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Performance of Boer-Spanish and Spanish Does in Texas: *Kid Production and Doe Stayability*[1]

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Summary

Data from 271 Boer-Spanish and Spanish does and their 1,936 kids obtained between 1995 and 2004 in the Edwards Plateau region of West Texas were examined to compare Boer-Spanish and Spanish does for kid production and stayability. The does were progeny of 24 sires, and their kids were progeny of 39 sires. Goats were maintained on native pastures for most of the year and were managed in an annual kidding system. Kids from Spanish and Boer-Spanish does had similar birth weights (3.19 kg ± 0.05 kg), 90-d weaning weights (16.9 kg ± 0.8 kg), and preweaning ADG (151 g ± 3 g). There were no significant differences between Boer-Spanish and Spanish does for litter weight at birth (5.59 kg ± 0.13 kg vs. 5.36 kg ± 0.14 kg, $P = 0.12$) or at weaning (23.33 kg ± 0.81 kg vs. 23.86 ± 0.91 kg, $P = 0.57$). Kid birth weight, weaning weight, and preweaning ADG generally increased with age of dam. Litter weight at birth and at weaning increased ($P < 0.05$)with age of dam. Stayability of Boer-Spanish does tended to be greater than that of Spanish does at 6 years of age (65 percent ± 4 percent vs. 54 percent ± 5 percent $P = 0.07$) and similar at all other ages ($P > 0.2$). No significant breed differences were observed for doe reproduction and kid growth through weaning from Spanish and Boer-Spanish goats in Texas.

Key Words: Boer-Spanish Goat, Spanish Goat, Stayability

Introduction

Goats are used for meat production around the world. In Texas, the primary breed of goat used for meat production was Spanish until the introduction of Boer from South Africa in the mid-1990s. The term 'Spanish goat' has been used in the southwestern United States to refer to a diverse population of goats used for meat production that are not Angora, Boer, or dairy breeds (Shelton, 1978). Performance of Spanish goats in Texas was reported by Bogui (1986). The improved Boer goat of South Africa is known for its large mature size, muscularity, growth rate, and prolificacy (Erasmus, 2000; Greyling, 2000; Malan, 2000). The number of Boer goats raised in the United States increased rapidly in the years following the first imports. Few studies have been done that provide a direct comparison of performance of Boer vs alternative breeds. Boer does were reported to be heavier than Spanish does in Tennessee (Browning et al., 2011), and Boer-Spanish does were reported to be heavier than Spanish does in Texas (Rhone et al., 2013). In Tennessee, Boer does had lower fertility, similar number of kids born, and lower number of kids weaned compared to Spanish does (Browning et al., 2011). Rhone et al., (2013) reported that Boer-Spanish does had greater fertility, greater number of kids born, and similar number of kids weaned compared to Spanish does in Texas. Boer does had lower survival than Spanish does in Tennessee (Pellerin and Browning, 2012). Environmental conditions may impact performance and length of productive life, especially in systems where the animals are managed in an extensive environment. Crossbred animals are sometimes used to take advantage of heterosis.

There is a need to measure kid production and stayability in a variety of environments and management systems in the United States. The objectives of this study were to estimate performance differences between Boer-Spanish and Spanish does for kid production measured by kid-birth weights, weaning weights, total-litter weight at birth and weaning, and doe stayability in extensive production conditions in West Texas.

Materials & Methods

The data for this study were collected from 1995 to 2004 on does born in 1994 and 1995 at the Winters Ranch located in McCulloch County, Texas (latitude: 31°5' N, longitude: 99° 22' W, mean-annual precipitation: 700 mm). Does were progeny of Spanish dams mated to either Boer or Spanish bucks.

In 1999, the goats were transferred to the Hill Ranch located in Edwards County, Texas (latitude 30 °15' N, longitude 100° 33' W, mean-annual precipitation: 580 mm). Records were obtained from 271 (152 Boer-Spanish, 119 Spanish) does sired by 24 (16 Boer, 8 Spanish) bucks. These does were bred in single-sire groups in an annual-kidding management system. Thirty-nine Boer (n=15) and Boer-cross (n=24) sires were used to produce 1,936 kids over the course of the study (Table 1). Does were randomly assigned to single-sire breeding pastures. Each breeding group had representative samples of Boer-Spanish and Spanish does. All procedures involving animals were approved by the Texas A&M University Institutional Agricultural Animal Care and Use Committee under protocols 4-111 and 2000-157.

