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Research Article

Efficiency of the oestrus synchronization with hand mating and artificial insemination on the reproductive performances of Woyto-Guji Goat under community-based breeding program

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Abstract: *The present study was designed to describe the efficiency of oestrus synchronization on Woyto-Guji goats under community-based breeding program in Konso zone. Single and double injections of PGF2α followed by AI and single injection followed by buck mating were the protocols applied. Percent responded, inseminated, conceived, delivered, aborted, time of insemination, gestation length and litter size were data collected for the experiment. A total of 177 does were used for oestrus synchronization by using PGF2α hormone. Overall, the findings revealed that about 88.14% of the does expressed oestrus within 57.48±2.64 hours after hormone administration. The overall percent inseminated, conceived, delivered and aborted and gestation length (day) were 91.67, 93.71, 72.03, 2.82%, and 152.48±2.34, respectively. The overall percent of kid sex born was about 51% female and 49% male, and litter size was about 58% single and 42% twin. The response rate was significantly affected by age (P<0.05). Percent inseminated, conceived, kid delivered and time of insemination were significantly affected by protocol, parity and age (P<0.05). Buck mating on hormone treated does was relatively easily applicable for increased conception rate under the community level.*

Keywords: *Konso, Oestrus, Synchronization, Woyto-Guji Goat*

1. Introduction

Animal breeding is improvement of a population through the selection of the best individuals of the current generation and using them as parents of the next generation (Solomon, 2014). To be successful in genetic improvement of livestock, appropriate breeding programs need to be planned, implemented and maintained. Small ruminant breeding programs in tropical countries are less organized and largely fragmented (Solomon et al., 2014). Many of the programs were based on the upgrading of the indigenous animal to exotic breeds. Most of the crossbreeding activities were not successful and sustainable due to incompatibility of the breeding objectives and the management approaches of the existing production system due to low owners' participation, complicated in terms of logistics, technology and infrastructure; indiscriminate crossbreeding and lack of analysis of the different socio-economic and cultural roles (Haile et al., 2009;

Ahmed, 2017, Dereje et al., 2019). Community-based breeding program is a recently advocated option for tropical traditional low-input livestock production systems (Gizaw *et al*., 2009; Haile *et al*., 2011; Philipsson *et al*., 2011; Wurzinger et al., 2011). This is because community-based breeding programs take into account the indigenous knowledge of the communities on breeding practices and breeding objectives and also consider the production system holistically and involve the local community at every stage, from planning to operation of the breeding program (Gizaw *et al*., 2013).

In Ethiopia, there are about 52.46 million goats where almost all of them are indigenous breeds, about 99.9 % (CSA, 2021). Woyto-Guji goat breed is one of eight genetically characterized goat breeds (Tesfaye, 2004) under the Rift-valley family (Solomon *et al.,* 2014) which are distributed throughout the country. Despite the large population of goats and the roles of goats at a household and national level, the productivity and the contribution of goats to the country economy is far below the potential. Goat production in Ethiopia is constrained by a lack of systematic breeding programs (Solomon, 2014).

Goats in temperate regions show reproductive seasonality due to a photoperiod effect (Usman *et al*., 2019). However, they show weak reproduction seasonality in tropical conditions. Non-seasonal breeding has the advantage of the continuous supply of milk, meat and surplus kids to the producers. However, low kid survival and growth happen if pregnancy and birth fall during low forage availability (Girma, 2009; Delgadillo, 2015). Oestrus synchronization tackles such unwanted oestrus cycle and oestrus length variability on goat reproduction (Omontese *et al*., 2016) by fixing does breeding time (Rahman *et al*., 2008).

Indigenous goats' reproduction management in tropics like Ethiopia can be improved by using various simple natural manipulation (buck mating), prostaglandins hormonal alteration and mixed protocols (Omontese *et al*., 2016). However, the choice of hormone and estrus synchronization protocols depends on cost-effectiveness, ease of application, and resultant fertility (Zeleke, 2015; Bekahegn *et al.,* 2022). In this regard, the efficiency of oestrus synchronization protocols is not examined for the Woyto-guji goat breed yet. Therefore, the current study aimed to evaluate the efficiency of oestrus synchronization protocols with hand mating and artificial insemination on the reproductive performance of indigenous goats under a community-based goat breeding program.

