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Livestock genetics flagship report

Consultancy report on the out-scaling of community-based breeding programs in Ethiopia

Joaquin Mueller[1], Aynalem Haile[2], Tesfaye Getachew[2], Rekik Mourad[2] and Barbara Rischkowsky[2]

[1]Instituto Nacional de Tecnología Agropecuaria Argentina

[2] International Center for Agricultural Research in the Dry Areas

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Box 30709, Nairobi 00100 Kenya
Phone +254 20 422 3000
Fax +254 20 422 3001
Email ilri-kenya@cgiar.org

ilri.org
better lives through livestock

ILRI is a CGIAR research centre

Box 5689, Addis Ababa, Ethiopia
Phone +251 11 617 2000
Fax +251 11 667 6923
Email ilri-ethiopia@cgiar.org

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Background

The International Centre for Agricultural Research in the Dry Areas (ICARDA) in partnership with various institutes has been implementing pilot Community-based breeding programmes (CBBPs) in Ethiopia. From both technical and socio-economic evaluations, it became clear that the pilot CBBPs are technically feasible and financially rewarding. The intention is now to propose a model for up/out-scaling of CBBPs in relevant sheep production regions.

Objective

Develop a model to use CBBPs to serve core populations with breeding sires based on pilots established in Menz, Bonga and Horro.

Summary of recommendations

- It is recommended to intervene in the three core production regions implementing new CBBPs, adjusting the operation of current CBBPs and improving or developing breeding links between general flocks and CBBPs.
- The project target populations are very large and implementing population wide breeding programs is very ambitious. It is recommended to narrow the target populations or to be prepared for a long-term project.
- If the proposed core populations are targeted then the number of CBBPs operating should be approximatively 7-22 in Menz, 9-28 in Bonga and 4-13 in Horro. The lower figures corresponding to low selection pressures and the high figures to high selection pressures.
- Reproduction should be optimized through adequate feeding management and health care.
- The proportion of male candidates from the potential male crop should increase from the present 20–30% to close to 100%.
- It is recommended to set selection pressures on breeding values to 50% and adjust visual selection pressure to the importance of non-measured traits.
- Artificial insemination can be useful when starting new CBBPs. Consultation with all stakeholders is recommended before starting an AI program.
- It is recommended and crucial to invest in the development of a market for CBBP produced young breeding rams.
- CBBPs in other sheep and goat populations can be planned using the general model developed here with appropriate population parameters.

Introduction

Several pilot CBBPs were established since 2010 in the Menz, Horro, Bonga and Afar regions. Only in Afar the establishment of CBBPs was not successful. This has been related to the harsh environmental and pastoral conditions of Afar. In the other regions, most initiated pilot CBBPs have been active and successful. The pilot CBBPs are based on local sheep named after their respective regions of origin. Sheep of these breeds may be present elsewhere in the country but in what follows core populations are defined in order to focus a new breeding project intervention area. Core or target sheep populations are those in the main production tract of each the three breeds.

Core population parameter

In the Menz region there are areas delineated for crossbreeding which are not considered here and rather areas identified for pure breeding of the local breed are considered as core Menz production region. The core population of Menz sheep is estimated at 700,000 head. Since average household flock size is 22.0 head, some 32,000 households are targeted in the region. About 55% of sheep are breeding females, so that the total number of breeding ewes in the core population is estimated at 385,000 served by 7,700 breeding rams given an average mating ratio (ewes per ram) of 50. According to the prevailing production system, where rams are used a maximum of three years with an annual survival of 95%, each year some 2800 young rams are needed for replacement of old ones. A breeding program aimed at improving the output of the core Menz sheep population ultimately needs to generate the conditions for the production and distribution of this number of genetically improved young breeding rams each year. Similar procedures can be used for Bonga and Horro sheep. The core population of Bonga sheep is located in the Kaffa zone of the South Nations Nationalities and Peoples State whereas the Horro sheep are widespread in the country. The target population of Horro sheep improvement is the Horro Gudero zone. Core population parameters for the three breeds are in Table 1.

