



Impacts of Crossbreeding

on Profitability in Vertically Coordinated Beef Industry Marketing Systems

Final Report

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Executive Summary

Project outline

- 400 Angus-based cows were randomly mated to 10 Hereford and 10 Angus bulls under typical Western range extensive conditions in year one of a three-year project. In years two and three the project was expanded to include 600 cows and 15 bulls of each breed. As much as possible, bulls that were above average for the major expected progeny differences (EPDs) of each breed were purchased, based on criteria provided by Lacey Livestock (ranch owners).
- The project was conducted as a “field trial” under real-world conditions, not as a traditional controlled research project.
- DNA samples were collected on all calves and only those cattle that could be traced to a single sire were used in the analysis.
- The hypothesis of the study was that we would anticipate a slight economic advantage to performance in the feedlot phase, while reducing quality grade to some degree. The expectation was that the true value of crossbreeding would be particularly manifested with maternal heterosis (the crossbred cow).



General conclusions

- 297 Angus-sired steers and 284 Hereford-sired steers were included in the final analysis.
- Preweaning performance had a slight but consistent advantage for Hereford-sired calves (approximately 10 lb. and \$12 per head).
- Backgrounding performance had a slight but consistent advantage for Hereford-sired calves (approximately 10 lb. and \$12 per head).
- Average daily gain (ADG) in the feedlot favored the Hereford-sired calves in two of the three years, and there was a very slight overall advantage to the Hereford-sired calves.
- Feed conversion (as fed and dry matter) had a consistent and marked advantage for Hereford-sired calves in comparison to the predominantly straightbred Angus.
- Cost of gain had a consistent and marked advantage for Hereford-sired calves in comparison to the predominantly straightbred Angus.
- Morbidity was close to equivalent for both breed groups with lower morbidity for the Hereford-sired calves in two of the three years.
- Quality grade consistently favored the Angus group for all three years.
- There were essentially no differences in carcass weight or yield of both sire groups.
- There were essentially no differences in percentage yield grades 4 or 5 between the sire groups. Hereford-sired calves had more yield grade 4/5 in year one and Angus-sired calves had more yield grade 4/5 in years two and three.
- Economic performance favored Hereford-sired calves in the feedlot in two of the three years, with an average return of approximately \$30 per head.
- Carcass performance favored the Angus-sired calves in all three years, with an average return of \$15.60 per head.
- Overall net return for the Hereford-sired calves was approximately \$30 per head in a vertically coordinated beef marketing system, this does not include the maternal advantages of the baldie female.
- Pregnancy rates for Hereford-sired females (black baldies) averaged 7% higher than those of the Angus-sired heifers.





Abstract

Vertically coordinated beef marketing systems (alliances and partnerships) have become breed specific, generally Angus, in an effort to improve quality grade and tenderness and focus on the consumer. However, by so doing, the value of crossbreeding (heterosis) has been diminished, particularly at the cow-calf level. The primary objective of this project was to measure the effect of controlled crossbreeding in range environments on predominantly Angus-based females. By determining the value of heterosis to beef cattle alliances, cattle breeding systems in the U.S. have the potential to be significantly modified to utilize systematic, controlled crossbreeding programs.

In year one, 10 Hereford bulls, selected for specific genetic parameters (EPDs) were matched with 10 Angus bulls of comparable genetics. Bulls were randomly mated to 400 mature Angus-based cows. In year two and three, 15 bulls of each breed were randomly mated to 600 cows. All cattle (cows and calves) were identified with electronic ear tags, and DNA samples were taken on all sires and calves to determine parentage.



All cattle had equal access to comparable feed resources and management in extensive, relatively harsh environments. Differences in weaning performance, feedlot performance, carcass value and overall profitability were measured. The only cattle included in the analysis were those individuals that were matched to one sire by parentage verification utilizing DNA.

Subsequent to measurement of individual heterosis, the F1 female was evaluated for the initial contribution of maternal heterosis by measuring pregnancy rates on the F1 females (Hereford $\times$ Angus) in contrast to the primarily straightbred (Angus) group.

Data indicates an economic advantage in the feedlot phase for the crossbred (Hereford-sired) calves. Primary differences were gain and feed efficiency, resulting in a lower cost of gain — approximately \$5 per cwt. The Angus-sired group had an advantage in quality grade, partially offsetting the value in the feedlot. However, the net advantage favored the Hereford-sired cattle by nearly \$30 per head for the entire production cycle.



Introduction

Historically, cattle improvement in the 1950s and 1960s was based on the introduction of purebred (registered) cattle to upgrade and improve native stock. Remarkable strides were made in improving the uniformity and quality of the product. By the mid-1960s most herds were emphasizing the use of purebred Hereford, Angus and Shorthorn cattle.

