The Importance of Type in an Effective Breeding Program

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Functional type appears to be related to culling rate and longevity in dairy cattle, thus it should not be ignored in an effective herd breeding program. The dairy cow is the foster mother of the human race, thus any discussion of dairy cattle breeding must necessarily begin with the production of milk. That is the primary reason for their existence. Therefore, any other trait included in a breeding program must contribute to the profitability of the herd to be considered.

Through vast increases in progeny testing over the last decade the potential for genetic improvement has increased rapidly. In the Holstein breed, for example, USDA summarized less than two dozen bulls in 1967 with predicted differences over +1000. In the 1977 November summary there were well over 100 bulls exceeding that same level.

Before the mid-1950's dairy cattle breeding was regarded mainly as an art. However, today, a mere twenty years later, with the selection tools having been developed through research, dairy cattle breeding has come of age and has gained "scientific status" much like your area of veterinary science has.

Planning an effective breeding program is one of the biggest challenges facing a breeder today. The decisions made today determine what kind of a herd will result in the 1980's. Sire selection plays a key note in the genetic improvement of a herd. The number of traits considered should be limited as the more traits included in a selection program, the less progress will be made in any one trait.

For a trait to be considered in a breeding program, one should consider these four basic questions: 1. What is the economic value of the trait? 2. Is it accurately measurable? 3. Is it heritable? 4. What is the genetic relationship with other traits?

It is reasonable to assume that a breeder will place considerable emphasis on improving his herd genetically for milk production. Beyond this point a dairyman usually focuses his attention on type characteristics when selecting which bull to include in his breeding program.

Let's look at these four basic questions as they relate to this secondary selection which a breeder makes. The Holstein-Friesian Association and researchers at Virginia Polytechnic Institute and State University have conducted extensive research on the type data bank compiled by HFA classifiers. I would be remiss not to recognize their work because it is largely their results that I will focus on in this presentation.

The *economic value* of type may come largely from two basic sources. The most often cited value is structurally sound, trouble-free cows. These cows cost their owners less to maintain by reducing the culling rate for udder injury, foot and leg problems, etc. Consequently, these cows are more profitable to their owners and allow him to exercise more selection pressure on production traits by reducing his involuntary losses within the herd. While some studies have shown type alone has a small effect on culling decisions, there is substantial evidence in reports from Canada and registered Holsteins in New York show that one out of eight cows leave the herd for some form of type-related defect. Type removals also appear to increase as a cow gets older.

A second area of importance comes from the sale of breeding stock. While this source of income varies from herd to herd and from year to year it does represent a sizable portion of income to many herds. Unfortunately, type does not have a constant economic value, thus a breeder must constantly critically evaluate the importance of type in his herd and mold his breeding program to fit that evaluation.

Can type be *measured* accurately? The statistical procedures in use have been well-documented in the literature and should rank sires accurately once the data is available. But what about the data collection? Skepticism has existed among Holstein breeders that the variation among classifiers might be large enough to invalidate the sire ranking procedures. Recent research by HFA indicates that classifiers tend to be much more consistent and uniform in their scoring of cows than many thought. Less than 5% of variation in final scores can be accounted for by differences in classifiers. Additionally, several major type traits have rather high repeatabilities as shown in Table 1. This means that scores above (or below) average on the first classification are very likely to also score above (or below) average on the second classifications.

Table 1

Repeatability of Major Type Traits

Trait	Repeatability
Final Score	73%
General Appearance	69%
Dairy Character	45%
Body Capacity	58%
Mammary System	67%

Several other descriptive traits have repeatabilities

"below 50%" as shown in Table 2. This means that cows need to be scored at least twice to get an accurate indication of these traits.

Table 2

Repeatabilities of Descriptive Type Traits

Trait	Repeatability
Stature	75%
Head	32%
Front End	26%
Back	41%
Rump	48%
Hind Legs	29%
Feet	27%
Fore Udder	47%
Rear Udder	49%
Udder Support	50%
Udder Quality	22%
Teat Placement	57%

Additionally, all descriptive traits except fore udder, udder support and teat placement tend to receive higher scores on later classifications. This should be considered when comparing bulls of different ages.

What about the unified dairy scorecard? What impact does it have on final score? Table 3 indicates that general appearance and mammary system receive more emphasis than initially intended. Likewise, body capacity and dairy character receive less.

