

What is Heterosis? <https://www.britannica.com/science/heterosis>

Heterosis, also called **hybrid vigour**, the increase in such characteristics as size, growth rate, fertility, and yield of a [hybrid](#) organism over those of its parents. Plant and animal breeders exploit heterosis by mating two different pure-bred lines that have certain desirable traits. The first-generation offspring generally show, in greater measure, the desired characteristics of both parents. **This vigour may decrease, however, if the hybrids are mated together; so the parental lines must be maintained and crossed for each new crop or group desired.**

Sire Selection Manual: This comprehensive manual features a variety of NBCEC research and genetic technology that producers can apply to their farms and ranches. http://www.nbcec.org/producers/sire_selection/chapter5.pdf Crossbreeding for Commercial Beef Production Bob Weaber, University of Missouri-Columbia

Improvements in cow-calf production due to heterosis are attributable to having both a crossbred cow and a crossbred calf. Differing levels of heterosis are generated when various breeds are crossed. Similar levels of heterosis are observed when members of the *Bos taurus* species, including the British (e.g. Angus, Hereford, Shorthorn) and Continental European breeds (e.g. Charolais, Gelbvieh, Limousin, Maine-Anjou, Simmental), are crossed. Much more heterosis is observed when *Bos indicus*, or Zebu, breeds like Brahman, Nelore and Gir, are crossed with *Bos taurus* breeds. **The increase in heterosis observed in British by *Bos indicus* crosses for a trait is usually 2-3 times as large as the heterosis for the same trait observed in *Bos taurus* crossbreds (Koger, 1980).** The increase in heterosis results from the presence of greater genetic differences between species than within a species

.... In general the Zebu (*Bos indicus*) crosses have higher levels of heterosis than the British-British, British-Continental, or Continental-Continental crosses.

December 2007 - The Value of Heterosis in Cow Herds: Lessons From the Past That Apply to Today
Matthew L. Spangler University of Tennessee at Martin

<http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1020&context=rangebeefcowsymp>

12-11-2007 The Value of Heterosis in Cow Herds: Lessons From the Past That Apply to Today Matthew L. Spangler University of Tennessee at Martin

The decision of whether or not to utilize a particular strategic system of crossbreeding depends upon individual production goals. First must come the blinding realization that no one breed excels in all areas that lead to profitability. In order to take advantage of breed complementarity, **breeds must be paired such that they excel in different areas that are critical to the overall production goal(s).**

A three-breed rotational system achieves a higher level of retained heterosis than a two breed rotational crossbreeding system does. After several generations, the amount of retained heterosis stabilizes at about 86% of the maximum heterosis, resulting in an expected 20% increase in the pounds of calf weaning weight per cow exposed above the average of the parent breeds (Ritchie et al., 1999)

<http://genex.crinet.com/page6208/TheValueOfHeterosis?print=1>

Value of Heterosis Bob Weaber, Ph.D., cowcalf Extension Specialist/Associate Professor, Department of Animal Science and Industry, Kansas State University

The value of heterosis affects every cow on your outfit, and it is value you can capture every year no matter how you sell calves. More importantly, it's not a \$20, \$40 or \$60 premium per head you might get for selling calves or carcasses ... the heterosis premium is much, much more.

The use of crossbreeding offers two distinct and important advantages over the use of a single breed. First, crossbred animals have heterosis or hybrid vigor. Second, crossbred animals combine the strengths of the parent breeds. The term 'breed complementarity' is often used to describe breed combinations that produce highly desirable progeny for a broad range of traits.

.....**To commercial producers the largest economic benefit (roughly 66%) of crossbreeding comes from having crossbred cows** (Table 2). Crossbreeding has been shown to be an efficient method to improve reproductive efficiency and productivity in beef cattle.

..... A variety of crossbreeding systems yield 20 to 30% improvements in weaning weight per cow exposed, not including the additional value generated through sire selection within breed. This represents a substantial change in output given relatively constant input. Simple examples of a 23% increase in weaning weight per cow exposed using a terminal sire/F1 (two cross) cow can generate \$250 to \$300 additional revenue per cow per year. I'm not aware of any set of calves that have generated carcass premiums of \$250 premium **per cow exposed** regardless of breed or grid. With today's calf prices the value of heterosis for a herd of 100 cows is \$25,000 to \$30,000 per year and represents a **decrease** in breakeven costs of more than \$40/cwt. on 200 lb. calves.

