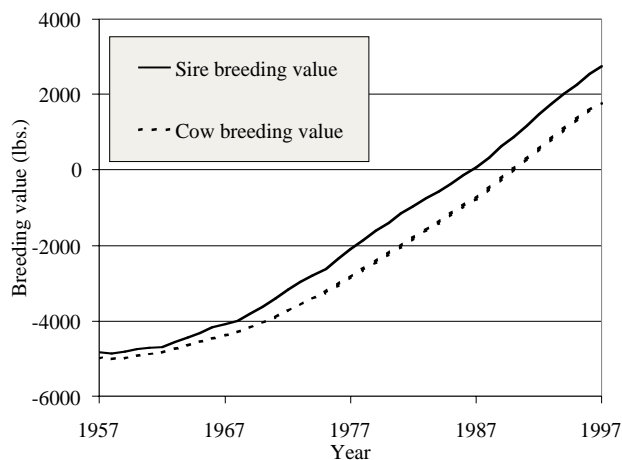# Selection for Disease Resistance: Why It Is Important and How It Can Be Accomplished

A.S. Leaflet R1899

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Genetic selection (based mostly on progeny testing) and the use of artificial insemination (AI) has produced remarkable increases in milk yield over the past 30 years, as shown by Figure 1. Milk, protein, and fat yields are currently increasing 260, 9, and 7 pounds per year, respectively, as the result of selection. However, selection for milk yield has not come without a price. Disease incidence (including reproductive and metabolic disorders) has increased in conjunction with genetic merit for yield.

Figure 1: Average breeding value by birth year for milk yield.

The antagonistic relationship between genetic merit for yield and genetic susceptibility to disease has heightened interest in selection for disease resistance. Selection for disease resistance could also address food safety and quality issues raised by consumers. These issues may have to be addressed through selection if restrictions are placed on the use of antibiotics. In addition, consumers may perceive breeding programs that include disease resistance to be more humane than those that do not. Finally, selecting dairy cattle for total merit (yield, type, longevity, disease resistance, etc., weighted by their relative economic values) requires knowledge of genetic differences between animals in their resistance to disease.

It should be remembered that selection for disease resistance can only supplement, not replace, good management. Furthermore, due to the relatively greater economic value of yield, it should be emphasized more than disease resistance in a breeding program.

Given that genetically improved health is desirable, how can we select for disease resistance? Because disease incidence is not routinely or consistently recorded in the United States, no direct measures of disease resistance are available. However, several indirect measures of disease resistance are available now, and others are being developed.

Breeding values (PTA) for milk somatic cell score (SCS), available since 1994, are currently being used to select for resistance to mastitis. Research has demonstrated that daughters of sires that transmit lower SCS have less mastitis. To achieve balanced selection for yield, longevity, and resistance to mastitis, producers may want to consider one of the new Net Merit indexes, Cheese Merit$, or Fluid Merit$, introduced by USDA in 1999. Cheese Merit$ weights Cheese Yield $ (less feed costs), productive life, and SCS according to their relative economic values, and is designed for producers selling milk to a cheese factory. Fluid Merit$ weights Milk-Fat$ (less feed costs), productive life, and SCS according to their relative economic values, and is designed for producers selling milk to a bottling plant. Including productive life (a measure of longevity) in these indexes should also improve disease resistance because longer productive life has been associated with lower incidence of mastitis and other diseases.

Breeding values for type traits can also be used to select for disease resistance. For example, research has shown that daughters of sires that transmit shallower udders have less mastitis. Therefore, selection for shallower udders should improve resistance to mastitis.

Several Scandinavian countries record disease incidence and use these data to estimate breeding values for individual diseases. In addition, these countries consider disease resistance when selecting AI sires. Many of these countries also import dairy cattle from the United States. Dairy cattle imported from the United States would most likely have relatives in the United States. So, breeding values for disease resistance could be estimated for U.S. dairy cattle by using the genetic evaluations of relatives overseas. These breeding values could then be used to select for disease resistance in the United States. However, U.S. cattle that do not have relatives in other countries would not receive a genetic evaluation for disease resistance. Furthermore, the reliability of breeding values calculated this way may be low. These breeding values might also be biased due to incomplete recording of disease incidence and the possibility that disease might be caused by different factors in other countries.

In the future, molecular and physiological markers may be used to select for disease resistance in dairy cattle. Molecular markers are based on differences between animals in the makeup of their DNA (deoxyribonucleic acid), the material genes are made of. These differences may be related to genetic differences in traits such as milk yield or disease resistance. Molecular markers that indicate differences in the Bovine Lymphocyte Antigens (BoLA) genes have been identified. The BoLA genes are partially responsible for the development and function of the cow's immune system (environment as well as other genes also impact the immune system). The differences in the BoLA genes have been associated with differences in mastitis susceptibility. Dairy cows receiving different copies of the BoLA genes differ in their resistance to mastitis.

Examples of physiological markers include measures of immune system function (based on laboratory testing of immune cells found in blood samples). Differences in these markers may be related to differences in resistance to disease. However, unlike molecular markers, differences in physiological markers are caused by both genetics and environment. As a result, differences in disease resistance based on physiological markers may not be entirely due to genetics.

Molecular and physiological markers of disease resistance are of particular interest because they can be measured on bulls, which eliminates the need for producers to record disease incidence. Furthermore, these markers could allow identification of disease-resistant animals early in life and may provide an indication of resistance to many diseases. However, before molecular or physiological markers can be used to select for disease resistance, research is needed to determine their relationship to the incidence of disease in dairy cattle. The next report, Evaluating Potential Markers for Selection for Disease Resistance: Health Traits Project, summarizes the progress to date on one such research project being conducted here at Iowa State University.