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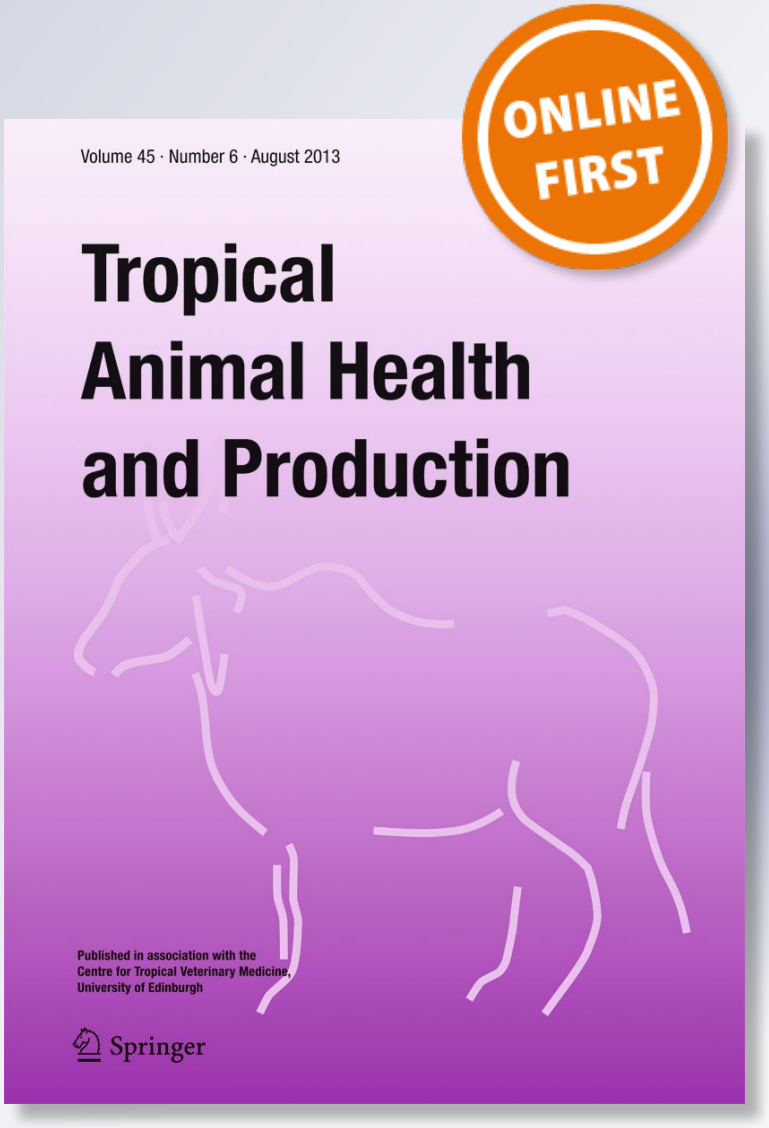

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REGULAR ARTICLES

Conception rates and calving intervals of different beef breeds at a farm in the semi-arid region of Namibia

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Abstract

A retrospective study from 2004 to 2017 investigated the effect of bull age, cow age and breed on conception rates, and calving intervals of beef cattle at Neudamm farm, Khomas region, Namibia. Bulls ranging from 4 to 14 years of age were used to breed cows up to 17 years of age. A total of 1804 pregnancies were diagnosed in Afrikaner (81.8%), Nguni (14.1%), and Simmental (4.1%) cows. The overall conception rate of beef cattle during the study period was 71.7 ± 9.5%. The overall conception rate of the Nguni cows (78.3%) was significantly higher than that of the Afrikaner (70.9%) and the Simmental cows (64.9%) ($p < 0.05$). The age of sires had no effect on overall conception rate in all three breeds ($p > 0.05$). Afrikaner dams more than 10 years old had the least rate of conception (60.4%, $p < 0.05$) within that breed category. Nguni dams between four to 10 years had the greatest conception rate (86.5%, $p < 0.05$). Age of dams had no effect on conception rates in Simmental cattle ($p > 0.05$). The overall mean length of all calving intervals in the Nguni cows (366 ± 35 days) was significantly shorter than those of the Afrikaner cows (487 ± 62 days) and the Simmental cows (484 ± 110 days) ($p < 0.05$). The 2013 breeding season produced the highest overall conception rates (~ 85%), and the 2007 breeding season produced the lowest overall conception rate (~ 51%). From a fertility point of view, the Nguni breed seemed best suited for the semi-arid conditions which are prevalent in most of Namibia.