2. Materials and Methods

2.1. Description of the study areas

The study was conducted in Baide community-based breeding cooperative village from 2020 to 2021 in Konso zone. Konso zone is located between the latitude of 5^{o}30 North and a longitude of 37^{o}30 East. Altitude ranges from 610 and 2,000 meter above sea level. The zone is bordered on the south by the Oromia Region, on the west by the Woyto River, on the north by the Dirashe special woreda, on the northeast by Amaro special woreda, and on the east by Burji special woreda.

The rainfall in the zone is not reliable with 800 mm per year. The majority of the rainfall is occurred in the months ranging from March and April. Temperature ranges from below 15 °C at night to 32 °C during the day. The main crops produced are sorghum and M*oringa stenopetala.* Despite erratic rainfall and poor soil fertility, the famous traditional soil and water conservation measures were practiced by the Konso people.

2.2. Sampling procedures

Breeding goats reared under a community-based breeding program were used for the experiment. For the effectiveness of the prostaglandin PGF2α hormone on active corpus luteum (Kefyalew, 2015); healthy, good body condition, cyclic and non-pregnant does were selected for the experiment. Pregnancy diagnosis was also conducted before hormone administration by using Pregtone (field ultrasound) to minimize abortion due to the PGF2α hormone. Breeding bucks were also selected based on their breeding soundness.

The synchronization agent used was prostaglandin-based estrumate hormone (Cloprostenol sodium 1ml/0.263 mg), which was administered intramuscularly at 1 ml dose, obtained from the South Regional Government Agricultural Office.

Immediately after hormone administration, does were randomly allocated either for the AI or to mate with selected bucks based on a 1:10 buck: does ratio. Two weeks before and during the breeding period, the breeding bucks were supplemented with concentrate per day to maintain their body weight loss. Those does showing heat signs were served with buck within 96 hours (Hamed *et al.,* 2012; Solomon *et al.,* 2016). Oestrous response to hormone administration was determined based on expression of standing heat when does were exposed to teaser bucks. Pregnancy diagnosis was conducted by non-return to heat. Kids were confirmed upon kidding records. Processed fresh semen, artificial vagina, breeding bucks, healthy breeding doe and prostaglandin PGF2α hormone administered 1ml/doe were used for the experiment.

2.3. Hormone administration protocols

Hormone protocols that were proposed by Gizaw et al. (2016) were used in the present study as indicated below.

Protocol 1: Single Injection of PGF2α hormone, heat detection and AI within 72 hours

Protocol 2: Single Injection of PGF2α hormone, heat detection and buck service within 72 hours

Protocol 3: Double Injection of PGF2α hormone at 11days interval, fixed AI at 48 hour post injection.

2.4. Data collection and analysis

Data collected for oestrus synchronization were the total number of does treated with PGF2α hormone, does responded, inseminated, conceived, delivered, aborted, time of insemination, gestation length, litter size and kid sex, protocol type, parity, and age by dentition, body condition score by feeling the backbone and the ribs with the thumb and fingertips (Gerald, 1994).

The collected data were analyzed using SPSS (version 20) and described by mean, standard deviation and frequency (chi-square) where GLM model was used for analysis [1].

