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HAS SELECTION FOR MILK AND GROWTH IMPACTED REPRODUCTIVE PERFORMANCE?

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Introduction

Genetic trends in all major beef breeds show a dramatic increase in growth rate and many breeds have also shown gains in milking ability as well (Chart 1 and 2; Kuehn and Thallman, 2016). These factors can have a significant impact on the weight of calves sold, but does it lead to increased production and more importantly increased profit? With advancements in the accuracy of genetic selection tools it is imperative that we make economically sound selection decisions that consider all aspects of profitability.

Total production is a function of average calf weight times number of calves sold, so it is critical to know what the relationship between calf weight and number of calves sold is. If that relationship is positive, then all is good, as you increase weight you simultaneously increase the number of calves sold and total production obviously goes up. However, if that relationship is negative then we must make sure that an incremental increase in calf weight, through improved genetics for growth and/or milk, does not lead to a decrease in the number of calves sold to the point that total production is reduced.

Although production often gets the lion's share of attention, profitability should be the driving factor of all selection decisions. However, we often must be reminded that income does not equal profitability! Profitability is impacted by both income and costs. Income and production are closely related and have a strong positive correlation; at a fixed price, more pounds of calf sold results in more income. Unfortunately, the relationship between production and costs is usually unfavorable; higher levels of production typically come at greater costs. This is still a workable situation if we can maintain a positive return-on-investment. In other words, for every dollar spent we must ensure that our return is greater than a dollar. Ultimately, a selection index is the best tool to make selection decisions based on economics with all traits and their interactions considered.

This paper will explore some of the relationships between traits impacting production (growth, milk, and reproduction) and ultimately their impact on profitability.

Production

Total pounds of production in the beef herd is driven by the genetics the calves have for growth and survivability, the genetics their mothers have for milking ability and reproduction, the management (nutritional/health/reproduction) they are exposed to, the environment we place them in and interactions between all of these. The total production system is extremely complex and not well understood so we will break down some of the important relationships and their impact on production.

Growth

The growth rate of a calf is dictated by the genetics it possesses for growth, the level of nutrition that it receives and other factors such as health and environmental constraints. The focus here will be on the genetic portion. It is well documented that selecting bulls with higher genetic potential (Expected Progeny Differences; EPD) for weaning weight, yearling weigh or carcass weight will increase the growth rate to those marketing endpoints (Thrift and Thrift, 2006). It is also known that these traits are all positively correlated with each other meaning that as we select for higher (or lower) genetics for one trait we expect the other traits to respond in the same way. What this means to beef producers is that you can select bulls for high growth EPD, and the resulting calf crop should have increased growth rates at all phases of production. Up to this point, this is all good news; however, there are other correlated traits that need to be considered.

Growth at earlier ages, weaning and post-weaning has a negative genetic correlation with milking ability (Garrick et al., 1989) and a positive genetic correlation with mature cow size[1] (Bullock et al., 1993). Both relationships have points to be considered. The negative genetic correlation between growth and milk means that as selection is made on a population for increased growth there is an overall reduction in the level of maternal weaning weight (or milk) in replacement females. Depending on the management/environment that these females will be placed in determines whether this is an advantageous or disadvantageous relationship. The positive relationship between early growth and mature cow size is to be expected, as selection is made for higher growth, the resulting replacement daughters tend to be larger. So, if replacement daughters are kept from these matings and considering the total production of the farm, the initial impression is that this is an advantageous relationship because pounds of cull cows marketed would be increased. Where it could have a negative impact is if the larger cows are not provided with greater resources, then reproduction could be negatively impacted, resulting in fewer calves to market and potentially decreased total production.

Another trait that impacts growth and thus production is the milking ability of the mother. As the genetics for milking ability increases in the cow herd the weaning weight of their calves increases (Marshall et al., 1993) and it has been reported (Berry and Evans, 2014) that a positive genetic correlation between milking ability and some reproduction traits exists. From this perspective milk should have a positive impact on production, however, like with mature size, if nutritional resources are not increased to meet this increased output by the cows, then the result could be decreased reproductive capabilities and reduced total production.

[1] Mature cow size is an important concept to understand. When someone refers to a cow being large, do they mean it has a lot of frame (height) or weight? Which is more important? I think most cattle producers think of frame when referring to size and most scientists are referring to weight; this is a problem. Cows nutritional needs are based on their weight, not their frame. Genetic trends in Angus (Charts 3 and 4) indicate we have leveled off the rate of genetic trend for Mature Cow Height, but not Mature Cow Weight. This means we are continuing to add weight, which means we are continuing to increase the nutrients required to maintain reproductive efficiency. There are limits to how much a cow can eat, so when her weight exceeds her capacity to consume enough nutrients to meet both maintenance and production, reproductive efficiency will decrease.