Keywords Conception rates · Calving intervals · Nguni · Simmental · Afrikaner · Namibia

Introduction

The profitability of a commercial beef enterprise hinges on producing as many calves as possible per cow during the latter's lifetime at the lowest possible cost (Corah and Lusby 2000). Without doubt, fertility of the herd, among other factors, underpins the profitability of a beef enterprise. Fertility is the ability of a male or female animal to produce viable offspring (Baez et al. 2016; Utt 2016). It is affected by several animal, environmental, and management factors. Fertility in the female can be measured by conception rate, pregnancy rate, and calving rate (Perry 2005). In this study, pregnancy rate was used as a measure of fertility. Pregnancy rate, expressed as a percentage, is the total of females that are diagnosed as pregnant divided by the total number of females exposed to the bull multiplied by 100 (Perry 2005; Ramsay 2017).

Animal factors that affect pregnancy rate in beef cattle are those that are inherent in the cow as well as in the bull. Season (Perea et al. 2006), relative humidity, rainfall (Rawat et al. 2014), and environmental temperatures (Pagthinathan et al. 2016; Sakatani et al. 2012) constitute the environmental factors that affect fertility. General health (Noseir 2013), reproductive health (Mushonga et al. 2017a, b), nutritional management and feeding, body condition, and live weight (Diskin and Kenny 2014; D'Occhio et al. 2018) as well as the method of mating/insemination constitute management factors affecting fertility of a herd (Argiris et al. 2018).

Inherent animal factors that generally affect fertility in cows and bulls include age (Nishimwe et al. 2015; Pagthinathan et al. 2016), age at first service (Mir et al. 2015), breed (Lemma and Shemsu 2015; Toledo-Alvarado et al. 2017), body condition (Ducháček et al. 2015), and even temperament (Ramsay 2017). In the cow, additional factors affecting pregnancy rate include parity (Bhagat and Gokhale 2016), milk yield (Thirunavukkarasu and Kathiravan 2009),

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size of uterus (Baez et al. 2016), and whether the cow has weaned or is still suckling (Upadhyay et al. 2015). Factors affecting bull fertility include, among others, scrotal circumference (Júnior et al. 2016), heritable genetic factors (Buzanskas et al. 2017), nutritional status, and testicular temperature (Kastelic 2013).

Extensive commercial beef farmers in Namibia generally make use of a limited breeding season. This is where bulls are allowed to run with the cows for a limited period of time, usually up to 90 days, before being removed. It is usually done once a year between November and March. Synchronization of cows under extensive conditions has not been found to have any economic advantage (Grobler et al. 2014) and is therefore generally not practiced.

This study analyzed farm records stretching from 2004 to 2017 so as to evaluate the fertility of the Neudamm farm beef herd and to establish some baseline information on the productivity of this beef enterprise. Information on fertility rates of the different beef cow breeds as well as the bulls used for breeding at Neudamm and elsewhere in Namibia exists only in "gray" literature and is not available on demand. Furthermore, the study intended to examine and compare the pregnancy rates of the different beef breeds at Neudamm farm, over a 14-year period (2004 to 2017), as well as to determine whether or not the ages of the bulls used had any effect on conception rates. The study was expected to shed light on the ideal breed, age of bull, and age of cow for more effective breeding at Neudamm farm, and more importantly, other areas of the world with similar agro-climatic conditions.

Methodology

Study area

Neudamm farm is a mixed beef, dairy, and small stock (sheep and goats) commercial farm which is situated approximately 40 km east of Windhoek in the Khomas region of Namibia, with geo-coordinates 22° 31′ 0″ S and 17° 15′ 0 ″ E. The farm is about 10,187 ha in size and is at an altitude of approximately 1963 m. The vegetation type is savanna which is dominated by shrub-veld. The Khomas region receives an annual rainfall of between 300 and 400 mm, mostly from November to April (Mendelsohn et al. 2002).

