ANALYSIS OF DETERMINANTS FOR SUCCESS AND FAILURE OF VILLAGE BREEDING PROGRAMMES

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SUMMARY

Village breeding programmes were defined as breeding activities carried out by communities of smallholder farmers, often at subsistence level. The classical components of breeding programmes (description of production environment, definition of breeding objectives, choice of traits to be selected, decision about breeding method and organisation structure) were analysed under the premise that environmental conditions are rough and not easily changed. Practical examples of breeding projects were sought to highlight approaches and problems.

Definition of a comprehensive breeding goal incorporating the specific needs and social circumstances of the target group as well as ecological constraints was found to be missing in virtually all cases. If defined explicitly at all, simplistic breeding objectives (improvement of growth or of milk yield) prevailed. Traits which represent a comprehensive breeding goal are mostly complex traits with components of production and reproduction (e.g., number or weight of offspring per year). Recording of such traits and individual animal identification is in many cases difficult. Use should be made of existing structures for transfer of knowledge and information.

Keywords: Village breeding programme, breeding plans, developing countries, livestock

INTRODUCTION

Successful animal breeding in the "developed" regions of the world is a high-tech operation, involving sophisticated methods of measuring and evaluating animals, biotechnologies and a very high level of organisation. In fast-reproducing species like poultry or (to a large degree) pigs, the business of breeding has been taken over by large companies exploiting the advantage of centralised data management and decision making to improve genetic gains. Even in dairy cattle breeding, which in many countries is still in the hands of farmers' organisations, the most important decisions about selection of bulls and sires of bulls are taken at a very high (often national) level. The system has proved successful in providing high yielding and more efficient animals. Alongside genetic improvement, the environment for farm animals has improved with regard to hygienic standards and availability of feed.

Transfer of technologies requiring high inputs of capital and labour and high levels of organisation to "developing" countries proved to be difficult or impossible in many instances. In a report on World Bank investments for sustainable livestock development in developing countries, Walshe (1990) found that the performance of 40 % of livestock projects under the bank's supervision (not all of them with a breeding component) was unsatisfactory according to

an internal rating system. Specialised livestock production projects were ranked the second least successful activity after fisheries.

The aim of this paper is to investigate ways of genetic improvement of livestock species in "developing" countries (mostly, but not exclusively, in a tropical environment) under the constraint that environmental conditions like availability of feed will not improve. Some general guidelines for implementing breeding programmes will be derived mainly from project reports and evaluations. The original idea was to find positive and negative examples of breeding projects for cattle, pig, sheep, goat, poultry and camelids and to learn from these. The primary measure of success of a breeding project should be its long term sustainability. Finding enough projects described in sufficient detail and evaluated over a longer period proved impossible even when searching at the FAO headquarters in Rome. The focus will therefore be a rather general one, conclusions regarding different components of breeding programmes will be supported by examples, but not to a degree the authors themseves would have liked to see.

DEFINITION OF VILLAGE BREEDING PROGRAMMES

"Village breeding programme" does not seem to be a term frequently used and we were not able to find a definition in the literature. Therefore, we will try to define our interpretation of village breeding programmes and the specific properties that make them different from other types like commercial or national breeding programmes.

Village breeding programmes are carried out by communities of smallholder farmers (villagers), often at subsistence level. The availability of feed for the animals is far from optimal with large seasonal variations and variations between years (e.g., droughts and floods in the tropics, summer and winter in extreme mountain regions of Asia). The pressure from diseases may be high (tropical regions). The level of organisation is low, hierarchical structures with good flow of information between levels of the hierarchy cannot always be assumed to work. Data recording in the sense used by animal breeders in the developed countries will often be missing.

These conditions are regarded as unchangeable, breeding activities and breeding plans have to operate under this set of conditions (denoted as low input production systems by Hammond, 1993), not under the assumption of an improved environment (Valle Zarate, 1995, see Valle Zarate, 1996, for an English version). From this definition we see that the expected response to selection will not be high, especially when considering selection within a breed.

COMPONENTS OF BREEDING PROGRAMMES

The design of breeding programmes involves description of and decisions about a series of interacting components. The most important ones will be discussed subsequently.

