

Research Article

Impact of Feeding Practices on the Reproductive Performance of *Kirdimi* Goats in the Department of Tandjilé-Center, Chad

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Abstract

The objective of this study was to determine the reproductive parameters of *Kirdimi* goats in relation to feeding practices in the department of Tandjilé-Center, in southern Chad. The study was conducted between April 2022 and January 2023 by monitoring 107 goats on 35 farms. The choice of animals was made according to the type of feeding practices implemented by the agro-pastoralists and are concerned, as the goats have given birth at least once. Reproduction data are collected once a month by the monitoring officer using an individual goat monitoring sheet and have been used to calculate a few reproduction parameters including: the interval between farrowing, the farrowing rate, the prolificacy rate and the pre-weaning mortality rate. The XLSTAT software (1.9.6) was used to analyze the data. The results indicate that calving occurs year-round with peaks in October and February; Births were single (50.50%), double (42.57%) and triple (6.98%). The mean farrowing rate is $72.27 \pm 44.98\%$, the prolificacy rate is $154.94 \pm 63.70\%$, the pre-weaning mortality rate is $15.56 \pm 33.40\%$ and the interval between births is 266.164 ± 100.70 days. The reproductive performance of *Kirdimi* goats was interesting and feeding practices combining feed supplements had positive effects on reproductive parameters. However, improvements need to be made in rationing and breeding management in order to promote better goat productivity in the department.

Keywords

Feeding Practices, Reproductive Performance, *Kirdimi* goats, Tandjilé-Center, Chad

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1. Introduction

In the Sahelian zone, the rearing of small ruminants, particularly goats, is one of the main socio-economic activities that is a determining factor in rural [1, 2] and is the source of income for the most disadvantaged rural community. It is also a main means of combating poverty in households in poor countries [3-6]. Despite their strong contribution to the economy and household food security in Sahel countries, the majority of goats are still managed according to extensive farming methods with the use of natural resources and few feed inputs [7-10] and without any objective of reproduction [11], thus causing a decrease in reproductive performance. Several factors justify this decline in the reproductive performance of the animals, among which the climate characterized by high temperature, reducing fertility and causing embryonic mortality [12]. Similarly, dietary deficiency and disease are major contributors to decreased reproductive performance in goats [13, 14].

In Chad, goats account for 32.5% of all national livestock with an effective of 30,519,349 head [15]. Goats, especially *Kirdimi* goats located in the Sudanian zone of the country, adapt very well to their agro-ecological habitats and make better use of local pastures dominated by grasses and shrubs. Despite the exploitation of poor fodder, they show a good reproductive performance characterized by a short cycle (21 days), sexual precocity (6-7 months) with a first parturition from 11-15 months [16] and have no sexual seasonality of reproduction. The average fertility rate is 164% and the prolificacy rate is 165 to 175% [16]. Double staves are the rule, triple staves are frequent, and quadruples are observed quite often [17].

These studies indicate the relatively good reproductive performance of *Kirdimi* goats under extensive rearing conditions. Despite the importance of this breed, there are very few studies on zootechnical performance (reproduction) in relation to feeding practices. For this reason, the present study is justified. Its objective is to determine the impact of feeding

practices on the reproductive performance of *Kirdimi* goats in the department of Tandjil éCenter by determining the reproductive parameters of these goats.

2. Materials and Methods

2.1. Description of the Study Area

This study took place in the Department of Tandjil éCenter in the Sudanian zone of Chad with an estimated population of 120,663 inhabitants. The Department is located at 9°19'00" North latitude and 16°09'00" East longitude (Figure 1). The climate is humid tropical. Apart from commercial activities, the population of the area mainly practices agro-sylvo-pastoral activities, rainfall varies between 500 and 1200 mm/year and the average annual temperature is around 35 °C. The rainy season (mid-April to the end of October) corresponds to the growing season and the dry season follows from November to mid-April. The hottest months are usually from March to April and the rainiest months are from July to August. The coolest months are from December to February. The vegetation of the Department consists of herbaceous plants such as: *Digitaria horizontalis*, *Cyperus haspan*, *Echinochloa stagnina*, *Hyparrhenia bagirmica*, *Hyparrhenia rufa*, *Sporobolus pyramidalis*, *Cymbopogon sp*, *Echinochloa stagnina*, *Eragrostis tremula*, *Sporobolus pyramidalis*, *Eleusine indica* and *Cenchrus biflorus*; As well as woody plants namely: *Anogeissus leiocarpa*, *Prosopis africana*, *Terminalia avicennioides*, *Vitellaria paradoxa*, *Stereospermum kunthianum*, *Securidaca longipedunculata*, *Pterocarpus lucens*, *Flueggea virosa*, *Indigofera garckeana*, *Celtis toka*, *Guiera senegalensis*, *Parkia biglobosa*, *Terminalia macroptera*, and *Ficus sycomorus*.

