAPER 25

Hormonal oestrus synchronization in four sheep breeds in Ethiopia: Impacts on genetic improvement and flock productivity

Hormonal oestrus synchronization in four sheep breeds in Ethiopia: Impacts on genetic improvement and flock productivity

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Contents

Tables

Figures

Executive summary

Lambing and kidding in village flocks is thinly distributed across the year and usually not planned. This has a number of implications. Flock performance is negatively affected if lambing/kidding does not match with appropriate seasons in terms of feed availability and disease load. Secondly, village genetic improvement is commonly not effective since only few selection candidates would be available in each round of selection due to dispersed lambing/kidding resulting in low selection intensity and thus slow genetic progress. Hormone-synchronized breeding could be a solution for achieving planned and concentrated lambing/kidding. Research on hormonal oestrous synchronization has been underway in Ethiopia for long. However, there are challenges which could hamper the application of the technologies under smallholder conditions. Results show that oestrous response to synchronization in village flocks varies and not consistent. The challenge with the technology is the variable oestrous response ranging from 4.3 to 100% depending on the synchronization protocol.

The Livestock and irrigation value chains for Ethiopian smallholders (LIVES) project initiated a series of field experiments in four sheep breeds in Southern Peoples, Nations and Nationalities (SNNP), Tigray, Amhara and Oromia regional states in 2015 and 2016 to evaluate and design hormonal oestrous synchronization and planned production in village small ruminants. The aim of these action research and demonstration activities were to introduce, evaluate and demonstrate synchronized breeding in small ruminants for planned lambing/kidding, increased selection intensities in village genetic improvement programs, and lamb/kid survival and growth.

The results show that lambing under natural oestrus was distributed throughout the year in the study areas, although there were some peak lambing months which accounted for only 25.5% of the lambings in a year. Overall, across the six field experiments 76.5% of the ewes treated with oestrous synchronization hormone expressed oestrous within 72 hours of hormone administration. The overall conception or pregnancy rate of ewes that showed oestrous was 73.6%. The average oestrous response achieved in the current study was within the upper end of the response range in the literature. The results showed that oestrus and lambing can be effectively synchronized artificially. The synchronizations achieved by hormone treatment were significantly higher than naturally synchronized lambings of 17.1–25.2% in the current study.

Ewe body weight was found to be a significant factor determining oestrous response and conception rates to hormone treatment. On a 1–5 body condition score, ewes that had 3.5 and more and 2.5–3.5 body condition score were respectively 5.05 and 3.36 times more likely to respond to hormonal treatment and exhibit oestrus than ewes that were in poor body condition. Multiparous ewes were more responsive to hormonal treatment with oestrous response rate of 0.91 compared to 0.79 for primiparous ewes.

In this study, no statistically significant advantage of double dose administration of hormone at interval of nine days was observed over a single dose hormone administration, though the double dose scheme gave 10% more oestrous response. Also increasing the Lutylase® hormone dose was not accompanied by a significant increase in oestrous response rate, oestrous rate increased by 23% when the dose of Synchromate® hormone was increased from 0.8 to 1.0 ml.

Year-round distributed lambing could minimize risk of losing the whole lamb crop due to some phenomenon of climatic change and could also be compatible with the function of small ruminants as a means of saving assets where saving in the form cash is not common or not accessible. However, distribution of lambings over the year could have implications in genetic improvement programs. Introducing hormonal oestrus synchronization gave 160.5–190.1% more profit than selection under natural oestrous synchronization. This is due to the concentrated lambing and lower lamb mortality rate under hormonal synchronization which enabled to achieve higher selection intensity and hence faster genetic progress. The data show that there is a fair correspondence between seasons or months of peak lambing occurrence and highest lamb survival. Yet, the peak lambing accounted for only 25% of the total lambings per year. Thus the natural lambing distributions could expose most of the lambs to unfavourable seasons for survival and growth. This study strongly indicated that oestrus could be effectively synchronized artificially using Lutylase® hormone at a single dose of 2.5 ml.

Introduction

Lambing and kidding in village flocks is thinly distributed across the year and usually not planned. This has a number of implications. Flock performance is negatively affected if lambing/kidding does not match appropriate seasons in terms of feed availability and disease load. Dispersed lambing/kidding also undermines the economies of scale of smallholders further (in addition to the already small flock size) for efficient input use and marketing (e.g. bulk marketing). Lastly, village genetic improvement (especially selective breeding) is commonly not effective since only few selection candidates would be available in each round of selection due to dispersed lambing/kidding resulting in low selection intensity and thus slow genetic progress.