Does responded, inseminated, conceived, delivered, aborted, time of insemination, and gestation length were considered as the response variables and collected using the formula indicted below [2-10]. Protocol types, parity, age by dentition and body condition scores were considered as fixed effects (Tegegn and Zelalem, 2017).

$$\mathrm{Yijklm} = \alpha + \mathrm{Ai} + \mathrm{Bj} + \mathrm{Ck} + \mathrm{eijk} \qquad [1]$$

Where;

- $\mathbf{Y_{ijk}}$ = the response variables
- $\boldsymbol{\alpha}$ = the intercept
- $\mathbf{A_i}$ = the fixed effect of protocol (1= Single shot and AI, 2 = single shot and buck, and 3 = double shot and fixed AI)
- $\mathbf{B_j}$ = the fixed effect of parity (1-5)
- $\mathbf{C_k}$ = the fixed effect of age (1-4 pairs of permanent incisors)
- $\mathbf{e_{ijk}}$ = random error

$$\mathrm{ORR} = \left(\frac{\text{Number of the does treated by hormone}}{\text{Number of the does responded}}\right) * 100 \qquad [2]$$

ORR = Oestrus response rate

$$\mathrm{CR} = \left(\frac{\text{Number of the does inseminated}}{\text{Number of the does conceived}}\right) * 100 \qquad [3]$$

CR = Conception rate

$$\mathrm{KR} = \left(\frac{\text{Number of the does conceived}}{\text{Number of the does kidded}}\right) * 100 \qquad [4]$$

KR = Kidding rate

$$\mathrm{RL} = \left(\frac{\text{Number of the does treated by hormone}}{\text{Number of the does loss}}\right) * 100 \qquad [5]$$

RL = Reproduction loss

$$\mathrm{AR} = \left(\frac{\text{Number of the does treated by hormone}}{\text{Number of the does aborted}}\right) * 100 \qquad [6]$$

AR = Abortion rate

$$\mathrm{DDR} = \left(\frac{\text{Number of the does treated by hormone}}{\text{Number of the does not responded}}\right) * 100 \qquad [7]$$

DDR = Does didn`t respond

$$\mathrm{DNI} = \left(\frac{\text{Number of the does responded}}{\text{Number of the does not inseminated mated}}\right) * 100 \qquad [8]$$

DNI = Does not inseminated

$$\mathrm{DDC} = \left(\frac{\text{Number of the does inseminated mated}}{\text{Number of the does not conceived}}\right) * 100 \qquad [9]$$

DDC = Does didn’t conceived

$$\mathrm{DDDK} = \left(\frac{\text{Number of the does treated by hormone}}{\text{Number of the does not conceived}}\right) * 100 \qquad [10]$$

DDDK = Does didn`t deliver kid

3. Results and Discussion

3.1. Efficiency of the oestrus synchronization

A total of 177 does were used for oestrus synchronization experiment. The overall percent of the does expressed heat sign were about 88.14% within 57.48±2.64 hours after hormone administration (Table 1). The overall rate of does inseminated, conceived, delivered and gestation length (day) were about 91.67%, 93.71%, 72.03% and 152.48±2.34 days, respectively. Except, for gestation length the current findings were higher than the results obtained under on-farm conditions for Abergele goat breed (Bekahegn *et al.*, 2022) for single prostaglandin hormone administration. The use of the "male effect" is reported to improve oestrus efficiency and fertility when used in combination with prostaglandins (Amarantidis *et al*., 2004). Protocols did not significantly affect gestation length. The current finding was in line with Girma (2009).

The overall abortion rate was about 2.82% (Figure 2). The abortion rate was not significantly ($P>0.05$) affected by protocol types, parity, and age. The low rate of abortion could be due to early pregnancy diagnosis by using Renco Corporation (2000) field ultrasound before hormone injection.

Table 1: Effect of hormone protocols, parity and age on performance of Woyto-Guji goat