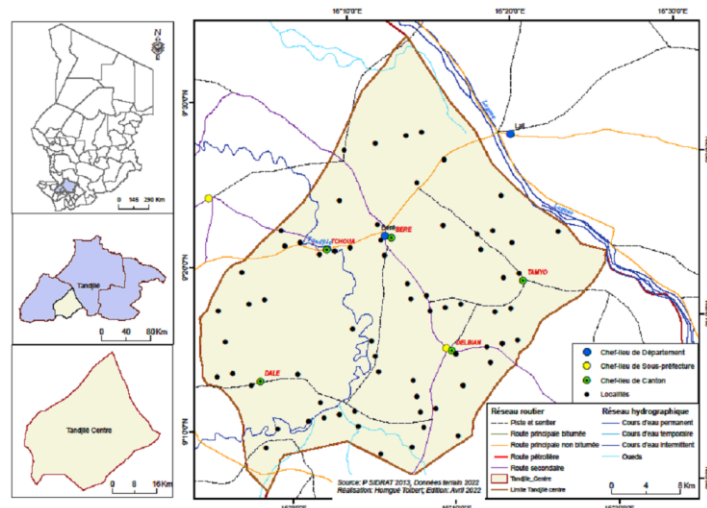


Figure 1. Location of the study area.

2.2. Material

2.2.1. Technical Equipment

The technical equipment consists of sheets for the monitoring of goats. The individual monitoring sheet allows data on a few reproductive parameters to be collected on a monthly basis. The information contained in the sheet is: the breeder's number, the identity of the goat, the previous farrowing date, the current farrowing date, the farrowing interval, the farrowing date, the farrowing date, the farrowing date, the farrowing date, the type of farrowing and the shade of kids.

2.2.2. Animal Material

The study involved 315 agrobreeders chosen according to different types of goat feed in the Department of Tandjil éCenter. Thus, 107 goats were selected on the basis of farrowing order (1st, 2nd, 3rd or even 4th) and identified using ear tags (Figure 2), distributed in 35 family farms including 3 goats per household.

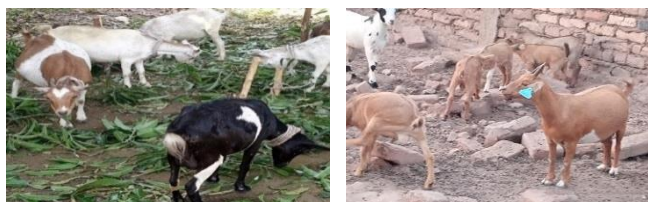


Figure 2. Goats monitored in Tandjil éCenter.

2.2.3. Power Flow

The animals were fed according to the feeding practices implemented by the agro-pastoralists. In addition to the natural pastures that all the animals enjoy, some farms receive feed supplements, composed of artisanal by-products (cereal bran, grains of local beverages) and agro-industrial by-products (peanut cake, cotton or cottonseed cake).

2.3. Methods

2.3.1. Animal Sampling and Monitoring

Across-sectional and retrospective survey of 315 agro-

breeders, taking into account the types of feeding practices implemented by goat agrobreeders in the Department of Tandjil éCenter.

The monitoring took place between April 2022 and January 2023, and concerned 35 farms in three (3) sub-prefectures of the Department. Data is collected once a month by the monitoring officer using an individual goat tracking sheet. The data collected included: date of farrowing, type of farrowing, number of kids born alive and dead, farrowing rank and previous calving date.

2.3.2. Parameters Studied

The data collected by the monitoring of goats on reproduction, in particular the date of farrowing, type of farrowing, number of kids born alive or dead, farrowing rank and previous farrowing date, made it possible to calculate some reproduction parameters, namely: The farrowing rate, the prolificacy rate and the pre-weaning mortality rate according to the method used by Lhoste *et al.* (1993):

- 1) The interval between farrowing: This is the time interval between two successive farrowing.
- 2) The farrowing rate: This is the number of offspring born (live or dead) in relation to the number of breeding females.
- 3) The prolificacy rate: The prolificacy rate is the number of pups born (live or dead) per birth.
- 4) Pre-weaning mortality rate: This is the number of pups that die before weaning age out of the number of pups born alive.

