**Tropical and Subtropical Agroecosystems**

NOTA CORTA [SHORT NOTE]

# REPRODUCTIVE, GROWTH, AND FITNESS TRAITS AMONG BOER, KIKO, AND SPANISH MEAT GOATS SEMI-INTENSIVELY MANAGED IN THE SOUTHEASTERN US

# [CARACTERISTICAS REPRODUCTIVAS Y DE CRECIMIENTO ENTRE LAS RAZAS CAPRINAS DE CARNE KIKO Y ESPAÑOLA, BAJO MANEJO SEMIINTENSIVO EN EL SURESTE DE LOS ESTADOS UNIDOS]

**Richard Browning, Jr.[1] and Maria Lenira Leite-Browning[2]**

*[1]Institute of Agricultural and Environmental Research, Tennessee State University. 3500 John A. Merritt Blvd. Nashville, TN 37209-1561 USA. [2]Alabama Cooperative Extension Service, Alabama A&M University. Normal, AL 35762 USA. *Corresponding AuthorE-mail: rbrowning@tnstate.edu*

.

## SUMMARY

During three falls (2003-2005), Boer (B; n=81), Kiko (K; n=64), and Spanish (S; n=59) straightbred does were exposed to B (n=11), K (n=9), and S (n=8) bucks in a three breed diallel to assess meat goat breeds for doe-kid performance on southeastern US pasture. There were 157 B, 152 K, and 150 S doe exposures. Birth and 90-day weaning weights were recorded for 781 and 635 kids, respectively. The proportion of does delivering live kids was lower ($P$<0.01) for B (82%) than for S (93%) and K (96 ± 3%). Litter size and litter weight at birth were not affected by dam breed. The sire breed x dam breed interaction affected ($P$<0.05) birth and weaning weights. Birth weights were heaviest for BxS, BxB, and BxK (3.44, 3.35, and 3.32 kg, respectively) and lightest for KxK and SxS kids (2.95 and 2.99 ± 0.09 kg). Weaning weights were heaviest for BxK and KxK (16.3 and 15.9 kg) and lightest for BxB and SxS (13.8 and 13.9 ± 0.4 kg). The proportion of exposed does weaning kids at 3 months was lower ($P$<0.01) for B (72%) than for K and S does (88 ± 4% each). Litter size at weaning was smaller ($P$<0.01) for B (1.55 kids) than for S dams (1.8 ± 0.06 kids); K were intermediate (1.65 kids). Litter weaning weight was lighter ($P$<0.01) for B (25.7 kg) than for K dams (29.5 ± 1 kg); S dams were intermediate (28.2 kg). Based on all does exposed, B does weaned a lower ($P$<0.01) kid crop percent and litter weight (112%, 18.5 kg) compared to K (144%, 25.8 kg) and S (157 ± 9%, 24.5 ± 1.5 kg). Annual lameness, internal parasitism and attrition rates were higher ($P$<0.01) for B (71, 50, and 21%) than for S (39, 24, and 8%) and K does (31 ± 5%, 17 ± 5%, and 7 ± 4%). Fecal parasite egg counts differed ($P$<0.01) among all dam breeds: B = 523, K = 331, and S = 233 ± 45 eggs/g. Breeds differed for meat goat doe-kid performance in the US Southeast.

***Keywords:*** Meat goat, breed differences, reproduction, growth, health.

## INTRODUCTION

Doe herd reproductive output is a major determinant of profitability in a commercial meat goat enterprise. Reproductive merit is important to consider when evaluating a new breed. Breed effects on maternal performance among meat goat breeds has received little research attention (Shrestha and Fahmy, 2007). Boer and Kiko importations in the mid-1990s created new opportunities for U.S. goat producers to infuse unique germplasm into breeding programs. The Boer goat is a breed developed in the semi-arid region South Africa for meat production (Casey & Van Niekerk, 1988). Boer is the predominant meat goat genotype in the U.S. today. The Kiko is a composite goat breed developed for meat production in humid New Zealand (Batten, 1987). Non-descript landrace goats commonly referred to as "Spanish" goats evolved from stock brought to the New World by Spanish explorers in the 1500s (Shelton, 1978; Mason, 1981). Spanish goats in the U.S. are mostly found in semi-arid, south-central Texas and represented the primary meat goat before Boer goats were imported. Maternal breed affects kid performance among various sire breeds (Goonewardene et al., 1998; Ward et al., 1998); however, such studies have not included doe reproductive performance. In a pilot study (Browning et al., 2004), Kiko does had higher reproductive output than Boer does.

