

The economics of competitive breeding programs

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Abstract

The principles of economics are relevant to the weighting of selection emphasis applied to breeding values for genetic traits and specific genetic loci. They are also relevant to the optimal design of breeding programs. In the 1970's and 1980's, theoretical development in this area focused on national improvement programs with a view of maximising the efficiency of production within the domestic industry. At that time, the globalisation of genestock supply was rapidly increasing, led by the most intensive livestock farming industries, and this has spread to intensive dairy cattle industries, and to a lesser extent, the extensive sheep and beef industries. With this globalisation, even national genetic improvement programs and agencies have come under increasing pressure to be competitive, in terms of both price and quality of genestocks supplied. As governments become increasingly reluctant to support national schemes competing against private entities (both domestically and internationally), there has been a shift in government and industry investment towards facilitating technologies, such as supporting national database and genetic evaluation developments, and blue skies research into new genomics technologies. This paper provides examples from the author's experiences of how economic principles, and their extension to market research techniques, can be applied to help breeding programs be more competitive. The additional roles of industries and governments in overcoming conflicts among industry stakeholders that arise due to market failure and short planning horizons are also discussed.

Introduction

Genetic selection technologies offer a powerful means of altering many characteristics of livestock production systems. Breed substitution and crossbreeding systems coupled with the small but steady and cumulative benefits from selection within breeds remain the predominant technologies of relevance in most livestock improvement programmes. In some situations, these are being further enhanced by selection on, and direct manipulation of, combinations of specific genetic loci.

Economics is relevant to all breeding programs through the specification of breeding objectives. The definition of breeding objectives has traditionally involved quantification of the levels of benefit associated with various individual or combinations of genetic changes in the numerous genetic traits expressed by farmed livestock. The units of benefit are commonly expressed in economic terms from the perspective of commercial farmers. Selection objectives can play an important, but

not exclusive, role in determining the optimal size and direction of genetic changes in traits.

Competitive breeding programs are specifically distinguished in this paper from national breeding programs. Flock and Preisinger (2002) list the demise of national poultry breeding programmes in a number of countries when borders were opened to international competition. This has happened despite the risks of disease transmission, and potential for genotype by environment interactions. National breeding programs are now largely a relic of the previous century, as governmental and industry bodies have switched their investment away from the selection and distribution of gene stocks. Instead they now focus on more generic research and development into, and operation of, national databases, genetic evaluation systems, new genomic technologies and related systems which underpin the genetic progress made by competitive breeding programs. Breeding programs which exclusively provide genestocks to a single large vertically integrated production enterprise might also be excluded from this definition.

This paper provides an overview of key issues faced by competitive breeding programs, and the degree to which economic tools that have historically been applied to breeding programs are relevant to their operation.

The time frame of genetic improvement

Time frame represents a key issue for competitive breeding programs. Activities which do not contribute to competitiveness in the short to medium term are difficult to justify to directors and shareholders of commercial companies. However, at the same time, accurately forecasting a long term shift in the production environment and its gene stock requirements can reap massive rewards for a forward thinking enterprise.

In New Zealand and Australia a substantial number of sheep breeders include selection for animal resistance to internal parasites (based on recorded faecal egg counts of animals under artificial or natural challenges) as part of their breeding programmes. In so doing, they sacrifice significant amounts of progress that could be made in alternative production traits and also incur significant recording costs. With effective drenching systems, the economic value of internal parasite resistance is low. However, the calculated economic value (Amer *et al.* 1999) can be based on a sustainable drenching regime, whereby the expected build-up of genetic resistance by the parasite to anthelmintic treatment is expected to be minimal. Those breeders who are themselves aware of the risks of drench resistant parasites and who have like minded ram buying clients, make the choice to adopt an index including an economic value calculated in this way. They take a long term view of the selection process.

