OPTIMIZING SHEEP AND CATTLE BREEDING IN THE E. E. C. WITH SPECIAL REFERENCE TO FRANCE

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Summary

The cattle and sheep populations as well as the production systems involved in the E. E. C. meat industry can vary considerably according to the wide geographical differences in physical and human characteristics.

The optimal use of the existing animal populations can be achieved by . developing crossbreeding systems in dairy herds or flocks and, in the case of other herds or flocks, between dam populations and sires from specialised paternal strains or breeds.

The breeding schemes for sires (male lines) are developed more and more according to the future use of their female progeny; paternal strains (slaughter cattle), maternal breeds (maximum use for breeding) and synthetic breeds. These schemes are being expanded in different ways, chiefly according to the percentage of artificial inseminations in a country or area:

- traditional stratified systems for pedigree breeders,
- integrated schemes, where recording facilities and decisions on breeding are thoroughly planned,
- intermediate schemes (mixed schemes. combining the two conditions).

Due to the small size of the herds and flocks, it is necessary to organise these schemes on a co-operative basis. The French example is mainly given here to illustrate this situation.

I. INTRODUCTION

Meat production from cattle and sheep plays an essential role in the E. E. C. This is the result of the importance of human consumption and its trends on the one hand, and of the large existing zones of plant crops and their by-products, which can only be used by sheep and cattle, on the other. The relative part played by these types of production is particularly important in France where they concern more than 1/3 of the beef, and a little less than 1/3 of the mutton produced in the E. E. C. Furthermore, owing to its geographical position involving several different ecological zones and ethnic influences and habits which intervene in Western Europe, the French situation is fairly representative of the physical and social environment of the cattle and sheep industry in the E. E. C.

IL POPULATIONS AND SYSTEMS OF PRODUCTION

To begin with we shall briefly present the cattle and sheep populations and systems of production. Due to the little time at our disposal we cannot deal with the British Isles whose situation is particularly well known in Australia.

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The present day European animal populations descend from the original local breeds which were traditionally used for multiple purpose production:

- cattle = meat and milk in Northern Europe,
  = meat, milk and draught in Southe rn Europe,
- sheep = wool and meat in Northern Europe,
  = wool, milk and meat in Southern Europe (where there were no or very few dairy cattle).

These breeds, particularly where sheep are concerned, were chiefly adapted to local environments and the specific, mainly extensive, husbandry systems developed in the area to make the best use of seasonal and geographical variations in nutritional resources. The following tendencies have been observed during the last decades:

- decrease in value (wool for sheep) or disappearance (draught for cattle) of animal products other than milk and meat,
- concentration of milk production in small specialised "family" farms, from more and more efficient dairy animals whose total number is decreasing.

Dairy farms are concentrating more and more in the areas with better climatic conditions in the case of cattle (zones with a maritime climate in the North West, the foothills of the Alps, and irrigated areas in the South), and around existing local facilities for collecting and processing milk in the case of sheep (South of France, the Mediterranean Islands and Italy).

Meat is also produced on these dairy farms, as well as in more extensive husbandry areas and on larger farms.

(a) As far as cattle is concerned, meat production can more and more be considered as a by-product of the dairy cattle breeding industry, according to the following process:

- use of the most efficient dairy breeds or strains (Friesian, Holstein) for milking,
- crossing least efficient cows on dairy farms (double purpose breeds) with beef breed sires,
- converting dairy herds into beef herds in extreme cases (triple purpose breeds of the mountainous zones in Central France),
- breeds traditionally used in beef herds (British Isles, Central France) and for draught (Central France).

(b) As far as sheep are concerned, if lamb production is growing in the dairy flocks of the E. E. C. countries of the South, the slaughter weight of lambs remains low. Meat flocks are developing independently in different situations where, as in the British Isles, and due to the small size of the farms, they are rarely considered as the main source of income on the farm. (One exception to this is perhaps the "Charmoise" areas in Central Western France.) They are generally connected to other productions on the farm, such as:

- dairy cattle under maritime climate (North West E. E. C.), longwool breeds,

- beef cattle in Central France, Merino and British type breeds,
- cereals in the lowlands of the Northern E. E. C. countries,'
- other: several plant and animal productions, in the mountainous and arid zones of the Southern E. E. C.

