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THE ROLE OF GENETICS IN HERD HEALTH

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In the efforts to reduce the costs and incidences of dairy cattle diseases, primary focus has been on improving management and environmental factors. It is well known that management and the environment play major roles in influencing disease incidence and severity. We have largely ignored genetic selection against diseases because of the low heritabilities of disease traits, a lack of a good disease recording mechanism, and the greater economic importance of genetic selection for production traits.

There has been a renewed interest in investigating the possibilities for genetic selection against disease incidence for several reasons. The heightened concern for animal welfare behooves us to investigate all avenues for decreasing animal diseases. The consumer has a heightened awareness of food safety and does not want to consume food products from diseased animals or animals treated with antibiotics. Disease incidence impacts a dairy farmer's "quality of life" beyond just economic considerations. Finally, as we have selected for higher producing animals, an increasing number of investigations have pointed to a genetic antagonism between increased production and overall animal health (Seykora, 1986, 1985, 1983; Emanuelson, 1988; Dentine, 1983; McDaniel, 1994). Single trait selection for increased milk production will tend to increase fertility problems, clinical mastitis, somatic cell counts, udder edema, ketosis, and locomotive problems.

Genetic Variability for Health Traits.

Heritabilities of health traits tend to be low (Table 1). Heritability (h^2) is the percentage of the differences between cows that is due to genetics. The low heritabilities of health traits indicate that health is influenced by the environment much more than by genetics. For that reason, an animal's phenotype is a poor indication of its genotype and individual selection based on an animal's own performance is not feasible for health traits because genetic differences will be masked by environmental influences. A bull's genetic value for lowly heritable traits can be estimated with a progeny test because environmental influences on the different daughters will tend to average out. However, many more daughters are needed to achieve the same level of accuracy as that needed for a moderately heritable trait such as milk yield. This relationship between heritability level, number of daughters and reliability of the bull's breeding value is illustrated in Table 2.

It is often assumed that if the heritability is low there is no genetic variation for a trait. This may not necessarily be true. Even though heritabilities are low, there still may be significant genetic variation in a trait. Genetic standard deviations and approximate net economic values for milk yield and some health traits are listed in Table 3 (Rogers, 1994). Clearly from the table, the genetic standard deviation in milk yield is worth more than any one disease trait. However, the aggregate of the disease traits does have a substantial economic impact and probably shouldn't be ignored if they can be utilized. Other health traits that have been shown to exhibit genetic variation are conception rate, cystic ovaries, retained placenta, age at puberty, dystocia, somatic cell count, and udder edema.

Genetic Evaluations Available for Health Traits

Lack of adequate disease records is the main reason that genetic evaluations for health traits are not available in the United States. Several European countries have solved this by implementing mandatory recording of veterinary treatments (Erikson, 1990). These European countries also have more daughters per sire in initial progeny proofs, giving initial sire evaluations for disease traits higher accuracy than would be achieved in the United States. The Swedish sire evaluation system ranks their AI bulls on an index which includes: milk production (protein and fat), conformation (udder, udder height, teat lengths, teat placement, teats, legs, temperament), fertility, growth rate, stillbirths, ease of milking, mastitis and other diseases (ketosis, retained placenta, milk fever, teat injury, hoof disorders, ovarian cyst, other ovarian disorders, other fertility disorders, infection, and metabolic disorders) (Erikson, 1990).

The U.S. dairy industry has attempted to indirectly select for healthy cows by selecting for conformation with some limited success. Comparing cows selected for milk production to an unselected control group dating back to 1964, (Jones, 1994) found that cows in the selection group averaged about $50 more for health expenses per year. Expenses for mastitis accounted for most of the differences between genetic groups, but the mastitis expense difference between the two genetic groups had not widened during the last 16 years of the study. Jones concluded the reason for this is "perhaps because AI organizations have placed considerable emphasis on udder conformation". Several studies have shown a direct correlation between udder conformation and mastitis resistance. The industry has also selected for a steeper foot angle, which has been shown to be correlated with fewer locomotive problems and greater longevity (McDaniel, 1994). On the other hand, the industry's emphasis on large size and level rumps may have increased health problems due to increased calving difficulty. Large cows may also be more prone to locomotive problems and digestive upsets.

