Breeding schemes for sustainable small ruminant genetic improvement in Ethiopia

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EIAR/ATA/ICARDA Workshop on small ruminant breeding programs in Ethiopia

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Presentation Outline

• Introduction – genetic improvement strategies

• Breeding schemes: current, alternatives, schemes for upscaling

• Concluding remarks, recommendations, points for discussion
I. Introduction

What is our genetic improvement strategy?

• ‘Official’ strategy: Crossbreeding, ‘fast growth’

• ‘Researcher-desired’ strategy: Selection, sustainable, conservation-based + Rational crossbreeding

• The official strategy:
  • Genetic improvement started with crossing in 1944
  • 1960’s: full-fledged program (Merino, Corriedale, Hampshire)
  • Continued till now: Saanen, A.nubian, Awasssi, Dorper, Boer,
Breeding zones delineated?
(selection, crossbreeding)

- Breeding zones
- Breeding system
- Selective breeding
- Terminal crossing
- Commercial breeding
- Crossbreeding in delineated production systems or areas
- Commercial crossbreeding
- Extensive-breeding in delineated production systems or areas
- Selective breeding
- Hybridisation
- Low potential Highland
- Medium-large farm
- Extensive-farming systems
- Selective-breeding
- Small-breeding flocks
- Large medium flocks
- Fattening system
- Breeding zones delineated?
What is our crossbreeding scheme?

- **Tier 1: Nucleus**
  - Nucleus Centers
    - Pure-breeding
      - Purebred Males
        - Commercial stud breeders
          - Pure-breeding

- **Tier 2: BED and commercial breeders**
  - BED Centers
    - Cross-breeding
      - Half-cross Males
        - Inter se mating
          - Half-cross synthetic breed
            - Straight-breeding seed stock
  - “Ethiopian Dorper”
    - “Ethiopian Boer”
  - Large scale farms
    - Cross-breeding
      - Half-cross Males
        - Inter se mating
          - Half-cross synthetic breed
            - Straight-breeding seed stock
  - Large scale farms
    - Terminal crossing
      - Half-cross Males
        - Breeding farms
          - Feedlots
          - Market
  - Male fattened

- **Tier 3: Village breeding**
  - Low input
    - Inter se mating
      - Quarter-crosses
        - Self-replacing flocks
  - Medium input
    - Straight-breeding
      - Synthetic half-crosses
        - Self-replacing flocks
  - Medium input
    - Upgrading
  - Medium input
    - Terminal crossing
      - Quarter-crosses
        - Females

- **Feedlots**
  - Market
The tragedy of small ruminant breeding programs

- Selective breeding started in the 1970s (Afar sheep/goat, BHS, Horro, Washera, Menz)
- No scheme (esp. dissemination of gains); programs were merely research endeavors, not properly supported by policy/strategy,
- Largely FAILED

Current genetic improvement Scenario

- The call for rationalized crossbreeding (zonation)
- The cry for selection to be adopted as official strategy
- Breeding schemes - Extensive research to design suitable scheme for smallholder systems
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II. Breeding schemes

• Breeding structure:
  • where should genetic gain be generated,
  • how should it be disseminated
  • How many tiers (if more than one is envisaged)
  • Interaction between breeding, multiplication, and production tiers

• Selection & Recording scheme (within breeding tier):
  • Defining breeding population structure (size to generate enough gain, mating structure/design, …
  • Selection criteria to meet breeding objective, recording & genetic evaluation scheme
Breeding schemes in current breeding programs

- **Structures:**
  - Central nucleus-based: Afar, Horro, Menz, Arsi-Bale goat
  - One-tier community-based: Menz, Horro, Bonga, Adilo, Abergelle, konso
  - Central nucleus schemes not based on genetic principles
  - Community-based schemes, are we clear on scaling up at breed level (regional program)?
• **Selection and recording:**
  
  • Breeding group size, Based on genetic principles?
  
  • Selection criteria largely subjective, farmer criteria; Selection mainly for body size
  
  • Is the record being used for selection?
  
  • Progressive Selection based on generation ??
  
  • Does the selection practice enable evaluation of genetic progress?
Alternative breeding schemes

• Conventional central nucleus schemes
• Community (Village)-based schemes
• Central Nucleus-Village based schemes
Conventional central nucleus schemes

- Commercial systems: Private ram studs → Production tier
- Developing countries:

  Research centers (DBARC) or Government ranches

  Government ranches (Amed Guya)

