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1993

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Larry V. Cundiff

U.S. Meat Animal Research Center, Larry.Cundiff@ars.usda.gov

Keith E. Gregory

U.S. Meat Animal Research Center

Robert M. Koch

University of Nebraska-Lincoln, rkoch1@unl.edu

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Cundiff, Larry V.; Gregory, Keith E.; and Koch, Robert M., "Cycle V of the Germplasm Evaluation (GPE) Program in Beef Cattle" (1993). *Roman L. Hruska U.S. Meat Animal Research Center*. 123.
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Cycle V of the Germplasm Evaluation (GPE) Program in Beef Cattle

Larry V. Cundiff, Keith E. Gregory, and Robert M. Koch¹

Introduction

Results from the first four cycles of the Germplasm Evaluation (GPE) Program at MARC demonstrated that vast genetic variation exists among and within breeds for most bioeconomic traits in beef cattle. The range for differences between breeds was comparable in magnitude to the range in breeding value of individuals within breeds for most traits. Thus, significant genetic change can result from selection both between and within breeds. Breeds can be selected to optimize performance levels for important bioeconomic traits with a high level of precision much more quickly than intrapopulation selection.

No single breed or biological type excels in all traits important in beef production. Breeds with the greatest retail product growth potential excel in gain per unit feed consumed to wt and time endpoints; however, they also 1) sire progeny with heavier birth wt and increased calving difficulty; 2) produce carcasses with lower levels of marbling; 3) tend to be older at puberty if milk production has not been emphasized in their selection history; and 4) have heavier mature wt increasing nutrient requirements for maintenance. Use of crossbreeding systems that exploit complementarity by terminal crossing of sire breeds noted for lean tissue growth efficiency with crossbred cows with optimum size, milk production and adaptation to the feed and climatic environment provide the most effective means of managing these trade-offs.

Results from Cycle IV of the GPE program demonstrated that breeds that have been selected for muscular hyperplasia (i.e., double muscling) may be an appropriate choice as a terminal sire breed to produce progeny (all steers and heifers would be slaughtered) suited for markets targeting lean-low caloric beef products. Piedmontese crosses ranked eighth (comparable to original Hereford Angus crosses) among the 11 breed groups in final wt, but ranked second to Charolais in wt of totally trimmed (0 mm) retail product due to exceptional dressing percentage and significantly higher retail product percentages than other breeds. Marbling was low in Piedmontese crosses, but estimates of meat tenderness were relatively high. Belgian Blue, another breed that has been selected for muscular hyperplasia, will be evaluated in Cycle V of the GPE program.

Bos indicus X *Bos taurus* crosses were exceptionally productive and efficient cows. A cooperative experiment conducted jointly at MARC and the Subtropical Agricultural Research Station, Brooksville, FL revealed that advantages of *Bos indicus* X *Bos taurus* cross cows over *Bos taurus* X *Bos taurus* cross cows were even greater under subtropical climatic conditions than under temperate climatic conditions. However, the advantages of *Bos indicus* crosses were tempered by increased birth wt and calving difficulty when *Bos indicus* bulls were mated to *Bos taurus* females, older age at puberty, increased mortality when born in colder seasons in temperate areas and reduced meat tenderness as the proportion of *Bos indicus* inheritance increased. In Cycle V, tropically adapted breeds that have evolved separately for at least 2,000 yr from European *Bos taurus* breeds and Asian *Bos indicus* breeds will be sampled and evaluated.

Specific objectives are to determine whether the earlier age at puberty and increased meat tenderness characteristic of *Bos taurus* germplasm has been retained or has shifted to levels characteristic of *Bos indicus* germplasm in response to selection for adaptation to tropical conditions.

Procedure

The GPE program has been conducted in five cycles. Table 1 shows the mating plan for each cycle. In Cycle V, as in previous cycles of the program, the base cows include Angus (about 500) and Hereford (about 350) cows calving at 4 yr of age or older. In addition, about 550 composite MARC III (1/4 Angus, 1/4 Hereford, 1/4 Pinzgauer and 1/4 Red Poll) cows calving at 4 yr of age or older are included in Cycle V. The cows are being mated to produce F₁ crosses by the following sire breeds.

