

Genetic and Environmental Influence on OSU Holstein Production

Jack D. Stout and Saghir A. Jafri

Story in Brief

Milk production for Oklahoma's Holstein herds on DHI records increased approximately 1 per cent per year for the last 10 years. This increase amounted to 1750 lb. During the same time interval, OSU's Holstein herd increased 3250 lb, 88 percent faster than the state average.

When OSU's Holstein lactation average dropped drastically in 1976, a study was initiated to determine the effect of genetic and environmental changes on herd production. Regular genetic progress was made through culling of low producing cows and breeding of genetically superior offspring for herd replacements. Environmental conditions imposed by nature and management had a much greater influence on production than did genetics.

Introduction

Milk production of the Oklahoma State University (OSU) Holstein herd has increased rapidly over the past 10 years. The lactation average was 14,190 lb milk, 426 lb fat in 1969, and improved to 17,440 lb milk, 660 lb fat in 1978. The rate of increase in milk production of the OSU herd was nearly double the rate of increase for all Holstein herds on Dairy Herd Improvement (DHI) records in Oklahoma. The Oklahoma average for Holsteins was 12,840 lb milk, 448 fat in 1969, compared to 14,590 lb milk, 516 fat in 1978.

Differences in milk production among herds are a result of the genetic ability of the cows and the environmental conditions imposed by management of each herd. A common formula is $P = G + E$, where P = milk production, G = genetic ability and E = environmental conditions. DHI records provide the data necessary to determine individual cow and total herd milk production and genetic evaluation. Therefore, the environmental condition of a herd can be determined by difference.

Genetic improvement may be accomplished by two methods which should normally occur simultaneously. One method is through selection or culling of the low producer. The other method is through the use of genetically superior bulls each year, resulting in an increase in the genetic ability of the offspring to produce milk.

Environment covers a multitude of factors, both controllable and noncontrollable by the herd manager. Weather conditions, feed supply and quality, or health problems are not always controllable by the herd management. However, they have a major effect on herd production in any given period. Hopefully, the environmental conditions controllable by herd management would always be the optimum mix of all factors involved to allow the cows to express their full genetic potential to milk.

A study was conducted to determine what portion of the increase in milk production of the OSU Holstein herd could be attributed to genetic improvement and what portion could be attributed to management improving or controlling environmental conditions.

Materials and Methods

The *Herd Ranking and Summary*, a genetic evaluation provided as a part of the DHI records by the Mid-States Dairy Records Processing Center, Ames, Iowa, was used to determine: annual lactation herd average, difference from Oklahoma Holstein average, breeding value of cows and sire average of bulls represented.

Nine genetic evaluations were calculated by the Processing Center during the 10-year period 1969 through 1978. The cows represented on the nine summaries were divided into three groups: 1) all cows in the herd during a summary period, 2) cows leaving the herd during each summary period and 3) cows entering the herd during each summary period. The breeding value (BV) for each group was determined by doubling the estimated average transmitting ability (EATA) of each cow. The EATA is calculated by the Processing Center using all available genetic information for each cow, including dam, paternal half-sibs, maternal half-sibs, daughters and own records.

All lactation averages used were standardized to 305 days in length, milked two times per day and adjusted to mature equivalent (305-2X-ME). The breeding value of the OSU herd was subtracted from the production difference from state average to determine the environment or management level of each herd ranking interval.

Results and Discussion

Milk production of the OSU Holstein herd increased 88 percent more than the average of all Oklahoma Holstein herds on DHI for the period 1969 through 1978. For the time intervals listed, the overall increase of OSU Holsteins was 3250 lb milk, 234 lb fat, compared to 1750 lb milk, 68 lb fat for the average of Oklahoma Holstein herds. State average for each interval represented from 185 to 240 herds, depending on the testing year. The OSU herd average was based on a herd size of 90 to 125 cows.

Table 1 lists the 305-2X-ME lactation average for the OSU herd, the Oklahoma average for all Holstein herds on DHI and the difference between the two for each of nine intervals. The drastic drop in milk production, -2760 lb, of the OSU herd on the September 1976 *Herd Ranking and Summary* prompted the start of this study. The study was continued for 2 additional years to bring out the effects of management changes concerning feed supply.

OSU's 1969 herd average of 14,190 lb milk was 100 percent of the Oklahoma Holstein average, whereas the 17,440 lb milk for 1978 represented 120 percent of breed

Table 1. Comparison of OSU Holsteins to state average.

