INTRODUCTION

The last two decades have shown a willingness on the part of animal breeders to grapple with the economic problems raised both by the choice of selection objectives and by the implementation of breeding plans. While there have been many papers dealing with the economics of investing in genetic means of improvement, there have been all too few discussing the means by which the necessary finance can be obtained and appropriate returns obtained from the marketplace. Edwards (1982) has examined in detail the case for government intervention and investment in breeding programmes, so I will not dwell on this aspect. My intention is to give some examples of improvement plans where investment would clearly be beneficial and then to discuss how finance for new ventures has been approached in the past and might be tackled in the future.

IMPROVEMENT PROJECTS NEEDING FINANCIAL SUPPORT

In the past we can point to the action of many countries in providing investments for breeding plans which at that time seemed appropriate and were certainly not inexpensive. For example, most countries would be able to instance AI centres and pig and bull performance testing stations, or computer installations, all dedicated to livestock improvement. At the present time there are several existing opportunities which, while clearly described in theoretical terms, still lack the finance to convert them into reality. In addition there are several potential opportunities requiring more research or development work to make them feasible but being no less promising. Some of the best examples are those provided by the reproductive technology of multiple ovulation and embryo transfer.

It is now a decade since Land and Hill (1975) showed how embryo transfer might be employed to speed up the rate of genetic improvement of beef cattle by factors ranging up to 80% improvement on that feasible with natural reproduction. The scarcity value attached to imported breeds in the 1970's led to the widespread adoption of the embryo transfer technique for multiplication purposes, and led to important advances in the reproductive technique itself but has not, as far as I am aware, resulted in any practical breeding plan resembling that proposed by Land and Hill.
The technique of embryo transfer was also examined for its potential application to dairy cattle improvement. Surprisingly small benefits were predicted until it was shown by Nicholas (1979) how a radical change in herd structure combined with embryo transfer could be used to increase the rate of improvement quite substantially. The further work of Nicholas and Smith (1983) has given improvement plans for dairy cattle which are not only more efficient than conventional progeny testing schemes but, because the improvement can be concentrated within a single herd, offer the opportunity of recording not only milk output but also feed intake and other factors for the selection herd. Although further improvement in the yield of ova from multiple ovulation would enhance the value or such breeding schemes, the use of present levels of expertise would nevertheless give useful gains in rates of improvement, far in excess of those achieved in many national breeding programmes. Investment in such programmes should therefore be very rewarding but unfortunately most countries seem wedded to the field progeny testing schemes which they have painfully built up over the years.

Multiple ovulation and embryo transfer may also be able to speed up the improvement of wool production. Smith (1981) has calculated that quite modest success with embryo transfer from ewe lambs would make possible new breeding schemes which greatly increase the rate of improvement. Although the yield and survival of eggs from the young females would at present be a major constraint on such a system, the calculations show that focusing attention on these aspects of the technique would, if successful, open up quite new opportunities.

It is not only in the field of reproduction that new technologies can have a major impact. For example, Skjervold et al. (1981) has demonstrated how the technique of X-ray tomography, originally developed for use in human medicine, is of great potential value in evaluating the body composition of live meat animals with precisions not hitherto available. But, once again, substantial investments are required since a standard X-ray tomograph might be expected to cost around £400,000 and with high running costs. If improvements in the meat qualities of terminal sires can be created by such means and disseminated to a large industry, it is easy to demonstrate the cost effectiveness of such expenditure. The problem in practice is how to arrive at such a situation for both raising the necessary capital investment and continuing operational costs, and integrating this with effective selection and dissemination of improved stock.

SOURCES OF FINANCE

Looking around the world at various breeding schemes, the recurring theme of many of them is practical feasibility rather than theoretical desirability. While I would be the last to decry those who practice the art of the possible, it may be useful to lift our vision to those projects that would also be feasible were the level of financial input greater. The starting point for this is to look at the sources of finance that have been employed for various breeding schemes.

(1) Government (or ultimately the tax-payer)
(2) Industry through voluntary or compulsory levies
(3) Pedigree or stud breeders
(4) Commercial farmers
(5) Company investors
It is interesting to note the characteristics of some of these
investors.

