

SELECTION OF FRENCH BEEF BREEDS FOR PUREBREEDING.

(La sélection des races à viande françaises pour une utilisation en race pure).

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I - INTRODUCTION.

The large muscle growth potential of French beef breeds (Charolais, Limousin and Blond d'Aquitaine) is the result of many generations of selection for large size and heavy muscled animals. At early stages, the farmers used them as draft animals and, therefore, selected for muscular development. Subsequently, selection in these beef breeds proceeded in small sized family farms, for production of heavy and older animals (3-4 year old steers) or very young animals with good conformation (veal calves), maternal traits (fertility, calving ability, milk production) were not a limiting factor in their production systems. From the 60's the development of artificial insemination in these small farms as well as in dairy herds, led to a large utilization of beef sires in purebreeding as well as in terminal crossing. The programs of selection for beef characteristics among beef sires intended for terminal crossing by artificial insemination (FREELING et al., 1972 ; GAILLARD et al., 1974 ; FOULLEY and MENISSIER, 1981), were set up in these conditions. This orientation of selection has been widely accepted as suggested by the number of inseminations made with French beef sires in France during the 1970's (2.614.000 cows inseminated in 1970) and by the diffusion of these breeds as sire breeds for crossing in foreign countries (VISSAC, 1971 and 1976 ; BLAJAN et al., 1973).

In the 1970's, and more particularly since the economic crisis in 1974, the utilization of these beef breeds augmented markedly. The increasing specialization of dairy herds and, consequently of specialized genotypes of dairy cows, jointly with the gradual disappearance of small sized farms and of dual-purpose type farms supplying a large proportion of the cows used in terminal crossing, led to a marked reduction of terminal crossing in these dairy herds and, consequently, in the number of inseminations made with beef sires (2.053.000 cows in 1975 - 1.578.00 in 1980). Simultaneously, A.I. centers and semen production units were forced to change their selection programs because of an increase in the sales of crossbred calves, immediately after birth, to French and foreign fattening units (this led to station progeny-testing). The investment and logistic difficulties associated with these new programs, as well as the reduction in the number of animals, may lead to less efficient selection on beef traits. Conversely, during the same period, there was a marked increase in the number of cows in the beef cattle herds (e.g. + 18 p.100 from 1972 to 1979), in the size of the herds and in the degree of intensity of production (BERANGER and MENISSIER, 1981). Thus, the improvement of dams productivity in order to reduce the production costs and labour requirements has become a very important goal in selection of specialized beef breeds.

In this context, with the aim of obtaining a better integration of selection programs for maternal ability under A.I. and natural mating, three main courses of action were considered in beef breeds (MENISSIER, 1979 ; MENISSIER and SAPA, 1982) : a) - Development and reorganization

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of on-the-farm performance recording for selection purposes ; b) - Selection of artificial insemination bulls on the maternal ability of their daughters ; c) - A more objective selection of bulls for natural mating. These three aspects will be analyzed in this paper.

II - DEVELOPMENT OF ON-THE-FARM PERFORMANCE RECORDING.

On-the-farm recording of calves growth has existed for long time in our beef breeds (1957-59 - AURIOL et al., 1961). The problem was to transform these schemes towards more general recording of suckling cow traits so that when applied to a maximum of beef herds, all cows and calves performance tested, and known ancestry, would provide the largest possible "basis of selection". These changes have been implemented in the last ten years and they are almost finished. The main achievement was to gather and process information on calf growth from cows and herds, and also to obtain a better management of the information stemming from developments in data processing.

The system of data collection and management is divided into 4 levels :

