Developing breeding strategies for lower input animal production environments. An Introduction

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Livestock currently account for over 30% of the total value of food and agriculture; where the term 'agriculture' includes such important products as draught for cultivation, irrigation, harvesting and transport; fibre for clothing and for meeting various other material needs; manure for cooking, heating and for use as fertilizer; employment generation throughout the year; risk management, where livestock frequently serve as 'the bank' and add resilience to the farming system; and the generation of foreign exchange through international marketing of livestock products in demand. Livestock also support many cultural needs of human communities; and particular products with special qualities often contribute importantly to the unique nature of local cuisines and of other local material goods, a role for within-product diversity in food and agriculture production.

Animal genetic variation

Globally, the genetic variation in inputs required and outputs produced by farm animals is very large, with differences often involving orders of magnitude. This diversity is available for farmers to use in meeting their needs, as well as those of the communities the farmers supply. Because of the comparatively permanent nature of this genetic variation, once it is deployed its benefits and liabilities are recouped year-in and year-out, making the use of genetic diversity an important consideration in livestock develop. There are three primary levels of this domestic animal diversity with each level contributing a portion of the total diversity available to farmers to utilise:

1. *Diversity amongst farm animal species* - as species evolved over time they developed unique adaptive and production characteristics, and were domesticated for these genetic qualities; thereby offering farmers choices amongst species and of combinations of species, depending upon the inputs available and the outputs required of the production environment.

2. *Diversity amongst the breeds of each species* - as breeds have developed they have become highly adapted to their particular production environment, in response to the environment's set of complex selection pressures operating repetitively over many generations of development. These production environments frequently differ markedly in the overall nature of the set of selection pressures imposed. So, it is not surprising to find 50 percent or more of the quantitative genetic variation for characteristics of a species being unique to the breed level, making decisions about breed selection also very imporatant to the sustainable intensification of livestock production.

3. *Diversity amongst the individual animals of each breed* - with coefficients of variation for input and output characteristics of interest in the breeding livestock populations of developing country production environments commonly being 30 percent or more, there are likely to be very large differences amongst farmers' animals of the same breed in ability to utilize feed and other inputs and to produce outputs.

Consequently, the utilisation of this species, breed and individual animal diversity should be an important element in livestock development within- and between-human communities. In fact its natural partition into the 3 levels is a further asset assisting farmers to manage the benefits it offers; where management covers understanding, accessing, use, development, and conservation of these genetic resources.

As animal reproduction does not permit the ready exchange of genetic diversity amongst species, once decisions are made on the animal species to be included in a production system, farmers' consideration of genetic development of their livestock can focus on:

1. Which breed or breeds?
2. When more than one breed is chosen: How to use these breeds? and
3. How to further develop the breed(s), i.e. which animals and how to use these to maximum benefit?

Importance of genetics in livestock development

One in six people in the world are in food poverty and in the developing country sector, some 88 percent and increasing of the world community, the demand for animal products is now substantially outpacing that for plant products. With population numbers in this sector set to continue to rise over at least the next half-century the pressures on inputs to produce food and other needs from agricultural will continue to intensify.

The drive by FAO, other international organisations and the developing countries themselves, is for food security and for sustainable rural development, 'the imperatives'.

More than 70 percent of the land used for food and agriculture production, approximately 80 percent of the world's livestock, and around 70 percent of all breeds of farm livestock currently reside in the 140+ developing countries, occupying a very broad spectrum of primarily lower input production environments. Few effective genetic improvement programmes have been initiated during the past half-century and of these very few are being sustained amongst the 4000 or so livestock breeds throughout these developing countries – ponder the various reasons why! Breed importation, generally involving high input, short lifecycle breeds and often combined with poorly planned crossing with local breeds, has been common during the past decades. However, at least in the lower input production environments where long lifecycle genetics is generally critical, these importation and crossing activities have frequently not resulted in sustained increases in food and agriculture production. Further, and perhaps even more importantly, it seems that these activities have frequently substantially reduced lifecycle productivity of the species in the production system. On the other hand well thought out genetic improvement once made is recouped one generation after another.

