TOWARD SCIENTIFIC METHODS OF BREEDING

Since the development of production testing programs, dairy cattle breeders and geneticists have been interested in the most accurate way to analyze and interpret this information as a guideline to identifying the genetic inheritance that will contribute to the greatest rate of improvement in succeeding generations.

There is a 1925 publication in the library of the American Jersey Cattle Association entitled, *The Jersey Breed: Its Origin, Development and Dairy Value.*

It is part advertisement, part handbook to the programs and services available to Jersey owners at that time. In it, Secretary R. M. Gow takes pains to outline a theory of genetic improvement, under the heading "Prepotency":

Prepotency in stock-breeding parlance means the power of handing on to offspring the qualities of the parents. The transmission of qualities is the essential characteristic which constitutes a breed. There are three important laws which govern breeding. They are heredity, variability and selection. The last of these only is in the breeder's control. The others are the result of the operation of natural laws and of the work of predecessors. The present-day breeder has the advantage of beginning where others left off.

The original characteristics of the ancestors of our domesticated animals show a marked tendency to reappear. Like begets like, or the likeness of an ancestor. Prepotency is the foundation upon which the constructive breeder must build if his work is not to be in vain—prepotency both in the breed and in the individuals he selects.

It universally is conceded that the Jersey possesses this quality, prepotency, in a very high degree. Good Jerseys, wisely mated, can be counted on, in nine cases out of ten, to produce offspring as good as the parents or even better. Type, color, markings, production, percentage of butter-fat, as they have been more or less prevalent in the various families, are passed on from father to daughter, from mother to son, with exceptions it is true, but with remarkable persistency. The breeder of Jerseys may confidently expect his matings to result in perpetuating the desirable qualities in type and dairy production possessed by ancestors, both those near and those more remote.

At the time The American Jersey Cattle Association was organized in 1868, the only credentials a Jersey bull had on the pedigrees of his offspring were a name and registration number. It would be decades before any sort of system would be devised that provided a method by which breeders could compare the transmitting abilities of different bulls. It would take a full century before the association would adopt unbiased evaluations developed by application of scientific method.

An official sire evaluation system began, interestingly enough, within the Register of Merit testing program.

ROM was established on May 6, 1903, "with the purpose of raising to a still higher standard the *average* excellence of the Jersey cow, and of securing an additional authoritative and permanent record to which reference can be made in the selection of breeding animals."

Breeders selected individual cows to be enrolled on this program; entire herds were not tested. The standards for entry varied with age. For example, a first-lactation cow calving before 30 months of age earned ROM recognition by producing at least 6,000 lbs. milk or 260 lbs. fat. Qualifying levels increased to a maximum of 10,000 lbs. milk or 400 lbs. butterfat for cows five years or over.

There were two levels for recognizing bulls in the Register of Merit. Class A bulls were those that were themselves scored at least 80% of the perfect score for conformation (according to the Scale of Points), and who had at least three daughters from as many different dams entered in the Register of Merit. Class B bulls were not scored for type, but did have the required number of daughters.

The ROM bull ratings were the first effort by the AJCC Board of Directors to obtain and publish assessments of a Jersey bull's merit as the sire of daughters (and

sons). It wasn't much of a selection tool by modern-day standards, but it was also not that different from what the other breed registry associations were offering. According to Harry A. Herman in *Improving Cattle By The Millions,* all early sire recognitions were "based on rather broad and sometimes not very significant standards."

Such programs, Herman recalled, did little to help a breeder achieve continuous improvement. "In the earlier days, it was often said by college professors that 'a man who picks three good bulls in a row is a successful breeder.' This feat was a difficult one, as most breeders found through experience. Some breeders achieved acclaim by being 'lucky' in choosing a bull that proved highly outstanding."

ROM bull ratings may have attempted to rate a sire's "prepotency," but they were more often just a way to merchandise one's breeding. By carefully selecting the three daughters to be tested and giving them preferential treatment, it was possible to make a bull look better than he really was.

Creating a system that was more accurate and reliable than ROM took time and depended upon developments in the production testing of dairy cattle outside of the AJCC's control.