- 1°. - Farmers in the same area are grouped in performance recording units ($n \approx 70$). Technicians of these organizations, officially chartered in the "Eta blissements Departementaux de l'Elevage" (E.D.E.), are responsible for collecting and for identification, weighing (every 3 months) and evaluation of the conformation (at weaning) of calves.
- 2°. - This information gathered and checked at the regional computer center (C.R.I.), constitutes a "regional file" ($n=6$). From this, herd reproductive and growth summaries are prepared and reproductive parameters for each cow, are calculated. Also calf growth and weight standardized at the age of 4 and 6 or 7 months. These weights are generally calculated by interpolation between two trimestrial weights and then standardized with a priori correction factors.
- 3°. - All this information is centralized in a "national file" for storage and statistical purposes and, especially, for evaluating the cows. The evaluation of the cows is based on the birth weight, 120 day weight and conformation score of their calves. It is made by accumulating each year (heritability = 0.20 and repeatability = 0.30) results from comparison of their calves with their herd contemporaries after correction of data with the mean and standard error for each combination of sex x season of birth x calving parity of the dam (REGIS, 1974). For reproductive parameters of the cows, only gross averages are used at present.
- 4°. - Each breed Association receives from the "national file" all data concerning calves and cows of the breed involved, so as to establish a "breed file" also comprising data collected directly by these Associations (shows, competitions,). Besides its use for breed qualification of breeding animals, the "breed file" is also used to establish individual sheets for each cow with a history of its own performance and that of its ancestry, and with a list including all calves with their performance until weaning.

Thus, each cow recorded and calving at least 3 times, has an evaluation for fertility (age at 1st calving, calving interval, gestation p.100 and calf crop), calving ability (calving ease score, index on birth weight), its maternal ability (120 day weight and conformation indices) and, for the cows registered in the Herd-Book, a breed qualification. This evaluation allows, on one hand, within-herd selection of dams intended for the replacement of the herd and, on the other hand, a choice of the best dams within the breed (one calf weaned per year, without birth difficulty, and weight at 4 months and conformation score indices over the average value) for production of animals for herd replacement especially that of sires used in natural mating or artificial insemination. Although representing less than 10 p.100 of the beef cows, more than 100.000 cows are recorded every year (table 1), among which about one out of two is evaluated and 2 to 9 p.100 only chosen to produce animals for replacement.

III - SELECTION OF BULLS USED IN ARTIFICIAL INSEMINATION.

Selection upon beef traits of beef bulls for utilization in artificial insemination mainly in crossbreeding is generally done in three successive steps (FOULLEY, 1976 ; FREBLING et al., 1972) : choice on the basis of paternal and maternal ancestry (with planned matings) ; individual selection on performance at weaning on-the-farm followed by station performance testing ; and selection in purebred or crossbred progeny either on-the-farm or at the station in different production systems (veal calves, young beef cattle produced in intensive condition). Regarding bulls intended for utilization in purebreeding, these different selection steps have been modified in order to select for maternal traits of females so as to consider their biological opposition with beef qualities (MENISSIER, 1976):

- 1°. - Primarily in selection upon ancestry, results of the evaluation of the dams play a larger part than formerly.
- 2°. - When selecting bulls on their beef performance both on individual value or on their progeny, a larger weight is given to growth rate and to skeletal development than to muscle development.
- 3°. - The most important aspect after selection on beef traits consists in a progeny testing of sires in purebreeding for reproductive performance of the females. Despite of its cost, this test is made at the station (one per breed) because of the low heritability of these traits, the existence of biases introduced by the choice of the farmers, when the heifers are bred for the first time, and because of better control of the test . The heifers for testing produced in the farm by planned random artificial inseminations and a sample of 20 daughters per sire is bought at weaning and then tested during 2 years at the station. They are reared and managed in standard conditions (pasture during the summer, free housing during the winter) but more intensively than in the farms, so as to be bred for the first time at an age of 15 to 16 months to obtain an early first calving which will elicit maximum expression of calving difficulties. All heifers are inseminated with the same test bull (or bulls) to control the sire effect on performance (fertility, calving, suckling). There is a large number of traits recorded (weighings,

size measurements and regular scoring in dams and calves, detection of oestrus, pregnancy diagnoses, calving traits, milk production) and they are used to estimate the growth and morphology of the dams, their fertility, calving ability and suckling ability. For each trait, the genetic value of the bulls is estimated by least-squares (taking into account the amount of information) from the mean performance of its progeny compared to those of the bulls tested in the same batch; the estimate is expressed as relative genetic value to the mean of the group ($m = 100$ and 20 points for one genetic standard deviation). For each of four main groups of traits, a selection index is calculated (I.T.E.B. - I.N.R.A., 1981) :

a - For growth and conformation, a classical index is calculated from muscle and skeletal development, and weight at 18 months so as to obtain the same relative genetic change in weight and conformation ;

