"Choose Parents Wisely"

Your Dairy Herd Breeding Program

DAIRY CATTLE BREEDING EXTENSION BULLETIN E-1150 JANUARY 1978

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A dairy breeding program consists of selecting sires to mate to the females on hand and raising offspring to replace breeding animals that leave the herd. Success in improving a herd's genetic ability and thereby its efficiency and profitability depends on the following factors:

—interest in dairy cattle,

—time to plan a program and make decisions,

—availability of modern cow and sire evaluations, and

—understanding of and willingness to use these evaluations.

The science of genetics has made rapid strides in recent years. The particulate nature of inheritance, genes and chromosomes are now even taught at the high school level. The dairyman, however, has to deal with a "package" of traits and characteristics, the dairy cow. This package contains desirable and undesirable components, many of which cannot be measured or even seen. Some are economically important and others are not. Some are transmitted to the next generation to varying degrees while others are not. Some are greatly affected by their surroundings or environment, others are not. Some components or traits often occur together, while others seem to be antagonistic toward each other. The dairyman's dilemma is to properly evaluate the total package represented by the dairy animal as to its future in his breeding program.

Dairy cattle breeding methods have developed rapidly in the past 20 years. Much of the research and development of aids to genetic improvement was made possible by use of computers to analyze and handle the millions of records gathered through the National Cooperative Dairy Herd Improvement Program (NCDHIP).

Rapid improvements in methods and aids, and the seeming reliance on computers for nearly everything have caused skepticism among some breeders. Methods have improved faster than the willingness of some dairymen to accept them. These dairymen ask, "Will modern methods really help us develop more profitable cattle, or will these cattle prove to be deficient in some area other than lactation production?"

Many breeders are also receiving more information in their record program and from artificial insemination and breed associations than they know how to use. Each breeder should understand the principles involved in modern methods of cow and sire evaluation. This understanding will lead to confidence in their use and more rapid genetic improvement of the herd.

Cow Evaluation

There are two basic prerequisites to developing a program for genetic improvement (1) the identification of each individual in the herd, including sire, dam, and birthdate; and (2) records of performance on each animal.

Many methods of evaluation have been used in the past. As improved methods were developed, dairymen who used them gained some advantage in rate of genetic improvement over other dairymen. This has progressed to the point where we now have the greatest range of genetic ability ever between the best and poorest herds. Most of this difference came about through the sires selected for use in the herds.

Cow evaluation and selection also plays a very important role in herd improvement. A most important contribution of cow evaluation procedures is in helping the dairyman understand the principles and methods involved in genetic improvement of the herd. Sire evaluation may be described as the gathering of individual cow evaluations on all of the daughters of a bull.

A quick test of anyone's insight into cow evaluation may be made with the following questions:

—How good is a 14,000 pound cow?

—Is she a good cow? an average cow? or a poor cow?

Although the initial reaction is often to say that she is a good or average cow, the question usually leads to more questions, and the process of cow evaluation has started. For example, how old was she, and what did she test?

To properly evaluate the ability of a cow to produce, it is necessary to look at her record of performance and then to systematically clear away the maze of things that tend to confuse us. A system for estimating a cow's producing ability in widespread use in the dairy record program is shown in Table 1. Estimated Producing Ability is the ability of the cow to produce either above or below her competition under those conditions.

A cow's producing ability is determined by her **genetic merit** and the permanent environmental conditions that affect all of her records. A homely example would be a first-calf heifer that was chased through a fence and injured her udder seriously enough to lose a quarter. The loss of the quarter was a permanent environmental condition that affected her producing ability but was not part of her genetic ability, as she didn't inherit the accident.

With a repeatability of .5 for a single lactation record, the weights for obtaining EPA from the average difference from herdmates would be as shown in Table 2.

As an example, if a cow has **three records** that average +4,000 pounds of milk above herdmates, the best estimate of her producing ability would be .75 x 4,000 = +3,000.

One record tells about half of what there is to know about a cow's ability to produce. Two records tell about two-thirds; three records, three-fourths; etc. For easy remembering, these weights or repeatabilities are equal to n/n + 1. The first record on a cow is by far the most valuable. Increasing the number of records beyond three or four provides little additional information for evaluation.