The breeding-herd does were maintained on native pastures for most of the year. Vegetation was characterized by dense, scattered, live-oak (*Quercus virginiana Mill.*) mottes with grass interspaces. The midgrass component of the grass interspaces was dominated by sideoats grama [*Bouteloua curtipendula* (Michx.) Torr.] and Wright's threeawn (*Aristida wrightii* Nash). Other important midgrasses included fall witchgrass *[Leptoloma cognatum* (Schult.) Chase], Texas wintergrass (*Stipa leucotricha* Trin. & Rupr.), and silver bluestem [*othriochloa saccharoides* (Sw.) Rydb.]. Short grasses were predominantly common curly-mesquite [*Hilaria belangeri* (Steud.) Nash] and red grama (*Bouteloua trifida* Thurb.). Honey mesquite (*Prosopis glandulosa* Torr.), Ashe's juniper, and redberry juniper were prominent woody species that were scattered through the grass interspaces in a savannalike fashion. Prickly pear (*Opuntia spp*. Mill.) was also abundant. Numerous species of annual forbs were also present when adequate soil moisture was available during the fall and early winter.

The start of the breeding season varied from 23 May to 5 October from 1995 to 2004. Length of breeding season varied over the years. A late season 'cleanup' mating was used to give all does that failed to conceive during the original breeding season an opportunity to produce kids. Therefore, kidding occurred from October to May. Prior to kidding, does were taken from pasture and placed in small pens to facilitate collection of kidding records. Kids were ear tagged and weighed within 1 d of birth. Does and kids were returned to pasture when kids were from 3 d old to 14 d old. Kids were weaned at an average age of 93 d. The age at weaning ranged from 37 d to 167 d. Date of weaning was chosen based on pasture conditions and the health of the kids. There were from two to five weaning dates within a year.

Does were not culled based on production. Does were only removed from the project if they had a health problem, such as mastitis, that would prevent them from raising kids. Additional details on the foundation females and

Table 1. Numbers of does kidding and kids born by age and genotype of dam.

	Number of does kidding		Number of kids born	
Age, yr	Spanish	Boer-Spanish	Spanish	Boer-Spanish
2	92	126	139	192
3	98	124	142	189
4	77	112	107	165
5	76	102	108	167
6	56	81	95	151
7	46	67	78	128
8	30	54	51	105
9	24	40	44	75
All	499	706	764	1,172

herd management were previously presented (Rhone et al., 2013).

Data Edits and Statistical Analyses

To account for changes in environment within a year, kids were assigned to contemporary groups according to kidding dates. A new contemporary group was created when there was a 10 d or greater interval between births. Additionally, if there were no breaks of 10 or more d between kidding dates, the maximum range of kidding dates for a contemporary group was 45 d (i.e. if the kidding dates for the year spanned more than 45 days, a new contemporary group was created so that the maximum range of dates for a contemporary group was 45 d).

Weaning weights of kids that were less than 60 d old or more than 130 d old at weaning were excluded from the analysis. Weaning weights were adjusted to 90 d prior to analysis. Preweaning average daily gain (ADG) was calculated as the difference between weaning weight and birth weight divided by the age at weaning. The models used to analyze birth weight, weaning weight, and preweaning ADG included fixed effects for breed of sire of the doe, production year, sex of kid, type of birth, age of dam, and contemporary group of the kid nested within year, and random effects for sire of kid, sire of doe nested within breed, and doe nested within sire of doe and breed.

Litter weight at birth was the sum of the birth weights of all kids born to a doe at one kidding. Litter weight at weaning was calculated as the sum of the age-adjusted weaning weights of all kids reared by the doe. Therefore, when a kid did not survive to weaning, its contribution to the litter weight at weaning was zero.

The models for litter weight at birth and weaning included fixed effects for breed of sire of the doe, production year, age of doe, a contemporary group for kidding date nested within year, and random effects for sire of kids, sire of doe nested within breed, and doe nested within sire of doe and breed.

Stayability was defined as a binary trait (present = 1 or absent = 0) at the beginning of each breeding season. The first breeding season for all does started at approximately 18 mo of age, so that the first kidding was when does were near 2 yr of age. Thus, stayability at the 2nd breeding season was the presence of the doe at the beginning of the breeding season, which would result in kidding when the doe was approximately 3 yr of age. Stayability was recorded annually through the start of a doe's 8th breeding season. The 8th breeding season would result in kidding when the doe was approximately 9 yr of age. Reasons that goats left the herd included death, mastitis, or other health problems that prevented them from raising kids. A Chi-square test of reasons for leaving the herd was used to test for a difference between breeds of sire.