Table 1: Core population statistics and parameter

Parameter		Menz	Bonga	Horro
Total number of sheep		700,000	550,000	218,000
Average flock size		22.0	8.5	17.4
Total number of households		31,849	64,706	12,529
Proportion of breeding females in population		0.55	0.55	0.55
Total breeding females	F	385,000	302,500	119,900
Mating ratio (ewes/ram)	mr	50	30	40
Total breeding males	M	7,700	10,083	2,998
Number of years rams are in service	y	3	2	3
Survival of rams	s2	0.95	0.95	0.95
Number of new rams needed yearly		2,841	5,443	1,106

Current CBBPs

At present (December 2017), there are five CBBPs in the Menz region, three well established ones and two new ones, located two in Molale, two in Mehal-meda and one in Dargegn. Each CBBP involves on average 85 households running a total of about 1877 from which 55% are breeding females. These ewes produce a number of male lambs which undergo performance recording and genetic evaluation. Each year two ram selection rounds are organized in which about 75 selection candidates are presented with their 6-month adjusted body weight breeding values. Out of the 30-top ranked about 20 are selected visually by an inspection committee and distributed in the community for breeding or sale. In Bonga there are 16 CBBPs in the zone, two old ones comprising 3000 sheep each and 14 new ones comprising 1750 sheep each. The selection procedure in Bonga CBBPs is based on 3 months adjusted body weights and visual inspection. Here surplus rams are selected for sale to CBBPs in under development or to other communities. In Horro there are two CBBPs with about 1100 sheep each which produce their own male replacement. A summary of the statistics and population parameter for average CBBPs in the three sites is in Table 2.

Table 2: Current statistics and parameter for average CBBPs.

Parameter		Menz	Bonga	Horro
Present number of CBBPs		5	16	2
Average number of sheep		1,877	1,906	1,100
Average flock size		22.0	8.5	17.4
Average number of households		85	224	63
Proportion of breeding females in population		0.55	0.55	0.55
Average number of breeding females		1,032	1,048	605
Mating ratio (females/male)		50	30	40
Average number of breeding males required		21	35	15
Number of years rams are in service	y	3	2	3
Survival of rams	s2	0.95	0.95	0.95
Average number of replacement males needed per year		8	19	6
Number of male lambs at measurement per year	n1	400	400	88
Number of male lambs at selection per year	n2	150	300	88
Number of male lambs selected on measurement per year	n3	60	160	35
Proportion selected on measurement	psm	0.40	0.53	0.40
Number of young rams for breeding per year	n4	40	100	23
Proportion selected on visual traits	psv	0.67	0.63	0.67

Strategies for up/out-scaling CBBPs

Current CBBPs are primarily designed for improved rams to serve in own community. However, some additional young rams are produced and sold externally. Its number is however substantially less than the number required for serving the whole target sheep populations of each breed. For example, in Menz 40 young rams (5CBBPsx8 replacements per CBBP needed) are needed yearly to replace old ones in the 5 CBBPs and there are 5x40=200 young rams available. Yet, a total of 2841 young rams are needed for replacement in the whole Menz target population. Only 7% of currently needed young rams are produced by the five Menz CBBPs (200/2841). In Bonga the gap between selected rams in the CBBPs and population-wide required rams is proportionally much smaller (16x100=1600 young rams produced in CBBPs vs. 5443 young rams required for target population). On the whole the present supply of young rams to the Menz, Bonga and Horro core populations is 7%, 29% and 4%, respectively of the total needed. The challenge of any population wide breeding program is to increase these proportions or otherwise consider a lesser ambitious program with smaller targeted core population sizes.

To increase the availability of improved rams there are three strategies: increase the number of CBBPs, increase the supply of improved rams per CBBP and increase the use of improved rams.

- Increasing the number of CBBPs requires additional project staff for recording and extension work, additional identification and weighing supplies, larger coordination and supervision efforts, etc.
- Increasing the number of rams supplied per CBBP requires participating farmers to enhance reproduction, recording and maintaining a higher proportion of male progeny till final selection. The supply can also be increased reducing the requirements for a ram to qualify for breeding. In the latter case this is achieved at the cost of a reduced selection differential.
- Increasing the use of improved rams through higher dissemination or through extending their use in time. Higher dissemination is possible through artificial insemination (AI). Increasing the age of ram disposal also leads to higher dissemination, although at the cost of an increased generation interval.