2.3.3. Data Analysis

The XLSTAT software (6.1.9) was used to analyze the collected data. Means, standard deviations, frequencies, proportions, and extremes were calculated using descriptive statistics. The comparison of means by multi-factor ANOVA used the Newman-Keuls test (SNK) at the 5% level.

3. Results and Discussion

3.1. Results

Reproductive Parameters of *Kirdimi* Goats Monitored by the Department of Tandjil éCenter

The farrowing rows of the monitored goats are shown in Table 1. This table shows that the proportion of goats with the first farrowing row is higher. Goats with the fifth farrowing row are lower.

Table 1. Farrowing rank of goats monitored by the Department of Tandjil & Center.

quavering Rank	Number of employees (n)	Percentage (%)
1	49	48,51
2	25	24,76
3	19	18,81
4	6	5,94
5	2	1,98

n: number

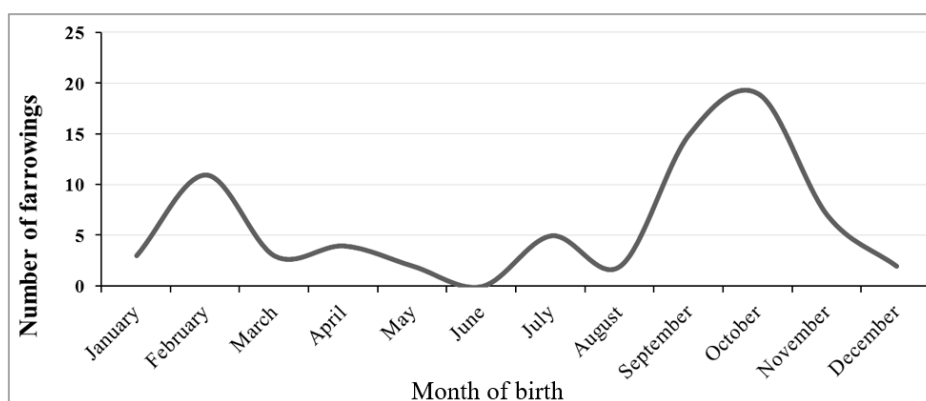
In Table 2, the proportion of single-type farrowing was the highest and triple-type farrowing was the lowest.

Table 2. Litter size of goats monitored from the Department of Tandjil & Center.

Type of farrowing	Number of employees (n)	Percentage (%)
Simple	51	50,50
Double	43	42,57
Triple	7	6,98

N: Number

During the year, farrowing was more observed from September, October and February, with a peak in October; However, in August, March, May, June and December, the farrowing were very low (Figure 3).

**Figure 3.** Annual distribution of Kirdimi goat farrowing monitored in the Department of Tandjil & Center.

The mean farrowing interval is $266,164 \pm 100.70$ days. The effect of feeding practices and bid rank on calving interval were tested. There was no significant difference in feeding practices and calving rank ($p > 0.05$). (Table 3).

Table 3. Farrowing interval of flocks monitored by feeding practices and farrowing rank.

Parameters	Farrowing interval (days)
Feeding Practices	
FN	$310,00 \pm 0.000^A$
FN+SPA	$262\,794 \pm 40,285^A$
FN+SPA+SPAI	$234\,667 \pm 71\,183^a$
Farrowing Rank	
1	$268\,909 \pm 0\,000^A$
2	$274\,056 \pm 29\,541^a$

Parameters	Farrowing interval (days)
3	$260\,824 \pm 29\,439^a$
4	$238\,500 \pm 52\,654^A$
5	$235\,000 \pm 100\,217^A$

Values with the same letter in the column indicate that there is no significant difference at the 5% level ($p > 0.05$); FN: Natural fodder; FN+SPA: Natural fodder + Artisanal by-products; FN+SPA+SPAI: Natural fodder + Artisanal by-products + Agro-industrial by-products.

Table 4 shows some of the reproductive parameters of the Kirdimi goats monitored. The rate of prolificacy and the pre-weaning mortality rate had no significant differences ($p > 0.05$) according to feeding practices. The farrowing rate according to FN-based feeding practices is lower than that of FN+SPA and FN+SPA+SPAI ($p < 0.05$).

