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Impact of some husbandry practices on productive and reproductive traits of desert goats *(Capra hircus)* in South Darfur State, Sudan

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ABSTRACT

This study evaluated the effects of husbandry practices on the productivity and reproduction of Sudan Desert goats. Conducted from 2014 to 2016 in South Darfur, it involved 40 female goats matched by body weight, age, physiological status, and parity. The interventions tested were shaded versus unshaded housing, restricted versus free suckling, and early versus traditional weaning. Data were analyzed using SPSS with significance at $P<0.05$. Surveys revealed that goat farming provided both milk and financial security. Most owners relied on hay, with only 5% using concentrates. Under traditional management, milk yield averaged 75.88 kg over 98.5 days. Challenges included disease (notably pneumonia at 61.5%), limited capital (26.2%), and poor pasture (22.3%). Experimentally, unshaded housing resulted in higher birth and weaning weights and better kid survival, especially with free suckling and delayed weaning. However, shaded housing shortened the kidding interval, improving reproductive performance. Single-born and male kids also had higher birth weights. The study concludes that shaded housing enhances reproduction, while unshaded conditions with improved suckling and weaning boost kid growth and survival. Recommendations include better veterinary support, regulated drug use, improved pasture, and supplementary feeding to increase goat productivity in the region.

Keywords: Desert goats, Husbandry practices, Influence, Performance.

INTRODUCTION

Livestock plays a pivotal role in the agricultural systems of developing countries, serving as a cornerstone ~~of~~ economic stability, food security, and social welfare. Approximately 60% of rural households in these regions engage in livestock rearing, and an estimated one billion people depend on it for food and livelihoods, particularly in South Asia and sub-Saharan Africa. In these contexts, livestock are not merely economic assets but also vital sources of nutrition, income, and social capital (Anissa *et al.*, 2023). Among various livestock species, goats are particularly significant due to their adaptability to harsh environments, low maintenance requirements, and ability to thrive under extensive and semi-intensive systems. Goats are primarily raised for meat and milk, with secondary products such as skin, hair, and manure adding further value. Their resilience to drought and water scarcity makes them indispensable in arid and semi-arid regions, where other livestock may struggle to survive (Navarrete-Molina *et al*., 2024).

In Sudan, livestock, including goats, play a major role in the national economy and rural livelihoods. According to estimates from the Ministry of Animal Resources, the country had over 138 million head of livestock, including 43 million goats. Goats are managed primarily by nomadic and semi-nomadic pastoralists, with the Sudanese Desert goat being the most widespread and economically significant breed. These goats are well adapted to Sudan's arid and semi-arid climates and serve as a crucial source of meat and milk, particularly in rural areas. Despite their potential, productivity among Sudanese Desert goats remains low due to several constraints, including inadequate husbandry practices, poor nutrition, high disease prevalence, and limited veterinary support. Additionally, environmental stressors such as heat and feed scarcity during dry seasons negatively impact reproductive performance. Addressing these challenges through targeted interventions—such as improved housing, nutritional support, and genetic selection—can enhance the reproductive performance and economic contribution of Sudan Desert goats.

The originality of this study lies in its combined approach: evaluating specific husbandry interventions, housing type, suckling method, and weaning age while also documenting existing production systems in South Darfur. This integrated methodology aims to provide comprehensive insights into the factors influencing goat productivity and reproductive performance in the region. The objective of this study is to assess the productive and reproductive traits of Sudan Desert goats under varying husbandry conditions and to describe the management practices used by goat breeders in South Darfur State. The findings aim to inform better breeding strategies, enhance productivity, and support sustainable livelihoods in arid regions.

MATERIALS AND METHODS

Area of Study

The experiment was carried out in South Darfur State at the Faculty of Veterinary Science Farm, located south of Nyala town, Mosey area, about 10 Km, during the period extending from 2014 to May 2016. The region is a flatland sloping from the West to the East, where the rain collects in a few water reservoirs. The soil is sandy (Goze) with clay vertisole.