Two indirect trait measures of animal health, Productive Life (PL) and Somatic Cell Score (SCS), have been computed by the USDA beginning in 1994. Productive Life measures the average productive length of time in months that a bull's daughters stay in the herd (maximum credit per lactation allowed is 10 months). The SCS is on a linear cell count score. Table 4 lists the top bulls for predicted transmitting ability (PTA) for lbs. protein in the U.S. The range in PTA PL for these top bulls is from .2 (Zebo) to 2.3 (Cubby) for a difference of 2.1 months. If the average productive life is around 27 months, this would indicate that Cubby's daughters have about an 8% longer productive life than Zebo's daughters. The SCS score range in this same group of top bulls is from 3.00 to 3.61. Transformed to actual somatic cell counts, these numbers are equivalent to 100,000 vs 152,000 cells per ml. Clearly, there is genetic variation in our top production bulls for both Productive Life and Somatic Cell Score. Both of these traits appear to be currently under-utilized by the industry in that neither PTA PL nor PTA SCS influence the price of semen (Chrystal, 1995).

Strategies To Improve Herd Health Through Genetic Selection.

1. The h^2 of all health traits are low. This means that management and environment have by far the biggest influence on herd health and that most herd health problems

will be solved through improvement of management, not genetics. Genetic selection for improved health can complement improvement in management but must be considered a small component to an overall herd health program. Also, because of the low h^2, AI bulls need many progeny for accurate evaluation and health trait evaluations are limited for U.S. bulls.

2. Productive Life and Somatic Cell Score evaluations are available for U.S. bulls and should be utilized. To put proper weightings on these traits they should be combined into an index. USDA's Net Merit Index gives PL 40% as much value as milk yield and SCS 10% as much as milk yield (Table 4).

3. Inbreeding should be avoided when selecting mates for individual cows. To do this, pedigree records must be kept on the cows and AI rather than natural service should be utilized. For each 1% increase in inbreeding, milk production decreases 50-80 lbs. per lactation. Inbred animals would be expected to have more health problems and higher somatic cell counts (Pagnacco, 1994). Detrimental effects of inbreeding would be expected to be greater for young calves than for cows.

4. Breeding heifers to top production bulls that sire calves that are born with less than average difficulty (8% or lower) is recommended. Herds that have few calving problems can probably get by using bulls with average difficulty of up to 10% on heifers. Herds with a lot of calving difficulty may wish to lower the cut off point to bulls below 7%. Why some herds experience more calving problems than others is not well understood but it is probably influenced more by nutrition and management than genetics. Calving difficulty in heifers causes increased deaths, lower lactation milk production and longer days open.

5. There appears to be an increase in crossbreeding of dairy cattle to alleviate some health problems. As of this time, we have very little recent research to be able to quantify the amount of improvement one might get from crossbreeding. Past studies would indicate that some heterosis for health traits would be expected.

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Table 1. Heritabilities of production and disease traits.

Trait	h^2
Milk yield	.25 - .30
Clinical mastitis	.02 - .12
Somatic cell count	.08 - .12
Ketosis	.05 - .10
Days open	.03 - .07
Udder edema	.10 - .15
Productive life	.03 - .09

Table 2. Reliability[1] of a bull's breeding value for traits with different heritabilities and numbers of daughters.

	h^2				
No. of daughters	.01	.02	.05	.10	.25
50	.11	.20	.39	.56	.77
100	.20	.33	.56	.72	.87
200	.33	.50	.72	.84	.93
1000	.71	.83	.93	.96	.99
2000	.83	.91	.96	.98	.99

[1] Reliability equals the accuracy squared.

Table 3. Genetic standard deviations and net economic values for milk yield and disease traits.

Trait	Genetic Standard Deviation (GSD)	Net Economic Value Per Unit (NEV) ($)	Value per GSD ($)
Milk yield	650 kg	.14	92.00
Days open	6 days	1.50	9.00
Clinical mastitis	.15	>$150	22.50
Ketosis	.06	>$100	6.00
Milk fever	.08	>$100	8.00
Displaced abomasum	.04	>$100	4.00
Laminitis	.10	>$100	10.00

Table 4. Top twelve U.S. AI bulls for PTA protein, January 1995.

	PTA's								
Bull name	Protein	Milk	Fat	Type	PL	SCS	Net Merit	Calving ease	Semen price ($)
Bellwood	73	2521	88	1.22	1.5	3.15	225	10	20
Hunter	67	2212	73	0.61	1.9	3.00	210	10	20
Andrew	67	2151	81	.7	1.8	3.30	201	12	18
Mascot	67	1526	48	1.66	1.0	3.20	158	11	40
Classic	64	1629	82	−.51	1.0	3.11	175	9	6
Riley	64	1904	63	−.22	1.2	3.61	166	10	8
Zebo	63	2311	85	2.06	0.2	3.13	192	--	20
Lingo	63	2225	68	.46	0.9	3.20	188	10	14
Mark Pappy	62	1688	47	1.03	1.7	3.08	170	8	16
Elvin	61	1870	62	1.57	2.1	3.18	184	15	25
Javelin	61	2380	47	.81	1.7	1.11	172	--	15
Cubby	61	1854	39	.38	2.3	3.34	172	10	12