..... A well-constructed crossbreeding system can have positive effects on a ranch's bottom line. It not only increases the quality and gross pay weight of calves produced, but also increases the durability and productivity of the cow factory. As you determine to straight-breed or cross-breed, don't give away a couple hundred dollars per cow to make a \$20 to \$60 premium per calf sold at market or on the rail when you can go for both!

Beef Sire Selection Manual Second Edition—2010 National Beef Cattle Evaluation Consortium

<http://www.nbcec.org/producers/sire.html>

Chapter 5 -Crossbreeding for Commercial Beef Production Bob Weaber, University of Missouri-Columbia

- Heterosis generated through crossbreeding can significantly improve an animal's performance for lowly heritable traits. Crossbreeding has been shown to be an efficient method to improve **reproductive efficiency and productivity** in beef cattle.
- Maternal heterosis improves both the environment a cow provides for her calf as well as improves the reproductive performance, longevity and durability of the cow.
- The increase in heterosis observed in British by Bos indicus crosses for a trait is usually 2-3 times as large as the heterosis for the same trait observed in Bos taurus crossbreds (Koger, 1980).
- Crossbred cows exhibit improvements in calving rate of nearly 4% and an **increase in longevity of more than one year due to heterotic effects.**
- Heterosis results in increases in lifetime productivity of approximately one calf and **600 pounds of calf weaning weight over the lifetime** of the cow.

However, the largest economic benefit of crossbreeding to commercial producers comes from having crossbred cows. Maternal heterosis improves both the environment a cow provides for her calf as well as improves the reproductive

performance, longevity and durability of the cow. The improvement of the maternal environment, or mothering ability, a cow provides for her calf is manifested in the improvements in calf survivability to weaning and increased weaning weight. Crossbred cows exhibit improvements in calving rate of nearly 4% and an increase in longevity of more than one year due to heterotic effects. Heterosis results in increases in lifetime productivity of approximately one calf and 600 pounds of calf weaning weight over the lifetime of the cow.

http://www.extension.umn.edu/agriculture/beef/components/docs/crossbreeding_systems_for_beef_cattle.pdf

Crossbreeding Systems for Beef Cattle - Pete Anderson University of Minnesota Beef Team

CROSSBREEDING WITH A PURPOSE Crossbreeding must be planned.

- Low lean, high marbling, moderate milk, moderate puberty – Angus
 - Moderate lean, low marbling, high milk, very late puberty, heat tolerant – Brahman – high growth
 - High lean, moderate marbling, high milk, moderate puberty – Simmental – very high growth
 - Three Breed Rotational Cross. Nearly all of the possible heterosis is realized with proper management of a three breed rotational crossbreeding system.
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Pete Anderson University of Minnesota Beef Team © 2012

https://www.extension.umn.edu/agriculture/beef/components/docs/crossbreeding_systems_for_beef_cattle.pdf

- Realization of heterosis is the closest thing to a free lunch that can be found in the cattle business. Thus, every commercial cattlemen should seek to maximize heterosis in his herd.
 - The more diverse the parent breeds are, the greater the heterosis will be. The best example of this is mixing of *Bos taurus* and *Bos Indicus* (such as Brahman) breeds. Since these breeds actually represent different species, their great diversity will result in tremendous heterosis.
 - Three Breed Rotational Cross. Nearly all of the possible heterosis is realized with proper management of a three breed rotational crossbreeding system.
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CROSSBREEDING SYSTEMS for BEEF CATTLE By David R. Hawkins Michigan State University

[https://www.canr.msu.edu/uploads/resources/pdfs/crossbreeding_systems_for_beef_cattle_\(e2701\)1.pdf](https://www.canr.msu.edu/uploads/resources/pdfs/crossbreeding_systems_for_beef_cattle_(e2701)1.pdf)

Three Breed Rotational

- Need 3 breeding pastures unless A.I.
 - Minimum of 75 cows.
 - Heterosis stabilizes at 86% of maximum.
 - Expect 205 improvement in lbs. of calf weaned per cow exposed.
 - Can utilize advantages of 3 breeds
 - Management becomes more complex
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<http://www.noble.org/ag/livestock/crossbreeding-advantages/> The Advantages of Crossbreeding

By Deke Alkire 1997-2016 by The Samuel Roberts Noble Foundation, Inc.

