2012

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Birth and weaning traits in crossbred cattle from Hereford, Angus, Norwegian Red, Swedish Red and White, Wagyu, and Friesian sires[1,2]

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ABSTRACT: The objective of this study was to characterize breeds representing diverse biological types for birth and weaning traits in crossbred cattle (*Bos taurus*). Gestation length, calving difficulty, percentage of unassisted calving, percentage of perinatal survival, percentage of survival from birth to weaning, birth weight, weaning weight, BW at 205 d, and ADG was measured in 1,370 calves born and 1,285 calves weaned. Calves were obtained by mating Hereford, Angus, and MARC III (1/4 Hereford, 1/4 Angus, 1/4 Pinzgauer, and 1/4 Red Poll) mature cows to Hereford or Angus (British breeds), Norwegian Red, Swedish Red and White, Wagyu, and Friesian sires. Calves were born during the spring of 1997 and 1998. Sire breed was significant for gestation length, birth weight, BW at 205 d, and ADG ($P < 0.001$). Offspring from Swedish Red and White and Friesian had the shortest gestation length (282 d), whereas offspring from Wagyu sires had the longest gestation length (286 d). Progeny from British breeds were the heaviest at birth (40.5 kg) and at 205 d (237 kg), and grew faster (0.97 kg/d) than offspring from other breeds. Offspring from Wagyu sires were the lightest at birth (36.3 kg) and at 205 d (214 kg), and had the slowest growth (0.91 kg/d). Dam breed was significant for gestation length ($P < 0.001$), birth weight ($P = 0.009$), BW at 205 d, and ADG ($P < 0.001$). Offspring from Hereford cows had the longest gestation length (284 d), whereas offspring from Angus cows had the shortest (282 d). Offspring from MARC III cows were the heaviest at birth (39.4 kg) when compared with offspring from Hereford (38.2 kg) and Angus (38.6 kg) cows. Progeny from Angus cows were the heaviest at 205 d (235 kg) and grew faster (0.96 kg/d), whereas offspring from Hereford cows were the lightest at 205 d (219 kg) and were the slowest in growth (0.88 kg/d). Sex was significant for gestation length ($P = 0.026$), birth weight, BW at 205 d, and ADG ($P < 0.001$). Male calves had a longer gestation length (284 d) when compared with female calves (283 d). Males were heavier than females at birth and at 205 d, and grew faster. Sire breed effects can be optimized by selection and use of appropriate crossbreeding systems.

Key words: beef cattle, breeds, germplasm, gestation length, growth, survival

J. Anim. Sci. 2012.90:2916–2920
doi:10.2527/jas2011-4694

INTRODUCTION

The Germplasm Evaluation (**GPE**) program at the U.S. Meat Animal Research Center (**USMARC**) has characterized breeds representing several biological types of cattle. Breed differences in performance characteristics are important genetic resources for improving the efficiency of beef production. Diverse breeds can be crossed to exploit heterosis or to match genetic potential with feed resources and potential markets. In the GPE program, birth and weaning traits have been evaluated for Cycles I (Smith et al., 1976), II (Gregory et al., 1978), III (Gregory et al., 1979), IV (Cundiff et al., 1998), and V (Casas et al., 2011).The sixth cycle of this program (Cycle VI) included 2 Scandinavian breeds (Norwegian Red and Swedish Red and White), Friesian (European dual-purpose, with no Holstein inheritance), Wagyu (Japanese Black and Japanese Red), and 2 British breeds (Hereford and Angus). The objective of this study was to characterize breeds representing diverse biological types for birth and weaning traits in crossbred cattle.

[1]Mention of trade name, proprietary product, or specified equipment does not constitute a guarantee or warranty by the USDA and does not imply approval to the exclusion of other products that may be suitable.

[2]The authors thank D. Light (USMARC) for technical assistance, the U.S. Meat Animal Research Center staff for outstanding husbandry and animal care.

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Received September 13, 2011.
Accepted March 2, 2012.

MATERIALS AND METHODS

Experimental procedures were approved and performed in accordance with U.S. Meat Animal Research Center Animal Care Guidelines and the Guide for Care and Use of Agricultural Animals Research and Teachings (FASS, 1999).

