



Utilization of Heterosis in a Beef Cow Herd

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Introduction

George H. Shull, while working as a corn geneticist at the Cold Spring Harbor Laboratory from 1904 to 1915, observed that when two different pure-bred lines of corn were crossbred the resulting progeny exhibited physical traits superior to those of the parents (Glass, 2010). Shull described the offspring of pure-bred crosses as having increased heartiness, size, fruitfulness, speed of development, resistance to disease, resistance to pests, and resistance to climatic rigors when compared to the parent varieties (Edwards, 2005). Offspring resulting from crossbreeding two different varieties, breeds or even species are referred to as hybrids (Merriam-Webster, 2011). The exhibition of the superior qualities exhibited by hybrids, George Shull called heterosis, other researchers called the condition hybrid vigour.

Having crops that exhibit heterosis or hybrid vigour can be very beneficial and profitable, whether a producer grows corn or beef calves. Heterosis in beef cattle can produce calves with enhanced reproductive, survival, longevity (Dhuyvetter, 1998), fertility, growth, meat quality (Peck, 2009), and even disease resistance traits (O'Neill, Weldon, & Hill, 1998; Dandapat, 2009). The benefits of heterosis on beef herd quality and consequently profitability are very well documented (Anderson, 1990).

Heterosis or hybrid vigour is achieved through crossbreeding. Heterosis is a powerful and valuable tool for commercial beef producers, especially cow-calf operations (Hoffelt, 2010). According to

Rumph (2009), “crossbreeding can increase the performance of any herd with little to no additional costs to the producer.” Beef producers worldwide have experienced the benefits of incorporating heterosis into their herd management programs (Ishmael, 2009; Brown, 2010; Long, 2009). In terms of cost for beef producers to implement, heterosis is inexpensive and takes very little time to implement. But, before starting a crossbreeding program a beef producer must establish needs and set genetic goals (CattleNetwork, 2008) which will led to herd improvement and increased profitability.

Some Heterosis Fundamentals

There are some fundamentals of heterosis that producers should know before putting heterosis into practice:

- 1) Normally, crosses of animals that are the most unrelated, for example *Bos indicus* and *Bos taurus* types, exhibit higher levels of heterosis than do crosses of two more related cattle, like the British breeds, Angus and Hereford.
- 2) Normally, lowly heritable traits show the greatest improvement from heterosis like maternal ability, reproduction, health, cow longevity, and overall cow productivity. Moderately heritable traits show moderate improvements. Highly heritable traits show little or no improvement (Weaber, 2007) (Table 1).

- 3) There are three beef heterosis types referred to in trade and research literature individual (crossbred calf), maternal (crossbred cow), and paternal (crossbred sire) heterosis (Buchanan, 2011).

aiming for using the Brahman-Braunvieh cross cows bred to Charolais bulls.

The Brahman breed provided hardiness and walking traits, the Braunvieh breed provided good milk and meat traits, and the Charolais provided the increased mass wanted by the feedlot. Obviously, Bruce Hunt’s herd crossbreeding program was implemented to address a South African environment (Jooste, 2009). But in any case, climatic factors, animal health, carcass characteristics, and calf growth are universal areas of concern for beef operations all over the world. So regardless of location, beef producers must tailor crossbreeding to meet their specific circumstances, environment, and market (Handley, 2010).

Scott Greiner of Virginia Tech identifies the following traits as being of economic importance to beef producers and that could be considered when utilizing heterosis for beef herd improvement: calving ease, calf survival, weaning weight, post-weaning growth, feed efficiency, mature size, red meat yield, and palatability (Greiner, 2010)

Table1. Heritability and Heterosis (Hybrid Vigor) Comparison

Traits	Heritability	Heterosis
fertility, mothering ability, calf survival	low	high
birth and weaning weight, milking ability and feedlot gain	medium	medium
mature weight, carcass quality	high	low

From (Handley, 2010)

Identifying Needs

Before utilizing heterosis in a commercial herd, producers must assess their herd and identify needs or areas in which a cross-breeding program would positively impact herd quality and profitability.

Bruce Hunt of Warrenton, South Africa is an example of a beef producer which identified his herd needs and implemented a crossbreeding program to meet those needs. Climate, animal health, meat quality, and calf growth were all factors affecting his profitability. He looked to heterosis for solutions. He decided that the herd specifically needed “hardy animals that could survive droughts, with sound hoofs, good meat characteristics and enough milk to raise their calves” (Jooste, 2009).

Utilizing heterosis to get the herd and calf crop he wanted, Hunt created a crossbreeding program using Brahman (origin: USA-India), Braunvieh (origin: Switzerland) to get Brahman-Braunvieh cross cows. Then, Hunt got the calves he was

Heterosis Types

In the Oklahoma State University Extension publication “The Genetic Principles of Crossbreeding” David Buchanan and Sally Northcutt gave the following explanations of heterosis types, “Individual heterosis is the advantage of the crossbred individual relative to the average of the purebred individuals.... Maternal heterosis is the advantage of the crossbred mother over the average of purebred mothers... (and) Paternal heterosis is the advantage of a crossbred sire over the average of purebred sires” (Buchanan, 2011).