Climate

The rainfall records kept by the farm management since 2002 until 2015 were captured on Microsoft Excel 2013 and graphically presented in Fig. 1. The average annual rainfall at Neudamm farm was 409 ± 196 mm. The highest precipitation (1009 mm) was recorded in 2011 and the lowest (159.5 mm) in 2007. As shown in Fig. 2, January, February, and March are the wettest months characterized by relatively high diurnal temperatures. The months of June, July, and August are the driest and coldest of the year. The diurnal variation of temperature is typically characterized by high daytime and low nighttime temperatures thus designating the Khomas region as a hot semi-arid region.

Study animals

The study animals consisted of all breeding beef cattle at Neudamm farm which were composed of Afrikaner, Nguni, and Simmental breeds, with the total numbers averaging 292, 105, and 28 animals, respectively, per annum. The animals were kept in different paddocks according to their breeds. All the animals were raised through extensive grazing with summer and winter lick supplementation being done during summer and winter, respectively. Neudamm farm exclusively uses natural service for breeding. Cattle are bred from November to January in the event of early rains, and from January to March in the event of late rains. The cows are bred at an average body condition score of 3 on a 5-point scale, and the heifers are bred when they reach 60% of expected mature weight. The body condition scoring was done by the different beef section supervisors who were in the employ of the university over the study period.

Neudamm farm used its own calves for heifer replacement and care was taken to avoid inbreeding of bulls with their progeny or blood relatives. The total number of bulls used during the study period was 91 resulting in an overall mean bulling rate of 19.8 cows/heifers per bull. The mean bulling rate for the Afrikaner, Nguni, and the Simmental were 19.7, 21.2, and 18.5 cows/heifers per bull, respectively. Four-year old bulls were the youngest which were used for breeding; however, bulls as old as 14 years were also used (Table 1). There was, however, no available farm records of semen analysis of the bulls prior to entering service, a fact which the farm manager confirmed was a direct result of an attempt to cut costs of this beef enterprise (Beukes 2018, Farm manager, Neudamm farm. Personal communication).

Entry into the beef section of Neudamm farm was limited to staff members employed in that section as well as students who are based at Neudamm Campus. Security personnel at the entrance gate ensured that access to the section was well controlled. The animals were routinely vaccinated against anthrax, brucellosis, botulism, and black quarter. Brucellosis vaccine was only administered to heifers once in a lifetime, before the age of 10 months as required by the Namibian legislation.

Pregnancy diagnoses were performed per rectum by veterinarians about 3 months after the end of the breeding season. Conception rates were calculated as the proportion of cows which were exposed to the breeding bull and were subsequently certified as pregnant per rectum by a veterinarian. Calving intervals were calculated by dividing the total number

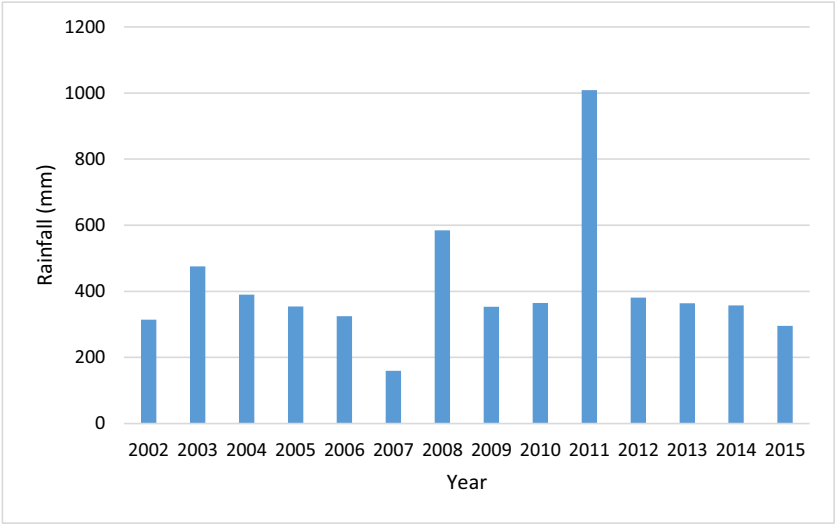

Fig. 1 Total annual rainfall at Neudamm farm from 2002 to 2015 (Kandiwa et al. 2017); used with permission

