BREEDING STRATEGIES FOR TARGETING DIFFERENT BREEDING OBJECTIVES

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SUMMARY
Uncertainty in the profitability of different production systems affects both the short and long term viability of seedstock production. Concurrent selection for different breeding objectives is one method of reducing the impact of this uncertainty on the seedstock breeder. The value of a specialist index, a split herd or an average index strategy, are examined in the context of seven determining factors.

Keywords: Breeding objective, selection index

INTRODUCTION
Long-term profitability of the seedstock breeder is dependent upon maintaining client satisfaction. The client is usually a commercial producer targeting a specific market, under a particular production system. This commercial producer aims to satisfy consumer demands by producing slaughter animals which comply with market specification. The seedstock breeder must therefore provide genetically superior sires specific to the commercial producer’s current needs.

The first rule in the development of a breeding objective (Ponzoni and Newman 1989) is that different breeding objectives are required for different breeding, production or marketing systems in the commercial sector. Thus a seedstock breeder should formulate a breeding objective specifically for a particular clientele. However, the implication is that a seedstock breeder should only meet the needs of one particular type of client. This is a perception encouraged in the literature, where there is a tendency to consider the development of breeding objectives for singular production and marketing systems (PMS) in isolation (eg. McClintock and Cunningham 1974; Ponzoni and Newman 1989; Newman et al. 1992).

Recent events have highlighted the variability of returns from different livestock enterprises. For example, reduced margins in grain fed cattle have forced many beef producers to sell to the domestic grassfed market. With the related change in size of these two markets, the number of commercial producers in each PMS and the premiums they would pay for superior bulls would be expected to change accordingly. To minimise the effect of this variation on short and long term viability, seedstock breeders may need to specifically target several different breeding objectives in their breeding programs. Hence there is a requirement for breeding strategies which maximise the return from seedstock production, provide greater opportunity to sell to different markets and minimise the variance of returns.

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ALTERNATIVE BREEDING STRATEGIES FOR MULTIPLE OBJECTIVES

In general, three strategies have been examined in the literature for the concurrent improvement of several breeding objectives:

1) specialist - select all animals on a single index derived to maximise one of the objectives
2) split herd - select within specialist sub herds for each of the different objectives
3) average - select all animals on an index derived to maximise the average of the objectives.

Del Bosque Gonzalez and Kinghorn (1990) considered the implications when contributors to an open nucleus breeding scheme, selected for an objective that differed from that of the nucleus. They concluded that for moderately correlated objectives, splitting the group was the best option. However, when the nucleus was retained, selection on an average index resulted in the greatest benefits. Selection on one index to maximise its corresponding objective resulted in the least.

Ponzoni and Walkley (1981) considered breeding objectives for the selection of Dorset sheep used as either a terminal sire (TS), as part of a crossbred dam mated to another breed (XD) or as part of a crossbred dam mated to a Dorset sire (XDT). They concluded that selection on the index which maximised XDT was sufficient to improve all three objectives. Likewise, in the French beef cattle industry, Phocas et al. (1995) examined the need for specific selection indices to improve breeding objectives for two types of production. They determined that selection on an index which maximised the average of the breeding objectives, produced selection response comparable to specialist selection for the two objectives.

In the context of genetic conservation, Smith (1985) examined the effect of selecting many breeding lines where each line was selected to improve a different breeding objective. The author concluded that from an international perspective, there were large possible returns available, relative to the costs involved with keeping these stocks. However, for an individual breeder, the benefit of maintaining a large number of stocks was minimal. This was due to the relatively short time horizon and the large risks from competition and variable margins generally suffered by a small enterprise. Nevertheless, at this level, the requirement to anticipate future needs was still advocated. This could be achieved by selecting the lines most likely to become profitable over a prescribed time horizon.

Thus for multiple objective selection, Ponzoni and Walkley (1981) and Phocas et al. (1995) recommended strategy 3 (average objective) whereas Del Bosque Gonzalez and Kinghorn (1990) and Smith (1985) recommended strategy 2 (split herd).

FACTORS AFFECTING MULTIPLE OBJECTIVE SELECTION

The following is an outline of the factors that determine the value of the three strategies when selecting for two breeding objectives.

