

Heterosis - Ignored or Forgotten?

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So why are we still talking about heterosis? I remember attending a cattlemen's meeting in 1967 in Bangor, California (population of 194!) when I was 9 years old. Our Farm Advisor gave this very clear, simplistic report on crossbreeding---and the data was irrefutable. Crossbreeding generated economic returns for commercial beef producers. The following spring, my Dad purchased the first Angus bulls to be used on a herd that ran very heavy to Hereford, with a smattering of "Durham" (Shorthorn) influence. It was not necessarily a popular decision with all of the neighbors!

Yet, forty years later, I think that as an industry we have ignored or forgotten the value of heterosis. The classical work conducted at Fort Robinson in the early 1960's provided the scientific documentation for heterosis (Gregory et al., 1965). The elegant and truly remarkable germ plasm evaluation and germ plasm utilization studies at the United States Meat Animal Research Center provided substantive and meaningful data on the value of crossbreeding (Cundiff, 1970; Gregory et al., 1978). If we design breeding programs that capture direct and maternal heterosis, we can increase lifetime productivity by over 20% (Ritchie et al., 1999). The literature is clear, overwhelming and consistent regarding the benefits of capturing heterosis in beef production systems.

I think back to my first animal breeding classes studying crossbreeding systems and discovering that nature was good to us..... we were able to use both selection and crossbreeding to make genetic progress! Not only could we effectively utilize selection within breed for highly heritable traits, we could also make significant improvement in lowly heritable traits with

crossbreeding. In graduate school in the early 1980's I had the very fortunate experience to work with people like Dr. Bob Taylor and Dr. Jim Brinks----practical, skilled animal breeders--- who had the ability to clearly elucidate the importance of designed breeding programs. From that experience, I was one of a handful of people who met in Denver in 1990 to form a group that worked on the utilization of "composite" seedstock. What I particularly appreciated about those "out of the box" thinkers is that it was not about protecting territory but about making progress.

Heterosis (hybrid vigor) is the amount (percent) by which the crossbred average exceeds the average of the two (or more) parental purebreds for a measured trait. From an economic perspective, the most important gains are made in lowly heritable traits that are often difficult to measure. Traits like calf livability, survival to weaning, conception rate, age at puberty and many others, all benefit from heterosis. The individual change in one trait is small, but the cumulative effect on total productivity and lifetime productivity is tremendous, ranging well over 20% (Taylor, 1994).

In this paper, I do not believe it is necessary to revisit the scientific evidence regarding hybrid vigor, but more importantly to address the failure of our industry to effectively utilize the powerful tool that nature has provided. For some reason, poultry and pork have seemed to figure out how to take advantage of genetic diversity and produce a consistent product. The beef industry has not done so on a widespread basis.

After participating in this industry at many levels (educator, cow-calf and stocker producer,

purebred breeder), I thought it appropriate to summarize ten reasons that we have ignored or forgotten about heterosis in our quest to make genetic progress. If assigning blame is important there is plenty to go around, including much of it directed to the historical direction of our research and education at Universities:

- 1) **A cultural bias that clearly reflects “purebreds are better!**, if for no other reason than they have a registration paper. Society, at many levels, rewards purity. Is your dog registered? Does your quarter horse *gelding* have papers? How far can you trace your ancestry? Please don't misunderstand---there is certainly value associated with that record, particularly our ability to track performance and predict genetic potential of purebreds. But being purebred should not be a presumption of superiority.
- 2) **Our predilection for single trait selection focusing on “bigger is better”**. This industry seems to choose a trait of importance and then put an inordinate amount of pressure on that trait, ignoring genetic antagonisms. If a 90 pound yearling EPD is good, 100 must be better! It is intuitive! We have already done frame, growth (weight of all kinds), milk, and carcass traits (both ribeye and marbling). I sometimes have to ask myself, “so what is the trait of the year this time?”. It is akin to the “flavor of the month” at the local ice cream shop. And because often have chosen relatively highly heritable traits, we have not needed to crossbreed to achieve those goals. The subtle, and cumulative improvement that heterosis provides does not lend itself to maximums.
- 3) **We have decided that measuring outputs is more meaningful than measuring inputs**, as well as easier to do. It is certainly easier to measure calf

performance on an individual basis, rather than all costs associated with that production. “ I can weigh them at weaning quicker than I can determine differences in treatment costs over time.”