(i) Government investment in the past has, in general, not been
too concerned about the returns achieved. In Britain, for example, we have
had improvement schemes based on sire licensing and Livestock Quality
controls for artificial insemination which have never been subject to cost-
benefit examination. Although there will not be many countries without some
form of recording introduced to foster livestock improvement, the use made
of those records is rarely subject to scrutiny. In developed countries,
most governments have national advisory services who are well placed to
promote the dissemination of improved stock, yet rarely do so with the
professionalism that would be demanded of those marketing a commercial
product. In centrally directed economies, the size of many State farms and
availability of staff for recording purposes should provide the basic
ingredients for useful improvement programmes. Although lip service is paid
to genetic principles, the general impression of such schemes is that genetic
opportunities are rather rarely utilised to the extent that would be possible,
and as a result animals from those countries do not appear to be highly
competitive in the international market place.

Edward (1982) has spelled out the convincing arguments for govern-
ment support of animal breeding programmes. Sadly governments seldom appear
to face up to these responsibilities and more frequently intervene in ways
which are not always helpful.

(ii) Industry finsed scheme5 may be set up by compulsory levies
or more rarely by voluntary contributions. As an example of these we have
various dairy cattle breeding schemes run by dairy boards in different
countries. As in other fields of endeavour the success of these schemes
appears to depend very much on the men of the moment. For schemes which
demand the continuity and long-sighted views of industry that are necessary,
such means of organisation may be too subject to the short term pressures
felt by, or imposed upon, the industry representatives of the moment.
Compulsory as distinct from voluntary schemes are less liable to economic
storms but by no means immune to such stresses.

(iii) Pedigree or stud breeders represent the oldest organisation
of grouping. They may act as individuals within a pedigree framework, or as
part of a co-operating group. Although usually seen as a conservative
element, there is probably no other group better informed about the
techniques of salesmanship and market penetration which comes from an
intimate knowledge of the industry. In some circumstances, and notably in
Scandinavia, the co-operative efforts of breeders may be so formalised as to
virtually constitute the type of scheme described in the previous paragraph.

(iv) Commercial farmers represent all grades of activity, ranging
from self-contained breeding schemes to the formation of powerful breeding
groups. The many group breeding schemes in Australia and New Zealand,
originating as I understand them, in the beginning from strictly commercial
interests, are a testimony to their popularity. In Britain we have an
interesting example in a group of commercial pig breeders who, because they
were dissatisfied with the pedigree pigs available at the time, started their
own breeding company which has come to be internationally recognised. Such
large investment is, however, rather rare and, if I were feeling cynical
about some group breeding schemes, I could perhaps suggest some of them owe
their success to the economy of a barter system in which so many ewes are exchanged for a ram, rather than any greater willingness to invest in future profits through genetic improvement.

(v) Company investors have come to rule the world in terms of poultry breeding and may well do the same with pigs. In some countries dairy cattle breeding companies also account for a large proportion of the market, and developing international trade in semen will lead to interesting international competition with co-operative and dairy board schemes. What I think is notable is that there seem to be no company breeding schemes that have scored notable successes with sheep or beef cattle. Is this development for the future or is there some more fundamental reason for the species difference?

ANIMAL BREEDING - HIGH RISK OR LOW RISK?

All prudent investors take steps to enquire into the uncertainties associated with their investment and animal breeders should clearly also consider the risks attached to their recommendations.

The first risk considered is usually whether the genetic change planned in the breeding scheme can in fact be achieved. Here I think opinion would be very strongly that if a proper assessment using relevant genetic parameters had been carried out and correctly construed into a prediction of progress (see Smith 1984), then the risks involved are rather low. Although some unsuspected antagonisms may be picked up during the course of selection, or some genes with both favourable and unfavourable effects, as in the halothane gene in pigs, the long term handicaps seem to be remarkably small. Lest there is too much complacency, however, let me suggest that if the genetic engineers are successful in their attempts to make dramatic changes in performance and to implement them on a wide scale, then well conceived and executed schemes of the present time might well be overtaken by rival schemes. The establishment of parallel groups operating without the benefit of special technology is probably not a major risk in the short term but in fact helps to sell such schemes. For the moment the main risks in a breeding programme are probably the chance of changing objectives and the absence of any means of demonstrating superiority to that section of the public who buys the improved stock, perhaps coupled with poor or misdirected marketing of the improved product.

