Animal Production (Group Scarabaeus)

Breeding strategies for improving animal performance

E.S. Tawfik*

Introduction

The low level of performance of the animal population in the Tropics and Subtropics and the necessity to improve the performance lead to considerations on transferring genes of European and American breeds to the Tropics and Subtropics.

Within the range of this topic the following points are to be discussed:

- Problems of import of high performance animals into the Tropics and Subtropics for pure breeding.
- Possible ways of applying such high performance animals in cross breeding.
- Selection within the local breeds and eventually applying imported breeds from areas of environmental conditions similar to the local conditions and
- The importance of genotype x environment-interactions for determining the breeding programme and the role of research for the decision.

Problems of import of high performance animals in the Tropics and Subtropics for pure breeding

The possible advantage of applying animals from temperate zones is the intensification of the performance, but it is only possible under optimal environmental conditions. These methods are not only very expensive, but lead to negative results as shown in many experiments. The factors limiting the rearing of animals from temperate zones in the Tropics can be summarised as follows:

- Very little acclimatisation to adverse climate conditions. They have little tolerance of heat as compared to native breeds.
- Their exposure to numerous diseases in the Tropics and Subtropics and
- the high demand of good feeding and rearing conditions.

These environmental factors and the interactions between them lead to the fact that the imported breeds in the Tropics and Tropics do not produce the expected results.

The possibility of keeping pure imported breeds in warm climates is limited to allocation of no infectious diseases and of course where sufficient feeding for these highly efficient animals is available. Even the few good results of high efficiency of temperate breeds in the Tropics have been due to favourable rearing conditions and good management. The results of these experiments are on no account to be applied to indigenous farmers where such favourable conditions are more or less impossible.
Over the last few years there has been intensive farming near the big cities where good marketing conditions are available for animal products. These farms are in the

* Prof. Dr. E.S. Tawfik, Dept. of International Animal Husbandry, Faculty of Agriculture, International Rural Development and Environmental Protection, Steinstr. 19, 37213 Witzenhausen, Germany

position to feed European breeds intensively and obtain good results. These farms produce well but they wholly depend on the import of both animal fodder and the animals themselves. In the light of this, such farms could not be classified under breeding to improve animal husbandry in their area. An example for that is the intensive import of poultry hybrids in many areas. These reasons lead more or less to joint breeding programmes.

Possible ways of applying high performance animals in the Tropics and Subtropics in crossbreeding

The purpose of crossing between high performance animals and the local breeds is to combine the high potential efficiency of the imported animals with the adaptation ability of the local breed to their rough environmental conditions. With the foregoing observations in mind, the next step is to consider some means whereby breeding programmes may be implemented. Recommendations are based on the premise that for any system to be effective some governmental participation and research work will be required - especially in guidance of programmes.

In numerous countries, individual breeders have initiated successful programmes of genetic improvement. They have not, however, been as judicious in consideration of their peers resulting often in dispersion of rather inferior stocks. Individual breeders frequently emphasise traits that may or many not be of the highest economic significance or contribute to the improvement in the general population. Furthermore, for a programme to be effective it should be closely allied to a research programme, which is another important reason for involvement of universities and research institutes.

In order to raise a new population which can adapt itself to the local environment there must be series of crossing procedures with different shares of genes of imported breeds measured on the environmental conditions.

The illustration in Fig. 1 is for grading up local population commonly practised in many tropical areas, frequently with disappointing results. This involves the importation of sires, semen or even groups of males and females, which are employed in a grading up scheme on local stocks. The major disadvantage as normally applied has been the same numbers of animals or semen imported. Nevertheless, this system has met in some places with reasonable success. In this system the local stock is gradually in independence in the environment replaced, but unless the environment is good the first generation cross may be the only group that performs satisfactorily. Disappointing late generations may result in a loss of confidence by villagers - and confidence is a critical feature in livestock improvement. This system should, therefore, be recommended on a broad scale only when managers understand all factors involved.

