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More meat, milk and fish by and for the poor *December 2016*

Delivering animal breeding programs in developing countries: Some lessons from the Livestock and Fish program

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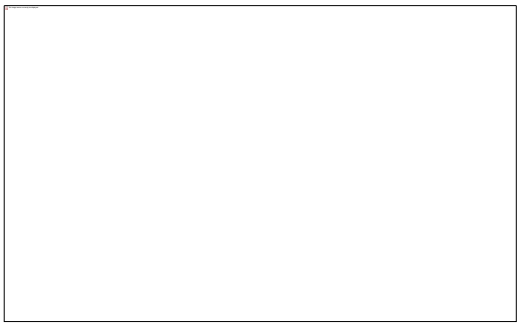
Key messages

- Ensure the genuine participation of livestock keepers in the design and implementation of breeding programs. Ownership of these programs by all stakeholders is key to their success.
- A conducive institutional environment, and the availability of policy support and complementary services, are crucial to the sustainability of breeding programs.
- Recent advances in phenotyping, genetic and genomic analyses and reproduction offer new opportunities to tailor the breeding of indigenous species in developing countries.

Breeding choices and priorities

Choice of species and structure of breeding programs are determined by the reproductive biology of the target species. Species with a long life expectancy and a few offspring a year require a different breeding program to those with shorter life expectancies and many offspring.



Improved Horro hens at Debre Zeit research centre, Ethiopia

Dairy cattle, goats, pigs and sheep are valuable to farmers and selection decisions (which animals to breed) have a direct economic impact on their owners. Empowering farmers to take ownership of breeding programs resolves this problem. In community-based breeding programs, farmers make collective selection decisions and individual farmers are compensated for any losses by contributing to the common good.

In contrast, chicken and fish have short life spans, are of little individual value to their owners and are very fecund. For these species, traditional nucleus-based breeding programs are more suitable as they leave selection decisions to breeders. Dissemination is relatively easy due to the high reproductive output. Short generation intervals allow for quick wins and easily demonstrates to farmers the value added of improved breeds (Box 1).

Box 1. Favourable indigenous breeds

Indigenous breeds are often favoured for perceived qualities related to cultural preferences or resilience. Such breeds must also be productive to be economically relevant. The Horro chicken breeding program in Ethiopia is a good example where an indigenous breed became economically relevant due to dedicated selection in a nucleus setting over generations. Survival, egg production and weight gain all increased to the level where the breed compared favourably with imported commercial breeds.

Breeding objectives are determined by the production environment and the objectives of the farmers concerned. The key success factor in adoption of breeding programs is to identify and address the traits that farmers consider most contribute to the economic profitability of their enterprises. Farmers should be interviewed and socio-economic assessments of farm livelihoods be undertaken to ensure their breeding objectives are captured (Box 2).

Box 2. Toolbox to define breeding objectives

- Personal interviews using structured questionnaires
- Workshops (focus group discussions)
- Hypothetical choice experiment
- Socio-economic assessment of farm livelihood
- Ranking of own animals
- Ranking of animals not known to farmers

Enabling environments

Breeding programs require an enabling environment to be effective, including:

Institutionalization: Formally registered cooperatives with clear by-laws and a formal organizational structure have been found successful in implementation and sustaining of community-based breeding programs (Haile et al. 2015). This is because collective action eases access to inputs, marketing, better selection and management of the flock, including the culling of unselected sires.

Policy support: Breeding programs need to operate within the country's livestock development policy, ensuring buy-in and support from research and extension. The public sector should provide a suitable or supportive policy environment (inputs and services, market infrastructure, technical backstopping, credit system, etc.).

Market access: To ensure a return on investment in breeding, there must be short- and long-term demand in local, national or international markets for the products (animals, meat, other livestock products, etc.) that are targeted for improvement. Livestock keepers may form cooperatives or farmer associations to ensure improved access to markets and enhanced negotiation power[1]. Cooperative members tend to have better access to credit and are able to negotiate more competitive prices for particular input services or products such as feeds or medicines as they can benefit from economies of scale.

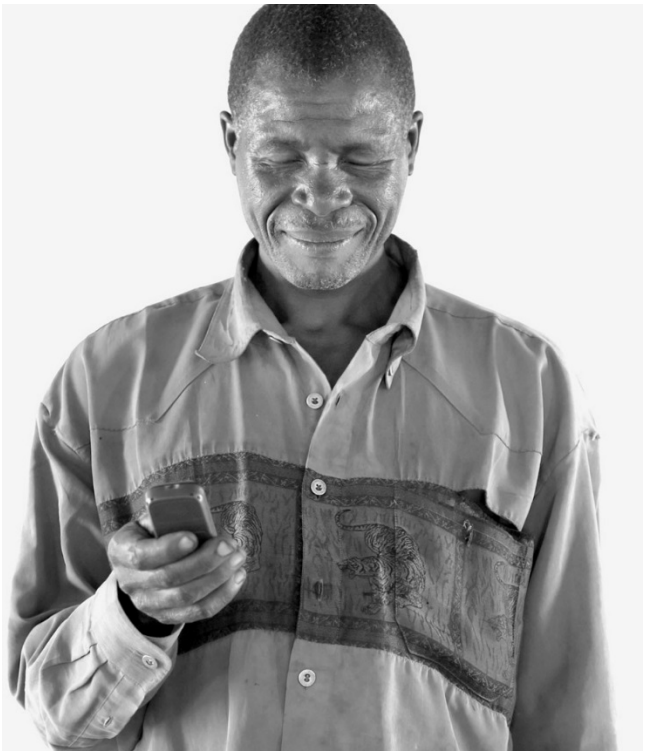
Complementary services: For the full benefits of improved genetics to be realized, it should be complemented by other interventions, notably, access to improved and affordable health services and access to adequate and quality feed resources. Developing the capacities of the different actors involved should form an integral part of the breeding program, thus ensuring management of the program is ultimately transferred to livestock keepers.