Selection of a Crossbreeding System

There are “endless” variations of crossbreeding systems which beef producers can incorporate into an operation (Rumph, 2009). A few of these are, two-breed terminal cross, three-breed terminal cross, two-breed rotation or crisscross, three-breed rotation, rotational-terminal sire combination (Bullock, 1997). However, in general all crossbreeding systems belong to one of two types, either terminal cross systems or rotational and composite systems (Handley, 2001).

In terminal cross systems all calves are marketed and replacement cows are purchased or acquired from another herd. Terminal cross systems emphasize bull selection for growth and carcass traits. In this type of system the maternal traits of the bull are not important because all replacement cows come from outside the herd (Handley, 2010).

Two-breed terminal cross and three-breed terminal crossbreeding systems were mentioned previously. The two-breed terminal cross system is the least desirable of these two systems, because it utilizes straight bred cows, bred to a bull of a different breed. Therefore, the benefits of hybrid vigor are only received from the individual heterosis of calf. However, the three-breed terminal cross system is a better system. It utilizes two-breed cross cows bred to a third breed bull. This system is excellent because it maximizes benefits received from the individual heterosis of the calf and the maternal heterosis of the mother. The three-breed terminal cross system is also good for any herd size (Bullock, 1997).

In rotational and composite systems, bulls are selected for growth, carcass, and maternal traits. Crossbred replacement cows come from within the herd. Therefore, benefits are realized from the maternal heterosis of the cows and individual heterosis of the calves. Previously, two-breed rotation or crisscross, three-breed rotation, and rotational-terminal sire combination were mentioned. These systems require more rigorous record keeping, extensive herd management, and more facilities than terminal cross-breeding systems. But, in rotational & composite systems there is a higher level of hybrid vigor than in other systems. "In rotational systems heterosis is retained at high levels, 66% in two-breed rotation, 86% in three-breed rotation" (Handley, 2001).

Producers should carefully study the different crossbreeding schemes to determine which is best for their particular environment and circumstances. The following are some basic features to consider when selecting a crossbreeding system (Handley, 2010):

- 1) Level of hybrid vigor (heterosis)
- 2) Merit of component breeds
- 3) Complementarity
- 4) Consistency of performance

- 5) Deals with genetic antagonisms
- 6) Meets end-product target

In selecting a system producers must also consider their resources: herd size, facilities, labor and management, amount and quality of feed available, potential market, and availability of high-quality bulls of the various breeds (Greiner, 2009; Bullock, 1997).

In all systems ease of calving is an important consideration (Handley, 2010)

Bull Selection

Bull selection is extremely important in developing a beef herd. Bulls are considered to be "half the herd" because they make up half of the genetics of the calves to be marketed. In breeding systems where replacement heifers are retained, the last three bulls can account for 87.5% of the genetic makeup of the calves (Bullock, 1997).

The first decision in bull selection is finding the right breed. No breed is superior in all traits. So, it is important to know the comparative strengths and weaknesses of each breed, which breeds complement each other in order to plan a cross-breeding system.

To create a successful cross-breeding program a beef producer must select quality bulls. Bull selection should be based on physical soundness, reproductive soundness, performance information and visual inspection. It is important that beef producers become educated and are proficient in the use expected progeny differences (EPD) and breeding soundness evaluations (BSE) to eliminate the guesswork in bull selection (Bullock, 1997). This topic merits much more in terms of basic understanding than this paper provides and the reader is encouraged to delve more fully into this important subject area.

Conclusion

Heterosis is a valuable tool which can be used by beef producers regardless of herd size. It does not require additional expense; it is "a free ride" with the caveat that the more you know the better you will be able to take advantage. Implementing heterosis in a beef herd does require assessment of herd needs, market

trends, setting targets or goals, a crossbreeding program, and creativity. To take advantage of heterosis the beef producer must be educated in beef breed types, crossbreeding schemes, and information resources like expected progeny differences (EPD) and breeding soundness evaluations (BSE).

