UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
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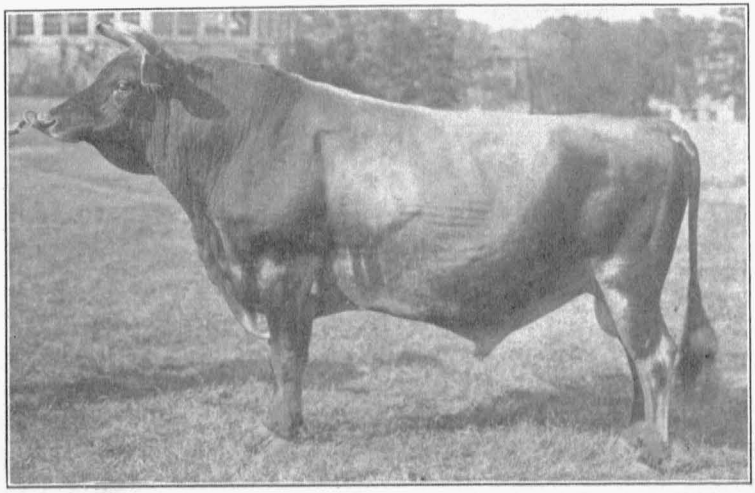
Selecting the Dairy Sire



Raleigh's La Rilla Lad 147892, a proved sire selected for use in the Jersey herd of the University of Missouri after his first thirteen tested daughters averaged 653 pounds of butterfat as mature or mature equivalent records, and five of his daughters that had dams with yearly records had produced 100 pounds more butterfat than their dams at the same age.

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UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE

Agricultural Experiment Station

Selecting the Dairy Sire

A. C. Ragsdale and Warren Gifford

Good sires are essential for continued improvement of dairy cattle. The ability of a dairy cow to produce milk and butterfat is inherited from both sire and dam. One half of the germ plasm which controls the characteristics of any individual comes from the male parent, and is a continuation of the germ plasm of his ancestors, and one half comes from the female parent and her ancestors. This fact has resulted in the popular statement that "the sire is half the herd", and while, from this viewpoint, the statement is true, there are yet many instances when certain excellent sires or certain inferior sires have been the principal influence in changing the production of a good herd to distinctly superior or markedly inferior production in a single generation. In other words, there are prepotent sires that transmit desirable characteristics and there are other sires that transmit to their progeny many of the undesirable characteristics of the breed.

Good cows likewise may have the ability to transmit to their sons and daughters their own good qualities, but individual cows, on the average, are not able to influence the herd or breed to nearly as great an extent as the male does, because they can produce such a small number of young in a lifetime, whereas the sire may have a large number of offspring. Some sires, in fact, have had more than four hundred progeny.

The importance of sires of good breeding and especially sires of proved merit is therefore evident, yet every year many bulls just coming to maturity and whose first daughters would soon be in milk are sent to the butcher. Definite information as to the real value of these sires is obtained too late. Their places are in turn taken by other young bulls, whose breeding qualities are unknown and cannot be known until perhaps they also have been slaughtered. Therefore, intelligent herd management demands that every effort be made to locate as early as possible those sires that have proved themselves capable of transmitting high production and superior type to their progeny, and to care for them so that their usefulness may be greatly prolonged. The breeder who studies seriously the problem of herd improvement, realizes that the whole future of the herd is at stake when a new sire is selected, and that a sire for which he would gladly pay possibly thousands of dollars may be lost when he lets a promising young sire go to the butcher before his daughters have had an opportunity to demonstrate their merit at the pail.

HOW THE SELECTION IS MADE

The selection of a purebred dairy sire usually involves one or more of the following considerations:

1. Type or appearance
2. Pedigree, i. e., a study of the ancestors
3. Character of the offspring.

The character of the offspring serves as the best guide in selecting a dairy sire. Since an understanding of the factors involved and of the qualities of a desirable proved sire are valuable in studying pedigrees and in judging type, this method of selecting a sire will be considered first.

SELECTING A PROVED SIRE

A proved sire is one with a sufficient number of daughters having yearly records that can be used in predicting the production and type of a greater number of daughters from similar dams. When all the daughters of a sire are tested as is often the case in cow testing associations or official herd improvement tests and there is thus no special selection of the daughters, the first six daughters having records that can be compared with their dams are, on the average, a good indication of the ability

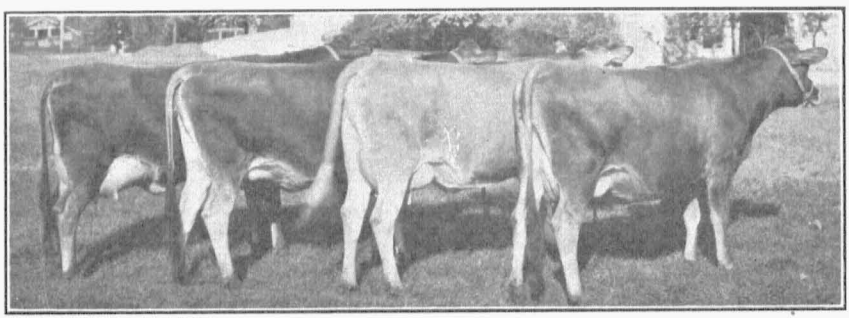


Fig. 2.—Four daughters of Raleigh's LaRilla Lad (shown on cover of this bulletin). These are his first four daughters to freshen in the University herd and at the average age of 3 years, 1 month, they have produced 10,186 pounds milk and 538.6 pounds butterfat each. This is the equivalent of 695 pounds butterfat on a mature basis.

