Goat Breeding Strategies
(Part 2)

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This presentation

• Problems to implement genetic improvement programs for goats in low input production systems of developing countries.

• Principles of community based breeding programs (CBBP).
  - Breeding objective and selection criteria
Characteristics of conventional breeding programs, typical in high input systems of developed countries

- International breeds – breeders associations
- Genealogical records – performance records
- Population wide genetic evaluations (BLUP)
- Functional genetic structures (clear roles – effective dissemination)
- Providers of genetic material (sires – semen – hybrids)
- Strategic services (AI, recording, genetic evaluations, DNA tests)
- Strong national R&D organizations
98% of goats in the world are in developing countries *
(and largely in low input production systems)

*All but: USA, Canada, Japan, Australia, New Zealand and West Europe.

Source: FAOSTAT (2011)
Problems to apply conventional breeding programs in low input systems of developing countries

- Limited breeding infrastructure and breeding skills
- Difficulties with animal identification
- Difficulties for performance recording
- Difficulties for pedigree recording
- Rarely functional genetic structures
- Deficient strategic services (AI, genetic evaluation, laboratories)
- Weak national R&D organizations
¿What can be done?

- Instead of large national or breed-based programs we may target groups of farmers in a particular region
  - with similar problems
  - similar animals
  - similar breeding objectives
  - socially linked
  - common interests

- and establish Community-Based Breeding Programs (CBBP)
INVITED REVIEW

Community-based livestock breeding programmes: essentials and examples

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To establish a successful CBBP

1. Enable a favorable environment
2. Clarify the production system and breeding objective
3. Choose selection criteria and records
4. Organize breeding structure
5. Make a priori evaluation

FAO, 2010
ICARDA, 2017
1. To enable a favorable environment

- Check motivation and commitment of farmers. For example in participatory diagnostic workshops. Promote farmer organization and farmer empowerment.
- Manage agreements and institutional support (involve extension services, consider legal framework, financing instruments, etc.).
- Analyze logistic feasibility (number of participants, number of animals, infrastructure, accessibility, etc.).
Example: Raeini goat CBBP in Iran

Credit to: Hamid Ansari, Seyed Momen, Mohsen Ehsani, Omid Alipour, Sepher Moradi

Politicians  
Religious authorities  
Specialists  
Community leader  
Extension officers  
Farmers
2. To understand the production system and define the breeding objective

- Characterize production system (see ppt by Dr JP Dubeuf)
- Analyze market/use of animal products (see ppt by Dr H Ansari)

- Identify farmer preferences for breeds/genotypes
- Identify farmer preferences for traits
- Determine the relative importance of these traits including appearance traits (size, horns, colors, etc.)
To identify breed/genotype preferences

✓ Discuss if local or exotic genotype.
✓ If exotic:
  – ¿What to do with $F_1$?
  – Replacement (absorption)?
  – Regular crossbreeding (hybrid vigor)? Synthetic (new genotype)?

**Note:** Changes of genotype (G) usually require changes in “environment” (E), due to G x E interaction

Feed quantity and quality, management and health care, new product market
Example using “pebble score” (Goats in Mexico)

Source: Wurzinger et al. (2013)
Identify trait preferences

Using “choice card analyses”  
(Lancaster 1966)  
(Example from Mexico)

Classing of animals:  
Own or from other farmers  
(Example from Ethiopia)
Suppose: $Y_1, Y_2, \ldots, Y_m$ are preferred traits

For example: Kid weight, Fleece weight, Milk production

Suppose: $a_1, a_2, \ldots, a_m$ are the relative importances of each trait

so that the “Breeding Objective Function” becomes:

$$H = Y_1 \times a_1 + Y_2 \times a_2 + \ldots + Y_m \times a_m$$

Or for example

$$H = KW \times a_{KW} + CW \times a_{CW} + MP \times a_{MP}$$
Participatory definition of breeding objective

For example detecting trait preferences and setting a’s so as to maximize genetic gains in the most preferred traits.
Formal definition of breeding objective

$$H = Y_1 \times a_1 + Y_2 \times a_2 + \ldots + Y_m \times a_m$$  
formal breeding objective function

where:  $Y_1, Y_2, \ldots, Y_m$  are economically important traits
and:  $a_1, a_2, \ldots, a_m$  are the relative economic importance of each

calculate $a_i = \text{economic value of 1 unit of } Y_i \times \text{lifetime expressions / goat}$

For example economic importance of kid weaning weight (WW):

$$a_{WW} = \text{price of 1 kg kid meat } \times \text{nr of kids sold / goat lifetime}$$
$$= 4 \$/kg \times 3 = 12 \$/kg$$

