Evaluation of 2 sources of Angus cattle under South Florida subtropical conditions

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ABSTRACT: The objective of this study was to compare performance and aspects of adaptability attributes of cattle from a Florida Angus bloodline (local source from a mostly closed herd for over 50 yr) to cattle that are representative of modern Angus bloodlines (outside source) in US subtropical conditions. Embryos from both sources were transferred to Brahman-crossbred cows in South Florida, and calves (n = 82) were born in 3 yr. Before weaning, summer tympanic temperatures were recorded hourly for 3 d in each year. Heifers were placed with fertile bulls until diagnosed pregnant. Traits relative to sexual maturation of bulls were recorded at 1- or 2-mo intervals until approximately 17 mo of age. Calves from outside sources had greater hip height at weaning than calves from the local source (P < 0.001; 108.8 ± 0.62 and 104.7 ± 0.68 cm, respectively). Local-source calves (n = 37) had greater (P = 0.03) exit velocity (2.7 ± 0.3 m/s) than outside-source calves (2.0 ± 0.29 m/s), which may be indicative of more nervous or temperamental disposition. However, no source differences were detected for other assessments of disposition (chute or pen score, P > 0.8). Few source differences for minimum, maximum, or range of daily tympanic (inner ear) temperatures were detected. At 17 mo of age, outside-source heifers were heavier (P = 0.05) and had greater (P < 0.001) hip height than Angus heifers from the local source. Heifers from the outside source were younger (P < 0.001) at the time of their first conception (454 ± 17.5 d) than heifers from the local source (550 ± 16.9 d). Outside-source heifers also had greater (P < 0.02) pregnancy and calving rates (0.7 ± 0.119 and 0.62 ± 0.125, respectively) from exposure to bulls within a year from weaning than the heifers from the local source (0.29 ± 0.089 and 0.19 ± 0.077, respectively). Bulls from the outside source were heavier (P = 0.05) at 320 d of age than local-source bulls. From 14 through 17 mo of age, outside-source bulls had greater (P ≤ 0.05) scrotal circumference and tended (P ≤ 0.15) to be heavier than local-source bulls. There appeared to be no performance or adaptation advantages for the local-source Angus through 17 mo of age. The large source difference for age at first conception in heifers merits additional attention and comparison with cow lifetime production performance for the 2 sources.

Key words: adaptability, age at first conception, Angus, beef cattle

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INTRODUCTION

Cow-calf producers in the southeastern US beef production system have enhanced income or profit by using Angus in straight or crossbreeding situations. Replacement animals must be able to cope with the rigorous environment of subtropical areas and be adapted to the conditions of the area to regularly reproduce throughout their lifetimes. Multiple generation residence of cattle in an area to which they were not originally adapted may result in acquisition of aspects of adaptation. Angus cattle have been raised and maintained in Florida...
for many years, but not in great numbers, perhaps because they are not well adapted to regional conditions. They would be of special value in the region if they could acquire the necessary adaptability.

The Angus herd at the Subtropical Agricultural Research Station has existed since the 1950s with minimal introduction of outside bloodlines (Riley et al., 2007). Angus cows and bulls from the University of Florida were obtained in the early 1950s, as well as from a Virginia research facility. Cows were also bred to bulls from a seedstock producer in Maryland until the late 1970s. Bulls produced primarily within the herd were used since that time, which may have facilitated some adaptation to the local conditions. Bulls were selected for 550-d BW through those years; females were culled based upon reproductive performance. Cattle in this Florida herd are visibly different than many modern Angus bloodlines, particularly because they are smaller (hip height and BW) throughout their life (Riley et al., 2007, 2010). Within-breed line comparison across many traits has been conducted for a Bos taurus breed in a temperate climate (MacNeil, 2009), but not in a climate to which the breed is not well adapted. The objective of this study was to compare the performance and aspects of adaptability of this Florida Angus bloodline with cattle that are representative of modern Angus bloodlines under US subtropical conditions.