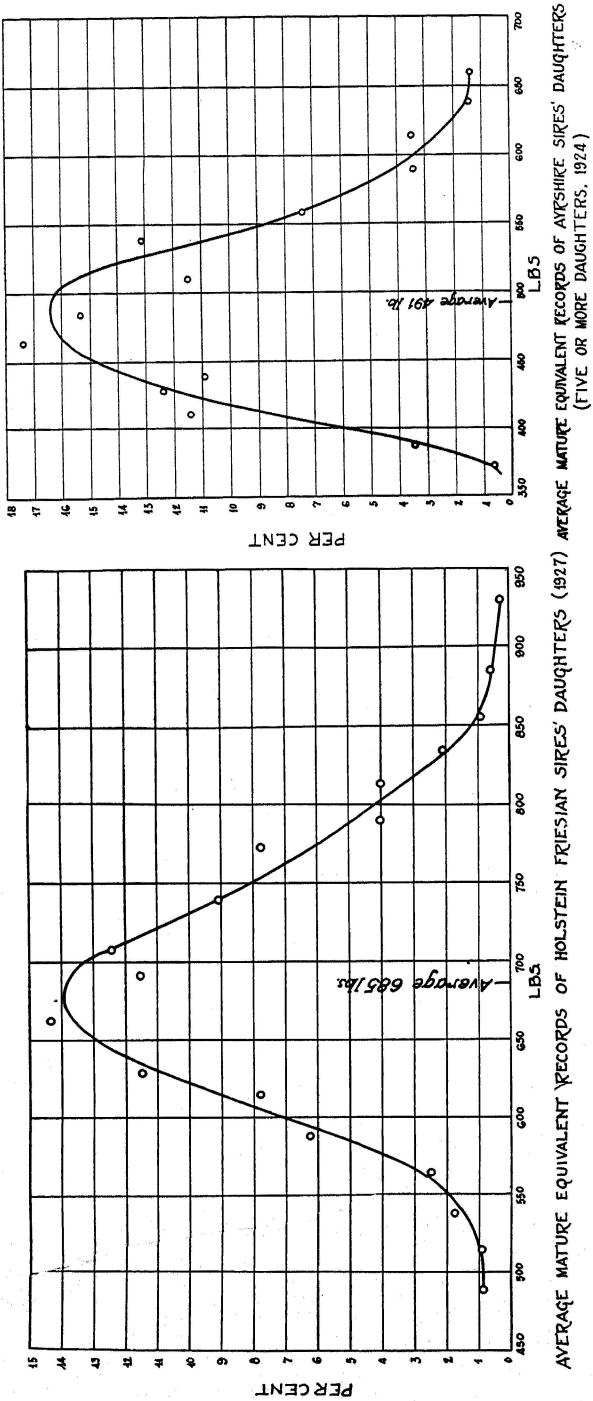
of the sire to transmit similar production to a greater number of daughters when he is mated with the same class of dams. In the case of Advanced Registry (or Register of Merit) sires, where the daughters tested are often a selected group, and where some daughters are often eliminated because they do not meet the production requirements, a sire should have ten or more daughters with production records, which may be compared with their dams, before they are of great value in predict-

ing with accuracy the production of a greater number of daughters. These numbers are ordinarily sufficient for predicting the approximate production of any greater number of the daughters of any sire, because the reliability of such a measure increases only as the square root of the number used. It is also believed, that the type or general appearance of a larger number of daughters will be similar to that of the first six or ten daughters out of similar dams. Figure 1 shows a proved sire selected for use in the University of Missouri Jersey Herd and figure 2 shows his first four daughters to freshen in the University Herd.

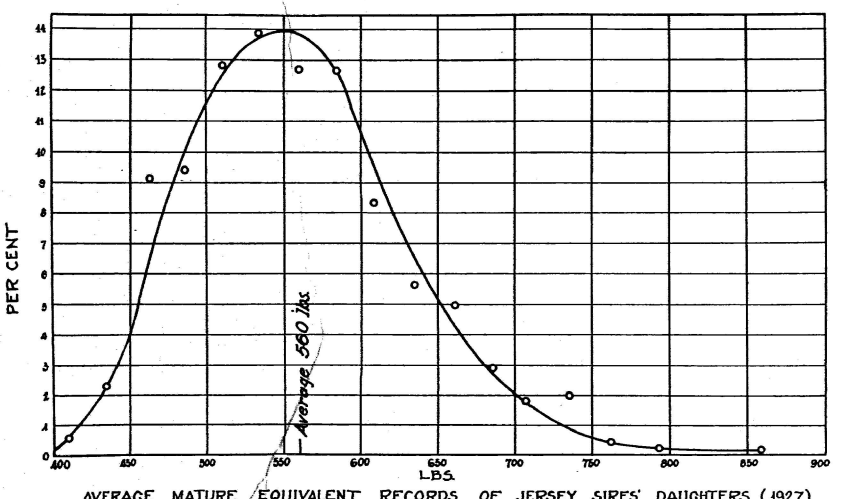
Since there is definite evidence of a proved sire's transmitting ability, it is comparatively easy to formulate standards which will help in deciding whether a proved bull is a desirable sire worthy to use in a good herd or whether he is an inferior sire that should be discarded. Since the profitable production of milk and butterfat is the primary reason for the existence of the dairy breeds of cattle, any discussion of the selection of a proved sire must necessarily be concerned first of all with the production records of his progeny. The importance of good type must not be overlooked, but since it is believed that the inheritance of type is controlled similarly to the inheritance of production, the same methods of selection should be exercised in the selection of sires for type, as is recommended for production.

Just what the average production of the daughters of a sire should be to classify him as one that transmits high production and one that it is desirable to use in any given herd depends upon the kind of dams with which he was mated, the distribution of the production of the daughters, the conditions under which the records were made, and the kind of cows with which he is to be mated in the new herd. If the sire was mated with low producing dams, a considerable increase should be expected in the production of the daughters as compared with their dams. If he was mated with high producing cows, then he may be considered a first-class sire if he maintains a production in his daughters equal to their dams or gives but a small increase. The exceptional sire is the one that increases the production of a very high producing herd. It is evident, therefore, that the amount of the increase in the production of a bull's daughters over their dams is, when considered alone, and without respect to the class of cows to which he was bred, a poor index of the transmitting ability or merit of a sire.