b - For fertility, the index combines empirically the relative value for early sexual maturity ($x0.15$), fertility ($x0.80$) and viability of calves ($x0.05$);

c - An index for calving ease represents the relative genetic value for the percentage of easy calvings, but a study is in progress to determine a more efficient estimator (GIANOLA and FOULLEY, 1982);

d - The suckling ability index is an empirical combination of relative genetic values for milk production ($x0.15$), growth ($x0.80$) and muscle development ($x0.05$) of the calves. For each of the batches, selection of bulls is generally made in 2 steps : first by elimination of those whose evaluations are lower than the average of the batch taking into account the mean genetic level of the latter estimated by one reference sire systematically tested in each batch; thereafter, among the remaining bulls, by selection combining the best beef characteristics with reproductive performance.

Since the creation of the stations (1968 : Charolais, 1972 : Limousin and Blond d'Aquitaine), 169 bulls (95 Charolais, 40 Limousin and 34 Blond d'Aquitaine) have been progeny tested on maternal traits and 67, i.e. 39.6 p.100 (44.2 p.100 in Charolais, 35.0 p.100 in Limousin, 32.4 p.100 in Blond d'Aquitaine), have been selected for use in purebreeding by artificial insemination. Selection pressure has been increased during the last batches and now reached one bull out of three. The within-batch selection differentials accumulated for the batches 1973-1975 to 1979-1981, show that selection has been efficient for the main traits (table 2). It should be pointed out that selection tends to increase the weight of heifers while maintaining their muscle development and improving, in particular, their reproductive ability. An important effort has been made regarding calving ability in the Charolais breed, and suckling ability in the Limousin breed ; in Blond d'Aquitaine, selection pressure has been less specific. Selection differentials estimated in more recent batches (with reference sire progeny and BLUP evaluations) confirm these trends.

However, the efficiency limits of this selection depend on several factors :

a - The small number of bulls tested per yearf (10 Charolais, 5 Limousin, 5 Blond d'Aquitaine, on the average) reduces selection differentials on maternal ability especially if at this stage there is still selection on beef performance (as in Charolais for instance) ;

b - This selection of bulls on beef traits is more or less efficient depending on the breed. In Blond d'Aquitaine and Limousin, the bulls to be progeny tested on maternal ability are generally chosen among those already selected (performance and progeny test) for crossbreeding with a high selection pressure (31 and 40 p.100 respectively in Limousin and Blond d'Aquitaine - COUZON et al., 1982); in the Charolais breed, selection is made independently of that carried out for crossing, with a less efficient selection realized in questionable conditions (performance testing on older bulls, progeny testing limited to birth status and conformation score of the offspring at weaning). At present, the beef selection programme for these bulls intended for purebreeding is being reorganized in the three breeds.

c - Even with an optimal selection on beef and maternal traits, the impact of these bulls within the breeds still depends on the restricted number of inseminations practised in the herds (about 17, 26 and 59 p.100 respectively in Charolais, Limousin and Blond d'Aquitaine) especially in pedigree herds. It is important not only to increase the number of these inseminations in the herds via oestrus synchronizations, but also to direct them towards matings with the elite cows so as to obtain heifers for the replacement of the herds and of the natural service bulls which are responsible for the diffusion of genetic progress.

IV - SELECTION OF BULLS INTEENDED FOR NATURAL MATING.

With natural mating being the dominant mode of fertilization in most of our beef breeds, it appears necessary to develop more objective techniques for estimating the merit of these breeding animals than those traditionally used by the breed Associations. One of the possibilities was to use the data from the beef recording system applied in the farms; on this basis, it should be possible to evaluate the bulls for the birth condition, growth characteristics and conformation of their offspring until weaning. However, because of the few exchanges of breeding animals between herds and the small number of bulls used in each herd (generally 1 to 3), the mean genetic level of these breeding animals may vary considerably from one farm to another. In these conditions it is difficult to separate genetic from environmental effects when adjusting for herd differences. In order to make comparisons among bulls more relevant and to improve the efficiency of their selection, it was therefore necessary to create a common genetic basis of comparison between the bulls of different herds. The system chosen in France (FOULLEY and MENISSIER, 1979) is based, as in other countries (U.S.A., NEW ZEALAND) upon the setting up of A.I. from reference sires in the different cooperating herds according to well defined technical standards (FOULLEY and CLERGET-DARPOUX, 1978 ; FOULLEY and SAPA, 1982) especially concerning the planning of matings (mode of choice of the cows, control of their size and muscle development, number of offspring to be produced). In addition, the "connection bulls" are chosen among the best bulls tested on maternal ability of their daughters so as to promote their diffusion in

TABLE 1 - SOME CHARACTERISTICS OF SPECIALIZED FRENCH BEEF BREEDS.
(figures estimated for 1980 according to various origins).

