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Nogueira D. M., Parker A., Voltolini T. V., Moraes S. A., Moreira J. N., Araújo G. G. L. and Guimarães Filho C.

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Original Article

Reproductive and Productive Performance of Crossbred Goats Submitted to three Matings in two Years Under an Agro-Ecological Production System in the Semi-Arid Region of Brazil

[*1,2]Nogueira D. M., [2]Parker A., [1]Voltolini T. V., [1]Moraes S. A., [1]Moreira J. N., [1]Araújo G. G. L. and [3]Guimarães Filho C.

[1] Embrapa Semiárido, BR 428, Km 142. Caixa Postal 23. CEP 56300-972, Petrolina, PE, Brazil.
[2]School of Veterinary and Biomedical Sciences, James Cook University, Townsville, QLD 4811, Australia.
[3] Consultant in goat and sheep production. Brazil.

Abstract

This study aimed to measure the productive and reproductive performance of does managed to have three mating seasons in two consecutive years, under an agro-ecological system in the semi-arid region of Brazil. At each mating season, an average of 57 non-defined genotype does were mated to two bucks. During the rainy season, animals were kept in Caatinga vegetation, while in the dry season they were maintained in buffel grass pastures. Average kidding interval (period between two parturitions) was 8.4 months, kidding rate (does that delivered kids/exposed does) was 55.4%, prolificacy (kids born/kidding does) was 1.82, weaning rate (kids weaned/kids born) was 81.8%, and average liveweight production at 240 days was 11.60 kg/exposed doe. Kids born in February/March (MS3) had a greater ($p<0.05$) bodyweight at birth, and at the age of 30 and 90 days than kids born in July/August (MS1) or May/June (MS2). The bodyweight at 240 days (16.3±0.7 vs. 12.7±0.8) and total weight gain (13.4±0.7 vs. 10.1±0.7) were greater ($p<0.05$) in MS3 than MS2, respectively. A kidding interval of 8.4 months (1.4 parturitions.doe.year) is technically feasible and has the potential to improve the annual productive performance of goats in the semi-arid region of Brazil.

Key words: Fertility, goats, mating season, meat, reproduction.

* Corresponding author: Embrapa Semiárido, BR 428, Km 142. Caixa Postal 23. CEP 56300-972, Petrolina, PE, Brazil.
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Introduction

Goat production is an important livestock activity in the semi-arid region of north-east Brazil. Goat production systems in this part of Brazil are based on the native Caatinga vegetation and normally operated by small family farming operations that inherently suffer from low animal production (Costa et al., 2008). In a traditional goat production system from north-east Brazil, natural mating in goats generally occurs with bucks that run freely with does during the whole year. Due to nutritional constraints and seasonality, the majority of breeding does normally show oestrus behaviour and conceive at the beginning of the wet season between November and December. However, it is also common to see some does kidding throughout the year, including during the dry season (Simplício et al., 1986). The lack of controlled breeding may result in a mortality rate of kids greater than 20% pre-weaning. In addition, the surviving cohorts of kids born in the dry season have a low growth rate, achieving a bodyweight of only 20 kg at one year of age (Moreira and Guimarães Filho, 2011).

The concept of the agro-ecological production system is to minimise external inputs of supplementary concentrates and to maximise the utilisation of home-grown forages. Moreover, this system utilizes a low stocking rate (0.15 AU/ha.year) allowing the regrowth of the natural Caatinga vegetation (Guimarães Filho and Nogueira, 2006). In this agro-ecological system there is a minimum of investment, however, animal production should be better than the traditional goat production systems in Brazil. To our knowledge, there are limited publish data on such systems.

In order to increase the performance of the traditional goat production system, it is suggested that managing the breeding doe herd to achieve three mating seasons in two years will provide a number of benefits to goat producers in the north-east of Brazil. There is a great interest by goat producers; however this reproductive management has not been introduced and/or evaluated in the semi-arid region of Brazil. The objective of this study was to measure the productive and reproductive performance of non-defined genotype does, which were managed to have three mating seasons in two consecutive years, under an agro-ecological system in the semi-arid region of Brazil.