Unless effective animal genetic improvement activity for meaningful breeding goals is introduced to these major lower input production environments and sustained, many developing country communities will experience even greater difficulty over the next half-century meeting their food and agriculture imperatives. Further, the majority of the 4 000 or so locally adapted breeds of these lower input production environments will (rightly or wrongly) be considered to be falling further behind the high input, high output, short lifecycle breeds which have been developed to supply most of the developed world community.

Requirements for genetic improvement

Sustainable genetic improvement programmes need to be planned, implemented and maintained for each of the livestock populations which farmers are still utilising, covering most of the medium to low input production environments of the developing world.

A primary issue is: What is required in the decision-making process for countries to begin realisation of this need?

Responding to the need is indeed a challenge for this large sector of the world community. In these countries, capacity and financial resources are severely limited. Further, those genetic improvement programmes which have succeeded over the past 5 decades in the developed countries are generally complex operationally and their development has enjoyed substantial human and technological capacity. They were developed under comparatively sophisticated and stable policy environments, and commonly aided with various forms of financial support throughout their prolonged development periods. For the developing countries, pragmatic and sustained approaches to policy development and technical opearations are necessary.

Knowledge base required for developing country decision makers to ensure successThe decision making process will generally not be commencing from nothing! Stable, basic policy environments are developing in many countries. Livestock production systems in the country will already be operational. Each production system will involve one or more animal species and there will be one or more breeds of each species to consider, i.e. the decision-makers will be operating in real time!

In these situations, and irrespective of species or production system type, the following information must be available to decision-makers who will plan and those who will implement and maintain a 'sustainable genetic improvement programme':

1. For existing livestock production activity:

- What is the current Development Objective of the relevant livestock sector (in a comprehensive sense of course, all inputs and outputs)?
- How is the livestock population structured, over a lifecycle of production; accounting for all aspects of structure?
- What policies are operating at the farm and higher levels, both socio-cultural driven and legislative based policies?
- What likely genetic gain is occurring for the possible spectrum of traits involved in this livestock production activity?

2. For the future livestock production activity:

- What should be the Development Objective and the Breeding Goals?
- What different technologies and different arrangements are required to realise effective and sustained selection, culling and mating practices?
- What opportunities are there to better utilise existing livestock population structural aspects to better realise genetic gain and, if the gain is realised first only in a sub-population, to disseminate the gain throughout the livestock population as a whole?
- Are there some changes required to the livestock population structure – again considering all structural aspects - to both realise the genetic gain being sought and, if the gain is made first only in a sub-population, to disseminate the gain throughout the livestock population as a whole?
- What opportunities are there to better utilise existing policy at the farm and higher levels, concerning the livestock, again considering both socio-cultural driven and legislative based policies?

- What changes of policy at the farm and higher levels, concerning the livestock, are necessary in the beginning and at later stages, again considering both socio-cultural driven and legislative based policies?
- What likely rates of genetic gain could be realised for the breeding goal, and for the possible spectrum of traits involved in this livestock production activity?
- What other support services and activities will be required to ensure that this genetic improvement activity is effective and sustained?
- How should this genetic improvement activity be funded initially and as it develops?
- What are the economics of the whole operation, and of different options?

Of course **each** of the above general questions involves many specific questions and decisions.

How to begin, and how to continue developing, over time?

An iterative approach to developing the breeding strategy, applied over time, must be considered – "optimising" in a technical sense may not even be considered in the first 10-15 years of an initiative being implemented.

Decision-makers must be encouraged to ask, in reasonably logical sequence, the fundamental questions concerning the development of sustainable breeding strategies for particular production environments, rather than to *de novo* identify the preferred approach. In addition, there will be advantages and disadvantages, about most decision points associated with utilising particular strategies in particular environments. It is important that the decision-makers are aware of pitfalls as well as strengths – this will also aid their appreciation of the folly of always utilising a particular strategy as the best. In this respect, the identification by leading experts of particular approaches, for example, open nucleus breeding schemes, or of MOET schemes, as being superior may be interpreted quite inappropriately by others with decision making roles. There may be lack of understanding of just how complicated technically and logistically a MOET programme can be, particularly for developing country use when capacity is seriously constrained.

Decision making structure for genetic development

As for other walks of life, recognising the decision-making structure for genetic development is crucial for effecting such development and ensuring its sustenance. Some levels of these structures are:

- **National structures.** It is necessary to account for several levels of in-country decision-making being involved in developing breeding strategies: as yet we have not finalised upon a suitable breakdown.