Experimental Animals

Thirty-two pregnant, adult, lactating desert goats (two years old, second parity) and three bucks from the Alseraif livestock market near Nyala, Sudan, were selected for this experiment, along with their kids. The goats had a medium body size (23-26 kg) (are close in weight) and varied in color. Both sexes had horns, and the does were ear-tagged. All animals were vaccinated against hemorrhagic septicemia, peste des petits, ruminants, and sheep pox. They were examined, treated for ectoparasites with Gamatox, and dewormed with Pamizole and Ivermectin. Data on productive and reproductive traits, including birth weight, weaning weight, mortality rate, gestation length, kidding interval, litter size, and age at first kidding, were collected for one generation.

Housing

The experimental animals were divided into two groups of 16 synchronized and non-synchronized does, matched for weight, age, and parity. Each group was further split into two subgroups (8 does) with different housing (shaded vs. unshaded), suckling (restricted vs. free), and weaning (early vs. traditional) conditions. All groups were housed in enclosures with sandy clay floors (plate 1). Unshaded groups (plate 2) were exposed to direct sunlight, while shaded groups had protection from the sun and rain. Kids were separated at night but allowed to stay with their does during the day, with measures to prevent suckling in the restricted group, which allowed suckling twice a day, early in the morning before starting grazing, and in the evening after they came back from grazing. The early weaning group was weaned early at 2 months of age, while the traditional group of kids was weaned at 6 months of age.

Feed and Feeding

The experimental animals were grazed on natural pastures from sunrise to sunset, with drinking water provided twice daily during the dry season. In autumn, when range plants were

Table 1. Effect of housing type, litter size, and sex of kids on birth weight in the synchronized and non-synchronized groups (mean ± SD)

	Synchronized		Non synchronized	
Housing type	Non-shaded	Shaded	Non-shaded	Shaded
	$2.16^{a} \pm 0.48$	$1.67^{b} \pm 0.50$	$2.10^{a} \pm 0.45$	$2.22^{a} \pm 0.60$
Litter size	Single	Twin	Single	Twin
	$2.07^{a} \pm 0.58$	$1.96^{b} \pm 0.49$	$2.37^{a} \pm 0.50$	$1.75^{b} \pm 0.42$
Sex	Male	Female	Male	Female
	$2.00^{a} \pm 0.45$	$1.76^{b} \pm 0.68$	$2.47^{a} \pm 0.49$	$1.89^{b} \pm 0.37$

[a,b] Mean values in the same row with different superscripts differ significantly (P < 0.05).

succulent, water was not offered daily. Bucks, averaging three years old, were used for mating and kept for about two years.

Estrus Synchronization Protocol

Estrus synchronization was performed by treating 16 does with vaginal sponge pessaries for 12 days. After removing the sponges, each doe received 500 IU of Syncropart PMSG intramuscularly. Estrus was expected 48-72 hours later, and bucks were introduced to the does. In the non-synchronized group, bucks were kept with the does, and mating was closely monitored.

Milk Yield Recording

In the first week after birth, kids were kept with their mothers, and the milk was considered colostrum. In the second week, kids with restricted suckling were separated from their mothers during the day, while free-suckling kids stayed with their mothers. Both groups were separated at night, and they were hand-milked in the morning. Milk yield was measured as half-day production and doubled to estimate the daily yield.

Data collection

Data from thirty-two does were arranged according to the conventional grazing system. For each female in the first season, the data on birth weight, weaning weight, weaning age, and mortality rate of kids were also collected. On the other hand, gestation length, litter size, milk yield, lactation length, kidding interval, and age at first kidding were recorded.

Statistical Analysis

The experiment used a factorial design to compare two groups—synchronized and non-synchronized—under a conventional grazing system, assessing the effects of interventions in housing, suckling, and weaning on productive and reproductive traits. Data were analyzed using analysis of variance (ANOVA) with a factorial design in the Statistical Package for Social Sciences (SPSS, ver. 11.5). Mean separation was performed using the Duncan Multiple Range test ($P \leq 0.05$). For the questionnaire data, the Chi-square test was applied, and the results were expressed as percentages.