Materials and Methods

This study was conducted over a period of 25.3 months on the experimental station of Embrapa Semiárido, in Petrolina, Pernambuco, in north-east Brazil, at an altitude of 376 m (09°09'00" S and 40°22'12" W). The mean annual rainfall at this station is 520 mm, distributed mainly from November to April (Embrapa Semiárido, 2008). The rainfall recorded during the experimental period was 525 mm in 2005, 367 mm in 2006 and 284 mm in 2007, with an average of 387 mm for the three years during which this study was carried out (Fig. 1).

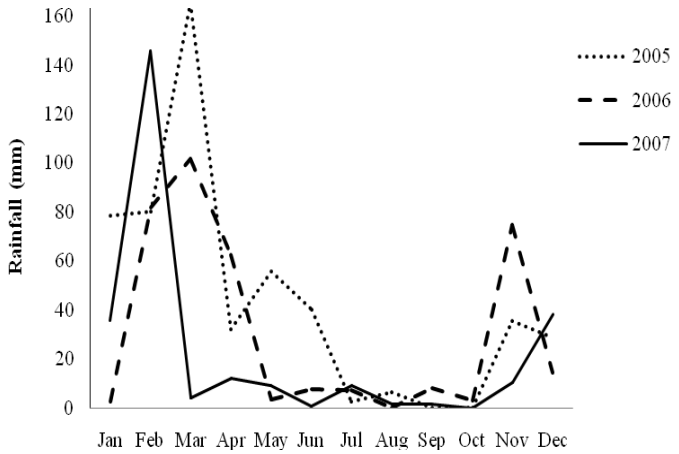

Fig. 1: Annual rainfall pattern (mm) from 2005 to 2007 in Petrolina-PE as recorded by the climate station of Bebedouro (Embrapa Semiárido, 2008).

The agro-ecological goat production system at the research station was dominated by native Caatinga vegetation. In the rainy season, Caatinga vegetation is characterised by the predominance of a woody-shrub stratum. In Petrolina-PE, north-eastern Brazil, it has been suggested that the amount of forage available in the ungrazed herbaceous stratum is 500 kg.DM.ha (Araújo et al., 2002). Among several browsed woody species for goats, the following were described by Barbosa et al. (2003): caatingueira (*Caesalpinia pyramidalis* Tul. - Leguminosae), faveleira (*Cnidoscolus*

phyllacanthus (Mull. Arg.) - Euphorbiaceae), juremas (Mimosoidea subfamily - Leguminosae) and umbuzeiro (*Spondias tuberosa* Arruda - Anacardiaceae). Normally, Caatinga vegetation is not used in the dry season due to its very low nutritional quality.

During the dry season (July to November), the animals were grazed on pastures of buffel grass (*Cenchrus ciliaris* L.), which had a phytomass from 3,356 to 6,492 kg DM.ha and a growing season from September to December (Moreira et al., 2007). According to these authors, buffel grass in the dry season has 3.04% to 4.52% crude protein, an *in vitro* digestibility of total dry matter of 29.76%, and digestibility of organic dry matter of 32.83%.

The agro-ecological production system was designed to minimise external inputs, such as supplementary concentrates and forages, and to maximise the utilisation of home-grown forages. Animal health management was based on disease prevention and the use of phytotherapy to control internal and external parasites (Guimarães Filho and Nogueira, 2006).

Animals and reproductive management

The goats were run as one herd, at a stocking rate of 0.15 Animal Units (AU)/ha.year, calculated by bodyweight$^{0.75}$ / 450$^{0.75}$. This is equivalent to a goat with 35 kg of bodyweight per hectare. The production system involved three mating seasons (MS) over two consecutive years, with the aim of increasing the productive capacity of the breeding does. It was utilized an average of 57 non-defined genotype does, which was a crossbreed between native breeds (Repartida, Marota, Moxotó and Canindé). The does were mated to Canindé and Anglo-Nubian bucks. Does were removed from the herd if they did not conceive after two consecutive mating seasons.