Parameters	Does injected (N)	Does responded (%)	Inseminated/mated (%)	Conceived (%)	Kidding rate (%)	Abortion rate	Time of insemination (hour)	Gestation length (day)
Overall	177	156(88.14)	143(91.67)	134 (93.71)	103 (72.03)	5(2.82±1.23)	143 (57.48±2.64)	103 (152.48±2.34)
Protocols		NS	*	*	*	NS	*	NS
1	58	51 (87.93)	45 (88.23)[c]	40 (88.89)[c]	31 (68.89)[c]	2 (3.48±1.22)	45 (63.20±3.5)[c]	31 (152.12±2.41)
2	65	57 (87.69)	55 (96.49)[a]	54 (98.18)[a]	40 (72.73)[b]	1(1.53±1.24)	55 (59.16±4.3)[b]	40(153.11±1.98)
3	54	48 (88.89)	43 (89.58)[b]	40(93.02)[b]	32 (74.42)[a]	2(3.70±1.23)	43(49.12±0.11)[a]	32(152.22±2.64)
Parity		NS	*	*	*	NS	NS	NS
1	35	31 (88.57)	28 (90.32)[c]	26(92.86)[b]	19(67.86)[c]	1(2.86±1.22)	31(57.34±1.86)	19(151.34±1.23)
2	41	36 (87.81)	35 (97.22)[a]	34(97.14)[a]	25(71.43)[b]	1(2.44±1.23)	36(57.23±2.34)	25(152.71±2.24)
3	38	34 (89.47)	33(97.06)[a]	32(96.97)[a]	25(75.76)[a]	1(2.63±1.24)	34(56.22±2.10)	25(152.85±2.41)
4	33	29 (87.88)	27(93.10)[b]	25(92.59)[b]	20 (74.07)[a]	1(3.03±1.24)	29(56.38±2.30)	20(151.35±1.11
5	30	26 (86.67)	20 (76.92)[d]	16(80.00)[c]	14(70.00)[b]	1(3.33±1.23)	26(57.93±3.45)	14(152.67±1.23)
Age (Dentition)		*	*	*	*	NS	NS	NS
1	1	45	38 (84.44)[b]	34(89.47)[b]	31(91.18)[b]	22(64.71)[b]	2(4.44±1.24)	34(56.98±2.45)
2	2	51	48(94.12)[a]	45(93.75)[a]	44(97.78)[a]	35(77.78)[a]	1(1.96±1.23)	48(57.65±1.98)
3	3	48	45(93.75)[a]	43(95.56)[a]	41(95.35)[a]	34(79.07)[a]	1(2.08±1.23)	45(57.51±2.12)
4	4	33	25(75.76)[c]	21(84.00)[c]	18(85.71)[c]	12(57.14)[c]	1(3.03±1.22)	25(57.71±2.11)

Protocol 1: Single Injection of PGF2α hormone, heat detection and AI within 72 hours; **Protocol 2:** Single Injection of PGF2α hormone, heat detection and buck service within 72 hours; **Protocol 3:** Double Injection of PGF2α hormone at 11days interval, fixed AI at 48 hour post injection; age by dentition (1=1 pairs of permanent incisors, 2 = 2 pairs of permanent incisors, 3 = 3 pairs of permanent incisors, 4 = 4 pairs of permanent incisors); [*]statistically significantly affected at $P<0.05$, [NS] statistically non-significant ($P>0.05$)

3.2. Factors affecting the efficiency of the oestrus synchronization

The present study showed that the rate of does inseminated, conceived and kid delivered were significantly affected by protocol, parity, and age ($P<0.05$) whereas the oestrus response rate was significantly affected by age (Table 1).

Does age (dentition 2 and 3) have shown better oestrus response rate than those of age groups 1 and 4. Studies on dairy cattle oestrous synchronization found a higher oestrous expression in cows (90.9%) than in heifers (63%) (Bayemi *et al.*, 2015). The oestrous responses in Nigerian goat breeds ranged from 20 to 100% (Omontese *et al.*, 2016). However, it was not affected by protocol and parity (p>0.05). In contradiction to this experiment, that Zelelek *et al.* (2015) reported lower oestrous response rate (55–65%) in Ethiopian sheep breeds. 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%).Does insemination rate showed better performance on protocol type 2; parity 2 and 3, and does aged 2 and 3.