RESULTS AND DISCUSSION

Birth Weight

Table 1 shows the effects of housing (shaded vs. non-shaded), sex, and litter size (single vs. twins) on kids' birth weight in synchronized and non-synchronized groups. The results revealed that housing type had no significant effect ($P>0.05$) on birth weight. In the synchronized group, kids in unshaded pens had slightly higher birth weights (2.16 ± 0.48 kg) than those in shaded pens (1.67 ± 0.50 kg). Moreover, in the non-synchronized group, kids in shaded pens had slightly higher birth weights (2.22 ± 0.60 kg) than those in unshaded pens (2.10 ± 0.45 kg). It was found that litter size significantly affected birth weight ($P<0.05$), with single-born kids being heavier than twins. In the synchronized group, single-born kids weighed 2.07 ± 0.58 kg in non-shaded and 1.96 ± 0.49 kg in shaded pens, while in the non-synchronized group, single-born kids weighed 2.37 ± 0.50 kg in non-shaded and 1.75 ± 0.42 kg in shaded pens. Sex also significantly influenced birth weight ($P<0.05$), with male kids weighing more than females in both groups. The heaviest male kids

(2.47 ± 0.49 kg) were in the non-synchronized group housed in non-shaded pens.Top of Form-Bottom of Form

The average birth weights of single and twin kids in the present study were 2.22 ± 0.54 kg and 1.90 ± 0.46 kg, respectively. These results are similar to those of Bushara *et al.* (2013), who found average birth weights of 2.10 ± 0.06 kg for singles and 2.02 ± 0.05 kg for twins in Sudanese Tagger goats. Elabid (2008) also reported comparable values for Sudanese Nubian goats, with singles weighing 2.49 ± 0.52 kg and twins weighing 1.96 ± 0.33 kg. The lighter weight of twins may be due to competition for nutrients and reduced prenatal space. This trend of singles being heavier than twins was also observed in other breeds, including Beetal, Osmanabadi, and Ethiopian goats. The average birth weight of male and female kids in this study was 2.23 ± 0.47 kg and 1.83 ± 0.53 kg, respectively. Additionally, this study's findings align with those of Bushara *et al.* (2013), who reported that the average birth weight of male and female Sudanese Tagger goats was 2.21 ± 0.06 kg and 1.92 ± 0.05 kg, respectively. Similarly, Bharathidasan *et al*. (2009) found that male and female Barbari goats had average birth weights of 1.92 ± 0.07 kg and 1.84 ± 0.07 kg, respectively. The heavier birth weight of male kids may be attributed to the anabolic effects of male sex hormones Hafiz (1962) or the slightly longer gestation period for carrying male kids Afzal *et al*. (2004). These results are consistent with studies by Koratkar *et al*. (1998) and Elabid (2008) on Sudanese Nubian goats.

Weaning and Post-weaning Performances

Data in Table 2 show the effects of housing type, suckling pattern, and age of weaning on weaning weight, post-weaning weight, and mortality rate. The results revealed significant differences in weaning and post-weaning weights between kids born to non-synchronized dams in shaded pens with restricted suckling and early weaning compared to those in the synchronized group. The non-synchronized group had weaning and post-weaning weights of 5.69 ± 1.02 kg and 12.74 ± 2.46 kg, respectively, while the synchronized group had weights of 3.82 ± 0.81 kg and 9.56 ± 1.34 kg, respectively.

Table 2. also shows a significant effect of housing type, suckling pattern, and weaning age on kids' mortality rate, with the highest rate (54.5%) observed in the synchronized group with restricted suckling and early weaning.