The model used to analyze stayability of the doe included fixed effects for breed, and year of birth, and a random effect for sire of the doe nested within breed. Seven analyses were conducted for stayability, for ages 3 through 9 yr.

In all analyses, random effects were assumed to have mean zero and a common variance. Data analyses were done using SAS PROC MIXED (SAS Inst. Inc., Cary, N.C.). Variances for random effects were estimated using restricted maximum likelihood estimation (REML) option.

Results and Discussion

Kid Birth Weight

Birth weights of kids were similar from Boer-Spanish and Spanish does (Table 2). The birth weights of kids from Spanish does (3.19 kg ± 0.05 kg) were higher than that from Spanish does reported by Bogui (1986) of 2.41 kg. Browning and Leite-Browning (2011) reported mean kid birth weights for Boer and Spanish dams of 3.1 kg when kids were sired by Boer, Kiko or Spanish bucks. When kids were sired by Boer bucks, as were most kids in the present study, Browning and Leite-Browning (2011) reported mean-birth weights of 3.3 kg. The U.S. studies that used Boer or Boer-Spanish goats reported birth weights that were lower than the range of 3.5 kg to 4.4 kg observed in Boer herds in South Africa (Van Niekerk and Casey, 1988; Schoeman et al., 1997) and China (Zhang et al., 2009). The mean birth weight differences among studies are likely due to a combination of different environments and/or the sample of the breed.

All other fixed effects in the model were significant sources of variation for birth weight. Male kids were 0.24 kg ± 0.02 kg heavier ($P < 0.05$) at birth than female kids (Table 3). Bogui (1986) reported a 0.21 kg sex difference. Browning and Leite-Browning (2011) reported a 0.34 kg sex difference for birth weight. Zhang et al. (2009) reported that Boer males were 0.4 kg heavier than females at birth.

Kid birth weight decreased ($P < 0.05$) as litter size increased (Table 3). Least squares means for kids born as singles, twins, and triplets were 3.57 kg ± 0.04 kg, 3.18 kg ± 0.04, and 2.81 kg ± 0.05 kg, respectively. The difference in birth weight between twins and singles was 0.39 kg ± 0.03 kg, which is similar to the differences reported by Bogui (1986) 0.42 kg, Browning and Leite-Browning (2011) 0.40 kg, and Zhang et al., (2009) 0.3 kg.

Least squares means for kid birth weight increased ($P < 0.05$) with age of dam up through 8-yr-old dams (Table 4). The pattern of increasing kid weight at birth with dam age was similar to that reported by both Bogui (1986) and Browning and Leite-Browning (2011). Dam body weight at the start of the breeding season also increased with age in the present study (Rhone et al., 2013). Browning et al. (2011) also

Table 2. Least squares means and standard errors of kid production traits.

	Records	Spanish	Boer-Spanish	*P*
Birth weight of kids, kg	1936	3.19 ± 0.05	3.19 ± 0.04	0.96
Preweaning ADG, g	1482	153 ± 3	153 ± 3	0.92
Weaning weight, kg	1482	16.94 ± 0.32	16.98 ± 0.28	0.92
Litter wt at birth, kg	1184	5.36 ± 0.14	5.59 ± 0.13	0.12
Litter wt at weaning, kg	1184	23.86 ± 0.91	23.33 ± 0.81	0.57

Table 3. Least squares means of factors affecting kid weight traits.

	Birth weight, kg	Preweaning ADG, g	Weaning weight, kg
Sex			
Male	3.31 ± 0.04^{a}	163 ± 3^{a}	18.01 ± 0.26
Female	3.07 ± 0.04^{b}	143 ± 3^{b}	15.91 ± 0.26^{b}
Type of birth			
Single	3.57 ± 0.04^{a}	175 ± 3^{a}	19.40 ± 0.28^{a}
Twin	3.18 ± 0.04^{b}	149 ± 3^{b}	16.61 ± 0.25^{b}
Triplet	2.81 ± 0.05^{c}	135 ± 4^{c}	14.87 ± 0.38^{c}

$^{a, b, c}$ Least squares means within a column not sharing a common superscript differ ($P < 0.05$)

Table 4. Least squares means of age of dam effects on kid production.