These avenues to reach a larger sheep population with improved rams are not exclusive and shall be considered jointly when planning different programs.

In order to test different out-scaling options for different sheep and goat populations of Ethiopia a parameterized model has been programmed on an Excel file (See ANNEX I). Such a model allows a quick overview on results and allows testing sensibility of parameters used; this being particularly helpful when field data are uncertain.

Out-scaling with more CBBPs

As seen before in the three sheep sites the supply of improved rams from present CBBPs is completely insufficient to attend the core sheep populations. For example, only 7% of the Menz core sheep population can be supplied with young improved breeding rams from the present five CBBPs in that region. Thus, a total number of 71 (5/7%) CBBPs of the same size, structure and operation of the current ones would be needed to attend the whole Menz target population. For Bonga and Horro it would be necessary to have a total of 54 and 47 CBBPs, of the same average size, structure and operation already established in these regions, respectively. Additional 66, 38 and 45 new CBBPs would be needed for Menz, Bonga and Horro, respectively. Clearly, the establishment of such a large number of new CBBPs is not a realistic proposal and it is also not necessary.

Up-scaling with more males produced per CBBP

The number of additional CBBPs needed can be substantially reduced from the above figures if more candidate males are included in the evaluation process of each CBBP. For example, in a current average Menz CBBP with 1032 breeding ewes only 400 male lambs are recorded, 150 considered for selection and only 40 young rams are finally selected for breeding.

Accepting the potential reproduction parameter shown in Table 3 the number of recorded male lambs could reach 658 (1032x0.64) and the number considered for selection could be 626 (1032x0.61). Even assuming current average number of males recorded (n1 in Table 2) the potential number of male lambs considered for selection could be 380 (400x0.95), more than double the current 150. Similar results can be derived for current Bonga and Horro CBBPs.

Table 3: Modelled male progeny production per breeding ewe in average CBBP.

Parameter		Menz	Bonga	Horro
Conception rate		0.9	0.95	0.9
Litter size		1.05	1.53	1.36
Lambing frequency per year		1.5	1.5	1.5
Reproduction at birth (progeny /ewe / year)	r	1.42	2.18	1.84
Survival from birth to measurement (n1/n0)	s0	0.9	0.88	0.8
Male progeny per breeding female at selection		0.64	0.96	0.73
Survival from measurement to breeding age (n4/n3)	s1	0.95	0.92	0.9
Male progeny per breeding female at breeding age		0.61	0.88	0.66

The potential number of young rams finally selected would depend on the selection pressure applied. There are basically two selection instances, first a proportion of candidates is selected on breeding values or measurements (psm) and finally a proportion is selected on visual traits (psv). Current psm for Menz, Bonga and Horro is 0.40, 0.53 and 0.40 and current psv is 0.67, 0.63 and 0.67, respectively (Table 2). These selection pressures are arbitrary and currently related to the expected number of young rams needed.

If candidates with above average breeding values are considered (psm=0.5) and from these 90% are visually acceptable (pmv=0.9) then 282, 416 and 180 young rams would be available for breeding in Menz, Bonga and Horro, respectively. In this case 10, 13 and 6 CBBPs in full reproductive potential would be sufficient to provide young rams to the core populations of Menz, Bonga and Horro (Table 4). For example, for Menz 10x282=2820 young rams.

Table 4: Number of CBBPs required for core populations when all potential male candidates are included in the selection program. Modelled number of males in selection process per CBBP

Parameter		Menz	Bonga	Horro
Average nr of breeding females per CBBP		**1,032**	**1,048**	**605**
Nr of male lambs born per year	n0	**732**	**1,143**	**555**
Nr of male lambs at measurement per year	n1	**658**	**1,006**	**444**
Nr of male lambs at selection per year	n2	**658**	**1,006**	**444**
Proportion selected on measurement	psm	**0.5**	**0.5**	**0.5**
Nr of male lambs selected on measurement per year	n3	**329**	**503**	**222**
Proportion selected on visual traits	psv	**0.9**	**0.9**	**0.9**
Survival from measurement to breeding age (n4/n3)	s1	**0.95**	**0.92**	**0.9**
Nr of young rams for breeding per year	n4	**282**	**416**	**180**
Nr of CBBPs necessary to provide rams to target population		**10**	**13**	**6**

For Bonga less than the presently operating CBBPs are needed (13 instead of 16). This is because present selection pressures are already very low (psm=0.53 and psv=0.63) and reproduction is very high.