In the southeastern U.S., efficient meat goat production is difficult because warm, humid pasture conditions are optimum for gastrointestinal parasites and hoof pathogens. Internal parasites represent the greatest threat to goat productivity, health, and survival (Kaplan et al., 2004). Internal parasites and lameness are also costly in terms of time, labor, and materials needed for prevention and(or) treatment. Work at this research station is evaluating reproductive rates and health indicators of Boer, Kiko, and Spanish does and progeny growth rates under the environmental conditions of the southeastern United States.

## MATERIALS AND METHODS

*Animals.*

Boer (n = 81), Kiko (n = 64), and Spanish (n = 59) straightbred does were managed together on pasture over three years (September, 2003 to August, 2006). The Spanish population was represented by six seedstock farms and at least 13 sires. The Boer, Kiko, and Spanish doe groups were each represented by a broad sampling of seedstock farms and sires. Does were between 1.5 and 6 years old with age and parity balanced across breeds. Service sires included 11 Boer, 9 Kiko, and 8 Spainsh bucks representing a diverse sampling of genetic lines within each breed. The study herd was managed on the Tennessee State University research station in Nashville, Tennessee, USA (36°17'N, 86°81'W). Nashville is in the humid, subtropical southeastern region of the United States, sits 183 m above sea level, and has a 30-year annual precipitation amount of 1222 mm. The 12-month precipitation amount during the study was 1434 mm for Year 1, 1338 mm for Year 2, and 978 mm for Year 3.

*Animal Management.*

Does were managed on tall fescue (*Festuca arundinacea*) and bermudagrass (*Cynodon dactylon*) pastures supplemented with orchardgrass hay (*Dactylis glomerata*) for *ad libitum* consumption and 454 g/d of a commercial concentrate (160 g CP/kg, 69% TDN, as-fed) medicated with monensin. The concentrate was fed for eight months from breeding to weaning. Stocking rates were approximately 15 does/hectare. Does were exposed for 45 days each fall to Boer, Kiko, and Spanish bucks in single-sire mating groups as part of a complete three-breed diallel mating scheme and kidded on pasture in March and May. A total of 157 Boer, 152 Kiko, and 150 Spanish doe matings occurred across the three years. Dams and kids were weighed at birth and at weaning (3 months). Does were dewormed twice each year, including individual doe anthelmintic treatments at kidding. Additional dewormings were administered to does displaying clinical signs of internal parasitism. Fecal samples were collected from a subset of lactating does at weaning to determine fecal egg count by McMaster technique as an indication of internal parasite burden. Does were also treated individually for hoof scald/hoof rot upon observation of lameness. Kid records included 781 birth weights and 635 weaning weights. Kids were not creep-fed, vaccinated, or dewormed as a group before weaning and buck kids were left intact. Culling of does from the research herd was involuntary.

*Statistical Analysis.*

Data were tested using MIXED model ANOVA procedures of SAS (SAS Institute, Cary, NC, USA). Fixed effects in the models included breed of doe, service sire breed, month of parturition and production year. The interaction of sire breed and dam breed was added to models for analysis of kid weight data at birth and weaning with weaning weights adjusted to a 90-day basis. Kid sex and litter size were also included in the kid weight models. Animal within breed of doe was specified as a random term in the mixed effects models. Fecal egg counts (FEC) were log-transformed using a log10 conversion for statistical interpretation. Binary responses such as successfully weaning kids and doe attrition from herd were also analyzed using MIXED models. Probability levels less than 0.05 for the F-statistic indicated significant main effect or interactive term effects. The Tukey-Kramer means separation test was used to compare least squares means for all traits (alpha = 0.01).

