Animal Breeding in Developing Countries Context

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Outline

- Introduction
- Why managing AnGR crucial?
- Lessons / Failures
- CBM of AnGR
- Participatory Animal Breeding
  - Animal breeding structures
  - Examples in the Globe
  - Some projects from Africa
- General conclusions
Introduction

Selectivity is one of nature's ways of ensuring the health and survival of plant and animal species.

Human beings, whether knowingly or unknowingly, have been a part of this process for ten thousand years.

Domestication and breeding of animals began around 9000 B.C. (e.g. Jacob’s wage, Genesis 30:31-43).

Sheep, cattle, goats, pigs, and horses were domesticated in that order.
Introduction…

Animal breeding represents a deliberate effort to induce specific traits beneficial to man.

Breeding weeds out undesirable characteristics and channels the desirable genes into future generations.

Earliest methods of human intervention was the use of Artificial Insemination by Arabs, as early as the 1320s.

Introduction…

• 1420: French monk Dom Pinchon attempted the artificial fertilization of fish eggs
• 1780: Italian physiologist Lazzaro Spallanzani used AI to obtain puppies
• Late 1700s: English biologist Robert Bakewell, developed several new breeds of livestock
• Late 1800s: Austrian monk and botanist Gregor Mendel, introduced principles of heredity
• 20th Century Charles Darwin’s theory together with Mendel’s law formed the basis of genetics research
1920s-30s: American Jay L. Lush applied Mendel's work directly to animal breeding

Statistical research by American geneticist Sewall Wright on evolution theory and by the team of C. R. Henderson and Alan Robertson.

1953: American biologist James D. Watson and English biologist Francis Clark discovered DNA, led to the new field of genetic engineering.
Introduction...

1997: Dolly, 1st animal to be cloned from an adult somatic cell, using the process of nuclear transfer at Roslin Institute, Scotland

Cloning: a viable tool for preserving endangered species? transgenic livestock?

Most of the world’s diversity is in the developing world

Centers of domestication

(1) turkey
(2) guinea pig, llama, alpaca
(3) pig, rabbit
(4) cattle, donkey
(5) cattle, pig, goat, sheep, Bactrian camel
(6) cattle, goat, chicken, river buffalo

(7) Horse
(8) Yak
(9) pig, swamp buffalo, chicken
(10) chicken, pig, Bali cattle
(11) Dromedary
(12) reindeer

Source: FAO, 2007
Cattle Domestication & African Pastoralism

Source: ILRI, 2006
Livestock keepers have been practicing selective breeding over many centuries.

Indeed the vast majority of breeds have been created by livestock keepers over many centuries.

Uncontrolled breeding remains to be a major feature of indigenous breeding.
Introduction...

Some African sheep, goat and cattle breeds – created by pastoralists
Why managing AnGR crucial?

- Domestic animals supply some 30% of total human requirements for Food and Agriculture.
- Livestock contributes at least 35% agricultural GDP in sub-Saharan African countries.
- 70% of the world’s rural poor depend on livestock.
- Well over a quarter of these AnGR is at risk of loss and the extinction rate is accelerating.
- Loss of genetic diversity reduces opportunities to improve food security.
- Genetic erosion in animals is much more serious than in crops because the gene pool is much smaller.
Lessons / Failures

Genetic improvement programs in SSA:

- Indiscriminate crossbreeding
- Breeding programs have been too complicated to be practical
- Centralized within-breed selection and cross-breeding programs have failed
- No analysis done as to the different socio-economic and cultural roles of livestock
- No comprehensive approach to design simple, yet effective breeding strategies
Community-based Management of AnGR

- ‘Putting the last first’; research driven by needs and wishes of end users
- Involves local communities and institutions in the design, implementation and ownership of breeding strategies
- Allows livestock keepers to fully participate in the:
  - identification of problems
  - choice of solutions
  - breeding objectives
  - designing and implementation of a breeding program
- Livestock keepers own and control superior genotypes
- Reflects the real production environment
Participatory Breeding

1967: Jim Shepherd (Australia) and AGH Parker (NZ) started “Group Breeding Schemes” in response to dissatisfaction with traditional breeding

1970s: GBS expanded into South Africa, Great Britain and other countries

1980s: Due to BLUP technology, GBS evolved into reference sire schemes

1990s: Group Breeding concept is reformulated into “Participatory Breeding” (from plant breeders?)
# Participatory and Modern Breeding

