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How are Milk Components Related?

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This NebGuide discusses genetic correlations of yield traits and percentage traits and how to use these relationships in selection and culling programs.

Most milk markets today have complicated payment plans that include fat, protein or solids-not-fat (SNF). These payment plans can create considerable confusion for a producer who is selecting A.I. proven sires to use in the breeding program or cows to cull because of low producing ability. The relationships of the various components to each other must be understood to make accurate culling and selection decisions.

As the marketing of a quality product becomes more complicated, a thorough understanding of the relationships among the various components is essential. All of the various parts of milk produced by a dairy animal are its components. Once the relationships of these parts are understood, selecting sires is much easier. And, understanding how the genetic mechanism works will dispel some of the myths about selection practices.

Yield (Pounds) Relationships

One term that must be understood is genetic correlation. The name is more intimidating than understanding its meaning.

Genetic correlation measures the extent to which the same genes influence the production of each trait (milk, fat, etc.). If two traits have a 100 percent correlation, then the same genes influence the production of each trait. For the production traits, there are many thousands of genes that may influence the quantity produced. For example, in milk production there are thousands of genes that all play a part in stimulating or affecting the actual production of milk. When thousands of genes affect a trait, the trait is called a quantitative trait. The production traits that most dairy producers are interested in are milk yield, fat, solids-not-fat and protein — all of which are quantitative traits.

What happens to the yield of protein, fat and solids-not-fat if selection is made for milk yield alone? This is where genetic correlation comes into play.

Table I presents the genetic correlations between the four most important yield traits — milk, fat, protein and solids-not-fat. As shown in this table, all of the yield traits for pounds of production are positively related. This means that as you select for a poundage increase in any one trait, you get a corresponding increase in all of the other traits.

If you select entirely for pounds of milk yield, there will also be an increase in the pounds of fat, protein and solids-not-fat produced. Therefore, you need not be concerned about decreasing the pounds of fat, protein or solids-not-fat produced if you select entirely for pounds of milk produced. The most highly correlated traits listed in *Table I* are between milk yield and solids-not-fat (.95) and protein (.90).

One other relationship that is quite high between the components is solids-not-fat and protein (.95). This means that if you select entirely for protein, you will be selecting for almost the same genes that influence the production of solids-not-fat.

Table I. Genetic correlations between the various yield traits of dairy cattle

Yields, lbs	*Milk*	*Fat (Yields, lb)*	*Protein*
Fat	.75		
Protein	90	.80	
SNF	.95	.80	.90

Protein and Solids-Not-Fat

The high positive relationship between solids-not-fat and protein yields should be reassuring to those producers who are paid partially on solids-not-fat, but whose Dairy Herd Improvement Association (DHIA) tests for protein in lieu of solids-not-fat. With these high correlations, a producer need not be concerned. Any selection for protein yield will also increase the solids-not-fat yield. The selection pressure will be nearly as strong for solids-not-fat as for protein.

Assume a producer is confronted with the choice of having to cull one of two cows in the herd. Each has the same milk and fat production, but different protein production. Even though the payment is based on solids-not-fat, the cow with the lowest protein yield will also, in all probability, have the lowest solids-not-fat yield.

Yield and Percentages

In the preceding example, we dealt with the yield of individual traits, i.e., the pounds of production. Let's take a look at the genetic relationships between the pounds of production and the percentage traits of fat, protein and solids-not-fat.

Table II shows the genetic relationships between the yield and percentage traits. Notice that milk yield is negatively correlated with all of the percentage traits. This implies that different genes are associated with yield, or pounds of production, and the percentage of the components in the milk.

The yield traits (pounds) are all positively related, but there is a negative relationship between the pounds of production and the percentage of different components. This means that if you select for pounds of production, the percentage of fat, protein and solids-not-fat in the milk will likely decrease.

Table II. Genetic correlations between yield traits and percentage traits

Yields, lbs	*Fat %*	*Protein %*	*SNF %*
Milk	-.35	-.30	-.20
Fat		-.10	-.25
Protein			-.10

Selection Criteria

How should a producer incorporate these genetic values into a selection program?

1. A producer should select for milk yield with only enough emphasis on the components to prevent a decline below the minimum market requirements. This policy is supported by current market conditions.

2. Dairy producers already selling milk above the minimum percentage levels for all components will make the most improvement in profit by selecting solely on milk yield.

3. Dairy producers that have low fat or solids-not-fat percentages, or both, should first check their feeding program. Feeding the properly formulated ration can increase the percentage of the components much faster than selecting on these traits.

Conclusions

To follow an effective sire selection and cow culling program, it is necessary to have a basic understanding of the underlying genetic correlations that influence the production traits.

1. The production yield traits are all positively correlated, indicating that the same genes are involved in production of all yield traits. The yield traits and the percentage traits are negatively related, implying that different genes control the yield traits than those that influence the percentage traits.

2. To improve yield of milk or components, a producer wishing to select on solids-not-fat, but who only has protein information available, can select on protein and at the same time increase solids-not-fat. This is because of the positive genetic correlation between the two traits.

3. Selection for percentage components of production is not recommended if you currently exceed the minimum standards for your milk plant. Selection for the yield traits only will increase income the most.

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