Description of production environment

The usual starting point when devising a breeding programme is the definition of breeding goals (e.g., Cunningham, 1976). The description of production environments normally gets less attention than necessary by animal breeders. Part of the reason for this may be that the classical literature about derivation of economic weights (Smith et al., 1986) claims that optimal management conditions should be assumed. The reasoning is (Gibson, 1992) that non-genetic improvements in management are made more rapidly than genetic improvements and we

should therefore breed for only those aspects of improvement that cannot be met by other management improvements. Management conditions for animals in tropical rural conditions are considered clearly suboptimal when looked at in isolation (e.g., amount and quality of feed not being acceptable). In the context of the total environment (farming system, social environment, availability of labor or investment capacity) one will often find that these conditions are not easily changeable at all and that genetic improvement has to operate under the given environmental conditions.

EXAMPLE: Yapi-Gnaore et al. (1997) analyse an open nucleus breeding programme for Djallonke sheep in the Ivory Coast. A selection programm was initiated in 1983 involving a total number of 71 farmers enrolled by 1992. Although this was a nationally funded programme with extra money provided for running it and some positive side-effects on management might have been expected from increased contact with advisory service, the phenotypic and environmental trends for growth were fluctuating but clearly decreasing over the total time period.

Sociological factors are ignored or considered less important than they really are. This may happen due to lack of knowledge or because in many cases a project would have to be considered intractable so that persons involved in the planning prefer to assume that attitudes may be drastically changed. Neidhardt et al. (1996) describe the human-animal interrelationship distinguishing between livestock users, livestock keepers, livestock producers and livestock breeders. The livestock user has a purely exploitative relationship with animals and simply takes precautions to protect his property with night corrals and to prevent damage by animals. The animals are left on their own as far as feed, water and reproduction are concerned. The step from user to keeper is enormous and requires man to consider the needs of animals. Fodder production, provision of water and minimum standards of management require time, work and capital spent on the animals in order to obtain higher yields in the future. Neidhardt et al. (1996) point out that the jump from livestock user to livestock producer (specialized stock keeper) constantly alleged in projects or national development programmes is too big and is not realized in this way by the target groups involved. The step to livestock breeder, therefore, will only succeed if the step to livestock keeper has already been successfully completed.

EXAMPLE: In his evaluation of an Austrian project in Tunisia (Genetical improvement using exotic bulls), Mauler(1979) points out that one of the major reason for the failure of this project was that the assumed change of the Tunisian livestock user to a livestock breeder was not achieved.

EXAMPLE: Pastoralists/nomads have been characterised as livestock producers (Neidhardt et.al, 1996) and indeed many of these communities have their own traditional breeding methods. Mirreh (1978) describes the propagation of herds belonging to the Nomads of Northern Somalia as largely well planned. Their herds are largely composed of camels, sheep and goats. The stud camel of the herd has to possess several qualities before it can be choosen to be one. Its father or itself should have mostly female offspring, be well built, strong, a good fighter able to assert itself in the herd and its offspring should be healthy, able to withstand the dry period and have a good record of milk production. This is true for the rams and the bucks as well.

Protocols for the description of the production environment should be worked out prior to considering breeding decisions. These protocols should be detailed and allow for distinction of target groups within the area/region for which the breeding programme is derived.
EXAMPLE: Valle Zarate (1995) gives a classification of Guinea pig management systems in Bolivia. Systems are grouped into intensive, semi-intensive, semi-extensive and extensive using a large number of indicators. Subsequently it is shown that different types of breeds and breeding systems are optimal for different conditions. This may or may not be the case in other breeding projects with larger livestock species.
EXAMPLE: The inability to distinguish between different production situations in a livestock and poultry project in Northern Pakistan was reported as a major weakness in the project design. The technical options and marketing opportunities available to farms close to the larger towns was never recognised as being different from those in the more remote valleys. (UNDP/FAO, 1996)