Fig. 2 illustrates a seemingly more appropriate approach than the previous one for widescale use. In this plan, the government agency initiates the programme by establishing a herd or flock of indigenous females, which are crossed with imported males to produce F_1 males and females. The herd could be carried on either by continuous replenishment of the local type females from the general population or by inter se rating of the crosses coupled with selection. Both methods have advantages. This system is more suitable in many respects than the one in Fig. 1 in that the first generation village animal would contain theoretically only 25 % imported blood and 75% of its native breeding. In subsequent generations, the infusions of imported stock would be

12 and 6%, respectively. Grading up could proceed for 4 to 5 generations before approaching the 50% level. By the time this stage is reached, either the stocks and managers should be good enough to go on with the scheme or the managers should be encouraged to take up some other type of enterprise. This system also has the advantage that if anywhere along the way some of the producers are capable of handling better quality stock, a direct cross can be made with the imported types. It also has flexibility and affords an opportunity to broaden the sampling of combinations of imported and local types.

Selection within the local breed

Although the selection within the local breed is slow, it is however a surer way to improve the animal material. This way has the advantage that because of natural and artificial selection the animals are adapted themselves to the raising conditions in their area.

The importation of breeding material from other tropical or subtropical areas similar to environmental conditions could be a possible method of improving the animals under the condition that there are no specific diseases in the area of breeding. The scheme in Fig. 3 shows an example for the selection within the local breed.

The simplest and least expensive system would be for the government or its agencies to initiate a recording system whereby representatives would go periodically to the village or individual farm and measure milk yield, in the case of dairy production, or weigh calves or lambs as a means of identifying females giving the best performance. The better producing females identified through these records would be earmarked so that their sons would be saved. The sons would be brought to a central location and reared in a common environment, where information could be obtained on rate of growth and development for use in making further selections among the males. Males selected from these groups could then be redistributed for natural service or artificial breeding (AI) for use among the general population of females. This system is illustrated in Fig. 3. The plan shows that the procedure would be repeated periodically, preferably on an annual basis, with the intent of genetic improvement. This would give primary emphasis to the use of superior dams. If used for milk yield in cattle, it would permit up to 33% of the total opportunity for genetic gain (Robertson and Rendel, 1950). In later years the rate of genetic improvement could be enhanced by progeny test information becoming available in the sires distributed in earlier years.

A second system, illustrated in Fig. 4, provides for the establishment of a breeding research institute as a seedstock herd or flock under intensive selection. Selected males could be distributed according to the previous plan for use among the general population. This procedure has often been applied but without very satisfactory results. The inadequacy has resulted from too few animals and too low selection differentials, mainly because the institute confined its base population to an original group of animals chosen principally on a phenotypic basis in one period of the year. The males, and indirectly the females, selected in this rather inefficient fashion have a large influence on later generations. This system could be effective if a selected herd or flock represented the upper 30% of the general population. A more efficient system would be to select a group of animals from the general population and assemble them at the research institute or a commercial farm, where they could be observed through one production cycle - e.g. lactation or lambing.

Following the first „production period“, 50% or more of the females should be discarded. The procedure of female selection should be repeated for several years - at least three and preferably five. The „selected“ herd could be developed as illustrated in Fig. 5. If the selection differential after arrival in the seedstock herd is 50% or higher, the basic group will be of much higher quality than a group produced by one selection period. This is not an expensive procedure as rental or condition of sale could be a part of the arrangements with the initial owners.

The plans described by no means represent all the possibilities. They are set forth to illustrate some possible systems, alone with their basic requirements and advantages. Independent of the breeding system there are important points for a successful breeding programme:

- Good co-operation between the breeding centre, the research institute and the farmers.
- Performance control and recording system as a basis for the selection of the breeding animals.
- Continuous systematic selection of the best animals for the breeding.

Importance of genotype x environment-interactions for the breeding programme and the role of research for the decision

In the last illustrations proposing possible ways of production of new breeds show bluntly that the addition of genetic materials is in many ways possible. The question here is whether the relative efficiency of breeding populations in the Tropics and Sub-tropics with different genes` shares of imported breeds remains the same even under different environments. From that point of view it remains to be decided which breeding population fits a particular environment and whether they possess special adaptable capacity for this environment.

Moreover questions of whether special breeding methods should be developed for extreme environmental conditions could be answered through information about the effects of interaction between genotype and environment.

The most important economic characteristics of animals which the breeders try to improve are the quantitative characteristics which generally are modified by environmental influences. The ability of a particular genotype for developing of a character is thus of no pronounced size, but just because of the environmental conditions under which it depends on:

Phenotypic characteristics value = genotypic characteristics value + environmental effect.