References

- Merriam-Webster*. (2011). Retrieved February 5, 2011, from Merriam-Webster:
<http://www.merriam-webster.com/dictionary/hybrid?show=0&t=1296821332>
- Anderson, P. (1990, Jan). *University of Minnesota Extension Service*. Retrieved Feb. 24, 2011, from Beef Cattle Management Update: Crossbreeding Systems for Beef Cattle:
<http://www.ansci.umn.edu/beef/beefupdates/bcmu03.pdf>
- Brown, S. (2010, March 26). *Crossbreeds Add Vigor to Herd*. Retrieved February 7, 2011, from Farm Journal Livestock and Production Editor:
http://www.agweb.com/article/Crossbreeds_Add_Vigor_to_Herd_193422/
- Buchanan, D. a. (2011, Feb. 11). *The Genetic Principles of Crossbreeding*. Retrieved Feb. 24, 2011., from Iowa Beef Center:
http://www.iowabeefcenter.org/Docs_cows/Genetic_Principles_Crossbreeding.pdf
- Bullock, D. (1997). Planning the Breeding Program. In U. o. Kentucky, *The Kentucky Beef Book* (pp. 5-1). Lexington.
- CattleNetwork, D. (2008, Dec. 9). *Cattle Breeding: Crossbreeding & Maximizing Heterosis*. Retrieved Feb. 24, 2011, from Dovers CattleNetwork:
<http://www.cattlenetwork.com/templates/newsarchive.html?sid=cn&cid=551661>
- Dandapat, A. (2009). Seminar on GENETIC RESISTANCE TO DISEASES IN CATTLE. *Seminar on GENETIC RESISTANCE TO DISEASES IN CATTLE* (p. 10). Pant University of Agriculture & Technology:
http://www.authorstream.com/Presentation/anjan_vet-190326-genetic-resistance-diseases-cattle-dandapat-science-technology-ppt-powerpoint/
- Dhuyvetter, J. (1998, March 5). *Hybrid Vigor Plays Key Role in Beef Reproduction, Calf Survival and Cow Longevity*. Retrieved February 7, 2011, from NDSU Extension Service :
<http://www.ext.nodak.edu/extnews/newsrelease/1998/030598/19hybrid.htm>
- Edwards, K. R. (2005). *Heterosis: Theory and Estimation*. Retrieved February 3, 2011, from Iowa State University: Raymond F. Baker Center for Plant Breeding:
<http://corn2.agron.iastate.edu/Lamkey/Publications/PDF/icb98.pdf>
- Evans, J. a. (2004, Nov. 19). *Crossbreeding Beef Cattle, I*. Retrieved Feb. 24, 2011, from Oklahoma Cooperative Extension Fact Sheets:
<http://pods.dasnr.okstate.edu/docushare/dsw eb/Get/Document-1929/F-3150web.pdf>
- Glass, B. (2010). *George Harrison Shull Papers*. Retrieved February 3, 2011, from American Philosophical Society :
<http://www.amphilsoc.org/guides/glass/shull.htm>
- Greiner, S. P. (2009, May 1). *Crossbreeding Beef Cattle*. Retrieved Feb. 24, 2011, from Virginia Cooperative Extension:
<http://pubs.ext.vt.edu/400/400-805/400-805.html>
- Greiner, S. P. (2010). *Heterosis: Defined and Research Experience*. Retrieved Feb. 24, 2011, from Animal Science Department-Cornell University:
www.ansci.cornell.edu/nbcec/professionals/slides/bb_IV/
- Handley, J. (2001, Feb.). *Crossbreeding Systems For Beef Production*. Retrieved Feb. 25, 2011, from Government of Ontario: Ministry of Agriculture Food & Rural Affairs:
<http://www.omafra.gov.on.ca/english/livestock/beef/facts/01-011.htm>
- Handley, J. (2010, Jan. 14). *Breeding Strategies for Your Beef Herd*. Retrieved Feb. 25, 2011, from Government of Ontario: Ministry of Agriculture Food & Rural Affairs:
http://www.omafra.gov.on.ca/english/livestock/beef/facts/info_brdgstrat.htm
- Herring, T. F. (n.d.). Retrieved from www.4cattlemen.com/ncba2005/tracks/PR103%20Herring%202005.ppt
- Hoffelt, J. (2010, March 3). *Crossbred Beef Cattle Outperform Purebreds*. Retrieved February 7, 2011, from Agri-View:

- http://www.agrview.com/articles/2010/03/04/livestock_news/livestock01.txt
- Ishmael, W. (2009, May/June). *Time to Cross Breed*. Retrieved February 7, 2011, from Western Cowman:
http://www.westerncowman.com/july_aug09/time_to_crossbreed.html
- Jooste, C. (2009). *Cross Breeding: Ideal crosses for the feedlot*. Retrieved Feb. 24, 2011, from Braunvieh SA:
http://www.braunvieh.co.za/index.php?option=com_content&view=article&id=24&Itemid=22
- Long, P. (2009). *The Power of Heterosis*. Retrieved February 4, 2011, from BNW Beef Northwest:
<http://www.beefnw.com/news/heterosis.php>
- O'Neill, C., Weldon, G., & Hill, R. a. (1998). *Adaptaur Association of Australia; A Breed Association Based On the Performance Recording of Adaptaur Cattle*. Retrieved February 7, 2011, from Animal Production in Australia:
<http://www.asap.asn.au/livestocklibrary/1998/O'Neill98.PDF>
- Peck, C. (2009). *Guarding Heterosis*. Retrieved February 7, 2011, from Yankee Creek Ranch:
<http://www.yankeecreekranch.com/images/01BEEFHeterosis.pdf>
- Rumph, J. M. (2009, Aug. 14). *Beef/Cattle Extension Program: Use of crossbreeding to make production gains*. Retrieved Feb. 8, 2011, from Montana State University:
<http://www.animalrangeextension.montana.edu/articles/Beef/reproduction/crossbreeding.htm>
- Weaber, B. (2007). *Crossbreeding for Commercial Beef Production*. Retrieved from Macdonald Ranches:
http://www.macdonaldranches.com/fileadmin/main/pdfs/NBCEC_Beef_Sire_Selection_Manual/chapter5-why-crossbreed-and-heterosis.pdf

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