dairy guidelines

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PREDICTED DIFFERENCE

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Daughters of some bulls give more milk than daughters of other bulls.

This is the basic premise of predicted difference (PD). PD ranks bulls on the average 305 day production of their mature daughters compared with breed average herdmates. It is derived from the production of a bull's daughters, evaluation of his ancestors, and the genetic worth of the daughter's contemporaries. Its major use is to rank bulls.

PD works like a prediction for a football team. Before the football season begins, we speculate on the success of our team in light of returning players, coaching changes, new recruits, etc. As the season progresses, we begin to lose interest in these factors and pay more attention to our success in the current season. Near the end of the season. we disregard our early speculations and have little trouble predicting the quality of our team from its performance this fall.

Similar circumstances influence our evaluation of a bull. For a young bull with few daughters, we must predict his quality from his ancestors. They had many of the same genes he is passing to his offspring. As the bull gains more milking daughters, we place less emphasis on his ancestors and more emphasis on those daughters. When the bull has many daughters, we ignore his ancestors and rely entirely on the performance of those daughters and their competition to estimate his genetic quality.

The formula for PD is complex but can be reduced to a few important components.

$$PD = R(\overline{MCD}) + (1-R)(GA)$$

Group Average
Modified Contemporary Deviation
Repeatability

Repeatability measures the accuracy of the PD. The closer repeatability is to 100%, the more reliable the PD.

Modified Contemporary Deviation is basically the average difference in 305-2X-ME production between daughters of the bull and their contemporaries (herdmates of the same age calving in the same season). The MCD also has been adjusted for the genetic quality (competition) of those contemporaries. Therefore, we can write:

$\overline{MCD}$ = Average daughter production (A)

             − Average contemporary production (B)

             + Average genetic value of contemporaries (C)

$\overline{MCD} = A - B + C$

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Group Average is the average of $\overline{MCD}$'s for other bulls with pedigree indexes similar to the bull being evaluated. The pedigree indexes (PI) are based on sire and maternal grandsire (MGS) PD's and are calculated as:

$$PI = .5(\text{sire PD}) + .25(\text{MGS PD})$$

$$\text{Example PI} = .5(+1032) + .25(+624) = +672$$

Then to find GA, one must use a chart similar to Table 1. Note that all A.I. Holstein bulls with PI's between +651 and +700 had daughter $\overline{MCD}$'s averaging +639. Therefore +639 is inserted into the PD milk formula as GA. The figures in Table 1 will change each year.

Table 1. Group $\overline{MCD}$ averages for A.I. Holstein bulls.

Pedigree Index for Milk (lbs)	Number of bulls	Group $\overline{MCD}$ Average (lbs) Milk	Fat
+701 up	341	+640	+13
+651 to +700	176	(+639)	+11
+601 to +650	132	+410	+ 6
+551 to +600	196	+414	+ 8
+501 to +550	199	+398	+ 7

USDA, Fall 1977   (To save space, only PI's larger than +500 are listed here)

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          An Example Calculation for PD Milk
  Bull:  PD = ? (to be calculated)
  Sire:  PD = +1032
  Maternal Grandsire (MGS):  PD = +624
  PI   =  .5(+1032) + .25(+624) = +672
  R    =  72% or .72 (based on 59 daughters in 53 herds)
  MCD  =  +1720 (Based on 59 daughters in 53 herds)
  1 - R =  1 - .72 = .28
  GA   =  +639 (See previous paragraph for explanation)
  PD   =  .72(+1720) + .28(+639) = +1417
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This method of computing PD's was initiated in 1974 as an improvement of the herdmate comparison method. Three major changes were implemented.

