

Modern Dairy Genetic Options

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Dairy producers and dairy cattle breeding companies should breed for more profitable dairy cattle. Producers are limited in their breeding decisions by the genes or families in the populations available and this is primarily under the control of breeding companies. Past selection for increased production and for improvement in several other traits (such as udder conformation) has been very successful. However, the genetic antagonism between production traits and health and between production traits and reproduction have resulted in increased disease rates and reduced reproductive performance in US dairy cattle. Some recent additions to our genetic evaluations (genetic evaluations in the US are called predicted transmitting abilities or PTAs) will help to breed more profitable, problem-free dairy cattle and will reduce or eliminate the downward trend in reproductive performance.

An important concept to improve cattle is the method used for making selection decisions when several traits should be considered in the selection criteria. Selection can be based on setting independent culling levels for all the important traits or by using a well-designed selection index where all the important traits are weighted based on their importance. Using independent culling levels requires breeders to set minimum or maximum values for genetic evaluations for all traits in the selection criteria. These minimum or maximum levels are critical and difficult to assign in some situations. A selection index allows the ranking and subsequent selection of individuals based on a single composite value. The index will properly weight each of the component traits. In addition, the selection index method of selection will always be more efficient at improving the breeding goal when compared to using independent culling levels. The efficiency of the selection index compared to independent culling levels increases as the number of traits used for selection increases. Breeding companies and producers should make their selection decisions based on well-designed selection indexes.

Many factors impact the traits that we should include in our breeding goal and the traits that we should use in making our selection decisions. In general, traits that have higher heritabilities tend to be easier to change through selection. However, traits with low heritabilities can be important in breeding programs, especially where progeny testing is an option. Medium to large progeny groups and indirect selection using correlated traits can make it possible to improve traits that have low heritabilities. Genetic correlations between the traits to be used for making selection decisions and the traits in the breeding goal are as critical as the heritabilities. These genetic correlations dictate how selection on one trait impacts a second trait. Selection on one trait to try to improve another trait is called indirect selection. Genetic correlations tell us how the genes that affect one trait impact the second trait. Many producers are familiar with the concept of selection for better udders and lower somatic cell counts (SCC) to ultimately improve udder health. Most dairy producers agree that to make their herd and the dairy population more profitable, we need to (1) improve production of milk and its components, (2) reduce the inputs required for milk production or increase feed efficiency, (3) reduce metabolic and digestive diseases, (4) improve udder health, (5) reduce lameness and foot and leg diseases, (6) improve cow fertility and reproduction, (7) reduce calving problems, (8) improve calf survival, and

(9) improve husbandry aspects (such as temperament and suitability to our milking equipment). We could probably add a few more minor characteristics to this list. I did not explicitly include reduced death rates and increased longevity in this list because they are indirectly reflected in these items. Several items on the list are very costly because they can result in cow death losses and cause premature culling. Death rates have increased substantially over the past 10 years on US dairy farms. The most frequent reason for cows leaving herds in Tennessee DHIA herds (as well as many other states) is on farm death. Cow death rates are approaching 10% on many US dairy farms up from 2 to 3% in the early 1990s. Survival is critical and must be addressed in some way. Selection based on PTAs for productive life is essentially an attempt to improve several of these breeding goal traits and ultimately reduce the culling and death that results from health problems.

In the US we do not have highly accurate PTAs for some of the traits listed in the breeding goal (above paragraph). However, we have recently added traits that allow us to select for improved reproductive performance and reduced calving problems. Currently in the US we have PTAs to help us with most of the important traits in our breeding goal. However, we still lack accurate PTAs or accurate indirect information for diseases and for calf survival. In some European countries (especially in Scandinavia), dairy cattle breeders have had access to accurate genetic information on most breeding goal traits for two decades or more.

Lifetime Net Merit (LNM) and related indexes in the US are likely the best US indexes to use for many dairy producers in the US. The focus in this paper will be on LNM in Holstein cattle although LNM is similar for the other breeds. The traits included in LNM and their relative emphases follows: protein yield (33%), fat yield (22%), productive life (11%), SCC (9%), udder composite (7%), daughter pregnancy rate (7%), feet and legs composite (4%), body size composite (3%), daughter calving difficulty (2%) and service sire calving difficulty (2%). Weights for SCC, body size composite, daughter calving difficulty and service sire calving difficulty are designed to reduce the magnitude of these traits.

