THE APPROACH OF AN INTERNATIONAL BREEDING ORGANISATION TO MEET REQUIREMENTS OF A NATIONAL PIG INDUSTRY

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SUMMARY

International as well as national programmes of genetic improvement can be successful in meeting national market requirements. Both approaches have their own problems which can be dealt with adequately or not. Differences in marginal economic values of traits between countries, and the impact of these on selection efficiency, suggest that differences between markets are not extremely important. These differences however have a major impact on product design using available lines/breeds. Genetic improvement programmes have to take existing and future (uncertain) market requirements into account. Line development strategy, based on an adequate number of lines, is important, but no straightforward procedure exists to develop such a strategy. The line development programmes of national and international breeding organisations will however have a major impact on their future success.

INTRODUCTION

The requirements of a national pig industry can be met with a national or international programme for genetic improvement. In theory with unlimited resources, all approaches can have the same impact but will be more or less cost effective.

This paper discusses the approach of an international as compared with a national programme, dealing with aspects such as existing and future market requirements, breeding objectives and line development, product design and evaluation, costs, flexibility and risks.

The question is whether and in what situations a national or international approach has a greater chance to be successful.

MARKET REQUIREMENTS

The requirements of the worldwide pig industry vary owing to a wide range of economic conditions, production environments and consumer demands. The variation within a national industry can however also be large due to geographic size (e.g. USA, Russia, Brazil, China), range of climates (e.g. USA, Russia, Brazil, China, Chile, Italy, Portugal), market segments (e.g. indoor versus outdoor production, low versus high carcass weight, fresh versus processed meat) and differences between producers (e.g. health status, feeding systems, quality of management).

Examples of national industries with a relatively uniform set of market requirements are those of Denmark and The Netherlands. More variable are, for instance United Kingdom, Italy and Spain.

In spite of all these differences, characteristics such as piglets weaned/sow/year, growth rate and feed conversion ratio are to a high degree relevant for all markets as they affect cost of production.

The most important differences are in carcass requirements (lean %, meat quality, muscle dimensions, skin colour) and robustness (disease resistance, leg quality, behaviour). Differences in market requirements result in different line/breed combinations for parent boars and gilts and in different marginal economic values (MEVs) for the breeding objective traits.

OPTIMAL LINE/BREED COMBINATIONS

An efficient crossbreeding structure can be a 5-way cross (AxB)♂ x (Cx(DxE))♀, i.e. the use of crossbred parent boars, crossbred GP sows and crossbred parent sows. This is however only true if the 5 populations that are most suitable for a certain market are available in that market.

An important question is whether those most suitable lines are most likely to be developed with a national or international programme. A general answer cannot be given.

The following aspects need to be considered:
- Changes in market requirements in the past. If the requirements have been very constant it is likely that a good national programme has resulted in a suitable set of lines. Sudden changes however often require imports of new lines/breeds which are not always readily available.
- Number of lines developed by an international breeding company. With a small number of lines it is unlikely that the wide range of market requirements worldwide can be met. For this reason it is difficult for national breeding programmes to expand to many other markets.
- Most traits can be combined in an overall economic evaluation. However, some have the characteristics of an all-or-none trait. For instance skin colour: in some markets slaughter pigs need to be white. Payment schemes do not always reflect the economic value of the carcass. Payment might be based on weight while the slaughter industry requires a high lean %, well conformed carcass. In that case carcasses that are not good enough are difficult to market, even for a lower price.

OPTIMAL LINE/BREED DEVELOPMENT

Partial derivatives of profit functions can be used to estimate MEVs. Use of profit functions requires knowledge of costs associated with defined variables and knowledge of mean performance. An internal study (Wilson and Bovey, 1989) looked at MEVs (relative to growth rate) for 7 different markets (countries). The ratio between the highest and lowest value was 4.6 for litter size, 4.3 for feed conversion ratio, 4.0 for backfat/lean % and 5.4 for killing out %. These results suggest that it will not be feasible to develop one set of five lines based on the "average" economic values and to use these lines in all markets.

A simple calculation might illustrate this. Assume two traits with equal heritability coefficient (0.25), $r_p = r_g$ and equal phenotypic variances. Market requirements can be described by the ratio of marginal economic values of both traits (V1/V2). The economic value of improvements due to selection based on "average" MEVs can be compared with those based on the market specific ones. Results are in Table 1.

Table 1. Percentage of genetic improvement using average MEVs as compared with using market specific values

	Market specific MEV's (V_1/V_2)				
$r_p = r_g$	0.25	0.50	1.00	2.00	4.00
-0.50	69	87	100	87	69
0.00	86	95	100	95	86
+0.50	94	98	100	98	94

With a ratio between the highest and lowest MEV of 4.0 (V_1/V_2 = 0.50 versus 2.00) use of the average (V_1/V_2 = 1) works reasonably well. The maximum loss, depending on the correlation coefficient between traits (-0.50 to +0.50) is 2 to 13%.

In our internal study, the use of one index resulted in no more than 1% loss of efficiency of selection in Dam lines and no more than 2.5% for Sire lines. This suggests that with selection in one set of lines we can meet all market requirements.

However,
- the above "loss of efficiency is expressed in terms of overall economic merit, assuming that all markets will truly evaluate their requirements in money. This is unlikely to be true: a too low level of one trait is rarely allowed to be fully compensated by an extra high level of another trait. In other words, overall economic merit may be too gross a simplification of a market's requirement;
- not all relevant traits/characteristics are incorporated in EBV calculations;

- differences between markets result in the use of more than 5 lines which need to be further developed.