Recall that ROM was an extremely selective testing program; herd owners selected the cows—even the lactation—to be tested. The bias of ROM (and other programs like it) became ever more apparent as cow testing associations were organized under rules that required production information to be collected from each and every cow in a herd.

The pressure for more unbiased testing created by the success of the early DHIA associations was reflected in discontinuation of the ROM sire rating program in 1932. It was replaced by the Tested Sire program, which can be seen as a step towards establishing the expectation that as many of a bull's daughters that could be tested, should be tested.

That idea, however, produced a new problem. How could a bull's merit be fairly compared to another bull's, when his average might be based only on first-lactation daughters and or only on a group of mature daughters?

The solution offered was to adjust records to a standardized basis. Age con-

version factors were developed and adopted by the Board of Directors on April 1 of that year.

Any Jersey bull could become a "Tested Sire" as there were no minimum requirements for number of daughters tested and production levels. In this light, then, the program probably served more to encourage "sampling" than it did to provide estimates of "prepotency."

In order to recognize outstanding sires, the Board instituted a Superior Sire award program. A bull earned the Superior Sire award when:

- At least 10 daughters had completed production records of at least 270 days in length under Register of Merit or Herd Improvement Registry (HIR) testing;
- At least 50% of bull's registered daughters four years of age and older were included among the tested daughters;
- The average butterfat production of all tested daughters computed on the mature yearly basis equalled or exceeded 600 lbs.; and
- At least 10 daughters were classified, that number being at least 40% of the bull's registered daughters, with an average score for all daughters of at least 82.0%.

The Superior Sire Award (and a Star Bull program adopted seven years later) was popular, but largely ineffective in promoting the selection and use of bulls able to transmit increased production to their daughters. Nothing is better testimony to that fact—and the concern it caused—than the Board of Directors' efforts in 1938 and 1939 to institute a selective registration program.

In a survey based upon five weeks of registration work, Lynn Copeland told the Directors on June 6, 1939 that "47% of the herd sires now in use in registered Jersey herds are under three years of age and that 62% of them are under four years of age. In this period, 950 bull calves were registered."

Copeland reported disturbing news about these potential future herd sires. "We found that 26% of the dams of these bulls have already completed either Register of Merit or Herd Improvement Registry records. It was also ascertained that just 6% of the bull calves now being registered were the sons of sires that had been proven either through Register of Merit or Herd Improvement Registry records."

In other words, the vast majority of Jer-

sey bulls in 1939 had no better credentials than their ancestors of 1868—just a name and number in the AJCC Herd Register. As Copeland commented, "Our present registration requirements do not include excellence or superiority in the animals registered and there is a growing demand for some further qualification other than purity of blood before an animal is entitled to final registration.

"It seems obvious," Copeland suggested, "that eventually a system of selective registration is going to be absolutely necessary if the registered Jersey cow is to survive. It seems obvious," he concluded, "that at first it should be applied to bulls." The Board voted to adopt a Selective Registration program to take effect January 1 of 1942, allowing time for breeders "to get their herds ready for the program."

The fact that at one time the AJCC did have selective registration for bulls is less important than the fact that such a program was adopted because there was a fear for the commercial survival of the Jersey breed.

Equally important, the program brought the AJCC into a closer working relationship with the Bureau of Dairy Industry at USDA. Its work beginning in 1935 to develop dairy sire evaluation programs would ever after impact Jersey sire evaluation programs.

The requirements for selective registration mark the first time that the Board of Directors officially recognized the USDA sire proofs and accepted DHIA production records. The Board did so through the requirements which it created for selective registration:

- The sire must be a proved bull in DHIA, whose daughters have an average yield of 400 lbs. fat on a 305-day basis; or an AJCC Tested Sire whose daughters' records on a 365-day basis must average 500 lbs. fat; *or*
- The dam must have a DHIA or Herd Improvement Registry or Register of Merit record with a mature equivalent 305-day production of 400 lbs. butterfat.

These requirements introduced many purebred Jersey breeders to the USDA daughter-dam comparisons. The general method of this sire evaluation was described by L. W. Specht. Pennsylvania State University, in a 1980 *Jersey Journal* article.