**MATERIALS AND METHODS**

All procedures involving animals were approved by the local institutional animal care and use committee.

All animals in this study were produced by embryo transfer. Embryos were from 2 sources. Embryos from 5 bulls and 15 cows at the Angus herd at the Subtropical Agricultural Research Station near Brooksville, Florida, composed the local source. Embryos from 5 bulls and 11 cows composed the outside source and were representative of modern popular Angus bloodlines; these were provided by a seedstock producer from the Great Plains. These 5 bulls had accuracies greater than 0.9 for their birth, weaning, and yearling weight EPD. At the time of preparation of this report, these bulls averaged 8,475 and 5,150 progeny included in their weaning and yearling weight EPD, respectively; the numbers of weaning progeny ranged from 2,235 to 16,929 (S. L. Northcutt, American Angus Association, St. Joseph, MO, personal communication).

Embryos were transferred into recipient cows at the University of Florida Range Cattle Research and Education Center near Ona. Embryos were transferred on multiple dates in 2003, 2004, and 2005. Recipient cows (n = 66) were Brahman-B. taurus crossbreds that were produced in the local University of Florida herd; some cows had calves in more than 1 project year. As much as possible, embryos for transfer were randomized by source and sire within source across these dates. All of the sires in this project had calves in 2 of the 3 project years, and 7 of the 10 sires had progeny in all project years.

Calves (n = 82) were born from mid-October through early January of the 3 project years (2003 to 2004, 2004 to 2005, 2005 to 2006). Calves were individually identified and weighed at birth. Gestation length was calculated as the difference in days between transfer date and birth date. In each of the project years, tympanic (inner ear) temperatures were recorded on 3 July days on a subset of calves (n = 16 calves annually) from each source and sex (n = 4 heifers and 4 bulls within each source) at an average of 235 d of age (approximately 1 mo before weaning). Tympanic temperature measurements were recorded on 30-min intervals using data loggers (Stow Away XT108 37-46, Onset Computer Corporation, Pocassatt, MA) attached to thermistor cables (model TMC1-1T, Onset Computer Corporation) positioned and secured within the ear canal using techniques described previously by Mader et al. (2002).

Figure 1 shows the hourly ambient temperature and relative humidity averaged across the sampling days of this study (FAWN, 2010). Calves were weaned in August of each year at an average 265 d of age. At that time, BW, BCS, and hip height were recorded for each calf.

All animals were evaluated for temperament at weaning using objective and subjective assessments. The amount of time required for a calf to move approximately 1.8 m when released from the working chute (Burrow et al., 1988) was recorded as an objective measurement and expressed as exit velocity (m/s). Temperament was measured subjectively (by a single evaluator) as chute score on a scale from 1 to 5: 1 = calm, no movement; 2 = restless shifting; 3 = squirming, occasional shaking of squeeze chute; 4 = continuous vigorous movement and shaking of squeeze chute; 5 = rearing, twisting, or violently struggling (Grandin, 1993). A pen temperament score was assigned by a single evaluator as a subjective assessment of calf (solitary) response to human approach in a 6-m² pen (Arthington et al., 2008): 1 = unalarmed and unexcited, walking slowly away from the evaluator; 2 = slightly alarmed, moving moderately quickly away from the evaluator; 3 = moderately alarmed and excited, moving away from the evaluator quickly; 4 = very alarmed and excited by the presence of the evaluator, moving very quickly and with head held high; or 5 = very excited and aggressive toward the evaluator.

Coat characteristics were assessed at weaning by a single evaluator (same evaluator each year and blinded to calf source) using a subjective 1 to 5 score: 1 = slick, short black hair; unshed, brown hair is virtually undetectable; 2 = mostly slick black hair, but with small amounts of longer brown hair in flank or leg regions, or both; 3 = conditions similar to 2 but with larger amounts of longer, unshed brown hair on the lower extremities of the body trunk and legs; 4 = larger amounts of unshed brown hair higher on the body trunk, nearing
the back; and 5 = unshed brown hair throughout the entire body (including the neck region).