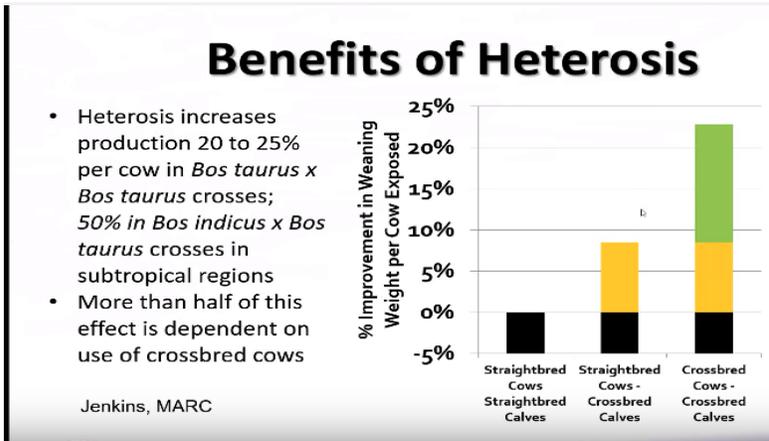
- Maternal Heterosis

Maternal heterosis is the advantage realized by using a crossbred cow versus a straight-bred cow. Research has shown that crossbred cows can have many advantages, including a 6 percent higher calving rate, a 4 percent higher calf survival rate, an 8 percent increase in efficiency, a 38 percent increase in longevity and a 23 percent increase in lifetime productivity. These advantages will be optimized when the breeds and individuals you select to create the crossbred cow fit your resources and goals.

- Direct Heterosis

Direct heterosis is the benefit observed in a crossbred calf. On average, these advantages include a 4 percent increase in calf survival, a 5 percent increase in weaning weight and a 6 percent increase in post-weaning gain. However, these effects are greatly influenced by breed

“Making A Positive Genetic Impact on Your Herd”, [NCBA's Cattlemen to Cattlemen](https://www.youtube.com/watch?v=X7QWsA9kOD4&feature=youtu.be&t=1m15s)
<https://www.youtube.com/watch?v=X7QWsA9kOD4&feature=youtu.be&t=1m15s>



The Dollars of Heterosis

100 cows, 80% Weaning Rate, 575 avg. weaning weight, 10 year horizon

Calf Survival to Weaning (6%) = 48 hd.
 Weaning wt. (4%) = +18,400 lb.

Weaning wt. per cow exposed (23%) = **+105,800 lb.**

...or the equivalent of 18 more 575 lb. calves/year

Heterosis is worth **~\$200/cow/year**

(\$2.00/lb for 5-6 cwt calves)

Decreases breakeven by \$0.37/lb...straightbred would have to generate an additional \$264 per head to be equivalent



https://www.beefmagazine.com/genetics/dollars-and-cents-crossbreeding?NL=BEEF-01&Issue=BEEF-01_20190215_BEEF-01_461&sfvc4enews=42&cl=article_2_b&utm_rid=CPG02000000657166&utm_campaign=36019&utm_medium=email&elq2=04d3723b5a1c4ad0a24626fe15d98867

The dollars and cents of crossbreeding

Why consider crossbreeding? The value of the improved productivity due to crossbreeding is worth \$150 per cow per year.

Feb 04, 2019 By B. Lynn Gordon

With the tight margins and high input costs facing beef producers today, they are more and more focused on the return on investment (ROI) of a production practice or strategy they may implement. Impacting the bottom line positively is the primary end goal. Can crossbreeding be a production practice that will provide an increased return on investment?

Related: [Back To The Future With Heterosis](#)

“The impact of crossbreeding is the result of capturing non-additive genetic merit in one’s cowherd,” says Bob Weaber, Extension beef specialist at Kansas State University (KSU). Genetic merit is made up of both additive effects and non-additive effects.

Additive effects are those effects reflected in EPDs, breeding values and indexes. Non-additive effects are the effects from the pairing of different genes together that result in heterosis, which is a benefit of crossbreeding.

Related: [Heterosis boosts bottom line](#)

“When thinking about genetic selection, you can focus on the additive effects to make selection decisions using EPDs and indices and also get a benefit from the heterosis piece by using different types of mating systems and managing them effectively,” says Megan Rolf, assistant professor of genetics, Kansas State University.

Commercial cattlemen need to focus on both additive and non-additive effects to gain the most benefit from crossbreeding, whereas seedstock producers often put a greater emphasis on the additive genetic merit which comes from EPDs and indexes in order to market superior genetics to commercial customers.

Adding heterosis to the mix

“Heterosis has the ability to generate value for the cow-calf industry,” says Weaber. In a series of multiyear studies conducted at the Meat Animal Research Center (MARC), researchers determined the improvement in weaning weight per cow exposed, to heterosis, increased production 20-25% per cow in Bos taurus x Bos taurus crosses. Research in the subtropical regions results showed a 50% increase in percent improvement in weaning weight per cow exposed when crossing Bos indicus x Bos taurus animals.