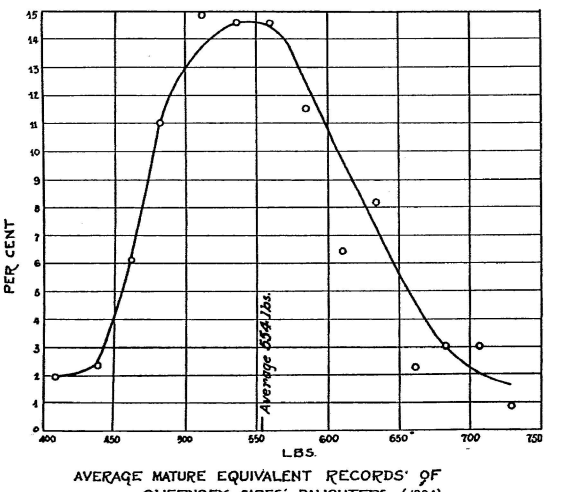
For breeders who are not acquainted with the average production records of the Advanced Registry daughters of sires of the various breeds, Figures 3, 4, 5 and 6 will be of interest, and may serve as a guide in comparing their own herd records with the average records of the officially tested cows of the various breeds. These figures show the distribution of the average *mature equivalent* records of all the daughters of all sires of



AVERAGE MATURE EQUIVALENT RECORDS OF HOLSTEIN FRIESIAN SIRES' DAUGHTERS (1927) AVERAGE MATURE EQUIVALENT RECORDS OF AYRSHIRE SIRES' DAUGHTERS (FIVE OR MORE DAUGHTERS, 1924)



AVERAGE MATURE EQUIVALENT RECORDS OF JERSEY SIRES' DAUGHTERS (1927)



AVERAGE MATURE EQUIVALENT RECORDS OF GUERNSEY SIRES' DAUGHTERS (1924)

Figs. 3, 4, 5, and 6—These figures show the grouping of the daughters of all sires of the various breeds having ten or more Advanced Registry Daughters.

the Ayrshire, Guernsey, Jersey and Holstein breeds that had ten or more Advanced Registry daughters up to the dates given in the figures.

The distribution of the production records of the daughters of any proved sire should be studied carefully. The minimum requirements for entry in the Advanced Registry of the various breed associations often serve to increase the production records of the daughters of the poor sires above what these records would be if *all* daughters had been included. This effect and a correct grouping of the records of a sire's daughters is illustrated in Table 1 and Figure 7 by the records of the

TABLE 1.—A COMPARISON OF THE MATURE EQUIVALENT FAT PRODUCTION OF THE DAUGHTERS OF TWO HOLSTEIN-FRIESIAN SIRES AND OF THEIR DAMS

Name and Registry Number of Sire	Year of Birth	Number of Yearly Records	Average Mature Equivalent Fat (Pounds)	Daughters with Mature Equivalent Records of								No. of Dams and Daughters Compared	Average Mature Equivalent Fat for Daughters (pounds)	Average Mature Equivalent Fat for Dams (pounds)
				Under 500 lbs.	500 to 599 lbs.	600 to 699 lbs.	700 to 799 lbs.	800 to 899 lbs.	900 to 999 lbs.	1000 to 1099 lbs.	Over 1100 lbs.			
King Pontiac Dione 82505	1910	24	516	11	10	3	0	0	0	0	0	No A.R.S.O dams		
King of the Pontiacs 39037	1905	55	766	1	2	14	14	17	4	3	0	8	760	737

daughters of the two Holstein-Friesian sires, King Pontiac Dione, 82505, and King of the Pontiacs, 39037. Figure 7 indicates that the average production for the daughters of King Pontiac Dione should be about 450 pounds instead of 516 pounds as given in Table 1. In such cases where there are a large number of daughters grouped in the lower production classes, and a distinct cutting off of a number of records in the frequency distribution, it is evident that the average mature equivalent progeny performance record for that particular sire is higher than it should be.

Authentic knowledge as to conditions under which the records were made is always desirable when it is possible to secure such information. Many cows are not able to make records that nearly approach their inherited potential possibilities because of lack of proper feeding, care, and management.

Obviously, the production and quality of the herd in which the sire is to be used will have some influence in making a selection. A

proved sire with only an average progeny performance record might be satisfactory in low producing herds of either grades or purebreds, whereas only the best of proved sires should be selected for the highly developed herd. No proved sire should be selected for use in any herd if the average production of his daughters is not equal to or above the average for the breed.

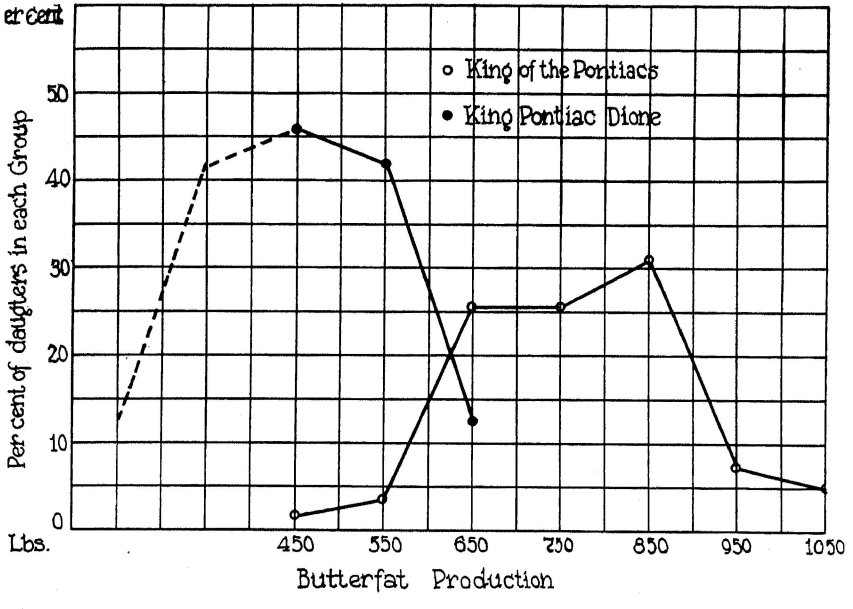


Fig. 7.—The distribution of the records of King Pontiac Dione's daughters indicates that approximately one-half of his daughters were not able to make the Advanced Registry requirements. It also shows that about 45 per cent of his daughters average approximately 450 pounds of butterfat. The majority of the daughters of King of the Pontiacs were in the groups between 650 and 950 pounds, and indicates that probably all of his daughters had the ability to make the requirements for the Advanced Registry. This kind of distribution is very desirable.

