Cattle Germplasm Evaluation and Germplasm Utilization Programs at MARC

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Breed differences in performance characteristics are an important genetic resource for improving efficiency of beef production. Diverse breeds are required to exploit heterosis and complementarity through crossbreeding and new composite breeds and to match genetic potential with diverse markets, feed resources and climates. This session was organized to review results from the ongoing Germplasm Evaluation (GPE) Program and the Germplasm Utilization (GPU) Program with cattle at the Roman L. Hruska U.S. Meat Animal Research Center, Clay Center.

Germplasm Evaluation Program

Two F_1 cross steers sired by each of the Tuli, Boran, Brahman, Belgian Blue and Piedmontese breeds were displayed. Pertinent results from previous cycles of the program leading to the current evaluations were reviewed and preliminary data from the first of three calf crops to be produced in Cycle V were discussed.

Tropically Adapted Breeds

To match genetic potential with the climatic environment, it is important for cows to include 25% to 50% of their inheritance from tropically adapted sources of germplasm in the Southern region of the U.S. Bos indicus breeds such as the Brahman, Nellore and Sahiwal have been an excellent source of germplasm for this purpose; however, their advantages have been tempered by older age at puberty and reduced meat tenderness. In Cycle V, Boran and Tuli crosses are being compared to Brahman crosses to characterize bioeconomic traits, including age at puberty and carcass and meat characteristics.

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 years 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.

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 years ago.

Australian scientists at CSIRO, Tropical Agricultural Research Station, Rockhampton, Queensland, and a consortium of private breeders in Australia imported frozen Tuli embryos from Zimbabwe and frozen Boran embryos from Zambia into Australia in 1990. Semen from nine Tuli and eight Boran bulls has been imported into the U.S. from Australia for use in the GPE Program. To evaluate the tropically adapted breeds in subtropical regions of the U.S., the program is being conducted cooperatively with experiment stations in Oklahoma, Georgia, Florida and three locations in Texas. Semen from the same sires are being used on Tuli and Brahman cows at all locations and the Boran are included at one station each in Texas, Oklahoma and Nebraska.

Heavy Muscled Breeds

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 weight, but ranked second to Charolais in weight 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, originating in Belgium, another breed that has been selected for muscular hyperplasia for at least 40 years, are being evaluated relative to Piedmontese and Hereford and Angus crosses in Cycle V of the GPE Program.

Germplasm Utilization Program

Retained heterosis was evaluated for the full spectrum of bioeconomic traits to 1) evaluate composite breeds as an alternative breeding system for using heterosis, and 2) evalu-

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ate composite breeds as a procedure to use breed differences to achieve and maintain optimum performance levels for major bioeconomic traits such as, a) growth rate and size, b) age at puberty, c) maternal traits including milk production, and d) carcass and meat traits. Breed effects were evaluated in the nine parental breeds (Red Poll [R], Hereford [H], Angus [A], Limousin [L], Braunvieh [B], Pinzgauer [P], Gelbvieh [G], Simmental [S], and Charolais [C]) that contributed to the three composite populations (MARC I = 1/4 B, 1/4 C, 1/4 L, 1/8 H, 1/8 A; MARC II = 1/4 G, 1/4 S, 1/4 H, 1/4 A; and MARC III = 1/4 R, 1/4 P, 1/4 H, 1/4 A).

Two steers each from composite population MARC I, MARC II and MARC III were displayed. Results from the project were presented and discussed, emphasizing recently completed experiments on carcass and meat characteristics.

Summary of Results

Rationale for Development of Composite Breeds

1. Heterosis (hybrid vigor) for major bioeconomic traits including reproduction, calf survival, maternal ability, growth rate and longevity of beef cattle is important. Heterosis can be used to increase weight of calf weaned per cow exposed to breeding by 20%.

2. Large differences exist among breeds of beef cattle for major bioeconomic traits including growth rate and size, composition of gain, milk production, dystocia, age at puberty and climatic and nutritive adaptability.

3. About 55% of the cows in the U.S. beef breeding herd are in units of 100 or fewer cows. This involves about 93% of the farms and ranches that have beef cows.

4. Crossbreeding systems may be used to achieve high levels of heterosis. However, optimum crossbreeding systems are difficult to adapt in herds that use fewer than four bulls.

5. Fluctuation in breed composition between generations in rotation crossbreeding systems can result in considerable variation among cows and calves in level of performance for major bioeconomic traits unless breeds used in the rotation are similar in performance characteristics.

6. Use of breeds with similar performance characteristics restricts the use that can be made of breed differences in average genetic merit for bioeconomic traits. This includes traits such as: (a) growth rate and size, (b) carcass composition, (c) milk yield, and (d) age at puberty.

7. Composite breeds offer opportunity to: (a) use high levels of heterosis on a continuing basis if population size in seedstock herds is sufficiently large to avoid inbreeding, (b) achieve and maintain optimum breed (additive genetic) composition needed to match performance characteristics of the composite breeds to each of a wide range of production situations and to different market requirements, and (c) achieve and maintain uniform performance levels from one generation to the next.

Conclusions from Experimental Results

1. Generally, high levels of heterosis were observed for growth rate, reproduction and maternal traits including milk production.

2. Heterosis differed among composite populations for some major bioeconomic traits. Results suggest that specific cross heterosis may be important; i.e., level of heterosis for some traits may vary among specific breed crosses.

3. Generally, retained heterosis in advanced generations was equal to, or greater, than expectation based on retained heterozygosity in the three composite populations.

4. Results suggest that although there is, generally, a high relationship between retained heterosis and retained heterozygosity, the relationship is not linear for all situations; i.e., for some traits and in some breed combinations, retained heterosis *may be greater* or *may be less* than expectation based on retained heterozygosity.

5. Even though results suggest that specific cross heterosis may be of some importance, it is not feasible to have estimates of F_1 heterosis and of heterosis retained in advanced generations of a large number of specific breed combinations in order to choose breeds as contributors to specific composite populations (breeds). Thus, use of *average* values for F_1 heterosis and of retained heterosis in advanced generations of *inter sè* mated composite populations is suggested.

6. These results, generally, support the hypothesis that heterosis in cattle is primarily due to dominance effects of genes. Thus, heterosis in breed crosses can be accounted for as recovery of accumulated inbreeding depression that has occurred in breeds since their formation.

7. Estimates of heritability and phenotypic standard deviations were similar for parental purebreds combined and for composite populations combined for most bioeconomic traits. Thus, increased genetic variation that may be expected in composite populations relative to contributing purebreeds was not observed.

8. Composite populations (breeds) offer an alternative breeding system that is *generally* competitive with crossbreeding for using heterosis and is easier to manage regardless of size of herd.

9. Composite populations (breeds) offer a procedure that is more effective than continuous crossbreeding for using genetic differences among breeds to achieve and maintain *optimum* performance levels for major bioeconomic traits on a continuing basis. This includes traits such as: (a) growth rate and size, (b) composition of gain, (c) milk production, (d) climatic and nutritive adaptability, and (e) age at puberty.

10. Large differences among parental breeds were observed for: a) growth rate and size, b) dystocia, c) age at puberty and scrotal circumference, d) maternal traits including milk production, and e) carcass and meat traits.

11. Composites were generally intermediate to parental breeds for carcass composition and more closely approached the *optimum* carcass composition; e.g., Hereford, Angus and Red Poll had more carcass fat than is *optimum* while the continental breeds tended to have less carcass fat than is optimum to meet current market requirements.