At the start of the experiment, the mean ± SEM age of the does was 3.8 ± 1.4 years. The total number of animals used and their bodyweights at the onset of each MS, and just before parturition are presented in Table 1. Each MS lasted 60 days.

Table 1: Total number of animals, mean ± SEM bodyweight of does at the beginning of each mating season (MS) and at parturition

	MS1 (Feb/Mar)	**MS2 (Dec 2005/Jan)**	**MS3 (Sep/Oct)**
Total number of animals, n	61	59*	54*
Bodyweight at onset of MS	34.2 ± 1.3	34.1 ± 1.4	31.2 ± 1.5
	Parturition1 (Jul/Aug)	Parturition2 (May/Jun)	Parturition3 (Feb/Mar)
Bodyweight at parturition	38.9 ± 1.4	37.0 ± 1.3	37.08 ± 1.4

* Reduction in total number of does used was due to culling or failure to conceive.

Feeding management

The breeding doe herd was allowed to graze pasture and Caatinga vegetation during the day without their kids. The kids were mothered on and allowed to suckle from the doe herd from 5:00 pm to 7.00 am the following day. They were weaned at 90 days of age. Until weaning, kids were creep-fed an organic concentrate, containing 40% babassu nut flour (*Attalea* sp.), 35% mesquite flour (*Prosopis juliflora*), 15% minerals and vitamins, 8% salt (NaCl), and 1% garlic powder and 1% homoeophatic product for the control of gastrointestinal parasites. On average, kids consumed 35 g.head.day of this concentrate.

During the rainy season, does were kept on the Caatinga vegetation from 7:00 am to 4:00 pm, and were housed overnight, with *ad lib* access to water and mineral salts. Kids were kept under shelter or in a paddock adjoining the shelter.

During the dry season, does had access to buffel grass (*Cenchrus ciliaris* L.) pastures from 7:00 am to 4:00 pm. They were housed overnight and supplemented with either leucaena hay (*Leucaena leucocephala*) or wild cassava silage (*Manihot glaziowii* Mull.) and 300 g.head.day of the before mentioned organic concentrate. Cactus forage (*Opuntia ficus*) was used as a strategic supplement when required, e.g. during extended dry

periods. In this situation, it was supplied to the herd at 3.5 kg.head.day as fed. Water and mineral salt were supplied to the does *ad lib*. When not used for mating, bucks were kept in buffel grass pastures, with free access to water and mineral salt.

Parameters evaluated

The following production parameters were evaluated: kidding interval (period between two parturitions), kidding rate (number of does that delivered kids/total number of exposed does), prolificacy (number of kids born/number of kidding does), weaning rate (number of kids weaned/ number of kids born), bodyweight at birth, and at 30, 90 and 240 days of age, mortality rate (number of dead kids/number of kids born) from 0 to 90 days and from 91 to 240 days, and average liveweight production at 240 days per doe (number of kids x weight of kids at 240 days/ number of exposed does).

The bodyweight at birth and at 30, 90 and 240 days were obtained by measurements carried out each month, following a fasting period from solids of 16 hours. The total weight gain (TWG) was obtained by subtracting the bodyweight at birth from that at 240 days, while the daily weight gain (DWG) was obtained by dividing TWG by 240 days.

Statistical Analysis

Descriptive statistics were presented for the following variables: number of exposed does, parturitions, twins or single births, mortality rate from 0 to 90 and 91 to 240 days, weaned kids, prolificacy, mortality rate and liveweight production at 240 days. To compare the bodyweight of kids, a completely random design of three MS, with an average of 41 repetitions (kids) per MS, was performed. The variables of kidding rate, mortality rate and weaning rate were analysed by χ^2 test. Analysis of Variance (ANOVA) was used to determine differences between mating seasons for the following variables: prolificacy, bodyweight between males and females and bodyweight at birth, 30, 90, 240 days, TWG and DWG. Tukey test was used to compare the differences between treatments. Results are presented as mean ± SEM and differences were considered significant when $p<0.05$. Interactions between mating seasons, parity order, and number of kids were found to be not significant and, as such, were not reported.