For example: economic importance of fleece weight (FW):

$$a_{FW} = \text{price of 1 kg cashmere } \times \text{nr of fleeces shorn / goat lifetime}$$
$$= 20 \$/kg \times 5 = 100 \$/kg$$

$$H = \text{WW x 12 \$/kg } + \text{ FW x 100 \$/kg } + \ldots$$
3. To choose selection criteria and records

- Identify/tag candidates
- If possible record pedigree
- Measure traits in H or traits genetically correlated with H
- Think of records also useful to producers for management and marketing
- Consider visual traits assessed with numerical scores
Suppose you have measurements:

\[ X_1, X_2, \ldots, X_n \]

For example: weaning weight and fleece weight (not milk weight). Then construct a selection index:

\[
I = X_1 \times b_1 + X_2 \times b_2 + \ldots + X_n \times b_n
\]

Or in the example

\[
I = WW \times b_1 + FW \times b_2
\]

where: \( b_1, b_2, \ldots, b_n \) are weights such that the correlation between \( I \) and \( H \) is maximized.

Note: \( X \) and \( n \) may be different from \( Y \) and \( m \).
Formal construction of a selection index if pedigree info is not available

Index weights are obtained from standard selection index theory:

\[ \mathbf{b} = \mathbf{P}^{-1} \mathbf{G} \mathbf{a} \]  (bold for matrices)

Elements (e) of columns in \( \mathbf{P}^{-1} \mathbf{G} \) are weights to calculate breeding values with BLP properties for each \( Y \):

For example \( \text{BVY}_1 = e_1 \times X_1 + e_2 \times X_2 + \cdots + e_n \times X_n \) then:

\[ I = \text{BVY}_1 \times a_1 + \text{BVY}_2 \times a_2 + \cdots + \text{BVY}_m \times a_m \]

Note: if \( I = X = Y \) then \( e = h^2 \)

Note: this \( I \) = previous \( I \)

Note: This index ranks candidates within contemporary group only
What does this all mean?

If you have a formal breeding objective function and if you use a formal selection index you maximize the economic return in the progeny of selected animals.
Formal construction of a selection index if pedigree info is available

Same selection index as before:

\[ I = BVY_1 x a_1 + BVY_2 x a_2 + \ldots + BVY_m x a_m \]

... but here BV’s with BLUP properties derived from solution of mixed model equations using data from genetically linked contemporary groups.

You will need some expertise and software (wombat, BLUPF90, etc.) to do this.

Note: This index ranks animals across contemporary groups
And what does this mean?

If you use measurements and appropriate pedigree information your selection accuracy increases and therefore your selection progress increases
In any case …

✓ Keep It Simple to be Sustainable ("KISS")
✓ Accuracy according to dissemination

![Diagram showing selection accuracy and dissemination of selected animals with various methods such as GWAS, BLUP, BLP, own records, visual, random, and Dam selection.](image-url)
**Use of index, BV and visual info to identify best animals**

<table>
<thead>
<tr>
<th>Buck</th>
<th>BVY₁</th>
<th>BVY₂</th>
<th>Index</th>
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<tbody>
<tr>
<td>633</td>
<td>1.3</td>
<td>0.8</td>
<td>119</td>
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<td>637</td>
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<td>619</td>
<td>1.0</td>
<td>-0.2</td>
<td>103</td>
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Suppose you need to select 3 bucks:
- Rank candidates on index
- Consider top 6 bucks on index
- Select 3/6 on visual assessment
- Check for specific BV preference
Use of index, BV, visual info and pedigree to identify best animals

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In small herds avoid mating of bucks on his own progeny crop.

If pedigree is available avoid rapid increase of inbreeding.

4. To organize the breeding structure

Mate best females with best males to increase probability of getting better progeny for replacement.

Discuss with farmers the most efficient and practical structure.

Some examples given on Sunday’s session:
5. To evaluate the expected benefit

✔ Consider technical criteria
  – Herd info, recording system, genetic evaluation
  – Selection and mating system
  – Genetic progress, number of bucks distributed

✔ Consider socio-economic criteria
  – Level of participation
  – Probability of being sustainable
  – Risk level in unfavorable circumstances

✔ Perform cost-benefit analyses
  – Benefit or return to investment
  – Distribution of benefit and costs

Typical cost-benefit outcome over time

Cost
Income

Cost-benefit analyses are very useful to engage funding agencies and plan loan support

Summary of recommendations

 ✓ Farmers: work together, build organizations => empowerment.
 ✓ Projects: involve all stakeholders from start, plan project exit.
 ✓ Implementation agents: go slow, plan tactically.
 ✓ Researchers: do not confuse farmers with your research objectives, be practical, provide technical options for farmers to choose from.
 ✓ Geneticists: explain the principles, apply common sense.
 ✓ Financing bodies: most programs require initial financing and technical support, but usually are very cost effective and have many positive collateral effects.
Thank you very much for your attention

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