"Choose Parents Wisely"

An Outline for Dairy Cattle Breeding

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Operation of the dairy farm for profit always creates a desire and need to replace the current milking herd with cows that have more potential for profit. The alternatives are to buy better cows or breed better cows, the latter being the more common method. To produce replacements within the herd most successfully we must manage the herd to produce the maximum number of heifers, reduce involuntary cow losses, and choose parents wisely.

Limitations

There are two limiting factors when trying to replace cows with more profitable offspring: (1) the number of replacements available and (2) the accuracy of choosing parents of these offspring. Nature places limitations on the number of replacements. A cow has her first calf at 2 years of age, with a gestation period of 280 days, and the need for a 52-day dry period limits us to one calf per year. Half of the calves will be bulls, and these facts combine to produce a long-generation interval. A long-generation interval does not necessarily restrict progress, but it certainly slows down the rate.

Management, too, plays a role. In practice, we do not have a 12-month calving interval; it is more like 13 months. Of the heifers born, probably 15% or more die or fail to calve. This limits the number of replacements available and the number of unprofitable cows that can be culled. Management is also important in the number of good cows lost each year due to infertility, disease and accidents. Replacing these cows may use up most of the best replacements.

Another limiting factor is our ability to choose parents of offspring. We must be able to choose parents whose offspring will be more profitable than the cows that are replaced.

From the foregoing discussion, it should be obvious that we will not have much option in the choice of dams of herd replacements. All cows kept for milking will become dams of heifers, so nearly all of our effort must be directed toward accurate sire selection. Therefore, the balance of this discussion will be on bull selection.

Accuracy of Selection

"Accuracy of selection" and "heritability of milk production" have the same meaning. Frequently, reference is made to the low heritability of milk production, which means that herd management, often referred to as the environment, tends to mask the genetic difference between cows. Actually there is nothing complex or peculiar regarding the inheritance of the potential for high milk production.

Every animal receives one-half of its genes from each parent. Although each half is a sample half of the parents' genes, we should expect the offspring to be an average of the parents, and they are. However, when the dairyman observes the outcome of a mating, he is inclined to doubt that that offspring represents an average of the parents.

Perhaps a discussion of what happens in a large population with and without selection will illustrate what is meant by accuracy or heritability. Michigan has two large cow populations: one is the tested (DHI) herds, and the other the nontested herds. Currently, the DHI herds average 14,200 pounds of milk, and the non-DHI average 11,000. Over time, the annual increase in DHI has been 200 pounds, with the nonDHI increasing at a slower rate. If we could impose the condition that herd management would not change in the future, and no selection of parents were made, then production would remain constant, forever. There would be no tendency for production to decrease as some would think, and in fact, it would be as difficult to decrease production by selection as to increase production by selection. For this to be true, offspring must be an average of parents.

Suppose a decision were made to increase production by 1,000 pounds in both groups. This could be done by removing enough of the low-producing cows to move the average up 1,000 pounds. The bottom 30% of cows and their offspring would be culled, and with the continuation of random mating, both populations should be increased 1,000 pounds. However, we do not get the increase expected from the selection. In the non-DHI populations, no change would occur. Without production records, accuracy of choosing the bottom 30% would be zero. Heritability of milk production under these conditions would be zero. In the DHI population, production would settle down at 14,400 or at a 200-pound increase. Heritability would be 20% since we selected for 1,000 and realized 200 pounds.

Cows are permanently different in potential ability to produce milk, due to genes inherited from parents. Temporary management, or environment, affects each lactation enough to at least partly mask the genetic difference among cows. In the example used, dairymen realize that if selection had been done 6 months or a year later, or earlier, different cows would have been culled. Our ability to predict a cow's next record from the current one is approximately 50%. This value is referred to as *repeatability*.

The conclusion that must be reached is that if we are only 50% accurate in predicting the next record of a cow from the current record, we would not expect to be this accurate when predicting what a daughter might do.

Improving Accuracy

Sometimes dairymen are pessimistic over the low heritability of milk production. We should be reminded that if we could invest our capital at a 20% return, we would certainly get rich, especially if we had very much to invest. As a matter of fact, we could do the same at 5% — it would just take longer. The question, then, is whether we can improve accuracy of selecting parents and speed up improvement.

Repeated records on the same cow should tend to cancel out some of the environmental effects and should improve accuracy. If the cow's parents have production records, we can improve accuracy. Information on other close relatives also improves accuracy of selection. This improvement, however, is mostly useful when selecting dams of bull calves. Cows kept for milking must be used also as dams of herd replacements.

Accuracy of choosing parents of bull calves should be the same as for heifers. Not many bull calves are needed; therefore, we have the opportunity to choose as parents those animals with complete pedigree information, thereby increasing accuracy of choosing parents.

Bulls do not produce milk, but by milking their daughters in sufficient numbers, we can approach 99% accuracy in predicting the performance of future daughters. Obtaining this degree of accuracy may be too costly in time and money; therefore we strive for a balance that maximizes progress and profit.

The current solution is to use something less than 30% of the first service to young bulls, and to strive for an accuracy provided by 20 to 50 daughters in 20 to 50 different herds, with testing completed before the bull is 6 years of age. These two factors determine the number of bulls that can be sampled.