When considering genetic improvement, it is important to maintain a long term focus when considering the design of the breeding program, and the direction of genetic change to take. Even competitive breeding programs utilising the latest technologies will face limited options for significant short term genetic changes. In addition to the time taken for a significant genetic change to be realised at breeding program level, there are commonly substantial additional delays through multiplier tiers of genetic dissemination (e.g. pig and poultry systems), and also for gene flows through commercial self replacing breeding populations (e.g. sheep and cattle populations).

Design of competitive breeding programs

Under traditional theory of breeding program design, a set of trait economic weights can be incorporated into complex breeding program models which also take account of costs of recording and other advanced technologies including reproductive technologies and DNA markers. Such models can be used to characterise the optimum level of investment in a breeding program.

In competitive breeding programs, there are many examples of both substantial over investment, as well as of substantial under-investment in technologies which contribute to the rate of genetic progress. For example, it might be argued that some international pig breeding programs have over-invested in new technologies, particularly those based around marker assisted selection and genomics. At least three factors are likely to be at play. Firstly, breeding programs with a large market share need to make sure that their breeding programs are not overtaken by competitors with a smaller market share, but which gain a substantial competitive advantage through first use of a new technology. Secondly, for technologies which have high fixed implementation costs (i.e. many of the costs can not be scaled down for a smaller breeding program), adoption by larger companies provides them with an advantage in that they can spread these costs over a larger number of gene stock sales, and so maintain their size dominance in the industry. Thirdly, use of “state of the art” technology can provide a key component of a sales story that attracts clients when true differences between gene stock products from competing breeding companies are small or difficult to establish objectively.

Under-investment in new technology can occur in breeding industries where there is an inability of commercial farmers to effectively evaluate the true differences between gene stocks from competitive breeding programs. Many extensive livestock industries fall into this category. Gene stocks can be difficult to compare because it is difficult to observe changes in animal performance over time because of environmental fluctuations and/or the extensive nature of farming practices. In addition, for maternal traits, it can be at least several years before the genetic influence of a new gene stock supplier become a significant part of the population of commercial breeding females. In these industries, breeder reputation based on show ring performance, and/or their status in society can play a greater influence on market share and price received for gene stocks. In these situations, there is much less traction from breeding technology based promotion. This is exacerbated when the demographics of commercial farmers tends towards older age groups and less education.

There is also a tendency for under-investment in new technologies which can be associated with various types of risks. Risks include technology failure, uncertain technology costs, and consumer rejection of products associated with them.

Given these factors, breeding program modelling to determine optimum design might be best considered as providing insights into how more genetic progress can be achieved in a cost effective way, rather than providing a prescriptive guide to optimal scheme design and size.

Economic selection indexes for competitive breeding programs

It is commonly known that the value of genetic progress from a breeding program can be relatively insensitive to changes in economic weights. In practice, animals can be made more profitable in different ways through changes in various combinations of traits. This robustness is of little advantage to national genetic evaluation systems seeking a single breeding goal, because they need to get the formulation of the breeding objective technically accurate to stave off criticisms from commercial entities that are disadvantaged by the national index. In contrast, competitive breeding programs might seek to breed for specific market niches, and apply more relaxed approaches to the establishment of the breeding objective using customised selection indexes, or desired gains indexes. Desired gains indexes are commonly used by large pig and poultry breeding companies where the elite purebred lines contribute to many different multiplier and production crosses servicing a range of countries and production systems.

Consumer theory within economics has given rise to analytical techniques which have had limited application in the area of breeding objectives. Hedonic price analysis involving the regression of animal prices on genetic traits (e.g. estimated breeding values) and some of their limitations have been discussed in the context of breeding objectives (Amer, 1994).

A common market research technique known as conjoint analysis offers an alternative but related approach to that of hedonic price analysis. With conjoint analysis, buyers or users are asked to assign preferences for, or rankings of, hypothetical products or services which differ in the key attributes of interest. The same or different respondents can be tested on multiple sets of competing variants of the same type of product or service. Analysis of the resulting data reveals the implicit relative emphasis placed on each key attribute of interest. Tano *et al.* (2003) describe an interesting application of this approach to farmer preferences for cattle traits in a less developed country. A big advantage is their ability to value the intangible (from a bio-economic modelling perspective) benefits from specific trait changes. These approaches have been used extensively in the areas of health economics and general market research.