Breeding objectives
Fewson (1993) gives a general definition of the breeding objective as follows. "Develop vital animals which will ensure that profit is as high as possible under future commercial conditions of production".
Baker and Rege (1994) stress the fact that defining objectives in those comprehensive economic terms (i.e. returns minus costs) is difficult enough in temperate agriculture and much more difficult in the tropics. Conventional approaches neglecting ecological and social costs favor intensive systems with high capital investments. Mpofu (1994) finds in model calculations for milk production in Zimbabwe that production levels below 5000 kg milk per lactation may not be profitable. It is obvious that, if such targets are set, only few producers will take part in milk production and others will have to give up production and migrate from the rural areas.
Valle Zarate (1995) gives also a general definition of the breeding objective for marginal regions in the tropics and subtropics with integration of ecological and social components and a strong orientation towards the target groups: "Breeding activities are aimed to support small subsistence farmers to develop cost- and resource-saving production methods and to become more market-oriented, in order to provide for their families and stay on the land. Animal products should be produced efficiently, taking account of specific environmental conditions with severe climatic and feed restrictions and seasonal fluctuations, as well as minimum investment opportunities".
Such a breeding goal should serve in defining the traits of interest and important components of the breeding strategy. One of the implications of such a breeding goal is that risk aversion plays a major role in livestock production in marginal regions. Loss of livestock due to diseases is more likely than in temperate zones and may have a catastrophic effect on the individual subsistence farmer. Orskov (1993) points out that the subsistence farmer's need to minimise risks cannot be over emphasised. With cattle, it may be more energy efficient to keep one large animal to pull the plough or to yield milk than to keep two smaller ones of the same weight or the same milk yield. The subsistence farmer prefers the small ones as the risk of the large one dying and leaving him with nothing is too great. For the same reason sheep or goats may be preferred to cattle as they spread the investment risk more widely. Another way of spreading

risk is to avoid specialisation and to have multi-purpose animals (milk, meat and draught; Bollig, 1992).
The definition of breeding objectives even in a more conventional sense of defining traits of interest and levels of performance to be achieved is in many cases absent, vague insufficient and unrealistic (Wollny, 1994).
EXAMPLE: One of the objectives of a FAO/UNDP project in Northern Pakistan (remote, mountainous poorest area of Pakistan) was to increase the production of poultry eggs and meat by the introduction of improved layer and broiler strains. This objective raises one fundamental question. Should the poultry industry, with its reliance on cereals, be encouraged? The strengthening of the poultry sector assumes that there is a surplus of cereal grains and that it is better to feed this to poultry. In fact, this area is an importer of cereals. An emphasis on improving backyard poultry production which does not compete with humans for food would have been a better strategy (UNDP/FAO, 1996).

Traits to be selected for
Animal breeding theory tells us that traits to be selected for must represent the breeding goal, must be easy to measure, heritable and not too many. Selection for antagonistic traits will result in low responses in either of these traits. With the general breeding goal for marginal regions as defined above in mind, long term reproductive performance of female animals will clearly be of higher value than it might be in intensive systems of temperate zones. Availability of feedstuffs is limiting in many cases and the rearing of female animals designated to become breeding animals is expensive. Natural selection helps the farmer to achieve this goal, as long-living, fertile animals produce more offspring. When other traits like gain or milk yield are considered in selection, the pressure applied to these traits has to be balanced against reproductive traits.
Quite often, composite traits, which may be visualised as biological indices (Fowler et al., 1976), will be used advantageously to represent the breeding goal. Such composite traits might be number (or total weight) of weaned offspring per dam and year, or lifetime production of milk. These composite traits may replace the classical selection index (Hazel, 1943), for which heritabilities and genetic relationships between traits have to be estimated or derived from literature on similar populations. The disadvantage of rather late availability of some of these composite traits depends on the breeding system and may be less pronounced than expected as ancestral information will be of more importance than in progeny testing schemes used in temperate zones.
Growth traits are comparatively easy to measure and record even without the use of a scale. Use of growth traits only for selection is clearly disadvantageous, as growth rate is primarily changed through changes in adult weight of animals (Taylor, 1980). Tropical climate tends to favor small animals because of their larger surface area to lose heat and the lower maintenance requirement (Sivarajasingam, 1990, Valle Zarate et al. 1994).
EXAMPLE: In the sheep breeding programme presented by Yapi-Gnaore et al. (1997), selection of lambs was for live weight at 80, 180 and 365 days of age. No justification is given for selection of the traits or the definition of the breeding objective (improvement of growth and liveweight of the local breed). Reproduction and adaptation are neglected.