Weaber explains when comparing various production practices, producers should use a metric that captures system-level dynamics. A metric like weaning weight per cow exposed captures a

breadth of data from cow exposure through weaning, providing a view of the whole production cycle.

“Weaning weights of calves is a relatively poor indicator of production efficiency as it only focuses on the elements of what went right in our production system, rather than the true picture of the entire system or cycle. Weaning weight per cow exposed includes the failures in the production system, such as reporting of cows that didn’t conceive, death loss, etc.,” he says.

“Crossbreeding systems generate value through improvements in a number of calf and cow traits. **About two-thirds of the economic value from crossbreeding comes from having crossbred cows, so if you only produce crossbred calves from straightbred cows, you miss about two-thirds of the free lunch from heterosis.**”

Financial focus

Weaber and Rolf report economic advantages from the crossbred cow include increased longevity of 1.36 years over their straightbred counterparts in the same production environment, as well as nearly one calf on average more in the cow’s lifetime. The enhanced longevity and fertility yield an additional cumulative 600 pounds of weaning weight from the crossbred cow. The result is greater profitability in cow-calf production.

Digging deeper, the advantages of a crossbred calf over a straightbred counterpart also reveal the impact of heterosis. Crossbred calves have 3.2% better calving rate; have 1.4% greater survivability to weaning; a 1.7-pound increase in birth weight; a 16-pound increase in weaning weight and; a 29-pound increase in yearling weight.

In summary, a guideline is that there is a about a 4% improvement in growth rate for the individual calf and about a 4% maternal effect on weaning weight with a crossbred calf.

Impact on profit

“Crossbreeding is one of the few technologies that appears to demonstrate a return on investment though an increase on revenue and a decrease in costs,” says Weaber. The two KSU researchers report when the cowherd lasts longer, fewer replacement heifers are needed to maintain herd size, thus decreases replacement costs. This reduction in replacements

provides the opportunity for more heifers to be marketed along with their steer mates to positively impact revenues.

The individual calf advantages from crossbreeding may seem limited. However, taking the improvements of reduced death loss and increased growth, the results overall can be substantial.

Using heterosis estimates from scientific literature, Weaber keeps an updated tally on the impact heterosis can have on a typical 100 head cow herd. Consider a herd with an 80% weaning rate, a 575 pound average weaning weight and over a 10-year time horizon. Then factor in the impact of weaning weight per cow exposed, a crossbred herd's increased annual productivity is equivalent to 18 more 575-pound calves.

What does this mean to a producer's bottom line? The value of this improved productivity due to crossbreeding in Weaber's example is worth \$150 per cow per year, using current calf prices of approximately \$1.50 per pound for a 5-6 weight.

For a straightbred operation to be competitive, the straightbred calves would have to generate \$198 per head more revenue to be equivalent to this crossbred herd. The straightbred herd weans fewer calves so each calf sold has to proportionally generate more income.

To make crossbreeding work for your operation, keep it simple by choosing a system that will work within your resources and managerial ability. Build a plan with attainable goals and stick to it.

B. Lynn Gordon is a freelance writer from Brookings, S.D.

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https://www.youtube.com/watch?v=IMNv_PqolDI&index=9&list=PLsDMBXSb2jYcUGaCNrQ09f0JxDJXJQu24

Cattlemen's Webinar Series: The 4 S's of Crossbreeding

Structured crossbreeding systems have been shown to have substantial impacts on the production efficiency of commercial cow-calf operations. Join the webinar to discuss keys for successful and profitable crossbreeding systems that enhance profit and sustainability. Managed heterosis, simple breeding systems and breed complementarity are the key value drivers you'll learn about.

<https://newsroom.unl.edu/announce/beef/1922/12111> Crossbreeding and the Benefits of Heterosis **By Dr. Matt Spangler, UNL Beef Genetics Specialist** The decision of whether or not to utilize a particular strategic system of crossbreeding depends upon individual production goals. First must come the blinding realization that no one breed excels in all areas that lead to profitability. In order to take advantage of breed complementarity, breeds must be paired such that they excel in different areas that are critical to the overall production goal(s). Advantages of crossbreeding can be thought of as: 1) Taking advantage of breed complementarity, 2) Taking advantage of non-additive effects (dominance and epistatic) thus leading to capturing heterosis (hybrid vigor).

