PUTTING IT ALL TOGETHER

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1. CLEAR SIGNALS

- The Pig Industry is responding to the increasing pressures from the consuming public for product description. Market specifications will increasingly highlight product quality and become tighter. In addition, the producers' and processors' long-term terms-of-trade are deteriorating. Productivity (Output per unit Input) must be increased to arrest this deterioration and maintain profit. The ability to do this and to reliably meet each market specification without 'over-shooting' is becoming more important.

- The Pig industry has increasingly recognised that substantial genetic differences for profitability exist both between and within breeds and strains. The potential exists to profit from the repeated and ongoing benefits of genetic superiority arising from each selection on genetic merit, by making extensive use of the best. Many also accept that for virtually all Input and Output traits of economic importance **we must predict genetic merit.** We are unable to look directly each animal's genes!

- The fundamentals then are:

  (i) **Clear market signals** relayed right back to the breeder,
  (ii) Procedures to reliably predict **genetic merit** on an on-going basis, and
  (iii) **Well planned managed recording and breeding structures**.

2. WHAT IS BREEDING ABOUT?

- There is no magic! **Breeding is about three basic and universal biological principles**:

  (i) Each piglet receives half its genetic makeup from its sire and half from its dam,

  (ii) The sample halves received by each piglet are different, i.e. virtually every piglet is genetically unique, and

(iii) Inheritance is imperfect for all traits of importance, i.e. what you see ain't necessarily what you get! However, additional information and better processing of existing information will help you see under the skin.

- Breeders and buyers who understand these principles have an advantage.

- In addition, to this fundamental biology then breeding is also about information, decisions and actions; **Information** describing the animals and their carcases, can be obtained visually only or by measurement, with varying degrees of further analysis. **Decisions** are made on the mentally and/or computer process differences. **Actions** then involve the culling, selecting, mating and marketing processes.

3. THE KEY COMPONENTS

Effective performance recording is essential to the successful modern breeding operation. Planning and continually refining the recording operations will enable greater genetic gains, for more reliable and better targeted information will be available to assist with answers to the nine categories of decisions discussed earlier in this Clinic. The principles for planning the recording operations were also been presented earlier.

Reams of performance, financial and other marketing information are of no use unless summarised and used in subsequent rounds of decision-making. **Mental analysis** of this information is valuable, particularly when done by the well trained and astute, but it is no longer sufficient to win market and maintain a competitive and profitable position. **Formal analysis and decision aids** must also be utilised.

4. THE 'MODERN BREEDING APPROACH'

- Although most texts of animal genetics and breeding deal with the many facets of genetic theory and sometimes interpret each in terms of what it means for achieving genetic change, it is generally very difficult for those who wish to use these descriptions in practice to obtain a clear global appreciation.

- The basic approach to genetic improvement in the pig industry is summarised by the so-called Modern Breeding Approach. It provides a simple and practical

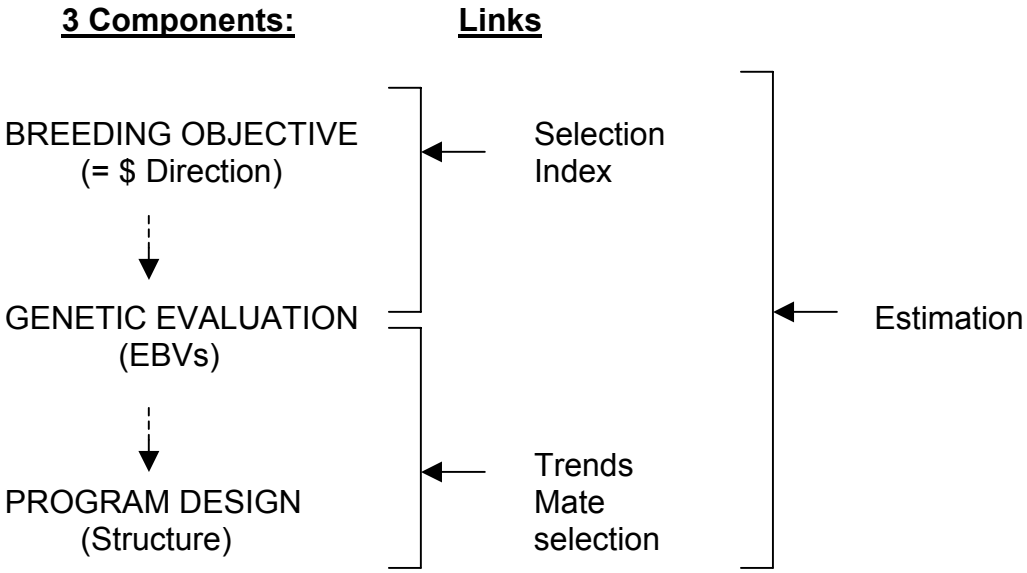
conceptual approach to manipulating genotypic variation within and between populations of animals. It is diagrammed in Figure 1.