Date	OSU Holsteins		Average of Oklahoma Holstein herds		Difference from state average	
	Milk	Fat	Milk	Fat	Milk	Fat
12-69	14,190	426	12,840	448	1,350	22
12-70	14,060	455	13,340	462	720	-7
5-72	15,470	495	13,860	476	1,610	19
5-73	15,840	522	13,980	484	1,860	38
9-74	16,010	560	13,620	475	2,390	85
9-75	16,380	571	13,940	481	2,440	90
9-76	13,620	490	14,110	499	-490	-9
9-77	17,080	640	14,750	522	2,330	118
10-78	17,440	660	14,590	516	2,850	144

average. The OSU herd made relatively steady progress in milk production at approximately 2 percent for 8 of the 10 years. State average herds had four minus years but an overall increase of approximately 1 percent per year.

The bar graph of Figure 1 shows the breeding value of the three groups of cows: 1) all cows in the herd during a herd ranking interval, 2) those cows sold during each interval and 3) those cows entering the herd during each interval.

The net change in breeding value of a herd is a slow process as the Group 1 levels will indicate. The OSU herd is a closed herd, requiring that herd replacements be only raised heifers. With the exception of animals going to the breed promotional sales, all animals leaving the herd represent a culling process. The college herd is typical in that not all cows are sold for reasons of low production. Reproduction failure, disease, injury, etc. works on this herd as all others. The herd being used as a research and teaching lab also puts constraints on the herd that may not be typical to other herds of Oklahoma. There was only one year, 1969, where cows sold were of higher BV than the average of all cows. Therefore the culling process improved the overall BV of the herd. The high breeding value of cows sold in 1969 was due to culling cows for udder health and conformation problems along with the normal culling low producers. Lowering the breeding value in this manner was a sound management decision which improved the environment for the cows remaining in the herd.

For seven of the nine intervals, the first lactation animals added to the herd had a higher BV than the cows sold. Also, for three of the nine intervals, the first lactation animals had a higher BV than the all cow average. This genetic superiority of the herd replacements resulted in the overall increase of the breeding value of the herd through the 10-year period.

A herd manager only has control over the genetic portion of the BV contributed by the sire. The cows having female offspring are randomly selected by nature. Also, death, loss of heifers and reproductive failure among heifers are somewhat at random. The extremely low BV for first lactation cows entering during the 1977 period was mostly the result of sire selection. One sire, used rather heavily, when selected had average superiority for milk production, high superiority for type traits needing improvement in the OSU herd and a relatively low repeatability. Many of his daughters have been acceptable replacements for the university herd. However, his genetic contribution to the BV of those daughters was a -555 lb milk. The culling rate has been higher on daughters of minus bulls than the 24 percent average for all cows.

Figure 2 is a bar graph showing the difference in milk production of the OSU herd from the Oklahoma Holstein average and the portion of that difference attributed to genetics and environment. The bar graph plainly indicates that the environment of a herd has more influence on the overall milk production than does the genetic effect. Only one year, 1970, did the genetic effect outweigh the influence of management.

The dominance of environment on performance is shown in the 1976 interval of both Figure 1 and Figure 2. In Figure 2 the average breeding value of all cows in 1976 was the highest of the 10-year period. Yet, Figure 1 shows that the lactation average was 490 lb milk below state average. The lactation averages for 1975-76-77 were 16,380, 13,620 and 17,080 lb of milk, respectively. The change in environment that caused milk production to drop 2760 lb one year and to increase 3460 lb the year following was quality of feed.

Quality and quantity of feed fed is probably the most influential environment factor on milk production of any herd. The quality of the total feed supply was a serious problem for OSU during the 1976 period. The herd is typically a dry-lot operation fed from a stored forage supply of sorghum silage and alfalfa hay. Alfalfa hay is purchased on bid according to requirements of state law. The silage is raised on ANSI