Consequently the small size of the flocks and herds makes it necessary to organise breeding schemes on a co-operative basis. At this stage to be efficient they have to be. simple.

III. BREEDING AIMS AND GENETIC VARIABILITY

The biological and economical unit of animal production is made up of the production of a dam-and its progeny per-year (which is the normal cycle for exploiting available plant resources by sheep and cattle). The aim of animal breeding is to find trait combinations of a dam and its progeny which give the maximum profit input/output ratio (DICKERSON. 1970). Several comments can be made in this respect:

(a) Biological functions and traits involved are often quite different for the dam (lactation, reproduction) and for the progeny (growth, food efficiency), (CARTWRIGHT 1970);

(b) Relationships between a given trait and economic profit, or between two traits are often not linear (breeding aims may often consist in research into the optimum values of traits, e. g. birth weight);

(c) At the level of genetic variability, numerous contradictions appear between dam and progeny traits or (in the case of composite traits, such as calving ability and weaning weight) between the genetic contributions of the dam and the progeny. These contradictions involve mainly:

- growth rate selected for in the progeny, and large mature size of the dam in general selected against,
- muscular development on the one hand, and fitness traits on the other.

More generally, increasing growth and muscling decreases the adaptability to stress. It is important to take this into account for the best environments and husbandry systems for cattle and sheep in relation to their use of different breeding types;

(d) Non additive effects of the dam's and the progeny's genes, generally have a favourable influence on traits, in particular those which are linked to fitness (CUNDIFF 1970).

If it was possible to control completely the reproduction of animals, the most efficient use of these results could be obtained by systematically transferring hybrid eggs between "male breeds" selected on their muscle growth potential, and recipient cows from "female breeds" selected for their reproductive, maternal traits and for their adaptation.

Besides this ideal situation, we know (DICKERSON 1972) that the three breed. cross is the system which, starting from a given female population, derives maximum profit from heterosis and existing incompatibilities between dam and progeny effects of genes on a given trait.

Several experiments are now in progress to compare different cross-breeding systems in different European environments.

(a) Dairy herds and flocks

CUNNINGHAM (1973) has shown that developing crossbreeding with beef sires at a maximum rate in a dairy population was the most efficient system, both for the overall profit of the herd, or separately for the quantity of meat and even milk Owing to artificial insemination, industrial crossing (commercial herds) has spread in Ireland, Great Britain and France where it concerns 50%, 32% and 19% of dairy cows respectively. Experiments chiefly involve comparisons of beef breeds in three situations where industrial (commercial) crossbreeding can be carried out in practice:

- slaughtering of all progeny before breeding (most common situation),
- slaughtering of female progeny after early calving of heifers (this situation is more adapted to intensive areas with small dairy farms),
- use of F_1 heifers in beef herds. This system, most common in the British Isles (Hereford x Friesian) is expanding in grassland areas and large farms in Central Western France (Charolais x Normand, Charolais x Friesian).

Using very well muscled sires, reduces maturity rate and allows one to obtain carcasses with sufficient weight at a given fatness for heifer calves. In the second and third systems, on the other hand, it decreases the sexual maturity and calving ability, of females.

The economical advantage of beef crossbreeding depends on differences in size and muscling between "dairy maternal** and "beef paternal" breeds.

The development of commercial crossing in dairy flocks depends on the increase of the weight of lambs at slaughter (Italy), and the artificial insemination rate.

(b) Meat herds and flocks

The situations vary according to the species, the type of female populations (rustic local breeds from difficult zones in the South, large-sized breeds from intensive areas in the North)and crossbreeding systems.