Decision about breeding method and breeding population(s)

When deciding about the method of breeding, the following options are normally considered in tropical conditions: improvement of local breeds through purebred selection, breed substitution (by other local breeds or, more frequently, by exotic breeds) and sytems of crossbreeding (terminal crosses, rotations, formation of synthetic lines). Cunningham (1981) gives a decision diagram that provides the favorable breeding method depending on breed differences and expected effects of heterosis. The diagram is somewhat problematic as it does not include the definition of a breeding objective and because it suggests that there are more options than will be available in reality. The predominant problem is that the comparative evaluation of different genotypes under village conditions is almost never performed (Henson, 1992, Orskov, 1993). Therefore, the main input parameters for the decision diagram are missing. Systems for characterising the structure and performance of animal populations under extensive tropical conditions have been devised and should be used (Bruns, 1995).

Selection of purebred local breeds is often deemed as a method that will produce genetic gains too slow to meet the increasing demand of a growing population. Superiority of exotic breeds is taken for granted given that these animals produce so much more (e.g., milk yield) under temperate conditions than local breeds. However, importing live animals and placing them into village conditions has almost invariably produced disastrous results (Hodges, 1990)

EXAMPLE on breed substitution: The Canadian International Development Agency - CIDA (1992) gives a number of examples of its projects where such a system failed. The greatest failing on the part of CIDA planners was not to recognize how much of the performance of a Canadian Holstein cow was tied to the Canadian methods of husbandry and management that had steadily grown with improvements in the genetic potential of the breed.

People, structures and organisations

Although orientation towards the target group was mentioned as one of the primary points in defining breeding objectives, little has been said up to now about the roles of the different groups of people involved in a livestock improvement programme or about stratification of breeding programmes and cooperation of partners in such a hierarchical system.

Very often, when establishment of a breeding programme is part of a development project carried out with foreign aid and donor money, substancial misconceptions about the necessitiy of activities and about the relative importance of traits arise.

EXAMPLE: In a project evaluation exercise conducted by the UN Dryland Ecosystems and Desertification Control Programme Activity Centre in Kenya, questions like "Do you know why project A is here?" or "Do you know why they help you" were given such replies like "Maybe they think we have a problem" (Reckers, 1996).

Village communities may have different perceptions and priorities. Having lived from generation to generation with what an outsider may regard as a problem, a community may not understand the necessity of any form of intervention. Communities have different sets of cultural and social values by which to judge, appraise and decide. The development of viable forms of cooperation between the village community, advisory service staff and so-called "decision makers" (national or from donor countries) is of primary importance for the success of breeding projects (see Flamant, 1991).

EXAMPLE: In the FAO/UNDP project in Northern Pakistan quoted above, an unnecessarily high reliance on expatriate expertise was found. National consultants have advantages including familiarity with the local people, language and value systems and will be more cost-effective. (UNDP/FAO, 1996).

Breeding programmes need structures for recording and exchanging information and making selection decisions at a regional basis. Although such structures were well established in many rural communities (for an example of cattle breeding in Rwanda see Schumacher, 1931, for an example with camels see Bollig, 1992), they often no longer exist and infra-structure has to be established in a different form. The procedures of individual animal identification, performance recording and supplying these informations to central databases often do not exist and may be difficult to establish. Existing advisory services and communites which are well organised should be incorporated and chosen to set up simple recording schemes.

A tractable way of a systematic improvement may to be through regional centers of breeding, forming the base of open nucleus systems (although the example given by Yapi-Gnaore et al., 1997 is not an encouraging one). Selection within such centers should incorporate data from the field, especially data about reproduction traits which may be relatively easy to record. Use of intensive biotechnological systems like MOET (multiple ovulation and embryo transfer) is sometimes advocated for (Bondoc and Smith, 1993) but will in most cases be too difficult to establish. The major problem for nucleus schemes genotype-environment interaction.

CONCLUSIONS

The decisive but most frequently missing step in the design of village breeding programmes is the definition of a breeding objective. The objective has to be comprehensive and incorporate the needs and interests of the target group, farmers mostly at subsistence level, as well as ecological conditions. Such breeding objectives can only be formulated in close connection with the target group. Differences in breeding objectives between groups of farmers at different levels of management (intensive/extensive) are much bigger than animal breeders from temperate zones are used to. Risk avoidance is an important integral part of breeding objectives in marginal regions that has to be considered.