Age at kidding, yr	Birth wt, kg	Preweaning ADG, g	Weaning wt, kg
2	2.7 ± 0.1^{a}	115 ± 12^{a}	13.1 ± 1.1^{a}
3	2.8 ± 0.1^{a}	127 ± 9^{b}	14.3 ± 0.9^{b}
4	2.9 ± 0.1^{a}	140 ± 7^{c}	15.5 ± 0.7^{c}
5	3.0 ± 0.1^{b}	155 ± 6^{d}	17.1 ± 0.5^{d}
6	3.3 ± 0.1^{c}	168 ± 5^{e}	18.5 ± 0.5^{e}
7	3.4 ± 0.1^{d}	168 ± 7^{e}	18.5 ± 0.6^{e}
8	3.6 ± 0.1^{e}	177 ± 9^{e}	19.5 ± 0.9^{e}
9	3.7 ± 0.2^{e}	172 ±13^{e}	19.0 ± 1.2^{e}

$^{a, b, c, d, e}$ Least squares means within a column not sharing a common superscript differ ($P < 0.05$)

reported increasing dam body weights, recorded at kidding, with age.

Weaning Weight and Pre-Weaning Average Daily Gain

Approximately 9 percent of the kids that were weaned were weaned either earlier than 60 d of age, or later than 130 d of age, and therefore those records were excluded from the analysis. There was not a significant difference between kids of Boer-Spanish and Spanish dams for weaning weight and preweaning ADG (Table 2). The least squares mean 90-d weaning weight of kids in the present study (16.9 kg ± 0.3 kg) was greater than was observed in most other studies that used Boer and Spanish goats. Kids from Boer and Spanish dams in Tennessee had 90-d weaning weights of 13.9 kg (Browning and Leite-Browning, 2011). Bogui (1986) reported 120-d weaning weights of Spanish kids of 17.9 kg. If one assumes linear growth rate from 90 d to 120 d in that study, the 90-d weaning weights would be approximately 14 kg. Boer kids in China had a mean 90-d weaning weight of 15.0 kg (Zhang et al., 2009). Schoeman et al., (1997) reported 100-d weaning weights of 17.8 kg in Boer kids in South Africa, which would be approximately 16.3 kg at 90-d.

All fixed effects, other than breed, were significant sources of variation for kid-weaning weight and ADG. Male kids averaged 18.01 kg ± 0.26 kg for weaning weight and were heavier ($P < 0.05$) than female kids, which averaged 15.91 kg ± 0.26 kg (Table 3). The 2.1 kg ± 0.16 kg difference was smaller than the 2.6 kg difference between male and female kids in Tennessee (Browning and Leite-Browning, 2011). Zhang et al. (2009) reported a 1.4 kg difference in China.

Weaning weights for single kids were 2.79 kg ± 0.19 kg heavier ($P < 0.05$) than that of twins (Table 3). This difference is within the range of estimates from Browning and Leite-Browning (2011) of 2.92 kg and Zhang et al. (2009) of 2.3 kg.

Weaning weights increased as age of dam increased ($P < 0.05$) up through 6 yr of age (Table 4). Differences in weaning weights from does with ages 6 through 9 were not significantly different from zero. Similar patterns were observed in other studies (Zhang et al., 2009; Browning and Leite-Browning, 2011). Erasmus et al. (1985) however reported a decrease in kid production after 4 yr of age in Boer goats in South Africa.

Results of the analysis of preweaning ADG followed the same pattern as weaning weight (Tables 2, 3 and 4). Male kids averaged 163 g ± 3 g ADG and gained more ($P < 0.05$) than female kids, which had an ADG of 143 g ± 3 g. Single kids gained faster than twins, which gained faster than triplets ($P < 0.05$).

Total Litter Weight at Birth and Weaning

Least squares means for Boer-Spanish and Spanish dams' total litter weight at birth and weaning are presented in Table 2. Breed of sire was not a significant source of variation for total litter weight at birth or at weaning. Litter

Table 5. Least squares means of age of dam effects on weight of litter at birth and weaning (90 days).