Whether these provisos make animal breeding investment a high or low risk will be a matter of opinion. If the level of investment allowed, the maintenance of diverse lines to meet future eventualities would seem a good insurance and a means of reducing the risk element to acceptable levels. Land (1981) has suggested the creation of special strains selected for diverse biological objectives to create flexibility for changes in future requirements. It seems unlikely to me that lines selected only for single components of performance would be that useful (except for research purposes) but that the concept is a valuable one. Given that some degree of replication is desirable in selection stocks, there might be merit in using selection indices for desired gains (see Brascamp 1984) to produce two or more lines straddling current objectives but allowing for some future changes in emphasis. Smith (1985b) has calculated that investment in diverse lines should be a very cost-beneficial type of investment, but the multiplication of costs as a means of reducing risk will not immediately appeal to many investors.

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An integral part of most plans for the production of improved stock would be consideration of the means by which monetary returns are achieved. Unless the scheme is government- or industry-financed, or part of an integrated operation, then means have to be devised for securing returns to pay for the investment that has been made and yield a profit. Some of the possible means are as follows:

(i) Sale or lease of male breeding animals
(ii) Sale or lease of female breeding animals
(iii) Headage payments on progeny from improved breeding stock
(iv) Payments based on the ultimate sales of derived animal products
(v) Sales of semen
(vi) Sales of ova

Of the alternative means of securing returns some appear much more attractive than others. Such is the prodigal nature of sperm production that the sale of individual doses of semen provides a very good means of securing returns, particularly so for cattle, where the annual number of doses produced per male is so very much greater than in either sheep or pigs. This fact, plus the ability to deep freeze bull semen with very satisfactory results makes this the method of choice. The sale of fertilised ova does not have the same attraction because of the additional costs involved in collection, storage in a frozen form if necessary, and re-implantation. As reproductive techniques improve and the yield of eggs improves, the method may acquire increased importance.

The traditional method of recouping expenditure through sales of breeding males may not be the ideal method because of consumer resistance to the high price which may be necessary to attach to an individual animal. Leasing methods in which a succession of sires are provided may be more effective in obtaining continuing returns, and a less expensive marketing system than depending on intermittent repeat sales requiring continuing marketing efforts. In those species where the reproductive rate allows the sale of females may be attractive and smaller margins may be compensated for by a greater volume of sales.

Payment systems based on the number of progeny or the amount of product sold might be attractive to those circumstances that permit their use. If, for example, meat processors at the time they purchased animals made a payment to the provider of the breeding stock, this would be an equitable arrangement, and a powerful means of ensuring that their raw materials meet important specifications.

There is certainly no one best way of securing returns from the market place but great scope for commercial ingenuity and experimentation. For the company investor some of these methods will be augmented by allied services such as the type scoring of dairy cattle to allow the planning of corrective matings. The services offered may also be outside the breeding field but of value in that farming system. For example, British pig breeding companies would set great store by the allied services offered in terms of improved pig health, pig husbandry and sometimes marketing.
With the first introduction of AI as a practical technique for the mating of cattle, many pedigree breeders were alarmed at what the new method might do to the sale of bulls. Some sought to ban the technique, at least as far as pedigree stock was concerned, and others, perhaps sensing the inevitable, sought to obtain royalties on the sales of doses of semen. This topic has long been a debating point in dairy cattle breeding. Those operating such schemes contending that pedigree breeders want the benefits of increased sales obtained through progeny testing without contributing to any of the costs involved in the running of such schemes. By and large this dispute seems to have been settled either by high prices for young bulls or by payments in installments as a bull passes successive hurdles in the breeding programme. The problem is, however, more far-reaching in that such schemes only provide for the immediate benefits and certainly make no recompense for the benefits accruing from the future multiplication of superior stock.