Reproduction

Female reproduction, in general, is a lowly heritable trait which means direct selection for these traits tends to progress slowly because they are greatly influenced by non-genetic factors, and the greatest genetic influences are non-additive which cannot be selected for (Bormann et al., 2006). This does not mean that selection for reproduction traits should be avoided because even small, slow progress can significantly impact profitability. Research is varied but does not generally show a negative genetic relationship between growth and reproductive traits (MacNeil et al., 1984; Berry and Evans, 2014; Abreu et al., 2018). In other words, there is little evidence to suggest that selection for increased growth and/or milk has advantageous or adverse genetic consequences to reproduction. Therefore, for the purpose of this paper, the focus will be on the reproductive consequences resulting from the interaction of the genetics of growth and milking ability with nutritional inputs.

The relationship between cow maintenance and reproduction is described in a classic study by Selk et al. (1988). In this study cows were exposed to varying nutrition levels going into calving and on to breeding. The cows that were fed a maintenance ration all the way through had the highest pregnancy rate (71%), those that were restricted until calving and then fed above maintenance to breeding were next (58%), those restricted until calving and then fed at maintenance until breeding were third (51%) and those that were restrictive all the way through breeding had the lowest pregnancy rates (42%). A more recent study (Weik et al., 2020) showed improved A.I. conception and overall pregnancy due to increased body condition scores. The evidence is clear that if a cow's nutritional needs are not met she will decrease body condition and this will result in reduced reproductive performance.

As stated in the previous section, but worth mentioning again, is that increasing the genetics for production in the herd in the form of increased growth rate of the calves (and replacement daughters are retained) and milking ability of the cows comes with the obligation of increasing nutritional resources to meet increases in maintenance and production requirements of the cow. Another way to look at it is to consider that if you have a fixed resource of land and nutrient availability and you want to increase the growth rate and milking ability of your herd, then you would have to decrease the herd size or increase external inputs to maintain the same level of reproduction (Rasby, 2010). If we are not concerned about the economics of our actions, we must conclude that we can increase total herd performance by selecting for maximum growth and milking ability, and supply adequate nutritional resources to maintain high reproductive rates, regardless of the cost (Please do not interpret that this is what I am recommending). On the other hand, if we are profit conscious then we must search for the right balance of these traits and our available resources.

Economic Efficiency (Profitability)

Increasing the total production of the herd is very simple to accomplish. Select bulls with high genetic potential for growth and milking ability, retain replacement heifers, and supply endless resources to the herd. Since these traits have reasonable heritabilities, the calves will have the genetics for growth and the nutrients, through both milk and other resources, to meet their genetic potential. As a result of these selection practices our cows will become larger and heavier milkers, but with endless resources reproduction can be maintained and productivity maximized. If you look at the genetic trend charts (Charts 1 and 2), this is exactly the model that some breeds appear to be implementing. Unfortunately, this model may not be the best if economic efficiency, hopefully profitability, are the goals.

Growth

To explore the implications of growth on economic efficiency we have to look closer at the relationship between calf growth and mature size. The genetic relationship between calf growth and mature size is very high (Bullock et al. 1993). This means that if bulls with high genetic potential for growth are purchased and replacement heifers are retained, we can expect the mature size of our cows to increase. This results in a positive impact on income (calf market and cull cow value), but there are costs that must be considered. Heavier cows have greater nutritional demands, which means they require more resources (acres of pasture or increased supplemental feed) to maintain an acceptable reproduction rate than lighter cows.

The question becomes, what is the relationship between the increased income and increased costs associated with a pound of genetic improvement for market weight? In other words, what is the return-on-investment? To answer this question definitively, we would have to know the future price structure of calves and cull cows and the exact relationship between mature cow weight and calf market weights. Lalman et al. (2018) suggests that each additional 100 pounds of mature weight results in between $6 and $30 of additional calf income, but the costs for an additional 100 pounds of mature weight were close to $42. Lalman et al. (2018) states:

> *To take this a step farther, in several published economic evaluations of varying cow size and a given land resource, smaller and moderate cows have a financial advantage for three primary reasons: 1) higher stocking rates for smaller cows result in more pounds weaned per acre; 2) lighter calves sell for a higher price per cwt; and 3) the increased revenue from added weaning weights do not offset the higher feed costs of larger cows (Bir et al., 2018).*

They further state there is additional cull cow income in the larger cows when they are marketed, but likely does not exceed the additional costs of development and maintenance. Bottomline, it appears that selection for high calf growth, particularly to extremes and/or with limited nutritional resources and without selection to control mature cow weight, is not cost-effective.

