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The Merit Indexes – 2006 Version

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The Merit indexes are dairy sire selection tools published by USDA that combine genetic evaluations for production, health, fitness, and fertility traits. The indexes are designed to improve the lifetime economic performance of future dairy cows. Periodic revisions include new traits and adjusted economic weights. This document describes the indexes as revised for August 2006. Future changes are inevitable, thus the title "2006 Version." Differences in milk pricing systems in the U.S. result in three forms of the merit indexes: Net Merit, Fluid Merit, and Cheese Merit. All three indexes consider production costs as well as income streams associated with genetic improvement under commercial dairy conditions. Net Merit is designed for producers who ship to milk manufacturing markets where protein premiums are paid, Fluid Merit is designed for producers who ship to fluid milk markets with no protein premiums, and Cheese Merit is for producers who ship milk exclusively to cheese plants.

The indexes are widely available throughout the AI industry, as well as from many other sources such as the VT Dairy website, *http://www.vtdairy.dasc.vt.edu/genetics.htm*.

The Merit indexes include traits recorded by the DHI system (production, survival, somatic cell score, reproduction, calving ease and stillbirths), and breed association type data. Table 1 shows how the different traits are combined to estimate lifetime economic merit of daughters of a bull. The Merit indexes vary slightly from breed to breed, though details for Holsteins only are shown here. The indexes are expressed as lifetime net income in dollars (income minus costs) expected from daughters of a bull relative to the genetic base, which is zero for the average cow within each breed born in 2000. Separate proofs are available for each of the traits in Table 1. See *The Animal Model*, Virginia Cooperative Extension publication 404-086, or *Health and Fitness Traits*, Virginia Cooperative Extension publication 404-087, for more information about the individual traits.

Table 1. Weights assigned to different traits in Net, Cheese, and Fluid Merit indexes for Holsteins, 2006 version.

	Percent emphasis		
Trait	**Net Merit $**	**Cheese Merit $**	**Fluid Merit $**
Protein	23	28	0
Fat	23	18	23
Milk	0	-12	24
Productive life	17	13	17
Somatic cell score	-9	-7	-9
Udder	6	5	6
Feet/legs	3	3	3
Body size	-4	-3	-4
Daughter pregnancy rate	9	7	8
Calving ability	6	4	6

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Emphasis on protein, fat, and milk has declined in different versions of the Merit indexes, from 62 percent in 2000 to 55 percent in 2003 to 46 percent in 2006 for Net Merit. The reduced emphasis reflects how the marginal value of additional milk production has declined relative to the costs of maintaining health and reproductive fitness of cows that produce a lot of milk. Genetic evaluations for daughter pregnancy rate and the incidence of stillbirths have been published because of the increased importance of those traits. As new traits were added to the "Merit" indexes, emphasis on other traits, including production, was reduced.

The weights shown in Table 1 are established by the economic value of each trait and its genetic relationship to other traits in the index. These relationships can be quite complex, so interpretation of the "percent emphasis" on individual traits is not straightforward. For example, selection for higher yields (which increases income) also increases somatic cell score and decreases fertility, both of which increase costs of keeping cows in production. Likewise, genetic progress in each trait from selection on Net Merit is not easy to predict from the "percent emphasis" figures. For example, milk receives "0" emphasis in Net Merit, but is expected to improve by 2,340 pounds in the Holstein population over a 10-year period through selection on Net Merit. This is because milk, protein, and fat are controlled by many of the same genes and selection to increase pounds of protein and fat automatically increases milk production.

Traits other than milk, fat, and protein receive more combined weight in Net Merit than in Cheese Merit. The need for milk with high fat and protein components in cheese manufacture requires some selection pressure on decreased volume of milk, thus reducing the selection pressure available for fitness traits. Of the seven fitness traits, productive life, somatic cell score, and daughter pregnancy rate receive the most weight. Somatic cell score and body size are given negative weights in each index because lower cell counts and smaller cows are economically advantageous. The "calving ability" composite is expressed on a dollar basis where fewer difficult births and stillbirths are more valuable. Thus, calving ability has a positive weight in Table 1, but the Merit indexes favor bulls with lower evaluations for the calving difficulty and stillbirth proofs. For more documentation of how Merit indexes are calculated see *http://aipl.arsusda.gov/reference.htm*.

Reliability of Merit Indexes

Reliability of Net Merit is a function of the reliabilities of the individual traits in it. Reliabilities for individual traits depend on the number of daughters (and herds) with data in the proof and on the heritability of the trait. Heritabilities are highest (40 percent) for size, slightly lower (30 percent) for the production traits, below 10 percent for productive life and calving ability, and less than 5 percent for daughter pregnancy rate. For an equal number of daughters, reliabilities will be lower for traits with lower heritabilities. Keep in mind that the number of daughters in the proof for each trait varies considerably for individual bulls, especially when they are first released into active AI service. For instance, not all daughters with records used in proofs for milk are also scored for type.