1. Daughters are now compared mostly to herdmates of the same age (contemporaries). The herdmate average weighted all herdmates equally. The contemporary average for first lactation daughters includes all first lactation herdmates, with the older herdmates counting as only one additional cow. The contemporary average for an older daughter includes older herdmates, with all first lactation herdmates counting as one additional cow.
2. Credit is given for the genetic quality of herdmates. When daughters of a bull are compared frequently to daughters of other high PD bulls, the competition is very keen, and a large superiority to herdmates is difficult to obtain. The current PD's include in the $\overline{MCD}$ compensation for the quality (high or low) of competition in the herds.

3.   A measure of the quality of the bull's pedigree influences the PD when repeatability is low. This is the GA described previously. The contribution of GA to the PD is large when daughters of the bull are few, but the contribution recedes quickly as daughters become more numerous and R increases.

The importance of $\overline{MCD}$ compared with GA in the ranking of bulls on PD is often misunderstood. Table 2 shows the emphasis on $\overline{MCD}$ is equal to that of GA when the bull has R = 20% and the sire has R = 50%. When R for the bull is 20% and for the sire is 90%, GA has more influence than $\overline{MCD}$. In all other situations, the daughters influence rankings of bulls from 1.7 to 32.3 times more than the pedigrees influence rankings. This is because the GA, when multiplied by (1-R), is fairly constant for different bulls.

Table 2. Emphasis of $\overline{MCD}$ (daughter performance) vs. GA (pedigree value) in the ranking of bulls on PD

Repeatability of Bull	Repeatability (%) of sire		
	20	50	90
20	1.7	1.0	.8
50	4.3	2.7	2.0
90	32.3	19.0	13.3

USDA

Only situation where pedigree outweighs daughter performance.

Repeatability has been described as a measure of reliability for the PD, but it is often misinterpreted. It has nothing to do with the performance of future daughters, but only indicates how much confidence can be placed in the PD as a true measure of the bull's genetic ability. Because repeatability is already included in the calculation of PD, it is suggested that confidence intervals be used in place of repeatability to minimize risk when choosing sires. Dairy guideline 89, "Confidence Interval" contains a good explanation of how this can be accomplished and why repeatability is often misused.

A discussion of PD would be incomplete without evidence that PD works. It has been stated that the expected percentage of daughters exceeding herdmates in mature equivalent production increases 2% for each 100-lb. increase in PD's of sires. A study of 10,000 Holstein first lactations has verified this nicely (Table 3).

Table 3. Percentages of first lactation Holsteins outproducing herdmates

PD of Sire	% Superior Daughters
Best group	76
2nd group	66
3rd group	57
4th group	48
5th group	43
worst group	26

McGilliard, Iowa

These data included PD's published before 1974. PD's calculated under the new system are more predictive of average daughter performance. Keep in mind that

daughters of any bull will vary in production, but on the average will produce as predicted in relation to daughters of other bulls.

Predicted differences are computed for milk, fat, fat percentage, and dollars for any bull with at least ten usable daughter records. PD dollars weights the PD milk and fat by national milk prices to estimate gross milk receipts from one lactation of a daughter. PD's for solids-not-fat, protein, and their percentages are being published, but their use is limited by current pricing policies and the small number of cows tested for these components.

Predicted differences are calculated by USDA in the winter and summer each year. PD's for bulls may be obtained through popular publications, breed associations, artificial insemination organizations, and the Cooperative Extension Service. For Virginia dairymen, the Virginia Tech Department of Dairy Science publishes the A.I. Sire Hot List of the eighty bulls with highest PD dollars and the Virginia Tech Sire Summary of all A.I. bulls available to Virginia dairymen. These are available from your local Virginia Cooperative Extension Service agent.

The base year for PD is 1974. That means PD's actually compare daughters to 1974 breed averages. This allows fair comparisons among bulls of different ages. In addition, genetic progress made since 1974 has led to all A.I. bulls now averaging more than +1100 lbs. PD milk. This average was only +500 lbs. when this guideline was first written 1978. Have you been participating in this tremendous progress?

The important point is that PD is the most accurate method of ranking or comparing bulls on the production of future daughters. Use it!