The average weaning weight of kids born to dams reared in unshaded pens and subjected to free suckling and traditional weaning in this study was 9.00 ± 2.41 kg. This finding aligns with the results of Elabid (2002) who reported weaning weights of 8.64 kg for male Nubian kids and 8.15 kg for females, indicating consistency in growth performance under similar breed and management conditions. The relatively high weaning weight observed may be attributed to prolonged milk access and the natural maternal-offspring bond maintained through traditional weaning practices. However, this result contrasts with the findings of Bushara *et al*. (2013) who reported significantly higher weaning weights averaging 10.95 ± 2.07 kg for Sudanese Tagger goats. Such variation may be explained by inherent breed differences, superior nutritional regimes, and possibly more intensive management practices employed in their study. In contrast, the kids reared under shaded pens and subjected to restricted suckling and early weaning in the present study exhibited a markedly lower weaning

Table 2. Effect of weaning type on weaning, post-weaning, and mortality rate (mean ± SD)

Animal performance	Synchronized		Non synchronized	
	Traditional weaning	Early weaning	Traditional weaning	Early weaning
Weaning weight (Kg)	$8.44^{a} \pm 1.36$	$3.82^{b} \pm 0.81$	$9.57^{a} \pm 3.45$	$5.69^{b} \pm 1.02$
Post-weaning weight (Kg)	$11.37^{b} \pm 1.77$	$9.56^{b} \pm 1.34$	$13.67^{a} \pm 2.48$	$12.74^{a} \pm 2.46$
Kids' mortality rate (%)	18.2%[a]	54.5%[b]	18.2%[a]	22.2%[a]

[a,b]Mean values in the same row with different superscripts differ significantly (P < 0.05)

weight of 4.76 ± 0.92 kg. This outcome is consistent with Egbunike (2007) who reported a similar weaning weight of 5.22 ± 1.24 kg for West African Dwarf goats subjected to restricted suckling for 66 days. The reduced growth performance in this group is likely due to limited milk intake resulting from early weaning and restricted access to maternal nutrition during the critical early growth phase. These findings underscore the significant influence of breed, suckling management, and housing conditions on pre-weaning growth in goats.

The study examined the effects of housing, suckling, and weaning type on post-weaning weight at 9 months of age, with an average weight of 12.08 ± 2.49 kg. This finding differs from that of Bushara *et al.* (2013), who found an average post-weaning weight of 18.68 ± 2.43 kg in Sudanese Taggar goats, likely due to variations in feed type and availability during grazing, leading to an imbalanced diet and poor weight gain compared to goats receiving supplemental energy. However, the findings align with those of Bushara *et al*. (2013), who reported a post-weaning weight of 14.30 ± 2.10 kg in goats fed on grazing pastures without supplementation. The observed kid mortality rate of 28.28% in this study aligns with findings from various regions, underscoring the multifactorial nature of kid losses in goat farming. In a study conducted in North Shewa, Ethiopia, a mean annual kid mortality rate of 42.3% was reported, with early life mortality attributed to agalactia, pneumonia, and cataract. This contrasts with the 28% mortality rate observed in a South African milk goat herd, highlighting regional differences in management practices and environmental conditions (Slayi *et al*., 2022).

In the Eastern Cape Province of South Africa, a community-based intervention approach reduced in kid mortality from 56.17% in the first year to 22.38% in the second year. This improvement was attributed to enhanced disease control measures and climate-related interventions, emphasizing the impact of management practices on kid survival rates (Geoffrey, 2024). A study in the Mexican Plateau identified white muscle disease as the primary cause of death in kids aged 8 –90 days, accounting for 49 out of 74 cases. This condition, linked to selenium deficiency, underscores the importance of nutritional management in preventing mortality (Geoffrey, 2024). In India, child mortality rates ranging from 16–33% have been reported, influenced by factors such as age, birth weight, season, and the presence of predators and diseases. Strategies such as proper nutrition, disease control, and environmental management are recommended to mitigate these losses.