of calves born with the total number of years the cows were bred. All the required information for this study was gathered from Neudamm farm records from 2004 until 2017. In Afrikaner and Nguni cows, up to eight parturitions and seven calving intervals were recorded for some of the animals. In Simmental cows, only up to five parturitions and four calving intervals were recorded.

Statistical analysis

Data was captured in Microsoft Excel 2013 and then imported into the Statistical Package for Social Sciences (SPSS) version 25 for analysis. The data from this study had a normal distribution with Shapiro-Wilk test scores of 0.94 and 0.96 on pregnant and non-pregnant groups, respectively. Mixed ANOVA was performed to expose the effect of breed, age of sire, and age of dam on conception rates, and p values ≤ 0.05 were considered significant. The Z test was used for comparison of population proportions of calving intervals and categories of calving intervals, and p values ≤ 0.05 were considered significant (Stangroom 2018).

Results

The total number of cows and heifers bred across breeds during the study period was 1804; 71.7% of which were pregnant. Overall, the Nguni had the highest pregnancy rate (78.3%) which was significantly greater than that in the Simmental (64.9%, $p < 0.05$) but not different from that in the Afrikaner (70.9%, $p > 0.05$). As shown in Table 2, the age of the sire had no significant effect on conception ($p > 0.05$).

As shown in Table 3, within the Afrikaner breed, pregnancy rate in cows less than 4 years old and those between 4 and 10 years (72.1% and 72.9%, respectively) had significantly greater pregnancy rates than those over 10 years old (60.4%)

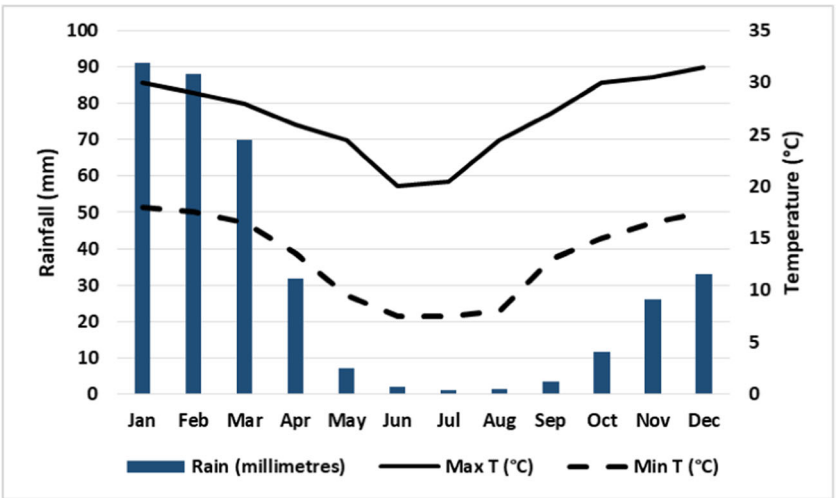

Fig. 2 Twenty-five–year climate data for Windhoek presented per month (Kandiwa et al. 2017); used with permission

Table 1 The breed and age of bulls used for breeding at Neudamm farm from 2004 to 2017

Year	Afrikaner	Nguni	Simmental	Total
2004	3^5, 2^6, $4^{7\#}$	0	0	9*
2005	1^4, 4^6, 3^8	0	0	8
2006	2^2, 1^8, 2^9	0	0	5
2007	1^6, 2^8, 1^{10}	0	0	5
2008	1^5, 1^6, 2^7	0	0	4
2009	3^5, 1^7	0	0	4
2010	1^4, 1^5	0	0	2
2011	1^5, 3^7, 1^{13}	0	0	5
2012	1^5, 1^6, 4^8	1^7, 1^{14}	0	8
2013	1^5, 1^6, 1^7, 2^9	2^5	0	7
2014	1^6, 1^7, 1^8, 2^{10}	2^6	0	7
2015	1^4, 2^5, 1^6, 1^8, 1^9, 1^{11}	1^6, 1^7	1^6	10
2016	1^5, 3^6, 1^8	2^8	1^4, 1^7	9
2017	2^5, 1^6, 2^7	1^6, 1^7	1^5	8
Total number of bulls	75	12	4	91