Keeping all male lambs available till measurement and keeping all selected young rams till breeding age for their eventual sale is costly and risky if there is no market for culled males and for the breeding rams produced. Although many animal production systems follow a pyramidal genetic structure in which farmers of the top layer (stud farmers) follow such a system. That is performance recording most of the male progeny for selection and eventual breeding and sale to lower levels of the pyramid.

Combinations of psm and psv can be modelled to get desired number of young rams (n4) and resulting number of CBBPs following the logic of Table 4. Examples of such combinations and number of CBBPs required supplying the core populations are in Table 5.

Table 5: Number of CBBPs needed to supply core populations with required young rams, given reproduction parameters from Table 3 and combinations of proportions of total male lamb crop selected on measurements (psm) and proportion selected on visual traits (psv).

Proportion selected on measurements (psm)	Proportion selected on visual traits (psv)	Menz	Bonga	Horro
0.3	0.7	22	28	13
0.3	0.8	19	25	12
0.3	0.9	17	22	10
0.5	0.7	13	17	8
0.5	0.8	11	15	7
0.5	0.9	10	13	6
0.7	0.7	9	12	6
0.7	0.8	8	11	5
0.7	0.9	7	9	4

Increasing selection pressures (by decreasing the proportion selected) implies that more CBBPs are required to produce sufficient young rams to supply core populations. These rams will be of higher breeding value and visual quality, the opposite would be true if selection pressures are relaxed. Relaxation might be more acceptable for advanced CBBPs offering already prestigious breeding stock. Bonga rams may have already this prestige.

Up-scaling with more intense use of males

Artificial insemination (AI) allows using fewer males and/or increase the number of females served with improved males. At CBBP level using fewer rams allows increasing selection differential and consequently increases the genetic progress. At the general flock level AI allows extensive dissemination of genetic superiority. Considering the costs involved in AI programs only outstanding rams should be considered for AI, particularly if used at the CBBP level. The genetic merit of AI males should be high and accurately measured. Such conditions are probably difficult to meet in most CBBPs because breeding values are normally based only on own phenotype and are therefore of low accuracy. Rams with high accurate breeding value may be found in full pedigreed CBBPs where comprehensive data are available for BLUP analyses. This might be the case in Bonga CBBPs where pedigree recording is more common. Potential AI rams could also be detected in well-designed progeny test trials. For example, if a community flock is split into single sire mating groups the comparison of average 6 months body weights would lead to the detection of superior sires, which then could be used in AI. Single sire mating groups may already exist where for example a clan of say five households run their sheep together with one ram. If this kind of information to accurately detect outstanding rams is not available, massive AI should be avoided at CBBPs level. AI with phenotypically outstanding males may still be implemented in flocks starting a CBBP provided several donor rams are used from advanced CBBPs.

Including AI in the modelling of the number of CBBPs needed to attend specific populations requires adjustment of the mating ratio parameter. For example, in Menz two mobile AI teams could inseminate about 1000 ewes per week during four weeks making a total of about 8000 ewes inseminated, that is about 2% of the 385,000 Menz core population ewes. Suppose AI mating ratio is 300 ewes/ram and natural mating ratio is 50 ewes/ram, then the overall average mating ratio is 300x2%+50x98% = 55, replacing this mating ratio in the model of Table 1 reduces the number of young rams needed to 2583 and less CBBPs may be needed. For example, given the parameters of Table 4, instead of 10 CBBPs only 9 would be needed in Menz.

The second way of intensifying the use of males is by keeping adult males for additional matings in the flock. For example, using males in the base flocks 4 years instead of 2 years almost doubles the number of young males available for distribution, or conversely allows to halve the number of CBBPs required for a given core population. Using males, additional years would not change the rate of genetic gain but would increase the genetic lag between CBBP and base flocks. Other considerations may also limit this option in low input systems.

a. Overall strategy for existing and new CBBPs

In order to involve a high proportion of core sheep populations in genetic improvement programs more improved rams have to be produced and disseminated. As seen before this can be done by replicating (out-scaling) CBBPs, increasing the number of rams produced (upscaling) in CBBPs, intensifying the use of rams through AI or extended use. The three strategies should be discussed with the regional leaders and, if possible, with other relevant stakeholders (extension officers, community elders, etc.). Each strategy has advantages and disadvantages which might apply more or less in different communities or institutional set-ups. Most probably the three strategies can be used with different emphasis in different regions.