In the case of breeding females from rustic breeds, the advantage of commercial crossing with sire breeds of high muscular development, is gener ally very important, whatever the environment (year, location) for cattle (CASU et al. 1975) and for sheep might be. But if the relative rank order of paternal breeds on

the value of their F_1 progeny is known and homogenous for cattle, where the milk production of cows is sufficient and where calves are under nutritional protection after weaning; we still need more information on this point for sheep. In fact, for this species the difference in growth potential of different sire breeds can be modified by the variation in maternal environment (uterine and suckling phase). As there is no great length of time between weaning and slaughtering, the maternal effect is more important here and its variations are great because of the variable prolificity and the large variety of environments. Moreover, the paternal breed must give lambs which have the required degree of fat at a weight defined by the market's demand. For all these reasons, it is difficult to imagine that interaction between paternal breeds and external or maternal environments should be small. A **co-operative** experiment between Spain, Italy and France is now in progress to analyse this.

Furthermore, in extensive conditions where local rustic breeds are reared, it does not seem to be appropriate to develop crossbreeding systems for females beyond the first generation (rustic x beef); or to raise dairy cows of F_1 (dairy x beef), coming from dairy herds of intensive zones located near extensive ones. However, some progress could be made in this respect, by rearing females from each breeding type in systems corresponding to their growth potential, e. g. a three breed cross between local and meat sheep developed in the United Kingdom from the highlands to the lowlands and the downs (Welsh Black x Border Leicester x Down). Such crossbreeding schemes for sheep are expanding in Southern France (between the Alps, the Massif Central and the lowland areas), and for cattle in the Pyrenées with the Gascon breed (Gascon x Blond d'Aquitaine x Charolais).

With regards to the female populations of large-sized beef types (breeds), the results of the crossbreeding experiment now in progress at Bourges (France) between Charolais, Limousin and Maine Anjou breeds, indicate the great interest of the Limousin for its maternal traits or effects, and the good complementarity which exists between this breed and the Maine Anjou in crossing. In such female populations, the development of crossbreeding schemes is limited by the calving ability of heifers and young cows. Schemes reducing the calving risks of these females, in which the choice of paternal breeds would depend on the age of the dam are put forward, e. g. :

- up to the third calving, rotational crossing with paternal breeds of intermediate size, good fertility and maternal ability (female progeny calves would be kept for breeding),
- after the third calving, terminal crossing with large-sized beef sires.

The interest of sheep breeders in using large meat breeds in the Northern E. E. C. areas is chiefly concentrated on the possible use of highly prolific breeds (Romanov, Finnsheep) to increase their profit. As a result of experiments carried out in France (1964 - 1968), three breed crossing systems - local breed x Romanov x meat breed - have been promoted in each of the French sheep areas. But it now appears that several other systems also have to be taken into consideration; up-grading of Romanovs, followed by three breed crossing from pure Romanovs; establishing a new breed - Romanov x local breed; and alternate

or rotational crossing involving Romanov and other maternal breeds to produce hybrid ewes for commercial crossbreeding with "terminal" sires.

Comparisons of crossbreeding systems for cattle or sheep are generally carried out when the female populations are in a state of equilibrium; but farmers rearing a given female breed who have to take a breeding decision require that their profit evolves from the initial stage to the state of equilibrium of the schemes. This sometimes requires a long period (10 - 15 years). So a sheep breeder who wishes to make money rapidly has to use meat breed sires for commercial cross-breeding; if he can wait 10 years for a larger profit and accept to be short of money for the first years, he will have to choose to up-grade his flock with Romanovs and then cross Romanov ewes with "terminal" rams (first generation or three breed crossing). Cash flow procedures would be very useful to help in drawing conclusions in this way.

V. BREEDING SCHEMES FOR SIRES

We shall now deal with the estimating and spreading of genetic progress in commercial herd populations by way of choosing and using sires from each population involved in the breeding system (MENISSIER et al. 1975).

(a) General breeding aims

The general aims in choosing sires in a given population or breed will depend initially on the potential use of their female progeny; percentage kept for breeding and, number of breeding cycles. The importance of these two parameters will determine the relative importance of muscular growth potential and meat traits on the one hand, and of the fitness and adaptability traits of breeding females on the other.

The practical situations which can be considered are the three following:

- selecting paternal or sire strains for terminal crossing. Only growth, conformation and fattening traits are then considered;
- selecting maternal or dam breeds in which a maximum proportion of female calves are kept for breeding as long as possible (local breeds well adapted to harsh environments constitute the female stock for commercial or terminal crossing operations);
- selecting "synthetic" breeds (selected for both paternal and maternal traits) in which an important part of the female calves are not bred, in pure breed and rotational crossing for example.