*# Integers represent the number of bulls and the suffices represent the age (years) of the bulls

($p < 0.05$). Within the Nguni breed, pregnancy rate in cows between 4 and 10 years (86.5%) was significantly greater than those in cows less than 4 years old and those over 10 years old (71.7% and 73.3%, respectively) ($p < 0.05$). Within the Simmental breed, there was no significant difference in the pregnancy rate in cows between all three categories ($p > 0.05$). There was, however, no evidence for overall effect of breed and age interaction on pregnancy rates ($p > 0.05$).

As shown in Fig. 3, the 2013 breeding season produced the highest overall conception rate (~ 85%), and the 2007 breeding season produced the lowest overall conception rate (~ 51%). The average conception rate over the 14-year study period was 71.7 ± 9.5%. Overall annual conception rates were above 71.6% in 2004, 2009, 2011, 2012, 2013, 2014, and 2015. Overall annual conception rates were below 71.6% in 2005, 2006, 2007, 2008, 2010, 2016, and 2017.

A total of 382, 103, and 35 calving intervals for Afrikaner, Nguni, and Simmental cows, respectively, were enumerated during the study period (Table 3).

Table 4 shows the proportional calving intervals in beef cows at Neudamm farm from 2007 to 2017. The proportion of Afrikaner calving intervals less than 1 year (26.9%) was significantly less than those between 1 and 2 years (57.7%), and those between 2 and 3 years (12.3%) were significantly less than those between 1 and 2 years ($p < 0.05$). Calving intervals greater than 3 years (3.1%) were significantly less than those between 2 and 3 years ($p < 0.05$).

The proportion of Nguni calving intervals less than 1 year (51.4%) were not significantly different from those between 1 and 2 years (46.6%) ($p > 0.05$) though these intervals were significantly greater than those over 2 years ($p < 0.05$).

The proportion of Simmental calving intervals less than 1 year (32.3%) was significantly less than those between 1 and 2 years (55.9%) but significantly greater than those between 2 and 3 years (5.9%) and those over 3 years (5.9%) ($p < 0.05$).

Discussion

The study shows an overall conception rate across all breeds of 71.7 ± 9.5%. These results fall within the 40 to 80% fertility rates reported in Australia and is much higher than the 34.53–57.7% reported in India, Rwanda, Cameroon, Sri Lanka, and Bangladesh (Bhagat and Gokhale 2016; Mollah et al. 2015; Nishimwe et al. 2015; Pagthinathan et al. 2016).

Results show that, overall, the Nguni breed had significantly higher conception rates than those of Afrikaner and Simmental breeds (Table 2). A review by Schoeman also found that Sanga (Nguni) cattle had the highest calving rates compared with four other beef breeds, and that they reached puberty earlier than the Bonsmara and Drakensberger breeds (Schoeman 1989). Nava-Trujillo and co-workers reported that the fertility of *Bos taurus* breeds was more sensitive to adverse environmental conditions than that of the *Bos indicus* breeds (Nava-Trujillo et al. 2005). Furthermore, workers from tropical regions of the world have suggested that *Bos indicus* breeds tend to be more heat tolerant than *Bos taurus* breeds which suffer from heat stress (De Rensis et al. 2015; Mwai et al. 2015). Heat tolerance has been reported to be an important adaptation conferring superior fertility in *Bos indicus* over *Bos taurus* breeds in arid and semi-arid eco-climatic regions (Nava-Trujillo et al. 2005). Studies previously conducted from Neudamm farm have reported that Neudamm farm temperatures have been rising as high as 33 °C in summer in the last 15 years (Kandiwa et al. 2017).

