Field synchronization of Ethiopian Woito-guji goats in South Omo Zone using prostaglandin-based protocols

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Rationale and objectives

In Ethiopia, the number of goats is estimated at about 24.06 million from which 71.06% are females and 28.94% are males (CSA, 2013). Even if goats play an important role as resource for poor farmers by providing many products and services such as meat, milk, cash income, skin, manure and security (insurance, their productivity remains very low (Adane and Girma 2008; Tesfaye 2010). In fact, as for sheep, reproduction of goats is season-dependant giving an onset of estrus activity with the beginning of the period of short and decreasing day length (Hafez & Hafez, 2000). This seasonal influence depends on the latitude and the breed of the animal. In tropical conditions, in contrast with extreme northern and southern latitudes where the impact of season is very prominent (Zeleke, 2003), local breeds of sheep and goats are non-seasonal breeders or exhibit only a weak seasonality (Mukasa-Mugrewa et al., 2002; Girma, 2008). This is explained by the fact that under tropical and subtropical latitudes, the daylight shows a low variation affecting the reproductive activity. Even in the absence of a seasonality of reproduction, several studies highlighted that reproductive activity decreases at some times of the year, especially in very harsh environments. This reduced activity is mainly due to nutrition (Gallego-Calvo et al. 2014), sociosexual interactions (Delgadillo et al. 2015) and climatic aspects (Silva et al. 1998; Morales et al. 2016). In Ethiopia, under prolonged drought in the arid and semiarid lowlands of the country, nutritional constraints and seasonal availability of forage (Yami, 2008), several studies reported conception peaks of doe corresponding to feed flushes and availability of crop residues (Mukasa-Mugerwa et al., 2002; Tatek et al., 2004). Differences exists between districts and breeds. The Woito-guji breed in the Rift Valley family of goats is a distinct breed type found in South Omo Zone. The major purpose of keeping goats in South Omo Zone is mainly for socio-economic purposes (cash, asset, security), production (meat, milk, blood) and for socio-cultural uses (rites, ceremony, dowry) (Berhanu, 2011b; Ayalew et al.; 2003). ICARDA and its partners from SARI have initiated a novel community-based breeding program in the pastoral system using the Woito-guji breed of goat as a model. For a wider dissemination of improved sires and the development of a delivery system to optimize the use of bucks through controlled natural mating and artificial insemination, this study investigated the efficiency of three different prostaglandin-based synchronization protocols in inducing and synchronizing estrus in South Omo Zone. The choice of the protocols was based on previous trials obtained in other systems and breeds such as in Konso and Abergelle.

Materials and methods

Study area

The study was conducted in Jinka Agricultural research center. This center is part of the Southern Agricultural Research Center (SARI), located in Jinka town, the only administration city of South Omo zone. South Omo zone is found in Southern Nation and Nationalities Peoples Regional State (SNNPR) (Figure 1). Jinka has a latitude of 5°47′ N, a longitude of 36°34′ E and a mean elevation of 1490 m above sea level. It is situated at 785 km from Addis Ababa. The climate is hot to warm semiarid. The average annual rainfall of Jinka is 492 mm and the mean daily minimum and maximum temperatures are 17.5 and 29.2 °C. South Omo zone has eight districts of which six (Malie, Benatsemay, Hamer Nayngatom, Salamago, and Dasenech) are categorized under pastoral areas. South Omo Zone is characterized by the Woito-guji breed of Rift Valley Family. These animals have short body sizes as compared to the highland parts like those in Konso and Gamo Gofa areas and are characterized by low genetic performance. Goats are reared under a traditional system with a high risk of inbreeding.

