

PROGENY TESTING IN DAIRY CATTLE AND THE SELECTION OF BULL CALVES TO RAISE FOR BREEDING STOCK

Pruebas de progenie en ganado vacuno lechero y la selección de terneros machos para futuros reproductores

L'élection des jeunes taureaux dans l'initiation des pepinières des reproducteurs de races laitières

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For centuries, man has been exerting a process of selection on animals and plants trying to modify certain characters. This mass selection is based in the election of the individuals of both sexes to be used for reproduction. In dairy cattle, since we need much fewer males than females for reproduction purposes, the bull has always been considered as playing a key role in improvement by selection. This role has still been increased since the establishment of Artificial Insemination as a common procedure. A.I. has had a tremendous impact on animal breeding, and has increased the necessity for above average or proven sires. Thus, the paramount importance of the election of sires, since the sire chosen may leave thousands of offspring every year.

The most effective method for evaluating the breeding value of an animal would be the determination of his genotype. Since this is not possible, we have to assess the evaluation by indirect methods with basis on the phenotype. This phenotypical assessment is based in the type-conformation, performance, etc., of the individual concerned, his ancestors, collateral relatives, or offspring. In dairy cattle, because milk production is a sex limited trait, a combination of this information and, mainly the final offspring proof (progeny testing) determines the value of a male as a breed improver (1, 2, 3, 4, 33, 58).

Several methods of progeny testing have been developed and used in dairy cattle trying to provide a measurement of the breeding value of an animal. The main methods used in the past are (2, 3):

1. GIFFORD's *Index*, or *Daughters'average*, adopted by the American Jersey Cattle Club (5, 15, 33, 51) which just considers the daughters'production without making any comparison. The method would be ideal if the daughters were distributed at random among herds under different levels of management, feeding and

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production. This random distribution is not commonly the case. Therefore, the daughters' average provides more information about the quality of management these daughters have received than on the transmitting ability of the sire.

2. *Comparison Daughters-Dams*. Perhaps the most widely used method in the past (26, 29, 57, 58), all the following systems are partially or totally based on it: *Method of Nils HANSSON*, *HANSSON-YAPP's Index*, *GOOWN-GOODALE's Index*, *Mount Hope's Index* (20), and methods utilized by the two breeders association of Netherlands (N.R.S. and F.R.S.) (21, 44, 45), the Brown-Swiss Central Association in Switzerland (14), the Ayrshire Breeders Association of U. S. (*RICE Index*) (11) and associate associations in Latin-America (8), and the Holstein-Friesian Association of America up to 1967 (34).

Foundamental weakness: the environmental modifications occurred in the interval between the time the productions of mothers and daughters were made.

3. *Danish method of Progeny Stations* (32, 33, 58). Trying to eliminate environmental differences, the daughters are kept in progeny stations under conditions intended to be identical. In fact, this is not the case: important differences have been detected between years, seasons of the year, and the different stations (59).

4. *Method of Difference from Expectancy* (6, 10, 25, 46). Used mainly in New Zealand and areas of Australia. Special conditions of breeding (large herds, cattle out in the pastures all year around, extensive use of grazing, importance of butterfat content in milk) and the fact that almost all bulls are used within each of their respective large herds, justify the system. Basically the use of an *Expected Daughter Average* shows the level of production expected for the daughters of an imaginary bull, which bull would be the average sire of the breed in the country. Daughters of the sire being tested are thus compared with the daughters of this «average bull».

5. *The British Method of Contemporary Comparison, Herdmate Comparisons* and methods partially or totally based on it. (1, 3, 7, 9, 12, 13, 15, 16, 17, 18, 19, 24, 25, 28, 31, 32, 33, 34, 35, 36, 42, 43, 47, 48). The *Relative Breeding Value* of a sire as described by ROBERTSON and RENDEL (50) and McARTHUR (39) is based in the comparison between a sire's daughters and their contemporary mates in the same herd. Widely used in the North American continent, this method has at last provided a system of evaluation where environmental factors are practically eliminated (1, 2, 3, 4, 32, 33).

The system has been improved in New York State by including in the comparison not only the contemporaries but also the rest of the herdmates, after applying the appropriate factors of correction for age (19, 24, 57). Thus, now for the first time we have a system considered as accurate and reliable for progeny testing of dairy cattle (2, 3, 4).

Nevertheless, in the process of selection of dairy sires there is a moment of election that should be considered as being of the maximum importance and which perhaps has not been sufficiently investigated yet. This moment of election arises every time that a bull calf is born to a purebred dairy herd and the breeder has to decide whether to raise that animal for breeding stock or to get rid of him. This process of selection of the prospective future sires, entirely left to the breeder, bears fundamental importance: from this initial selection will emerge the group of males that later on will be the breed sires. The ones rejected at this early stage will never be used nor tested.