- Only 3 primary components cover all formal and practical aspects of breeding, viz.

  (i) **The Breeding Objective**. Establishes the direction to breed in economic terms (the $ Direction). This is often done intuitively in the industry - no calculation, just by guess and "experience". It can also be done using formal calculation and in future this will be necessary to maximise the exploitation of genetics.

  (ii) **Genetic Evaluation**. Provides the estimates of genetic merit (we use the EBVs) for each animal for the measures and combinations of measures; and, if required, the estimate of risk (Accuracy) associated with each EBV. Genetic evaluation enables animals to be ranked on their overall economic merit (for a particular breeding objective).

FIGURE 1: THE MODERN BREEDING APPROACH



  (iii) **Breeding Program Design**. Establishes the optimum mating structure (including numbers of females per sire) and amount of selection, and the optimum period parents are used in the herd, breed or sector of it.

- Components 1. and 2. are linked by the **selection index** (that formally or mentally derived combination of measures - or separate EBVs - which has the maximum association with $ Direction). Components 2. and 3. are linked by the genetic changes or trends achieved in the breeding operation; and by a

future development termed **mate selection** which will not simply rank animals on their estimated genetic merit, as EBVs do, but will identify the mating combinations which best fit the $ Direction (breeding objective) established for the enterprise.

- Finally, Estimation of the necessary parameters, such as economic values, heritabilities and correlations, and breed and cross differences, provides the formal 'backbone' to the total breeding operation.

- This conceptual approach is directed specifically at supplying to the industry all the key breeding decision aids in a ready and easy-to-use form which are necessary to reliably generate rapid gains in productivity and product quality.

  The approach requires that cost-effective and accurate measurements exist which relate to all traits in the breeding objective. This is certainly not currently the case for the production-marketing combinations in the pig industry. Better direct and indirect measurements of reproduction, production and product, including low cost measures which can be taken on the whole herd early in life, and automated measures, will form an increasingly active area of research and development.

5. WHERE DOES PIGBLUP FIT?

- The PIGBLUP system already incorporates two of these three components of the Modern Breeding Approach, viz. customised breeding objectives and genetic evaluation, for within breed/line additive genetic differences, for a number of measurements (average daily gain, backfat and number born alive, with options for feed intake and a carcase option coming) of the breeding objective.

- The PIGBLUP package includes:

  (i) **Advanced mixed model evaluation** procedures which utilise the vast majority of the information content of the records associated with the measurements.

  (ii) A carefully defined, **practical and flexible computing strategy** which has potential to accommodate all sectors of the industry concerned with making breeding decisions.

(iii) **An ongoing research and development program** to achieve a fully comprehensive and flexible breeding information system for the industry, and to provide basic technical support.

(iv) **A highly experienced bureau** in the performance recording and genetic evaluation arena, to **market** and maintain the product, and **distribute the ongoing upgrades**. An effective **maintenance** contract is essential for effective use of such software tools in the commercial breeding environment.

