

CURRENT STATUS AND FUTURE OF NATIONAL BREEDING PROGRAMMES

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SUMMARY

This paper arrives at two different routes of development of national breeding programmes. One is coined as a programme of concerted crossbred breeders. In that case breeders collaborate in a closed selection programme, and pure breeding stock is available within the programme only. The product of the system is parent stock and the organization of these systems very much resembles a breeding company except the ownership of breeding pigs (i.e. company vs breeders). The Danish breeding programme and the programme of the Dutch Pig Herdbook are examples of this route. These systems are expected to be competitive. Another route is where breeding value estimation across herds and resulting breeding stock are used by various commercial pig producers and integrated pig chains. The breeding stock may be produced in several selection programmes. This situation exists in France and Canada and to a lesser extent in the USA and Australia. Especially in France the situation is expected to be stable because of strongly organized commercial pig production sharing breeding stock from a common -national- source.

It is expected that integrated pig chains organizing commercial pig production will be increasingly important in situations where markets of supply replace markets of demand. National breeding programmes only may survive in such situations if they can reach a strong degree of organized collaboration between breeders.

INTRODUCTION

Breeding of pigs on a national scale probably started in the beginning of this century in Denmark with the set up of a central progeny testing system. Similar systems were set up elsewhere in Europe later on, such as in The Netherlands (1930) and Britain (1954). Results of these testing stations provided breeders information on the genetic merit of their boars (and sows). Utilization of better genetic stock within and across herds was stimulated by this improving the overall genetic level as a basis for pig production. These testing systems were a part of pig industries utilising pure breeding, and improvement primarily was sought for carcass quality. In present industries, cross breeding is the rule and genetic improvement is directed to a breeding goal integrating soundness, growth, efficiency, meat quality and reproductive performance along with carcass quality. Current breeding programmes all over the world show many similarities, shaped by the finding that crossbred animals show clear advantages above purebreds (Fredeen, 1957) and that performance testing is more efficient than progeny testing (King, 1955). Following Smith (1964) generally breeding goals for sire and dam lines differ. Pigs are mostly tested under ad lib feeding to avoid feed intake capacity limiting lean growth (Fowler *et al.*, 1976). BLUP Animal model is the standard to estimate breeding values (Henderson, 1973) often utilising PEST (Groeneveld and Kovac, 1990) or PIGBLUP (Long *et al.*, 1990). The design of breeding programmes often follows methods and general findings as by De Vries (1989) on derivation of breeding goals, size of lines and utilization of test capacity.

In spite of these similarities, the organization of pig improvement varies considerably between countries. In some cases, e.g. the United Kingdom, all breeding stock is produced by commercial breeding companies with very little or no "national" involvement. Many of these companies operate internationally and the situation is very similar to that in poultry, though far

less companies supply the international poultry market. In other cases, e.g. Canada, testing facilities and services to evaluate breeding values are provided nationally and utilized by most breeders. The purpose of this paper is to discuss the situation in a few countries¹ and changes taking place.

Smith (1978) compared the appraisal of investments in animal production looking at programmes aimed national interest and programmes by a commercial breeding firm or breeder. Brascamp (1982) looked at some consequences for the organization of pig improvement. Ideas developed in these papers will be discussed.

GENERAL FRAMEWORK

Animal improvement programmes involve both selection systems to continuously improve genetic stock and multiplication systems to disseminate superior genes throughout the commercial population. An early example of a study evaluating both aspects is Lindhé *et al.* (1977). Genetic improvement and dissemination are parts of the production pyramid, which consists of nucleus herds (improvement of 'pure' lines), multiplication herds (multiplication of purebreds and production of -crossbred- parent stock) and commercial herds (weaner producers and growers). Following this separation breeding programmes may involve the following elements:

1. Definition of breeding goals
2. Estimation of breeding values
3. Production of purebred breeding stock
4. Production of crossbred parent stock
5. Production and valorization of the slaughter generation

Herdbooks breeders traditionally only involve the elements 1-3, where individual breeders may or may not follow rules common to the herdbook as a whole. Often breeding goals are adopted on the level of pure breeding -traditionally focussing on carcass traits- ignoring the overall economy of the crossbred final product. Modern *purebred breeders* also only involve elements 1-3, but produce breeding stock for crossbreeding programmes. Breeding goals will be defined accordingly, often differing between sire and dam lines. *Breeding companies* mostly cover items 1-4. They produce parent stock (and sometimes also grandparent stock) for various customers in different markets. *Integrated pig chains* are involved in all items 1-5. In theory, in the latter system there exists an optimal interaction between breeding goals defined and consumer market requirements. In many cases a system doesn't follow any of these categories precisely (e.g. in case an integration dealing with element 5 utilizes parent stock provided by a breeding company) but it clarifies different options.