<https://extension.psu.edu/crossbreeding-is-a-good-idea> Crossbreeding is a Good Idea - Crossbreeding is a good idea because heterosis is free money.

A word of caution

Just because you mate cattle of different breeds does not mean there will be a large heterotic or average breed effect. Selection of the parents for their potential genetic contribution to a trait (called the additive genetic effect) will be more important than heterosis or breed effects. The use of EPDs and other selection tools within a breed should not be discarded for the sake of heterosis. Heterosis will not improve poor cattle. Adapted from Cundiff et al., 1994

Crossbreeding improves more lowly heritable traits

Heritability describes the proportion of the variation in a trait due to genetics as compared to the environment (nutrition, health, etc.). More lowly-heritable traits-such as milk production, longevity, reproductive fitness-will result in more heterosis than highly heritable traits such as carcass traits. Table 3 shows how important traits vary in heritability.

Table 3. Heritability and Heterosis

Traits	Heritability	Heterosis
Reproduction	low	high
Growth	medium	medium
Carcass	high	low

<https://www.pubs.ext.vt.edu/400/400-805/400-805.html> Crossbreeding Beef Cattle 400-805 Scott P. Greiner, Extension Animal Scientist, Virginia Tech 540-231-9159 sgreiner@vt.edu Ph.D., Animal Science (Meat Science), 1997, Iowa State University M.S., Animal Science, 1992. Michigan State University B.S., Animal Science, 1989, Iowa State University

Another key factor for crossbreeding sire selection is **the matching of frame score across the individual bulls selected. Frame score has a strong relationship with cow size. Therefore, minimizing differences in the frame scores of the bulls used to produce replacement females will assist in minimizing differences in mature size of the resulting cowherd.**

<https://www.drovers.com/article/inexpensive-effective-method-weaning-more-total-pounds> An Inexpensive but Effective Method for Weaning More Total Pounds Justin Rhinehart, University Of Tennessee June 26, 2018 10:11 AM

Phone: (931) 486-2129 email: jrhinehart@utk.edu Ph.D., West Virginia University, Reproductive Physiology, 2007 M.S., University of Kentucky, Reproductive Physiology, 2003 B.S., University of Tennessee, Ag. & Extension Education, 1999

To dispel a couple of the major misconceptions before going further, it is important to note that crossbreeding does not necessarily mean introducing bos indicus (“eared”) genetics, although that might be a good option in several scenarios.

..... Traits that are lowly heritable show little response to selection for improvement but respond well in heterosis. Fortunately for the commercial cow-calf producer, those traits that respond well to crossbreeding are reproductive traits (fertility, ability to recycle after calving, settling on first service, mothering ability, etc.).

..... Many studies have shown that traits high in heritability respond well to selection for improvement, but show little response in heterosis. Traits that are lowly heritable show little response to selection for improvement but respond well in heterosis. **Fortunately for the commercial cow-calf producer, those traits that respond well to crossbreeding are reproductive traits (fertility, ability to recycle after calving, settling on first service, mothering ability, etc.).**

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http://www.rangebeefcow.com/2015/proceedings/10Weaber_117-130.pdf Proceedings, The Range Beef Cow Symposium XXIV November 17, 18 and 19, 2015 Loveland, Colorado CROSSBREEDING STRATEGIES: INCLUDING TERMINAL VS. MATERNAL CROSSES R.L. Weaber Department of Animal Science and Industry Kansas State University

Traits such as reproduction and longevity, essential for cow-calf profitability, have low heritability. These traits respond very slowly to selection but heterosis generated through crossbreeding can significantly improve an animal’s performance. **The largest economic benefit (roughly 66%) of crossbreeding to commercial producers comes from having crossbred cows (Table 2.) Crossbreeding has been shown to be an efficient method to improve reproductive efficiency and productivity in beef cattle.**

...In general the Zebu (Bos indicus) crosses have higher levels of heterosis than the British-British, BritishContinental, or Continental-Continental crosses.

A well-constructed crossbreeding system can have positive effects on a ranch’s bottom line by not only increasing the quality and gross pay weight of calves produced but also by increasing the durability and productivity of the cow factory.....

it is essential that profit minded producers develop a clear understanding of the economic tradeoffs of concentrating the percentage of one breed in a breeding system and the corresponding decreased heterosis and associated reduced production efficiency.