Hormone-synchronized breeding could be a solution for achieving planned and concentrated lambing/kidding. Research on hormonal oestrous synchronization has been underway in Ethiopia for long (Tegegne et al. 1986; Zeleke 2009; Tegegne et al. 2012; Tadesse et al. 2016). However, there are challenges which could hamper the application of the technologies under smallholder conditions. Results show that oestrous response to synchronization in village flocks varies and not consistent, the challenge with the technology is the variable oestrous response ranging from 4.3–100% (Omontese et al. 2016) depending on the synchronization protocol (Omontese et al. 2016). Oestrus responses to hormonal synchronization ranging from 65 to 100% have been reported for Ethiopian sheep breeds (Zeleke et al. 2016; Zeleke 2009). Furthermore, introduction of synchronized breeding in small ruminants by using relatively cheaper and easily administrable hormone (prostaglandin) is limited due to difficulty of selecting non-pregnant females from the flock since prostaglandin induces abortion if injected in pregnant animals. This is mainly because of the impracticality of using per rectum palpation technique to diagnose pregnancy in small ruminants unlike in cows.

The LIVES project initiated a series of field experiments in diverse sheep breeds and agro-ecological zones to evaluate and design hormonal oestrous synchronization and planned production in village small ruminant. The aim of these action research and demonstration activities were to introduce, evaluate and demonstrate synchronized breeding in small ruminants for planned lambing/kidding, increased selection intensities in village genetic improvement programs, lamb/kid survival and growth, and introduce and demonstrate a pregnancy diagnosis device (Preg-Tone) for effective hormone-synchronized small ruminant breeding and production.

Material and methods

Experiments

This study was based on six experiments. Additionally, published data from Zeleke et al. (2016) were used to study the effect of hormone dose and breed on oestrous response. The experiments were conducted in SNNP (Arbegona district), Amhara (Dessi Zuria district), Oromia (Ejere district) and Tigray (Ganta Afeshum and Saesi-Tsaeda-Emba districts) states in Ethiopia in 2015 and 2016. The locations of the six experiments represent different agro-ecological zones and sheep breeds/types. The sheep breeds/types studied in the four states, respectively, were Arsi-Bale sheep, Wollo sheep, Horro sheep, and Tigray Highland sheep.

The experiments were conducted under field conditions on farmers' flocks. The ewes were owned and managed by smallholder sheep farmers. Most of the participating farmers were members of cooperative village sheep breeding groups organized by LIVES project. Farmers and livestock development agents were trained on hormonal oestrous synchronization and discussions were held with farmers to select participating farmers and flocks.

Oestrous synchronization protocols

Ewe flocks of the cooperative breeding groups were screened for pregnancy status using Pregtone® (Renco Corporation, USA). A total of 664 non-pregnant ewes of farmers willing to participate in the experiments were selected for the six experiments (Table 1). The ewes were then scored for body condition from 1–4 following Abebe and Yami (2008), (BCS) 1=thin/emaciated; BCS 2= thin/poor; BCS 3= acceptable/moderate; BCS 4= fat). The ewes' parity was also recorded. The ewes in Oromia and Amhara 2015 experiments were flush-fed for about two weeks prior to administration of hormone. The selected ewes were treated with two types of oestrous synchronization hormones, 2.5 or 2.0 ml Lutylase® and 0.8 or 1.0 ml Synchromate®. Ewes that came into standing heat were observed by farmers and hand-mated to selected rams. The rams used were Begait rams in Tigray, Bonga rams in SNNPR, local ram in Oromia and local and Awassi ram in Amhara experiments. Pregnancy was confirmed 40 days after mating using Pregtone® ultrasound scanning.

Table 1: Description of six experiments conducted to evaluate hormonal oestrous synchronization in four sheep breeds in four regional states in Ethiopia

Experiment	Year	No. of ewes	Hormone
Oromia	2016	96	Synchromate®
SNNP	2016	41	Lutylase®
Tigray	2016	120	Synchromate® and Lutylase®
Tigray	2015	126	Synchromate® and Lutylase®
Amhara	2015	85	Synchromate® and Lutylase®
Amhara	2016	196	Synchromate®and Lutylase®

Statistical analysis of oestrous response and conception rates

Oestrous response to hormone treatment was determined based on expression of standing heat when ewes were exposed to rams. Conception rates were determined based on pregnancy diagnosis using Pregtone® or apparent pregnancy upon visual observation or lambing records. Effects of ewe parity and body weight on oestrous response and conception rates were analysed separately since the two factors (parity and body weight) are confounded. Body condition score was included in the models of analysis of both parity and body weight. Descriptive statistics, multinomial regression, binary logistic regression and chi-square analyses were conducted to determine the statistical significance of the effects of parity, body weight, body condition and various oestrous synchronization protocols on oestrous response and conception rates.