Milk

Adding growth through milk becomes even more difficult to assess from an economic standpoint. David Lalman (personal communication, 2022) summarized multiple studies to suggest it takes about 42 pounds of milk to put on a pound of calf weight gain. It would require approximately 275 pounds of additional forage dry matter to produce an additional 10 pounds of weaned calf due to increased milk production (NASEM, 2016 and Jeff Lehmkuhler, personal communication, 2022). In other words, when comparing two bulls with a 10-pound difference in Milk (EPD), daughters from the bull with the higher milk value would require an additional 275 pounds of forage dry matter during lactation to maintain the same level of body condition. Using some crude estimates of increased pasture needs and additional hay/supplements, that comes out to less than $5.00 of increased feed cost for $18 of additional calf value (assuming $180/cwt calf prices). Based on this, the initial thought would be to put as milk in a cow as possible and reap the benefits. However, as suggested before, there are limits to how much a cow can consume, especially in pastures with sparce or low-quality forages. To meet maintenance, an average weight cow (1400 pounds) producing average milk (25 pounds per day) would need about 20.5 pounds of TDN or 20 Mcals of energy and 3.5 pounds of crude protein (NASEM, 2016). As you add more mature weight and milking ability these values continue to increase and can easily exceed a cow's ability to consume that quantity, leading to potential reproductive failure.

Reproduction

Reproductive efficiency is generally achieved through supplying the appropriate nutritional resources to meet the demands of the females. This means that reproduction can usually be maintained in a herd if the cows are fed adequately and based on the previous sections this means that larger cows require more nutrition and heavier milking cows require more nutrition, but does it meet our return-on-investment standard of returning at least one dollar for every dollar invested?

It may be possible to calculate the reduction in reproductive efficiency we could expect to see if we did not increase our resources as we increased our productive capabilities of our cows, but this would require a lot of speculation and guesstimation. Fortunately, this is not required; the better approach is to simply look at the increased cost associated with increased growth and milk to maintain a constant level of reproduction. This is exactly what we did in the two sections above. Based on those conclusions, it is evident that reproduction would be negatively impacted if we did not increase our resources as we increase productivity and that when we do supply the necessary resources to maintain reproduction it may not be cost effective.

Summary

Total herd production is an important aspect of any beef operation, but we need to keep everything in perspective. Growth in the form of direct genetics for gain and the milking ability of the cow herd are important factors in herd productivity and the income portion of profitability, but they are certainly not the whole picture. Increased productivity that results from heavy mature cows and/or extreme milking cows, without providing adequate nutrition may result in reduced reproduction and potential loss of profitability. Additionally, if the cows exceed their ability to meet their nutritional needs through low-cost foraging, then higher cost supplementation may be required or reductions in reproduction will likely occur, likely wiping out potential profits. The best way to make the proper selection decisions is using a selection index, and preferably one that is based on your available resources and marketing method (Spangler et al., 2022).

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Chart 1: Genetic Trends for Weaning Weight in Several US Breeds (Kuehn and Thallman, 2016).

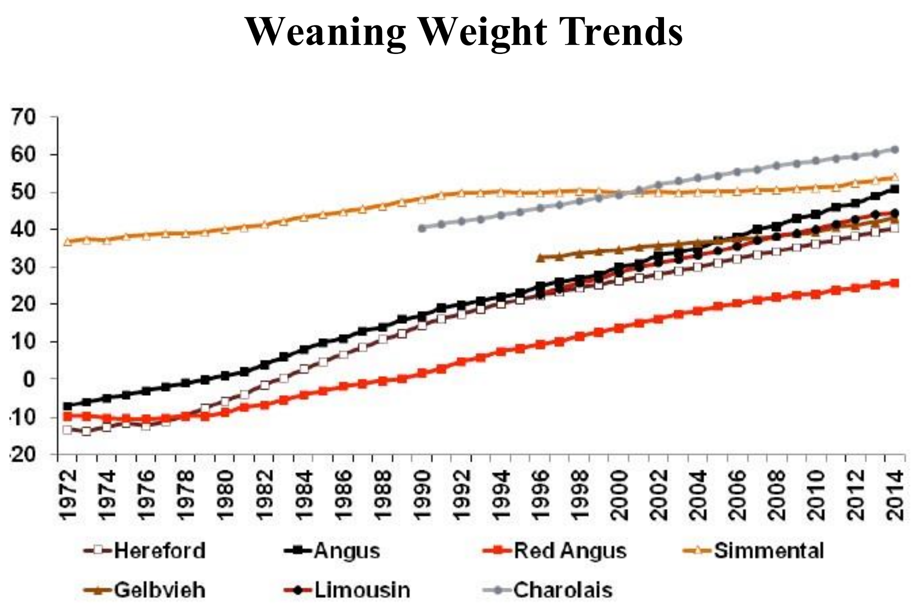

Chart 2: Genetic Trends for Maternal Weaning Weight (Milk) in Several US Breeds (Kuehn and Thallman, 2016).