SELECTION BY PEDIGREE

Under conditions existing today, there is a great scarcity of desirable proved sires, and it is necessary that the great majority of breeders use young bulls whose merits have not been proved. Selection based upon pedigree with some consideration of individuality offers the best means of selecting the unproved bull.

The pedigree is a written record or tabulation of the ancestors of the individual, and should include a statement of the actual production records, if any, of all females appearing in the pedigree and also the records of all the tested daughters and proved sons of both sires and

dams. Show ring records, and sometimes sales records and other items tending to indicate the merit of any of the individuals appearing in the pedigree are also commonly included.

There is no satisfactory mathematical formula for evaluating the animals in a given pedigree and it is doubtful if such a problem will ever resolve itself into such a simple interpretation. Because of this, many colorful pedigrees are very misleading and the unskilled breeder often has difficulty in properly interpreting them.

Only the "close-up" ancestors are of importance in determining the qualities of the individual under consideration. This is well illustrated in Figure 8. It shows that, on the average, an individual is made up of one half of the germ plasm of the immediate parents, one fourth of the germ plasm of the grandparents, and one eighth of the germ plasm of all of the great-grandparents combined; and so on. This illustration, although true on the average, may be quite misleading in individual cases, due to the prepotency of certain animals, different breeding index values of the records given on pedigrees, and the effects of a combination of different hereditary factors. An individual may, therefore, have a much greater or much less influence than the illustration indicates. Nevertheless, it is the "close-up" individuals that will exert the greatest influence. The presence of the name of a noteworthy individual of the breed in one of the remote generations in the pedigree is of no real value unless the progeny from such a line of breeding has carried these same desirable characteristics down to the "close-up" individuals.

The sire in the pedigree of the bull in question should receive first consideration. Only when he is a proved sire is it possible to judge his ability to transmit the desirable dairy qualities, production and type, to his offspring. This statement is not in accord with the heretofore common practices of breeders and students of pedigrees who have most often given the records of the dam first consideration. It has been proved very conclusively, however, that the relationship between the average progeny performance record of a proved sire and the average production of his son's daughters is much greater than any other records in the pedigree. In other words, the records of the sisters and half-sisters are the best indices by which an unproved bull can be selected.

The dam of the bull that is to be selected together with her sisters should then be considered. It is very desirable that she be a cow of excellent type and one that has a good Advanced Registry, or other authentic record, as an indication of her milk and butterfat producing ability. Such a production record alone is not enough, however, because studies of breeding records have revealed the fact that a cow's own record of production is a poor index to her breeding ability. Many cows that are themselves outstanding producers are not able to transmit to their