<table>
<thead>
<tr>
<th>Feature</th>
<th>Participatory</th>
<th>Modern</th>
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</thead>
<tbody>
<tr>
<td>Drivers of program</td>
<td>Demand (users)</td>
<td>Supply (breeders)</td>
</tr>
<tr>
<td>Structure</td>
<td>Usually open to upward gene-flow</td>
<td>Usually closed to upward gene-flow</td>
</tr>
<tr>
<td>Genotype</td>
<td>Local breeds</td>
<td>Int. breeds</td>
</tr>
<tr>
<td>Breeding objective</td>
<td>Set by participants</td>
<td>Set by breeders</td>
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<tr>
<td>Traits</td>
<td>Adaptation, etc.</td>
<td>Production, etc.</td>
</tr>
<tr>
<td>Selection criteria</td>
<td>Visual, performance</td>
<td>Pedigree, performance</td>
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</tbody>
</table>

Source: Modified from J. Mueller (unpublished)
Breeding structures

Modern breeding - breeders decide breeding objective and genetic progress depend on the breeders work: three tiers (Breeders, Multipliers, Base flocks)

Open Nucleus Breeding Structure: has Nucleus which is open to base population - base decides breeding objective supplying “adapted” females to produce their males

Optimum Design of Open Nucleus Breeding Structure: 10% elite animals are retained in the nucleus and 90% in the base; gene flow between layers; genetic progress; inbreeding rate; age structure; progeny testing; selection accuracies; genetic variance, etc will be considered
Genetic structure:
Centralized and dispersed nucleus

Source: J. Mueller (unpublished)
Genetic structure:
Dispersed progeny test – Reference sire scheme

R: Reference sire: proven “good” male
C\textsubscript{1-4}: Candidates: young untested males

Ranking of progeny tested males.
The best is the new reference sire.

Source: J. Mueller (unpublished)
Genetic structure: Connected population

A-P: males

ABC

BDE

AFJ

FOP

KLM

ADK

BLUP analyses

Ranking of all animals

Source: J. Mueller (unpublished)
Genetic structure:
Male nucleus and performance test

Source: J. Mueller (unpublished)
Genetic structure: Centralized progeny testing scheme

Source: J. Mueller (unpublished)
Global Examples

1995: Sheep in the “Sierra Central” of Perú – university supported; capacity building to farmers

- 4,000 sheep / community with about 1000 families
- Multi-communal flock – up to 100K sheep from 20 villages – ONBS; high organization and farmers participation and ownership
- Breeding plan: Agreement on breeding objective; Performance recording in nucleus; Sire evaluation (progeny test); Visual classing in nucleus and multipliers; Dissemination program
- Presently: 500 in the nucleus; multi-communal nucleus; 15 communal flocks each about 3000; and more than 4000 families
Global Examples

1995: Sheep in the “Sierra Central” of Perú – university supported; capacity building to farmers - Reasons for their success:

- Breeding structure with social implications
- Attraction of further national and international cooperation
- Improved marketing capacity (scale)
- Interaction with industry improved definition of breeding goals
Global Examples

- Llamas in Turco, Bolivia – Male nucleus station
- Alpaca in Peru, Puno – Male nucleus station
- Angora Goat project in Argentina – Nucleus, multiplier and general flocks: they let the communities choose their multipliers! In 1990s the nucleus was part of a communal evaluation system and had buck keeping facility

After more than 10 years of iterations and adjustments to the approach annual income jumped from US$ 4K to US$ 12K

Success reasons: regional integration, complementation farmers / institutions, discussion and agreement by all parties in overall planning and changes
Examples from Africa
Improving the Livelihoods of Poor Livestock Keepers through Community-Based Management of Indigenous Farm Animal Genetic Resources in Africa

CBM of AnGR in Africa

Project on CBM of AnGR

- Characterized chicken and goats in Benin, cattle in Ethiopia and sheep and goats in Kenya
- Analyzed husbandry practices and the livestock-keepers’ perceptions of performance-related traits
- Assessed breeding objectives through cross-sectional and longitudinal questionnaire surveys, choice experiments, formal group meetings, structured individual interviews, household gender analysis, gender-specific group discussions and market-chain and policy analyses; preferences of livestock traders and meat consumers were also assessed.
Communities were fully involved in the implementation phases of CBM of AnGR in Africa.
Key outputs