Animals

Data were obtained from 1,370 calves born and 1,285 calves weaned at the USMARC. Hereford, Angus, and MARC III (1/4 Hereford, 1/4 Angus, 1/4 Pinzgauer, and 1/4 Red Poll) mature dams (5 to 11 yr of age) were mated by AI to 31 Hereford, 28 Angus, 14 Norwegian Red, 16 Swedish Red and White, 19 Wagyu, and 24 Friesian sires. No purebred Hereford or Angus matings were made to avoid confounding sire breed effects with heterosis effects. Hereford and Angus were treated as 1 sire breed (British).

Dams were maintained on improved pasture from April to November. In April to June and later in September to November, they were maintained on predominantly cool-season smooth bromegrass (*Bromus inermis* Leyss.). In June to September they were maintained on warm-season mixtures of predominantly big bluestem (*Andropogon gerardi* Vitman), switch grass (*Panicum virgatum* L.), Indian grass [*Sorghastrum nutans* (L.) Nash], with some little bluestem [*Schizachyrium scoparium* (Michx.) Nash], sideoats grama [*Bouteloua curtipendula* (Michx.) Torr.], and sand lovegrass [*Eragrostis trichodes* (Nutt.) Alph. Wood]. During December to April, the dams were fed grass and alfalfa (*Medicago sativa* L. subsp. *sativa*) hay [or corn (*Zea mays* L.) silage and alfalfa hay] on pasture. Cows were observed closely for calving difficulty.

Offspring were born during spring of 1997 (n = 751), and 1998 (n = 619), beginning in late March and ending in mid-May. Table 1 shows the number of animals born by breed group and year. Calves were weighed, tattooed, and tagged for identification. Male calves were castrated within 24 h of birth. Calves were creep-fed whole oats (*Avena sativa* L.) from mid-July until weaning in early October. Calves averaged 241 ± 26 d of age at weaning. Table 2 shows the number of animals weaned by breed group and year.

Traits

Traits analyzed included gestation length, calving difficulty, percentage of unassisted calving, percentage of perinatal survival, percentage of survival from birth to weaning, birth and weaning weights, BW at 205 d, and ADG from birth to weaning. Gestation length was calculated as the difference between AI date and birth date. Calving difficulty was scored as 1 = no difficulty, 2 = little difficulty (assistance given by hand), 3 = little difficulty with calf jack, 4 = slight difficulty (assistance given with jack or calf puller), 5 = moderate difficulty (calf jack used), 6 = major difficulty (calf jack used and major difficulty encountered), and 7 = caesarean birth. Calves with abnormal presentation or posture were removed from the study. Percentage of assisted calving included all calves with a calving difficulty score of 2 or greater. Percentage of perinatal survival included calves alive after 3 d of age. Percentage of survival from birth to weaning included calves alive at weaning. Body weights at weaning were adjusted to 205 d by multiplying ADG from birth to weaning by 205 and adding birth weight. Table 3 shows the number of observations, the mean and SD, and minimum and maximum values for each trait.

Table 1. Number of offspring born by sire breed and dam breed in each year

Dam breed	Year	Sire breed[1] British	NR	SRW	Wagyu	Friesian	No. born
Hereford	1997	29	11	17	29	29	115
	1998	28	13	9	23	24	97
Angus	1997	71	26	26	50	54	235
	1998	67	28	29	42	50	216
MARC III[2]	1997	135	34	51	81	100	401
	1998	100	37	39	68	62	306
No. born		430	149	171	301	319	1,370

[1]British = Angus or Hereford. Angus sires were only bred to Hereford cows and Hereford sires were only bred to Angus cows. Both British sire breeds were bred to MARC III cows; NR = Norwegian Red; SRW = Swedish Red and White.

[2]MARC III = 1/4 Hereford, 1/4 Angus, 1/4 Red Poll, and 1/4 Pinzgauer.