Where possible, use should be made of existing structures and ways of transfer of knowledge and information. This may include traditional structures as well as national advisory services or structures provided through village development programmes not specifically related to animal breeding.

Improving local breeds may often be advantageous to the use of exotic breeds or even crossbreeding schemes. Characterising the potential (in relation to the comprehensive breeding objective) of various breeds and types of crossbreds under village conditions is an inevitable exercise before deciding about a breeding scheme.

REFERENCES

Baker, R.L. and Rege, J.E.O. (1994) *Proc. 5th World Congr. Genet. Appl. Livest. Prod.* **20**: 405-412.

Bollig, M. (1992) *Nomadic Peoples*, **31**: 34-50.

Bruns, E. (1995) Paper presented at the 2nd Europ. workshop on advanced biometrical methods in animal breeding, 12-20 June, Salzburg, Austria

CIDA (1992) Guidelines for dairy development projects. Internal Memo of the Canadian International Development Agency

Cunningham, E.P. (1976) *Anim. Blood Grps. Biochem. Genet.* 7:191-200.

Cunningham, E.P. (1981) *FAO Animal Production and Health Paper* **24**: 279-288.

Fewson, D. (1993) In "Design of livestock breeding programs" p.53-58, Animal Genetics and Breeding Unit (AGBU), Armidale, Australia.

Flamant, J.C. (1991) In "Genetic resources of pig, sheep and goat" World Animal Science -B8, ed. Maijala, K., Elsevier, Amsterdam.

Fowler, V.R., Bichard, M. and Pease, A. (1976) *Anim. Prod.* **23**: 367-387.

Gibson, J.P. (1992) "Economic breeding plans" Manuscr. Nordic Postgrad. Course, Greve, Denmark

Hammond, K. (1993) In "Memoria simp. sobre los recursos geneticos animales in America Latina", p.19-27., Santiago, Chile 29 de Julio 1993.

Hazel, L.N. (1943) *Genetics* **28**: 476-490.

Henson, E.L. (1992): *FAO Animal Production and Health Paper* **99**: 57-59.

Mauler Kurt (1979) Evaluierung Oesterreichisher Tierzuchtprojekte in Tunesien. Mimeo.

Mirreh G. A. (1978) Die sozialökonomishen Verhältnisse der nomadischen Bevölkerung im Norden der Demokratischen Republik Somalia. Akademie Verlag Berlin.

Mpofu, N. (1994) *Proc. 5th World Congr. Genet. Appl. Livest. Prod.* **20**: 413-416.

Neidhardt, R., Grell, G., Schrecke, W. and Jakob, H. (1996) *Animal Research and Development* **43/44**: 44-52.

Oskov, E.R. (1993) Reality in rural development aid with emphasis on livestock. Rowett Research Services Ltd, Aberdeen, UK.

Reckers, U. (1996). *entwicklung + ländlicher raum*, **6/96**: 28-29.

Sivarajasingam, S. (1990) *Proc. 4th World Congr. Genet. Appl. Livest. Prod.* **14**: 360-364.

Schumacher, M.A. (1931) *Zeitschr. f. Ethnologie*, **73**: 162-193.

Smith, C., James, J.W. and Brascamp, E.W. (1986) *Anim. Prod.* **43**: 545-551.

Taylor, S.C.S. (1980) *Anim. Prod.* **30**: 161-165.

UNDP/FAO (1996) Northern areas livestock and poultry improvement Pakistan. Project findings and recommendations. FAO, Rome.

Valle Zarate, A., Horst, P. and Weniger, J.H. (1994) *Archives of Animal Breeding* **37**: 185-198.

Valle Zarate, A. (1995) *Archives of Animal Breeding* **38**: 461-478.

Valle Zarate, A. (1996) *Animal Research and Development* **43/44**: 99-118.

Walshe, M.J. (1990) *FAO Animal Production and Health Paper* **107**: 37-53.

Wollny, C. (1995) In "Proc. Intl. Symp. Livest. Prod. Anim. Breed. Genet.", Univ. of Zimbabwe, p.61-70, editors K. Dzama, F.N. Ngwerume and E. Bhebhe.

Yapi-Gnaore, C.V., Rege, J.E.O., Oya, A., and Alemayehu, N. (1997) *Animal Science* **64**, 301-307.