Correlation between indices and objectives. Assume that the 2 objectives have the same genetic variance, their respective, specialist indices are equally accurate and the correlation between the 2
objectives as well as between the 2 indices is \( r \), where \( r = 0.8 \). While response in one objective will be maximised by selection on a specialist index, sub-optimal response will be made in that objective by selection on the specialist index of the other. The ratio of sub-optimal response over maximum response in strategy 1 is therefore \( r \) but in strategy 3 will be \( \sqrt{2}(1+r) \). Therefore, under strategy 1, selection for one objective results in a 20\% loss in the maximum response of the other. In contrast, the loss in maximum response in both objectives under average selection is only 5\%. Thus, for moderately correlated objectives the loss in genetic gain under an average index is less than that incurred by a specialist strategy but at the expense of sub-optimal response in both objectives.

**Structure of seedstock herd.** The splitting of herds in strategy 2 would effectively produce a specialist herd for both objectives but of half the size of the original. Due to the smaller population size, a greater proportion of sires would need to be selected, thereby reducing the selection intensity. If each sub-herd required proportionately twice as many sires as the intact herd, there would be a corresponding reduction in genetic gain of approximately 9\%.

**Opportunism in the allocation of seedstock.** With fluctuations in the price received for superior sires and the genetic variation within a particular seedstock crop, opportunity exists to sell animals to the market in which they return the highest income. This advantage is greatest in strategy 3 where seedstock have been selected to improve both objectives simultaneously. Strategies 1 and 2 provide less of this opportunity as animals produced under a specialist strategy will be less suitable in the market for which they were not intended. Unfortunately, the advantage of strategy 3 diminishes with time as the animals selected for the average objective become less similar to the type of animal required for specific markets.

**Recording costs.** If there is a trait which is expensive to record and is relevant to only one objective, the recording costs may be reduced by adopting strategy 2. For instance, selection for marbling may only be possible through progeny testing. By splitting the herds, the only animals required for testing are those in the sub-herd dedicated to improving the marbling objective. Selection under strategy 3 would require that all animals were tested.

**Minimising variation of income.** The uncertainty about expected income is due to both price variation over time and the variation of genetic merit in a seedstock crop at the time of sale. Price variation results from economic circumstances beyond the breeder’s control and as such will have the greatest effect on uncertainty. Large fluctuations over time will greatly affect the specialist herd, while selection under strategy 2 will dilute this effect, assuming that at least one market remains viable. Strategy 3 has similar benefits to those of strategy 2 but the greater ability to allocate seedstock will allow a herd selecting in this way to further buffer the effects of income variation.

**Current merit of the seedstock herd.** The feasibility of a breeder to select for one breeding objective over another is determined by the existing merit of the seedstock herd. If a herd is
already exceptional for one objective, the advantage of concurrently selecting for another
objective will be less than that for a herd which is intermediate for both.

**Long term fluctuations.** In addition to the annual changes in price and demand, long term trends
may cause one market to fail or a new one to appear. Under these circumstances, the split herd
strategy has similar benefits to those described by Smith (1985). Selecting several lines not only
increases the chance of providing for future needs but also provides the resources with which to
produce entirely new lines. However, as the number of different objectives increases, the
proportion of currently unprofitable lines also rises. Thus, to address long term variation in
demand, it may be more appropriate to consider the herd on a national or international level where
different breeds pursue there own, different objectives.

**CONCLUSIONS**

When different breeding objectives are moderately or highly correlated, the best method for
concurrent selection is strategy 3. Selection on an average index allows higher selection
intensities to be practiced, permits sires to be allocated to different markets and minimises the
impact that fluctuations in price and demand have on the variation of the breeder's income.
However, when the correlation between objectives is low or when recording costs for objectives
differ markedly, strategy 2 is better suited to multiple objective selection. In addition, the benefits
of strategy 2 increase over time as the selection of different lines insures against future changes in
market demand.

Future work will determine the optimal breeding strategies for a number of breeding objectives,
relevant to the Australian beef cattle industry.

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**REFERENCES**

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