Age at kidding, yr	Birth wt, kg	Weaning wt, kg
2	2.8 ± 0.5^{a}	7.2 ± 3.3^{a}
3	3.5 ± 0.4^{b}	11.9 ± 2.6^{b}
4	4.1 ± 0.3^{c}	15.8 ± 2.1^{c}
5	4.9 ± 0.3^{d}	21.0 ± 1.7^{d}
6	6.3 ± 0.3^{e}	26.6 ± 1.7^{e}
7	6.9 ± 0.3^{ef}	29.0 ± 2.1^{e}
8	7.6 ± 0.4^{f}	35.9 ± 2.8^{f}
9	7.8 ± 0.6^{f}	41.3 ± 3.9^{g}

$^{a, b, c, d, e, f, g}$ Least squares means within a column not sharing a common superscript differ ($P < 0.05$)

weight at birth and at weaning increased (P < 0.05) with age of dam (Table 5). Nine-year-old dams had the highest value for litter weight born and weaned of 7.8 kg ± 0.6 kg and 41.3 kg ± 3.9 kg, respectively. The advantage in litter weight at weaning appears to result from the higher number of kids born and weaned (Rhone et al., 2013) rather than the increased weight of kids because the differences in kid weights were not significantly different among ages 6 to 9 yr.

The litter weight at birth for Spanish does (5.36 kg ± 0.14 kg) was higher than reported by Bogui (1986) of 4.10 kg. Browning et al. (2011) reported that litter weights at birth were not different between Spanish (5.86 kg ± 0.33 kg) and Boer (5.78 kg ± 0.33 kg). However, at weaning, the litter weight produced by Spanish does (26.51 kg ± 1.48 kg) was greater than that of Boer (23.02 kg ± 1.51 kg) in Tennessee (Browning et al., 2011). The mean-litter weight of Spanish dams in the study of Bogui (1986) was 24.76 kg.

Body weights at the start of the breeding season of the Boer-Spanish dams were 3 kg greater than those of the Spanish dams (Rhone et al, 2013). Boer dams were 4.3 kg heavier than Spanish dams in the Tennessee study (Browning et al, 2011).

Stayability

The results for stayability at each age are presented in Table 6. A Chi-square test of reasons for leaving the herd did not show a difference between breeds of sire. The largest breed difference for stayability was at age 6 where the mean stayability of Boer-Spanish does was 65.0 percent ± 4.1 percent compared to 53.6 percent ± 4.5 percent for Spanish does (P = 0.07). At all other ages, the higher mean value for stayability of Boer-Spanish does was not significantly different from that of Spanish does. Spanish does had greater stayability than Boer does in Tennessee (Pellerin and Browning, 2012). These apparently contrasting results between the two studies could be due to heterosis, because the Tennessee study used purebred Boer does (no heterosis) and our study used Boer-Spanish does (maximum F1 heterosis). Another difference between the studies is the substantial difference between environments. The location of the Tennessee study has a mean annual precipitation of 1,222 mm and the two locations for the current study had mean annual precipitation of 700 mm and 580 mm. Internal parasites were responsible for 28 percent attrition in Boer does and 10 percent in Spanish does in Tennessee (Browning et al., 2011). The dry climate in Texas resulted in less parasitism in the goats in the present study. Boer goats were developed in South Africa in an area that has an environment that is similar to that of Texas. Another difference between the studies is that stayability, as used by Pellerin and Browning (2012), was evaluated as years in the herd rather than age, as in the current study. Stayability is an economically important trait in goats that affects profitability. However, the heritability of stayability has been reported to be low (10 percent or less) in range-raised sheep (Borg, et al., 2009). Incidence of mastitis, one of the more frequent reasons for does leaving the herd in the present study, has been shown to be heritable (13 percent to 49 percent) in meat sheep (Larsgard and Vaabenoe, 1993).

Kid production, as measured by kid weights at birth and at weaning, was similar for Spanish and Boer-Spanish goats in Texas. However, Boer-Spanish does had greater body weight than Spanish does at mating (Rhone et al., 2013). Boer does also had greater body weight than Spanish does at kidding in Tennessee (Browning et al., 2011). In a study that separated kid growth from maternal environment by removing kids from their dams and raising them on milk replacer and then feeding them on a concentrate diet, Boer-Spanish kids had a greater body weight than Spanish kids at approximately 200 d of age (Luo et al., 2000; Cameron et al., 2001). These results suggest that Boer and Boer-Spanish goats may have a greater direct postweaning-growth rate than Spanish goats. In a meat production enterprise, the importance of postweaning-growth rate is a function of when, relative to weaning, kids are marketed.

Table 6. Least squares means for stayability (percent) of Spanish and Boer-Spanish does in Texas.