Although infertility was not determined in this study, previous work undertaken at the same institution has reported a case of persistent *corpus luteum* in an Afrikaner cow (Mushonga et al. 2017a) and cases of dystocia in these breeds (Kandiwa et al. 2017).

Results (Table 3) also show that, in Ngunis, a significantly high proportion (98%) of conceptions occurred in the 4–10-year category and was lower in below 4 years and above 10 years categories. In the Afrikaner, the highest conceptions were in the group below 4 years and that aged 4 to 10 years but lower in the group older than 10 years of age. The explanation for the differences in Afrikaners can be attributed

Table 2 Breed and sire age-related conception rates of beef cattle at Neudamm farm between 2004 and 2017

Category	Non-pregnant	Pregnant	Total animals	Pregnancy rate (%)
Breed				
Afrikaner	429	1047	1476	70.9[a]
Nguni	55	199	254	78.3[b]
Simmental	26	48	74	64.9[a]
Sire age				
< 7 years	355	919	1274	72.1[a]
7 to ≤ 11 years	139	336	475	70.7[a]
> 11 years	16	39	55	70.9[a]
Overall	510	1294	1804	71.7

Values sharing the same suffix [a,b] within each category were not different since $p > 0.05$

to immaturity of the reproductive tract in younger animals and senescence of the same in animals over 10 years old (Moorad and Nussey 2016). Similar results have been reported by several workers (Bhagat and Gokhale 2016; Mir et al. 2015; Mollah et al. 2015). The fact that Ngunis reach puberty early (Anon 2008; Carvalheira et al. 1995; Strydom 2008) may explain the low pregnancy in these younger animals below 4 years as they could have been exposed to bulls, perhaps, before maturation of the reproductive tract. In the Simmental breed, there were simply no differences in all age categories. This could be due to the low numbers of this breed in the study.

The relatively high pregnancy rate in the Afrikaner age group below 4 years can be explained by the fact that primiparous and nulliparous cows are young and their metabolism has not yet been overwhelmed by the rigors of previous gestations and lactations (Kamga-Waladjo et al. 2011). In addition, it has been argued that primiparous and nulliparous cows experience less negative energy balance and thus experience no resultant postpartum ovarian dysfunction that multiparous cows often experience (Parr et al. 2015).

Table 3 Within-breed conception rates of beef cattle at Neudamm farm between 2004 and 2017 according to age of cow

Cow breed	Non-pregnant animals	Pregnant animals	Total
Afrikaner ($n = 1476$)			
<4 years old	163	421[a]	584
4 to 10 years old	190	510[a]	700
> 10 years old	76	116[b]	192
Nguni ($n = 254$)			
< 4 years old	32	81[a]	113
4 to 10 years old	15	96[b]	111
> 10 years old	8	22[a]	30
Simmental ($n = 74$)			
< 4 years old	7	19[a]	26
4 to 10 years old	18	26[a]	44
> 10 years old	1	3[a]	4
Overall	510	1294	1804

Values with the same suffix [a, b] within breed categories were not different since $p > 0.05$

Although the negative correlation between milk production and fertility in dairy cows is well known (Toledo-Alvarado et al. 2017), studies in Zebu cattle have reported contrasting results (Mollah et al. 2015). Kamga-Waladjo et al. (2011) have also observed optimum fertility in cow aged 5–7 years (Kamga-Waladjo et al. 2011). According to Mollah et al. (2015), pregnancy rate of the 4–6-year-old cows is actually positively correlated with milk production (Mollah et al. 2015). The decreasing fertility of the cows over 10 years of age can be explained by normal reproductive organ senescence.

Looking at the rainfall diagram (Fig. 1), it can be observed that the highest rainfall occurred in 2011 and as shown in Fig. 3, the 2013 breeding season produced the highest overall conception rates (~ 85%). Very few would argue that adequate nutrition promotes fertility as it has been demonstrated that improved quality and quantity of food improves fertility (Cordeiro et al. 2015; D'Occhio et al. 2018; Pala and Mccraw 2005). It has been established that adequate nutrition in an animal plays an important role in the subsequent fertility of a cow/heifer indirectly through the regulation of GnRH neurons of the hypothalamus by metabolic hormones (like leptin, IGF1, and Ghrelin) that are derived from food. In addition, nutritional factors have a direct influence on follicles, oocytes, and embryos (D'Occhio et al. 2018).