## RESULTS AND DISCUSSION

*Doe traits*

The proportion of doe matings resulting in at least one live kid at birth was lower ($P < 0.01$) for Boer (82%) than for Kiko and Spanish does (96% and 93 ± 3%). At kidding, Spanish dams were lighter ($P < 0.01$) than Boer and Kiko dams (44.5 vs. 52.5 and 51.5 ± 1.1 kg). Litter size and litter weight at birth were similar among Boer (2.06 ± 0.1 kids, 6.82 ± 0.29 kg), Kiko (2.02 ± 0.1 kids, 6.47 ± 0.30 kg), and Spanish dams (2.08 ± 0.1 kids; 6.56 ± 0.29 kg). Maternal breed did not affect litter traits at birth. However, Boer does had lowered levels of fertility as expressed by parturition rates.

The proportion of exposed does resulting in at least one live kid weaned was lower ($P < 0.01$) for Boer does (72%) than for Kiko and Spanish does (88 ± 4% each). Spanish dams at weaning were lighter ($P < 0.01$) than Boer and Kiko dams (44.5 ± 1.2 vs. 52.4 and 51.9 ± 1.3 kg). Dams generally maintained their body weight during the three-month preweaning period. Reproductive performance and production efficiency as characterized by litter traits at weaning were consistently lower ($P < 0.01$) for Boer does than for Kiko and Spanish does (Table 1). Postpartum weight loss does not seem to explain the differences expressed between the dam breeds for reproductive output at weaning.

Table 1. Litter traits at weaning as influenced by breed of doe.

| | Breed of doe | | | |
|---|---|---|---|---|
| Trait | Boer | Kiko | Spanish | s.e. |
| Per doe weaning kids | | | | |
| Litter size, kids/dam | 1.55 [b] | 1.65 [ab] | 1.80 [a] | 0.06 |
| Litter weight, kg | 25.7 [b] | 29.5 [a] | 28.2 [ab] | 1.0 |
| Litter weight / dam wt, % | 52 [b] | 61 [ab] | 67 [a] | 2 |
| Per doe exposed to bucks | | | | |
| Litter size, kids/doe | 1.12 [b] | 1.44 [a] | 1.57 [a] | 0.09 |
| Litter weight, kg | 18.5 [b] | 25.8 [a] | 24.5 [a] | 1.5 |

[ab] Means with different letters differ significantly.

Internal parasitism and hoof infections are constraints to efficient goat production in wet climates. A larger proportion ($P < 0.01$) of Boer does experienced lameness (71 ± 5%) and internal parasitism (50 ± 5%) than Kiko does (31% and 17%) and Spanish does (39% and 24%). Geometric mean FEC for Boer, Kiko, and Spanish does were 523, 331, and 223 ± 45 eggs/g, respectively and differed ($P < 0.01$) between each breed. Annual attrition rates due to deaths and involuntary culling were greater ($P < 0.01$) for Boer does (21 ± 4%) than for Kiko (7%) or Spanish does (8%).

Health indicators may help to explain the lower reproductive rates of the Boer does. The need for frequent anthelmintic and hoof treatments in Boer-influenced herds is a common remark of producers in the southeastern United States. Doe genotypes with enhanced hardiness would benefit these producers. Internal parasite resistance has been demonstrated in other doe breeds (Baker et al., 1998). Spanish and Kiko does showed hardiness when exposed to conditions conducive to internal parasitism and lameness. Spanish does performing at levels similar to the Kiko was unexpected. It was thought that Spanish does would perform more like Boer does given their similar dry climate origins. In computer simulations, reproductive traits under excellent forage conditions were similar for Boer and Spanish does or tended to favor Boer, whereas reproductive output under poor forage conditions were higher for Spanish does (Blackburn, 1995). The separation of Spanish and Boer does in the current project under semi-intensive pasture management concur with Blackburn (1995) for moderate to low forage conditions. Kiko and Boer does differences agree with the earlier exploratory project at this research station (Browning et al., 2004). Reasons for poor reproductive performance and generally poor fitness of the Boer does are not clear. Blackburn (1995) and van der Waaij (2004) each suggested that large, fast growing breeds may be at a disadvantage in limited resource environments. Unimproved goats were more disease resistant than Boer goats in South Africa (Ramsay et al., 1978).