From previous modelling results it is clear that simple replication of present CBBPs is not a realistic option if the whole target populations are to be involved in the improvement program. Additional 66, 38 and 45 new CBBPs would be needed for the three sheep breeds (Menz, Bonga and Horro, respectively). Present CBBPs could produce about 4, 3 and 5 times more candidates and, applying reasonable selection pressures, could offer 7, 4 and 8 times more selected rams than at present, respectively. By doing so, the additional number of CBBPs required to provide the whole target populations will be much less. In Menz, for example, only five new CBBPs would be needed.

Ram production does not automatically imply ram distribution. Therefore, a key challenge is to develop a market or distribution system of CBBPs produced rams. At present a demand for males from CBBPs by base population farmers seems to be lacking in Menz and Horro and is only limited in Bonga. Some activities which could be emphasised or implemented to motivate and facilitate such a demand are:

- Explaining extension officers and rural NGO officers the general strategy for genetic improvement: participating in a CBBP or taking advantage of their rams.
- Participating in rural events explaining to general flock farmers the importance of using “good” rams.
- Organize financial incentive (credit or subsidy) for general flock farmers when buying CBBP (certified) produced rams.
- Extending the bi-annual ram distribution events inviting general flock farmers.
- Promoting and advertising certified CBBP rams across the core breeding regions.
- Offering outstanding rams in AI programs to jump start new CBBPs or base flock communities.

This is also relevant when choosing the location of new CBBPs. Apart from considerations of genuine community interest, feasibility, etc.; the location of new CBBPs should also consider the potential market for surplus males. Thus, regional sheep density, accessibility and regional ram demands should be considered.

As the demand for improved rams increase, selection policies at established CBBPs need to be adjusted. We do not know the present genetic difference between old CBBPs, new CBBPs and general flocks, so we cannot set exact threshold selection and culling levels of rams in the CBBPs. Currently the number of candidates at selection stage and the number selected for breeding are related to the replacement necessities and expected ram sale opportunities. The proportions selected on breeding values are in the range 0.4-0.53 and the proportions finally selected visually are in the range 0.63-0.67. These selection pressures are reasonable and close to suggested proportions of 0.5 and 0.9, respectively. Those rams with breeding value above average (standardized selection intensity = 0.8) and visually acceptable would be genetically acceptable. Approximate genetic gain expected from the use of these males can be calculated, which multiplied by lifetime expressions and economic value gives an indication of the relative economic benefit per animal of the program (a full economic evaluation requires more sophisticated methodology).

As mentioned above AI is a powerful tool for genetic improvement and may be useful in many ways in the proposed out/up scaling of CBBPs. If genetically outstanding rams can be detected with high accuracy AI can increase the rate of genetic gain at CBBP level. In average Menz CBBPs there are 1032 breeding ewes, 21 breeding rams and 8 young replacement rams (Table 2). Suppose the best two breeding rams are used for inseminating 150 ewes each (300/1032=29% of total CBBP ewes inseminated), then the average mating ratio would be mr=29%x150+71%x50=79 and only 13 breeding rams and 5 young replacement rams are needed in a typical Menz CBBP. If such a program is applied routinely over years then on average the proportion of young replacement rams selected is reduced from 8/n4 to 5/n4 with the corresponding increase in selection differential and genetic gain. According to previous experiences of trained AI teams, such a program could be applied to all five Menz CBBPs during the peak reproductive season of the breed. However, it is recommended to discuss such a program in each case with all stakeholders. Reservations to AI may arise with the required logistics at community level, with the application of hormones, with the resulting concentrated lambing dates, with alternative use of project resources, etc.

Whether justified or not, such reservations need to be addressed to ensure community participation and approval.