Milk Yield

Milk production data Table 3 shows that during the three months of lactation, shaded synchronized does produced significantly more milk than non-shaded synchronized does (P<0.05), while no significant difference was observed in non-synchronized does. In the third month, milk yields were similar within both groups, but synchronized shaded does still produced significantly more milk than non-synchronized does (P<0.05). In this study, the lactation length was 90 days, with average daily milk yields of 179.2 kg for synchronized does and 166.7 kg for non-synchronized does, resulting in 16.13 and 15.0 kg of total lactation yield, respectively. These results are consistent with those of Bedhane *et al.* (2012), who reported 209 g daily yield, 86 days of lactation, and 18 kg total yield for Arsi-Bale goats. Variations may be due to breed, nutrition, kidding season, and environmental factors. In a comparison, quarter-bred Saanen goats yielded 31 kg of milk over 84 days, while pure Adal

Table 3. Means of milk yield (kg) of synchronized and non-synchronized does

Lactation month	Synchronized		Non synchronized	
	Nonshaded	Shaded	Nonshaded	Shaded
First month	963.6^a ± 311.9	1025.2^a ± 414.2	885.8^b ± 205.1	893.1 ± 262.
Second month	1124.8^a ± 345.7	1290.0^a ± 557.5	1110.4^b ± 222.3	1080.1 ± 272
Third month	952.7^a ± 321.5	989.6^a ± 375.5	887.9^b ± 216.0	910.6 ± 248.

^{a,b} Mean values in the same row with different superscripts differ significantly (P < 0.05) goats produced 24 kg (Banerjee *et al*., 2000). Milk yield in mammals is also subject to seasonal variation (Harding, 1999).

Reproductive Performance

The data on the effect of housing on various reproductive traits, including gestation length, kidding interval, litter size, and age at first kidding, are presented in Table 4. A significant effect (P<0.05) on kidding interval was observed between synchronized and non-synchronized groups. Non-synchronized dams kept in unshaded pens had the longest kidding interval compared to their synchronized counterparts (271.25 ± 36.19 days vs. 239.25 ± 1.83 days). Similarly, synchronized does reared in shaded pens had a significantly shorter kidding interval compared to non-synchronized does in shaded pens (239.00 ± 1.41 days vs. 267.13 ± 33.54 days). Housing had no significant effect on gestation length, litter size, or age at first kidding.

The study recorded an average gestation length of 150.21 ± 1.89 days in the experimental goats. Notably, the synchronized group exhibited a slightly longer gestation period compared to the unsynchronized group. This difference is likely due to the hormonal manipulation involved in estrus synchronization protocols. Such treatments can influence the timing of fertilization, luteal function, or embryonic development, potentially causing slight delays in implantation or altering the pace of fetal growth, both of which may contribute to a modest extension in gestation length. These results are consistent with previous findings. For example, Devendra and McLeroy (1987) reported a gestation range of 144 to 153 days, with an average of 146 days across various tropical goat breeds. Similarly, Mukasa-Mugerwa and Mukasa (1988) documented a slightly broader range of 145 to 155 days for sheep and goats. Thus, while the observed gestation length of 150.21 days falls well within the established range, the slight increase seen in the synchronized group likely reflects the physiological effects of hormonal treatments. When compared to other regional studies, the current average also appears marginally longer, Jubartalla (1998) reported a gestation range of 143 to 149 days, and Elabid (2002) observed a mean of 148.57 ± 3.6 days. Badawy *et al.* (1971) found a similar gestation period of approximately 148.81 days in Egyptian Baladi goats. These slight variations could be attributed to factors such as breed-specific genetic traits, nutritional status, or differing management practices in the studied population.

The average kidding interval in this study was 254.16 ± 28.04 days. These findings suggest that the observed kidding interval in this study falls within the typical range for tropical goat breeds. Factors such as nutrition, management practices, and environmental conditions likely contribute to this reproductive pattern. For example, WAD goats in humid areas tend to exhibit shorter kidding intervals than those in other regions, possibly due to the relative abundance of feed resources throughout the year (Ayizanga *et al*., 2018). The present results align with findings from various recent studies on tropical goat breeds. For instance, a study on West African Dwarf (WAD) goats reported a mean interval of 246.90 days, indicating a comparable reproductive performance (Jesuyon *et al*., 2023). Similarly, research on indigenous goats in a tropical humid forest zone found that 64% of farmers reported kidding intervals of 4–7 months, with a majority leaning towards 6–7 months. The shorter kidding interval observed in synchronized does, compared to non-synchronized does, is likely due to synchronized births and factors like