The ultimate result of an evaluation is to enable the breeder to compare his animals, one with the other. The estimated producing ability shown above does this. Each cow in the herd may fairly be compared with each other cow regardless of her length of lactation, age, month and year-season of freshening, or number of records.

Figure 1 shows a desirable situation for a breeder — many more cows are "plus" than are "minus." The poorest cows in previous years have been culled, and the good cows are being challenged sufficiently by good feeding and management to "stretch" up into the higher production categories.

Table 1 — Evaluating the cow's ability to produce.

What Affects a Cow's Production?	What Can We Do About It?
1. Length of lactation 2. Times milked per day 3. Age	**Standardize** the records to a 305-2x-M.E. basis.
The lactation records are standardized to 305 days in length, twice a day milking, to an average month of freshening, and to a mature equivalent or prime of life basis so that these three won't hinder a comparison between cows.	
4. Breed 5. Herd 6. Year 7. Season	**Compare** the cow's production with that of her herdmates. (Herdmate comparison)
The herdmates of a cow are all other cows of that breed that calved in that herd during that year and season.	
8. Temporary conditions (affect one lactation only) Calving interval Days dry Sickness or injury Chance and other	If the cow has several records, **average** them so the plus or minus "temporary" affects tend to cancel out.
If a cow has only one record it is impossible to "average" and this is the reason that we don't know as much about a first calf heifer as we do about a cow with several records.	
Producing Ability of the Cow	
9. Permanent conditions (affect all of her lactations) 10. Genetic merit of the cow	The average difference from **herdmates** weighted for the repeatability of that number of records is her **Estimated Producing Ability (EPA)**

Table 2 — Weights for obtaining EPA from average difference from herdmates.

Number of records	1	2	3	4	5	6	7	8
Weight	.5	.67	.75	.80	.83	.86	.88	.89

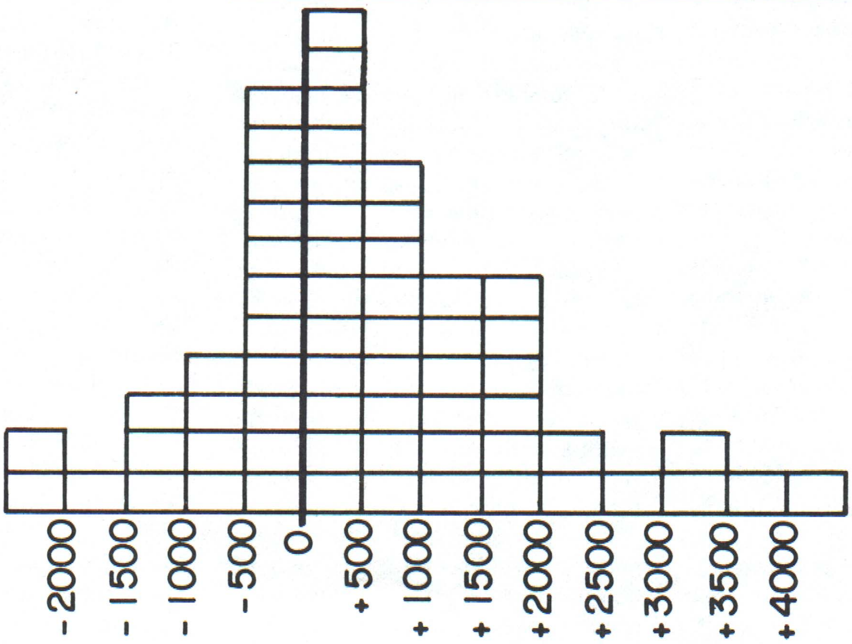

Figure 1 — Distribution of EPA's in a 62-cow herd of grade Holsteins with above average management, production, and genetic level.

Evaluating the Cow's Ability to Transmit

Estimated producing ability — This is not a very precise estimate of a cow's genetic merit as it doesn't consider the degree to which production is inherited. To improve the accuracy of evaluating a cow's genetic ability, her relatives' production records may be used. The resulting evaluation is usually expressed in terms of a cow's ability to transmit to her offspring. This genetic transmitting ability is called by various names in the industry.