MEETING MARKET REQUIREMENTS

Different market requirements, within one or several countries can be dealt with in the following way.

1. Derive an appropriate profit equation that contains as far as possible all potential breeding objective traits.
2. Calculate MEVs for markets of interest.
3. Study the profitability of all potential 2,3,4 and 5 way crossbreeding schemes for all individual markets. Model calculations will need to be based on accurate comparisons of lines and estimated maternal and individual heterosis components.
4. Decide upon products to produce for the individual markets. The decision is based on the results of step 3, production efficiency, competitive position and other issues not included in the profit equation.
5. Evaluate performance of designed products in the individual markets.
6. Further develop existing and new lines to meet future market requirements.

These steps need to be repeated regularly which results in an evolution of line and product development. The last step, future line development, is one of the most difficult ones. It requires good knowledge of future market requirements.

FUTURE LINE DEVELOPMENT

a. Lines used in existing products and market conditions. The target MEVs for markets are assumed to be based on short to medium term predictions of the future economic situation (approx 5 years) without expectation of dramatic changes. Economic values for individual lines and traits depend upon the contribution of lines to products, importance of products in different markets and the range of economic values for a trait in different markets.

The following example illustrates the procedure. Assume four dam lines to produce 3 products for 5 markets with a different MEV for the trait under consideration.

Product	Country	Market within	Line contribution				Volume (relative)	MEV
			L1	L2	L3	L4		
1	1	1	½	¼	¼	0	0.15	0.10
2	1	2	¼	½	¼	0	0.35	0.20
2	2	1	¼	½	¼	0	0.15	0.30
2	3	1	¼	½	¼	0	0.05	0.40
3	3	2	0	¼	¼	½	0.30	0.50
Vector notation			c_1	c_2	c_3	c_4	v	n

$v \otimes n$ is the Hademar product of vectors v and n

The economic values for the four lines can be calculated as $MEV_i = c_i' v \otimes n / c_i' v$ which gives the values 0.194, 0.281, 0.300 and 0.500 for the four lines, respectively. For the five markets this gives average values, weighted for the line contributions of 0.242, 0.264, 0.264, 0.264 and 0.395, i.e. the ratio with the initial MEV is 2.4, 1.3, 0.9, 0.7 and 0.8, respectively.

It can be useful to opt for a more extreme solution in order to create large differences between lines which makes the pool of lines possibly more suitable for future conditions. In this example we might decide to use MEVs for the four lines of 0.10, 0.25, 0.50 and 1.00 and thus increase the ratio between highest and lowest value from 1.6 (=0.395/0.242) to 10.0 (= 1.00/0.10).

The ratio of effective MEVs for the five markets with the initial values will then be 2.4, 1.4, 0.9, 0.7 and 1.4, respectively, which is as acceptable as the previous solution.

b. The second situation is one where we believe a new scenario is likely. The implications of new technology (e.g. exogenous PST, non surgical embryo transfer, cloned embryos), new attitudes or legislation (a move away from close confinement of sows, banning of certain drugs, a price incentive for meat quality traits) can be more dramatic than gradual changes. For these new scenarios we can follow steps 1, 2 and 3 as described before. This would result in lines identified as the most useful for these new conditions. These lines could then be further developed with these new scenarios in mind, in which case we need a compromise with the conclusions from the previous section.

In general it can be concluded that line development is based on a combination of the known and the unknown; a combination of science (statistics, models) and art (crystal ball and strategy). A large number of lines opens more opportunities as long as it is not at the expense of the "quality" of individual line development. The line development strategy will however determine whether national programmes can deal with changing requirements and whether international programmes can cope with a range of changing market requirements. This will be one of the crucial factors that will determine the success of both types of programme in the future.

THE NATIONAL PROGRAMME AS COMPARED WITH THE INTERNATIONAL APPROACH

In this section an attempt is made to compare the characteristics, advantages and disadvantages of good national and international programmes.

A national programme will involve development of 4 to 5 lines. With adequate resources (capital, skills, know-how, organisational structure) this can result in a product suitable for local market conditions. Relatively large changes in requirements are difficult to cope with unless additional genetic material is readily available (for purchase). The selection objective will be determined by the local market.

An international programme will involve development of a relatively larger number of lines, preferably under different environmental conditions in several countries. This results in a pool of lines that can be used to meet national market requirements by selection of the most appropriate set of lines and crosses. In combination with a strategy to increase the differences between lines, this allows the design of new products for future market requirements. The number of lines should however not be at the expense of genetic improvement and inbreeding within lines.

All-in-all good national and international programmes can both be competitive. In the end "value for money", or genetic superiority produced with a competitive cost structure, will be one of the determining factors. National programmes run the risk of not being sufficiently flexible to meet different future requirements, being too expensive for the size of the market and being unable to develop and apply new technology. This may be because of lack of capital and starting off with lines that are not competitive. On the other hand International programmes run the risk of not adjusting to national market requirements due to having too few lines (genetic diversity), not knowing the market requirements in detail, being spread too thinly worldwide, and having a structure that does not guarantee continuity. This last point requires some further explanation. Owing to national disease control programmes, international movement of stock is not always possible. A worldwide structure of Genetic Nucleus herds (line development) and boar, pure line gilt and crossbred gilt multiplication, needs to be in place in order to guarantee flexibility and the ability to react to changing circumstances. GN farms need to be linked through animal movement, AI or embryo transfer. A network of AI stations, with a strategic spread, is an integral part of this structure of production units.