...Crossbreeding and sire selection are complementary and should be used in tandem to build an optimum mating system in commercial herds.....The biggest keys to success are the thoughtful construction of a plan and then sticking to it! Be sure to set attainable goals. Discipline is essential...**Regardless of the crossbreeding system selected, a long-term plan and commitment to it is required to achieve the maximum benefit from crossbreeding**.....As producers seek to produce environmentally adapted crossbred cows and market targeted progeny, separation in sire selection decisions for dams that will produce replacements and dams that produce terminal progeny is encouraged..... The breeds included

have similar genetic potential for calving ease, mature weight and frame size, and lactation potential to prevent excessive variation in nutrient and management requirements of the herd.

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<https://articles.extension.org/pages/74072/crossbreeding-for-the-commercial-beef-producer>

Crossbreeding for the Commercial Beef Producer

Alison Van Eenennaam University of California, Davis alvaneennaam@ucdavis.edu

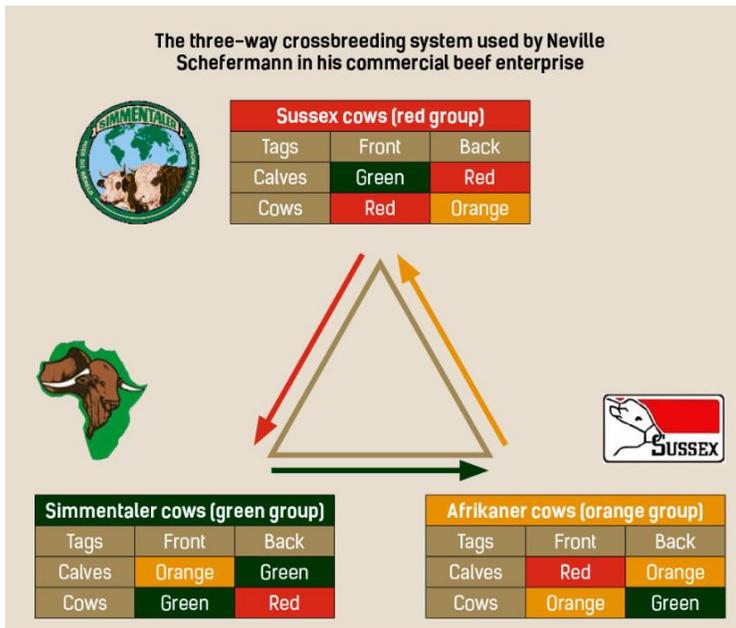
Crossbreeding has been shown to be an efficient method to improve reproductive efficiency and productivity in beef cattle. **The greatest impacts on profitability from heterosis are the increases in overall production and the longevity of crossbred cows** (Table 1).

Trait	Heritability	Level of Heterosis
Carcass/end product Skeletal measurements Mature weight	High	Low (0 to 5%)
Growth rate Birth weight Weaning weight Yearling weight Milk production	Medium	Medium (5 to 10%)
Maternal ability Reproduction Health Cow longevity Overall cow productivity	Low	High (10 to 30%)

The benefit of increased longevity should not be underestimated. Crossbred cows will stay productive longer. Cows are most productive between five and ten years of age. From an economic standpoint in a commercial herd it is best to have a high percentage of the cow herd in the 5 to 10 year age group and minimize the number of replacement heifers that are retained each year.

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<https://www.farmersweekly.co.za/animals/cattle/beef/three-way-crossbreeding-for-optimal-production/>



The Sussex genetics, also *Bos taurus* and originating from south-east England, were desirable because Neville's family wanted a beefier, fertile, and adaptable animal with good mothering abilities. The *Bos indicus* Afrikaner breed was chosen for its hardiness, red colour, good temperament and the fact that, according to Neville, the cows invest considerable energy into growing their calves.

Finally, crossing *Bos taurus* and *Bos indicus* genetics introduces desirable hybrid vigour. The commercial beef enterprise on Alford Farms

currently runs three separate breeding cow herds.

Notes on how to use EPDs within Same breed of Sire: From American Simmental Association staff discussions April 2, 2019. These notes came from emails I had back and forth with ASA Staff members.

"disclaimer" on ASA document (see below):

Important disclaimer: DO NOT compare index values of purebreds of different breeds, hybrids of different breed composition or purebreds with hybrids — our system was not developed to make valid comparison among these groups. Therefore, you must first determine the breed and breed composition appropriate for your herd and use index values to compare animals within that population.

My (Joe)statement in the email:
Is this correct?

Use API to select the most profitable females within a group of females that all have the "same breed of sire"?

Do not compare API between two females that have different Sire Breed?

API does not reflect any effect heterosis has on the genetic potential of the female?