USDA cow index — This is the best known and probably the most widely used estimate of transmitting ability. Paternal sisters are used in the USDA Cow Index in addition to information on the cow herself.

USDA cow indexes are computed three times a year or with each sire summary run and are made available to breed associations and to each state extension dairyman for dissemination to herdowners. A list of the high indexing cows is extensively used by artificial insemination associations in determining which cows to special-mate to obtain bull calves for sampling. Cow indexes are occasionally shown in extended pedigrees printed by the breed associations.

Estimated (average) transmitting ability — (EATA or ETA) — These estimates are calculated at several of the dairy record processing centers. The relative information used varies from paternal sisters only, to a combination of paternal sisters, dam, daughters, and maternal sisters.

Paternal sisters are by far the most valuable of all relatives in evaluating a cow's ability to transmit. In fact, paternal sisters often contribute more to a cow's evaluation for transmitting ability than even her own production records. The least valuable group of relatives is maternal sisters.

As an example, suppose a cow has two records that average +2,000 pounds of milk above herdmates, and her sire has a thousand other daughters that average +500 pounds above herdmates. From the table above the proper weights or emphasis are .140 for the cow and .355 for the paternal sisters. The estimate of the cow's transmitting ability is (.140 x +2,000) + (.355 x +500) = +458 pounds of milk. The USDA Cow Index is somewhat more involved than this simplified example.

The relative importance of the other sources of information in estimating the transmitting ability of a cow may be seen in Table 4.

The weight or amount of emphasis given to records on the cow and her paternal sisters are by far the greatest. Including records on the dam, daughters, and maternal sisters brings in the "cow family" and increases accuracy of the evaluation about 5 to 7%.

Table 3 — Approximate weight given to information on the cow and paternal sisters in estimating transmitting ability of the cow.

Records on the cow	Number of paternal sisters			
	0	10	40	1000
1	.125/0	.115/.155	.105/.285	.100/.395
2	.170/0	.160/.135	.150/.255	.140/.355
3	.195/0	.185/.125	.175/.235	.165/.330
5	.225/0	.210/.115	.200/.220	.190/.305

(weights shown are for: cow/paternal sisters)

Table 4 — Approximate weight given to five sources of information in estimating transmitting ability of the cow.

	Amount of Info.	Weight	Amount of Info.	Weight	Amount of Info.	Weight	Amount of Info.	Weight
Records on cow	1	.105	1	.095	1	.090	5	.160
No. of Paternal sisters	10	.150	10	.145	1000	.385	1000	.310
Records on dam	1	.045	5	.075	1	.045	5	.065
No. of daughters	1	.040	2	.075	1	.035	2	.055
No. of Maternal sisters	1	.020	2	.025	1	.020	2	.020

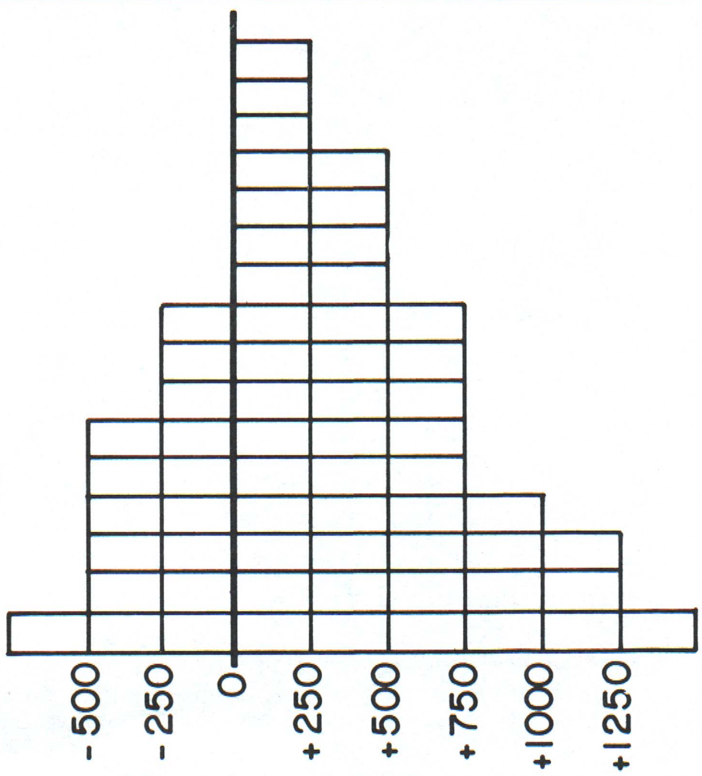

Figure 2 — Distribution of cow indexes (EATA's) in a 62-cow herd of A.I. sired grade Holsteins with above average management, production and genetic level.