After weaning, all calves were confined to a single bahiagrass (*Paspalum notatum* Flügge) pasture for a 28-d acclimation period. During this time, calves were provided approximately 3.5 kg of supplemental concentrate per calf each day. After the postweaning acclimation period, bulls and heifers were managed for approximately 9 mo in separate groups on bahiagrass pastures. During this annual observational period of yearling growth and reproductive development, heifers were provided 2.2 kg of DM daily of a sugarcane molasses/cottonseed meal slurry (80:20; as-fed basis), and bulls were provided 4.5 kg daily of dry concentrate supplement.

**Heifers**

Approximately 1 mo after weaning (September), heifers (*n* = 39) were exposed to an unrelated (as much as possible) Angus bull for 9 mo. Within each year and before the start of the breeding season, bulls were confirmed fertile by a breeding soundness exam. Heifer BW was measured at weaning and 100 and 150 d later. Average daily BW gain was calculated for each interval (weaning to 100 d postweaning; 100 to 150 d postweaning) and total increase in hip height from weaning through 17 mo of age. Heifer hip height was measured at weaning and 100 d later. Age at conception was calculated by subtracting 280 d from the day of calving (Reynolds et al., 1980). Pregnancy rate and percentage of calf crop at birth and weaning were evaluated by assigning values of 1 to each heifer that was palpated pregnant, calved, and weaned a calf, respectively. Values of 0 were assigned to heifers that were not pregnant or that failed to calve or wean a calf. Birth and weaning weights of calves of these females were recorded.

**Bulls**

Body weight, BCS, and scrotal circumference measurements were recorded 5 times after weaning (average ages at each recording were 320, 363, 426, 462, and 511 d). At each of these times, a semen sample from each bull (*n* = 42) was obtained and evaluated for percentage individual motility, percentage normal morphology, and sperm concentration. Average daily BW gain was calculated within and across these intervals. Total increase in scrotal size from 11 to 17 mo of age was calculated. Among the bulls that had satisfactory semen characteristics at the last evaluation as described above, 4 bulls from each source group were placed in single-sire breeding herds, each with 20 multiparous Braford cows, for a 90-d breeding season. Calving rate was determined for each source, and evaluated as a trait of the bull.

**Statistical Analyses**

All traits (unless otherwise noted below) were analyzed using animal models with ASReml 3 (Gilmour et al., 2009); the pedigree included 4,299 animals across 46 generations. Average inbreeding coefficients were 0.054 and 0.05 for the local- and outside-source groups, respectively. The average additive relationship for animals from different sources was 0.017; the average within-source additive relationship was 0.2 and 0.22 for animals in local and outside sources, respectively. Heifer pregnancy rate, calving rate, and weaning rate (from exposure to bulls from weaning until 1 yr later) were analyzed assuming a binomial distribution and employing a logit link function. Models were built by investigating these fixed effects: source group, year, sex, recipient age in years, and interactions. Age in days was investigated as a linear covariate. Preliminary analyses indicated the need for transformation of tympanic temperatures as log(temperature). Tympanic temperatures that were analyzed included the overall average and the maximum and minimum temperature of each day, and the difference between the two. Additional analyses were conducted in which recorded tympanic temperatures from the 3 different days were averaged for each calf at each hour, and as such were evaluated as indicative of an average 24-h cycle. Any means from results of transformed variables or those using a link function were back-transformed to the original scale for graphic or tabular presentation. Bull reproductive and growth traits were also assessed in repeated measures analyses using similar models; results were similar and will not be reported. For analyses of heifer BW and ADG, records of pregnant heifers were excluded (pregnancy status was assigned to heifers at the various record collection dates by comparison of date of record to estimated date of conception). Pregnancy rates of Braford cows exposed to the 2 sources of bulls were compared with *χ*² expectation using the FREQ procedures (SAS Inst. Inc., Cary, NC). Source group was the effect of interest in all analyses. Any effect that did not have an *F*-ratio with *P* < 0.15 in the model building phase was excluded from final analyses.