Statistical Analysis

Data were analyzed with the MIXED model procedure (SAS Inst. Inc., Cary, NC). The model included the fixed effects of sire breed (British, Norwegian Red, Swedish Red and White, Wagyu, and Friesian), dam breed (Hereford, Angus, or MARC III), and sex (male

Table 2. Number of offspring weaned by sire breed and dam breed in each year

Dam breed	Year	Sire breed[1] British	NR	SRW	Wagyu	Friesian	No. weaned
Hereford	1997	29	11	17	27	29	113
	1998	27	13	9	24	21	94
Angus	1997	68	25	27	58	53	231
	1998	60	25	25	41	43	194
MARC III[2]	1997	128	33	49	80	97	387
	1998	90	28	33	56	59	266
No. weaned		402	135	160	286	302	1,285

[1]British = Angus or Hereford. Angus sires were only bred to Hereford cows and Hereford sires were only bred to Angus cows. Both British sire breeds were bred to MARC III cows; NR = Norwegian Red; SRW = Swedish Red and White.

[2]MARC III = 1/4 Hereford, 1/4 Angus, 1/4 Red Poll, and 1/4 Pinzgauer.

Table 3. Number of observations, mean, SD, minimum, and maximum for the traits studied

Trait	No.	Mean	SD	Minimum	Maximum
Gestation length, d	1,370	283	5	267	299
Calving difficulty[1]	1,370	1.01	0.24	1	7
Unassisted calving, %	1,370	99.5	6.6	0	100
Perinatal survival, %	1,370	96.0	19.5	0	100
Survival birth to weaning, %	1,370	93.1	25.3	0	100
Birth weight, kg	1,370	39.1	4.9	22.7	58.1
BW at 205 d, kg	1,285	230	25	145	303
ADG, kg/d	1,285	0.93	0.11	0.55	1.26

[1]Calving difficulty scores: 1 = no difficulty to 7 = cesarean birth.

or female). The model also included all possible 2-way interactions. The linear and quadratic effect of age of the cow (years of age) at calving and the linear effect of day of year of birth date of the calf were included in the model as covariates. The random effects of sire within sire breed, and birth year were included in the model. The Kenward-Rogers option of the MIXED procedure of SAS was used to ascertain degrees of freedom. Hereford and Angus were treated as 1 sire breed (British), leaving the difference between reciprocal crossbred Hereford × Angus versus Angus × Hereford to be accounted for as part of the sire breed–dam breed interaction. Least squares means and probability values for differences were estimated for significant effects. Probability values were corrected for multiple testing. A Bonferroni adjustment was applied to the probability values using a factor of 9, which is the number of traits analyzed.

Table 4. Levels of significance, least squares means, and SEM for factors affecting gestation length (GL), calving difficulty (CD), unassisted calving (UC), perinatal survival (PS), and survival from birth to weaning (SBW)

	Trait				
Factor	GL, d	CD	UC, %	PS, %	SBW, %
Sire Breed					
Significance	<0.001	0.811	0.797	0.865	0.986
Least squares means					
British	283[b]	1.03	99.3	96.2	93.3
Norwegian Red	283[b]	1.00	100.0	95.4	93.3
Swedish R and W	282[c]	0.99	100.0	95.7	94.2
Wagyu	286[a]	1.01	99.7	96.7	94.4
Friesian	282[c]	1.00	99.9	97.3	93.7
SEM	1.3	0.02	0.6	3.0	3.6
Dam Breed					
Significance	<0.001	0.550	0.569	0.360	0.110
Least square means					
Hereford	284[a]	0.99	100.0	98.5	96.5
Angus	282[b]	1.02	99.6	96.0	94.2
MARC III[1]	283[a]	1.01	99.6	94.3	90.6
SEM	1.3	0.02	0.4	2.8	3.4
Sex					
Significance	0.026	0.315	0.426	0.752	0.871
Least squares means					
Male	284[a]	1.02	99.6	96.4	93.6
Female	283[b]	1.00	99.9	94.3	93.9
SEM	1.3	0.01	0.4	2.7	3.3

[a-c]Within column and factor, means without a common superscript differ ($P < 0.05$).

[1]MARC III = 1/4 Hereford, 1/4 Angus, 1/4 Red Poll, and 1/4 Pinzgauer.