B R E E D :	C O W S :						BULLS (1 st A.I.):	
	Total number: (1)	Recorded: (2), (1)/(2)	Evaluated (3), (3)/(2)	(a) Selected (4), (4)/(3)	(b) P.100 estimated bred by A.I.s	Total number:	Use in purebreeding:	
CHAROLAIS	Nbr = 1080.000 p.100 = 100	66.140 6.1%	29.087 44%	2.038 7.0%	~ 13%	868.201	~ 145.000 ~ 17%	
LIMOUSIN	Nbr = 410.000 p.100 = 100	32.314 7.9%	18.127 56%	2.886 15.9%	~ 33%	509.833	~ 135.000 ~ 26%	
BLOND D'AQUITAINE	Nbr = 185.000 p.100 = 100	14.244 7.7%	6.195 43%	263 4.2%	~ 62%	195.168	~ 115.000 ~ 59%	

'a) - Cows with 3 calvings at least.

'b) - Cows calving every year, without calving difficulties and evaluated about the average.

the pedigree herds (FOULLEY and MENISSIER, 1979). The system adopted is based in the availability of 3 connection bulls for a given mating season and one of these 3 bulls is replaced every year. During a breeding season, the farmer has to use at least two of these three bulls among which one is imposed to ensure the connections between herds and also between years within the same herd. Because of small size of the French herds, planning is made with the aim of evaluating the bulls after two years of utilization.

The application of this program (FOULLEY and SAPA, 1982) started in 1979 within a group of ten farmers selecting Charolais cattle in Vendée. It has been continued by the promotion of this system within the Limousin breed. In 1981, 39 Charolais and 72 Limousins bulls distributed into 17 and 39 herds, respectively, were being evaluated. The setting up of this program at the national level gives rise to many difficulties in practice because of technical constraints and because of its consequences on traditional systems of breeding animal evaluations. However, the interest for that program expressed by participating farmers clearly demonstrates the demand for the development of efficient selection tools. This program only represents one of the available for selection; It is necessary not to forget the advantage of testing these young bulls on their own performance at the station (or breeding centers), in order only to carry out progeny testing on bulls which have been previously selected. This selection on individual performance can only be efficient if the testings are made on bulls sufficiently young, numerous and homogenous relative to their pre-test environment and using a testing design well adapted to the objective of this selection and to the utilisation system of these natural mating bulls.

V - CONCLUSION.

The changes observed in the last ten years in the utilization of beef breeds in France, span from program adaptations to fundamental changes. Changes have occurred vis a vis trends of selection, in order to take more into account reproductive performance and maternal ability relative to beef traits, with respect to the organization of sire selection in order to make selection of breeding animals used in natural mating more objective, and in order to search for a better complementarity between various selection schemes.

TABLE 2 - RESULTS ABOUT THE PROGENY TEST ON DAUGHTER GROUPS PRACTISED IN THE CHAROLAIS (CH), LIMOUSIN (LI) AND BLOND D'AQUITAINE (BA) BREEDS