Results

The three mating seasons and parturitions happened within 25.3 months, which resulted in a kidding interval of 8.4 months; in other words, an average of 1.4 parturitions.doe.year (Table 2).

Table 2: Productive and reproductive parameters of goats raised in an agro-ecological production system in the semi-arid region of north-east Brazil

Parameters	MS1 (Feb/Mar)	MS2 (Dec/Jan)	MS3 (Sep/Oct)	Average/Year[1]
Total exposed does, n	61	59	54	81
Total parturitions, n	35	27	34	44
Twins births, n (%)	13 (37.1)	10 (37.0)	6 (17.6)	14 (42.9)
Kidding rate, %	57.3	45.7	62.9	55.4
Total kids born, n	48	37	40	59
Prolificacy, n	1.3	1.3	1.2	1.8
Mortality of kids, %				
0-90 days (weaning)	22.9	16.2	12.5	17.2
91-240 days, %	5.4	12.9	5.8	8.0
Weaned kids, n	37	31	35	48
Weaning rate, %	77.1	83.7	85.5	81.8
Kids weaned/ exposed does, %	60.6	52.5	64.8	59.2
Liveweight of kids at 240 days/ exposed doe (kg)	9.1	5.8	9.6	11.6

There were no significative differences ($p>0.05$). MS = mating season.
[1]Annual average considering a kidding interval of 8.4 months (1.4 parturitions/year).

There were no differences (p>0.05) among mating seasons for total number of parturitions, twinning rate, kidding rate, total kids born, prolificacy, mortality rate of kids, number of weaned kids and weaning rate (Table 2).

Male kids were heavier (p<0.05) than female kids, respectively, at birth (2.7 ± 0.07 kg vs. 2.3 ± 0.08 kg), at 90 days (10.4 ± 0.36 kg vs. 9.3 ± 0.39 kg) and at 240 days of age (16.8 ± 0.64 kg vs. 13.0 ± 0.68 kg). In addition, male kids had a greater (p<0.05) TWG at 240 days (14.1± 0.62 kg vs. 10.6 ± 0.66 kg) and DWG (58.0 ± 3.0 g vs. 44.0 ± 2.0g) than female kids, respectively.

Mating season had an effect on the kids' weight at birth, 30 and 90 days of age (Table 3). Kids born in February/March (MS3), in the rainy season, had a greater (p<0.05) bodyweight at birth, 30 and 90 days than kids born in May/June (MS2) or July/August (MS1), in the dry season. Bodyweights of kids at 240 days, TWG and DWG between MS1 and MS3 did not differ (p>0.05). However, for MS1 and MS3 these parameters were greater (p<0.05) than those for MS2 (Table 3).

Table 3: Number of kids (males and females), bodyweight at different ages, total weight gain and daily weight gain of kids born in different times of the year following three different mating seasons (MS)

Parameters	MS1 (births in Jul/Aug)	MS2 (births in May/Jun)	MS3 (births in Fev/Mar)
Number of kids, n	48	37	40
Number of males, n (%)	30 (62.5)	18 (48.6)	20 (50.0)
Number of females, n (%)	18 (37.5)	19 (51.3)	20 (50.0)
Weight at birth, kg	2.3 ± 0.09^{b}	2.5 ± 0.09^{b}	2.8 ± 0.09^{a}
Weight at 30 days, kg	5.2 ± 0.27^{b}	5.3 ± 0.28^{b}	6.3 ± 0.26^{a}
Weight at 90 days, kg	9.5 ± 0.45^{b}	8.2 ± 0.46^{b}	11.0 ± 0.44^{a}
Weight at 240 days, kg	15.8 ± 0.78^{a}	12.7 ± 0.81^{b}	16.3 ± 0.73^{a}
Total weight gain (kg/ 240 days)	13.5 ± 0.76^{a}	10.1 ± 0.78^{b}	13.4 ± 0.71^{a}
Daily weight gain (g/ day)	56.0 ± 3.0^{a}	42.0 ± 3.0^{b}	55.0 ± 2.0^{a}

Values with different letters in the same rows are significantly different using Tukey test (p<0.05).