**RESULTS**

**Birth Through Weaning**

Models for production traits (*n* = 82 calves) through weaning indicated that year effects were consistently important (*P* ≤ 0.1). Bull calves were heavier than heifers at birth (*P* = 0.02; Table 1) and weaning (*P* = 0.06), but gestation length means did not differ by sex (*P* = 0.97). Outside-source calves had greater hip height at weaning (*P* < 0.01) than local Angus. Source group effects approached significance for weaning weight (*P* = 0.16), in which local calves had lighter weaning weights. Source group effects were not retained in analyses of other traits (*P* > 0.7). No interactions of main effects were retained in models (*P* > 0.3).

Year and sex effects were retained in models for temperament traits and coat score (*P* < 0.15). Heif-
Ewes had greater ($P \leq 0.05$) chute and pen subjective scores than bulls, indicating a more volatile or nervous temperament (Table 1). Heifers also had greater ($P < 0.001$) exit velocity than bulls. Heifers had decreased ($P = 0.03$) coat scores compared with bulls, indicating more sleek coats. Outside-source calves had a slightly decreased coat score mean ($P = 0.13$) compared with the local calves. Local-source Angus calves had a greater exit velocity mean ($P = 0.03$) than outside-source calves, but source group was not retained in models of other temperament traits ($P > 0.8$). Regression of coat score on calf age ($-0.01 \pm 0.006$) approached significance ($P = 0.06$). Interaction effects were not detected ($P > 0.2$) for these traits.

**Tympnic Temperature**

Year effects were significant in analyses of daily and average minimum and maximum temperatures (n = 37 calves), and the associated ranges, but no other effect met requirements for inclusion in models ($P > 0.2$). In results from repeated records analysis, year and hour

<table>
<thead>
<tr>
<th>Item</th>
<th>Source</th>
<th>Sex</th>
<th>$P$-value</th>
<th>Bulls (n=42)</th>
<th>Heifers (n=40)</th>
<th>$P$-value</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth wt, kg</td>
<td>Local</td>
<td>Outside</td>
<td>0.86</td>
<td>29 ± 0.9</td>
<td>27 ± 0.9</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>226 ± 3.8</td>
<td>215 ± 3.9</td>
<td>0.06</td>
<td>0.7 ± 0.13</td>
</tr>
<tr>
<td>Weaning wt, kg</td>
<td></td>
<td></td>
<td>0.16</td>
<td>107.8 ± 0.65</td>
<td>105.6 ± 0.64</td>
<td>0.02</td>
<td>0.1 ± 0.02</td>
</tr>
<tr>
<td>Hip height, cm</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
<td>2.0 ± 0.14</td>
<td>2.3 ± 0.14</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.9 ± 0.16</td>
<td>2.4 ± 0.16</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Chute score</td>
<td></td>
<td></td>
<td>0.03</td>
<td>2.1 ± 0.26</td>
<td>2.7 ± 0.26</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Pen score</td>
<td></td>
<td></td>
<td>0.13</td>
<td>3.1 ± 0.29</td>
<td>2.8 ± 0.29</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Exit velocity, m/s</td>
<td></td>
<td></td>
<td></td>
<td>2.7 ± 0.30</td>
<td>2.0 ± 0.29</td>
<td>0.03</td>
<td></td>
</tr>
</tbody>
</table>

1Source of Angus: local calves (n = 37) were embryos produced in a Florida research herd that has been mostly closed to outside bloodlines for approximately 60 yr; outside calves (n = 45) were embryos from a seedstock producer on the Great Plains using popular, modern bloodlines.