Selection for increased protein yield and fat yield should continue. However, the emphasis on these traits has declined in recent years because of the recognized importance of other traits and the antagonism between yield traits and functional traits.

Productive life receives 11% of the emphasis in LNM. In the future, as accurate PTAs for health traits and other functional traits come available, the emphasis on productive life will likely decline. However, productive life is currently important for the selection of functional traits not included elsewhere in LNM. Productive life likely helps to improve reproductive performance and health traits to a limited extent despite the low accuracy of productive life evaluations on cows and bulls with daughters that have not had the chance to be in herds for multiple lactations. Bulls with high productive life PTAs tend to have daughters with better reproductive performance and with improved health. Longevity evaluations are not very valuable for selection within Scandinavian dairy populations because they have genetic evaluations for most health traits and reproductive traits. However, longevity evaluations from other non-Scandinavian countries are useful to Scandinavian countries because the longevity

evaluations provide some information to the Scandinavians about functional aspects of animals from outside their populations.

Somatic cell counts and udder composite are included in LNM to improve mastitis resistance and reduce labor associated with milking. In the US like most other countries we do not have a system for consistently recording mastitis in the population and thus do not have direct PTAs for mastitis. Indirect selection using SCC and udder traits is the current method for improving mastitis resistance. Results from several studies indicate that bulls with the lowest daughter SCC have daughters with the lowest frequency of clinical mastitis. Selection for lower SCC will reduce mastitis. In addition, selection for higher, more tightly attached udders (improved udder composite) will also reduce mastitis and improve longevity. Selection for improved udder conformation and, recently, for reduced SCC has helped US dairy populations to minimize increases in susceptibility to mastitis that could have resulted from continued intense selection for increased yield.

One of the most recent traits to be added to LNM is daughter pregnancy rate. Predicted transmitting abilities for daughter pregnancy rate receive 7% of the emphasis in LNM. Daughter pregnancy rate is calculated as a function of days open so daughter pregnancy rate reflects days open. A 1% change in daughter pregnancy rate is equivalent to 4 days open. Selection for improved daughter pregnancy rate will improve reproductive performance over time. However, reproductive traits, including daughter pregnancy rate, have low heritabilities so progress in these traits will be slow. Our expectation is that including daughter pregnancy rate in LNM and using daughter pregnancy rate in selection will result in slightly improved reproduction after a few years. Any decline in reproductive performance from selection for increased yield will be eliminated.

Feet and legs composite receives 4% of the emphasis in LNM. Lameness is a huge problem for many dairy producers. Costs associated with lameness continue to increase as does the frequency of lameness in many herds. Selection for improved feet and legs will reduce lameness but the improvement will be slow. Low heritabilities and moderate genetic correlations between feet and leg traits and lameness limit the improvement in lameness that we can expect from our current selection programs. Lameness and feet and leg disease data, if routinely available, could help our current selection procedures to reduce lameness problems.

Body size composite receives 3% of the emphasis in LNM. The intent of including body size composite in LNM is to keep selection on other traits from increasing average size of our dairy cattle and to perhaps increase feed efficiency. Selection for higher udders by using udder composite and selection for increased yield could result in unwanted increases in size if not for the inclusion of body size composite in LNM. Research results from many studies indicate that genetically larger dairy cattle are not desirable for modern production practices.

Daughter calving difficulty and service sire calving difficulty are each included in LNM at a 2% level. Recent availability of PTAs for daughter calving difficulty made it desirable to include these traits in our selection process. The expected result is a small decrease in calving difficulty after several years.

Lifetime Net Merit is the most complete and best index that we have ever had available in the US for making genetic progress. Former indexes lacked one or more of the important traits that are included in LNM. Newer TPI and JPI formulas closely resemble LNM. However, final score for type is not included in LNM because of its emphasis on increased size and angularity in final score. Recent TPI formula has included a negative weight on dairy form. Future revisions of LNM may include more emphasis on dairy form or body condition score.

Nutritionists and physiologists have recognized for a long time that very thin cows have more health and reproductive problems than cows that maintain adequate body energy reserves (especially during early lactation). Within most herds, those cows that are very thin tend to have more problems than those that are able to maintain adequate body reserves. Recent research indicates that these relationships hold true at the genetic level as well. Bulls that sire daughters with higher dairy form (more angularity) scores also have daughters with higher disease frequency. Higher dairy form scores are closely associated with lower body condition scores. Body condition scores reflect body energy reserves. In addition, lower body condition scores are genetically associated with reduced reproductive performance. Selection for reduced dairy form and higher body condition scores will have a desirable impact on disease resistance and reproductive performance.