Analysis of impact on genetic improvement

A breeding and synchronization scheme was simulated to evaluate the genetic impact and economic feasibility of hormonal oestrus synchronization. A cooperative village breeding nucleus flock with 1308 ewes serving as a source of improved rams for 14,466 ewes in Ejere district, Oromia state was modelled. ZPLAN (William 2008) was used for the simulation study. Two oestrus synchronization schemes were evaluated against breeding and lambing patterns under natural oestrus expression. The parameters for the natural mating and lambing pattern were derived from data collected in a cooperative breeding group in the district (Figure 1 and 3). The Lutylase® (Protocol 1) and pregnant mares' serum gonadotropin (PMSG) (Protocol 2) hormonal synchronization protocols were based on, respectively, the results presented in the current study (Figure 4) and Zeleke (2009). The proposed scheme for delivering oestrous synchronization service was kebele-based where the livestock development agent and veterinary assistant in kebele health posts will serve as technical experts and supported and coordinated by the district livestock development office. Each health post will have facilities and supplies for oestrus synchronization. Oestrus synchronization will be staggered with groups of 100 ewes being synchronized at once. This is to limit the number of rams required for mating. Mating ratio for the village nucleus was calculated assuming one ram can breed seven synchronized ewes in two days defining a mating period of 10 days in each year or breeding season. The biological, technical and financial parameters are summarized in Table 2.

Economic values (required for designing the genetic improvement program) was estimated for six-month weight, litter size and lamb survival by constructing a bio-economic model on Microsoft Excel sheet that described the production system of Ejere area (http://www.researchgate.net/profile/Solomon-gizaw2). Costs associated directly with selection (organizing the cooperative breeding group, animal identification and recording, data processing) were estimated. The costs were estimated using current market prices of products and services. The direct costs of selection were incurred in the breeding tier.

Table 2: Biological and technical parameters for three oestrous synchronization schemes (two hormonal and one natural oestrus) planned for Ejere district Horro type sheep genetic improvement program with one village breeding nucleus group (1308 ewes) supplying improved rams to 14,466 ewes in the district

	Oestrous synchronization protocols		
	Natural oestrus	Hormonal-Protocol 1	Hormonal-Protocol 2
Basic features of schemes			
Hormone	Natural	Lutylase®	PMSG_MAP
Oestrous response rate (single dose)	-	0.76	1.0
Oestrous response rate (repeat dose)	-	0.94	-
Conception rate	0.85	0.74	0.71
% ewes lambing at peak season (single dose)	25.5	56.3	56.3
% ewes lambing at peak season (repeat dose)		69.5	69.5
Mating ration (ewe to ram)	45	70	70
Synchronization costs (ETB/dose)			
Cost of synchronization			
Hormone price (per dose)		48.8	82.3
Hormone price (per 1.24 dose)		60.2	-
Hormone procurement and administration		0.28	0.38
PD test device (Preg-Tone) (cost per ewe)		2.11	2.11

Picture 1: Livestock experts in field demonstration/training on hormonal oestrous synchronization in Amhara (left) and Tigray (right) regions.