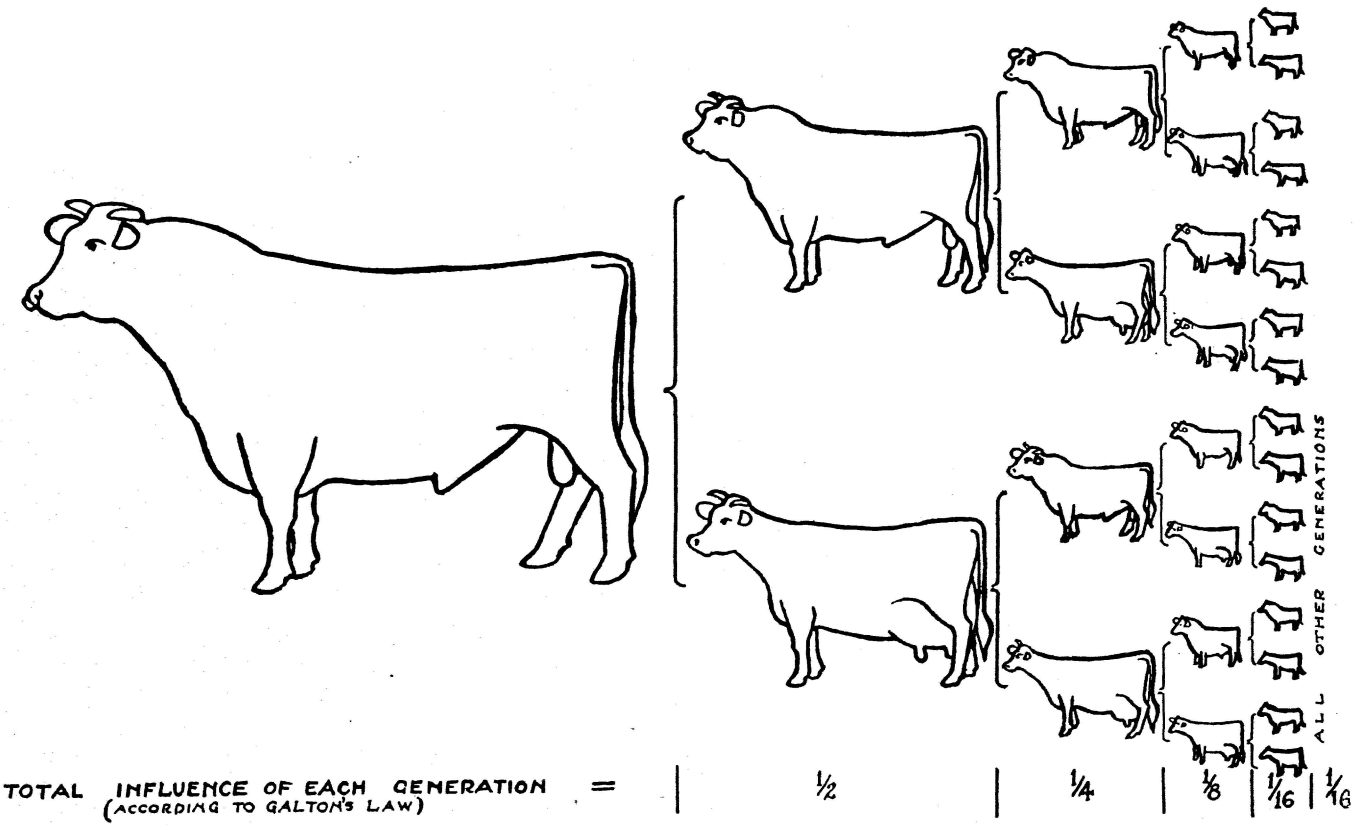


Fig. 8.—The size of the figures represents the average relative value of each individual in the pedigree when measured by the same standard. The "close-up" ancestors listed in the pedigree are the only ones that should receive serious consideration. The immediate sire and dam are the most important, since one-half of the inheritance comes from each, or when considered in relation to all other animals in the pedigree, each individually contributed one-fourth, or both together are half of the effective inheritance when measured by the same standard. The four grandparents in the next generation contribute one-sixteenth each, or all combined one-fourth of the total inheritance.

daughters or sons those factors that endow them with the potential possibilities for high production. Since this fact has not been generally recognized, thousands of breeders have met with great disappointments when they selected a sire wholly upon the records of the dam and granddams. The value of a cow's production record as an index of her own transmitting ability is greatly increased if she is one of a large number of sisters of similar production.

The most valuable record that a dam can have as an index of her transmitting ability is the average production record of a number of daughters. A dam with a progeny performance record is just as desirable in the pedigree as a proved sire. Since there are so few dams that have progeny performance records during their reproductive periods, it is usually necessary to predict their breeding values by means of their own production records strengthened by records of sisters both on the grandsire's and granddam's side of the pedigree. In other words, it is important to see that the majority of the immediate relatives and ancestors of the sire that is to be selected are good producers and that the immediate dam is not a "freak" within the family. If the majority of the family of the dam have been common to average producers, the chances are much too great that the production of the daughters from a son of the "freak" cow, however big a record she may have, will only make average records.

Figure 9 is a pedigree of a young Holstein-Friesian sire, Campus King Idol, that has a very excellent "close-up" pedigree. The sire, King Fayne Ormsby 237602, has 22 daughters that have a mature equivalent average of 624.0 pounds of butterfat and an increase above an excellent producing group of dams of 23 pounds of butterfat. The paternal grandsire is Sir Pietertje Ormsby Mercedes 44931, a sire that has 70 A. R. S. O. daughters with a mature equivalent of 761 pounds of butterfat. The 42 daughters that have dams with records average 63 pounds more butterfat per year than their dams. The paternal granddam, Miss Fayne Segis Beauty, has a yearly record of 23,479.4 pounds of milk and 846.2 pounds of butterfat, and an average progeny performance record of 647 pounds of butterfat for four daughters.

The dam of the young sire has six daughters with yearly records, which, on a mature equivalent basis, average 703 pounds of butterfat. She also has 20,510 pounds of milk and 703 pounds of butterfat as her own individual record. This record made at 4 years and 11 months is the equivalent of 749 pounds of butterfat on a mature basis. These facts indicate that she was able not only to produce large quantities of milk and butterfat, but was also able to transmit high production to her daughters. The maternal grandsire has six A. R. S. O. daughters with a mature equivalent record of 647 pounds of fat which is an increase of 173