AI can also be very useful in disseminating genetic superiority of outstanding rams to general flocks and therefore reducing the number of breeding rams needed to be produced at CBBP level. This would either allow keeping fewer candidates in the CBBPs and/or reduce the number of CBBPs required to attend the target population. The selection of target flocks and organization of AI in general flocks is however not so obvious. Farmers of a community interested in participating in such a program would most probably be interested in establishing a new CBBP for its own. Thus, AI is probably useful for establishing new CBBPs. One drawback in this case is that AI would compete with established CBBPs interested in selling more rams. Again this option needs participative discussion of options, advantages and disadvantages.

The out/up-scaling planning process may consider progressive intermediate options. For example, progressively establishing new CBBPs and, at the same time, progressively increasing the demand of rams from existing CBBPs and progressively using AI.

Enabling environment (brief comments)

Lessons from pilot CBBPs

A crucial antecedent for being optimistic regarding out-scaling of CBBPs in Ethiopia is the successful operation of several pilot CBBPs in both, sheep and goat breeds for more than 5 years in different regions. The breeding programme and methodology has been tested and adjusted, the communication channels between stakeholders are working and positive results are already documented. Thus, a positive working environment is already in place.

Stakeholders involvement

The Ministry of Livestock and Fisheries and its decentralized regional research centres with extension officers, enumerators, veterinarians and researchers are directly involved in all CBBPs and interested in continuing to do so. A clear communication net is already operative. Roles and responsibilities have been defined and adhered to in the pilot phases. However, detailed consultations and agreements are needed as the pilot phase moves to population-wide programs. There may be additional stakeholders involved and the roles, duties and obligations of present ones may change. This is particularly important since farmer organization and communication which develops from the implementation of CBBPs is often the starting point of other activities of common interest, for example collective purchase of supplies or collective sale of products, where other stakeholders become important.

Required institutional/organizational arrangements

The breeding efforts should be accompanied by other crucial interventions such as health, nutrition and marketing activities which may require additional arrangements.

Infrastructure and equipment needed

Additional AI teams will need additional equipment.

Establishment of support services

AI campaigns can start immediately with one team per site already available but additional teams may be needed in the future.

Supportive policies and regulations

Credit and subsidy policies should be attached to CBBP activities.

Micro-finance need of cooperatives

Initial finance for revolving funds may be needed.

Major costs of CBBPs (brief comments)

More CBBPs will require more enumerators and transport costs. AI campaigns will also draw substantial resources.

Breeding methodology (brief comments)

Breeding objective

Breeding objectives for the three breeds have already been discussed and agreed on. It is important to also agree on the relative importance of measured traits and non-measured traits. This will affect selection pressure on breeding value (psm) and visual traits (psv). For example, if weight at 6 months is equally important to other non-measured traits, a large room for visual selection should be allowed for. There should however be a reasonable agreement on the importance of these other traits; otherwise there is no point in a high visual selection pressure.

Identification and recording

Identification is based on ear-tags, although other methods are being investigated (NZ chips). Web-based data Recording and Management System (DREMS) is already developed in partnership with EMBRAPA and is being used. The major challenge is the internet connection which is unreliable in most rural Ethiopia. Therefore, we are in the process of developing an offline version of DREMS. Mobile data recording is also being tested. Role of stakeholders should be clear: farmers inform enumerators when there is new birth and when they face problems, enumerator takes body weights and collects all field information; researchers calculate breeding value, farmer teams make visual assessment, etc.

Genetic evaluation

For Menz and Horro sheep, lamb weights are taken at 5-7 month of age and linearly adjusted to 6-month weights, usually correcting for birth weight. Deviations from community mean are multiplied by the heritability of this trait to get breeding values. These deviations or breeding values are comparable within CBBP not across CBBPs, unless rams are shared between CBBPs with full pedigree recording. Adjustments are made for known sources of variation like birth type and age of dam. An additional trait of interest might be the dam lifetime-reproductive performance, indirectly selecting for reduced lambing interval. In Bonga and Horro birth type information is also considered. In Bonga breeding values for weight at 3 months of age and dam performance are considered. Ideally this should be done in form of a selection index. BLUP evaluation is not necessary, unless comprehensive pedigree is available, this being the case in Bonga. Measurement of weights in females is not worthwhile as most females will be used for breeding anyway.