RESULTS AND DISCUSSION

Levels of significance, least squares means, and SE of the means are shown in Tables 4 and 5 for the effects of sire breed, dam breed, and sex on gestation length, calving difficulty score, percentage of unassisted calving, percentage of perinatal survival, percentage survival from birth to weaning, BW at different ages, and ADG. Year of birth was considered a random effect because year effects cannot be predicted to recur in the future, and it is appropriate for producers to make decisions about sire breed and dam breed based on information averaged over the 2 yr.

There was no significant effect ($P > 0.05$) of sire breed, dam breed, or sex, for calving difficulty score, percentage of unassisted calving, percentage of perinatal survival, and percentage survival from birth to weaning. No interaction was significant ($P > 0.05$) for any of the analyzed traits.

Gestation Length

The overall mean for gestation length was 283 d. Table 4 shows a significant effect of sire breed ($P < 0.001$), dam breed ($P < 0.001$), and sex ($P = 0.026$). Animals derived from Wagyu sires had a greater gestation length when compared with animals derived from other sire breeds. Rogers et al. (2002) compared gestation length among reciprocally crossed Angus and Wagyu cattle and found that Wagyu calves had a longer gestation length (288 d) when compared with Angus calves (278 d). This is similar to results from the present study. Numabe et al. (2001) reported a gestation length for Wagyu cattle of 292 d. Oyama et al. (2004) indicate the gestation length for purebred Wagyu cattle is 289 d, which is longer than the gestation length observed in the present study. Wagyu cattle produce offspring with the longest gestation length. Animals derived from Swedish Red and White and Friesian sires had the shortest gestation length. Offspring from British breeds and Norwegian Red had an intermediate gestation length, but closer to the gestation length of offspring from Swedish Red and White and Friesian sires.

Consistent with previous reports (Smith et al., 1976; Gregory et al., 1978, 1979; Cundiff et al., 1998; Casas et al., 2011), gestation length for progeny of Hereford dams was longer ($P < 0.001$) when compared with gestation length for progeny of Angus dams. Progeny of MARC III dams had an intermediate gestation length between

Table 5. Levels of significance, least squares means, and SEM for factors affecting birth weight (BWT), weaning weight (WWT), BW at 205 d (W205D), and ADG

	Trait		
Factor	BWT, kg	W205D, kg	ADG, kg/d
Sire breed			
Significance	<0.001	<0.001	<0.001
Least squares means			
British	40.5[a]	237[a]	0.97[a]
Norwegian Red	38.7[b]	231[b]	0.94[a]
Swedish R and W	38.5[b]	231[b]	0.94[a]
Wagyu	36.3[c]	214[c]	0.87[c]
Friesian	39.7[ab]	227[b]	0.91[b]
SEM	0.8	2	0.01
Dam breed			
Significance	0.009	<0.001	<0.001
Least square means			
Hereford	38.2[a]	219[a]	0.88[a]
Angus	38.6[a]	235[c]	0.96[c]
MARC III[1]	39.4[b]	230[b]	0.93[b]
SEM	0.7	1	0.01
Sex			
Significance	<0.001	<0.001	<0.001
Least squares means			
Male	39.9[a]	234[a]	0.95[a]
Female	37.6[b]	222[b]	0.90[b]
SEM	0.7	1	0.01

[a-c]Within column and factor, means without a common superscript differ ($P < 0.05$).

[1]MARC III = 1/4 Hereford, 1/4 Angus, 1/4 Red Poll, and 1/4 Pinzgauer.

progeny of Hereford and Angus cows. Gestation length was previously reported for offspring of MARC III cows (Casas et al., 2011).

Male calves averaged 1 d longer gestation lengths than female calves. This result is similar to studies from Smith et al. (1976), who found differences of 1.7 d; Gregory et al. (1978), who reported differences of 1.3 d; Gregory et al. (1979), who reported differences of 2 d; Cundiff et al. (1998), who reported differences of 1.8 d; and Casas et al. (2011), who reported differences of 1 d.