"In the first USDA proofs, a sire was termed a proven sire when the production

records of at least five of his unselected daughters were compared to the records of their dams. All records used in the tabulation were limited to the first 305 days of production, were age-adjusted to a mature basis, and all three and four time milking per day records were reduced to a twice-a-day basis."

The daughter-dam proofs did not have any other influence upon the other AJCC sire awards. For nearly three decades, the following recognition program was promoted by the association:

- Tested Sire, which was based upon a minimum of 10 daughters, averaging their highest HIR or ROM records, and reporting the number of the bull's registered daughters and their average classification score;
- Superior Sire, which recognized Tested Sires having an average daughter yield of at least 8,400 lbs. milk and 470 lbs. fat, and average classification scores of 83.0%, with at least 50% of the registered daughters included in the evaluations;
- Senior Superior Sire, an award requiring a daughter average of 9,500 lbs. milk and 510 lbs. fat or greater, plus an classification average of 84.0%; and
- Century Sire, recognizing bulls with a minimum of 100 tested daughters and 100 classified daughters, achieving production and classification levels equal to that for the Superior Sire award.

In contrast to the stagnating AJCC programs, USDA researchers were quickly improving the daughter-dam comparison. It had become the standard for selecting and evaluating A.I. bulls, but there were increasing concerns about its accuracy.

"In the 1950s and up until 1962," recalls Penn State's Specht, "many A.I. units turned to the A.I. daughter average as a method of ranking sires. (They did so because) this eliminated some of the biases found in single herd daughter-dam comparisons, including preferential treatment of the daughters of a sire and changes in the quality of management over the time period. These practices almost always made the daughters look good at the expense of their dams. Thus sires were given credit for genetic superiority when, in fact, they looked like breed improvers only because of improved management practices."

The A.I. daughter average system thus drew attention to the need for evaluating a large number of daughters milking in many different herds. But it was not a viable al-

ternative to the USDA daughter-dam proofs. Noted Specht, "In their search for something to advertise, studs began to compare their sires with those in other studs where nutrition and management programs for the cow herds might be very different. A.I. daughter averages were not effective in ranking sires for genetic merit under such circumstances."

To address such issues, researchers at Cornell University began to develop evaluations based upon comparison of herdmates, broadly defined as the other cows milking in the same herds and in the same time period as the daughters of the sire being evaluated.

"In 1962," wrote Specht, "USDA reached an agreement with the breed associations to publish herdmate comparisons on all sires. The breed associations agreed to cease publication of separate summaries and USDA became the sole producer of 'official' sire summaries. Sires were listed with herdmate comparisons which were essentially the daughter average production minus herdmate average production."

But again, the AJCC sire awards—Tested Sire, Superior Sire, Senior Superior Sire, and Century Sire—were largely unaffected by these developments in USDA genetic evaluations. The report of a Special Performance and Type Advisory Committee on August 26, 1962 advised only updating the minimum requirements for breed awards. The Board would discontinue the Tested Sire award effective January 1, 1965, providing a substitute in the Approved Sire award.

The revolutionary moment the AJCC's evaluation of Jersey bulls started early in 1967. On February 12, at the Fort Hayes Hotel in Columbus, Ohio, President Stanley N. Chittenden, called the meeting to order, then told the Directors:

"I feel we as a Board are facing one of the most crucial times in our history. We have some very important decisions to make in the very near future if we expect to continue this progess we have in motion (in registrations and the All-Jersey milk program).

"I think we have stalled too long doing something constructive and possibly radical with both our testing and classification programs if we expect them to survive. I don't think we can sit and watch what the other breeds are doing or use the IBM machines as an excuse any longer. We have got to take the bull by the horns and do something about these problems.

"I hesitated to say these things when I know our staff has worked way beyond the call of duty to try and recover from the moratorium and business machine problems. However, I think even they will agree we have to do something—and quick."