This PIGBLUP system and the overall integrated R&D and marketing team is unique world wide.

6. EVOLUTION OF PIGBLUP

- It is totally impractical to design and achieve effective industry use of a 'Rolls Royce' breeding technology from Day 1. We must try to start with a well thought out 'T model' and evolve the complete system, to accommodate evolution of the R&D, of transfer requirements, and of user understanding. The correct evolutionary path must be technically sound, otherwise substantial time and money will be wasted. It must promote industry uptake, feedback and learning, involve a minimum of backtracking, and provide for system upgrades to easily 'slot in'.

- PIGBLUP already is achieving this. A further description of the BLUP procedures on which the system is based is given by Long, Brandt and Hammond (1991).

7. PIGBLUP AND THE BREEDING PROGRAM

- You have a recording system in place, you are utilising PIGBLUP to establish your breeding objective, produce all necessary EBVs, including the $Indexes for each animal, and report your genetic trends. How do you integrate all this to win the (breeding) race?

- We now list the pointers for maximising the effectiveness of the within breed/strain selection program. This program may involve:

  (i) A closed herd, or

  (ii) Purchasing all replacement breeding stock, or

  (iii) Breeding some and purchasing some.

What are the pros and cons of each?

- **Let the buyer of seedstock beware!** of:

  (i) The seller's breeding objectives and selection index.

  (ii) The nature and efficiency of the seller's breeding program - are the stock equal or superior to stock from other sources, and is the genetic potential of your herd likely to continue to increase over time if you continue to use this source?

  (iii) How the information provided is being obtained and presented for the stock available for sale.

  (iv) How to obtain valid comparisons between herds?

7.1 How Far Ahead to Plan?

At least 5 to 7 years (2 to 3 pig generations). Difficult? Yes. Impossible? No. The true breeder has no option; even to stand still requires definition and action!

7.2 Key Points in the Design of Selection Programs.

The following applies to all seedstock producers, whether commencing a selection program or having a second look.

7.2.1 Definition

- Carefully consider your breeding objectives and selection index, remembering the environment you're producing in and the slaughter and seedstock markets for which you are producing.

- Include all economic traits in the breeding objective, and only those measurements in the index that are capable of making a significant contribution to achieving the objective.

- $INDEX in PIGBLUP puts the total procedure required for defining your breeding objective and developing your index in your hands.

7.2.2 Herd Size

- Start with a large gene pool.
- Close the herd if it is large enough - why not breed your own boars?
- Maximise the number of sires - foundation and annually.
- Make further introductions only after convincing yourself of their superiority in relation to YOUR objective.
- Small herds can make continual use of external AB, IF the boars are available - REMEMBER from where the progress is coming - but use a good number of boars.
- Take special care when contemplating the use of "new techniques in reproduction - watch inbreeding depression and the impact of chance (resulting from the way the biology works to form eggs and sperm and at fertilisation).

7.2.3 Selection

(i) Accuracy

- Keep good records, on all breeding stock and piglets if possible.
- Select within COMMONLY managed LARGE groups.
- Maximise the number of sires represented in each management group.

(ii) Amount

- Concentrate on your selection index and be ruthless.
- Select replacement boars and gilts from the whole drop if possible.
- Decrease joining percentage.
- Maximise piglets weaned per female mated.
- Increase herd size.

7.2.4 Generation Turnover

- Use boars as young as possible - their genes do not improve with age!
- In using PIGBLUP type genetic evaluation procedures for all traits of interest, replace sires only with superior boars unless inbreeding depression is becoming a concern.
- Otherwise, turn boars over rapidly - regardless of a boar's superiority, some of his sons will be even better, so continue to use the "new models".