The reason for the highest conception rate occurring in 2013, 2 years after the highest recoded rainfall, becomes easy to see if the "developmental origins hypothesis" (Brameld et al. 2010) is put into perspective. According to this developmental origins hypothesis, proper management of females during their prenatal development does program embryonic growth of its tissues such that there is subsequent

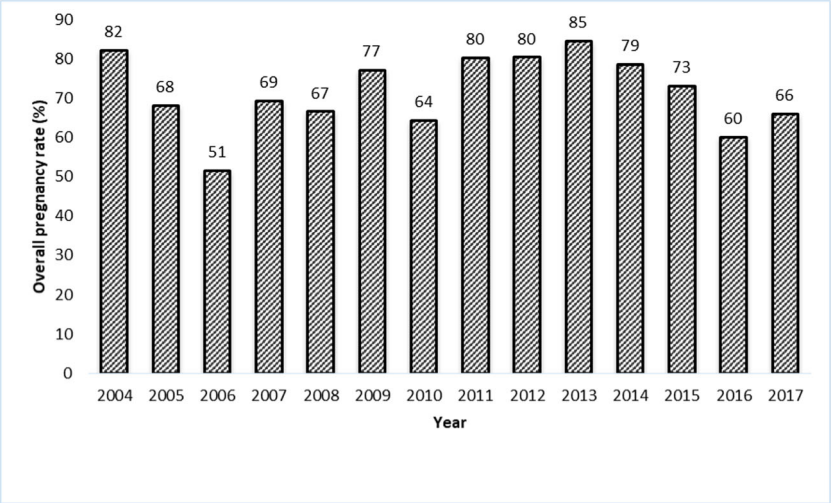

Fig. 3 Overall annual pregnancy rates in cattle at Neudamm farm from 2004 to 2017

enhancement of growth, efficient productivity, fertility, carcass quality, and minimization of adverse environmental effects in the later stages of that individual's life (Brameld et al. 2010; D'Occhio et al. 2018; Greenwood et al. 2017). Similarly, a negative prenatal environment of an embryo will indelibly negatively affect subsequent post-natal development of the calf into adulthood.

In line with the above hypothesis, cows that were bred in the January–March period of 2011 would calve down in between September and December of 2011. The Neudamm farm managers breed their heifers at 18–24 months of age. This means that cows bred in 2011 had surplus food and were in positive energy balance during the prenatal period of their calves. The so produced calves would be only ready for breeding in 2013. The conception rates of these calves were high in 2013, their primiparous year. With regard to multiparous cows, it could be argued that when they were in positive energy balance in 2011, their energy reserves were not exhausted in the following 2012 season and there could have been a spillover effect of optimum ovarian function into 2013, their conceptions thus augmenting those of the primiparous heifers conceived in 2011, resulting in the highest conception rate in 2013. The above 71.6% conception rates in 2004, 2011, and 2014 can be explained in the same manner although the breed effect of the cows might have blurred the pattern and thus warranting a separate study.

The "developmental origins hypothesis" can also explain the finding that the 2007 season produced the lowest overall conception rate (~51%) (Fig. 3). By looking at the rainfall pattern of 2005, it is clear that this year experienced the lowest rainfall during the study period. The heifers that were negatively affected in utero that year would in turn conceive in 2007. Thus, severe prolonged under-nutrition of cows in 2005 breeding season would produce heifers that would be born late in 2005. These heifers would in turn conceive in 2007. According to Greenwood et al., "the evidence that effects of prenatal nutrition on postnatal development of a wide variety of tissues directly related to the production of meat, milk, and wool, as well as reproduction, is now indisputable"(Greenwood et al. 2017). Similarly, the less than 71.6% conception rates in 2008, 2016, and 2017 are explained by the droughts that occurred 2 years prior to each year. Similar studies of this nature over a longer period would probably bring these observations into sharper focus.

