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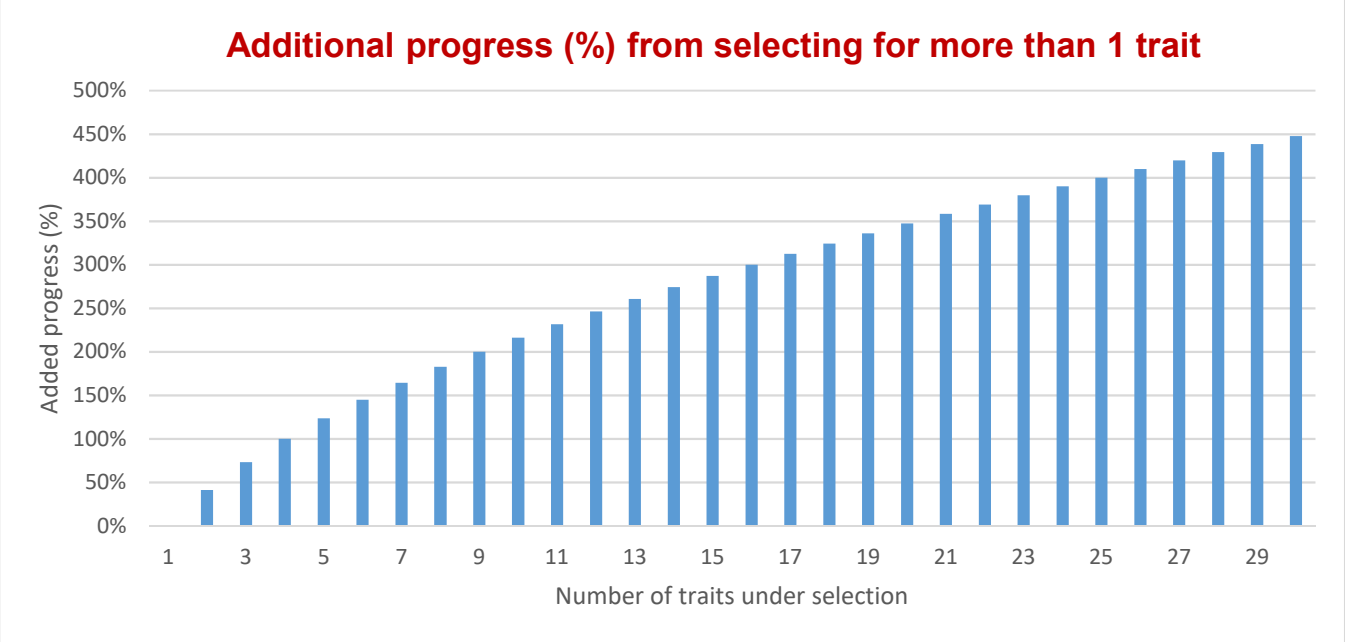
Select Genetic Index that Considers Most Heritable Traits with Economic Value

By Dr. H. Duane Norman[1]

Screening breeding animals independently for individual traits will never deliver as much economic gain as if using a well-constructed composite index. Potential service sires should be ranked using an index appropriate for the economic situation of the herd. Next, follow the ranking when purchasing semen to simplify herd mating activities. Two other things still need to be considered: semen prices and inbreeding of individual matings. The same standard for a composite index should be considered when making breeding and culling decisions among females.

When I was a graduate student, it was emphasized that selection for multiple traits reduces the improvement that one makes in each trait. If assigning equal selection emphasis to several traits, the progress expected in each trait – compared to what would be achieved in a single trait – is determined by dividing 1 by the square root of the number of traits under selection. It sounds complicated, but it isn't. For illustration, if one selects for 2, 4, 9, 16, 25 or 36 traits, one will make 70.7%, 50.0%, 33.3%, 25%, 20% or 16.7% (respectively) as much progress in each trait as would be made in a single trait with all emphasis directed toward it. The clear message sent to me was, "Be wise and don't select for too many traits because that will detract from progress in the main trait."

Now, years later, it's finally obvious to me that a more comprehensive message should have been communicated. **"One can achieve more progress improving several traits than by improving just one."** How so, if – using the illustration above – two traits have equal economic value and equal emphasis is assigned, then 70.7% of the potential progress will be made in each? This means one expects a benefit of twice the 70.7% (141%, i.e., 41% more) in combined gains. Even more benefit is expected if selecting for more than two traits. When selecting for 4, 9, 16, 25 or 36 traits, one would achieve 100%, 200%. 300%, 400% or 500% more benefit than when selecting for one trrait. Figure 1 illustrates the combined gain from up to 30 traits. **The bottom line: for maximum progress, use an economic index that incorporated all the heritable traits that have economic value.**



This illustration is presented primarily to explain the principle because it's unlikely one would ever find 10 or 30 traits of "equal" economic value, all needing improvement. However, we can easily find 30 traits needing attention that have "some" economic value. Typically differential selection is given to several traits by assigning weights according to each trait's individual value when designing the composite index. In fact, the predicted changes shown in the graph above are correct only when no correlations exist among the traits. In reality, improvement in the traits would be even greater if there are positive genetic correlations among them but less with negative correlations. Composite indexes should be credited for producing our current dairy populations and having qualities appreciated by producers.

The Council on Dairy Cattle Breeding (CDCB) offers four lifetime merit indexes – net merit [NM$], cheese merit, fluid merit and grazing merit – to provide alternatives for producers to choose the one most appropriate for their herd's management and milk pricing situation. These CDCB composite indexes incorporate up to 38 traits and weight each by their economic value. Sufficient emphasis is placed on each, so all will be improved. The formulas for these indexes developed by USDA AGIL[2] staff for CDCB use have been peer reviewed and published, and the genetic progress delivered for individual traits is placed tri-annually onto CDCB's website at https://queries.uscdcb.com/eval/summary/trend.cfm. As CDCB represents several industry sectors, it strives to provide objective rankings, comparing all animals on the same basis regardless of who owns them.

The returns to producers using well-designed genetic indexes are huge. For example, if all selection is based on NM$, cows dying while in the milking herd is projected to decline from 17% to 10% within a decade. As owners lose about $1200 when a cow dies and they would lose fewer cows each year, salvage sales to U.S. producers could increase by $394 million annually by the 10th year. Salvage income will increase more quickly than before because genetic evaluations for *Cow Livability* were made available in August 2017 and incorporated into all four CDCB lifetime merit indexes four months later.

The questions to ask are: Do the indexes promoted by others incorporate as many traits? Are the traits incorporated weighted appropriately? Will an alternative index deliver benefits equivalent to one of the four CDCB lifetime merit indexes? New technology is arriving to assist in the management of dairy herds. New data is coming from many sources, including reproduction, health and milking system monitors. CDCB will be evaluating more traits in the future and incorporating them into the composite indexes. In so doing, even greater economic progress can be expected in the future.

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