In many herds, body condition scores are used by herd managers to help make daily management decisions. Excessively fat cows are more likely to have problems at or shortly after calving. Low body condition scores (thin cows) and excessive loss of body condition in early lactation are associated with reduced reproductive performance as well as feeding or other management problems. Low body condition scores and high angularity scores are also associated with high milk production so managers and breeders often talk about cows that look like they produce high milk yields. In US breeding programs we have selected for increased yield and purposely selected for increased angularity or increased dairy form/character (partly through the use of final type scores that are considerably influenced by dairy form/character) at the expense of body condition. Essentially we have selected for high milk production and had additional selection for cows that look like they produce very well. The show ring has likely perpetuated the selection of cattle that “look like high producers” because actual production is not used in most shows for placing.

We now know that sires with higher genetic evaluations for dairy form (have daughters that are more angular and thin) also tend to produce daughters with a higher disease frequency. This relationship seems to hold for all categories of diseases including reproductive diseases, metabolic and digestive diseases, and foot and leg diseases. In addition, the relationship between dairy character or dairy form and diseases is unfavorable after removing the impact of yield (since yield is related to both dairy character and the diseases). In other words, if you take two sires with equivalent daughter production, the sire with the daughters with the lowest dairy form scores or lowest dairy character scores would be expected produce daughters with lower disease incidence. Selection for more angularity leads to deterioration in disease resistance.

So what is the relationship between strength and disease frequency, or between body depth and disease frequency? Some people expected body depth and strength to have favorable

genetic relationships with disease frequency but recent studies indicate that these measures were not strongly related to disease frequency. Unfortunately, selection for increased body depth or increased strength will likely have little impact on diseases in dairy cattle. Of course, selection for vigorous and healthy cows is justified but it appears that strength and body depth do not give us a very good indication of vigor and disease resistance. Breeding programs around the world need to rethink how they are using dairy form, angularity and body condition scores in their selection programs as genetic evaluations for these traits may provide useful selection information to improve reproductive performance and disease resistance.

Calving difficulty is known to significantly impact the economic efficiency of dairy production. Most developed countries have genetic evaluations for service sire calving difficulty (calving difficulty as a trait of the calf). In addition, some countries have genetic evaluations for daughter calving difficulty (calving difficulty as a trait of the mother). Research results indicate that the only trait other than actual daughter calving difficulty currently measured in most countries that might be useful to improve daughter calving difficulty is rump angle. More slope from hip bones to pin bones is genetically associated with decreased maternal calving difficulty so selection for more slope to the rump may be justified in Holstein populations.

Crossbred cows currently make up a small proportion of dairy cows in the US, but crossbreeding is gaining in popularity in the US. Somewhere between 25 and 50% of the herds in Tennessee are probably utilizing some crossbreeding. Crossbreeding is gaining popularity because producers are beginning to recognize the advantages in health, reproduction and survival that can be expected from crossbred cows. Inbreeding problems in purebred cows are eliminated in crossbred offspring. In Tennessee, Holstein X Jersey crosses are most prevalent but Brown Swiss crosses are being used in several herds. Semen from Scandinavian Red breeds is also being used in several herds. Scandinavian Red crosses with Holsteins and Jerseys may fit very well in many US herds. Crossbreeding is not for all dairy producers but commercial dairy herds may be able to benefit from crossbreeding. Purebred herds should not be threatened by crossbreeding in commercial herds because purebred herds are needed to produce sires used in crossbreeding programs. For those herds adopting crossbreeding, it is important to use good sires and to use 3 (or more) breeds in a rotation. Commercial producers should take advantage of the improvements that result from purebred selection programs but can also see improvement in many traits (especially health and reproductive traits) from crossbreeding.

In the future, several new technologies will impact the way we breed for improved profitability in dairy cattle. For example, robotic milking may increase the importance of some traits like udder conformation and cow behavior. Increased data collection will occur because of increased automation and some of the new data may be useful for improving dairy cattle. The routine measurement of electrical conductivity of milk for diverting milk from the human food chain may provide benefits in the genetic improvement area. In addition, DNA markers and specific genes identified may allow us to do a better job of choosing bull mothers and young bulls for progeny testing. Use of markers may especially be useful in selecting for traits with low heritabilities like health and reproductive traits.