Discussion

In this study, it was not possible to obtain a kidding interval of eight months (1.5 parturitions/year) because it was necessary to improve the body condition of the does after parturition prior to the next MS. The 8.4 months kidding interval of this study is less than the traditional goat production systems in Brazil, which can have kidding intervals of 12 months (Freitas et al., 2004) or more than14 months, in Mexico (Galina et al., 1995). Alexandre et al. (2001) working with Creole goats in Guadeloupe, a humid tropical island of the Caribbean area, found a kinding interval of 265 days (8.8 months). The reduction in kidding interval increases the number of kids born per year; therefore, increasing the profitability of goat production systems. The lack of differences for reproductive parameters between MS may be due to the limited number of animals.

The breeding behaviour of crossbred goats in north-east Brazil is all-year-roung, but the fertility can be reduced in the dry season. In addition, feed supplementation should be given to avoid reduction of the bodyweigh in the dry season (Nogueira et al., 2011). Goat kids perform better when fed at high energy/protein plane (Tameem Eldar et al., 2012).

Mating season had an effect on weight of kids at birth. The smaller incidence of twinning, and, consequently, a greater number of single births (Table 2) may have contributed to the greater bodyweight at birth for MS3 (2.8 kg) compared to MS1 (2.3 kg) and MS2 (2.5 kg) (Table 3). Normally, bodyweights at birth of singletons are greater than those of twins or triplets. In addition, the greater (p<0.05) bodyweight at birth for MS3 was associated with the rainy season (Feb/Mar) and

vegetative growth (Figure 1). Moreover, this corresponded with the does gestating during the wet season, with abundant and good quality forage from the Caatinga vegetation. Similar results were found by Bushara et al. (2012) who worked with Taggar female kids in Sudan and reported that rainy season secured higher birth weight (2.0 kg) compared with dry season kidders (1.9 kg). Data from the present study for bodyweight were similar to those reported by Silva et al. (2000) who reported bodyweight at birth for crossbred Anglo-Nubian kids from 2.8 to 3.5 kg, while Canindé kids have lower values at birth (1.9 kg). In agreement with this study, Montaldo et al. (2010) reported from evaluations of purebred Nubian in Mexico a birth weight of 3.1 kg, prolificacy of 1.5 and mortality of 15.5% (0-15 days). However, Alexandre et al. (2001) reported a kidding rate of 92.7% and prolificacy of 1.89 in Creole goats, values greater than those found in this study (Table 2).

It was observed that birth weights and bodyweights of kids at 30 and 90 days were similar ($p>0.05$) for MS1 and MS2. However, bodyweights at 240 days, TWG and DWG for MS1 and MS3 kids were greater ($p<0.05$) than those of MS2 kids (Table 3). A logical explanation for this is that kids born in July and August (from MS1) were weaned in October and November, which is the start of the rainy season. Those kids were then taken to the Caatinga vegetation with abundant and good quality forage on offer. In contrast, kids born in May and June (from MS2) were weaned in August and Sepember, during the dry season, and put on buffel grass pastures. This difference in feeding management after weaning likely resulted in kids from MS1 obtaining higher ($p<0.05$) productive performance at 240 days than kids from MS2.

The results from the effect of MS on subsequent birth weights and growth rates of the offspring demonstrate the importance of aligning the reproductive and productive management of goat herds in the north-east of Brazil with the environmental constraints of the system. Having three MS in 24 months has a number of benefits over the traditional sytem of only one MS in 12 months or more. Finally, the three mating seasons suggest it is possible to produce kids for slaughter or for market more than once per year. Goat producers may be able to then capitalise on favourable prices with out-of-season product.

Conclusions

The productive and reproductive performance of of non-defined genotype does is related to the mating season and the corresponding nutrition during the pregnancy and rearing phases on different vegetation and forage availability. For goats raised under an agro-ecological production system, a kidding interval of 8.4 months is technically feasible and has the potential to improve the annual productive performance of goats in the semi-arid region of Brazil.

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