Hereford and Angus. Semen from polled and horned Hereford bulls and from Angus bulls is being used to produce F₁ cross progeny. Hereford-Angus reciprocal crosses have been used as a reference breed throughout the GPE program to facilitate pooling of data and comparison of breeds in different cycles. More than 30 bulls of each breed, some of which were included in Cycle IV (born from 1982-1984) and others born since 1988, are being used in Cycle V.

Tuli. The Tuli, a Sanga type of cattle (non humped), are believed to trace to crosses between original humpless longhorn types (*Bos taurus*) that were present in northern Africa and humped types (*Bos indicus*) first introduced into Africa from southwest Asia about 3,000 to 5,000 yr ago. The Tuli breed was developed relatively recently in a research program initiated in the 1940's using foundation cattle considered to be the most productive type selected from indigenous Tswana cattle in Zimbabwe. Australian scientists at CSIRO, Tropical Agricultural Research Station, Rockhampton, Queensland, and a consortium of private breeders in Australia imported frozen Tuli embryos from Zimbabwe into Australia in 1990. Semen from nine Tuli bulls has been imported into the U.S. from CSIRO and the consortium of private breeders through an export facility approved by the USDA Animal Plant Health Inspection Service maintained by the Victoria Artificial Breeders Cooperative (VAB) in Australia.

Boran. The Boran was also imported along with the Tuli into Australia from East Africa (Zambia). Borans are a pure zebu breed (*Bos indicus*, humped) that evolved in southern Ethiopia and are believed to have been developed for milk and meat production under stressful tropical conditions. They are believed to have originated from *Bos indicus* cattle imported into Africa about 1,300 to 1,500 yr ago. Semen from eight Boran bulls has been imported into the U.S. from VAB for the experiment.

Belgian Blue. Belgian Blue cattle originate in Belgium. Muscle hyperplasia (double muscling) has been favored for at least 40 yr by Belgian Blue breeders in Belgium. Semen from 26 bulls is being used in the experiment.

Brahman. Semen from a current broad sample of at least 30 Brahman (Grey and Red) bulls will be used to produce F₁ progeny. Semen will also be used from sires sampled in

¹Cundiff is the research leader, Genetics and Breeding Research Unit, MARC; Gregory is a research geneticist, Genetics and Breeding Research Unit, MARC; Koch is a professor emeritus of animal science, University of Nebraska-Lincoln.

Cycle III of the GPE program (bulls produced in the early 1970's) to facilitate pooling of data and to estimate genetic trends in the breed.

Piedmontese. Piedmontese originate in the Piedmont region of northern Italy. Seventeen Piedmontese sires included in Cycle IV of the program are being repeated to produce one calf crop (1992) in Cycle V.

Calves will be produced in the spring of 1992, 1993 and 1994. At least 100 male and 100 female progeny will be managed following the same experimental procedures as have been used throughout the GPE program. In addition, matings have been made to provide sufficient progeny for intensive nutrition, carcass and meats, reproductive, and biological engineering research studies at MARC.

To evaluate the tropically adapted breeds in subtropical regions of the U.S., cooperative experiments are being conducted at research stations in Oklahoma, Georgia, Florida and three locations in Texas. The mating plans for each location are shown in Table 2.

Results

Preliminary data for calving traits in the first of three calf crops are shown in Table 3. Significant differences were observed among sire breeds for gestation length and birth

wt. Differences in calving ease are not significant at this point in the experiment.

As in earlier cycles of the program, progeny of Brahman sires had significantly longer gestation length and heavier birth wt than progeny of Hereford and Angus sires. Progeny of Boran sires, like those sired by Brahman and by other *Bos indicus* breeds reported previously (i.e., Nellore and Sahiwal) had relatively long gestation lengths and heavy birth wt. Progeny of Tuli sires had relatively long gestation length, but significantly lighter birth wt than progeny of any other sire breed. Progeny of Belgian Blue sires had relatively short gestation length, similar to progeny of Hereford and Angus sires. Birth wt of progeny by Piedmontese and Belgian Blue sires ranked between those sired by Hereford and Angus sires. Progeny of Hereford sires tended to have longer gestation length and heavier wt at birth than those by Angus sires.