7.2.5 Inbreeding Depression

- Use more than 6 sires per mating round (*to reduce impact of genetic drift more than to reduce inbreeding!*)
- Turn sires over rapidly.
- Small herds (6-10) boars used per year) - select no more than 2 boars per sire progeny group.
- Avoid more than 1 common grandparent in a mating in small herds.
- Increase the joining percentage.
- Closed herds using more than 10 new sires per mating round, inbreeding is of no importance.

7.2.6 Mating

- In large herds (say 300+ females) mate selected stock at random.

7.2.7 Records

- All genetic improvement relies on comparing performance of different animals or groups.
- Choose your system(s) of animal identification carefully.
- Consider carefully your method of collecting and keeping records.

7.2.8 Integrating the Selection Program and Management System

- Aim for SIMPLICITY - your program will be more effective.
- DO NOT FIDDLE - continuing progress requires steady pressure in the chosen direction on your whole gene pool.
- Design your program into your management system, NOT the reverse.
- Use pencil and paper to draw up EVERY step in one complete cycle of your program then proceed to make refinements and talk the PLAN over with appropriate advisors.

7.2.9 Common Deficiencies In Selection Programs

- The breeding program which cannot be made more efficient and effective does not exist!
- Appreciable improvements to the design and/or operation of all existing programs could be achieved by altering one or

more of the following for the herd (not in order of importance):

(i) Careful **definition** of breeding objectives for the herd and of the selection index on which replacement decisions are to be made. At least write down your objectives - to be referred to (and maybe updated) once every one to three years. This will prevent the mind from wandering (we are all fallible!), or even creating a 'tread-mill' situation (achieving no change in the herd).

(ii) Maximise the **size of:**

a. The **breeding herd**, and

b. The **groups** from which replacements are selected, being careful to maximise the number of sires represented in each management group.

This will help you achieve as much selection pressure as possible and hedge against the influence of chance (luck) going against your attempts to improve. In addition, the larger the breeding herd the less the potential problem of inbreeding.

(iii) **Guard against over-emphasising accuracy** of selection at the expense of amount of selection and generation interval. In this respect, information on individual performance of the animals being ranked for selection is frequently under-used and/or under-valued. At this stage PIGBLUP does not calculate an accuracy for each EBV, but it will in future.

(iv) **Sires are kept is frequently kept too long**. Turn them over - their genes do not improve with age and, if you are improving your herd, the best of their sons should be superior to them. Use them for 6 months to one year only. Of course, by keeping sires longer the amount of selection pressure can be increased (less replacement sires required per year) but the resulting increase in generation interval generally more than soaks up any additional improvement from the extra selection pressure.

(v) The **average age of the sow herd** can be decreased (by increasing the annual replacement rate), to reduce the generation interval on the female side. However, this is done at the expense of slightly reducing the amount of selection pressure (because of the higher number of gilt replacements) and increasing the 'running' cost of females. This is generally not a major area for action, except in very old herds.

(vi) Of greater importance is **the age groups of female breeders from which replacement gilts and boars come**. The failure to select replacements from the young age groups of breeders (including gilts!) increases the generation interval and reduces the amount of selection which can be applied (because there will be less young pigs from which to select). If the herd is improving, the younger age groups should be superior!

(vii) The **ratio of boars to sows** varies between herds from around 1:10 to more than 1:30. The fewer boars required the greater the potential for selection, but in small herds (60-120) the number of boars used per year will also have to take into account inbreeding and chance effects - better to use a couple more boars per year in a small herd to hedge against these two potential problems.

(viii) The **level of knowledge** on all aspects of breeding in the industry must be improved. A concerted effort is required by all sectors associated with the industry and by the industry itself.

(ix) Associated with the previous point, many breeders lack **confidence** in their ability to further concentrate the superior genes in their gene pool.

Good Planning, Good Luck and Good Breeding!

Reference

Long T, Brandt H. and Hammond K. (1991) Application of Best Linear Unbiased Prediction to Genetic Evaluation in Pigs. *Pig News and Information*. **12(2)**:217-219.

NOTES