P = G + U

The validity of this equation is to be based on one of the most silent conditions which says:

There is no interaction between genotype and environment, i.e. their effectiveness behaves independently of one another. It is, however, conceivable that the possible reactions of individual genotypes could be interpreted in different ways. This means that Genotype x Environmental Interaction exists. In the equation an additional changing effect between Genotype and Environment (P = G + E + GE). According to Pirchner (1979) there exists Genotype x Environmental Interaction, when the efficiency of a particular genotype in a particular environment does not show any explanation of the average value of both factors but deviate from that expected data.

To clarify a summarised meaning of a genotype x environment relationship in animal breeding, the real changing effects could be limited as illustrated in Fig. 6.

The genotypes could be imported breeds, local breeds or crossbreeds with different genetical shares from the imported and local genes. The environmental conditions could depend on location of the farm, feeding or management even within the Tropics and Subtropics.

In case 1 there is a balanced change of efficiency in the genotype through the bad environmental conditions Here there is no change in order of sequence of the genotypes and no noticeable change in the variation between the genotypes depending on the environment.

Case 2 shows clearly that a change in environment causes different effects in the genotypes. The genotypes A and B experience a decrease whereas genotypes D and E achieve an increase in valuable efficiency. That leads to a decrease of the genetic variations in the environment (Y) although the order of sequence remains unchanged.

In case 3 change in the order of sequence of the genotypes takes place in which some genotypes improve their order of sequence in the second environment (Y). However, there are others who do not improve but deteriorate. In this case, there is a clear genotype x environment-interaction whereby the variation between the genotypes remains the same.

In the last case, like in case 3, a change in the order of sequence occurs in the genotype, but leads additionally the change in efficiency to a decrease in variation between the genotypes in the environment (Y).

Like the illustration 6 shows the genotype x environment-interaction can be due to two reasons:

1. Populations show variations in different environments.
2. A change in the order of sequence of genotypes occurs in different environments.

Naturally the shifting order of sequence makes difficulties in the practical breeding work. This is very important for the selection of a population for a certain environment or even for the selection of breeding animals within the population.

This means that the order of sequence of sires in an environment is not transferable to other places. Genotype x environment-interaction has an influence on the selection possibilities and has an effect on successful selection in the environment affected.

There are many methods for research into genotype x environment-interaction. The first condition for research is that animals examined for the planned breeding are animals within a population which are surveyed under their environment. For any environment the suitable breeding groups should be sorted.

The necessity of examining the availability of genotype x environment-interaction

There is literature that is available on genotype x environment-interaction for meat and milk production. This examination has mostly to do with intro-origin genotypes (sires within origin) or with environments within the temperate zones.

No unpronounced genotype x environment-interaction has been taken notice of. The environmental conditions under which the genotypes have been examined are not so extreme as in the Tropics and Subtropics.

The genotype x environment-interaction may, however, be clearly expected depending on the difference between the genotypes and environments within the area.

These are no tests about the productivity of different breeds and crosses in the Tropics and Subtropics under different environmental levels. This makes it difficult to determine the suitable population for a certain environment. Here is the important role of the research institutes to find out the suitable breeds to the local environments.

Of interest are the tests of MADSEN and VINTHER (1975) in Thailand (Table 1 and 2) in which they tested many different crossing levels and the effect of different gene shares of Bos taurus regarding not only the milk production but the calving interval and the mortality rate. The results showed that under the good management at the Danish-Thai Farming and Training Centre, the increase in milk production was due to the increase in percent of the Bos taurus.

The problem of this test was that fertility rate (measured on the calving interval) had a significant effect on the annual milk yield. Cross breeding with high percentage of Bos taurus genes showed a high mortality rate, especially between the age of 6 months to maturity (23,7% mortality). Due to these results the breeding of 50% Sindhi/Sahiwal) and 50% Red Danish were considered suitable for the environmental condition in the area.

Unfortunately, there were no comparisons between the crossing methods carried under minimum conditions as shown with native breeding animals. By the judgement of the breeding groups, it must be clear that the crossing between different breeds could have crossing effects which overestimate the genetic efficiency of the F_1 generation. Moreover, each distant generation is reduced to half. This means that a sizeable genetic material would not remain within but lost, a fact that always been neglected.