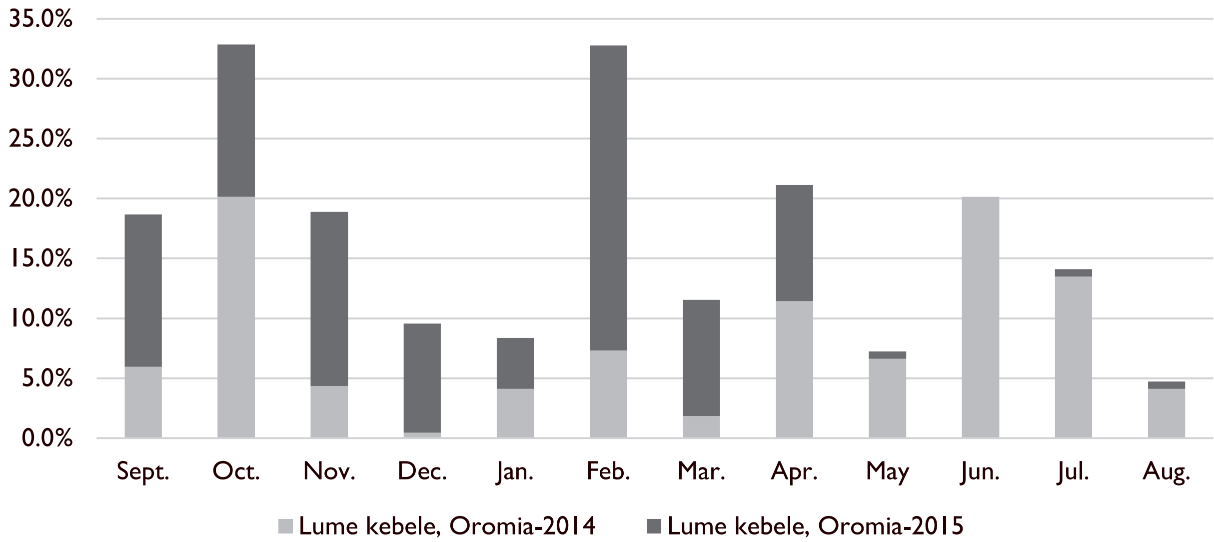
Results and discussion

Lambing distribution under natural oestrus

Lambing was distributed throughout the year in the study areas, although there were some peak lambing months. The peak lambing months were in February (25.5% of the lambings), June and October (20.1%) in Oromia (Figure 1) and in January (25.2% in Habes kebele) and December (17.1% in Habes kebele and 16.1% in Golgol-Nae'le kebele) in Tigray state (Figure 3). The peak lambing season shifted from June/July/October in 2014 to November/February in 2015. The variations in the peak lambing months across locations and years could be attributed to variation in rainfall distribution corresponding to availability of feeds. However, the peak lambing seasons accounted for a maximum of only 25.2% of the total lambings per year.

In traditional continuous mating systems under smallholder small ruminant farming systems, lambing is commonly distributed throughout the year. In Ethiopia, the peak lambing months commonly occur during the main rainy season, but the percent lambing in this season was reported to be only 14–15%, for instance, in two districts in SNNP state in Ethiopia (Legesse 2008). A similar low percentage of about 13% the total lambings over a year was reported for smallholder systems elsewhere (Setiadi et al. 1995).

Figure 1: Lambing distribution over a year in Lume kebele, Oromia, in 2014 and 2015



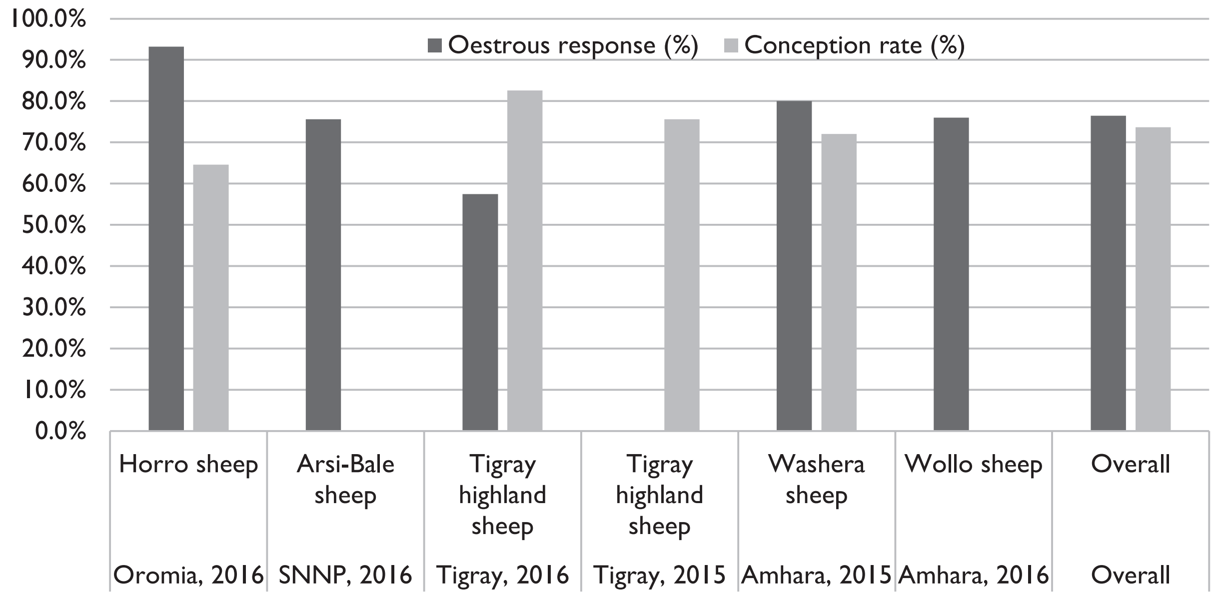
Oestrous responses/conception rates

Overall across the six oestrous synchronization experiments in the four regional states and four sheep types, 76.5% of the ewes treated with oestrous synchronization hormone expressed oestrus within 72 hours of hormone administration. The overall conception or pregnancy rate of ewes that showed oestrous was 73.6% (Figure 2). The average oestrous response achieved in the current study was within the upper end of the response range in the literature. For instance, Omontese et al. (2016) review of oestrous responses in Nigerian goat breeds ranged from 20 to 100% and conceptions from 65.0 to 100%. For Hampshire and Colombia breeds (Jacksons et al. 2014), hormonal treatment of ewes resulted in higher percentage of ewes exhibiting oestrous (75 to 89%) and conception (46 to 62%) compared to the control ewes (without hormonal treatment) of which 67% exhibited oestrous and 37% conceived. In Ethiopian breeds, Zelelek et al. (2016) reported 55–65% oestrous response rate.