The transmitting-ability estimates shown in Figure 2 are of less magnitude than the producing ability estimates shown in Figure 1. This is because only a portion of the variation is heritable, and a cow transmits only a sample half of her superiority (or inferiority).

Sire Evaluation (Predicted Difference)

Since there is no measure of a sire's individual performance, his evaluation is based on the performance of his daughters. An estimate of a sire's ability to transmit may be arrived at in two steps. First, an overall average is calculated from the average difference from herdmates for all of his daughters. Second, this overall average difference is weighted according to the repeatability of that amount of information. The resulting estimate of the genetic transmitting ability of the sire is called the **Predicted Difference** (PD). Examples of the distribution of daughters for two sires formerly in use in artificial insemination are shown in Figures 3 and 4.

These distributions show the basic difference between a high and low PD sire. A higher proportion of daughters of the high PD sire out-produce their competition, their herdmates. The fraction of a bull's daughters that outproduce their herdmates increases about 2% for each 100 pounds increase in PD as shown in Table 5.

It is interesting that the poor bull has some good daughters while the good bull has some poor daughters. It would be a fallacy to try to evaluate any bull based on only a few daughters. There is no way to be sure that a few daughters are representative of the total distribution of future or possible daughters. As more daughters are added, especially daughters from different herds, the likelihood of these daughters being representative of that sire's true genetic transmitting ability is increased. The measure of this likelihood is called the Repeatability of the sire's summary.

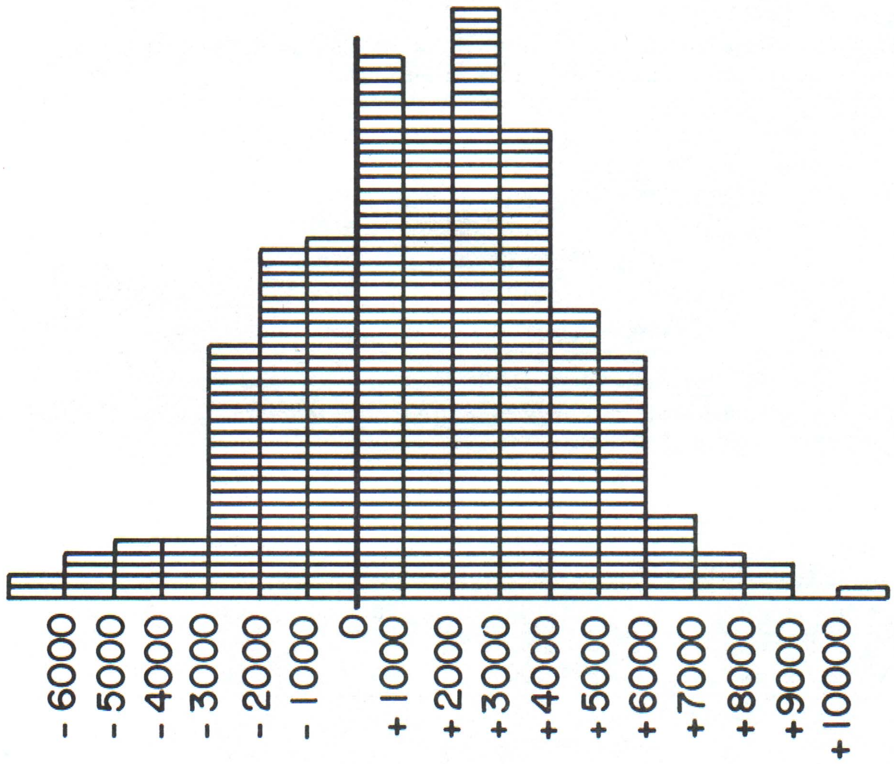

Figure 3 — Distribution of daughters of a Holstein sire having PD's of +1309 milk and +48 fat, 92% Repeatability, 331 daughters in 141 herds, and 10% culled in first lactation.