  Villages in Menz region

  Villages
# Community (Village)-based schemes

<table>
<thead>
<tr>
<th>Breeding scheme</th>
<th>Description</th>
<th>Applicability / feasibility</th>
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<tbody>
<tr>
<td><strong>Within flock selection</strong></td>
<td>- Recording and selection within each flock</td>
<td>- Extensive systems, individual flock grazing (Abergelle)</td>
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<td>- Flock with at least 150 breeding females</td>
<td>- Business feasibility</td>
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<td>- Rams for own and other flocks</td>
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<td><strong>Ram circles</strong></td>
<td>- Farmers Organized into ram circles</td>
<td>- High accuracy of selection is achieved</td>
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<td>- Selected males moved from farm to farm</td>
<td>- But operationally very DIFFICULT</td>
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<td>- Males evaluated based on progeny performance in each participating farm</td>
<td></td>
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<tr>
<td><strong>Two tier cooperative</strong></td>
<td>- Farmers form a nucleus flock</td>
<td>- Suits smallholder system</td>
</tr>
<tr>
<td></td>
<td>- Recording/selection in nucleus</td>
<td>- Operationally difficult</td>
</tr>
<tr>
<td><strong>Dispersed nucleus scheme</strong></td>
<td>- Top females in each flock mated to selected males</td>
<td>- Requires hand mating or the best males and females in each flock have to be herded separately from other flocks</td>
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<td>- Male progeny is retained for evaluation and eventual replacement</td>
<td></td>
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<tr>
<td><strong>One tier cooperative</strong></td>
<td>- No nucleus flock is established</td>
<td>- Suits smallholder mixed crop-livestock systems under communal grazing, existing breeding structures</td>
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<td>- Recording/selection in whole coop. flock</td>
<td>- Extra cost of recording in base flocks</td>
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<td></td>
<td>- Evaluation in village or station</td>
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A breeding group
- The group is sub-grouped into ram groups each using a ram communally
- The group should ideally have 500 breeding females

A ram group
- A ram group may have one or more farmers depending on the farmers' flock sizes

A cooperating farmer in a ram group
- The smiley’s size represents the flock size

- Young rams born in the breeding group are evaluated together
- 10 breeding rams are selected and divided between ram groups by lottery

Cooperative groups can serve as sources of improved males for other villages which are not participating in the improvement program
Cooperation and Participation A MUST

![Graph showing the relationship between the proportion of flocks participating and profit. The graph illustrates that as the proportion of flocks participating decreases, the profit increases. The line for participating flocks shows a downward trend, while the line for non-participating flocks shows a slight increase.]
Designs for regional/breed level breeding programs

Scheme 5: Central nucleus scheme

73.4 Birr/ewe/yr.

20816 ewes
Designs for regional/breed level breeding programs

Scheme 1: Coop. village breeding group
• One-tier scheme
- A coop. breeding group of 2-3 gots
- Sharing common resources
- with 1500 ewes
- The whole population involved in generating genetic improvement

Scheme 2: Coop. village breeding group with a nucleus
• Two-tier scheme
- Nucleus flock = 10% of pop.; selection

Birr 46.94
Birr 44.24
Scheme 4.1, 4.2: Central nuclei scheme with village nuclei

42.15 | 31.81

Menz Mama  | Menz Qeya  | Menz Gishie

Menz Lallo  | Menz Gera

Amed Guya Ranch

1000 ewes
Scheme 3: Dispersed village-based nuclei scheme

Birr 36.76
How feasible is CBBP (cooperative village breeding) scheme

- Genetic progress

<table>
<thead>
<tr>
<th>Generation</th>
<th>Birth weight (kg)</th>
<th>3 month weight (kg)</th>
<th>6 month weight (kg)</th>
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<tbody>
<tr>
<td>1st</td>
<td>2</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>2nd</td>
<td>2</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>3rd</td>
<td>2</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>3rd</td>
<td>2</td>
<td>8</td>
<td>16</td>
</tr>
</tbody>
</table>
- Genetic evaluation

![Graph showing EBV (kg) over generations for Nucleus and Village flocks. The Nucleus flock shows a steady increase, starting from -0.5 in the 1st generation to approximately 3.5 in the 11th generation. The Village flock starts at 0 in the 1st generation and reaches 3.5 by the 11th generation.](image-url)
III. Conclusions / Issues for discussion

**Strategy**

- The dominant strategy as an organized program is crossbreeding
- The crossbreeding activity has to be rationalized
- Selective breeding validated with research as a sustainable and effective genetic improvement strategy
- Selective breeding currently widely accepted, but yet to be accepted and adopted officially as a strategy
- Selective breeding not yet an organized breeding program
Breeding schemes

- Crossbreeding schemes need to be redesigned, more research required (upgrading, terminal crossing, synthetics, …)
- Crossbreeding schemes designed by research not adopted
- Selective breeding schemes well researched, feasible alternatives availed, tested by research to be effective, suitable to smallholder systems
Institutionalization of genetic improvement

- CBBP activities widely adopted, but fragmented across institutes,
  - need coordination,
  - standardization of breeding schemes
  - = institutionalization

- Who should lead CBPP

- Who and what are the roles of participating institutions

- Funding source?

Value chain approach (input delivery, marketing group)

Biotechnological and genomic tools as appropriate (more research required)
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