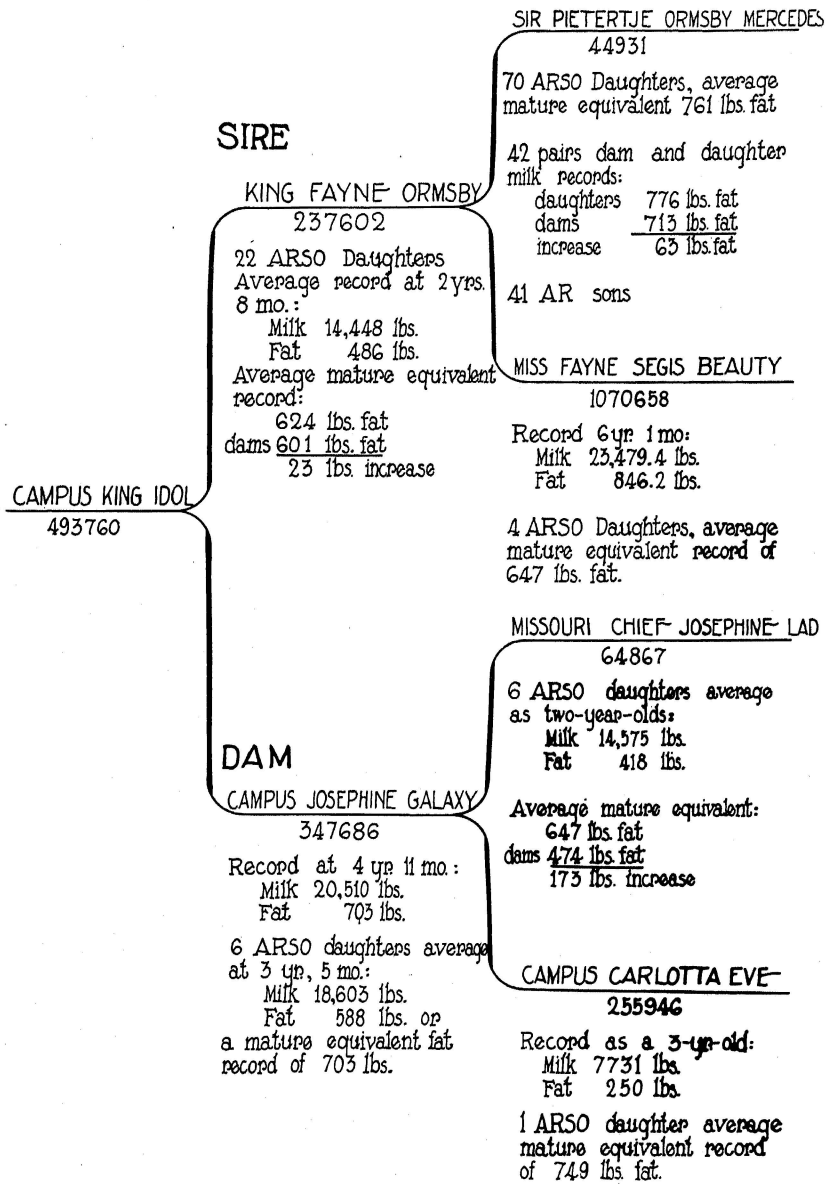


Fig. 9.—A Young Holstein-Friesian Sire With an Excellent "close-up" Pedigree.

pounds of fat over their dams at the same age. The maternal granddam has a small individual record tending to indicate that she was an inferior cow, but did not transmit this low production to her only tested daughter.

SELECTION BY TYPE

It is important to have cows of good conformation and it is believed that the type or appearance of the dairy bull is some guide to the conformation of his daughters. It is well recognized however, that the "looks" of the bull offer little as a means of judging how he will transmit ability for milk and butterfat production.

The bull should be typical and medium to large for the breed to which be belongs. The average weights for mature bulls of the various breeds are about as follows: Jersey 1300 to 1600, Guernsey 1500 to 1900, Ayrshire 1600 to 2000, Brown Swiss 1800 to 2200, and Holstein 2000 to 2400 pounds. He should have good conformation, show marked masculinity and be full of vigor and nervous energy, but withal show a proper degree of quality.

EVALUATING MILK AND BUTTERFAT RECORDS

Comparing Records at Various Ages.—It has been observed by dairy cattle breeders, for many years, that milk and fat production, increases on the average until maturity, and then gradually decreases with the onset of old age. Therefore, it is not accurate to compare a record made by a 2-year-old cow with a record made by a mature cow. In order to compare the values of records for cows of various ages, conversion factors have been worked out so that records made at various ages may be converted to *a mature equivalent.* These factors were determined from the ratio of average fat production at maturity to the fat production at various age intervals. The factors for age intervals of six months are presented in Table 2. To convert a record to its mature equivalent, it is necessary only to multiply the fat production record by the age conversion factor for the age at which the record was made. The product is the amount of fat that, on the average, might be expected of the same or similar cows tested at maturity and under similar conditions of feeding and management. When a cow has more than one yearly record, the largest converted record is thought to express best the animal's inherited producing ability. The conversion factors given in Table 2 are not in exact accord with the allowance for the various ages at present allowed in the requirements for entry in the Advanced Registry of the various breed associations. They are, however, based upon the actual records made by all Advanced Registry cows of the various breeds and are therefore believed to much more accurately represent the true differences that actually exist between the various age groups than the allowances now commonly used by the several purebred breed associatios.

Converting 305-Day Records to 365-Day Records.—Since a large number of records made in the Advanced Registry of the various breeds

TABLE 2.—AGE CONVERSION FACTORS-FAT BASIS

Age in Years	Jersey	Holstein	Guernsey	Ayrshire
Under 2	1.484	1.473	-----	-----
2.0	1.448	1.365	1.313	1.402
2.5	1.344	1.269	1.251	1.343
3.0	1.248	1.196	1.194	1.283
3.5	1.164	1.140	1.142	1.226
4.0	1.115	1.099	1.100	1.192
4.5	1.083	1.066	1.064	1.123
5.0	1.052	1.041	1.041	1.084
5.5	1.034	1.023	1.023	1.050
6.0	1.023	1.009	1.013	1.028
6.5	1.014	1.003	1.006	1.012
7.0	1.008	1.000	1.000	1.000
7.5	1.004	1.000	1.000	1.000
8.0	1.000	1.003	1.004	1.002
8.5	1.000	1.005	1.009	1.008
9.0	1.004	1.011	1.017	1.019
9.5	1.008	1.018	1.029	1.030
10.0	1.012	1.031	1.041	1.044
10.5	1.025	1.046	1.058	1.059
11.0	1.038	1.064	1.075	1.077
11.5	1.052	1.085	1.093	1.094
12.0	1.065	1.106	1.113	1.114
12.5	1.093	1.131	1.137	1.135
13.0	1.096	1.156	1.162	1.157
13.5	1.110	1.204	1.191	1.180
14.0	1.127	1.227	1.219	1.205
14.5	1.147	-----	-----	-----
15.0 and over	1.164	-----	-----	-----

are for 305 days, it is also necessary to convert them to a 365-day basis in order to compare them with records for a full year. If this is not done, the complete ability of the cow is not expressed. Frequently there are a few records that have not been completed due to one cause or another. Some cows may go dry due to their lack of persistency, and therefore, should not have anything added to their record. Since most 305 day or other long time records are due to other causes, however, it is believed that such records (above 180 days) are valuable and should be converted to 365-day records for the purpose of making comparisons. Table 3 contains conversion factors which can be used to estimate very closely

TABLE 3.—CONVERSION FACTORS FOR COWS MILKED LESS THAN 365 DAYS —FAT BASIS

Lactation Month	Days on Test	Conversion Factor
5	150	2.10
6	182	1.78
7	212	1.56
8	243	1.39
9	274	1.26
10	305	1.15
11	335	1.07
12	365	1.00

the amount of butterfat that would be produced in the 365-day period if the record for a shorter time is multiplied by the factor for the particular period.