Competitive breeding programs could benefit greatly from further application of market research methods in the formulation of breeding objectives. However, some work is needed to conduct market research studies in a way that the long term nature of genetic change is accommodated. Otherwise there is a risk that these approaches may be captured by short term issues, which will be gone by the time any meaningful genetic progress has been achieved. There will always be a role for conventional approaches to formulating breeding objectives to test the robustness of desired gains and market research approaches and ensure that they do not place too much emphasis on traits of little long term economic value, or which are difficult to make genetic progress in.

Views of society

Accommodation of the views of society creates a dilemma for competitive breeding programs. Without doubt the views of at least some European consumers and

European society in general is a significant issue for breeding programs supplying gene stocks for production systems for these markets. Essentially, a competitive breeding program must attempt to judge the rate at which these views are internalised into real market forces operating at the level of commercial production systems. Examples of internalisation occur when constraints are placed on production systems that prohibit undesirable (perhaps from the perspective of animal welfare, or environmental pollution) management techniques. Such constraints can be achieved through legislation of farming practices, compliance requirements for support payments or supplier conditions imposed by retailers. Over the past decade, these factors have gone some way to providing meaningful incentives to competitive breeding programs to change their direction of genetic progress. However, there are still severe problems in that any prescribed restrictions on farming practices are often very crudely administered. For example, there is little economic incentive to improve the nitrogen excreted from individual animals through genetics if the level of environmental pollution by a farm is measured by counting the number of animals present on the farm.

The role of industry bodies and governments

Competitive forces mean that the long term benefits of genetic improvement fall to consumers (through better quality products and lower prices) as well as farming and processing sectors (that can benefit from increases in market share, and through the value of scarce resources that they hold such as suitable farm land), rather than to competitive breeding programs (Amer and Fox, 1992). The competitive breeding programs are on a technology treadmill, and must constantly improve to maintain their existence, or perhaps improve their market share.

In many industries, there are factors that might contribute to an under investment in genetic improvement by competitive breeding programs as discussed already above. This is particularly so where production systems are extensive, and the performance of individual animals sourced from different breeding programs is hard to compare objectively. These industries commonly require large numbers of breeding males whose first priority is to achieve pregnancy of females. This along with a diversity of economic and environmental circumstances means that there is often a large number of competitive breeding programs servicing the industry.

In these situations, governments and industry bodies can provide underpinning tools to facilitate a higher rate of genetic change without becoming directly involved as competitors themselves. These tools have historically involved national genetic evaluation systems, development of national, and or customisable selection indexes, and to a decreasing extent, extension services for genetic improvement programs. In general terms, tax and industry levy payers have probably received a good return on these investments. In many cases though, the actual level of return may be well short of the potential due to low rates of adoption of improved gene stocks.

More recently there has been a switch to development of new genomic technologies and their application to livestock breeding programs and beyond. Tax and industry levy payers are yet to see a positive return on this investment, although the potential remains for substantial benefits from these technologies, particularly through genetic progress in traits which are difficult to improve and which may otherwise have been

deteriorating. It is pertinent that improvements in these traits are also desired by members of society with an interest in the environment and animal welfare. However, competitive breeding programs will also need to see benefits from them before they will be adopted.

Implications

Some of the more conventional theories and approaches to the optimum design of breeding programs and the formulation of breeding objectives have turned out to be less relevant to competitive breeding programs than might originally have been anticipated. However, these theories and approaches are still valid and useful, provided that it is recognised that competitive forces and strategies will lead to breeding program implementations that deviate from what might otherwise have been considered theoretically optimal. In some situations, where industries have many breeders supplying extensive production systems, market failures may lead to justification of investment in underpinning genetic improvement services and new technology development by industry bodies and governments. When doing so however, particular attention must be made to the behaviour and technology adoption characteristics of competitive breeding programs.

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