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Introduction

Matching germplasm to resources through designed crossbreeding programs can contribute to optimum beef production efficiency. This is particularly true in light of the wide diversity of environmental conditions encountered by beef producers in the U.S. This approach requires considerable knowledge about genetic diversity among breeds in components of performance and furthermore how those components interact to influence life-cycle efficiency in the production setting. It was largely this identified need, coupled with the importation of a number of new breeds from continental Europe, that gave impetus for the establishment of the Germplasm Evaluation (GPE) Program. In Cycles I and II of the GPE program, increases in cow output associated with higher breed potential for growth rate and milk production were largely offset by equivalent or greater increases in feed requirements for maintenance and lactation. Additionally, in Cycle III, output of calf weaned per cow in the breeding herd was high for *Bos indicus* x *Bos taurus* crosses relative to *Bos taurus* crosses. More information is needed to evaluate F$_1$ cross of *Bos taurus* versus *Bos indicus* x *Bos taurus* sources of germplasm. Therefore, this study was conducted to: 1) estimate input/output components, and 2) estimate life-cycle efficiency of Cycle III breeds representing these types of F$_1$ cross females.

Procedures

This study was conducted in two phases. The first phase was experimental while the second was modeling in nature. Procedures used are given, in brief, for each phase separately. Both phases involved the study of breed groups of cows resulting from the mating of Hereford (H) or Angus (A) cows to Brahman (Bm-X), H or A (HA-X), Pinzgauer (Pz-X) or Sahiwal (Sw-X) sires.

Phase 1. This phase of the study was designed to estimate all inputs and outputs of F1-cross females during an 18 wk drylotted period while the females were open and nursing calves. Calves were sired by Charolais sires and were born during late March to early May of 1987. Cows and calves were moved to the feedlot at approximately 40 days after calving and were assigned to replicated pens (3 pens/breed group) with 12 pairs per pen (breed of dam of cow, sex of calf and age of calf were balanced within pen). Most cows were 11 or 12 yr of age with a few seven-yr olds included in the Pz-X group. Cows were fed to maintain their initial wt for 126 days commencing at approximately 50 days postpartum. Cow and calf wt were recorded biweekly. If avg pen wt was reduced below the initial wt, feed was increased or visa versa. The avg biweekly daily metabolizable energy (ME) consumption for each pen of cows was adjusted statistically to zero biweekly wt change using regression procedures (based on linear regression of mean daily wt change on mean daily ME consumption for 10 biweekly periods in each pen). The cow diet included corn silage (77%), ground brome hay (19%) and a supplement

(4%) which included soybean meal, limestone, dicalcium phosphate, vitamins, aureomycin and trace mineral premix. Calves were allowed access to creep feed (whole oats) but not to dam feed. Creep feed consumption was recorded on biweekly intervals. Milk production was estimated by weigh-suckle-weigh procedures at four times during the study (corresponding to 58, 85, 125 and 160 days of lactation) as well as on a group of 44 cow-calf pairs representing the same breed-cross groups in 1986. Lactation curves and curve parameters were used to estimate daily and total milk yield. Fat thickness and visual condition scores were also assessed at the beginning and end of the experimental period to monitor changes in body composition.

Phase II. The second phase of the study involved development of a deterministic computer model to allow estimation of life-cycle efficiency of these breed groups when used in a totally contained breeding system. The system modeled was one of F$_1$ cross cows bred to Red Poll sires for their first calving as two-yr olds and Simmental sires thereafter. Replacement females were produced in the system. Input and output avg for each subclass of a herd of females made up of the Cycle III breed groups were utilized from the Phase I results, or were obtained from a pooled analysis of data from females produced in Cycles I-III. Energy inputs for maintenance, lactation, pregnancy and female growth were modeled based on Phase I results and avg literature estimates. Herd age distributions were derived from GPE data to 11 yr of age. Weather and environmental conditions were included as model parameters. Final model computations resulted in total herd life-cycle efficiency calculated as:

$$TVALEFF = \frac{(cow + calf\ input,\ Mcal)}{(weaned\ calf + .55 \times cull\ cow\ output,\ lb)}$$

Results

Results from the Phase I experiment are presented in Table 1. Overall avg are given for calf gain, creep feed energy consumption, cow wt, fat thickness, daily milk yield and total energy consumption and overall biological efficiency during the 126-day period. Performance for each breed-cross group is presented as a ratio relative to the overall mean (i.e., a ratio of 112 for progeny energy consumption from HA-X dams indicates that calves in that group consumed 12% more creep ME than the overall avg of 592.2 Mcal ME during the 126 days).