*Kid traits.*

Sex and litter size affected birth and weaning weights. Birth and weaning weights were heavier ($P < 0.01$) for male kids compared with female kids and kid weights decreased ($P < 0.01$) with increasing litter size.

The interaction of sire breed by dam breed was significant ($P < 0.01$) for kid birth weight (Figure 1). Among straightbred kids, Boer kids were heavier ($P < 0.01$) than Kiko and Spanish kids, the latter two did not differ. Within Boer dams, Boer-sired kids were heavier ($P < 0.01$) than Kiko-sired kids with Spanish-sired kids intermediate and not different from the other two. The same relationships were true within the Kiko dams. When born to Spanish dams, Boer-sired kids were heavier ($P < 0.01$) than kids of the other two sire breeds.

The sire breed by dam breed interaction was significant ($P < 0.01$) for weaning weights (Figure 2). Among straightbred kids, Kiko kids were heavier ($P < 0.01$) than Boer and Spanish kids, the latter two did not differ. Within Boer sires, kids were heavier ($P < 0.01$) from Kiko dams than from Boer or Spanish dams, the latter two did not differ. Within Kiko-sired kids, Kiko dams produced heavier weaning weights ($P < 0.01$) than Spanish dams; weights from Boer dams were intermediate and not different from the other two. The same was true for Spanish-sired kids.

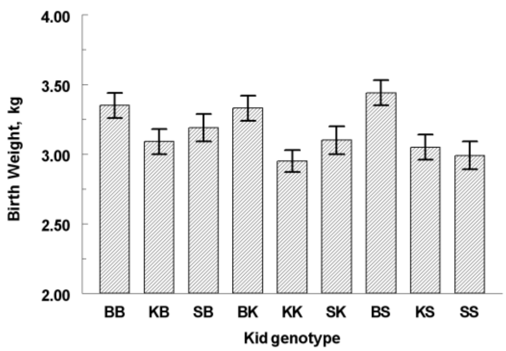


Figure 1. Birth weight (LSM ± s.e.) for meat goat kids out of Boer (B), Kiko (K), and Spanish (S) parental stock. First letter of kid genotype represents sire breed. Second letter represents dam breed

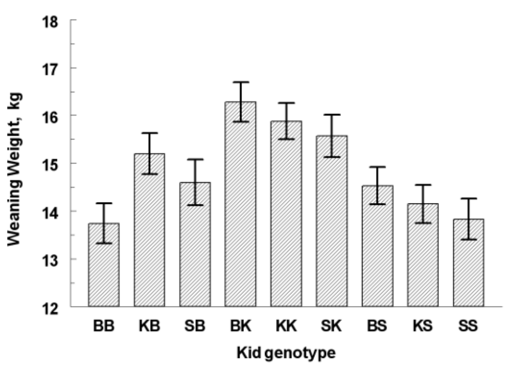


Figure 2. Weaning weight (90-day adjusted; LSM ± s.e.) for meat goat kids out of Boer (B), Kiko (K), and Spanish (S) parental stock. First letter of kid genotype represents sire breed. Second letter represents dam breed.

Sire breed influenced birth weights within dam breed with kids out of Boer sires generally exhibiting larger weights. However, dam breed modulated weaning weights within sire breed with Kiko dams having the most positive effect. The weight advantage of Boer-sired kids at birth was not maintained through weaning, an observation also reported by Goonewardene et al. (1998). The inability of Boer straightbred kids or Boer-sired kids to maintain a weight advantages from birth to weaning brings into further question the suitability of Boer goats for commercial meat goat production in the southeastern U.S. or under limited input, semi-intensive management. Speculation provides a variety of explainations as to why Kiko dams improved weaning weights across different sire breeds.