Table 4. Effect of housing type on gestation period, kidding interval, litter size, and age at first kidding among synchronized and non-synchronized does

Reproductive trait	Synchronized		Non synchronized	
Gestation length (days)	149.38 ± 1.41	149.44 ± 1.13	151.25 ± 2.12	150.78 ± 2.22
Kidding interval (days)	239.25^{b} ± 1.83	239.00^{b} ± 1.41	271.25^{a} ± 36.19	267.13^{a} ± 33.54
Litter size	1.38 ± 0.52	1.38 ± 0.52	1.38 ± 0.52	1.13 ± 0.35
Age at first kidding (days)	513 ± 6.78	520 ± 0.00	506 ± 40.40	516 ± 14.14

^{a,b}Different superscripts within the same row indicate significant differences (P < 0.05) for the same parameter among different treatments.

nutrition, suckling, parity, and breed. Additionally, reproductive efficiency is related to the length of the kidding interval; does with longer intervals have lower reproductive efficiency (Yiwas, 2023).

The average litter size in this study was 1.32±0.48. These findings suggest that the observed litter size in this study falls within the typical range for tropical goat breeds. These findings are consistent with results from various studies on indigenous and tropical goat breeds. For instance, a study on indigenous goats in Tanzania reported an average litter size of 1.82, indicating a slightly higher reproductive performance in that population. Similarly, research on West African Dwarf goats found that litter size increased with parity, reaching a maximum of 1.79 ± 0.05 at higher parities (Nguluma *et al.,* 2022). These findings suggest that the observed litter size in this study falls within the typical range for tropical goat breeds. Factors such as breed, nutrition, and management practices likely contribute to this reproductive pattern. For example, a study on indigenous goats in Tanzania highlighted that twining ability is influenced by management practices, with high-energy diets associated with a greater proportion of multiple births. The variation in litter size observed here may be due to the effects of parity and doe maturity on reproductive efficiency. As does age and experience increase, they often exhibit improved reproductive performance, leading to larger litter sizes. This trend underscores the importance of considering doe age and parity in breeding programs aimed at optimizing reproductive outcomes.

The average age at first kidding observed in this study was 513.75 ± 20.44 days (approximately 17 months). These findings suggest that age at first kidding observed in this study falls within the typical range for tropical goat breeds. Factors such as breed, nutrition, and management practices likely contribute to this reproductive pattern. These results are consistant with findings from various studies on indigenous and tropical goat breeds. For instance, a study on indigenous goats in Tanzania reported an average age at first kidding of 14.4 ± 4.35 months, indicating a comparable reproductive performance in that population. Similarly, research on indigenous goats in the Tigray region of Ethiopia found that the mean age at first kidding ranged from 12.45 ± 1.4 months to 14.56 ± 3.1 months, depending on the breed (Chanie *et al*., 2015; Teweldemedhn *et al*., 2023). The variation in age at first kidding observed here may be due to genetic factors and nutritional status. Goats that are not provided with adequate nutrition may experience delayed sexual maturity, leading to a later age at first kidding. Additionally, genetic differences among breeds can influence the timing of sexual maturity and the onset of reproductive activity. Therefore, improving nutritional management and selecting early-maturing breeds could help reduce the age at first kidding and enhance reproductive efficiency in goat populations.

CONCLUSION

Shaded housing significantly improves reproductive efficiency in Sudan Desert goats by reducing the kidding interval. These goats show strong adaptability to harsh conditions, making them vital to local livelihoods and the national economy. However, the dry season poses challenges to pasture availability, affecting body condition and reproduction. Breeders also face limited feed, veterinary care and structured breeding programs. Targeted interventions—such as improved housing, nutrition, and genetic selection can enhance productivity. Ongoing research and farmer support are crucial for optimizing breeding strategies and ensuring the sustainable development of goat farming in arid and semi-arid regions.Bottom of Form

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