Improvement programmes also may be looked at from another angle. Runavot (1992) coined the phrases *open selection* and *closed selection* to distinguish situations in which breeding stock from various breeding herds is used freely by others or where breeding stock uniquely is used within a breeding organization. Runavot took breeding companies and integrated pig chains to follow "closed selection" and allocated purebred breeders to "open selection". It should be recognized that in some countries an open selection system exists for the relationship among

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purebred breeders being part of one breeding programme. Their breeding stock is not available, however, for breeding outside that programme. In that case, the items covered by the programme actually are 1-4, and these breeders better might be categorized as "concerted crossbred breeders". In Table 1 various options are summarized.

Table 1. Organization of pig improvement depending on the incorporation of various of 5 items¹⁾ included in the breeding programme.

Availability of purebred stock	Category	Items
Open selection	Herdbook breeders	1-3
	Purebred breeders	1-3
	Concerted purebred breeders	1-3
Closed selection	Concerted crossbred breeders	1-4
	Breeding company	1-4
	Integrated pig chain	1-5

¹⁾ These items are: 1. Definition of breeding goals; 2. Estimation of breeding values; 3. Production of purebred breeding stock; 4. Production of crossbred parent stock; and 5. Production and valorization of the slaughter generation.

STATUS OF NATIONAL PROGRAMMES

In the United Kingdom a national programme of progeny testing started in 1954. At the end of the sixties these programmes were converted into performance testing stations. At the same time breeding companies were gradually coming into the market with a share of some 20% in 1968. The role of the national breeding programme carried out by the Meat and Livestock Commission (MLC) then typically involved providing testing facilities and breeding value estimation of tested animals. After about 20 years the scheme terminated. During this period breeding companies grew to a 100% market share. In the seventies the MLC carried out Commercial Product Evaluations to provide customers with comparative information on end-products of the breeding companies.

Denmark followed a completely different development. Starting as an open selection system of purebred breeders the programme met problems somewhat over 10 years ago. Up until then the programme focussed on purebreeding primarily in Landrace. Because of emphasis on carcass lean percent and testing under a restricted feeding system, voluntary feed intake caused a serious limitation for lean growth and lean feed efficiency (cf Fowler *et al.*, 1974). The Danish system then changed to crossbreeding exploiting Landrace and Yorkshire as dam lines and Yorkshire, Hampshire and Duroc as sire lines. Recently, the Danish testing system has been modified to the usual performance test system. Breeding value estimation using the animal model allows a direct comparison of centrally tested breeding animals and animals tested on farm. AI plays a central role in linking herds both for the estimation of breeding values and for the dissemination of superior genes. The Danish system may look as an open selection system, but in fact is organized as a closed system and may be seen as a programme of concerted crossbred breeders. It tends to an integrated pig chain because of its strong links with the slaughter industry. Its organization very much resembles a breeding company (Brascamp, 1993), except for the fact that nucleus pigs are bred on several herds and are owned by the individual pig breeders. In Denmark breeding companies have a very small share. The system in Norway shows similarities with the Danish system. It may be seen as concerted programmes of purebred breeders, however, probably

because as yet there is no or little competition with other actors on the market of breeding stock. Some typical aspects of the Norwegian aspects are that nearly 100% of matings are by AI and that only 30% of slaughter pigs is crossbred.

The development of the Dutch national breeding programme is very similar to the Danish. The "Nederlands Varkens Stamboek" (Dutch Pig Herdbook) originates from several regional organizations of herdbook breeders, but presently is a programme of concerted crossbred breeders, utilising Yorkshire and Duroc on the male side and Dutch Landrace, Yorkshire and some Finnish Landrace on the female side. Note that for about 10 years both Yorkshire lines have been divergently selected for sire and dam-line breeding goals respectively. The programme is in open competition with five internationally operating Dutch breeding companies and several foreign ones. Its market share is rather stable at about 50%. It deliberately attempts to keep its breeding stock protected from utilization by competitors. It should be noted that the evolution of the Dutch herdbooks to the present system was accompanied by declining public participation in funding. Traditionally, AI plays a central role both for nucleus breeding and commercial production. Central testing presently is carried out at one station, but its prolonged utilization is under discussion where the combination of on farm testing and the animal model is expected to be competitive and safer from a sanity point of view.