2Chute score: 1 = calm, no movement; 2 = restless shifting; 3 = squirming, occasional shaking of squeeze chute; 4 = continuous vigorous movement and shaking of squeeze chute; 5 = rearing, twisting, or violently struggling. Pen score: 1 = unalarmed and unexcited, walking slowly away from the evaluator, 2 = slightly alarmed, moving moderately quickly away from the evaluator, 3 = moderately alarmed and excited, moving away from the evaluator quickly, 4 = very alarmed and excited by the presence of the evaluator, moving very quickly and with head held high, or 5 = very excited and aggressive toward the evaluator. Coat score: 1 = slick, short black hair; unshed, brown hair is virtually undetectable; 2 = mostly slick black hair, but with small amounts of longer brown hair in flank or leg regions, or both; 3 = conditions similar to #2 but with larger amounts of longer, unshed brown hair on the lower extremities of the body trunk and legs; 4 = larger amounts of unshed brown hair higher on the body trunk, near the back; and 5 = unshed brown hair throughout the entire body (including the neck region).

3Means were not estimated when source was omitted from models ($P > 0.16$). Regression coefficient estimates that did not differ from 0 ($P < 0.05$) were omitted from models.
of record were highly significant, but again no other effects were detected ($P > 0.21$). Hour of record means (Figure 2) indicated that the low and high tympanic temperature averages occurred at 0700 and 1400 h, respectively, which corresponded to 1 to 2 h after the ambient maximum or minimum temperatures (Figure 1).

### Heifer Growth

Outside-source heifers were heavier ($P = 0.05$) than local-source heifers at 17 mo of age (Table 2). Year effects were important in analyses of BW ($P < 0.01$). No other fixed effects were retained in models of heifer BW. Outside-source heifers had greater ($P < 0.001$) hip height at 17 mo of age than local heifers. Average daily BW gain of open heifers was greater from weaning to yearling age ($P = 0.05$) for outside-source heifers relative to local-source heifers. There was no detected source group difference for ADG for the interval from yearling to 17 mo or in the overall period, or for the increase in hip height during the same period ($P > 0.27$).

### Reproductive Traits

Source group ($P < 0.02$) and year ($P \leq 0.05$) were fixed effects retained in models for all reproductive traits of heifers (n = 39). Local-source heifers had a much older ($P < 0.001$) age at first conception mean (almost 95 d older) than outside-source heifers (Table 2), but decreased ($P \leq 0.04$) pregnancy rate and calving rate means (as proportions of females exposed to bulls in the breeding season of the previous year).

#### Table 2. Source means for growth and reproductive traits of Angus heifers, probability values of F-ratios, and estimates of regression on age in days$^{1,2,3}$

<table>
<thead>
<tr>
<th>Item</th>
<th>Local</th>
<th>Outside</th>
<th>$P$-value</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW, kg</td>
<td>291 ± 5.8</td>
<td>309 ± 6.3</td>
<td>0.05</td>
<td>0.9 ± 0.23</td>
</tr>
<tr>
<td>Hip height, cm</td>
<td>107.5 ± 0.68</td>
<td>113.5 ± 0.73</td>
<td>$&lt;0.001$</td>
<td>0.1 ± 0.03</td>
</tr>
<tr>
<td>ADG, kg</td>
<td>0.1 ± 0.02</td>
<td>0.2 ± 0.03</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>AFC, d</td>
<td>550 ± 16.9</td>
<td>454 ± 17.5</td>
<td>$&lt;0.001$</td>
<td></td>
</tr>
<tr>
<td>Pregnancy rate</td>
<td>0.29 ± 0.089</td>
<td>0.70 ± 0.119</td>
<td>0.016</td>
<td></td>
</tr>
<tr>
<td>Calving rate</td>
<td>0.19 ± 0.076</td>
<td>0.62 ± 0.125</td>
<td>0.005</td>
<td></td>
</tr>
</tbody>
</table>

$^1$Source of Angus: local heifers (n = 21) were embryos produced in a Florida research herd that has been mostly closed to outside bloodlines for approximately 60 yr; outside heifers (n = 18) were embryos from a seedstock producer on the Great Plains using popular, modern bloodlines.

$^2$AFC = age at first conception in days. Pregnancy and calving rates are the proportion of cows that were diagnosed as pregnant or the proportion that calved of those cows exposed to bulls in the breeding season of the previous year.