That "something" was introduced to purebred Jersey owners hrough a technical article in the September 20, 1967 issue of the *Jersey Journal*. Written by R. D. Plowman and B. T. McDaniel of the Animal Husbandry Research Division, USDA, the article outlined the new concepts of Predicted Difference and Repeatability. *"Changes in USDA Sire Summary Procedures"* explained that the June summaries had been improved on the basis of "research results" and because "electronic data processing equipment could accommodate more sophisticated methods."

The *Journal's* editorial pointed out that the "considerable change in terminology" was indicative of an even more significant change in calculating sire breeding values. Things would never again be the same: "As the new evaluations become available more and more breeders and A.I. units will make use of them and breeders will need to be versed in the terminology and meaning of the evaluations whether considering their whole herd or special matings."

Predicted Difference, the editorial explained, "is an estimate of a bull's expected performance when used on the general population of cows within a breed and takes into consideration the number of daughters of a sire, the number of herds in which they made their records, and the number of records per daughter."

Repeatability "is a figure attached to the Predicted Difference. This figure is used to express the degree of certainty to which a bull's future performance in the general population will approximate his calculated breeding value," or Predicted Difference.

These concepts required reforming one's thinking, but "Students of breeding, geneticists, statisticians and knowledgeable dairymen who have studied these new methods are agreed that the new USDA Sire Summary Procedures offer much promise for ranking sires proved in both natural service and through A.I. use."

Just a few weeks later, on November 6, Dean Plowman of USDA met with the Board of Directors and soon 10 months of "studying the feasibility of changing to this new program" were concluded. On November 7, 1967, the Jersey association entered into a Memorandum of Under-

standing with USDA that provided for "scientific and uniformly derived expressions to effectively identify the breeding value of (Jersey bulls) for production traits three times yearly based on Standard DHIA production data."

The Directors then acted radically—as President Chittenden had suggested they might. The existing sire awards program was discarded in favor of a new medal system based upon "the Predicted Difference of a sire, the Repeatability of the information available and the Type Classification average of a bull's daughters":

· Gold Medal Sire: PD milk +400 lbs. or greater;
· Silver Medal Sire: PD milk +250 lbs. to +300 lbs.; or
· Bronze Medal Sire: PD milk +100 lbs. to +249 lbs.; and
· with minimum Repeatability of 20% and minimum type classification average of 83.0%.
· One star to be awarded for each 10% repeatability above 20%.
· Medal rankings updated with each USDA summary.

For the first time in history, a single, clear signal was being sent to breeders by the AJCC, in cooperative with USDA, about the development of Jersey sires: *Select and use Plus Proven bulls.*

In a guest editorial in the December 20 1967 issue, Stanley Chittenden wrote, "I am personally convinced that modernization of these programs, based upon more realistic information has been long overdue. Our previous system of sire ratings based upon only the selected highest record of a bull's daughters is unrealistic and outmoded.

"No one needs to be reminded of the competitive challenges that exist today and our future depends upon our courage to make adjustments to meet these challenges . . . And I am sure every realistic thinking Jersey owner will agree our number one challenge is to chart a course that will lead to the fastest possible improvement in production to match the asset of efficiency of the Jersey breed.

"These decisions will prove," Chittenden predicted, "to be the most far reaching yet made in providing an opportunity for faster breed improvement."

Milestones In The Development Of Jersey Sire Evaluations

1902 The American Jersey Cattle Club adopts a plan to publish production records supported by the Babcock test.

1903 Register of Merit testing is established.

1905 The first "cow testing association" (forerunner of DHIA) is organized in Michigan.

1922 Holger 108744 becomes the first Medal of Merit bull.

1932 The Tested Sire rating and Superior Sire Awards are established.

1938 On May 16, the first collection of dairy sire semen for artificial insemination is made at Rutgers University.

1939 The Star Bull program is adopted.

1940 There are 4.8 million farms in the United States reporting milk or cream sales. Average annual production per cow is 4,622 lbs. milk. Cows on DHIA and DHIR testing programs average 8,133 lbs. milk.

1942 Selective registration of bulls is established, with Lucretias Ashburn Kahn 430123 being the first male registered. Procedures for the Tested Sire and Star Bull programs are revised by adjusting production records to a 305-day, 2x mature equivalent basis before daughter averages are calculated.

