Elements of a Breeding Program

1. Production objective
   - Target population
   - Production system

2. Breed choice
   - Straightbreeding
   - Crossbreeding

3. Breeding plan
   - Breeding objective*
   - Selection criteria
   - Mating system

4. Breeding structure*
   - Conventional
   - Participatory
Breeding objective

- Adaptation to the system (GxE):
  - Survival, health, reproduction, longevity, easy care, etc.

- Productivity (kg/animal):
  - Meat, fiber, milk

- Product value ($/kg):
  - For example: fiber diameter, length, strength, VM contamination, uniformity (CV), color, etc.

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**Wool Auction Australia Average 2007-08**

Source: IWTO (2009)
**Wool quality**

**Vegetable matter contamination discount**

<table>
<thead>
<tr>
<th>Vegetable matter (VM)</th>
<th>Discount (cents)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% VM</td>
<td>0</td>
</tr>
<tr>
<td>4% VM</td>
<td>-40</td>
</tr>
<tr>
<td>8% VM</td>
<td>-60</td>
</tr>
</tbody>
</table>

**Staple strength discount**

<table>
<thead>
<tr>
<th>Staple strength (&gt;125 mm)</th>
<th>Discount (cents)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>18</td>
<td>-20</td>
</tr>
<tr>
<td>20</td>
<td>-40</td>
</tr>
</tbody>
</table>

**Mohair Auction South Africa Winter (July) 2009**

- **Cape mohair tops**
  - Adult 37 microns: 13.00
  - Young goat 33 microns: 15.50
  - Super young goat 31 microns: 19.00
  - Kid 28 microns: 27.00
  - Kid 25 microns: 43.00

**Source:** Mohair South Africa (2009)
Mohair quality

Figure 2.1. The relative contribution to the variance in greasy mohair price accounted for by mean fibre diameter, vegetable matter, visual grades and selling period and combinations.

Australian Mohair auctions

Speciality Fibres

Quotations for all the following fibres and tops are average prices in US$ per kg. Sources: Seal International, Bradford.

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>84.0</td>
<td>84.0</td>
<td>84.0</td>
<td>84.0</td>
</tr>
<tr>
<td>Hosiery 38mm</td>
<td>79.0</td>
<td>79.0</td>
<td>79.0</td>
<td>79.0</td>
</tr>
<tr>
<td>Weaving 32mm</td>
<td>82.0</td>
<td>82.0</td>
<td>82.0</td>
<td>82.0</td>
</tr>
<tr>
<td>Brown</td>
<td>75.0</td>
<td>75.0</td>
<td>75.0</td>
<td>75.0</td>
</tr>
<tr>
<td>Hosiery 38mm</td>
<td>66.0</td>
<td>66.0</td>
<td>66.0</td>
<td>66.0</td>
</tr>
<tr>
<td>Weaving 32mm</td>
<td>59.0</td>
<td>59.0</td>
<td>59.0</td>
<td>59.0</td>
</tr>
</tbody>
</table>

Cashmere

Source: WMR 27 Aug 2009

Source: Schneider (2009)
Breeding objective function
(Selection Index)

\[ H = a_1 \text{BW} + a_2 \text{FW} + a_3 \text{FD} + \text{etc.} \]

Where:
- \( a_i \) = relative economic importance
- \( \text{BW} \) = Breeding value for body weight
- \( \text{FW} \) = Breeding value for fleece weight
- \( \text{FD} \) = Breeding value for fiber diameter
- Etc.

Accuracy of breeding value estimation

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>0%</td>
<td>30%</td>
<td>70.4%</td>
<td>90%</td>
<td>100%</td>
</tr>
<tr>
<td>Example: ( \text{FW} h^2=0.4 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Genetic progress is function of selection accuracy

Measurements = 2 x Visual
Importance of Fiber sample analyses

\[ y = -0.613x + 66.29 \]

\[ R^2 = 0.437 \]

Breeding structures

(Dissemination strategy)
Conventional Breeding Structures

Breeders
♂
Base flocks

Gene flow (males, ♂)

Multipliers
♂
Base flocks

Conventional Breeding Structure

Genetic merit

Breeders
♂

Multipliers
♂

Base flocks

2Gen

Genetic improvement rate

Time
Non-structured population

General Strategy: Generate a genetic structure
“Participatory Breeding Program”

Genetic structure:
One farmer is chosen as nucleus

Example: a farmer is chosen as nucleus to produce the males
Advantage: simple, no need to move females
Disadvantage: if not the best farmer, then delayed progress
Genetic structure: Nucleus with best available females

Example: all participants contribute best females to a nucleus
Advantage: simple
Disadvantage: Who takes care of the nucleus?