$^3$Regression coefficient estimates that did not differ from 0 ($P < 0.05$) were omitted from models.

**Figure 2.** Hourly average tympanic (inner ear) temperature (°C) means and means ± 1 SE for Angus calves (n = 37; 12.3 per year; approximately equal numbers of bulls and heifers; average age 235 d) recorded on 3 July days of each year.
Source differences were not detected for birth weight of calves (n = 39) from these females (P = 0.54), but calves born to outside-source heifers tended to be heavier than those from local heifers at weaning (P = 0.15). In these analyses, year and sex (bulls were heavier than heifers) were important components of the models (P < 0.02), as well as age at weaning (P < 0.001; 0.6 ± 0.06 kg).

**Bull Growth**

Differences between BW of bulls (n = 42) from the 2 source groups were not detected across the postweaning evaluation period from weaning through 17 mo of age (Table 3); however, differences approached significance (0.059 ≤ P < 0.21) for all BW, with bulls from outside sources tending to be heavier. Average daily BW gain from 363 to 426 d of age was greater (P = 0.04) for outside-source bulls (1 ± 0.06 kg/d) than for local-source bulls (0.9 ± 0.06 kg/d). In the entire interval from weaning through 17 mo of age, ADG of outside-source bulls (0.8 ± 0.03 kg/d) tended to be greater (P = 0.13) than that (0.7 ± 0.04 kg/d) of local bulls. No source group differences were detected for ADG in the interval from weaning to 100 d postweaning and in the interval from 163 to 248 d postweaning (P > 0.36).

**Bull Reproductive Traits**

Source group effects approached significance for scrotal circumference in bulls (n = 42) at 426 d of age (P = 0.1) and were different at 462 and 511 d (P ≤ 0.05; Table 4); at those times, outside-source bulls had greater scrotal circumference means. The total increase in scrotal circumference across this time period did not differ by source (P = 0.2). At 426 d of age, local-source bulls had 73.1 ± 4.37% normal morphology, as compared with 61.3 ± 3.39% for outside-source bulls (P = 0.04). There were no other detected source group differences at any of these 5 examination times for percentage individual sperm motility or percentage normal morphology (P > 0.27). Concentration (millions of spermatozoa/mL) never differed for the 2 source groups (P > 0.45), but total spermatozoa per ejaculate was greater (P = 0.03) for local bulls (7.7 ± 0.21 million cells) than for outside-source bulls (6.8 ± 0.22 million cells) at 363 d of age. This was reversed at 426 d of age, which approached significance (P = 0.12): 8.5 ± 0.19 million cells for outside-source bulls, and 8.0 ± 0.24 million cells for local-source bulls.

When bulls (n = 24; 12 per source) were placed in single-sire herds with 20 Braford females per herd, the proportions of pregnant cows were 0.85 (170/200) for cows exposed to local bulls and 0.89 (248/280) for cows exposed to outside-source bulls. These did not differ from the χ² expectation (P = 0.25). No source differences were detected for birth weight (P = 0.54) of calves born to these Braford cows. The difference in weaning weights between calves (n = 324) sired by bulls from different sources approached importance (P = 0.15; outside-source and local means were 254 ± 2.3 and 249 ± 2.6 kg, respectively).

**Table 3.** Source means for postweaning weight (kg) of Angus bulls, probability values of F-ratios, and estimates of regression on age in days1,2,3

<table>
<thead>
<tr>
<th>Age, d</th>
<th>Local</th>
<th>Outside</th>
<th>P-value</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>320</td>
<td>229 ± 7.2</td>
<td>250 ± 4.6</td>
<td>0.05</td>
<td>0.8 ± 0.15</td>
</tr>
<tr>
<td>363</td>
<td>298 ± 7.2</td>
<td>318 ± 5.9</td>
<td>0.15</td>
<td>0.9 ± 0.13</td>
</tr>
<tr>
<td>426</td>
<td>351 ± 8.8</td>
<td>372 ± 7.2</td>
<td>0.15</td>
<td>1.0 ± 0.24</td>
</tr>
<tr>
<td>511</td>
<td>408 ± 12.2</td>
<td>437 ± 11.0</td>
<td>0.13</td>
<td>0.9 ± 0.28</td>
</tr>
</tbody>
</table>