- A framework (per community) for CBM of AnGR developed and tested; 7 legally registered and functional farmers coops formed in Benin, Ethiopia and Kenya.
- Market opportunities for indigenous livestock quantified in the three countries;
- Producer and consumer preferences for alternative livestock genotypes quantified;
- Policy constraints to conservation and sustainable use of indigenous livestock identified, and
- National capacities (16 graduate students (4 PhD and 12 MSc plus researchers and farmers) for conservation and sustainable use of AnGR strengthened.
Designing community-based breeding strategies for indigenous sheep breeds of smallholders in Ethiopia

Aynalem Haile, Markos Tibbo, Gemeda Duguma, Tadele Mirkena, Maria Wurzinger, John Solkner, Okeyo Mwai and Luis Iniguez
Community-based Breeding

A community is a group of people bound together by social, cultural and economic relations based on common interests, goals, problems or practices shared interests & living in a well defined area.

Geographically, a community can be defined as of any size comprising of a village area, an ethnic group or an eco-regional zone.

Communities are not homogeneous; there may be differences between sub-groups (e.g. families) & individuals in a community. However, shared interests in cooperation outweigh competing interests that serve as the glue linking members together.
Indicators of success

- Decentralized and participatory breeding programs, at least one per breed
- Process involved in the definition of goals and breeding plans are available
- Methodology for across site comparison of breeding schemes available
- Characterization of the breeds and their production systems available
- Constraints to market access for indigenous sheep and sheep products available
- Two PhD and 7 MSc students trained
- Database on small ruminant genetic resources updated
Indicators of success

- Income increased (e.g. culling, linking producers to market)
- Productivity improved
- Linkage among stakeholders involved in the project strengthened
- Working ground for other interventions

Attitudinal change:

- Breed improvement is NOT feed and health only!
- Genetic improvement is NOT crossbreeding only!
- Selection is technically and financially feasible when community is involved at all stages
Project sites in Ethiopia

Sites/breeds:
(1) Horro
(2) Bonga
(3) Menz
(4) Afar
Methodology

- Description of the production system
- Definition of breeding goals
- Assessing traditional institutions and policies
- Development and implementation of a community-managed breeding strategy
- Joint evaluation of results and development of guidelines
- Impact assessment
- Analyzing access to markets
Accomplishments so far

- Site and community selection
- Stakeholders consultation workshops
- Description of production systems
- Definition of breeding goals
  - a. Choice card experiments
  - b. Individual own flock ranking
  - c. Group ranking
- Estimation of heritability and correlations of farmers preferred traits and social network with communities
Sheep grazing after harvest in the Ethiopian highlands

Courtesy by Tesfaye Getachew (2008)
Sheep and goats grazed together in the Afar lowlands

Courtesy by Tesfaye Getachew (2008)
Livestock keepers do have indigenous knowledge and control breeding to some extent:

- Ram isolation
- Castration
- Cord tying around the neck of the scrotum and of the penis

Afar pastoralists in Ethiopia, tie penis to the base of the scrotum and looped over the prepuce to prevent extrusion.

Maasai herdsmen in Kenya use ‘olor’, made from cowhide, to control mating.

Source: http://news.bbc.co.uk/2/hi/africa/7648860.stm
Some undesirable practices

Better rams with good body conformation and potential for fattening are subjected to castration early (10-18 months of age)

Meaning, faster growing rams are removed from the flock before passing on their genetic potential to the next generation – demand for cash income from sales of fattened rams!

Slow growing ones are left to mature mating in uncontrolled communal gazing system – negative selection!
General conclusions

- Community involvement is crucial for success.
- Farmers are innovative in finding ways to combine production and adaptation to their breeding stock.
- Open to opportunities to develop approaches for sustainable improvement.
- Researchers are not only interested in conducting a study and then leaving.
- Continuous feedback, during and after the project is of paramount importance.
General conclusions

- For planning genetic improvement an intelligent balance of genetic principles and consideration of practical aspects is needed.

- Solutions to practical problems may be found in experience of other projects and basically from farmers themselves (local knowledge).

- For implementation it is essential to have all stakeholders involved right from the start: this increases commitment and therefore efficacy and sustainability.
General conclusions

Most breeding projects require initial funding and technical help, but should be planned to become self-driven.

The challenge for field geneticists is to organize programs fitted to each situation and sustainable in time.

For high impact a functional genetic structure is necessary.

It is essential to have farmers motivated, organized and trained.
We Need to Manage our Valuable AnGR! Otherwise...

Thank you!

Wetlands of Nile under threat
Courtesy by Solomon Gebresellasie (2007)