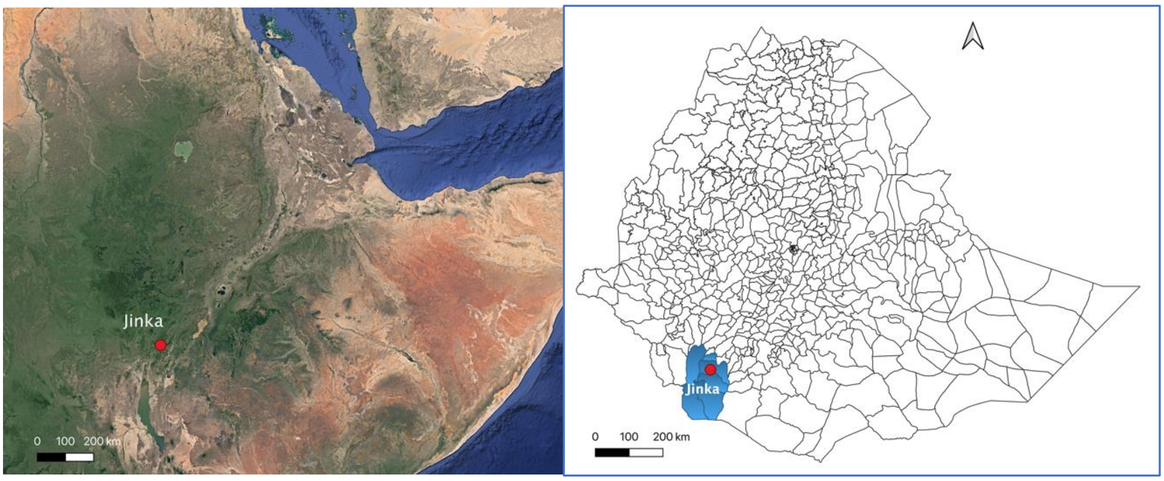

Figure 1. *Localisation of the study area*

Experimental animals

In this trial, a total of 104 non-pregnant and non-suckling adult females of the Woyito-Guji local goats were be used. Prior to synchronization, non-pregnancy was verified using ultrasonography (B-Ultrasonic Diagnostic 23500/1000 Minitub GmbH; Tiefenbach, Germany). Prior to and during the experiment, the animals were kept outside and exposed to natural daylight without any supplementary light. At the start of the experiment, live weight and age were estimated. Twenty days before mating and the subsequent 10 days, all experimental animals were fed quality hay ad libitum and should receive a supplementation of 300-400 g concentrate by head/day. They had free access to fresh water twice a day. The experimental animals were drenched against internal parasites.

Experimental procedures

In the experimental area, the main breeding seasons of the goats are (i) 1st season: mating time of March to May and kidding time August to September (ii) 2nd season: mating time of August to September and kidding time from December to January. In this trial, the 2nd season was targeted. In relation to age, live weight and BCS, animals were subdivided into 3 homogeneous groups and were assigned to 3 different synchronization treatments. Goats in the first group (n=36) received a singular i.m. of 5 mg of the $PGF_{2\alpha}$ analogue dinoprost (1 ml Enzaprost®; CEVA Laboratories, Libourne, France) (PGF_s). Goats in the two other groups (n=34 in each group) received each 2 i.m. of 5 mg of the $PGF_{2\alpha}$ analogue dinoprost (1 ml Enzaprost®; CEVA laboratories, Libourne, France) administered 7 and 11 days apart (PGF_7 and PGF_{11}). The schedule of implementation of the 3 protocols is displayed in figure 2. After synchronization, estrus onset, estrus end and oestrus duration were controlled using aproned bucks every 4 hours for at least 96 hours. In fact, every 4 h, goats were individually teased with an aproned male for up to 5 min at a time. The most common signs of estrus behavior including the immobility reflex (the classical indicator of estrus) and tail flagging (the most conspicuous characteristic of estrus goats) were recorded.