Although Neudamm farm managers breed their cows from November to March depending on early or late arrival of rains, several authors have reported positive correlation between the cold dry season and increased fertility (Pagthinathan et al. 2016; Perea et al. 2006; Rawat et al. 2014; Sakatani et al. 2012). In fact Sakatani et al. (2012), and later, Pagthinathan et al. (2016) demonstrated the detrimental effects of high environmental temperatures and relative humidity in both bull and cow fertility (Pagthinathan et al. 2016; Sakatani et al. 2012).

Table 4 Proportional breed-related length of calving intervals in beef cows at Neudamm farm from 2007 to 2017

Calving interval category	Within breed proportions (%)		
	Afrikaner	Nguni	Simmental
≤1 year	26.9	51.4*	32.3
1–2 years	57.7*	46.6	55.9*
2–3 years	12.3	1.0#	5.9#
>3 years	3.1#	1.0#	5.9#
Overall	100.0	100.0	100.0

* Highest within breed proportion

Lowest within breed proportion

Results (Table 4) show that the overall mean calving interval for Neudamm was 486 ± 163 days. These results mostly lie outside the range (380–450 days) reported in Ireland (Titterington et al. 2016), indicating a substantial need for improvement. The current authors believe that this range resulted from the fact that the majority of the animals in the study were *Bos taurus* (Afrikaner and Simmental) characterized by a high calving interval in this particular region. Therefore the farm's strategy of reducing other breeds in favor of Nguni will eventually work, over time, to improve herd fertility by reducing the overall calving interval of the herd.

Since Nguni cattle have a smaller frame compared with the other two breeds, their nutritional requirements are relatively less, and this, coupled with the fact that they are more adapted to the semi-arid conditions of Namibia, makes them a better choice for beef production. However, the only drawback might be the fact that the Nguni may not produce bigger cuts of meat which may be required by Namibia's international beef trading partners, especially the European Union. However, studies have shown virtually no differences between indigenous and exotic European/British breeds with regard to meat quality (Strydom 2008).

The reproductive superiority of the Nguni, over the other two breeds, however, cannot be overstated. The study has clearly demonstrated that Nguni had higher male fertility, higher female pregnancy rate, higher pregnancy rate in the 4–10-year age group and shorter calving interval. Empirical evidence from discussions with the farm manager supports this notion. Findings of superior reproductive performance of the Nguni dam, in comparison to the Afrikaner and the Simmental, therefore reinforce the Neudamm farm strategic management decision to adopt the Nguni as the breed of choice in the face of a certain threat arising from climate change.

A number of authors have argued in favor of Nguni breed (Anon 2008; Carvalheira et al. 1995;

Strydom 2008). According to the same authors, the Nguni cows were reportedly younger at first calving (attain sexual maturity as early as 15 months of age), displayed a shorter calving interval (shorter calving interval than any southern African beef breed), had higher offtake than the Afrikaner cows, and yielded 30% more calf weight ($p < 0.001$). Furthermore, Nguni cows calve easily and regularly each year for many years, are adapted to poor grazing conditions, and have high tick resistance. However, cows over the age of 14 years were significantly less fertile than the younger categories. There are recorded cases of highly fertile cows which lived between 17 and 21 years; in one instance, an Angus cow even lived up to 36 years of age and produced 29 calves (Sanders 2012). The current study indicates that the average longevity of the three beef breed cows at Neudamm farm is 10 to 13 years. Thereafter, the conception rates drop significantly and it becomes unprofitable to keep them.

Conclusion

In conclusion, this study showed that there are opportunities for improvement with regard to beef cattle production at Neudamm farm. Breeding cows in winter may prove to be a viable and rewarding option in a scope to improve conception rates. In addition, improvement of rangeland conditions could also achieve modest gains in the productivity of the farm. The farm managements' drive to gradually replace Afrikaner beef cattle with the Nguni in the long term is commendable. Sanga cattle should be reared more in southern Africa, and in Namibia in particular, because of the breed's high fertility rates and adaptability to the country's semi-arid conditions in which periodic droughts prevail. Breeding cows and bulls can also be productive upwards of 10 years. However, such animals advanced in age are severely downgraded at slaughter, leading to poor returns. A balance has therefore to be found in order to avoid such losses.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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