In the 1960s, a tremendous body of research was developed evaluating the use of systematic crossbreeding to improve the profitability of beef production. The theory was to capitalize on heterosis (hybrid vigor) to improve lowly heritable traits and to breed complementarity (advantages and disadvantages of each breed). Systematic crossbreeding has the potential to significantly enhance traits that are difficult to measure (calf livability, mortality, conception rate, longevity, etc.) (Gregory, et al. 1991). Data suggest tremendous improvement in calves weaned per cow exposed when crossbreeding is properly implemented. (Ritchie. 1994, 1996).

Based on this research, commercial producers began to utilize crossbreeding extensively to improve overall profitability. The increased longevity and lifetime productivity of the F1 cow became obvious and the “black baldie” became famous as the “ideal cow.” However, crossbreeding was not always systematic and planned but was frequently the result of simply introducing a new breed as an experiment. The result was often an inconsistent cow herd, consisting of multiple breeds with diverse biological types.

Beginning in the 1990s, there was a strong focus on consumer demand, which caused producers to emphasize carcass merit, particularly an improvement in quality grade (marbling). Concomitantly, there was a growing trend toward vertically coordinated marketing systems (alliances) between producers, feedlots and packing plants. The intent was to produce a more uniform, acceptable product for the consumer. These two trends resulted in a dramatic shift toward one breed (Angus) and a reduction in crossbreeding throughout the U.S. This trend has been occurring for well over 15 years and does not appear to be moderating. Carcass traits have improved, but the result is the development of a predominantly Angus cow herd under commercial range conditions that has limited hybrid vigor.

Under the new market direction, with vertically coordinated systems becoming typical, it is critical to evaluate differences in profitability when controlled crossbreeding is implemented in an Angus-based operation. Potentially, there are significant opportunities for the cattle industry to capture value from crossbreeding, while not sacrificing the consumer focus of the beef industry.

The primary objective of this study was to conduct a controlled crossbreeding system comparing Angus and Hereford bulls under commercial conditions emphasizing economic differences at the ranch, feedlot and packing plant. Major traits that have the potential to impact the overall profitability to a vertically coordinated alliance are being recorded. Results should be applicable to any large-scale cow-calf operation and of particular interest to those participating in vertically coordinated partnerships and/or alliances.

In order to fairly assess the impact of crossbreeding, data on the productivity of the F1 female will be important and will require long-term commitment to measuring lifetime productivity.





Methods

Four hundred mature Angus-based cows were sorted and identified with electronic ear tags in the Lacey Livestock program, based in Independence, Calif. In year one predominantly Angus cows were randomly mated to 10 Hereford or 10 Angus bulls selected based on rigorous genetic parameters (EPDs) for overall merit. In years two and three, the project was expanded to include 15 bulls of each breed and 600 Angus-based cows. The project was conducted for a three-year period, the typical lifespan of a bull under Western range conditions.



Lacey Livestock has utilized Angus bulls exclusively for the past 10 years on an Angus-, Hereford- and Gelbvieh-based cow herd. Retained replacement heifers are predominantly Angus, yet still include other breeds. Heterosis would not be maximized within this system. However, the breed composition of the cow herd is similar to many commercial programs in the West and the results should have application to most operations that have been using Angus sires for several years.

During selected phases of the production cycle (pre-conditioning, weaning, feedlot, carcass), complete records were maintained on all calves born to the project. However, these data were collected under extensive range conditions (real-world), so cattle were not managed like those in a traditional research project, but were managed similar to those in field trial data. For example, birth dates, weights, etc. were not recorded. All calves were weighed on the ranch at pre-conditioning. DNA samples were obtained for parentage verification, and each calf was identified with an electronic identification device (EID) placed in the ear.



At feedlot arrival, cattle were sorted into sire breed groups. Hereford-sired steers and Angus-sired steers were fed in separate, adjacent pens located at Harris Feeding Co. under traditional commercial feedlot conditions. Only steers that could be individually identified to one sire (not multiple sires or unknowns) were included in the analysis. Individual morbidity and mortality were recorded, along with group feed efficiency and gain data. Ultrasound of rib fat and an interim weight were used to assist in the determination of logical harvest endpoint for year one. Interim weights were used in year two and three, since researchers found little additional value in the ultrasound.



At the point of harvest, all carcass traits were determined by a USDA (U.S. Department of Agriculture) grader (carcass weight, backfat, ribeye areas, KPH, marbling score). Dressing percent was calculated using a pooled carcass weight divided by gross-truck weight.

Data were analyzed using standard statistical procedures for comparing within and across breed variations. All economic values (input and output) were monitored, and economic models assessing the value of heterosis were evaluated.