Cow Testing Association Records.—Cow testing association records (known also as dairy herd improvement association records) are usually made by cows under ordinary farm conditions of feeding, care and management, and usually with but two milkings per day. Such records are not supervised in a manner that will insure the accuracy that is obtained in Advanced Registry records, nevertheless, such records are very valuable and helpful in measuring the value of sires. In order to compare such records with Advanced Registry records, they should be converted to records that will, on the average, give results equal to mature records for the cows if they were tested under official test conditions. Unfortunately, there are no data published at the present time that give cow testing association records for the different ages for the various breeds. There are available, however, cow testing association records of all purebred dairy cows as published by the United States Department of Agriculture. The conversion factors in Table 4 have been calculated from these records and may be used (1) to change cow testing association records made at any age to mature records such as are made under cow testing association conditions; (2) to change cow testing association records made at any age to their corresponding mature equivalent records such as are made under Advanced Registry conditions; (3) to change cow testing association records to their equivalent Advanced Registry records of the same age; (4) to change Advanced Registry records to their equivalent cow testing association records of the same age.

It has been frequently suggested that a record made in a cow testing association should be multiplied by 1.5 to change it to a record that is comparable to an official record at the same age. According to the data that is plotted in Figure 10, representing more than 29,300 cow testing association records and 40,000 official records, it will be observed that there is a much greater range between some of the records at various ages than this figure would indicate. Conversion factors which seem to represent more closely the exact relationship are given in Table 4.

Short Time Official Records.—Seven-day, fourteen-day or other strictly official short time records are now recognized by only one of the leading national dairy cattle breed associations. Such records were very popular in the early periods of the official testing of dairy cattle, but experience has shown that they are of relatively little value in indicating a cow's productive value over a long period, such as ten months or a year, because they furnish little indication of the persistency of lactation. Students of breeding today attach but little importance to this type of records in selecting breeding stock.

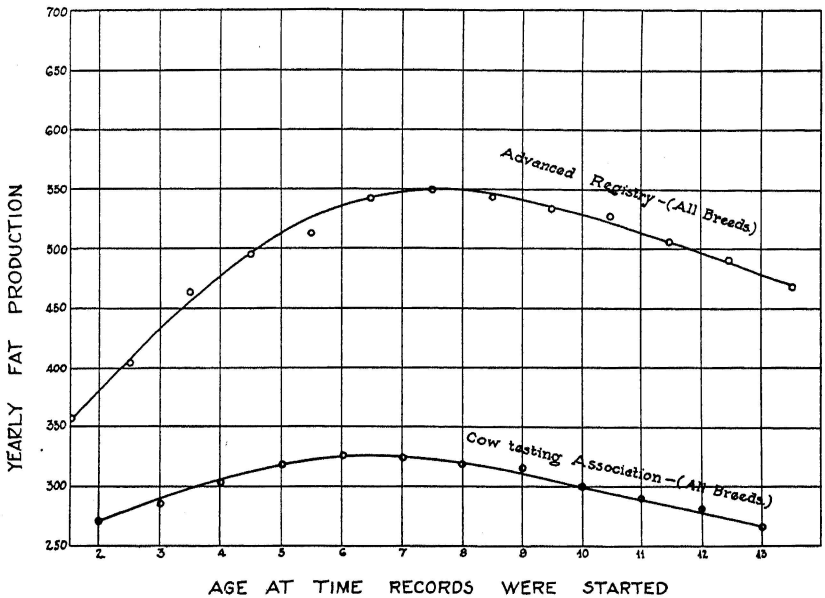


Fig. 10.—Comparison of yearly records made by purebred dairy cows (all breeds) at various ages in Cow Testing Associations and those in Advanced Registry. The data used for plotting the above lines were taken from the records published by Mc Dowell in U. S. D. A. Circ. 26, 1928 and by Turner, Ragsdale, and Brody, Missouri Agricultural Experiment Station Bulletin 221.

TABLE 4.—CONVERSION FACTORS-FAT BASIS

Age in Years	C. T. A. to Mature Equivalent C. T. A.	C. T. A. to Mature Equivalent A. R.	C. T. A. to A. R. Same Age	A. R. to C. T. A. Same Age
2.0	1.204	2.033	1.426	0.701
2.5	1.165	1.968	1.452	0.689
3.0	1.140	1.926	1.509	0.663
3.5	1.102	1.861	1.566	0.638
4.0	1.066	1.800	1.574	0.635
4.5	1.045	1.765	1.598	0.626
5.0	1.019	1.721	1.605	0.623
5.5	1.006	1.699	1.625	0.615
6.0	1.000	1.689	1.652	0.605
6.5	1.000	1.689	1.677	0.596
7.0	1.000	1.689	1.683	0.594
7.5	1.012	1.711	1.711	0.585
8.0	1.025	1.732	1.726	0.579
8.5	1.032	1.743	1.727	0.578
9.0	1.035	1.748	1.725	0.585
9.5	1.062	1.736	1.736	0.576
10.0	1.080	1.823	1.754	0.570
10.5	1.098	1.855	1.777	0.563
11.0	1.117	1.886	1.773	0.564
11.5	1.132	1.913	1.770	0.565
12.0	1.140	1.926	1.740	0.575
12.5	1.194	2.018	1.783	0.561
13.0	1.245	2.103	1.827	0.547
13.5	1.274	2.153	1.843	0.543

BREEDING TERMS, PRACTICES AND FALLACIES

Systems of Breeding.—The experience of the early breeders and our present knowledge of genetics make available to us much knowledge that is making possible new or improved practices in the selection and development of dairy cattle that were not available to the early breeders. Among the most popular of these systems of breeding are grading-up, inbreeding or close breeding, and outcrossing.