Oestrous responses and conception rates varied across the six experiments in the current study (Figure 2). Oestrous response ranged from 93.2% in the Oromia experiment to 57.5% in the Tigray-2016 experiment. Conversely, the highest conception rate was achieved in the Tigray 2016 experiment (82.6%) and the lowest in the Oromia experiment (64.6%). Based on the available information on the experimental conditions, the possible explanation for the higher oestrus response rate in the Oromia and Amhara 2015 experiments was that the ewes were flush fed. The six experiments were also conducted in different seasons/environmental conditions and season has a significant effect on oestrous response, for instance a higher oestrus response of 80% was recorded in the cold-dry season compared to the 20% response observed both in the hot-dry and rainy seasons (Omontese et al. 2016). The conception rate after hormonal oestrous synchronization is believed to be generally lower than conception to natural oestrus. Many studies report that synchronization causes reduced fertility after cervical artificial insemination and after natural mating (Santoralia et al. 2011 and references therein). However, Stanimir et al. (2016) reported a higher conception rate of 60% to hormonally induced oestrus than to natural oestrus (37%). Similarly, Samir (2014) reported that pregnancy rates in heifers was higher (97–87.5%) when oestrus was induced hormonally than naturally (64.3%).

The current results showed that oestrus and lambing can be effectively synchronized artificially. The synchronizations achieved by hormone treatment were significantly higher than naturally synchronized lambings of 17.1–25.2% in the current study (Figures 1 and 3). This has a great implication on flock productivity and for designing effective genetic improvement programs under smallholder sheep and goat production systems as discussed in Section 3.1. The six 'experiments' were undertaken on village flocks following action research protocols under existing flock management and environmental conditions. The Amhara 2016 experiment particularly was a part of the scaling out of a relatively controlled village experiment in 2015 in Amhara region. The results from Amhara 2015 and Amhara 2016 activities were, however, highly comparable (Figure 2). This is in contrast to results from action research and large-scale development interventions in dairy cattle oestrous synchronization where the oestrous response and conception rates were significantly higher in the action research (88.9% and 60.3%) than the scaled out development intervention (66.2% and 36.3%) (Gizaw et al. 2016).

Figure 2: Oestrous response to hormone treatment and conception rates as percentage of ewes showing oestrous following hormone treatment in four sheep types in four regions in the highlands of Ethiopia in 2015 and 2016



Picture 2: Lambs born from hormonally synchronized ewes in Atsbi district in Tigray region.

Factors affecting oestrous and conception rates

Ewe body weight was found to be a significant factor determining oestrous response to hormone treatment (Table 3). The regression analysis indicates that there would be 14.7% more chance of oestrous response for an increase of one kg in body weight. This effect of body weight was independent of body condition of the ewes as the two factors (which could be confounded) were analysed in the same model. A similar trend was found for conception rate although the effect was not statistically significant (Table 4). On a 1–5 body condition score, ewes that had 3.5 and more and 2.5–3.5 body condition score were respectively 5.05 and 3.36 times (Table 3) more likely to respond to hormonal treatment and exhibit oestrus than ewes that were in poor body condition (Table 3). Body condition was also found to be a determinant factor for success of oestrous synchronization in oestrous synchronization and artificial inseminationin dairy cattle breeding program in Ethiopia (Gizaw et al. 2016). These results, however, contradict with the absence of flush feeding on oestrous response and conception rates (Table 5), although body condition score has proved useful as a management tool for subjectively assessing the nutritional status of ewes. The Santoralia et al. (2011) review of factors affecting efficiency of synchronization indicates that high body condition score has been associated with an increase of ovulation, with recommended body condition score of 2.5–3.0 and a score of <2 and >3 resulting respectively in the lowest and the highest pregnancy rates in sheep. It was also found that a one unit reduction in body condition score from previous partum to 30 days postpartum resulted in a 2.4-fold increase in pregnancy loss (López-Gatius et al. 2002).

Parity has been found to significantly influence oestrous response and conception rates to hormone treatment. In the current study, multiparous ewes were more responsive to hormonal treatment with oestrous response rate of 0.91 compared to 0.79 for primiparous ewes (Table 3). The probability of multiparous ewes responding to hormonal treatment was 2.26 time more than the primiparous ewes. Similarly, conception rate was higher among multiparous ewes (Table 4). Ungerfeld and Sanchez-Davila (2012) found a significantly higher oestrous response to hormone treatment in multiparous ewes (91.5%) than in primiparous ewes (75.0%), but the conception rates were statistically similar (59.6% and 50.0% in multiparous and primiparous ewes). Studies on dairy cattle oestrous synchronization also found a higher oestrous expression in cows (90.9%) than in heifers (63%) (Tadesse et al. 2016), but non-significant difference in conception rates between cows and heifers (Bayemi et al. 2015; Tadesse et al. 2016).