Protocol type 2 followed by 3; parity 2 and 3, and does aged 2 and 3 have revealed a better conception rate. The conception rate on Abergele goat breed reported by Bekahegn *et al.* (2022) was lower than the current finding. Kidding rate was performed better at protocol type 3; parity 2 and 4, and aged 2 and 3. Almost similar kidding rate was reported by Bekahegn et al. (2022) on Abergele goat. The average conception and kidding rates achieved in the current study were within the range of the conception rate in Nigerian goat breed ranged from 65.0 to 100% (Omontese *et al.*, 2016). In contrast, Ungerfeld and Sanchez-Davila (2012) found a significantly lower oestrous conception rate was reported although it was statistically similar (59.6% and 50.0% in multiparous and primiparous ewes, respectively). Similarly, studies on dairy cattle revealed a non-significant difference in conception rates between cows and heifers (Bayemi *et al*. 2015). This effect of parity was independent of age of the ewes, as the two factors could be confounded. However, estrous detection, early pregnancy diagnosis, and unknown time of ovulation, cause low reproduction performance of goats (Baldassarre and Karatzas, 2004).

Does oestrus duration was better observed at protocol 3 and parity 3 and 4. This might indicate that double injection and higher parity were conducive for the oestrus duration. Contradicting result was reported on Abergele goat (Bekahegn *et al*., 2022).

On other hand, abortion rate was not statistically significantly affected by the parameters. Solomon *et al.*, (2016) observed that AI technicians' skill on identification of functional corpus luteum (CL), parity, protocol and AI skill are important determinants of successful oestrous synchronization and pregnancy diagnosis.

Figure 1: Buck serving does on heat (left), and kids born after synchronization (right)

3.3. Reproductive losses of Does

The overall reproductive loss rate was about 44.63% as depicted in Figure 2. This has indicated that there was reproduction wastage across reproduction cycles. The total percent of does didn't respond, didn't inseminate/mate, didn't conceive, didn't deliver kid and abortion rates were about 11.86%, 7.34%, 6.29%, 23.13%, and 2.82%, respectively. This has indicated that there was the reproductive wastage across reproduction cycles due to different factors like failure to mate; failure of fertilization in mated animals; loss during any stage of gestation (embryonic, fetal losses) and neonatal mortality and subsequent loss occurring until the time of weaning (ESGPI, 2009).

3.4. Woyto-Guji goat prolificacy

Kid sex born (%) and litter size (%) are presented in Figure 3. An overall percent of kid sex born was about 49% male and 51% female. These findings indicated that almost equal percent of male and female kids was born, which indicates the natural norm (ESGPIP, 2009).

About 58 and 42% of kids born were single and twin, respectively (Figure 3). The current finding revealed that Woyto-Guji goat breed has lower twinning rate. These results are in line with the findings of Abergelle and Central Highland goat breeds (Deribe 2008; Bekahegn *et al.*, 2022). However, higher prolificacy was observed in Kaffa (Belete, 2009).