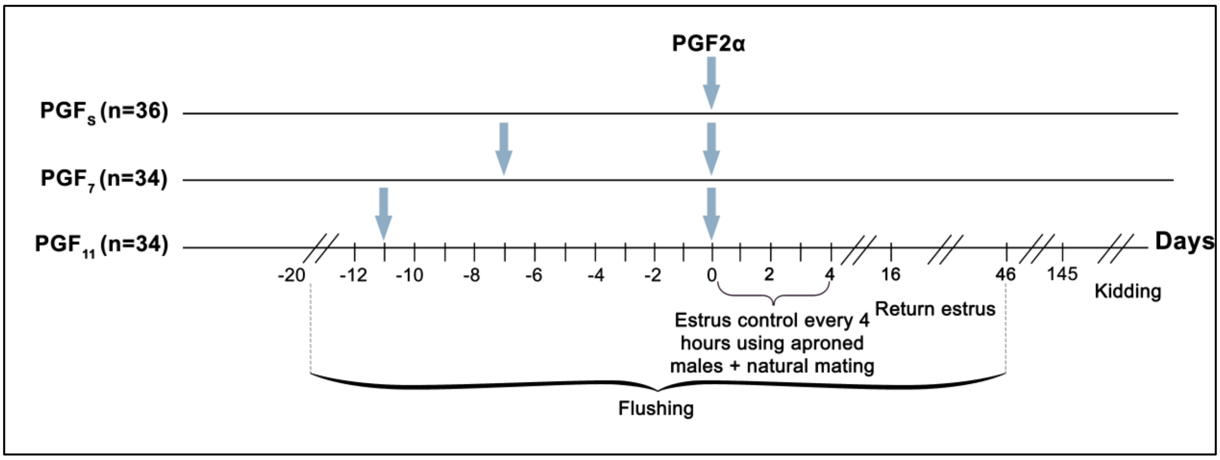

Figure 2. The schedule of implementation of the 3 experimental protocols

Mating

Bucks selected on the basis of their estimated breeding value (ratio of 1 to 8), checked for normal breeding soundness, proven libido and treated for internal parasites were used for natural mating and received a supplementation similar to females. Once detected in estrus, goats were mated twice at 12 h interval. After the induced mating (first 120 h after the end of the hormonal treatment, same bucks were used to ensure return estrus are served. Kidding date and number of kids were recorded to estimate fertility and litter size later.

Measured reproductive traits

Time of onset of estrus was calculated as the time halfway between the last rejection and the first toleration of a mounting male, while the end of estrus was set halfway between the last toleration and the first rejection (Holtz et al. 2008). Estrus duration was defined as the time elapsed between the first and last accepted mount within the same estrus period. Estrus response was calculated as [ER = 100 x (number of does expressing estrus/total number of does)]. Conception rate (CR) was calculated according to the formula [CR = 100 x (number of does that conceived (kidded + aborted)/number of does expressing estrus and mated)]. Abortion rate (AR) was calculated as [AR = 100 x (number of does that aborted)/number of does expressing estrus and mated)]. When lambing occurred, the number of lambs born was recorded and Kidding rate was calculated as [KR= number of kids born alive/number of does expressing estrus and mated]. Mean litter size (LS) was also calculated.

Statistical analyses

Estrus response, time for the onset of estrus, end of estrus, duration of estrus, CR, AR, KR and LS were calculated, coded and entered into Microsoft excel 2007 software program for further analysis.

The data concerning estrus response, CR, AR and KR in groups of goats of different location, age, parity, weight and receiving the 3 experimental protocols were analysed using a chi-square test (biostat TGV, https://biostatgv.sentiweb.fr/?module=tests/chideux).

For factors showing significant effect, a chi-square test comparing two per two the different classes (biostat TGV, https://biostatgv.sentiweb.fr/?module=tests/chideux). ANOVA (IBM

SPSS Statistics® ver. 23.0) was conducted to compare the effect of different parameters (location, age, protocol, parity and weight) on estrus response, time for the onset of estrus, end of estrus, duration of estrus and LS. For factors showing significant effect, a t-test of Student was used to compare different classes (IBM SPSS Statistics® ver. 23.0).

Effects were considered to be significant when the level of probability was 5% or less. All results are presented as the mean or the percentage ± SD.

Results

Estrus response, onset and duration

Does in Besso and Shaba Argemenda showed a higher estrus response than animals located in Botosulia. The onset of estrus was earlier and the duration of estrus was longer in does located in Botosulia followed by does located in Shaba Argemenda. The lowest values were recorded for animals located in Besso (Table 1).

Conception rate, kidding rate and litter size

For the 96 does detected in estrus, 62 does conceived in response to natural mating giving an overall CR of 64.58±4.88. None of the studied parameters (location, age, protocol, parity and weight) affected significantly the CR ($p>0.05$) (Table 2).

For the 96 does detected in estrus, 12 does aborted giving an overall AR of 12.50±3.38 which is high (>5%). The highest AR was recorded for the nulliparous youngest goats located in Shaba Argemenda. The overall KR was 53.13±5.09 and the highest KR was recorded for adult does located in Besso (age>4), having a parity of 3 and having a weight>24kg (Table 2).

For the 96 does detected in estrus, only one female gave twins giving an overall mean LS of 1,02±0,14. None of the studied parameters (location, age, protocol, parity and weight) affected significantly the LS ($p>0.05$) (Table 2).