Bulls to Sample

Not many young bulls can be sampled. We should be as accurate as possible in the choice of parents of young bulls to be tested. The importance of accuracy in the choice of parents dictates that we should carefully plan matings to produce bulls for sampling, rather than leaving it to chance.

Previous discussion has emphasized that accuracy increases as information on the parents increases. Animals selected as parents of bulls should be those whose performance indicates they are genetically superior, and when there is enough information to be reasonably sure they are.

The philosophy suggests that artificial breeding units will have a distinct advantage in planned matings for bull calves. They have personnel devoting full time to location of the best females of the breed, and have access to semen of all bulls that have proven to be outstanding. AI units have an advantage in the sampling of a young bull. They can supervise semen collection, distribution to herds, and semen use to insure a reliable multiherd proof. A disadvantage is the risk and cost of storing large numbers of bulls while awaiting the sampling results.

The results of testing bulls to estimate performance of future daughters are given in Table 1. If the information in this table is understood, we should have everything needed to make wise decisions selecting sires of herd replacements. To have confidence in the published results we need to understand the facts that have been considered.

When trying to determine why two cows differ in the amount of milk produced, we must consider the genetics, the environment and the amount of information available.

Sampling Results

	No. Herds	No. Dams	Pct. Rpt.	Predicted difference Milk	Pct.	Fat	$
Bull A	326	500	95	1,615	—.13	38	120
B	19	24	48	812	—.18	3	46
C	1	11	18	75	+.02	6	9

Genetics of Breeding

One-half of the inheritance comes from the sire and one-half from the dam. In bull proofs we are only interested in the sire's contribution. To properly account for the dam, we must estimate her breeding value, or eliminate the effects of her contribution. The most accurate solution is to mate the bull to a random group of cows so that the sum of their breeding values is zero. Bulls sampled in AI are usually mated to 400 to 500 cows in 40 to 50 herds with little or no selection of mates. There is not much likelihood that dams bias bull proofs.

A number of non-genetic factors affect each record of a cow in a similar manner, and can be corrected or adjusted. These are:

—Number of times milked daily;
—number of days milked;
—age at calving;
—year of calving;
—season of calving;
—days open;
—region of calving.

Each record of every cow enrolled in DHI, regardless of days milked, is adjusted to a common base of: 2 × 305 region/season/mature equivalent.

There is an environmental influence common to only one group of cows, and this is the herd in which the cow is milked. To compare cows milked in different herds, we eliminate herd management by comparing each cow with all other herdmates calving in the same herd/year/season, and of similar ages. This procedure results in each record of every cow being expressed as a difference from daughters of other bulls calving in the same herd/year/season of similar age.

Since all herds do not use the same bulls, nor the same quality of bulls, we adjust for genetic difference among herds by including the breeding value of the sires of herdmates.

There are three other non-genetic factors that are mostly due to chance, and we depend on number of daughters to cancel the effects. Earlier the subject of non-repeatability of records on the same cow was discussed.

These are the good and bad things that happen to a cow for a particular record. With large numbers of daughters of a bull and herdmates, the plus and minus effects will cancel out.

We also briefly mentioned the sampling nature of inheritance. When each offspring receives a sample half of the parents' genes, by chance some will get a good sample, some a poor sample, but most will get an average. Twenty or more daughters will surely cancel these effects.

Furthermore, not considered before, but known to be important, is the number of days a cow is pregnant during the first 305 days of lactation. There are accurate adjustments for days carried calf, but the information is not readily available on each cow. However, it seems unlikely that there will be any difference in the average days pregnant for a daughter of a bull and herdmates. It might be important when selecting dams of bull calves.

A final problem is the limitation of information available, or reliability of our estimate. The reliability of the estimate of a bull's breeding value is determined by the number of herds in which the daughters are milked, the number of daughters, and the number of herdmates. These numbers are properly considered and expressed as a repeatability value. The least reliable estimate used is derived from 10 daughters in a single herd, which is 15 to 18%. The most reliable, of course, would be of the order of 99%, which value 300 daughters in 300 herds would approach.

Use of Proofs

There are five items of information in published sire proofs that can be used for selection. Each bull can be compared with other bulls on the bases of predicted difference (PD) for milk, butterfat test, fat and dollar value. Dollar value is derived from a combination of milk price and butterfat differential. Bulls can be ranked on either of these items and if used in your herd, they should be ranked the same way. The percent repeatability is your confidence factor when choosing one or more of the bulls available.

The wise choice when selecting sires is to use the best bulls available to you at the time you need to breed a cow, or your herd. The best bull will be the highest ranking bull based on predicted difference (PD) for what you consider important: milk, test, fat or dollar value.

You should expect the bulls' daughters to rank the same in your herd as the PD ranks the bulls. Level of production in your herd will not affect ranking. Repeatability reflects the amount of information available for estimating the PD. Information on a bull that includes daughters in 20 or more herds should not lead to many errors in the choice of bulls.

Summary

We can outline the management steps and choice of parents of herd replacement that will result in a highly satisfactory breeding program:

1. Enroll the herd in DHI.
2. Identify each animal by date of birth, sire and dam.
3. Keep heifer losses below 5%.
4. Feed the herd for maximum profit.
5. Keep involuntary cow losses to a minimum.
6. Strive for a 365-day calving interval.
7. Use up to 30% of your first services for sampling young bulls.
8. Breed the balance of the herd to the highest PD bulls available.
9. Replace the poor cows with these heifers.

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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