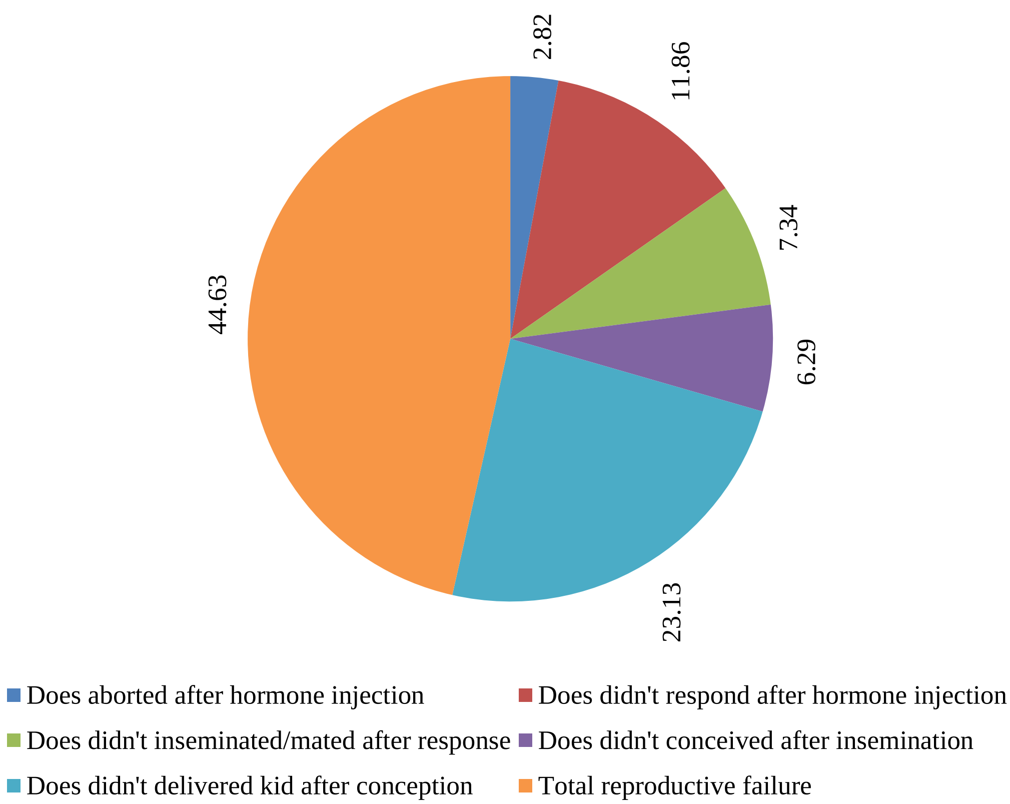

Figure 2: Reproductive failure (%) of Does

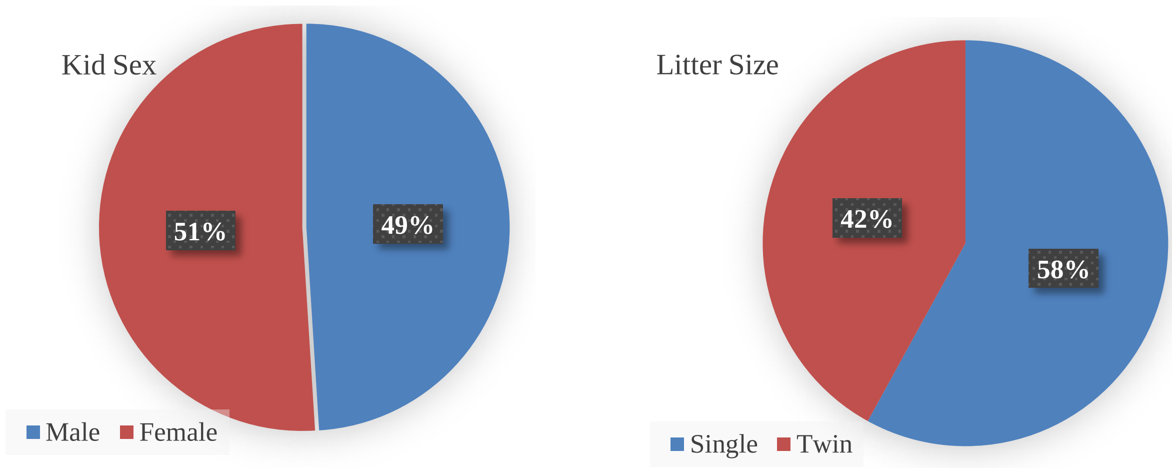

Figure 3: Sex of kids delivered (left) and liters size (right) after hormone synchronization

4. Conclusion and Recommendations

The response rate was about 88.14% within 57.48 ± 2.64 hours. The overall conception rate and kidding rate were about 93.71% and 72.03% respectively. Both conception rate and kidding rate were assumed to be better indicators of the reproductive performance efficiency measurement. Non-return to heat and/or early pregnancy diagnosis for increased reproduction rate was needed to be more experienced to minimize reproduction loss. Both single shot and double shot followed by buck mating and fix AI, respectively, were better indicators for kidding rate. However, the use of the single shot followed by buck mating might be more applicable at the farmer level to improve oestrus efficiency. Therefore, the applicability of the protocols at the smallholder level needs to be given further attention.

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Data availability statement

Data will be made available upon request.

Declaration of interest's statement

The authors declare no competing interests.

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