The only bases of consideration yet for this process of early election are, the male's ancestry, his collateral relatives, and to some extent his own type. Lately, a certain amount of work has been dedicated in order to develop scientific methods for the prediction of the genetic superiority of young bulls (1, 38, 57), but there are many factors not enough investigated yet about this process of early election and the way this is being done by the breeders.

MATERIAL AND METHODS

A survey has been made among 75 Ayrshire and 500 leading Holstein-Friesian breeders of the province of Ontario, Canada, carefully chosen trying to select the ones that really have an impact in providing the breed sires.

Every breeder was asked to state which factors he takes mainly into consideration and in what order, when a purebred bull calf is born in his herd and he has to decide whether to raise it or reject it.

TABLE 1

IMPORTANCE ATTACHED TO VARIOUS FACTORS BY BREEDERS WHEN DECIDING TO RAISE A BULL CALF FOR BREEDING STOCK — HOLSTEIN BREED

Factor	Percentage of breeders' for each factor										
	Placed 1st	Placed 2nd	Placed 3rd	Placed 4th	Placed 5th	Placed 6th	Placed 7th	Placed 8th	Placed 9th	Not Considered	Left blank
Milk production	44	23	20	9	4	—	—	—	—	—	—
Fat production	1	33	26	25	8	5	2	—	—	—	—
Type scores	27	18	25	10	9	9	1	1	—	—	—
Exhibition prizes	—	1	—	5	9	12	28	20	2	5	18
Transmitting ability	27	10	14	24	16	5	4	—	—	—	—
Continue family line	3	10	9	12	25	18	10	3	—	—	10
Type of bull calf	3	7	2	14	19	25	6	12	3	1	8
Recom. CDA or other agency	—	—	1	1	3	2	12	9	30	3	39

Part 1. Factors taken into consideration by the breeder when selecting bull calves for breeding stock. Nine factors, which we feel might be involved in this process of selection, were suggested to the breeders:

Animals in the bull calf's pedigree, including collateral relatives, with: 1) Good milk production records; 2) Good fat production records; 3) Good type scores; 4) Good record of exhibition prizes; 5) High prices paid at auctions or private sales; 6) Good transmitting ability of parents and grandparents (good results in progeny testing); 7) To continue a good breeding family line followed in the

herd for years; 8) Good type of the bull calf himself as appraised by the breeder; 9) Recommendations of the Department of Agriculture or other agencies, based on predicted or expected progeny superiority studies.

We realize that the selection or rejection of a bull a calf by the breeder is not done on a one factor basis. The decision to retain a bull calf must involve a great many parameters and it is difficult to place, these in any preferential sequence since all of them have to be present, perhaps in equal proportions, in order for a bull calf to be considered worthy by the breeder.

TABLE 2

IMPORTANCE ATTACHED TO VARIOUS FACTORS BY BREEDERS WHEN DECIDING TO RAISE A BULL CALF FOR BREEDING STOCK — Ayrshire Breed

Factor	Percentage of breeders' for each factor										
	Placed 1st	Placed 2nd	Placed 3rd	Placed 4th	Placed 5th	Placed 6th	Placed 7th	Placed 8th	Placed 9th	Not Considered	Left blank
Milk production	60	28	3	6	3	—	—	—	—	—	—
Fat production	6	52	33	3	3	—	—	3	—	—	—
Type scores	3	6	36	25	12	6	3	3	—	—	6
Exhibition prizes	—	—	—	3	3	12	31	18	3	3	27
Hig auction prices	—	—	—	3	—	6	6	24	27	3	31
Transmitting ability	25	3	18	18	9	9	3	—	—	—	15
Continue family line	—	12	6	31	21	9	—	—	—	3	18
Type of bull calf	6	—	6	9	37	15	12	3	—	—	12
Recom. CDA or other agency	—	—	—	—	—	15	9	6	21	6	43

We are also aware of the fact that the selection or rejection of bull calves is a very complex matter embodying the use of judgment, analysis and understanding and are not trying to relegate it to a simple mathematical deduction capable of being computerized. The many factors involved cannot be simultaneously controlled through mechanical means to achieve results that could be predicted with arithmetical accuracy. Nevertheless, we still intended to get at least an indication of how this early and first election of the prospective future sires is being performed by the breeders.

Part 2. Factors considered by the breeder when rejecting a bull calf.