The genetic ratio between the imported Bos taurus breed and each local breed is determined by the environmental conditions. Areas of different production levels (where the climatic effects, the food deficiency and poor management have great effects on productivity on local farms and where the local breeds show specific adaptation properties) enjoy the presence of genotype x environmental interaction to a great extent. In the light of these cases, it can be concluded that a gene transfer for these production conditions is not recommendable.

Data on 2422 and 27756 Friesian cows in Egypt and Germany, respectively, were used to estimate genetic and non-genetic effects on initial milk yield in 70 days (IM), 305-day milk yield (305-dMY), lactation period (LP) and calving interval (I). Data was collected in the period from 1987 to 1992 in Egypt and from 1979 to 1993 in Germany. Least squares analysis shows the significant effect of season and year of calving and parity on all traits.

In Table 3 are the results of the performance of animals in Egypt compared with the data in Germany.

Table 3: Means, standard deviations (SD) and coefficients of variability (CV) of unadjusted records of traits, initial milk yield (IMY), 305-day milk yield (305-dMY, lactation period (LP), and calving interval (CI) of Friesian cows in Egypt and Germany

	Egypt			Germany		
Trait	Mean	SD	CV	Mean	SD	CV
IMY, kg	966	319	33	1552	318	21
305 dMY, kg	4736	1097	23	6641	1484	22
LP, day	298	62	21	301	10	3
CI, day	379	72	19	396	58	15

Coefficients of variation computed from residual mean squares divided by the overall least squares means of a given by (Harvey Programme, 1990)
Numbers of records were 2422 in Egypt and 27756 in Germany

Hassan G. El-Awady, Ezzat S. Tawfik, Mohamed K. Mohsen

Table 4 shows the ranking from high to low of certain groups of cattle for characteristics indicative of suitability to a hot environment under either advantageous or disadvantageous management conditions. The results of that test show according to the clear interaction between genotypes and environment the importance of the research to find out the suitable breed for that environment.

Table 4: Ranking from high to low of certain groups of cattle for characteristics indicative of suitability to hot environment under either advantageous or disadvantageous management conditions, breed groups in the same column with a common superscript (1 or 2) are not significantly different, but do differ from those not having the same superscript (P < 0.5)

Methods of measuring adaptation

Rise in body temperature	**growth rate**	**milk yield**
Environment „A“ adequate nutrition, no serious disease problems, good management[A)]		
Zebu	Brown Swiss	Holstein
Zebu-European X	Charolais	Brown Swiss
Santa Gertrudis	Holstein	Jersey
Brown Swiss^{1}	Zebu X^{1}	Zebu X^{1}
Jersey^{1}	Santa Gertrudis	Zebu 2
Charolais^{1}	Hereford^{1}	
Angus^{1}	Angus^{1}	
Hereford^{1}	Jersey^{1}	
Holstein^{1}	Zebu^{1}	
Environment „B“ low nutrition, disease problems, poor management B)		
Zebu	Zebu X	Zebu X
Zebu	Zebu	Jersey
Brown Swiss^{1}	Brown Swiss^{1}	Brown Swiss^{1}
Jersey^{1}	Hereford	Holstein^{1}
Angus^{1}	Charolais^{1}	Zebu^{2}
Charolais^{2}	Holstein^{1}	
Holstein	Jersey^{1}	
Hereford^{2}	Angus^{1}	

A) Assumes ample quantity and quality of feed throughout the year, good disease control measures and experienced personnel for management
B) Assumes poor quality feed with serious seasonal fluctuations, little effort made to control disease, and inexperienced personnel

Summary

1. The use of pure breeds from temperate zones in the Tropics or Subtropics where the environment is severe, seems to be impossible.
2. The use of such imported breeds in a crossing programme with the local breeds is possible in different ways under the consideration of the local environmental factors.
3. The selection within the local breeds is a long but sure way to improve the performances
4. The role of research is very significant to find out the suitable programme for a certain environment
5. Independent of the breeding system there are important points for a successful breeding programme:
   - Good co-operation between the breeding centre, the research institute and the farmers
   - performance control and recording system as a basis for the selection of the breeding animals
   - continuous systematic selection of the best animals for breeding