ASA response: **You have it down perfectly!**

When doing sire selection for breeding, look at the EPDs of the group of females that he would breed to determine which areas need the most improvement and, therefore, which bull EPDs to focus on to try to improve the calves coming from those matings?

. That said, since their daughters are different breed proportions than the mothers... and that you're actually gauging terminal traits with your ratio... the API comparison is something we shouldn't even be making between daughters sired by different sire breeds.

Joe,
There is no doubt that nobody scrutinizes things as well as you!

----- ASA document --

Quick Reference to ASA EPDs and \$ Indexes

Expected Progeny Differences (EPDs): EPDs are the most accurate and effective tool available for comparing genetic levels. In using EPDs, the difference between two sires' EPDs represents the unit difference expected in the performance of their progeny. For example, if sires A and B have EPDs of +10 and -5, a 15-unit difference would be expected in their progeny (moving from -5 to +10 yields 15 units). Key to using EPDs is knowing what units they are expressed in. For example, if the above case referred to weaning weight EPDs, A would be expected to sire 15-*pounds* more *weaning weight* than B. If calving ease were the trait, A would be expected to sire 15-*percent* more *unassisted births* in first-calf heifers; in other words, if B sired 30 assists in a group of 100 heifers, we'd expect A to require 15 assists. A percentile-ranking chart is required to determine where a bull's EPDs rank him relative to other bulls in the breed. For percentile rankings or more detailed information about EPDs and \$ indexes visit www.simmental.org. Listed below are the units ASA EPDs are expressed in:

All-Purpose Index (API): Dollars per cow exposed under an all-purpose-sire scenario. (See below for more details.)

Average Daily Gain (ADG): Pounds of postweaning daily weight gain.

Back Fat (BF): Inches of backfat.

Birth Weight (BW): Pounds of birth weight. **Calving Ease (CE):** Percent of unassisted births when used on heifers.

Carcass Weight (CW): Pounds of carcass weight.

Docility (DOC): Percent of offspring achieving a docile (1) score.

Maternal Calving Ease (MCE): Percent of unassisted births in first-calving daughters.

Milk (MLK): Pounds of weaning weight due to milk.

Marbling (MRB): Marbling score.

Maternal Weaning Weight (MWW): Pounds of weaning weight due to milk and growth.

Ribeye Area (REA): Square inches of ribeye.

Warner-Bratzler Shear Force (WBSF): Pounds of force required to shear a steak.

Stayability (STAY): Percent of daughters remaining in the cowherd at 6 years of age.

Terminal Index (TI): Dollars per cow exposed under a terminal-sire scenario. (See below for more details.)

Weaning Weight (WW): Pounds of weaning weight.

Yearling Weight (YW): Pounds of yearling weight.

Yield Grade (YG): Yield grade score.

\$ Indexes: Though EPDs allow for the comparison of genetic levels for many economically important traits, they only provide a piece of the economic puzzle. That's where \$ indexes come in. Through wellconceived, rigorous mathematical computation, \$ indexes blend EPDs and economics to estimate an animal's overall impact on your bottom line. The same technology that led to the dramatic progress in swine, poultry and dairy genetics over the last several decades was used to develop the following \$ indexes: **All-Purpose Index (API):** Evaluates sires for use on the entire cow herd (bred to both Angus first-calf heifers and mature cows) with the portion of their daughters required to maintain herd size retained and the remaining heifers and steers put on feed and sold grade and yield.

Terminal Index (TI): Evaluates sire for use on mature Angus cows with all offspring put on feed and sold grade and yield.

Using API and TI: First, determine which index to use; if you're keeping replacements use API, if not, TI. Then, just as with EPDs, zero in on the unit difference between bulls. (As described above, index units are in dollars per cow exposed.) The difference can be used to determine how much a bull is worth compared to another. Or, put another way, how much you can pay for one bull compared to another. For example, when buying an all-purpose-type sire, you can quickly figure a bull scoring +100 for API is worth an extra \$6,000 over a +50 bull if both are exposed to 30 cows over 4 years (\$50 diff. x 30 hd. x 4 yr. = \$6,000). A percentile-ranking chart is required to determine where a bull's index value ranks him relative to other bulls in the population. For percentile rankings or more detailed information about EPDs and \$ indexes visit www.simmental.org.

Important disclaimer: DO NOT compare index values of purebreds of different breeds, hybrids of different breed composition or purebreds with hybrids — our system was not developed to make valid comparison among these groups. Therefore, you must first determine the breed and breed composition appropriate for your herd and use index values to compare animals within that population.