The current results also suggest variation in response to hormone treatment among breeds (Table 3 and 4). Oestrous response rate was higher in the local Menz ewes than the Awassi-Menz crossbred ewes ($\chi2 = 0.10$, P = 0.75). Lambing rate was also higher in the local Menz ewes ($\chi2 = 2.81$, P = 0.09). These results agree with the Tadesse et al. (2016) results where crossbreds and local cows/heifers showed statistically similar oestrous responses and conception rates.

Table 3: Effects of body weight, body condition, parity and breed on oestrous response to hormone treatment of ewes

Oestrus[a]		N	Mean	SE	B	Sig.	Odds ratio (Exp.(B))
Body weight					0.147	0.029	1.16
Body condition	Greater than 3.5	11	1.00	0.029	1.62	0.21	5.05
	Between 2.5 and 3.5	122	0.89	0.00	1.211	0.12	3.36
	Less than 2.5	10	0.70	0.153	0[b]		
Parity	Multiparous	102	0.91	0.028	0.815	0.141	2.26
	Primiparous	34	0.79	0.070	0 b		
Breed	Local	80	0.57				
	Exotic cross	80	0.55				

a The reference category is: Oestrous response.

b This parameter is set to zero because it is redundant.

Table 4: Effects of body weight, body condition, parity and breed on conception rate of ewes bred after hormonal synchronization of oestrus

Conception[a]		N	Mean	SE	B	Sig.	Odds ratio (Exp.(B))
Body weight					0.039	0.448	1.04
Parity	Multiparous	141	0.52	0.04	0.495	0.098	1.641
	Primiparous	85	0.35	0.05	0[b]		
Body condition	Greater than 3.5	16	0.63	0.13	NA	-	-
	Between 2.5 and 3.5	174	0.49	0.04	-	-	-
	Less than 2.5	39	0.28	0.07	-	-	-
Breed	Local	46	0.67				
	Exotic cross	44	0.50				

NA: analysis result not available.

a The reference category is: Positive pregnancy diagnosis

b This parameter is set to zero because it is redundant.

Efficiency of synchronization protocols

In this study, no statistically significant advantage of double dose administration of hormone at interval of nine days was observed over a single dose hormone administration, though the double dose scheme gave 10% more oestrous response (Table 5). A similar result was also reported by Greyling and van Niekerk (1986) where differences in oestrous response following one (oestrous rate of 77.1%) or two (oestrous rate of 93.2%) injections of cloprostenol was not significant. However, Fierro et al. (2013) suggests that although various prostaglandin-based protocols can be used for estrus synchronization, a second prostaglandin injection improves estrus response when the stage of the estrous cycle at the first injection is unknown. Increasing the Lutylase® dose was not accompanied by a significant increase in oestrous response rate, but oestrous rate increased by 23% when the dose of Synchromate® was increased from 0.8 to 1.0 ml.

The efficacies of the two prostaglandin-based estrus synchronization protocols Lutalyse® (dinoprost tromethamine sterile solution equivalent to 5 mg dinoprost per ml) and its analog, Synchromate® (cloprostenol sodium equivalent to 0.250 mg cloprostenol per ml) were similar. In this study, only prostaglandin-based protocols were evaluated. Previous studies (Gonzalez-Bulnes et al. 2005) show that the efficacy of prostaglandin and progestagen-based protocols were similar in terms of oestrous response (81.5% versus 72.4%, respectively), ovulation rate (1.7 versus 1.7), fertilization rates (70.6% versus 66.7%), and final embryo viability rate (58.9% versus 46.1%, P = 0.07). These authors argue that progestagens could have negative effects on the functionality of ovulatory follicles. On the other hand, prostaglandin-based protocols were found to be inferior to other protocols (FIS, fluorogestone intravaginal sponges/eCG, equine chorionic gonadotropin) with oestrous rate and lambing rate of 85.72% vs. 57.14% and lambing rate of 128.7% vs 76.0% (Wei et al. 2016). Evaluating prostaglandin (PGF(2)alpha), a progesterone-releasing intravaginal device (PRID) and Synchro-mate B (SMB), Tegegne et al. (1989) concluded that both PGF(2)alpha and SMB produce a satisfactory estrus response and pregnancy rate in cattle. The choice of a hormone protocol or a combination of hormone protocols would depend on its efficacy and issues of chemical residues. Light et al. (1994) argues that $PGF2\alpha$ is quickly metabolized with a minimum residue level. The use of $PGF2\alpha$ seem not to affect the natural cycle as Mukassa-Mugerwa et al. (1989) found that events following $PGF2\alpha$ treatment in Ethiopian Highland zebu cows closely parallel those observed in natural cycles. Gebrekidan et al. (2014) also reported that oestrous characteristics observed in hormonally synchronized oestrus in four sheep breeds in Ethiopia, the oestrous signs were nearly similar to naturally occurring signs of heat.