TRAITS :	HERITA- BILITY USED:	MEAN PERFORMANCE (1):			SELECTION DIFFERENTIAL (2):					
		CH:	LI:	BA:	CH:		LI:		BA:	
					av:	ro:	av:	ro:	av:	ro:
Number of heifers	-	2412	796	870	-	-	-	-	-	-
* GROWTH AND CONFORMATION AT 18 MONTHS:										
Weight (kg)-----	0.35	429	378	389	+ 6.5	103	+ 8.9	106	+10.1	105
Muscle development (score)---	0.50	62	(18.6)	61	- 0.2	100	(+ 0.5)	105	+ 1.3	102
Skeletal development (score)	0.30	67	(6.5)	65	+ 2.2	105	(+ 0.4)	108	+ 1.3	102
* FERTILITY:										
P.100 in oestrus at 15-16 months-----	0.05	91	(64.5)	60.1	+ 0.6	100	+ 2.9	101	+ 7.9	102
P.100 pregnant/inseminated	0.15	79.9	80.0	69.6	+ 2.9	102	+ 4.7	102	+ 5.6	102
* CALVING:										
P.100 difficult calving-----	0.15	44.2	18.6	22.6	- 7.7	97	+ 0.8	100	- 2.9	99
Calf birth weight (kg)-----	0.15	38.1	34.9	39.7	+ 0.4	102	+ 0.2	101	+ 0.1	100
Dam weight after calving (kg)	0.45	501	465	480	+12.2	106	+ 3.5	102	+10.9	105
Pelvic opening after calving (cm ²)-----	0.40	(261)	(244)	283	+ 4.6	105	+ 2.1	102	+ 4.5	103
* SUCKLING:										
Calf growth (birth to 4 months)(g/day)-----	0.20	814	660	681	+12	102	+30	105	+32	105
Calf weight at 120 days (kg)	0.15	136.3	113.6	119.7	+ 1.6	102	+ 3.8	106	+ 3.5	104
Milk production at 120 days (kg/day)-----	0.40	5.5	4.9	2.9	+ 0.2	102	+ 0.4	105	+ 0.2	102
* CHARACTERISTICS OF PROGENY TESTING (at the Station):										
Start of test					1968/70		1972/74		1972/74	
No of batches (sires) tested					12 (116)		4 (40)		7 (39)	
No of sires evaluated and selected					116/45		38/14		34/12	
Selection rate (3).....					33.8%		36.8%		35.3%	
No of first AI per year with proven sires (4)					~ 90 000		~ 30 000		~ 50 000	
100 x (AI with proven sires / AI in pure breeding) (5)					55 to 65%		20 to 30%		40 to 45%	

(1):from 1981.

(2):measured on daughter performance from 1972 to 1981 in absolute (av) or relative (ro) value.

(3):in p.100 from 1972 to 1981.

(4):in 1981.

(5):estimated in 1981.

Such reorganization requires an important and coordinated effort both at a national and a regional level, by the professional, technical administrative and scientific organizations, in order to adapt simultaneously the structures, methods and programs of evaluation and selection of breeding animals. This is the ambitious and long lasting task on which we have been working for several years, in order to render the French beef breeds still more efficient for beef production within suckling cow herds.

SUMMARY :

Selection of French beef breeds (Charolais, Limousin, Blond d'Aquitaine) has mainly been directed towards a large muscle growth potential. During the last 10 years, a reduction of industrial crossing and an increase in the number of purebred suckling cows have changed the trends and priorities of that selection. In order to give a larger importance to the reproductive or maternal performance of females and to selection of breeding animals for natural mating, the following 3 measures have been taken : a)- reorganization of on-the-farm performance recording for selection purposes ; b)- selection of A.I. bulls intended for purebreeding, on the basis of on-the-station testing of the reproductive performance of their daughters ; c)- an objective evaluation of natural mating bulls using on-the-farm progeny testing in conjunction with artificial insemination with reference sires used in multiple herds. These different steps are discussed and analysed.

RESUME :

La sélection des races à viande françaises (Charolaise, Limousine et Blonde d'Aquitaine) a été orientée principalement vers la recherche d'un fort potentiel de croissance musculaire. Au cours des 10 dernières années, la réduction de l'importance du croisement industriel et l'accroissement du nombre de vaches allaitantes de races pures ont entraîné des changements d'orientations et de priorités dans cette sélection. Pour mieux prendre en compte, d'une part, les performances de reproduction des femelles et, d'autre part, la sélection réalisée sur les reproducteurs de monte naturelle, trois aspects sont mis en oeuvre : a)- La réorganisation des contrôles de performances en ferme à des fins de sélection ; b)- La sélection des taureaux d'insémination artificielle destinés à une utilisation en race pure, à partir d'un contrôle en station des performances de reproduction de leurs filles ; c)- L'évaluation objective des taureaux de monte naturelle, à l'aide notamment d'un contrôle sur descendance en ferme réalisé grâce à des inséminations artificielles de connexion entre élevages. Ces différentes étapes sont décrites et analysées.

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