- 4) **Uniform phenotypes for qualitative traits (color) have a distinct and real marketing advantage that is difficult to ignore**. That does not mean you cannot have uniformity of color within a crossbreeding program, but the widespread and indiscriminate planning (or lack thereof) of many crossbreeding programs certainly gave us some interesting marketing challenges. Generally, it is easier to produce a uniform color in straightbred programs.
- 5) **Heterosis is very difficult to visualize and even more difficult to measure**. Because heterosis is expressed as a small net positive in many traits we do not know it when we see it. Slight changes in morbidity, age at puberty, conception rate and significant changes in longevity are not easily observed. However, we all know when calves gain faster in the feedlot.
- 6) **The presentation of complicated crossbreeding systems as a “normal practice” to diverse cattle operations, especially the countless small beef herds in the United States**. Many of the systems that we teach as part of standard animal breeding or beef production courses have very limited application in the real world. Most beef herds are too small to implement the “standard systems”.
- 7) **Our penchant for telling people how to modify their environment in order to “get heavier calves, higher percent calf crop and more total pounds”**, rather than how to increase net return. How many new supplementation

programs can you develop in order to get your heifers bred or wean bigger calves? In fact, we can recommend programs for non-cycling females.....you just have to pay for it and then pass those genetics to the next generation! Heterosis provides some improvement in traits at relatively little cost. However, we have obscured the opportunity for producers to focus on those traits, because they are so busy masking differences with artificial environments.

- 8) **Historically, there has been active resistance to crossbreeding from some traditional marketing outlets, some purebred producers and (in some cases) breed associations.** I would like to commend many of the associations who, quite recently, have taken the risk of suggesting where their animals fit most effectively in crossbreeding programs.
- 9) **Inappropriate use of breed diversity.** Nothing undermines crossbreeding more quickly than the unplanned “Heinz 57” or “Breed of the Month Club” approach. For those who were willing to experiment in crossbreeding, there was often very poor planning of the combination of breeds and the selection within those breeds.
- 10) **Our industry and University systems have focused on individual trait measurement for over fifty years.** We have done a very poor job of incorporating real world economics into our models. We have EPD’s for a plethora of traitsand we are adding more! Economic indices are starting to catch up, but we are still behind. Has anyone thought about measuring return per acre or return on investment? We have had a disconnect between agricultural economists and animal science that has not been well bridged.

We tend to think lineally rather than laterally, which has reduced the application of innovative crossbreeding.

So, where are we now? In the far west (as in much of the United States), we have seen a move towards less crossbreeding and more reliance on a single breed. Generally, that has been quite positive, because many of the herds were crossbred and had high levels of heterosis. Therefore five to eight years of one breed has reduced heterosis, but provided a consistent, highly marketable product, with some maternal heterosis still present in the cow herd. Recently, I am hearing concern from some very large, progressive producers as their cows become more straightbred in a tough environment. Longevity, rebreeding, calf survivability all become important issues. I don’t think it is because they have bought the wrong bulls or managed their ranch incorrectly. It is because they have forgotten or ignored heterosis.

It is time for many producers to design long term, simplistic plans that capture maternal heterosis. I would not want to manage cattle in any environment without that incredible value. And the tougher the environment the more critical hybrid vigor becomes. For those of us who are educators, we need to work more effectively in presenting straight forward workable solutions. We need to renew our efforts in educating producers that selection is not about maximums----other than sustained profit. Animal breeders do not need to give us one more individual EPD that measures outputs. We need to incorporate dollars and we need to measure inputs.

With all of the potential pitfalls in utilizing heterosis, I have observed success in pockets of the industry. Producers who have developed a plan, targeted a market, understand their resources and environment and are focused on profit are successfully capitalizing on heterosis. I see terminal systems with moderate crossbred cows under limited feed producing a successful product that performs in the feedlot. I see other

ranches that are highly focused on quality, using moderate crossbred cows, mated to produce $\frac{3}{4}$ blood calves for specific markets---the heterosis is lower, but the market rewards are real.

There is no single solution. However, as we turn the corner in the cattle cycle and begin to experience somewhat lower prices, I am confident that we can no longer forget how to reduce input costs---and heterosis has to be part of that equation.

References

Cundiff, L V (1970). Experimental results on crossbreeding cattle for beef production. *J. Anim. Sci* 30:694.

Gregory, K E, Swiger, L A, Koch, R M, Sumption, L J, Rowden, W W and Ingalls, J J E (1965). Heterosis in preweaning traits of beef cattle. *J. Anim. Sci* 24:21.

Gregory, K E, Koch, R M, Laster, DB, Cundiff, L V and Smith, G M (1978d), Heterosis and breed maternal and transmitted effects in beef cattle 3: Growth traits in steers. *J. Anim. Sci* 47:1054.

Ritchie, H.D., B.D. Banks, D.D. Buskirk, J.D. Cowley and D.R. Hawkins. 1999. Crossbreeding systems for beef cattle. Michigan State Univ. Extension Bulletin E-2701.

Taylor, R E, Field T G. Beef Production and Management Decisions. Upper Saddle River, New Jersey. Prentice Hall. 1994.