Integrating breeding into production systems

Once a breeding program context has been determined and enabling environments are put in place, implementation begins. Animal identification, data recording and genetic evaluation are critical factors to be integrated within a production system.

Animal identification is needed to record the pedigrees of animals and to avoid inbreeding. Mass selection combined with rotational exchange of animals between flocks/villages can be an acceptable alternative when identification is erratic or unreliable. In community-based breeding programs, farmers exchange animals on a regular basis between flocks. These exchanges are intuitively simple for farmers and have proven very effective in controlling the rate of inbreeding.

Data recording and collection is logistically challenging if executed by farmers and if the existing infrastructure is underdeveloped. Information and communications technologies now offer workable solutions. For instance, farmers can be equipped with mobile devices with applications and trained to enumerate and upload data at regular intervals. Feedback on data collection can be instantaneous and, if necessary repeated, if data seems unreliable. Smartphone/tablet data recording is rapidly becoming standard practice in many breeding programs.



Genetic evaluation is needed when animals are to be selected on pedigree-based estimated breeding values rather than own performance. Breeding programs need to be integrated with production systems; this presents a challenge because recording is undertaken in farmer-owned flocks, and genetic evaluation requires highly trained people. In community-based breeding programs, data and pedigree are collected and evaluated by dedicated trained personnel from affiliated research institutions.

Introducing advanced technologies

The ability to obtain DNA sequences cheaply and accurately has revolutionized genetics. Among the advanced technologies developed is the ability to measure single-nucleotide variations in a DNA sequence—referred to as single nucleotide polymorphisms (SNPs). These have been applied in livestock and fish in very different ways. Two examples are given below.

[1] This will probably lead to increases in animal sales and the quantity of livestock products for sale, as was the case with community-based breeding programs in Ethiopia.

Dairy cattle

In livestock, on-farm performance monitoring and robust breed-type comparisons have been constrained in developing countries by the absence of pedigree records in smallholder herds. The innovative application of genomic technologies has allowed use of the high density genomic SNP chips to determine breed compositions in 1824 crossbred cows in two East African countries (Ojango et al. 2014; Mujibi et al. 2014).

Milk production, reproduction, health performance and related economic parameters were monitored in these cows/herds for two years using on-farm recording and participatory approaches under real farm studies. This enabled robust comparisons to be made on the relative performance and suitability of various dairy cattle breed types to different low-input production systems, as well as testing of the potential of using genomic selection is such systems (Brown et al. 2016). This allowed optimized choices of crossbred dairy cattle genotypes and related genetics investment recommendations for smallholder systems in East Africa.

Fish

SNP analyses have also been used to estimate the relationships between individual fish, recreating pedigrees in cases where no other information was available. For instance, SNP analyses were employed in developing the base populations used to start breeding populations of three carp species in Bangladesh. Wild fish fry were collected from each of the three remaining wild sources of Rohu and Catla carp. Individual fish collected for the breeding program were genotyped at several thousand SNPs to eliminate individuals with genes from other species present in the areas, so to as develop pure stocks with which to start the breeding programs. In addition, to avoid mating between closely related fish, each carp used in breeding was also genotyped and their relationship to the others was established.

Sustainability

Ideally, sustainable breeding programs:

- meet breeding objectives of the individuals, communities and nations for which they were established;
- are self-sufficient (technically, economically and socially);
- are environmentally friendly (locally and globally).

An evaluation of Ethiopian sheep breeding programs suggests that sustainability largely depends on effective and well-functioning breeder cooperatives (Gutu et al. 2015). Strengthening the financial capacity of cooperatives by linking them to better markets can contribute to the sustainability of these community-based approaches. Tailored training (on financial and technical management of breeding programs, etc.) can also form part of support offered to cooperatives.

Although cooperatives and associations can build strong institutional (and financial) capacity in the short run, they cannot be expected to run breeding programs without technical support from research and extension (Gutu et al. 2015). Continuous technical and institutional support to cooperatives from national research and extension is crucial to their sustainability.

Conclusions

Implementing sustainable breeding programs requires careful consideration of the species in question, their specific biological constraints, the production environment and the trait preferences of farmers, as well as a careful selection and use of innovative technology. Successful breeding programs rely on livestock keepers as co-owners of breeding programs as such programs are meant for them and they benefit from their full participation.

These breeding programs need the support of appropriate policies and public–private partnerships (research institutes, cooperatives, agribusiness etc.) that secure access to markets and supporting services. To succeed, breeding programs, particularly those in low input systems, need significant government support.

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