Table 3

Impact of Scorecard Traits on Final Score

Trait	Scorecard	Actual
General appearance	30	35
Dairy character	20	14
Body capacity	20	14
Mammary system	30	37

Further attention to descriptive traits indicate that stature and rear udder contribute most to final score followed by front end, fore udder, and udder support.

The *heritability* of traits included in a breeding program are important when considering the amount of progress one can expect from one generation to the other. The heritability values refer to the proportion of superiority (or inferiority) in the parents that should be transmitted to the offspring. Table 4 lists the heritabilities obtained from a calculation of 30,-714 daughter-dam pairs on record at the Holstein-Friesian Association.

From Table 4, final score, all unified scorecard traits, stature, back, rump, fore udder, rear udder, udder support, and teat placement are all heritable enough to expect reasonable progress from selection. Unfortunately, some descriptive traits which many consider important to the longevity of a cow in the herd are not high enough to show significant response to selection. Among these are front end, udder quality, feet and legs. However, Table 5 shows the result of further research into the heritability of descriptive subtraits. Obviously some subtraits respond differently to selection than does the overall trait.

Table 4

Heritability of Type Traits

Trait	Heritability (%)
Final score	31
General appearance	29
Dairy character	19
Body capacity	27
Mammary system	22
Stature	51
Head	10
Front end	12
Back	23
Rump	25
Hind legs	15
Feet	11
Fore udder	21
Rear udder	21
Udder support	21
Udder quality	0
Teat placement	31

Table 5

Heritability (Subtraits)

Code & Trait	Subtrait (h^2 %)	Overall (h^2 %)
1 – Stature - upstanding	47%	51%
4 – Head - short	44%	10%
5 – Rump - sloping	46%	25%
1 – Hind leg	28%	15%
5 – Hind leg - too straight	39%	15%
1 – Fore udder	37%	21%
5 – Fore udder	33%	21%
5 – Rear udder	36%	21%
5 – Udder support	35%	21%
3 – Rear teats - too far back	83%	31%
1 – Misc. - winged shoulders	20%	–
4 – Misc. - crampy	43%	–
5 – Misc. - small for age	25%	–

Many type traits evaluated by HFA can be improved genetically through selection. Higher heritabilities of some of the undesirable subtraits make it evident that a breeder can stay out of severe trouble through selection. However, the very low heritabilities of the desirable subtraits leave little hope that we can significantly improve these traits as they are presently measured. This suggests a possible alternative to traits like udder quality where current methods of evaluation are unsuccessful in measuring genetic differences. Perhaps a group like AABP could suggest a method of measurement which would allow more accurate evaluation to be made.

Genetic relationships between type traits do exist. The number of type traits measured by the various breed associations creates a problem in itself. If a type trait existed that was highly correlated genetically with all other traits the problem would be simplified a great deal. One could merely eliminate the need for selecting for the many subtraits in the breeding program. The HFA data suggests that such a trait does exist in cows' final scores. As shown in Table 6, the genetic correlation of final score with the major subtraits are relatively high. Let's define genetic correlation as being the measured response in two traits when they are affected by the same genes.

Table 6

Genetic Correlation with Final Score

Trait	Correlation
Stature	.70
Head	.43
Front end	.79
Back	.44
Rump	.58
Hind legs	.48
Feet	.40
Fore udder	.56
Rear udder	.62
Udder support	.44
Udder quality	.52
Teats	.48

Just how effective is selection on final score? Table 7 provides several examples with optimum breeding programs for type. Values in the table represent the percentage of the maximum genetic improvement in these combinations of traits which is expected from selecting on final score alone. In most examples, selecting on final score alone gives a very high percentage of the improvement achieved by properly combining the traits into a performance index.

Table 7

Percent of Improvement for Several Optimum Breeding Programs Obtained by Selecting on Final Score

Type Traits in the Breeding Program	% of Maximum Improvement
ST, FE, BK, RP, HL, FT	95
ST, FE, BK, RP	90
HL, FT	94
FU, RU, US, TT	87
FU, RU, US	96
HL, FT, FU, RU, US	100
HL, FT, US	95

ST - Stature; FE - Front End; RP - Rump; HL - Hind Legs; FT - Feet; FU - Fore Udder; RU - Rear Udder; US - Udder Support; TT - Teats.

In terms of practical breeding decisions, the HFA results indicate that selections to improve type should be based on final score for cows and on predicted difference for type (PDT) for bulls. Likewise, in the long run it would be less effective to use a bull who was especially strong in one descriptive trait but poor in overall type.