Calf gain relative to cow wt was significantly higher for Bm-X and Sw-X groups than for Pz-X and HA-X groups. Calf creep consumption was inversely related to levels of milk production with the exception of the Pz-X group. This appeared to be due to a lower level of persistency of lactation of this breed group resulting in calves consuming larger amounts of creep feed than other groups late in the study.

Significant differences (P < .01) existed between F$_1$-cross groups in cow size, milk yield and level of fatness. Bm-X cows were the largest and gave the highest daily milk yield. Sw-X females were similar to Bm-X in milk yield and level of fatness but were significantly smaller in mature size. Pz-X cows were intermediate in milk yield and mature size and were similar to those from the HA-X group in level of fatness. HA-X cows were the smallest in size of the four groups and gave the lowest amount of milk per day.

When inputs and outputs were combined into an estimate of biological energy efficiency (lb calf/gain/total ME intake of cow and calf) for this portion of the annual production cycle, Sw-X and Bm-X breed-cross groups were approximately10% more efficient. This was a function of several factors including lower energy requirements per unit of mature size for the cows and lower creep feed energy consumption with higher wt gains of progeny. In the case of the Sw-X group, breed size complementarity from mating of Charolais sires to smaller mature size females also may have given this group an advantage.

These results are somewhat in contrast to those found in similar work from Cycle II of the GPE program. In that study, efficiency results generally favored smaller mature size females due to increases in calf gain from larger mature size and higher milk levels being offset by increased energy consumption required to support that level of performance. The different results of this study are most likely due to 2-3 times higher levels of heterosis generally observed in *Bos indicus* x *Bos taurus* crosses than in *Bos taurus* crosses. This would have given a distinct advantage in components of efficiency to the Sw-X and Bm-X groups. Additionally, any heterosis advantage from increased longevity would have favored the two *Bos indicus-X* groups since these females were 11-12 yr old during the study (as compared to 7-8 in Cycle II).

When results from Phase I and other results from previous components of the GPE program were combined to model life-cycle efficiency of these breed groups, ranking for TVALEFF (Mcal/lb equivalent) was the same as observed in Phase I but differences between the breed groups were narrowed (20.9, 21.6, 22.5, 22.6 Mcal/kg equivalent for Sw-X, Bm-X, Pz-X and HA-X groups, respectively. There still appeared to be an approximate 6% advantage in efficiency for the two *Bos indicus-X* groups over this *Bos taurus-X* counterparts after accounting for all inputs and outputs of the system. This is practically significant given that this system was modeled under conditions (south central Nebraska) to which these breed groups are not naturally adapted and indicates the seeming importance of advantages offered from additional heterosis gained in *Bos indicus* x *Bos taurus* crosses.

Results from this study indicate favorable potential for use of *Bos indicus* germplasm in designed crossbreeding programs in the more temperate regions of the U.S. It is important to note that these results are applicable to cow-calf production systems to a weaning endpoint but may change if evaluated on a slaughter basis from any price differential in carcass value from *Bos indicus-X* relative to *Bos taurus-X* calves or differential feedlot performance between the two.

Table 1—Output/input of differences among F_1 cows of diverse biological type

Item	Overall mean	Breed group[a]			
		HA-X	Bm-X	Sw-X	Pz-X
Progeny (126 days)					
Wt gain, lb	284.3	92	108	103	99
Energy consumed, Mcal ME[a]	592.2	112	92	94	102
Dams (126 days)					
Milk prod., lb/d	15.5	90	105	101	103
Cow wt, lb	1,236	98	105	97	100
Fat probe, in	.31	91	102	112	95
Energy consumed, Mcal ME	3,292	93	106	97	104
Efficiency (126 days)					
Progeny gain, lb/Mcal ME intake by cow and calf	.073	95	104	106	95

[a] Ratio percentages computed relative to overall mean where HA-X = Hereford or Angus, Bm-X = Brahman, Sw-X = Sahiwal and Pz-X = Pinzgauer sired F1 crosses out of Hereford and Angus dams.