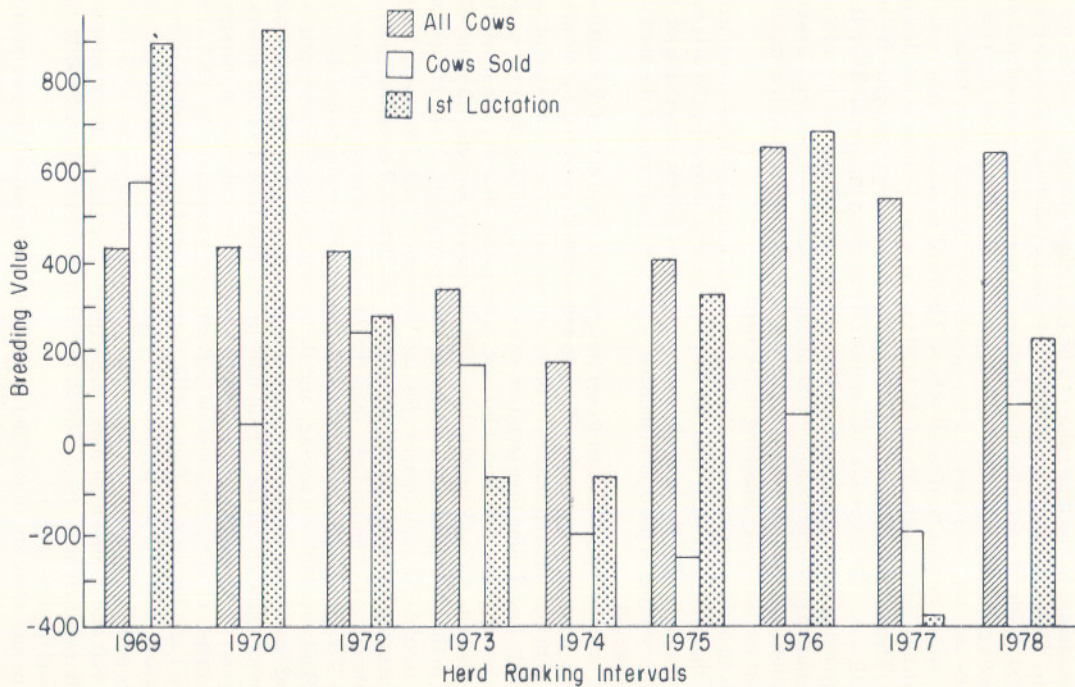


Figure 1. Breeding value of OSU Holsteins.

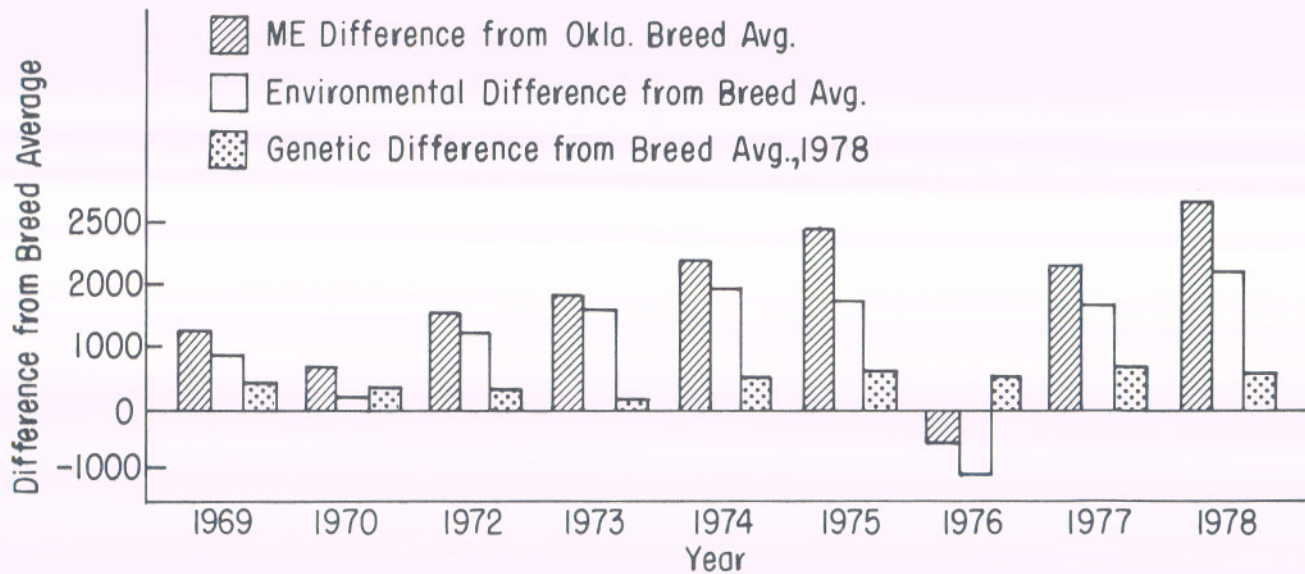


Figure 2. Management and genetic level of OSU Holstein herd.

Department-assigned land. The 1976 period was a very bad one for growing forage. There was no rain during the early alfalfa season, and it was dry through the late silage growing season. The short supply of alfalfa caused the market value to double the normal first cutting price. As a combined result of bid requirements, fluctuating hay prices and low rainfall, OSU's stored forage supply was short and of low quality. The grain ration was also affected by rapidly changing cost. To keep total cost within the allotted budget, wheat "mids" were utilized at varying percentages of the ration, thus affecting quality. When the feed supply returned to normal in 1977, the cows responded with milk production back on line with their potential.

This study has been beneficial to those involved in OSU herd management and the DHI records program. At Oklahoma's request, starting with January 1980, the *Herd Ranking and Summary* calculated by the Mid-States Dairy Records Processing Center will provide the genetic profile of each herd.