It will be important to effectively involve the high-level decision-makers, whether they be in government or the private sector (including farmer bodies). These will not be involved with the many technical, operational and even policy decisions of detail.

Often individual farmers or local farmer groups will not have the capacity nor inclination to work through decisions requiring technical detail; although they must of course be able to obtain practical interpretations associated with particular decision options.

Consider utilising just 2 decision levels in guiding the planning, implementation and maintenance of sustainable genetic improvement programmes. For example, these levels could be:

- Decision-Level 1: *Operations and Management Decision-Making*
- Decision-Level 2: *Executive Decision-Making*

Decisions-Level 1 could be broad and include most of the decisions required in planning, implementing and maintaining the operation – decisions by individual small farmers to local farming groups, by operations planners and managers including the applied technicians involved, by extension agents, and even by researchers, educators and trainers associated with maintaining the necessary ongoing amount of training and research to enable capacity building and the development of subsequent stages of the programme.

Decision-Level 2 could provide for the major enabling decisions within, <u>and</u> across, genetic improvement activity within and across species, production systems and for the country as a whole. By definition, these will involve critical but broad policy decisions. Of course at least part of the basis for these will also be technical in nature.

- **Structures for decisions within particular breeding strategies.** It will be necessary to encourage the development of decision structures which fully involve the key stakeholders from the outset, to generate ownership. Very important stakeholder groups are:

  - *Farmers* - who generally own and have the responsibility for day-to-day decisions concerning the animals of the herds and flocks responsible for producing most or all of the food and agriculture from livestock
  - *Policy and planning developers* – create an enabling environment in responding to <u>consuming</u> and <u>farming</u> needs.
  - *Collaborators* – a number of important sub-groups with potential to provide additional human operational and management resources and additional funding resources. The latter in particular will generally be required for the early stages of development of a genetic improvement initiative, including capacity building.

- **Farm community structures.** Finally, the food and agriculture production structure of communities can be a significant structural consideration itself when one is addressing the design of genetic improvement. Broad design structures induced by the food and agriculture production structure of communities or by government or community socio-economic policies may benefit by structuring the genetic improvement initiative to:

  1. Involve only 1 or a few herds / flocks with some form of reliable system to be developed for dissemination of the improvement over time – sustaining dissemination of improvement in developing countries must be very carefully considered; or

  2. Form a first tier as responsible for the genetic improvement comprising a good number of farmers who are more developed or have good geographic access to each other; this approach also requiring a reliable system for dissemination of the improvement over time to all farmers;

  3. Involve all farmers in the production system in the breeding activity, as a flat structure.

This food and agriculture production structure of communities, induced by government or community socio-economic policies, can differ greatly amongst communities. Existing characteristics of these structures may be used to enable increased genetic improvement. In other situations the community may be willing to alter some of its structural characteristics to introduce a more effective breeding programme. In still other communities particular structural aspects may be so important to the socio-cultural environment that there will be unwillingness to alter them to introduce a more effective breeding operation or to permit use of a particular strategy.

Some beginning examples of farm community activity with implications for policy, operational and technical decisions in the development of breeding strategies:

- The scavenger livestock component of many production systems, particularly common with poultry species and goat, e.g. chickens providing eggs and meat for the small farming family and also some cash (generally in the form of chicks / birds sold) in times of need;
- Roving transhumant groups of herds or flocks that are run separately or together for all or part of the year;
- Many small herds being maintained by individual farmers in local communities but using males in common with all / some number of the farmers being involved in the selection of the common males, as part of community's socio-cultural activity - service may be provided naturally or through artificial insemination;

- Landless, peri-urban production systems where virtually all replacements and feed, etc is introduced and product is sold commonly for a domestic (city) market, or sometimes for export (often requiring higher production plus standards);
- Individual animals of larger species in particular may, in some production systems, be permanently tethered / controlled, with all feed and other inputs brought to the animals (perhaps simple measures of intake are possible in these situations); whilst in other systems
- Animals roam freely, whilst
- Fertile males may be retained separate, run with the herd / flock for part of the year, e.g. in spring and summer, or the total herd / flock run together permanently; or
- All fertile males may be left entire, or the majority may be castrated for cultural reasons or because some communities prefer castrates for particular uses such as draught.