Grading-up means the continued use of good purebred sires of the same breed on native or unimproved or low grades, so that with each successive generation the herd becomes more uniform and improves in type and production. If superior sires are used, the improvement is rapid. Figure 8 illustrates the rapidity with which the inferior germ plasm disappears. It should be understood, however, that no amount of grading-up can result in the progeny of other than purebreds being eligible to registry. Bull calves developed from this system of breeding should never be retained for breeding purposes. Such calves may be outstanding individuals for type and from splendid producing dams, but the chances for reversion or a cropping out of some of the inferior characters of their ancestors are always greater than where good purebred sires are used and progress in building up the herd will invariably be uncertain at best.

Inbreeding has played an important role in the improvement of our dairy herds. Inbreeding is any practice which results in the mating of closely related individuals and may vary greatly in intensity. It is usually divided into two categories, namely, *close breeding* and *line breeding*.

Close breeding is the term commonly used to indicate the mating of animals such as full brother and sister, half brother and sister, a sire to his daughter, or a cow to her son; in other words, the mating of animals possessing 50 per cent or more of common inheritance. The term line breeding is used to indicate the mating of animals more distantly related, as for example, cousins, a cow to her grandsire, or a bull to his granddam.

Close breeding intensifies or fixes the characters most rapidly, but the characters may be good, bad or indifferent. Whatever they may be, they are not changed in the least by this or any other system of breeding. Many of the weaknesses of dairy cattle, such as low production, sterility, and low resistance to disease are believed to be recessive characters, and may be present in the germ plasm in the heterozygous form without being segregated, unless the individuals are mated with other animals of similar genetic constitution. Inbreeding does not create new characters, good or bad, but is the best method of sorting

out the good and bad characters into a homozygous condition. Therefore, close breeding is recommended only for those breeders who are well versed in the fundamentals of breeding, and are willing to practice rigid selection. Such breeders should be financially able to discard the undesirable animals and the results obtained from this system of breeding depend mainly upon the breeder's ability to select and discard those animals that exhibit the weak characteristics and also upon his ability to select and mate those animals that possess the desirable characteristics. The results depend on the genetic constitution of the individuals concerned, and not upon any pernicious effect of close breeding itself.

Line Breeding has been practiced by dairy cattle breeders for many years, and this sytem of breeding has produced a greater proportion of the prepotent sires. Line breeding is an attempt to achieve the benefits of close-breeding without entailing its disadvantages. Since there is a slightly wider relationship of the individuals mated, which permits the introduction of two different lines of descent, homozygosis is not so easily attained and the undesirable recessive characters are not disclosed so soon. In general practice, this system of breeding is carried out by selecting successive sires from the same family and usually close descendants of a prepotent animal of the family. Line breeding is an excellent system for the average breeder, if the proper care and precautions are taken in selecting the animals to be mated, and a rigid individual selection is made in the progeny.

Outcrossing is the mating of animals within a given breed which are not related or at least carry little common inheritance. It is frequently desirable in order to introduce new characters and it has a tendency toward a regenerative effect. Excellent results may be obtained, provided great care and good judgment is used in the selection and mating of good animals. Thus, the continued use of only high class proved sires, whether related or not, may be expected to give good results, but if great precautions are not exercised in selection of the sires used, it becomes more or less of a hit or miss system, and does not intensify the desirable characteristics of the animals mated as does close breeding or line breeding.

Effect of the Age of Sire and Dam on the Butterfat Production of Their Offspring.—The ability to produce a certain amount of milk and butterfat at a certain age and under a definite type of feeding, care and management, is an inherited characteristic. Since this ability is inherited from the germ plasm of the sire and dam of the individual and since the characters are believed to behave in a true Mendelian fashion, the age of the sire or dam does not affect this inheritance. On the average a cow

will inherit the same quality from a sire when he is first available for service, as she would if her dam were served by the same sire at the time of his maturity or in old age.

Controlling Sex.—For years dairy cattle breeders have been keenly interested in the factor determining sex. There are more than five hundred theories recorded for the control of the sex of animals. None of these theories, however, have stood the test. Scientific investigators have proved quite definitely that the spermatozoa of the bull is made up of two types of germ cells, one type that produces the females, and one that produces the males, when united with the female germ cells. These two types are, on the average, in approximately equal distribution, which will, when large numbers are included, always keep the number of males and females approximately equal. Therefore, it seems useless for the breeder to waste effort in trying to control sex.

Free-Martin.—A free-martin is a female-appearing calf that is born as a twin to a male. In a majority of cases the external appearances are similar to those of a normal heifer calf. Less than ten per cent of these heifers ever prove to be breeders, however, and on the average it is not advisable to keep them in the herd with the expectation that they will prove to be breeding animals. The males are not affected by such twinning, and are just as valuable for breeding purposes as if they had not been born with the female.

Fallacies in Breeding.—*Telegony.* In the past, many breeders have believed that after a female has borne young by a certain male, her subsequent offspring will show characteristics derived from the previous sire. According to this belief, a purebred Jersey cow bred to a purebred Jersey bull, after dropping offspring from a Holstein bull, would not drop a purebred Jersey calf. Fortunately, this theory has been proved to be false.

Saturation. There was a theory rather prevalent among the earlier breeders of dairy cattle that with the persistent use of a certain sire, the later offspring tended to resemble that sire more than the first, and also the dam tended to become more like the sire. Such a belief is based upon a cumulative effect of telegony and there is much scientific evidence to disprove such a theory.

Maternal Impressions. The belief in maternal impressions assumes that what the pregnant female may see, hear, or experience, from the time she is bred until the calf is born, will in some way have a specific effect upon the offspring. This old belief has long been repudiated by means of animal experiments that have given negative results in all cases.