The animal situation contrasts with that prevailing in most countries for improved plant varieties. In Britain plant variety rights were introduced in 1965 and provide for the provision of royalty payments for a 15 year period covering all sales of a particular variety between different individuals. The operation of such a scheme depends upon standards of uniformity and distinctiveness which might be thought difficult to translate into animal terms except for the fact that outbreeding species of plants such as grasses and clovers are somehow encompassed in the scheme. The returns which are obtained from plant royalties represent appreciable sums recompensing plant breeders for past endeavours and providing for future investment and new varieties. The scale of these is illustrated in Table 1 for cereals in Britain.

If we use the farmgate values as an index of the importance of different commodities, then it can be seen that the returns to plant breeders in the form of royalty payments are not insubstantial. It is not known what rewards in terms of premium breeders of cattle, sheep and pigs obtain from the market place, but it is possible to make some extremely rough estimates of the costs put into improvement plans for each of the major species. These individual figures are probably very inaccurate but they do show that were animal breeders rewarded with royalties on the scale that plant breeders enjoy, then not only could current improvement costs be covered, but there would be substantial room for greater investment.

In making the conversion I am using the tacit assumption that by and large animals can be improved at about the same percentage rate as plants. This may surprise some but the figures for the genetic improvement of wheat and barley in Britain (Silvey 1978) show that this is not an unreasonable assumption for cereals. It should also be made clear that although the time scale of some animal breeding programmes is long, for example in the progeny testing of dairy bulls, the time period for the production of finished varieties of cereals is still greater. I am therefore contending that animal breeders are only the poor relations of plant breeders in that they have not succeeded in achieving a system of royalty payment.
TABLE 1

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<th>UK COMMODITIES: Farmpgate values, estimated royalty payments and improvement expenditure</th>
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<td>Farmpgate values</td>
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Sources: (1) UK Annual Review of Statistics 1983 estimates
(2) M R Turner (1985, private communication)
(3) Own estimates derived from Annual Reports of the NLC and MNS, and Mitchell et al. (1983)

Discussions on the implementation of an animal royalty system usually break down on the grounds of the difficulty of policing, yet we have the elements of such a system in breeds where the pedigree system is maintained and preserves identity over the generations. In Britain pedigree cattle are worth more than non-pedigree ones of the same ancestry, so in a way the royalty system is operating. Sires can be suggested of improving the situation through the use of pedigree indices of performance of dairy cattle or performance test scores for beef cattle. Any premiums which these methods can retain from the market will be useful to the breeder, but they are still only short term measures and give no further returns and once the pedigree label is dropped and the stock is propagated. This demarcation may not be strictly true in the case of pure breeds that calve-mark their calves and so gain a premium but such a benefit is shared by all the animals of that particular colour and not only those of an individual improved stock.

There is a new opportunity presented by developments in genetic engineering. This technology can help in two ways, firstly in providing a better means of identification. As Soller and Beckman (1982) have pointed out, calculations about restriction fragment length polymorphisms show that it should be possible to develop enough markers to uniquely identify stocks of animals. This mapping has yet to be done and even when it is available will not be a test without its own cost. The mere existence of such a system may, however, be sufficient to ensure that improved stock was not unfairly propagated.

The second possibility presented by genetic engineering is the fact that introduced genes can probably be patented in many countries. This means
that all producers employing such stock would become liable for royalty payments. Some appropriate method of collecting the royalties would be required but if the gains in performance thus obtained are dramatic enough, then the scene would be set for the introduction of a new mechanism to recover breeding costs. I am therefore suggesting that whatever the gains are through genetic engineering, the patenting of improvements might be one of the consequences which could help all those willing to invest in animal breeding, but now seeking adequate methods for recompensing them for that expenditure.

CONCLUDING REMARKS

The present review has concentrated on the problems of raising finance for investing in future genetic improvement. The benefits from such schemes have not been emphasised because almost invariably all such enquiries have concluded that quite small improvements when disseminated to a large industry represent excellent investment opportunities. In competition with other forms of investment for agricultural improvement, the basic advantage of the genetic approach in providing gains which are both permanent and cumulative, still seems to be overlooked. I hope that these arguments will prevail and that by a greater ingenuity in securing returns from the market place, perhaps through royalty payments, the overdue investment in genetic improvement can be made.

REFERENCES