The 200-day weaning wt of progeny by Brahman sires were significantly heavier than those by Boran and Tuli sires. The relatively heavy 200-day weaning wt of Hereford and Angus sired progeny reflect continuing strong genetic trends for growth rate in these breeds. Belgian Blue sired progeny tended to be heavier than Piedmontese sired progeny in 200-day weaning wt.

Table 1—Sire breeds used in Germplasm Evaluation program at MARC

Cycle I (1970-72)	Cycle II (1973-74)	Cycle III (1975-76)	Cycle IV (1986-90)	Cycle V (1992-94)
F₁ crosses from Hereford or Angus dams (Phase 2)^a				
Hereford	Hereford	Hereford	Hereford	Hereford
Angus	Angus	Angus	Angus	Angus
Jersey	Red Poll	Brahman	Longhorn	Tuli
S. Devon	Brown Swiss	Sahiwal	Salers	Boran
Limousin	Gelbvieh	Pinzgauer	Galloway	Belgian Blue
Simmental	Maine Anjou	Tarentaise	Nellore	Brahman
Charolais	Chianina		Shorthorn	Piedmontese
			Piedmontese	
			Charolais	
			Gelbvieh	
			Pinzgauer	
3-way crosses out of F₁ dams (Phase 3)				
Hereford	Hereford			
Angus	Angus			
Brahman	Brangus			
Devon	Santa Gertrudis			
Holstein				

^a In Cycle V, composite MARC III (1/4 Angus, 1/4 Hereford, 1/4 Pinzgauer and 1/4 Red Poll) cows are also included.

Table 2—Mating plans for evaluation of tropically adapted breeds by location.

Location ^a	Breed of dam ^b	Sire breeds				
		Tuli	Boran	Brahman	Hereford	Angus
MARC, NE	H, A, III	X	X	X	X	X
STARS, FL	A	X		X		
El Reno, OK	HA, A	X	X	X		
Uvalde, TX	A	X		X		
Overton, TX	Bm, A	X		X		X
McGregor, TX	H, A	X	X	X		
Tifton, GA	Crosses	X		X	X	X

^a Location: MARC denotes the Roman L. Hruska U.S. Meat Animal Research Center, ARS, USDA, in cooperation with the University of Nebraska, Clay Center, Nebraska; STARS denotes the Subtropical Agricultural Research Station, ARS, USDA in Cooperation with the University of Florida, Brooksville, Florida; FRLR denotes the Forage and Livestock Research Laboratory, ARS, USDA in Cooperation with Oklahoma State University, El Reno, Oklahoma; Uvalde, Overton and McGregor denote Texas A & M University, Texas Agricultural Experiment Station, Agricultural Research and Extension Centers at Uvalde, Overton and McGregor, Texas; and Tifton denotes the Coastal Plain Station, Georgia Agricultural Experiment Station, Tifton, Georgia.

^b A = Angus, H = Hereford, III = Composite MARC III (1/4 Angus, 1/4 Hereford, 1/4 Red Poll, 1/4 Pinzgauer), HA = Angus - Hereford crosses or the reciprocal cross, Bm = Brahman, crosses = rotational crosses of Hereford, Angus and Santa Gertrudis.

Table 3—Breed group means for preweaning traits (preliminary data, 1992 calf crop).

Sire breed of calf	No. calves born	Gestation length days	Calvings unassisted %	Birth wt lb	200-day wean wt lb
Hereford	76	286.3	97.4	99.5	543
Angus	47	284.6	96.1	94.4	522
Tuli	144	291.0	97.9	88.7	496
Boran	125	293.3	95.4	100.7	513
Brahman	136	292.6	92.1	105.6	536
Belgian Blue	135	285.8	94.6	97.7	527
Piedmontese	145	289.9	96.1	96.7	511