Table 4. Variation in Reproductive Rates (%) of Kirdimi Goats in Tandjil é-Center.

Parameters	Feeding Practices			Average
	FN	FN+SPA	FN+SPA+SPAI	
Farrowing rate	50 \pm 0,00 ^A	76,82 \pm 11,02 ^{Ld}	60,00 \pm 20,26 ^{from}	72,27 \pm 44,98
Prolificacy rate	181,81 \pm 0,00 ^A	152,63 \pm 18,67 ^A	125,00 \pm 33,70 ^A	154,94 \pm 63,70
Pre-weaning mortality rate	15,15 \pm 0,00 ^A	15,13 \pm 10,90 ^A	25,00 \pm 19,66 ^A	15,56 \pm 33,40

Values on the same line with different letters are significantly different at the 5% threshold (p0.05); FN: Natural fodder; FN+SPA: Natural fodder + Artisanal by-products; FN+SPA+SPAI: Natural fodder + Artisanal by-products + Agro-industrial by-products<; BMI: Farrowing interval

The highest calving rate was recorded in livestock fed on natural fodder and agropastoral by-products (p0.05)<

3.2. Discussion

Reproductive Parameters of Kirdimi Goats Monitored

1) Distribution and mode of Farrowing

Farrowing was spread throughout the year but was more pronounced from September, October, November and February with a peak in October. However, the rate of down-feeding from March to August was very low. The peak calving period indicates that the matings occurred during the wintering period, when forage abundance occurs, and supports the rationale that diet is effective in improving productivity in goats [16] reproductive performance observed in Kirdimi goats in this study is comparable to work reviewed by other authors on goats elsewhere. A similar trend was observed by [16] in Kirdimi goats in southern Chad, whose Farrowings were spread throughout the year with a peak in September and very low proportions of calving recorded in the warm dry season (March-June). Farrowing was single, (50.50%), double (42.57%) and triple (6.98%). These results are similar to those of [16] on Kirdimi goats in southern Chad and [1] in western Cameroon. Moreover, they are slightly lower than those reported by [19] for Djallonké goats in West Africa and [20] in DRC in dwarf goats.

2) Farrowing Interval

The interval between Farrowing in Kirdimi goats monitored averaged 266,164 \pm 100.69 days (approximately 9 months). Indeed, neither the feeding practices of the agro-breeders nor the farrowing rank had any influence on the interval between quavering. These results corroborate those reported by [21] in dwarf goats in Nigeria. On the other hand, they are higher than those of [22] in Senegal and [20] in the DRC with a calving interval of 231.3 and 240 days, respectively. Moreover, they are lower than those of [23] in dwarf goats in Niger and [19] in Djallonké goats in West Africa, whose farrowing interval is 476.1 and 295.8 days, respec-

tively. Reproductive management, dietary influence [24, 19] as well as pathologies may also be the factors contributing to the variation in the interval between farrowing. Indeed, the method of managing reproduction, in particular free or controlled riding, would contribute to shortening or extending the interval between calving. According to [19], good nutrition promotes the possibility of reproduction all year round with two births/year in 65% of females. In goats in western Sudan, litter size significantly influenced calving intervals [25]. According to the authors, triple births were recorded at long intervals (287.99 \pm 18.54 bd) of farrowing compared to double births (249, 59 \pm 4.79^{bd}) and single births (241, 77 \pm 3.32^{bd}).

3) Farrowing Rate

The average quavering rate of monitored goats is 72.27 \pm 44.98%. Farms that combine supplements in goat feed (FN+SPA and FN+SPA+SPAI) had the highest farrowing rate (p>0.05) compared to those using natural fodder alone (<FN). The difference in proportions could be explained by the way the animals were fed. In fact, in addition to the natural fodder that all the animals in three groups of the farms receive, the animals of the FN+SPA and FN+SPA+SPAI groups receive food supplements which are sources of protein and energy, which are very essential for periods of sexual activity. For the animals of the FN+SPA breeding group, these are artisanal by-products (cereal bran and local drinking grains) and for the animals of the FN+SPA+SPAI breeding group, it is in addition to artisanal by-products, there are agro-industrial by-products (cottonseed, peanut or cotton cake) which are difficult to access to farmers because of their high price and availability in the locality. It should be noted that feeding practices had a significant influence (p<0.05) on the farrowing rate; Similarly, the season was a factor in the variation in the calving rate, as calving was more likely to occur in the wet dry season (September-October) and warm dry season (February). The same observation was made in Lubumbashi in the DRC, where the season was a factor in the variation of the calving rate among dwarf goats [26].