1Source of Angus: local bulls (n = 15) were embryos produced from cattle in a Florida research herd that has been mostly closed to outside bloodlines for approximately 60 yr; outside bulls (n = 27) were embryos from a seedstock producer on the Great Plains using popular, modern bloodlines.

2Average age at weaning was 263 d.

3Means were not estimated when source was omitted from models (P > 0.15).

**Table 4.** Source means for scrotal circumference (cm) of Angus bulls, probability values of F-ratios, and estimates of regression on age in days1,2

<table>
<thead>
<tr>
<th>Age, d</th>
<th>Local</th>
<th>Outside</th>
<th>P-value</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>320</td>
<td>29.7 ± 0.60</td>
<td>31.1 ± 0.55</td>
<td>0.34</td>
<td>0.03 ± 0.01</td>
</tr>
<tr>
<td>363</td>
<td>32.3 ± 0.78</td>
<td>34.3 ± 0.75</td>
<td>0.05</td>
<td>0.02 ± 0.01</td>
</tr>
<tr>
<td>426</td>
<td>32.3 ± 0.78</td>
<td>34.3 ± 0.75</td>
<td>0.05</td>
<td>0.02 ± 0.01</td>
</tr>
<tr>
<td>511</td>
<td>33.0 ± 0.70</td>
<td>35.2 ± 0.67</td>
<td>0.02</td>
<td>0.02 ± 0.01</td>
</tr>
</tbody>
</table>

1Source of Angus: local bulls (n = 15) were embryos produced from cattle in a Florida research herd that has been mostly closed to outside bloodlines for approximately 60 yr; outside bulls (n = 27) were embryos from a seedstock producer on the Great Plains using popular, modern bloodlines.

2Means were not estimated when source was omitted from models (P > 0.1).
DISCUSSION

There were no advantages for either source group, evidenced by the few differences detected in this study for traits related to performance or adaptation. This was unexpected because of the visual distinctiveness of the 2 lines. The absence of line differences for many of the traits, including BW, may be influenced by the hot South Florida summer conditions; it could be considered that any size advantage of outside line Angus was negated under those conditions (except for any advantage that might be associated with being taller). However, growth to weaning may be minimally affected by heat tolerance of the calf if the dam is heat tolerant. It is possible that greater nutrition can mask any lack of adaptation in a group (Frisch and Vercoe, 1978). Advantages of the experience of native cattle in a given environment (Bailey et al., 2010) with regard to foraging and diet selection could not be a factor in the present study (unless such experience could be inherited) because both local and outside cattle were born in the environment. The failure to detect differences in tympanic temperature between source groups may be attributed to the decreased BW and body condition of these animals compared with finished cattle groups in which tympanic temperatures were obtained previously (Mader et al., 2002).

Consistent with other work with the Florida line of cattle, outside-source cattle were taller (as indicated by hip height) than cattle of the local Brooksville Angus line (Riley et al., 2007, 2010; and unpublished results for steers on feed). Angus from local sources had greater exit velocity means than those from outside sources, which has been reported as indicative of more nervous or temperamental disposition. It may be possible that long-term handling procedures at the research station may have resulted in indirect selection for animals to move quickly in large groups. There were, however, no source differences in chute temperament score or pen temperament score.