Practically speaking, several situations arise between the two following cases: on the one hand, selecting breeding females before the first calving or lambing (sheep populations and British beef breeds), and on the other, breeding decisions after several breeding cycles in large-sized beef, and sometimes sheep, breeds when the slaughtering value of the cow or ewe is at a maximum.

This rough classification of breeding aims for sires is chiefly founded on the proportion of genes used in calves during the growth and fattening phases, or by breeding females, and does not consider fitness and adaptation traits of the sires. The importance and the kind of traits chosen will vary for example between

natural service and artificial insemination, where sexuality is expressed under artificial environment and with artificial methods.

(b) Practical breeding schemes for sires

Practical breeding schemes for sires (sheep or cattle) in operation in Europe concern each of the above three situations and also dairy cattle or sheep breeding. Their use depends on several influences:

- the spread of artificial insemination which concerns: for cattle 90% of dairy cows and less than 50% of beef cows (30% in some beef and mountainous breeds); and for sheep 5 to 10% of dairy ewes and only a few experimental meat flocks;
- the extension of recording and progeny testing and performance testing operations,
- the ability of the operators in animal breeding and industry, to use these facilities at best, in order to estimate the breeding value of sires and spread their genes in commercial populations.

Practical situations can be divided up into three groups:

(i) Integrated schemes

Situations where practically all matings are by artificial insemination - dairy or paternal beef cattle strains. These schemes involve the three classical and consecutive steps:

- individual selection of male calves on growth and conformation traits,
- progeny testing and selection for the same traits (paternal strains) or for dairy traits (dairy herds or flocks),
- selection of breeding females (contract matings) by their performance and on the index of their sire.

These schemes are more and more concerned with an integration of recording and testing facilities; also artificial insemination is planned at the level of the whole population in order to maximise genetic and economic progress (profitability of breeding investments) (ELSEN et al. 1974). Thus, the female population is divided into three parts: the nucleus herd or elite for contract mating; the breeding females used for progeny testing of young sires; and the commercial herds.

As regards the selection of paternal strains, owing to the reserve of pedigree breeders to restrict the scope of their breeding only to growth and carcass traits, artificial insemination co-operatives are now controlling all breeding schemes of beef strains. These schemes are more and more carried out from a gene pool of beef breed animals (mainly Charolais, Maine Anjou, Blonde d'Aquitaine, Limousine) only selected on their growth and conformation traits.

(ii) Stratified traditional systems

These traditional stratified systems correspond to populations using only or mainly natural service and operate under the control of pedigree breeders.

These systems are largely based upon subjective appreciations and have lead to a stratification of herds or flocks for breeding, multiplying or commercial producing functions. The development of recording operations has improved the efficiency in classifying and promoting sires. This concerns in particular: growth and conformation traits for paternal or "synthetic" populations, and fertility or mothering ability traits of dams for "synthetic" and maternal populations (indexing females). The regional organisation of producers also makes it easier to improve the efficiency of certain breeding operations by:

- establishing co-operative performance testing stations for male calves after weaning (Limousine breed, for instance),
- constituting nucleus herds or flocks opened to the best indexed breeding females of recorded farms and whose progeny males be used for breeding (rustic local breeds of sheep in Central France).

(iii) Intermediate ("mixed") systems

During the phase of artificial insemination development (dairy sheep, breeding area of beef cattle and meat sheep breeds, synthetic populations), these "mixed" systems can improve the efficiency of selection by using this technique for:

- Organising progeny testing operations. This was particularly important to improve the efficiency of large-sized beef cattle or meat sheep breeds. The expansion of these breeds in ranging conditions required rapid progress in the fitness traits – which had been handicapped in the past by the small influence of natural selection with traditional European rearing systems – this involves several kinds of protection; small herds or flocks whose fertility and calving or lambing were permanently supervised by cattle and sheep breeders. Owing to the difficulties of accurately estimating the breeding value of males on field data, progeny tests of artificial insemination bulls or rams were organised in centres, on the fertility and maternal ability of a sample of their female progeny. Such centres now operate for beef cattle (Charolais, Limousin, Blond d'Aquitaine) and sheep (Ile de France, Texel).
- Distributing semen of the best sires after progeny testing in breeding herds. Male progeny will, in a second step, transfer the genetic progress in commercial herds or flocks by natural service, artificial insemination being not sufficiently used for a direct transmission of this progress to the whole population.