Table 5: Efficiency of oestrous synchronization protocols

Protocols	N	Oestrous rate *	χ2 statistic
Synchronization protocols			
Single dose scheme (Amhara)	40	0.78	0.0346
Double dose scheme	40	0.88	
Lutylase® hormone 2.5 ml (Amhara)**	40	0.63	0.0019
Lutylase® hormone 2 ml	40	0.60	
Synchromate® hormone 1 ml (Amhara)**	40	0.63	4.052
Synchromate® hormone 0.8 ml	40	0.40	
Lutylase® hormone (Tigray) *	93	0.366	0.0004
Synchromate® hormone	33	0.333	
Nutritional intervention			
Flush feeding (Tigray)	15	0.60	0.0071
No flush feeding	124	0.59	
Flush feeding (Amhara)	40	0.85	0.0087
No flush feeding	40	0.80	

* Conception rate for Tigray Lutylase®/synchromate® result.

** Source: based on data in Zeleke et al. (2016).

Impact on genetic improvement and flock productivity

Year-round distributed lambing could minimize risk of losing the whole lamb crop due to some phenomenon of climatic change. Besides, year round lambing could also be compatible with the function of small ruminants as a means of saving assets where saving in the form of cash is not common or not accessible. However, distribution of lambings over the year could have implications in genetic improvement programs. Lambing patterns affect the efficiency of village sheep genetic improvement programs. Gizaw et al. (2014) reported that due to the small number of candidate ram lambs available for selection as a result of year round lambings, a higher than desired proportion (5–10%) of the available candidates had to be selected to meet the farmers' requirements for breeding rams, thereby limiting the selection intensity and genetic progress in a cooperative village sheep breeding program in Ethiopia. Unpublished simulation study has shown that it is both bio-economically and operationally feasible to introduce hormonal oestrous synchronization in small ruminant breeding programs under the smallholder system.

The impact of introducing hormonal oestrus synchronization on genetic gain and its economic feasibility was evaluated with two synchronization protocols (Table 6). A higher selection intensity and genetic gains in the breeding objective and breeding objective traits were achieved from hormonal synchronization of oestrus. Introducing hormonal oestrus synchronization gave 160.5–190.1% more profit than selection under natural oestrous synchronization. This is due to the concentrated lambing (Figure 1) and lower lamb mortality rate (Figure 3) under hormonal synchronization which enabled to achieve higher selection intensity and hence faster genetic progress. Protocol-2 gave higher genetic progress and profit than Protocol-1. However, the operational feasibility of the protocols also need to be considered. The Lutylase® oestrus synchronization protocol (Protocol-1) modelled in this study should be operationally feasible since the protocol chosen balanced efficiency and simplicity. There is also field experience with the technology under smallholder condition in dairy cattle breeding in Ethiopia (Tegegne et al. 2012; Gizaw et al. 2016). Protocols that would give higher oestrus response such as PMSG administration after 14 days application of MAP sponge may not be practical for a large-scale application in the smallholder system.

Picture 3: Ewes were hand mated with selected rams after hormonal oestrous synchronization, Amhara region.

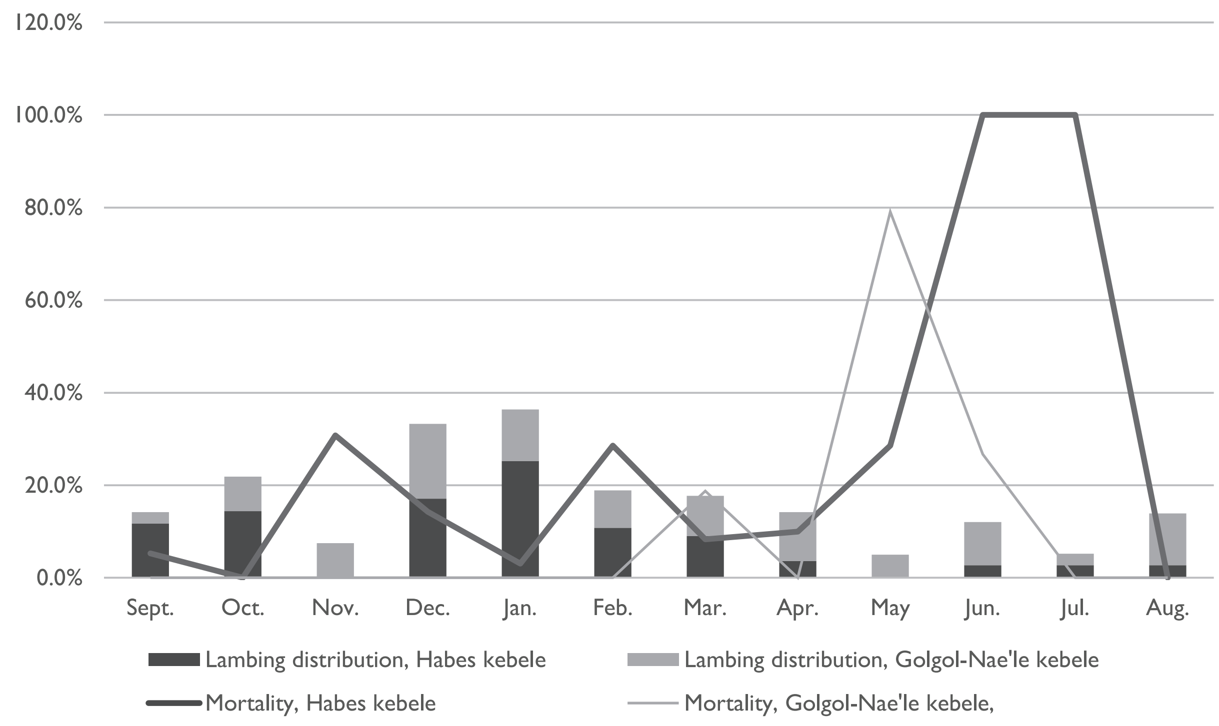
Table 6: Genetic gains (ΔG, per ewe per year) and profits from selective breeding under natural and hormonally synchronized oestrus cycle (Protocol 1 and 2)