Table 1 Differences in estrus response, onset, end and duration according to the different parameters

		Estrus response (%)		*Onset of estrus (h)*		*End of estrus (h)*		*Estrus duration (h)*	
Parameter			*P value*	*(Mean±SD)*	*P value*	*Mean±SD*	*P value*	*Mean±SD*	*P value*
Location	Besso	34/36 (94.44±3.82)	**0.04***	33.33±19.50^{a}	**0.03***	46.00±19.92^{a}	**0.03***	12.67±1.63	0.36
	Botosulia	36/42 (85.71±5.40)^{a}		61.73±26.25^{b}		73.73±24.91^{b}		12.00±3.02	
	ShabaArgemenda	26/26 (100.00±0.00)^{b}		48.26±18.83		61.30±18.32		13.04±2.16	
Age	<3	30/31 (96.77±3.17)	0.52	47.60±19.25	0.18	60.72±18.96	0.22	13.12±2.17	0.26
	[3, 4[	31/34 (91.18±4.86)		63.78±26.92		75.33±25.77		11.56±3.13	
	>4	35/39 (89.74±4.86)		48.55±25.94		61.27±25.16		12.73±2.41	
Protocol	PGF$_{S}$	33/36 (91.67±4.61)	0.39	54.00±23.09	0.87	66,80±21.89	0.87	12.80±2.53	0.84
	PGF$_{7}$	33/34 (97.06±2.90)		51.33±24.08		63,78±23.33		12.44±2.33	
	PGF$_{11}$	30/34 (88.24±5.53)		49.06±22.96		62,00±22.45		12.94±2.66	
Parity	0	22/22 (100.00±0.00)	0.23	50.00±20.27	0.36	63.20±19.81	0.39	13.20±2.28	0.18
	1	12/14 (85.71±9.35)		38.00±11.31		50.80±11.80		12.80±1.79	
	2	26/28 (92.86±4.87)		66.67±24.97		78.00±23.46		11.33±3.01	
	3	18/22 (81.82±8.22)		50.50±31.53		62.00±30.09		11.50±2.56`	
	≥4	18/22 (81.82±8.22)		50.67±22.40		64.67±22.72		14.00±2.19	
Weight	≤20	26/29 (89.66±5.66)	0.38	55.54±20.10	0.69	68.15±18.88	0.74	12.62±2.22	0.35
	]20, 22]	27/27 (100.00±0.00)		45.27±23.24		58.36±23.15		13.09±2.59	
	[23, 24]	24/27 (88.89±6.05)		48.55±22.79		62.00±22.98		13.45±2.70	
	>24	19/21 (90.48±6.41)		54.40±27.87		66.00±26.26		11.60±2.27	
Overall		96/104 (92.31±2.61)		51.07±22.98		63.78±22.25		12.71±2.46	

SD= standard deviation, *=p<0.05, **=p<0.01 *** =p<0.001,
values with different superscripts (a and b) in the same column are significantly different (P < 0.05).

Table 2 Differences in conception rate (CR), abortion rate (AR), kidding rate (KR) and litter size (LS) according to the different parameters