The negative genetic relationship between type and milk production was documented early in the literature, although on very limited data. Because of these early results many have been content with the idea that selection for milk yield will not alter type and vice versa. However, recent work at VPI does not agree entirely with this early work. In using PD milk values from 455 Holstein bulls which had an average of 393 officially classified daughters each, the results in Table 8 were obtained.

Only the correlation with dairy character is positive. All correlations are significant except between udder support and PD milk. These results do not suggest that selection for type and production would be futile however. What they do imply is that

Table 8

Correlations Between PD Milk and Type

Trait	Correlation
Final score	- .23
General appearance	- .24
Dairy character	+ .41
Body capacity	- .22
Mammary system	- .24
Stature	- .11
Head	- .10
Front end	- .19
Back	- .16
Rump	- .23
Hind legs	- .15
Feet	- .16
Fore udder	- .36
Rear udder	- .14
Udder support	- .08
Udder quality	- .13
Teats	- .09

there will be fewer bulls who are plus for both milk yield and type than there would be if the correlations were zero or positive. These results also suggest that if conformation is completely ignored, then serious weaknesses are likely to develop in some of the functionally important traits. Since the negative relationships are slight to moderate, some attention to these traits should allow them to be maintained in the herd, while major emphasis is placed on production.

Researchers at Cornell University, for example, have shown that cows with very tightly attached fore udders tend to be culled more often for low production while those with deeper udders tend to be culled less often for low production, but more often for udder trouble. Therefore, very tightly attached fore udders may well be incompatible with high levels of milk yield. Selection for an intermediate may be optimum.

But is there an optimum balance between type and production? Obviously each dairyman must decide for himself what the relative weight between the two will be for his situation. Table 9 shows the amount of genetic progress expected per year in a herd when various weights are given to milk yield and type. It is interesting to note that even at 20:1 selection for milk and type, the overall type pattern of the herd is expected to remain fairly constant.

Table 9

Expected Change Per Year from Sire Index Selection

Relative Weight Milk:Type	Expected Genetic Change Per Year Milk Yield (lb)	Final Score
3:1	43	.10
6:1	50	.06
9:1	51	.04
20:1	56	.01

But how does milk and type fit together with longevity? A recently completed study at VPI on the joint influence of predicted difference milk (PDM) and various type traits found that scores for descrip-

tively coded traits were about as valuable in determining longevity as was PDM alone. The results of daughters from 788 bulls are summarized in Table 10. A key point here is that PDM alone is much more highly correlated to longevity than predicted difference type (PDT) alone.

Table 10

Correlations Between Various Production or Type Traits and Lifetime Production and Percent Daughters Completing Four Lactations

Production or Type Traits	Lifetime Production	% Days Completing Four Lactations
PDM alone	.52	.34
PDT alone	-.05	-.07
PDM & PDT	.54	.33
All descriptive traits	.31	.29
Descriptive traits + PDT	.34	.33
All scorecard traits	.33	.24
Scorecard traits + PDT	.33	.24
Descriptive + PDT + PDM	.58	.43
Scorecard + PDT + PDM	.54	.38

These same 788 bulls were stratified on the basis of their PDM, the results are shown in Table 11. The average PDT declines as PDM increases and total milk yield through four lactations increases steadily as the PDM of the sire increases. Daughters of the top PDM group produced over 20,000 pounds more milk through four lactations than the low group.

Table 11

Sires PD Milk, Type and Total Milk Production Through Four Lactations and Percent of Daughters Completing Four and Five Lactations

Avg. PDM	No. Bulls	PDT	Milk Prod.	% 4	% 5
+1099	24	-.6	67,746	52.7	40.3
+ 738	48	-.9	62,152	52.1	37.8
+ 435	102	-.6	60,889	52.3	37.9
+ 140	144	-.5	58,195	50.0	35.0
- 156	166	-.3	55,889	48.7	35.2
- 442	149	-.1	53,791	47.0	32.8
- 712	92	+.1	50,558	44.9	30.2
-1035	39	+.3	49,550	42.4	32.6
-1500	24	+.3	44,180	39.0	28.1

These results indicate that it would be unwise to totally ignore type in a herd breeding program. However, based on the relative economic value of milk and type, a relative emphasis of from 1:1 to 6:1 for most registered breeders should result in optimal genetic progress for both traits.

As stated at the outset, functional type appears to be related to culling rate and longevity, thus it should not be ignored in an effective breeding program.