Estimated weaning weight heterosis levels were 6.28% for Boer-Kiko matings, 5.66% for Boer-Spanish, and 0.03% for Kiko-Spanish. Heterosis values for meat goat weaning weights involving Boer crosses are not readily available in the scientific literature. The ability of Boer goats to generate hybrid vigor in should be explored further as this may provide some direction on how they may be effectively used in commercial meat goat production systems.

## CONCLUSION

Reproductive output of the doe herd significantly impacts profitability and sustainability of a commercial meat goat operation. Boer does were less fit and with lower reproductive output than Kiko or Spanish does under these research conditions. Poor fitness in a doe herd results in reduced production levels, higher maintenance costs, and(or) higher attrition rates. Semi-intensive pasture management environments are dynamic and often less than ideal. Widespread use of Boer germplasm without sufficient research to characterize breed strengths and weaknesses under restricted-input management programs can prove commercially detrimental in the long-term. Spanish and Kiko does exhibited general hardiness and appeared better suited for commercial meat goat production on humid, subtropical pasture.

## REFERENCES

Baker, R.L., Mwamachi, D.M., Audho, J.O., Aduda, E.O., Thorpe, W., 1998. Resistance of Galla and Small East African goats in the sub-humid tropics to gastrointestinal nematode infections and the peri-parturient rise in faecal egg counts. Vet. Parasitol. 79, 53-64.

Batten, G.J., 1987. Kiko: A new meat goat breed. In: Proceedings of the 4th Int. Conf. on Goats. Mar. 8-13, Brasilia, Brazil. Vol. 2, pp. 1330-1338.

Blackburn, H.D., 1995. Comparison of performance of Boer and Spanish goats in two US locations. J. Anim. Sci. 73, 302-309.

Browning, R.,Jr., Kebe, S., Byars, M., 2004. Preliminary assessment of Boer and Kiko does as maternal lines for kid performance under humid, subtropical conditions. So. Afr. J. Anim. Sci. 34, 1-3.

Casey, N.H., Niekerk, W.A., 1988. The Boer Goat I. Origin, adaptability, performance testing, reproduction and milk production. Small Rumin. Res. 1, 291-302.

Glimp, H.A., 1995. Meat goat production and marketing. J. Anim. Sci. 73, 291-295.

Goonewardene, L., Day, P., Patrick, N., Scheer, H., Patrick, D., Suleiman, A., 1998. A preliminary evaluation of growth and carcass traits in Alpine and Boer goat crosses Can. J. Anim. Sci. 78, 229-232.

Kaplan, R.M., Burke, J.M., Terrill, T.H., Miller, J.E., Getz, W.R., Mobini, S., Valencia, E., Williams, M.J., Williamson, L.H., Larsen, M., Vatta, A.F., 1994. Validation of the FAMACHA© eye color chart for detecting clinical anemia on sheep and goat farms in the southern United States. Vet. Parasitol. 123, 105-120.

Mason, I.L., 1981. Breeds. In: *Goat Production*. C. Gall, ed. Academic Press, London. pp. 57-110.

Ramsay, K.A., Smit, C.H., Casey, N.H., 1987. The potential of the indigenous veld goat as an alternative to the improved Boer goat in South Africa. In: Proceedings of the 4th Int. Conf. on Goats. Mar. 8-13, Brasilia, Brazil. Vol. 2, p. 1369.

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

Shrestha, J.N.B. and Fahmy, M.H., 2007. Breeding goats for meat production: 2. Crossbreeding and formation of composite population. Small Rumin. Res. 67, 93-112.

van der Waaij, E.H., 2004. A resource allocation model describing consequences of artificial selection under metabolic stress. J. Anim. Sci. 82, 973-981.

Ward, B.J., Waldron, D.F., Willingham, T.D., Hallum, C.R., Casey, J.E., 1998. Factors affecting birth weight and weaning weight in kids of Spanish and Boer-Spanish does. J. Anim. Sci. 76(Suppl. 1), p. 77.

*Submitted June 30, 2008 – Accepted May 08, 2009*