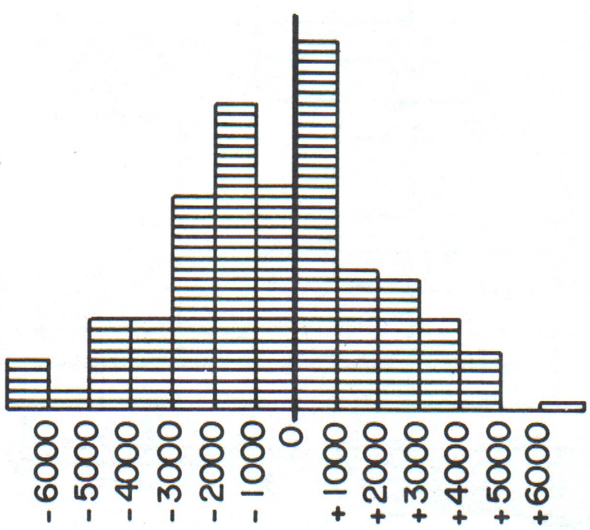

Figure 4 — Distribution of daughters of a Holstein sire having PD's of —1,140 milk and —2 fat, 90% Repeatability, 177 daughters in 87 herds, and 37% culled in first lactation.

Table 5 — Expected percent of daughters exceeding herdmates.*

Predicted Difference	Ayrshire, Jersey, Guernsey	Brown Swiss Holstein
+1400	76	72
+1000	69	66
+ 800	66	63
+ 600	62	59
+ 400	58	56
+ 200	54	53
0	50	50
— 200	46	47
— 400	42	43
— 600	38	40
— 800	34	37
—1000	31	34

**Barr and Allaire — Ohio*

Repeatability (R) of Sire Summaries

The repeatability of a sire's summary varies in magnitude depending on the following:

- —No. of daughters;
- —No. of herds;
- —Distribution of daughters across herds;
- —Records per daughter;
- —Days in milk of records in progress;
- —No. of herdmates; and
- —No. and average R of sires of herdmates.

The addition of more daughters in one herd increases the R very little. The additional representation of more herds in the sire's summary makes a greater increase in R. This should be expected because more dairymen are involved, more feeding programs, milking systems, facilities, types of management and especially more sets of herdmates or contemporaries for competition. Sire summary repeatabilities vary from about 15 to 99%. At low levels we have some indication of the sire's true ability, while at the higher levels we may be reasonably certain that the summary has accurately evaluated the sire.

The USDA-DHIA Modified Contemporary Comparison

The official sire evaluation that is in nationwide use is computed by USDA and is called the Modified Contemporary Comparison (MCC). To understand the value of the MCC over a simple average of daughter-herdmate differences it is necessary to understand some problems that have arisen in sire evaluation.

Many herdowners have used high Predicted Difference sires year after year and have developed entire herds sired by these top sires. These herds have far surpassed the average dairy herd in their genetic ability for production. Each new heifer coming into these herds faces formidable competition. This is especially the case where heifers are also competing against older cows who themselves are the "cream" remaining from previous crops of heifers. Any bull whose daughters are competing in herds of this caliber had a difficult time coming up with a high PD.

In contrast, other herdowners have been using mediocre sires. In many cases very little culling has been done on production because of the loss of cows for other reasons. It is obvious that a heifer entering such a herd faces easier competition because of the poorer quality of the herdmates. Likewise, a bull whose daughters are competing in these herds was made to look comparatively better than he should. In short, some rather large differences between herds in genetic merit have developed in recent years. These differences are a tribute to the dairymen's use of the tools for genetic improvement available to them.

The USDA-MCC takes into account the genetic level of herdmates competing with the daughters. This is done by use of PDs of the sires of these herdmates.

Another frequent problem in sire evaluation is the bias due to culling that the older cows have survived. This may be a problem when a bull's summary includes older daughters as well as when the competition the heifer faces includes older cows. The MCC contains an adjustment for bias that occurs due to culling for production after the first lactation.