In Germany a national (i.e. federal) breeding programme did not exist; Herdbook breeders were organized on a regional level, and presently are organized on a state level. In the early seventies initiatives were taken to set up a Federal Hybrid Programme (Deubrid) and after extensive testing of various crossbred combinations the present programme got its shape. The programme has the highest nationwide sales of crossbred gilts (about 25%) and has a market share of little over 5% in terminal sires. Due to the preference of high carcass grades, herdbook bred boars (mostly Pietrain) still have two thirds of the market. In Germany there are presently some 12 breeding companies competing -most of them operating internationally-. About another 10 crossbreeding organizations of breeders are active on this market. Presently many herdbooks are in a transition process to a crossbreeding organization moving to a market of breeding stock which is completely occupied by many (relatively small) crossbreeding organizations, a few larger ones and several internationally operating breeding companies.

In France the national breeding programme plays a very active role (Runavot, 1992). Within the programme five central stations are used to test the better breeding animals. Selected boars are used for AI or returned to breeders. Animal model breeding value estimation is used evaluating breeding stock across herds. Though still about 15% of nucleus sows are owned by independent breeders, most important are -mostly national- breeding companies and integrated pig chains. The latter programmes often are initiated by feeding firms and slaughter houses. The various programmes all may utilize breeding stock tested in the national programme and a common improving gene pool therefore provides breeding animals for various integrated pig chains. Most important breeds are Large White (currently split into a sire and a dam line), Landrace and Pietrain. France recognizes breeding companies and crossbreeding schemes if they meet particular quality levels and these programmes are regularly publicly compared for growth and carcass traits. Reproductive performance is evaluated as well but is made available to the participating programmes only. Recognized programmes have a market share of about 70% and 85% in boars and gilts sold respectively. It should be emphasized that in France it is attempted to incorporate breeding companies into the national breeding programme.

The situation in Canada somewhat resembles the French one. Some 20% of slaughter pigs originate from two international breeding companies, not taking part in the national breeding programme. Organizations participating in the national programme mostly can be seen as concerted purebred breeders as they share a central testing station, across herd evaluation of breeding animals and AI. There are national rules for the testing of pigs and all on farm testing is done by technicians employed by provincial programmes. Predominant breeds are Yorkshire,

Landrace, Duroc, Hampshire and Lacombe. In the United States across herd breeding value estimation is carried out as well for purebred breeders and concerted purebred breeders. The situation seems less stable, however, with a considerable increase in market share of breeding companies and also integrated pig chains. Traditionally in the US various rotational crossbreeding systems have been predominant, but there is a tendency to static crossbreeding systems as used by breeding companies.

The Australian market is a rather isolated one due to distance and health status. Its market is therefore not open to international competition, but nationally various groups act on a competing market. Nearly 15% of the market share is kept by an integrated pig chain. Another 60% is mainly held by four breeding companies (among which one international company and two internationally operating Australian). Independent purebred breeders comprise the remaining 25%. A national breeding programme offers a breeding value estimation procedure (PIGBLUP) on a within herd basis and a module enabling breeders to define breeding goals based on profit equations. There is a tendency that costs for these are to be payed by the industry itself and the independent purebred breeders probably only can remain competitive if they evolve to a concerted purebred (or crossbred) programme.

Summarising, national programmes have disappeared or seem to disappear in the UK and Germany. Strong and active national programmes are in existence in France and Canada with across herd breeding value estimation of animals which are available to the industry as a whole. The situation with similar set ups in the USA and Australia seem to have less impact. Programmes originating from national ones are in operation in Denmark and The Netherlands. These no longer are open selection systems, however. Breeding stock only is available to herds being part of the system of crossbred breeders. Other Nordic countries run similar programs, but are less confronted with closing the selection system or not by lack of competition. Possible participation in the European Union may change this situation, though health regulation may form a strong barrier.