Birth Weight

Effects of sire breed were significant for birth weight (Table 5). Offspring derived from Wagyu sires were the lightest at birth. The heaviest calves were produced by British breed sires, although they were not significantly different ($P > 0.05$) from calves produced from Friesian sires. Offspring from Norwegian Red and Swedish Red and White sires had similar birth weight ($P > 0.05$) than offspring from Friesian sires. Rogers et al (2002) found that Angus calves were heavier (37.9 kg) than Wagyu calves (31.0 kg). Numabe et al. (2001) produced Wagyu calves in vitro and in vivo. Calves produced in vitro had an average birth weight of 31 kg, whereas calves produced in vivo were lighter (27 kg). Similarly, Aziz et al. (2005), indicate that birth weight for Wagyu cattle has a mean of 27 kg.

Calves from MARC III cows were heavier at birth than progeny from Hereford or Angus cows. No difference in birth weight was observed between calves from Hereford or Angus cows. Smith et al. (1976), Gregory et al. (1978, 1979), and Cundiff et al. (1998) indicated that calves from Hereford cows were heavier at birth than calves from Angus cows. The difference in birth weight for progeny from MARC III cows and Hereford and Angus cows could be explained by retained heterosis in the composite breed (Gregory et al., 1991).

Male calves were heavier ($P < 0.001$) at birth than female calves. Difference between males and females was 2.3 kg. Birth weight differences between the sexes are usually detected (Bellows et al., 1996; Cundiff et al., 1998; Chase et al., 2000; Holloway et al., 2002; Riley et al., 2007; Casas et al., 2011).

Body Weight at 205 days and Average Daily Gain

Table 5 shows the least squares means for weaning and 205 d BW, and ADG. Sire breed, dam breed, and sex were significant ($P < 0.001$) sources of variation for all traits.

Progeny from British breeds were the heaviest at 205 d, whereas offspring derived from Wagyu sires were the lightest. Rogers et al. (2002), when comparing reciprocal crosses between Angus and Wagyu cattle, indicated that Angus calves were heavier at weaning (220 kg) when compared with Wagyu calves (196 kg). The results from this study corroborate that offspring from Wagyu sires produce lighter calves at 205 d.

Offspring from Norwegian Red, Swedish Red and White, and Friesian had similar weaning weight among them. The weaning weight of calves produced by these sire breeds was intermediate between offspring of British breeds and Wagyu sires.

Offspring from British breeds, Norwegian Red, and Swedish Red and White sires had similar growth, but grew faster ($P < 0.001$) than offspring from Friesian and Wagyu sires. Offspring from Friesian sires had an intermediate growth. Calves produced by Wagyu sires had the slowest growth. Rogers et al. (2002) compared pre-weaning ADG between Angus and Wagyu. Angus calves grew faster (1.07 kg/d) than offspring with Wagyu inheritance (0.86 kg/d). Results from the study by Rogers et al. (2002) are similar than those found in the present study.

Progeny from Angus cows were heavier ($P < 0.001$) at 205 d, and had faster growth. Offspring from Hereford cows were the lightest at weaning, at 205 d, with the slowest growth. Calves from MARC III cows were intermediate. A similar result was reported by Casas et al. (2011), when comparing growth performance of calves produced by Angus, Hereford, and MARC III cows.

Herring et al. (1996) found that calves from Angus cows were heavier at weaning when compared with progeny from Hereford cows. Gregory et al. (1979) indicated that Angus cows produced heavier calves at 205 d when compared with Hereford cows. Results from these studies are similar to those found in the present study.

Male calves are heavier at 205 d, with fastest growth when compared with females. This has been previously observed by Herring et al. (1996), Chase et al. (2000), Riley et al. (2007), and Casas et al. (2011).

Significant differences exist among crossbred progeny derived from British breeds, Norwegian Red, Swedish Red and White, Friesian and Wagyu sires for gestation length, birth weight, and ADG from birth to weaning. The use of breeds such as Norwegian Red, Swedish Red and White, and Friesian could be a suitable alternative to the use of British breeds in cow-calf operations. This is due to similar gestation length, calving difficulty, percentage of unassisted calving, perinatal survival, and survival from birth to weaning than British breeds. Calves from Friesian sires have similar birth weight than calves from British breeds. Calves from Norwegian Red, and Swedish Red and White have similar ADG than calves derived from British breed sires. Breed differences can be exploited to optimize performance in crosses or in composite populations relatively more quickly than performance can be optimized by intra-population selection.

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