		Conception rate (CR)		***Abortion rate (AR)***		***Kidding rate (KR)***		***Litter size (LS)***	
Parameter		*Does conceiving (kidding+aborting) /Does detected in estrus (%±SD)*	*P value*	*Does aborting/does detected in estrus (%±SD)*	*P value*	*Does kidding/Does detected in estrus (%±SD)*	*P value*	*Mean LS ± SD*	*P value*
Location	Besso	25/34 (73.53±7.57)	0.38	2/34 (5.88±4.04)^{a}	**0.03***	24/34 (70.59±7.81)^{a}	**0.009****	1,04±0,20	0.54
	Botosulia	22/36 (61.11±8.12)		3/36 (8.33±4.61)^{ac}		19/36 (52.78±8.32)		1.00±0.0	
	ShabaArgemenda	15/26 (57.69±9.69)		7/26 (26.92±8.70)^{b}		8/26 (30.77±9.05)^{b}		1.00±0.0	
Age (years)	<3	18/30 (60.00±8.94)	0.77	8/30 (26.67±8.07)^{a}	**0.01***	10/30 (33.33±8.61)^{a}	**0.02***	1.00±0.0	0.55
	[3, 4[	20/31 (64.52±8.59)		3/31 (9.68±5.31)		17/31 (54.84±8.94)		1.00±0.0	
	>4	24/35 (68.57±7.85)		1/35 (2.86±2.82)^{b}		24/35 (68.57±7.85)^{b}		1,04±0,20	
Protocol	PGF_S	22/33 (66.67±8.21)	0.95	2/33 (6.06±4.15)	0.32	21/33 (63.64±8.37)	0.30	1,05±0,22	0.45
	PGF_7	21/33 (63.64±8.37)		6/33 (18.18±6.71)		15/33 (45.45±8.67)		1.00±0.0	
	PGF_{11}	19/30 (63.33±8.80)		4/30 (13.33±6.21)		15/30 (50.00±9.13)		1.00±0.0	
Parity	0	14/22 (63.64±10.26)	0.41	7/22 (31.82±9.93)^{a}	**0.02***	7/22 (31.82±9.93)^{a}	**0.07**^{t}	1.00±0.0	0.63
	1	8/12 (66.67±13.61)		2/12 (16.67±10.67)		6/12 (50.00±14.43)		1.00±0.0	
	2	15/26 (57.69±9.69)		2/26 (7.69±5.23)^{b}		14/26 (53.85±9.78)		1,07±0,26	
	3	15/18 (83.33±8.78)		1/18 (5.56±5.40)^{bc}		14/18 (77.78±9.80)^{b}		1.00±0.0	
	≥4	10/18 (55.56±11.71)		0/18 (0.0±0.0)^{bcd}		10/18 (55.56±11.71)		1.00±0.0	
Weight (kg)	≤20	15/26 (57.69±9.69)	0.44	7/26 (26.92±8.70)	0.53	8/26 (30.77±9.05)^{a}	**0.01***	1.00±0.0	0.41
	]20, 22]	18/27 (66.67±9.07)		4/27 (14.81±6.84)		14/27 (51.85±9.62)		1.00±0.0	
	[23, 24]	14/24 (58.33±10.06)		0/24 (0.0±0.0)		14/24 (58.33±10.06)^{b}		1.00±0.0	
	>24	15/19 (78.95±9.35)		1/19 (5.26±5.12)		15/19 (78.95±9.35)^{bc}		1,07±0,26	
Overall		62/96 (64.58±4.88)		12/96 (12.50±3.38)		51/96 (53.13±5.09)		1,02±0,14	

SD= standard deviation, *=p<0.05, **=p<0.01 *** =p<0.001,
values with different superscripts (a, b, c and d) in the same column are significantly different (P < 0.05).

Discussion

- Does in Besso and Shaba Argemenda showed a higher estrus response than animals located in Botosulia. Management conditions englobing nutritional and health state of does should be verified in Botosulia since in this region the lowest estrus response was recorded.
- Even if the lowest estrus response was recorded in Botosulia, animals in this village showed an earlier onset and a longer duration of estrus. This observation allow to anticipate on the use of, artificial insemination (AI) in this location, recommending special care when using fixed time AI.
- In this study, the overall abortion rate is high (12.50±3.38) exceeding >5%. Particular attention should be paid to the farm management condition and to the body condition. of animals before reproductive season (sanitary, nutritional and phusical state).
- The highest AR was recorded for the nulliparous youngest goats located in Shaba Argemenda. Farmers should be careful at the age and the condition score of yearlings when first breeded. In fact, age and condition score of the kid at first service affect it's the later fertility including abortion rate
- The overall KR was 53.13±5.09 and the highest KR was recorded for adult does (age>4) located in Besso, having a parity of 3 and having a weight>24kg. Kidding rate was higher in Besso in relation to the higher estrus response recorded in this same location.

Reference

Adane, H. and Girma, A. 2008. Economic significance of sheep and goats pp 1-4. In: Alemu Yami and R.C.Merkel (eds.). Sheep and goat production handbook for Ethiopia. Ethiopian sheep and goat productivity improvement program, 1–4.

Ayalew, W., King, J.M., Bruns, E. and Rischkowsky, B. 2003: Economic evaluation of smallholder subsistence livestock production: lessons from an Ethiopian goat development program. Ecological Economics, 45. 473–48

Berhanu, T. 2011. Purposes of keeping Goats, Breed preferences and Selection criteria in Pastoral and Agro-pastoral districts of South Omo Zone. Unpublished PhD thesis, Department of Animal Science, Faculty of Agriculture, Kasetsart University, Bangkok, Thailand.