FUTURE OF NATIONAL BREEDING PROGRAMMES

From the previous paragraph it seems that two routes are exploited to maintain "national breeding programmes" as opposed to increasing market shares for breeding companies. One is that a national programme evolves to a closed selection system, producing parent stock. In Denmark, this system provides parent stock for essentially one commercial national system. In The Netherlands the programme of crossbred breeders sells parent stock to a range of commercial producers and to integrated pig chains as well. Both systems are increasingly organized similar to breeding companies. The ratio of numbers of purebred pigs to crossbred pigs very much is dictated by the size of the market of parent stock. Increasingly, there seems to be no clear advantage (or disadvantage) as compared to breeding companies. Initially, breeding companies had a logistic advantage of stricter organization. This currently is less obvious. Perhaps there is one continuity advantage in that breeders owning the nucleus pigs are able and prepared to continue production in economically difficult periods. Smaller breeding companies may lose market share in such periods to larger, internationally operating, companies. The second route is exploited especially by France and Canada, and to a lesser extend by USA and Australia. Basically the strength of this system is that a large testing and selection system is kept in place to serve various commercial producers. The French situation seems particularly strong, where integrated pig chains share improved stock in this way, which probably reduces costs. As long as such a national programme can produce breeding stock competitively in terms of price and quality there seems to be a secure future. Probably, the strong organization of commercial pig production by feeding companies and slaughter houses very much contributes to this stable situation. The Canadian situation seems less clear in this respect, where commercial hog production is less integrated.

DISCUSSION

None of the countries reviewed lacks nationally based breeding organizations, be it (concerted) purebred or crossbred breeders or breeding companies. This is a situation different from poultry, in which only a very limited number of internationally operating companies supplies the majority of markets. Bichard (1977) gives two reasons why this will not occur at that degree in pigs: lower reproductive rates and less uniform environmental conditions. In relation to this the question is relevant if nationally based breeding organizations are critical for the competitiveness of a pig sector. This may be so if specific market requirements ask for specific breeding goals. It seems, however, that an internationally operating breeding organization also should have the flexibility to offer specific line combinations for specific markets.

It seems that increasingly actors organizing the commercial production will dictate the shape of pig improvement schemes. These actors, in turn, increasingly are governed by consumers market needs. This picture would hold for situations where pig production is changing from a market of supply to one of demand. In the United States large integrated pig chains are appearing with over 1 million slaughter pigs. These organizations require a regular delivery of parent (or grand parent) stock. This necessitates a strictly organized system of purebreeding and crossbreeding. For concerted purebreeding systems to be competitive in such a situation, individual breeders have to be prepared to collaborate very well. Otherwise, breeding companies will provide the breeding stock required, generally being stricter organized.

When I started this paper I considered both routes national breeding programmes followed as "national programmes". The result of the first route, however, resembles very much the structure and organization of a breeding company. It may, therefore, be more logical to limit the phrase "national breeding programme" to systems like in France, Canada, USA and Canada where commonly used systems of breeding value estimation are used and resulting breeding stock is exchanged between breeders and breeding organizations.

Smith (1978) compared the investment levels justified for breeding companies on the one hand and for national breeding programmes on the other. Differences he observed were time horizon (short vs long), and reasons to invest. Smith (1973) also noted low risk of no returns for a national programme and high risk of no return for a breeding company. This picture coincides quite well with the above interpretation of the phrase national breeding programme. It concerns investments in breeding which are for the benefit of various breeders or breeding organizations and may be expected to benefit the pig production sector as a whole. Brascamp (1982) used these thoughts to ask the question how a national contribution to pig breeding might look like. He concluded to the support of breeding programmes as one activity, of which nation wide public breeding value estimation is an example. He also discussed the situation of a market 100% covered by closed competing selection programmes and suggested public evaluation of products as a national activity in that case. The value of this is unclear. Guy (personal communication) mentioned that competition between companies in Britain 'keeps them all on their toes', although very little public information (on value of products) is available. In such a case public evaluation will not add very much to overall genetic improvements in stock. If competition is not active due to small numbers of competitors or because markets are not transparent, evaluations may be useful.

Are there advantages for national programmes in terms of expected genetic change? An answer may be reached looking at it as a matter of a closed versus an open nucleus breeding system. The open nuclei in that case utilize a common system of estimation of breeding values and AI. It seems probable that average rates of genetic improvement are larger in the case of open nuclei, while the systems don't have the problems of a mammoth organisation if all nuclei are ran by one organization. It is obvious, however, that this advantage will be fairly small if each of the constituting nuclei has a large population size.

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