Heterosis and its Impact Updated March 05, 2019 Grady Ruble *SDSU Extension Cow/Calf Field Specialist*

<https://extension.sdstate.edu/heterosis-and-its-impact>

If the cows are crossbred, every animal on the ranch is impacted by heterosis, which is a value that can be captured every year regardless of how the calves are marketed (Weaber, 2015). The added value due to heterosis is not subject to change like other branded beef programs, which makes the “premium” for heterosis very impactful.

<https://simmental.org/site/index.php/glossary/363-heterosis>

Term	Definition
Heterosis	The improved or increased productivity of hybrid offspring compared to the parents, also known as hybrid vigor. Some traits exhibit more hybrid vigor than others; for instance, fertility is a trait with a large improvement in crossbred offspring over the parents while carcass traits typically have less heterosis . The improvement above the average of the parents is due to non-additive traits.

fertility is a trait with a large improvement in crossbred offspring over the parents

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<https://www.internationalgeneticsolutions.com/>

"We're extremely proud of the collaboration we have with IGS. It really is the first of its kind in the world," says Stewart Bauck, vice president of Agrigenomics for Neogen Genomics. **"We will, along with IGS, be developing and refining a set of tools that we can make available to commercial producers so they can select superior females in a multi-breed or crossbreeding operation."**

" If we look at geneticists and the knowledge that we've gained from their research across the years, **we know that crossbreeding leads to hybrid vigor**, and so being able to **have crossbred commercial cows should really be the goal for any commercial cattleman because, at the end of the day, they sell pounds,**"

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<https://www.youtube.com/watch?v=FCCdapJkBVm&list=PLsDMBXSb2jYcUGaCNrQ09f0JxDJXJQu24&index=2&t=0s> Making the Best Use of Current Genetic Selection Tools Added Feb. 2020

Hair Shedding

- Proposed indicator for heat tolerance and tolerance to fescue toxicosis
 - Not an ERT
- Scored on a 1-5 scale in April-June
 - 5 = 0% shed; 4 = 25% shed, 3 = 50% shed; 2 = 75% shed; 1 = 100% shed.
 - Lower EPD more desirable
 - Scored on cattle of at least yearling age
 - $h^2 \sim 0.40$
 - Repeatability model used

18:20 - Spangler – there is no more important EPD for a herd keeping replacements than Stayability/longevity

Look at \$M and \$C in Angus EPD's. these have been changed

24:46

Some Reminders on Genomics

- Genomic selection
 - The use of genomic information to increase genetic merit in nucleus (seedstock) populations.
 - Conditional on data in the evaluation (predicting within the data space)
- Genomics at the commercial level
 - Using genomics to make selection decisions (e.g., replacement heifers) at commercial level
 - Marker effects will never be as reliable here (external population) as above (where effects are estimated from data of genotyped animals)
 - Represents a potential refinement after gross level genetic SOP is handled
 - Sire selection
 - Structured crossbreeding program

29:20 Spangler – use genomics AFTER using it on sire selection and AFTER implementing a “structured crossbreeding program”

Genomic Data in Commercial Populations

- The best use case is when genomic data enables capture of phenotypic data at the commercial level
 - Ties commercial animals to seedstock relatives
 - Improves seedstock genetic evaluations
 - Enables EPD on commercial animals that could be used for management purposes

Future directions

- Published evaluations have always been in expansion mode
 - A reductionist approach would seem wise (e.g., BWT)
- Making decisions, among a growing list of partial solutions, is challenging at best.
- Decision support software (IGENDEC) is under development to aid in the sire selection process
 - Enterprise specific indices
 - Across-breed comparisons
 - Accounts for additive and non-additive contributions

32: iGENDIC across-breed comparisons in a crossbreeding herd to compare the performance of sires of different breeds - to be released in beta version this summer (2020) and final version in 2021

From <http://www.bifconference.com/bif2019/documents/2019BIFSymposium-MattSpangler-ProducerApplications.htm>

After building the program, the team is charged with training the key technology adopters to accurately and efficiently use it.

“Part of that is filling existing knowledge gaps as they may relate to breed and heterotic effects for things that simply do not exist in the literature today,” Spangler said.

37 minutes Alison Van Eenennaam, Ph.D. (UC Davis) – for commercial operations – most important consideration is crossbreeding. It has more impact on profitability than any other input in a commercial operation. That is because of the improvement in reproduction and longevity. Lifetime production in weigh is increased by 36% for Taurus crossbreeding (English and Continental) AND EVEN MORE IF INDICUS CROSS IS ADDED.