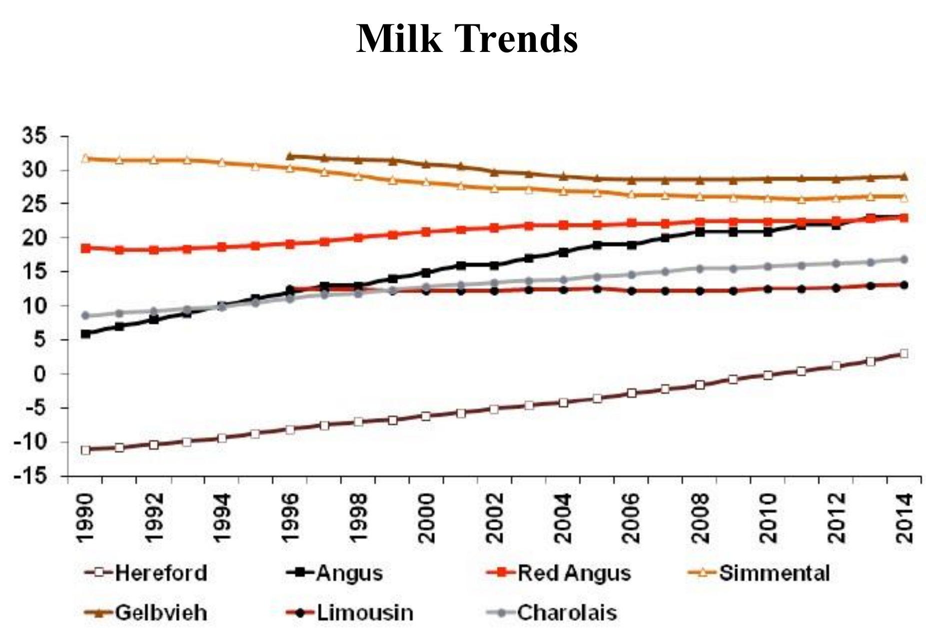

Chart 3: Genetic Trend for Mature Height in Angus Cattle (Angus.org).

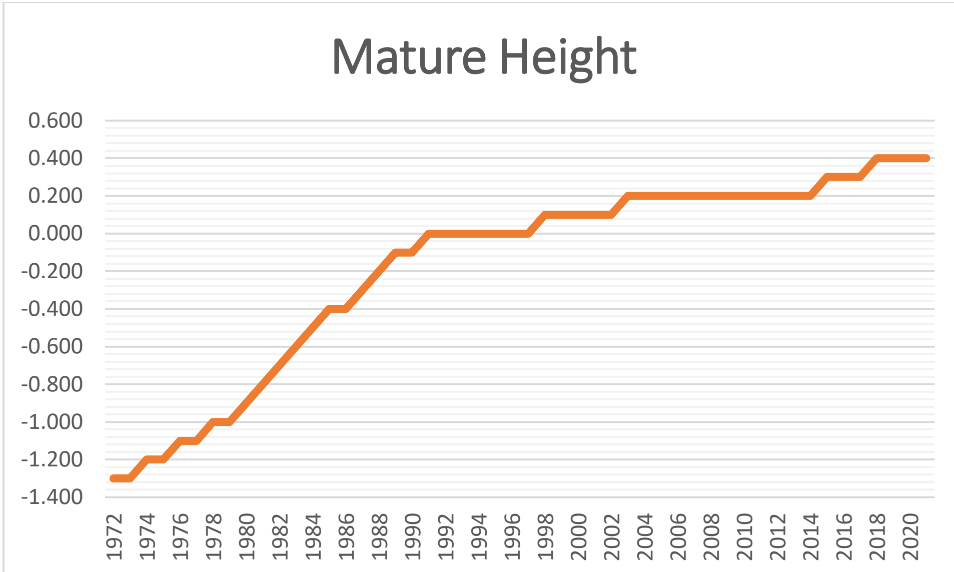

Chart 4: Genetic Trend for Mature Weight in Angus Cattle (Angus.org).