Genetic structure: Closed and open nucleus

Closed nucleus
Advantage: Selection only in nucleus.
Disadvantage: Inbreeding?

Open nucleus
Advantage: Improves genetic progress by about 15% and reduces inbreeding by about 50%.
Disadvantage: Every year nucleus female replacements are selected from all participants.
Genetic structure: Dispersed nucleus

Dispersed nucleus: Each farmer has some nucleus females
Advantage: Does NOT need an independent nucleus.
Disadvantage: Requires selection in all flocks, keeping of young males and a genetic link.

Genetic structure: Dispersed nucleus with Progeny Testing “Reference sire system”

R: Reference sire: proven “good”
1-6: Candidates: “young promising”

Simple Analysis

Ranking R, 1-6
Best is new R
Dispersed system with full pedigree recording

BLUP Analysis

Genetic structure: Dispersed nucleus with central performance test

Advantage: Does NOT require keeping young males, selection is centralized.
Disadvantage: Requires a performance test site. Evaluation is not 100% accurate.
Example: Llamas in Turco, Bolivia

1. Young promising males are selected visually in each household. All participate.

2. Participants feed and manage young males in turns.

3. Participants select their preferred males.

4. Males go for 15 days mating in participants' flocks.

Example: Selecting llama males in Turco, Bolivia
Example: Alpacas in Huancavelica, Perú

Genetic structure:
Centralized progeny testing scheme

Family flock
Performance test site
Best females

Participating flocks

Young candidate males

Progeny test station

Adult proven males
Genetic structure: 3-tier system

Individual farmer
Communal nucleus
Multi-communal nucleus

Best females
♂

Example: Angora goats in Patagonia, Argentina
Example: Alpacas in Pasco, Peru

Two multi-communal nucleus flocks

- Individual farmer
- Multi-communal Nucleus
- Communal flocks
- Best females
- Males

Example: Multi-communal nucleus of Huacahuaganan, Peru
Example: Controlled mating at Macusani, Peru nucleus flocks

Example: Macusani, Peru

Two nucleus in different regions
With best females available

Munay Paq’o cha nucleus

Itita nucleus

1. Stratification of nucleus males and farmers alpaca females.
2. Mating with equal or superior males.
3. Mating is recorded.
4. Return of mated females to farmers (members)
## Participatory and conventional breeding

<table>
<thead>
<tr>
<th>Feature</th>
<th>Participatory</th>
<th>Conventional</th>
</tr>
</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>Internat. breeds</td>
</tr>
<tr>
<td>Breeding objective</td>
<td>Set by participants</td>
<td>Set by breeders</td>
</tr>
<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>
</tr>
</tbody>
</table>

**Location Map:**
- **Tokmok**
- **Akbeket**
- **Khudzand**
- **Kazakhstan**
- **Kyrgyzstan**
- **Uzbekistan**
- **Tajikistan**
- **China**
- **Dushanbe**
- **Tashkent**
- **Almaty**
Breeding plans: general

<table>
<thead>
<tr>
<th>Plan</th>
<th>Scientist</th>
<th>Objective</th>
<th>Number of farmers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akbeket, Kyrgyzstan</td>
<td>Kudaybergen Abdykerimov</td>
<td>Meat Sheep</td>
<td>5</td>
<td>No breeding experience. Easy access</td>
</tr>
<tr>
<td>Tokmok, Kyrgyzstan</td>
<td>Asambek Ajibecov</td>
<td>Dairy Sheep</td>
<td>5</td>
<td>New production objective</td>
</tr>
<tr>
<td>Khudzand, Tajikistan</td>
<td>Matazim Kosimov</td>
<td>Mohair Goats</td>
<td>5 + new</td>
<td>Experienced and isolated</td>
</tr>
</tbody>
</table>
Akbeket (meat)

- Measurements:
  - BW0
  - BW1
  - BW6
  - BW12
  - Pedigree

- Maternal ability
- Growth rate

Aman Omorov
Erkin Toktogonov
Joldosh Mambetaliev
Keldibek Toktogonov
Shaken Rysbekov

Tokmok (dairy)

Nurjan Abdymajitov

2007

2008
Tokmok (dairy)

Measurements:
- BW0
- BW1
- BW6
- BW12

Milk (nucleus) pedigree

Khudzand (mohair)
Some general experiences with participatory small ruminant breeding plans

- 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.
Some general experiences with participatory small ruminant breeding plans

• 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