The MCC takes its name from the use of contemporary groups or herdmates that are of a similar age. It makes use of two contemporary groups. Contemporary Group 1 includes first lactations only. Contemporary Group 2 includes second and later lactations. The greatest emphasis in the sire evaluation is given to the comparisons of daughters' records with contemporary information — with Group 1 records in the case of a daughter's first lactation or with Group 2 records for second and later lactations of daughters. A daughter's non-contemporary herdmates are also included but are counted the equivalent of only one additional contemporary.

Another characteristic of the USDA-MCC sire summary is the use of pedigree information on the sire. The pedigree information used is the PD of the bull's sire and that of his maternal grandsire. Each bull is put into a "genetic group" based on this pedigree evaluation. The average superiority (or inferiority) of the daughters of the bulls in this genetic group is then used in the sire's summary. This pedigree group average is weighted along with the daughter's information according to the genetic worth of each source. As daughter information (Repeatability) increases, the weight given to the pedigree group average decreases. This relationship is R to 1-R where R is the Repeatability and 1-R is the weight given to the pedigree group average.

The PD computed by USDA is adjusted to a constant genetic base such as PD74. This means that a breed average bull in 1974 had a PD of zero. As the breed improves genetically, more and more bulls will have higher and higher PD's. The breed average of sires may be +400, +500 or even higher after a period of years. This genetic improvement of the breed may necessitate changing the base to PD-80 (1980 base), PD82, or some other year base so that an average bull is again zero and the "+" sign will again denote a breed improver. Additional information on this sire evaluation is available in USDA Research Report 165.

Pedigree Evaluation

The sire and dam contribute equally to the genetic makeup of the offspring. The estimates of these contributions are the PD of the sire and the Cow Index (CI) or **Estimated Average Transmitting Ability** of the dam. The pedigree estimate of breeding value (EBV) of a heifer or bull would therefore be:

Pedigree EBV =
Sire's PD plus Dam's CI

As an example, suppose a heifer calf is sired by a bull with PD = +1,200 and is from a cow with CI = +1,000.

Pedigree EBV =
+1200 plus +1000 = +2200

The best estimate of this heifer's future producing ability, above or below her competition, is +2,200. Since she is expected to transmit only a sample half of her genetic superiority to her offspring, the best estimate of her future transmitting ability would be half her pedigree EBV, or +1,100. The offspring is expected to be intermediate in genetic merit to her parents.

The use of PD and CI, the estimates of transmitting abilities of sire and dam, is obvious in this example. Just how accurate are these estimates? Are they effective in a dairyman's breeding program? To find the answers to these questions much research has been done. Some of the results are shown in the following tables.

These studies were made from available DHIA data. Table 6 shows the results of first lactation heifer production in relation to herdmates. Table 7 shows the percent of bulls whose daughters outproduced their herdmates. In each case the pedigree information proved to be extremely valuable. A reliable pedigree index on a young bull is about equal in value to a sire summary based on 10 daughters in different herds. A third example of the effectiveness of pedigree evaluation using the predicted difference of the sire added to the cow index of the dam is shown in Table 8. In this study, heifer calves were purchased in pairs from many different herds. One member of each pair had a high pedigree estimate of breeding value. The other had a low pedigree EBV. The heifers were raised, bred, allowed to freshen into the herd and their production compared.

The high pedigree heifers as a group outproduced the low pedigree heifers about as expected. Although some individual pairs of heifers didn't follow the pattern, the pedigree EBV's were very reliable for the group. This response is the same as the comparison of daughters of high and low predicted difference sires in the distribution shown in Figures 3 and 4. The low bull has some good daughters and the high bull some poor ones, but the entire group shows the true picture of each bull's superiority.

Traits to Consider

Each breeder must decide whether to put all of his emphasis on production or to give attention to other traits as well. Factors that may make the emphasis different from herd to herd are the milk market, the market for surplus stock, serious conformation problems in the herd, and the necessity for making the herd conform to the available facilities.

The **basic** reason for emphasizing any type of management trait in a breeding program is its effect on lactation and lifetime production or the efficiency of obtaining this production. Whether attention should be given to a trait depends on the following criteria:

1. **Can it be measured?**
   The breeder must know what he is looking for and be able to accurately identify the animals that are desirable for the trait.