Going the other way around, we surveyed the breeders about the factors that they take into consideration when deciding not to keep a newborn bull calf. This approach is perhaps more realistic: the rejection of an animal because of one very undesirable factor is regularly done. Taking a negative point of view, a deficiency of significant magnitude in any one aspect provides the breeder with enough evidence to make a rejection with finality. This is more simple and adaptable to being computerized.

The results of Part 1 are summarized in Tables I and II. Part 2 in Table III.

TABLE 3

WHY BULL CALVES ARE BEING REJECTED FROM DAIRY HERDS

(Based on a 1966 study survey data from 75 Ayrshire and 500 Holstein Holstein selected purebred herds in Ontario)

Main Factor for Rejection	for each factor Percentage of breeders rejecting										Not Considered	Left blank
	Placed 1st	Placed 2nd	Placed 3rd	Placed 4th	Placed 5th	Placed 6th	Placed 7th	Placed 8th	Placed 9th	Placed 10th		
Low milk production (*)	52	23	18	5	1	—	1	—	—	—	—	—
Low fat production (*)	—	34	29	21	4	1	2	4	—	1	—	4
Low type scores (*)	30	28	29	4	2	1	2	3	1	—	—	—
Low type of bull calf	8	5	8	34	11	6	4	4	3	8	1	8
Low breeding regularity (*)	5	4	7	8	27	6	8	6	9	4	1	15
Low resistance to disease (*)	—	—	2	6	10	16	4	5	10	23	1	23
Susceptibility to mastitis (*)	—	1	2	4	10	13	23	12	10	7	1	17
Poor disposition (*)	1	5	1	4	7	15	21	16	11	4	1	14
Poor longevity (*)	—	—	3	1	9	9	12	19	13	13	1	20
Poor speed and ease of milking (*)	4	2	1	9	11	20	11	9	12	6	1	14

(*) Of ancestors in pedigree.

DISCUSSION

Regarding each of the traits, the following aspects can be considered: a) economic importance; b) heritability values, and c) correlation of traits.

a) The economically important traits that should be considered for selection are: milk production, percent of butterfat in milk, size and shape of udder, speed and ease of milking, disposition, feet and legs, breeding regularity, freedom from mastitis, longevity, depth of body, size, levelness of rump, style and symmetry, and feeding habits.

Analyzing the results of the survey, it is clear enough that milk production is the first choice of the breeders. Fat is considered important too. Regarding size and shape of udder, feet and legs, depth of body, size, levelness of rump, style and symmetry, all of these are separately included in Type. The mammary system gets 30 points out of 100 in the present method of Type classification.

Also important to the breeder are speed and ease of milking, disposition, breeding regularity, freedom from mastitis, and feeding habits, but these must be postponed when selecting due to several reasons: low heritability values in the first place, and the fact that pretending to select for several traits at the same time leads to a much lower and slower rate of improvement in each individual trait in particular.

b) When considering the heritability values of desirable traits, we have milk production with a value of (0.25) if not high enough as to expect a rapid genetic improvement by selecting for it, yet one of the best bets; this is the first advocated trait by the breeders in the survey. Type, which includes size and shape of udder, udder attachments, feet and legs, levelness of rump and dairy character, is the second advocated factor in the survey by the breeders. The largest value for a factor (0.55) for butterfat in milk, is also given preference by the breeders.

When coming to the lower heritability values, we observe that breeding regularity with a value of (0.03) is placed low by the breeders. The same happens with freedom from mastitis (0.05). Finally we see that only a few breeders try to consider longevity that has a heritability value of nearly zero.

c) Correlation of traits. For a rapid progress, it could be considered economically advantageous to select for one or two traits only, such as milk production and type. It might even be better to select for one single factor, as milk production. Also, the correlation of traits should be clearly kept in mind: among the various correlated traits, milk production and type are perhaps the ones having been most investigated. Not long ago, these two traits were considered as being closely related. Then, in the last few years, they were believed to be just slightly correlated. Today, it is a firm conclusion among researchers that the genes carrying and transmitting these two traits, milk production and type, are completely different and independent so that correlation between these two traits does not exist at all.

Obviously, after production (milk and fat), and type, transmitting ability of parents and grandparents is strongly favoured by a majority of the breeders. Since we have concluded that progeny testing is the only reliable method of providing an accurate assessment of the breeding value of an animal (2), this indicates that the Ontario breeders are performing this important process of early election of the future prospective sires with basis in the accumulated scientific knowledge to this date.

Regarding recommendations of the Canada Department of Agriculture or other agencies with basis in predicted or expected progeny superiority studies, these have not been yet sufficiently provided.

When analyzing the differences found between the results in the Holstein and Ayrshire breeds, the only significant dissimilarity seems to be the more emphasis given to fat by the Ayrshire breeders (52 % second choice and 33 % third) and a little less to type (3 % against 27 %, and 6 % second against 18 %).