1945 The Senior Superior Sire award is established.

1947 The National Association of Animal Breeders (NAAB) is organized

1949 Lilac Sire Challenger, owned by Ralph Cope of Oregon, sets a new Tested Sire record for the breed with 10 daughters averaging 13,200 lbs. milk, 5.9% and 787 lbs. fat (2x-305-m.e. basis).

1950 The number of businesses selling dairy sire semen in the United States peaks at 97.

1952 Jersey bulls used in artificial insemination are required to be bloodtyped. New requirements are adopted for the Superior Sire and Senior Superior Sire awards.

1954 A plan is established, effective March 1, 1955, for publishing a Preliminary Sire Rating for Jersey bulls with at least five, but less than 10 tested daughters. The Century Sire Award is established.

1962 USDA changes from the daughter-dam comparison to the daughter-herdmate comparison method of summarizing sires' breeding value.

1967 The June USDA Sire Summary implements Predicted Difference and Repeatability.

1968 The Board of Directors adopts the USDA Predicted Difference Sire Summary as the basis for the AJCC Sire Award Program. Surville Ceres Pride is the top sire of the breed for PD milk (+1,008 lbs.). The AJCC records 42,862 progeny of 4,219 different bulls. Of these, 71.5% were sired by 798 bulls. Five of the top 10 sires of sons were minus for Predicted Difference milk.

1972 For the first time, the top 10 sires of sons were all plus for Predicted Difference milk. Milestones Generator is the leading sire of sons (231) and daughters (2,312).

Marlu Milestone is voted winner of the *Jersey Journal's* Great Bull Contest. His son "Generator" ranks sixth.

1973 The Idea Committee of the AJCC Board of Directors proposes implementation of a Young Sire Proving Program.

1973 The Gold, Silver and Bronze Medal awards are discontinued. The Modified Contemporary Comparison (MCC) procedure is adopted by USDA for calculating sire summaries.

1977 Average Jersey production increases 1,750 lbs. milk and 58 lbs. fat in the first decade of adoption of the USDA-AJCA Sire Summaries.

1978 Predicted Difference for Type is calculated for the first time. The Production Type Index is introduced; the single score weights PD dollar value and PD type in a ratio of 3:1. On the first PTI list, Willrich Mercury (LL) ranks first, followed by his sire, S.S. Quicksilver of Fallneva. The average for all Jersey sires in active A.I. service is +757M and +26F, compared to the non-A.I. sire average of +126M and +3F.

1980 The Young Sire Program is implemented

1983 Five bulls from the AJCC Young Sire Program receive their first USDA summaries, averaging +1,088M, +47F and +$154.

1985 A-Nine Top Brass becomes the first Jersey sire to have more than 300 sons recorded in a calendar year (338). The first regional young sire proving group is organized.

1987 Average Jersey production increases 2,007 lbs. milk and 76 lbs. fat in the second decade of the USDA-AJCA Sire Summaries.

1988 Highland Magic Duncan becomes the first Jersey sire to have more than 400 sons recorded in a calendar year (438).

1989 The Animal Model is adopted as the basis for genetic evaluations, introducing the concept of Predicted Transmitting Ability (PTA) to replace Predicted Difference.

1991 The Functional Trait Index (FTI) is introduced. It is the sum of the PTAs for linear type traits times their relative economic values.

1994 The Production Type Index is revised with five factors—PTA protein, PTA fat, Functional Trait Index, Productive Life and PTA somatic cell score—weighted 8:2:2:2:-1.

1997 Average Jersey production increases 3,152 lbs. milk, 127 lbs. fat and 97 lbs. protein in the third decade of the USDA-AJCA Sire Summaries.

1999 Jersey DHIR production sets a record of 16,841 lbs. milk, 750 lbs. fat and 619 lbs. protein (2x, 305-day, m.e.). The Production Type Index is updated: PTA protein, PTA fat, Functional Trait Index and PTA somatic cell score are weighted 10:4:3:-1. Weights for each linear trait are also updated and implemented in FTI calculations.