For the purposes of this report, economic differences were assessed by actual costs and return to the feedlot and packing plant.



Results and Discussion

The value of direct and maternal heterosis has been irrefutably established in previous research, most notably the elegant work at the U.S. Meat Animal Research Center (USMARC) by Koch, Cundiff and Gregory. However, the real economic value returned to the producer under extensive Western conditions and current market structure has not been determined.

Direct heterosis is defined as the increase in performance of the crossbred calf relative to the average of the straightbred parental breeds. Maternal heterosis is the increase in performance of the crossbred cow relative to the average of straightbred females of the parental breeds. A summary of literature has established the following values for heterosis:

Direct heterosis - examples

Survival to weaning – 1.9%
Weaning weight – 3.9%
Post weaning gain – 2.6%
Yearling weight – 3.8%
Feed conversion – 2.2%

Maternal heterosis - examples

Calving rate – 3.7%
Weaning weight 3.8%
Longevity – 38%
Number of calves – 17.0%
Cumulative weaning weight – 25.3%

Decades of research have established that the primary advantage to crossbreeding is in the lowly heritable traits in areas that are generally classified as reproduction or fitness traits. There are small, net-positive effects in many areas (pregnancy rate, calf livability, health, general performance, etc.) that result in a very significant return but are very difficult to measure.

The value from crossbreeding is primarily evidenced by increased number of calves (lifetime), cow longevity and cumulative weaning weight (lifetime). Similarly, one would not anticipate dramatic differences in feedlot and carcass performance in crossbred cattle because these traits tend to be highly heritable. However, the increase would be anticipated to be positive for several measures of feedlot performance.

The most significant advantage to crossbreeding will be in the utilization of the crossbred female. Developing and maintaining a crossbreeding system which captures maternal heterosis is critical to long-term profitability in the commercial cow-calf business.





The base cow herd from which the subset of 600 cows was selected had been utilizing Angus bulls for approximately 10 years prior to the initiation of this project. However, the cows were not straightbred Angus. There were still previous breed influences present in many of the cows (primarily Gelbvieh and/or Hereford), but there is no question that the herd was predominantly Angus. Therefore, most people would anticipate slightly lower values for heterosis than the literature values since the females were not 100% Angus. However, the authors would argue that this field trial more accurately reflects how crossbreeding is applied under real-world commercial conditions.

This project was not designed to determine lifetime productivity (assessing maternal heterosis). Since it was conducted as a field trial under extensive range conditions for three years, there was an opportunity to assess economic return for both feedlot and carcass traits (direct heterosis). The authors hypothesized a slight advantage in feedlot performance for the Hereford-sired calves. Pregnancy data for yearling heifers were obtained for two years; that information provides preliminary insight into lifetime reproductive performance (maternal heterosis).

Approximately 30 days prior to weaning, calves were individually weighed and pre-conditioned. Hereford-sired calves (n=290) averaged 15 lb. more than Angus-sired calves (n=304), weighing 513 and 498 lb. respectively (Table 1). These data reflect approximately 3.0% direct heterosis for weaning weight, which mirrors the expectation in the literature (3.9%), especially considering the dams were not straightbred. Based on the standard price for the duration of the study of \$1.20 per lb., the economic advantage to the Hereford-sired calves was \$18.

Cattle were weaned and delivered to a grower lot for a short backgrounding phase prior to arrival at the feedlot. The project calves were part of a much larger contemporary group from a large scale operation. All very light calves that were not ready to be sent to the feedlot were removed from the group and returned to a forage diet prior to delivery to the feedlot.

Steers were fed an average of 155 days on a standard feedlot finishing ration. There were no differences in average daily gain calculated, leaving “deads-in” in a standard feedlot financial performance summary (3.45 Angus-sired, 3.48

Table 1. Ranch performance summary (preweaning weight)

Traits	Angus-sired (n = 304)	Hereford-sired (n = 290)
Weight	498	513
In Value (\$1.20)	\$597.60	\$615.60
Value Difference		\$18.00



Hereford-sired). Feed conversion favored the Hereford-sired calves significantly (7.44 Angus, 7.05 Hereford), an approximate 5% effect due to direct heterosis, somewhat higher than anticipated based on previous estimates. There were slight but non-significant differences in morbidity (10.77% Angus-sired, 9.51% Hereford-sired) and hospital costs (\$14.52 Angus-sired, \$12.68 Hereford-sired).

Ultimately, the major difference in the feedlot summary was the difference in cost of gain. When all traits were combined, the Hereford-sired calves had a lower cost of gain of \$4.37 per cwt. and a lower breakeven of \$2.22 per cwt. The primary contributor to the advantage to the Hereford-sired, crossbred calves was feed conversion. Feedlot performance data were relatively consistent for all three years (Table 2).