2. **Is it heritable?**
   A trait should have a reasonably high heritability if much progress through breeding is to be expected. Heritability indicates what percentage of the superiority or inferiority in the parents is likely to be transmitted to the offspring.

Table 6 — Fractions of first lactation Holstein heifers that outproduced their herdmates.*

Dam's Index	Fraction of daughters that were +	Sire's PD	Fraction of daughters that were +
over +1,260	.81	over +1,160	.76
+840 to +1,260	.65	+ 580 to +1,160	.66
+420 to + 840	.66	+ 141 to + 580	.57
+ 75 to + 420	.56	− 580 to + 141	.48
+ 75 to − 420	.50	−1,160 to − 580	.43
−420 to − 840	.40	under −1,160	.26
under − 840	.38		
Average	.53	Average	.53

**M. McGilliard — Iowa*

Table 7 — Effectiveness of pedigree information for estimating the breeding value of 340 young Holstein A.I. bulls.*

Grouping based on sire's PD	Sires average PD	% Plus	Son's PD % Plus 500 or More
Top 25%	+1,045	73%	34%
Second 25%	+729	65%	18%
Third 25%	+372	38%	11%
Bottom 25%	+142	31%	4%
Grouping based on dam's index	**Dams average index**	**% Plus**	**Son's PD % Plus 500 or More**
Top 25%	+577	65%	28%
Second 25%	+340	51%	18%
Third 25%	+187	46%	12%
Bottom 25%	+0	45%	8%
Grouping based on pedigree index	**Average pedigree index**	**% Plus**	**Son's PD % Plus 500 or More**
Top 25%	+792	76%	40%
Second 25%	+577	61%	13%
Third 25%	+375	38%	9%
Bottom 25%	+68	31%	4%

**Butcher — North Carolina*

Table 8 — Expected (EBV at purchase) and realized performance of Holstein heifers selected on pedigree.*

			First Lactation			
	No.	Expected production	M.E. milk	M.E. fat	Actual milk	Actual fat
High pedigree	29	+1,373	16,652	633	13,120	508
Low pedigree	36	− 427	14,627	570	11,587	460
Difference (High minus Low)		+1,800	+2,035	+63	+1,533	+48
Adjusted for herd of origin and season of calving	65	+1,816	+1,850			

**Freeman and Atkinson — Iowa*

3. **Is it economically important?** The trait must be of economic importance in itself (production), affect lactation or lifetime production (mastitis resistance, breeding regularity), or affect the ease and efficiency of obtaining this production (milking speed, etc.)

As shown in Table 9, the more traits selected for, the slower the progress in any one of them. Maximum progress toward increasing the herd's ability to produce may be obtained by selecting for production only. Any deviation from this goal must be justified by the three criteria listed above.

The main problem areas in addition to low production are reproduction and mastitis. About 12 percent of dairy cows are culled for a type defect. (See Table 10.)

No single type trait stands out as most useful in determining herd life. Since final type score is highly correlated genetically with all of the individual type traits, some attention to final score would likely prevent development of serious conformation defects in most herds.

Table 9 — Relative progress for primary trait if selection emphasis is equal for several traits.

No. of traits selected for	Relative progress in primary trait
1	100%
2	71
3	58
4	50
6	41
8	35
10	32

Table 10 — Why cows are culled from herds.*

Reason	% of cows culled	Heritability of trait
Low production	32.5	.25 to .30
Poor reproduction	26.6	0 to .10
Mastitis	10.4	.10 to .25
Teat and udder injury	6.2	.05 to .20
Weak attachments and floor	5.0	.10 to .25
Feet and legs	2.0	.05 to .17
Hard milker or leaker	1.9	.20 to .30
Other type traits	1.2	.05 to .25
Poor disposition	.8	.20 to .30

**Van Vleck and Norman — New York*

One fear expressed by dairymen regarding selection for high production is that the high producing first-calf heifers won't last in the herd long enough to be really profitable. Tables 11 and 12 show that high first-lactation heifers stand a better chance of remaining in the herd through six lactations than do lower producing heifers.

In addition, heifers destined to remain in the herd for more lactations maintain their superiority through each successive lactation.