These results are lower than those reported by [27] in Mali, [28] in Senegal and [29] in Benin whose farrowing rates were 93%, 84.1% and 85.34 respectively. The difference between

our results and those of others could be related to the ration and the farming method.

4) Prolificacy Rate

The prolificacy rate in this study averaged $154.94 \pm 63.70\%$. The feeding practices of the different groups of the farms did not influence the prolificacy rate of the goats monitored. However, farrowing rank was a factor in the variation of the prolificacy rate. Indeed, from the 1st to the 4th quavering rank, the prolificacy rate gradually increased to fall to the 5th farrowing rank, which explains why multiple births (twins and triples) were observed according to the increase in the quavering order of the female, especially her age. Thus, multiple births were observed much more from the 2nd rank of farrowing in this study. The same trend was observed by [30] and [8] whose multiple births were recorded from 2 and 3 farrowing rows. [19] report in the literature review on Djallonke goats from West Africa, that prolificacy in general is influenced by the age of the mother. It also increases with parity. It is influenced by the farrowing season. In addition, the same authors point out that artificial insemination could also be a factor in the variation of this reproductive parameter. According to [24], prolificacy is also highly dependent on feeding conditions at the time of breeding. This is a consequence of the relationship between food availability, body condition and ovulation rate in females.

These results are similar to those reported by [16] on *Kirdimi* goats in southern Chad. On the other hand, they are higher than those observed by several authors: 121% in Burkina Faso for Mossi goats [16]; 136% in Niger [23]; 112% in Burkina Faso [4], $129 \pm 0.43\%$ [31] on Sahelian goats in Chad; 146% [19] on Djallonke goats in West Africa and 114% [32] in Algeria.

5) Pre-weaning Mortality Rate

The pre-weaning mortality rate in *Kirdimi* goats averages $15.56 \pm 33.40\%$. Feeding practices did not influence pre-weaning mortality, nor did calving rank be a factor in the variation of mortality rates. However, the weight of kids at birth and the birth season appear to be factors in pre-weaning mortality, as kids weighing 1 kg or less die a few days after birth. Also, mortalities have been observed in kids born during the wintering period (July-August). This appears to be linked to health problems, particularly endoparasites during the rainy season. Several authors confirm age and season of birth as factors in the variation of the mortality rate [19, 33]. In addition, other factors influencing mortality have been reported in West African Djallonké goats by [19], namely the age at first calving of the female and the type of birth that can be correlated with the birth weight of the kids. Similarly, [20] report that pre-weaning mortality is influenced by diet, housing as well as climate. According to [24], food insufficiency significantly increases the mortality rate of kids.

The mortality rate in this study is higher than that reported by [29] in Benin (4.11%) and [34] in Lubumbashi, DRC (14.5%). The difference between our results and those of other authors could be explained by the way livestock is

managed and the environmental aspects (climate). It is in agreement with that reported by [27] in Mali. However, it is significantly lower than those reported by [24] in goats in tropical Africa, [1] in western Cameroon, [35] in Ghana and [33] in Togo whose rate is 45%, 28%, 20.9%, $41.3 \pm 7.1\%$ respectively.

4. Conclusion

The objective of this study on *Kirdimi* goats in the department of Tandjilé-Center is to determine the reproductive performance of *Kirdimi* goats in relation to the feeding practices implemented by agrobreeder. The results indicate that calving occurs year-round with peaks in October and February. They are single, double and triple with a significant calving rate. The reproductive performance of *Kirdimi* goats is good. In addition, feeding practices combining dietary supplements have had positive effects on reproductive parameters. However, improvements need to be made in the rationing of breeding females as well as in the management of livestock (hygiene practices) to promote better productivity of goats in the department.

Abbreviations

FN	Natural Fodder
SPA	Artisanal by Products
SPAI	Agro Industrial by Products

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Author Contributions

Nestor Odjigüe: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Resources, Writing – original draft, Writing – review & editing

Madjina Tellah: Formal Analysis, Methodology, Software, Supervision, Validation, Visualization, Writing – review & editing

Félix Missi Tamya: Investigation, Methodology, Resources

Brice Leng Tchang: Investigation, Resources, Visualization

Michel Assadi: Investigation, Resources, Visualization

Mama Baizina: Resources, Visualization, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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