CONCLUSION

It was the purpose of this work to investigate how the early election of bull calves (the sires of the future) is being done at the farm level by the breeders in the province of Ontario, Canada.

A survey has been made among 75 Ayrshire and 500 Holstein-Friesian leading breeders, trying to determine what factors they mainly take into consideration and in what order, when deciding to keep or to reject a newly born bull calf.

It appears to be that in general they are acting according with what the accumulated scientific knowledge up-to-date suggests. Milk production is the first advocated trait (fat follows very closely). The heritability values of these traits

warrant this priority. Likewise, the traits with lower heritability values are given low priority.

After production and type, transmitting ability of parents and grandparents follows in order of preference. Since progeny testing is considered the only reliable proof to determine the value of an animal as an improver (phenotypical assessment instead of genotypical which is not directly feasible), this constitutes another indication that the breeders' task of early election of males is being fairly accurately performed.

The Ayrshire breeders show more interest in fat and less in type than the Holstein-Friesian breeders. This is the only significant difference between them.

SUMMARY

The bull plays a fundamental role in dairy cattle improvement by means of selection, role that has been still increased by the systematic use of Artificial Insemination. The best way of estimating the breeding value of a sire would be the determination of his genotype. Since this is not possible, an indirect assessment has to be made with basis on his phenotype: milk production, dairy characteristics, type, etc., of his ancestry and collateral relatives but, in the final analysis only the progeny testing determines the sire's value.

Several methods of progeny testing have been used in the past, now replaced by the Comparison with Herdmates which is seemingly the best available system since it eliminates environmental factors.

Yet, in the process of election of dairy sires there is an extremely important moment of selection that arises every time that a purebred bull calf is born and the breeder has to decide whether to keep it or reject it. This early selection of the potential sires—the ones discarded at this point will never be used nor tested—has been investigated among the main breeders of Ontario, Canada, and found to be done, in general, according with what the accumulated scientific knowledge up-to-date would suggest.

RESUMEN

El toro desempeña un papel fundamental en la mejora del ganado lechero por medio de selección, papel aún incrementado por el uso sistemático de la inseminación artificial. La mejor forma de evaluar el valor de cría de un reproductor sería la determinación de su genotipo. Puesto que ello no es posible, hemos de valernos de una determinación indirecta sobre la base de su fenotipo: producción, temperamento lechero, tipo, etc., de sus antepasados y parientes colaterales; mas, al final, solamente la prueba de progenie determina el valor del semental.

Varios métodos de prueba de progenie han sido utilizados en el pasado, ahora reemplazados por el *Método de comparación con compañeras de establo*, que es aparentemente el más efectivo, puesto que elimina los factores de origen ambiental.

Sin embargo, en el proceso de elección de sementales existe un momento de extrema importancia que ocurre cada vez que nace un ternero macho puro de *pedigree* y el criador ha de decidir entre criarlo para futuro reproductor o desecharlo.

Esta selección temprana de toros en potencia—los que son desechados a este nivel nunca serán ni usados ni probados—ha sido investigada entre los principales criadores de Ontario, Canadá, con el resultado de que, en general, está siendo realizada de acuerdo con lo que indican los conocimientos científicos acumulados hasta la fecha.

RESUME

Par moyen de la sélection, le taureau joue dans l'amélioration du bétail laitière un rôle fondamental et important. Ce rôle a été autant augmenté par l'usage systématique de l'insémination artificielle. Le meilleur moyen d'évaluer la valeur génétique de taureau sera-t-il sa détermination du génotype. Puisque cela n'est pas possible, nous devons recourir à une évaluation indirect, basé sur le phénotype: production laitière, caractéristiques laitières, le type morphologique, etc. de ses ascendants et ses relatives collatéraux, mais dans l'analyse finale seulement l'évaluation de la descendance détermine la valeur du taureau.

Dans le passé, plusieurs méthodes d'évaluation de la descendance avaient été employées, lesquelles on été remplacées par la comparaison avec les sujets du même troupeau, laquelle paraît-il le meilleur méthode au courant, puisque elle élimine les facteurs d'environnement.

Plus encore, au cours de sélection des taureaux il y a un moment extrêmement important, qui si produit chaque fois que naisse un pur-sang veau-mâle et l'éleveur doit décider lui retenir ou lui éliminer. Cette sélection préliminaire aboutissant à des taureaux potentiels—ceux qui ont été éliminés à cet stage ne seront jamais employés non plus évalués—a été étudiée parmi des principaux éleveurs de Ontario, Canada, en ayant trouvé qu'à présent, on le fait avec les données scientifiques plus récents.

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