At harvest there were minor differences in carcass weight, dressing percent and yield grade (including all factors related to yield grade). However, there was a significant advantage in marbling score (quality grade). (Table 3).

The Angus-sired steers had a 19.5% advantage in percent grading Choice or higher (66.4% versus 46.9%, respectively), resulting in a \$15.60 per carcass advantage to the Angus-sired group due to carcass quality. The price spread differential varied between Choice and Select at the time of harvest of each group. For purposes of the economic analysis, we used the average difference of \$10 per cwt.



Table 2. Feedlot and financial performance summary

<u>Traits</u>	<u>Angus-sired</u>	<u>Hereford-sired</u>
Head	297	284
Dead	4	4
Finished	288	275
Weight in	673	674
Weight out	1,232	1,232
Feedyard performance summary		
Day on feed	155	155
ADG	3.45	3.48
Conversion-as fed	7.41	7.05
Conversion-dry matter	5.52	5.25
Cost of gain	\$79.77	\$75.98
Death loss percent	1.35%	1.41%
Morbidity		
Percent morbidity	10.77%	9.51%
Hospital cost/head treated	\$14.52	\$12.68
Hospital cost/head placed	\$1.91	\$1.30
Cost Summary		
Delivered cost/cwt.	\$119.68	\$119.68
Total cost of gain/cwt.	\$87.05	\$82.68
Breakeven/cwt.	\$105.18	\$102.96
Value Difference		\$27.50

Table 3. Carcass performance summary

<u>Traits</u>	<u>Angus-sired</u>	<u>Hereford-sired</u>
Carcass Summary		
Live weight	1,236	1,232
Hot weight	782	782
Yield percent	63%	63%
Quality Grade Summary		
Prime	.82%	0
Choice	65.66%	46.9%
Choice or better	66.4%	46.9%
Select	33%	53%
Yield Grade Summary		
Total Yield Grade 1 & 2	43%	49%
Yield Grade 3	51%	45%
Total Yield Grade 4 & 5	6%	6%
Value Difference	\$15.60	



Results and Discussion continued

In summary, the two different sire breed groups were remarkably similar in most traits. Differences at weaning (preweaning weights) showed a consistent advantage to the Hereford-sired calves. There were relatively slight differences in feedlot performance, but the data tended to favor the Hereford-sired cattle. Again, this fits with our expectation of crossbreeding — small differences in many traits with a large net positive.

The most notable and dramatic difference was the lower feed conversion for the Hereford-sired calves over all three years. This fact, coupled with the other feedlot traits, resulted in a significantly lower total cost of gain and breakevens for the Hereford-sired cattle. In terms of carcass performance, data were similar for most traits, with the exception of marbling score/quality grade, which significantly favored the Angus cattle.

Because of the length of the project, researchers were only able to collect limited data on reproductive performance, an area where you can anticipate the most dramatic response to crossbreeding. Remember, for the majority of cow-calf producers the effect of maternal heterosis is critical to overall profitability. Pregnancy rates on yearling heifers that had been identified back to Hereford or Angus sires were collected in year two and three of the study. In both instances, there was a 7% advantage in pregnancy to the Hereford-sired cattle (93% vs. 86%) in a relatively short breeding season where heifers were bred with artificial insemination.



These data are similar to those of another large crossbreeding study — Circle A Ranch Heterosis Project conducted in Missouri — where results were identical. The long-term implications of higher pregnancy in yearling heifers are dramatic. This information allows for deeper culling of either mature cows or replacement heifers and/or the opportunity to grow the cow herd because of a higher calving rate. In addition, there is the documented effect of increased calf livability, increased rebreeding rates and, most notably, a dramatic increase in longevity.

When the Circle A data were analyzed by Vern Pierce, University of Missouri, for economic emphasis, the results showed an advantage of \$514 net per cow over a 10-year period or \$51 difference per cow per year. Analysis shows that over a 10 year period a producer who utilizes Hereford bulls on Angus-based cows compared to a producer who uses Angus bulls on the Angus-based cows will have improved cash flow, increased herd size and more calves to sell. (Pierce. 2009)

The data from both, extensive field trials mirror previous research. The Harris project includes a real-world economic analysis that favors crossbreeding for the commercial cow calf producer in our current market structure (Table 4). The economic data suggest crossbreeding has the potential to significantly boost return in a vertically coordinated marketing system.

Table 4. Economic summary

<u>Traits</u>	<u>Angus-sired</u>	<u>Hereford-sired</u>
Ranch		\$18.00
Feedlot		\$27.50
Carcass	\$15.60	
Net Value Difference		\$29.90



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