	Oestrous synchronization protocols[1]		
	Natural oestrus	Protocol-1	Protocol-2
Selection intensity	1.838	2.408	2.603
ΔG in breeding objective (ETB)	4.259	8.663	9.367
ΔG 6 month weight (kg)	0.099	.1297	.1402
ΔG Litter size	0.0011	.0014	.0015
ΔG Pre-weaning survival (%)	0.09	.12	.0013
Profit (ETB/ewe/year)	16.14	42.04	46.83

1 Protocols are described in Table 2.

Year-round distributed lambing could also have a great impact on flock productivity, farmers' flock management and marketing strategy. Flock productivity is affected if lambing occurs in unfavourable seasons for young survival and pre-weaning growth. The current results indicated that lamb mortality rates were found to be higher for lambs born and raised during the long rainy season (May–June) (Figure 3). A study in the Ethiopian highlands (WoldeMariam et al. 2014) also showed that lamb mortality could reach as high as 40% and that faecal egg counts were significantly high in wet season (July and August) and PCV (packed cell volume) was significantly lower in the wet season than the dry season. Belay and Haile (2011) also found that lambs born during the post rain and dry periods showed a higher survival rate than lambs born during the wet season and Abebe (2015) also reported a lower pre-weaning lamb survival and growth rate for lambs born during the main rainy season. The data in Figure 3 show that there is a fair correspondence between seasons or months of peak lambing occurrence and highest lamb survival. Yet, the peak lambing accounted for only 25% of the total lambings per year. Thus, the natural lambing distributions could expose most of the lambs to unfavourable seasons for survival and growth.

Figure 3: Lambing distribution over a period of one year in Habes and Golggol-Nae'le kebeles in Tigray region in 2015.



Conclusions and recommendations

i. Year-round lambing adversely affects flock performance: This study showed that lambing is thinly distributed throughout the months of the year. The maximum concentrated lambing accounted for only 25% of the lambs born in a year. This has a great implications on the effectiveness of village-based small ruminant genetic improvement programs which has now been adopted at a national level by the Ethiopia livestock master plan (Shapiro et al. 2015). Synchronizing breeding of village flocks could result in concentrated lambings so as to achieve high enough selection intensity for accelerating genetic progress. Mortality was found to be highest for lambs born and reared during the long rainy season. Lambings could be synchronized to match with low environmental burden (disease, feed shortage, cold shock, heat stress) on the new born and the lactating dam.

ii. Oestrous can be effectively synchronized in village flocks: Oestrous responses as high as 93.2% with a conception rate of up to 82.6% could be achieved with hormone treatment. This study was conducted with a large sample size, across a range of agro-ecological conditions and seasons and sheep breeds, under field conditions and with full participation of the sheep keepers. The results could be taken as strong indications towards effectiveness of the technology.

iii. Ewe conditions significantly influence effectiveness of synchronization: Application of synchronization technology should consider the conditions of the ewe, including its body weight, body condition and parity.

iv. Oestrous synchronization has a tremendous impact on genetic improvement and flock productivity: The results clearly showed that hormonal oestrous synchronization increased the selection intensity thereby increasing the genetic response to selective breeding. The return to investment in oestrous synchronization was also found to be high suggesting the economic feasibility of hormonal oestrous synchronization. This has an important implication in village-based cooperative small ruminant breeding programs currently in place for a number of small ruminant breeds in Ethiopia. Mortality was found to be high in some seasons of the year in the study areas. Thus synchronizing lambing to occur in seasons of high lamb survival is expected to improve flock productivity and farmers income.

v. Recommended oestrous synchronization protocol: Hormonal oestrous synchronization would be most feasible if introduced in cooperative sheep and goat breeding villages. The following protocol could be suggested: Lutylase® hormone at a single dose of 2.5 ml.

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