(c) The French example

One can illustrate this idea by a schematic presentation of the main French schemes for each type of breeding aim (Table 1):

TABLE 1

French breeding schemes for cattle and sheep

1. Cattle

Location	Breed	Type of scheme*	A. I. percentage	Breeding goals
The whole country	Friesian Normande Montbeliarde	I (8-10)	90	Milk
South-West Centre-West East	Charolais Limousin Blond d'Aquitaine (+ gene pool types)	I (4)	70	Meat (paternal strains)
South-West Centre	Charolais Limousin Blond d'Aquitaine	m (3)	30 - 50	Meat (synthetic populations)
Pyrenées Centre-South	Gascon Aubrac (Rustic breeds)	m	30	Meat (maternal populations)

2. Sheep

Location	Breed	Type of scheme*	A. I. percentage	Breeding goals
Roquefort area Pyrenees	Lacaune	m (2)	5-10	Milk
Centre-North	Berrichon du Cher (project)	m (1)	< 1	Meat (paternal strains)
Around Paris	Ile de France Texel (project)	m (2)	< 1	Meat (synthetic populations)
Centre	Limousin Bizet Blanc de Lozère (Rustic breeds)	m	< 1	Meat (maternal populations)

* I = integrated; m = mixed.

The voting of the Livestock Act (Loi sur l'elevage) by Parliament in 1966 (BOYAZOGLU 1975) codified and organised these activities. This Act defines the role of each operation in the breeding process and considers the following individually:

(i) Procedures for data collection and evaluation, involving three types of bodies from the farm to research institutions:

- at the local level (EDE) for identifying and recording animals in a given area no matter what their breed or breeding type (80 to

90 EDE local units),

- at the regional level (ARSOE) for checking and transferring data onto cards or tapes for computing operations (8 to 10 regional ARSOE groups),
- at the national level (CTI) a computing centre under the supervision of research workers of the "Département de Génétique Animale de l'INRA", for indexing sires and dams of each breeding scheme (Table 2):

TABLE 2
Indexation systems on animal populations

Species	Origin of data	Traits	Number of animals recorded	Indexation systems*
Cattle	Dairy herds	Milk characters	1 300 000	D ♂♂ C ♀♀
	Beef herds (veal)	Growth	10 000	D ♂♂ (Terminal crossing)
	Beef herds (weaned calves)	Growth Fertility of cows	100 000	D ♂♂ I ♀♀
	Performance test station	Growth Food efficiency	500	I ♂♂
	Progeny test station (♀♀) (beef breeds)	Growth Fertility Maternal ability	500	D ♂♂
Sheep	Dairy flocks	Milk characters	50 000	D ♂♂
	Meat flocks	Growth Fertility Maternal characters	240 000	I ♀♀ D ♂♂

* I = individual value; D = index on progeny; C = combined index.

(ii) Procedures for decision taking which concerns:

- breeding or semen production units:- 10 to 12 for cattle in France, each of them producing semen for some 0,5 to l'million artificial inseminations; these units have the means and responsibility of developing sire selection schemes for one or more breeds in a given area;
- at the breed level, the UPRA (breed selection and promotion unit) within which are grouped all bodies operating for the improvement of the breed (artificial insemination centres and artificial insemination breeding units, pedigree breeders, recording associations, organisations of farmers) has substituted the old Herd-Book association.

Any questions or problems which arise at this practical level and, more generally, on breeding schemes, are discussed for each species by a national Committee for animal breeding (CNAG). This committee which comprises an equal number of representatives from the Department of Agriculture (Research, Teaching and Administration Branch) and the professional organisations, acts as an advisor to the Minister of Agriculture for these matters and also for matters concerning imports and exports of breeding animals.

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