Production traits are less important in Net Merit than they once were, but they are still important. Reliabilities of production traits dominate reliability of Net Merit. Several of the traits in Net Merit will have much lower reliabilities than milk or type proofs, especially on first crop daughter information, because heritability is lower for those traits. Thus, reliability for Net Merit will be less than PTA for milk, though not a lot less as the example below shows.

Published reliabilities for Merit indexes are calculated by a matrix algebra procedure. A good approximation is obtained by multiplying reliability of PTA for milk by 0.85 and adding reliability of PTA for productive life times 0.15. For a bull with reliabilities of 90 percent for milk and 60 percent for productive life, approximate reliability of Net Merit would be $.85(.9) + .15(.6) = .86$ or 86 percent.

Proofs with lower reliabilities are subject to more change (up or down) as new daughter information becomes available than are proofs with higher reliabilities. Change in proofs for individual traits may or may not affect Net Merit very much. Large changes in evaluations that receive little weight in Net Merit will not change the index much. If the evaluation for one trait changes in an unfavorable direction while another improves, the changes may offset each other. On the other hand, relatively small changes in the same direction for several of the more important traits in Net Merit may have a large combined effect on Net Merit. Producers should expect more change in Net Merit indexes than in proofs for milk production, but this should not discourage producers from using the Merit indexes. Producers should use the highest ranking AI proven bulls that fit a particular semen budget. If several AI sampled bulls are used, perhaps three to six, a decline in proof for any one bull will not affect the genetic merit of a heifer crop very much. Such advice is a double edged sword. Using too large a group of AI bulls in a herd breeding program prevents the best bulls from being used frequently enough to leave many daughters in a herd.

Rank Percentiles

USDA uses Net Merit to produce a measure called "Rank Percentile." It is the most useful single number available about the overall genetic merit of an AI bull. Interpretation of rank is straightforward. If a bull ranks at the 70th percentile, he is genetically superior to 70 percent of active AI bulls of his breed on the PREVIOUS active AI lineup. The previous list is used during "early-release" week when only owners of bulls see the evaluations. During "early-release" week, bull studs create a CURRENT active AI list with newly proven bulls added and older bulls removed. This list is the one released for use by the public.

Rank Percentile is important because it shows a producer how many "better" bulls are available than the bull in question. Individual bulls decline in rank with time even if there is no change in Net Merit. Genetically better bulls are continually added to the top of the active AI list, which increases the number of better choices than a bull with a constant Net Merit evaluation. Rank Percentile encourages use of bulls whose current genetic merit is outstanding and discourages producers from becoming attached to a familiar bull whose relative merit is declining. The recommended "target" for Rank Percentile of new service sires is the 80th percentile or higher. Semen price, availability of sufficient inventories of semen, and interest in genetic evaluations other than Net Merit can be valid reasons not to meet this target. However, producers should always consider the option of using a higher ranking bull when purchasing semen from sires below the 80th percentile. At some point as producers move down in rank percentile for proven bulls, AI young sires may be a better choice. Research (2, 3) has shown that around the 70th percentile is a good point to consider such an alternative.

Using the Merit Indexes

A list of available AI bulls, sorted on one of the Merit indexes, is all that is required. Bulls at the top of such lists have the best *combination* of traits used in the index. There may be good reasons not to use the very highest ranking bulls. Such bulls are in high demand, semen price may be prohibitive and supply limited. Very acceptable genetic progress can be achieved by selection of bulls further down the list – but do consider high ranking bulls first. Approximately 600 U.S. Holstein bulls are in active service in the United States at any one time. International sires swell those ranks even more. The top 20 percent of active AI Holsteins (those above the 80th percentile, well in excess of 120 bulls) will enable commercial herds to make excellent genetic progress and still allow choices based on semen price, availability, pedigree diversity, calving ease, and secondary selection on specific traits.

Summary

Net Merit, Fluid Merit, and Cheese Merit are comprehensive selection indexes designed to improve the lifetime economic merit of cows in commercial dairy herds. These indexes are available for three different milk markets. Producers in areas where no protein premiums are paid should consider Fluid Merit for sire selection, or find alternatives to top Net Merit bulls whose semen price is high because of high PTAs for protein. Another group of producers in the United States sell milk directly to cheese plants. Cheese Merit is the index of choice for such producers or for producers whose protein premiums are very high. Most commercial producers will want to use Net Merit to rank AI service sires.

Rank percentiles are the single most useful piece of information available on active AI bulls. Bulls above the 80th percentile are recommended for heaviest use. Not all cows can be bred to the top 20 percent of bulls for Net Merit because those bulls cannot produce enough semen for all such services. At some point in the relaxation of selection standards, young sires in AI sampling programs become a better choice for genetic improvement than lower ranking proven bulls. Young sires with the best pedigrees are very competitive with proven bulls at about the 70th percentile and genetically superior to proven bulls below that ranking. Heavy use of young sires is not the breeding program of choice for everyone, but they are worth considering in circumstances were proofs based on progeny performance are not judged to be critical.

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