Doe age, yr	Spanish	Boer-Spanish	***P***
3	96.0 ± 1.8	96.8 ± 1.7	0.75
4	86.0 ± 3.1	89.9 ± 2.8	0.35
5	66.6 ± 5.9	76.1 ± 5.0	0.23
6	53.6 ± 4.5	65.0 ± 4.1	0.07
7	41.0 ± 5.0	49.3 ± 4.5	0.23
8	34.4 ± 5.3	42.4 ± 4.6	0.26
9	26.2 ± 5.4	33.0 ± 4.6	0.34

Conclusions

The performance differences between Boer-Spanish and Spanish females in the current study are a function of breed substitution and heterosis. Kid production, as measured at kidding and weaning, in a range environment using an annual kidding management system, was similar from Spanish and Boer-Spanish does. Doe stayability was greater for Boer-Spanish does when evaluated at 6 yr of age and no differences were significant at other ages. Under Texas-range conditions, when kids are marketed at or soon after weaning, this study indicates no advantage of Boer-Spanish does over Spanish does when both produce Boer-Spanish cross kids.

Literature Cited

Bogui, N. S. 1986. Reproductive performance and preweaning growth of Spanish goats. M.S. thesis. Texas A&M Univ., College Station, TX.

Borg, R. C., Notter, D. R. and Kott, R. W. 2009. Genetic analysis of ewe stayability and its association with lamb growth and adult production. J. Anim. Sci. 87:3515-3524.

Browning, R. Jr., and M. L. Leite-Browning. 2011. Birth to weaning kid traits from a complete diallel of Boer, Kiko, and Spanish meat goat breeds semi-intensively managed on humid subtropical pasture. J. Anim. Sci. 89:2696-2707.

Browning, R. Jr., M. L. Leite-Browning, M. Byars Jr. 2011. Reproductive and health traits among Boer, Kiko, and Spanish meat goat does under humid, subtropical pasture conditions of the southeastern United States. J. Anim. Sci. 89:648-660.

Cameron, M. R., J. Luo, T. Sahlu, S. P. Hart, S. W. Coleman, and A. L. Goetsch. 2001 Growth and slaughter traits of Boer x Spanish, Boer x Angora, and Spanish goats consuming a concentrate-based diet. J. Anim. Sci. 79:1423-1430.

Erasmus, J. A., Fourie, A. J. and J. J. Venter. 1985. Influence of age on reproductive performance of the Improved Boer goat. S. Afr. J. Anim. Sci. 15:5-7.

Erasmus, J. A. 2000. Adaptation to various environments and resistance to disease of the Improved Boer goat. Small Rumin. Res. 36:179-187.

Greyling, J. P. C. 2000. Reproduction traits in the Boer goat doe. Small Rumin. Res. 36:171.177.

Larsgard, A. G. and A. Vaabanoe. 1993. Genetic and environmental causes of variation in mastitis in sheep. Small Rumin. Res. 12: 339-347.

Luo, J., Sahlu, T., Cameron, M., and A. L. Goetsch. 2000. Growth of Spanish, Boer × Angora and Boer × Spanish goat kids fed milk replacer. Small Rumin. Res. 36:189-194.

Malan S.W. 2000. The improved Boer goat. Small Rumin. Res. 36:165-170.

Pellerin, A.N. and Browning, R. Jr. 2012. Comparison of Boer, Kiko, and Spanish meat goat does for stayability and cumulative reproductive output in the humid subtropical southeastern United States. BMC Vet. Res. 8:136-144.

Rhone, J. A., D. F. Waldron, and A. D. Herring. 2013. Performance of Boer-Spanish and Spanish goats in Texas I: Body weights, fertility, prolificacy, and number if kids weaned. J. Anim. Sci. 91:4679-4683.

Schoeman, S.J., J.F. Els, and M.M. van Niekerk. 1997. Variance components of early growth traits in the Boer goat. Small Rumin. Res. 26:15-20.

Shelton, M. 1978. Reproduction and breeding of goats. J. Dairy Sci. 61:994-1010.

Van Niekerk W.A. and N.H. Casey. 1988. The Boer goat. II. Growth, nutrient requirements, carcass and meat quality. Small Rumin. Res. 1:355-368.

Zhang, C., Y. Zhang, D. Xu, X. Li, J. Su, L. Yang. 2009. Genetic and phenotypic parameter estimates for growth traits in Boer goat. Livest. Sci. 124:66-71.