Mating Systems

A number of systems for making corrective matings in dairy herds have been developed. Their purpose is to correct the conformation weaknesses in a herd by mating each cow to a bull that is strong in the characteristics where that cow is weak. With the weaknesses "corrected," the offspring should last longer in the herd. These systems make sense to a great many dairymen and are widely used and growing in popularity. None of the mating systems has come forward with concrete evidence that it either improves the herds or produces a profit for the dairymen that use it.

Summary

The ultimate goal for the dairy herd breeding program is to produce replacement heifers that will:

1. produce large quantities of milk with a protein, fat, and total solids content that will command a premium price.
2. reproduce regularly and without problems, calving every 12 or 13 months.
3. have a minimum of health problems such as mastitis, milk fever, ketosis, etc.
4. be completely mobile and require minimal care of feet.
5. have a disposition that allows them to fit the facilities and management routine for the herd.
6. milk out quickly, cleanly, and without special labor requirements at milking time.
7. wear well and do the above for a long lifetime.

The most rapid avenue for attaining this goal is by selection of the best

Table 11 — Survival of cows divided into four groups according to first lactation production.*

Production group	1st records No.	2nd record %	3rd record %	4th record %	5th record %	6th record %
Top 25%	87,409	84	67	50	35	22
Second 25%	83,467	80	61	45	31	20
Third 25%	73,211	75	52	36	25	16
Bottom 25%	73,214	55	32	20	13	8

**Wickham and Everett — New York*

Table 12 — Actual lactation average for cows making 1 to 6 lactations.*

No. of lactations	No. of cows	Pounds of milk during lactation No. 1	2	3	4	5	6
1	73,967	7,972					
2	60,720	10,698	9,548				
3	46,053	11,180	12,588	10,777			
4	37,169	11,419	13,017	13,962	11,357		
5	30,168	11,481	13,225	14,319	14,590	11,436	
6+	53,959	11,316	13,155	14,425	14,922	15,409	13,429

**Wickham and Everett — New York*

sires available through artificial insemination. Top pedigreed young sires are also a good buy and can contribute to herd improvement if a number of them are used, each sparingly. If natural service sires are used, they should be highly selected, with a high pedigree estimate of breeding value, and should be used sparingly and no more than one season.

Milk production is the primary trait to select for. Fat, protein, or total solids are also highly important and likely to increase in importance when and if nutritional pricing becomes widespread. Some attention to conformation is necessary to avoid serious problems, especially in the udder traits. The best approach is probably to select the highest production sires and then eliminate the very poorest ones based on total score of their daughters. This should avoid creating conformation problems that cannot be controlled by light culling of females in the herd.

Common sense dictates that the breeder should be aware of how much production is being sacrificed each time a lower PD sire is accepted in hopes of obtaining an improvement in some other trait. If the possible improvement in that other trait is worth more than the potential loss in production, the sacrifice should be made. If too many sacrifices in production are made, the genetic improvement for production in that herd will grind to a stop.

Further Information

Every dairyman can improve the genetic ability of his dairy herd to produce. Modern cow evaluations are available through the National Cooperative Dairy Herd Improvement Program in every state. Accurate and useful sire evaluations are available from the United States Department of Agriculture through the extension dairymen, artificial insemination (AI) associations, and breed associations. Service to top sires is available through AI. Breed associations provide additional programs of benefit in the breeding and management of dairy herds especially through their type classification programs. The Cooperative Extension Service in every state stands ready to help with explanations and suggestions for use of all available information.

The ingredients for a successful breeding program to improve the efficiency and profitability of the herd are available. It is up to each dairyman to take the necessary time to plan, to make decisions, and to use the cow and sire evaluations for the improvement of his herd.

This publication and its four companion publications on dairy genetics were developed by the Planning Committee of the 1976 National Workshop on Genetic Improvement of Dairy Cattle. Committee members are: Clinton E. Meadows, Chairman, Michigan State University; Basil Eastwood, Iowa State University; Robert Everett, Cornell University; Evans Wright, University of Kentucky; William E. Kelso, Washington State University; and N. P. Ralston, Program Leader, Dairy Production, Extension Service, United States Department of Agriculture.

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