CSA (Central Statistics Agency). 2013. Agricultural Sample Survey, 2012 /1 (2005 E.C). Volume II, report on livestock and livestock characteristics. Statistical bulletin, 570, April 2013, Addis Ababa, Ethiopia.

Delgadillo JA, Flores JA, Hernández H, Poindron P, Keller M, Fitz-Rodríguez G, Duarte G, Vielma J, Fernández IG, Chemineau P. 2015. Sexually active males prevent the display of seasonal anestrus in female goats. Horm. Behav. 69:8-15.

FARM-Africa. 1996. Goat types of Ethiopia and Eritrea. Physical description and management systems. Published jointly by FARM Africa, London, UK, and ILRI (International Livestock Research Institute), Nairobi, Kenya. Pp. 76.

Gallego-Calvo L, Gatica MC, Guzmán JL, Zarazaga LA. 2014. Role of body condition score and body weight in the control of seasonal reproduction in Blanca Andaluza goats. ANIM. Reprod. Sci. 151: 157-163.

Girma A. 2008. Reproduction in sheep and goats. Alemu Yami and R.C. MERKEL (eds.). IN: Sheep and goat Production Hand Book for Ethiopia. Ethiopia sheep and goats productivity improvement program (ESGPIP), Addis Ababa, Ethiopia. pp. 57-72.

Hafez, B. and Hafez, E. S. E. (2000). Reproduction in farm animals. 7th ed. Awolters Kuwe Company. Philadelphia, USA

Holtz, W. Sohnrey, B. Gerland, M. and Driancourt, MA. 2008. Ovsynch synchronization and fixed-time insemination in goats. Theriogenology. 69, 785–792

Morales JU, Nieto CAR, Ávila HRV, Manjarres EVA. 2016. Resumption of ovarian activity is modified by non-photoperiodic environmental cues in Criollo goats in tropical latitudes. Small Rumin. Res. 137: 9-16.

Mukasa-Mugerwa, E., Anindo, D., Sovani, S., Lahlou-Kassi, A., Tebely, S., Rege, J.E.O. and Baker, R.L. 2002. Reproductive performance and productivity of Menz and Horro sheep lambing in the wet and dry seasons in the highlands of Ethiopia. Small Ruminant Research 45 : 261-271.

Russel, AJF. Doney, JM. and Jun, RG. 1969. Subjective assessment of body fat in live sheep. J. Agric. Sci. 72, 451-454.

Silva E, Galina MA, Palma JM, Valencia J. 1998. Reproductive performance of Alpine dairy goats in a semi-arid environment of Mexico under a continuous breeding system. Small Rumin. Res. 27:79-84.

Tatek W, Hailu Dadi, Mieso Guru and Dadi Gelashe. 2004. Productivity of Arsi Bale goat types under farmers' management condition: a case of ArsiNegelle. In: Tamrat Degefa and Fekede Feyissa (Eds). Proceedings of the 13th Annual Conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 25-27, 2004. ESAP, Addis Ababa. Pp67-71.

Tesfaye, AT., Yadav, BR., Hanotte, O. and Jianlin, H. 2006: Genetic characterization of indigenous goat populations of Ethiopia using microsatellite DNA markers. Proceedings of a workshop on Sheep Breeding Strategies for Ethiopia held at ILRI, Addis Ababa, Ethiopia on 21 November 2006.

Tesfaye, K. 2010. Assessment of on-farm breeding practices and estimation of genetic and phenotypic parameters for reproductive and survival traits in indigenous Arsi-Bale goats, (unpublished MSc thesis, Haramaya University).

Yami, A. 2008. Nutrition and feeding of sheep and goats, pp. 103–159. In A. Yami and R.C. Merkel, (eds.). Sheep and Goat Production Handbook for Ethiopia. Ethiopia Sheep and Goat Productivity Improvement Program (ESGPIP). Addis Ababa, Ethiopia.

Zeleke MZ. 2003. Improving the reproductive efficiency of small stock by controlled breeding. Thesis in Faculty of Natural and Agricaltural Sciences, Department of animal, Wildlife and Grassland sciences. The university of The Free State Republic of South Africa.