The source difference in age at first conception was very large, with local heifers having a mean age almost 100 d older than outside-source heifers. This is also reflected in the pregnancy rates and calving rates for heifers after their first year of exposure, with outside-source heifers having much larger means than local heifers. The relatively late reproductive success of the local Angus heifers is consistent with age-at-first-conception results (difference of 79 d) in heifers sired by local Angus sires (same source as the local animals in the present study) compared with those sired by outside-source Angus bulls (Riley et al., 2010). Results within this line appeared to be inconsistent with the reputation for early maturation of Angus cattle (e.g., Wiltbank et al., 1966). Reproductive success may be in part dependent upon BW. Consistent with other work with this local line of Angus cattle (Riley et al., 2010), outside-source heifers were heavier than local heifers at 17 mo of age; however, this includes only that subset of heifers that were determined to be open at that time. Bigger differences between these sources for BW were expected. Breeding values for these animals (derived from breed association published expected progeny differences) were −0.76, 2.2, and −2.6 kg for birth, weaning, and yearling weight, respectively, in the local-source group; corresponding values were 2.6, 42, and 75 kg, respectively, for the outside-source group. Inbreeding could be detrimental for traits related to fertility (Burrow, 1998), but was not clearly associated with source differences because the average inbreeding coefficients of animals from the 2 groups were almost the same.

Results related to BW, growth rate, and coat score from the present study were not consistent with most of the results reported in the study that characterized genotype × environment interactions in lines of Hereford cattle originating in Florida and Montana (Butts et al., 1971; Burns et al., 1979; Koger et al., 1979). In that classic work, comparisons of Montana and Florida lines in Florida almost always favored the Florida cattle for those traits measured both pre- and postweaning (Pahnish et al., 1983, 1985). Butts et al. (1971) reported that the Florida line had shorter wither height than the Montana line, which is consistent with height differences reported in the present study. Inconsistency between the studies may be due to tremendous changes in beef cattle production in the United States in the approximately 50 yr that have passed since that work.

Scrotal circumference was greater in the outside-source bulls beginning at an average age of 14 mo. This may be indicative of earlier maturation, faster growth rate, or larger size of the outside-source bulls.

Earlier puberty has been documented in breeds that have been selected for increased milk production (Cundiff et al., 1986; Gregory et al., 1991; Martin et al., 1992); the correlation between age at puberty and milk production in B. taurus breeds was strongly negative (Martin et al., 1992). Udder development is influenced by estrogen produced by the ovary, so selection for heifers (by dairymen) for greater mammary development at young ages favored heifers with precocious ovarian development, and earlier estrogen production and estrogen-associated behavior (L. V. Cundiff, USDA, ARS, Roman L. Hruska Meat Animal Research Center, Clay Center, NE, personal communication). A similar relationship between age at puberty and milk production may exist for different lines within a breed, that is, if 1 of the 2 was selected to some degree for increased milk production. Milk EPD were not available on many animals, but it seems a reasonable assumption that the local-source heifers likely had smaller milk production breeding values than the outside-source group. This enormous difference in reproduction success as young cattle may be a consequence of sampling error, chance, or intended combinations of genotypes, the absence of selective pressure for early calving (for many years the Brooksville herd was managed to calve as 3 yr olds), or even drift and inbreeding within the local group. Alternatively, if the local group could be considered to have
acquired some adaptation to Florida conditions, then one aspect of that adaptation may be later maturity, as is seen in Bos indicus and other types of tropically adapted cattle. Although early maturity and calving at 2 yr of age is viewed as desirable in US beef production systems, especially those using B. taurus cattle (Núñez-Domínguez et al., 1991), there may be advantages for delaying breeding of heifers to older ages in subtropical environments (Morrison et al., 1992), and at one time this was considered even in temperate environments (Cundiff et al., 1974). Results for calving and weaning rate were not consistent with the substantial advantage of the Florida Hereford line relative to the Montana line in pregnancy and weaning rates in both environments, but especially in the subtropical environment (Butts et al., 1971; Koger et al., 1979). Results from the present study for those traits seem to be more related to attainment of early maturity; they could not be considered to be representative of calving or weaning rates as mature cows. Evaluation of lifetime productivity of cows and bulls of both the local and outside sources would clarify adaptation differences of the 2 sources for cow-calf producers in this subtropical environment.

**LITERATURE CITED**