Selection procedure

Twice a year farmers gather for selection and distribution of males. In Menz about 40% of top ranking 6 months weight breeding values are presented to famers who select on visual traits young breeding males for replacement. For example the top 30 ranked males out of 75 are presented to farmers for selection. In Bonga about 200 male lambs are recorded, about 150 lambs are present at selection time, from these 80 are selected on breeding values, 75 are left at around 3 months of age. After this pre-selection a final visual selection is performed at 6 month of age selecting 50 for replacement and sale.

The visual selection criteria should exclude traits already measured and include all other traits of interest to farmers. Setting the culling level to the mean, so that above average performing males can be candidates for visual selection would allow increasing somewhat the offer of males for visual selection. Although being arbitrary, this criterion is simple to understand and justify, all these males are "improvers" compared to their contemporaries. The criterion should be independent of flock size but may be adapted to age of the CBBP. Recent programmes may have comparatively lower quality male lambs.

Performance of dams shall be considered when selecting males. However, selection for more than one trait requires discussion of their relative importance and construction of selection indices or definition of independent culling levels. Traits like, colour, horn type, tail type are also considered and lambs that do not fulfil the criterion are independently culled.

Inbreeding issues

In pedigreed CBBPs inbreeding can be avoided easily tracking common ancestor when selecting nucleus replacements. Without pedigree it is advisable not to use rams more than 2 matings in the same flock or group (within CBBP), in order to avoid sire-daughter matings. Circular mating or sire exchange between groups and even between CBBPs is also advised. However it should be noted that all CBBPs are of a reasonable size and with more than 3 new males every year which is normally sufficient for maintaining a low inbreeding rate.

Certification of improver sires

Executive persons from credible institutions should extend the certification documents in due time. Apart from paper documentation, a visible physical identification (adding a special tag or tattoo) of the certified animal is useful for identification in the field and marketing. Certification should include health status and reproductive ability, so that certified rams are guaranteed healthy, apt for reproduction and genetically above average.

A guideline is being prepared.

Dissemination

In Menz young breeding rams are used basically by members of the respective CBBP. If general flocks are to benefit from established CBBPs more males need to be offered and distributed to these flocks. In the Bonga region there is already an incipient market for CBBP produced males since these males are well known and appreciated in the region. In Bonga several new CBBPs were established recently and were supplied with rams from the established CBBPs. In Menz and Horro this is not the case and actions promoting and facilitating the demand need to be considered as mentioned elsewhere. A key marketing tool is for CBBPs to offer officially certified rams. In the future farmers may be prepared to pay for guaranteed rams. In CBBPs of other countries the open nucleus concept is used and base farmers acquire rams from the nucleus (CBBP) in exchange of selected replacement females.

Genetic progress and economic benefit

Genetic progress and economic benefit has been calculated (in preparation). Using the results of these studies, in the future we can make an exercise following the gene flow logic of Amer et al. (2007).

References

- AMER, P.R.; NIEUWHOF, G.J.; POLLOT, G.E.; ROUTGHSEDGE, T.; CONINGTON, J.; SIMM, G. 2007. Industry benefits from recent progress in sheep and beef populations. Animal 1: 10, 1414-1426.
- ICARDA. New Guidelines.
- Aynalem progress paper.
- Certification Guideline.

ANNEX I

Parameterized model

Suppose we want to model the number of young replacement rams YM needed in a population with F breeding females and M breeding males. M may be a known quantity or may be estimated assuming a identified mating ratio mr (ewes/male) such that M=F/mr. Then, the number of young replacement rams YM depends on the number of years y the rams are in service and their survival s2 from year to year, then $YM = \frac{M}{\sum_{t=1}^{y}(s2)^t}$. If s2=1 then YM=M/y.

For example, if the total number of rams in a population is 7,700 (M=7,700), rams are used 3 years (y=3) and their survival from year to year is 95% (s2=0.95) then $\sum_{t=1}^{3}(0.95)^t = 2.71$ and the number of young rams needed to replace old ones is 7,700/2.71 = 2,841.

Now suppose we want to model the reverse case. We want to know the number of breeding females F needed to produce a given number of young replacement males YM. To do this we have to account for survival and selection rates in order to reach the number of progeny which should have been born and from this number calculate the number of breeding females which would have produced it. Suppose the survival from selection time to breeding age is s1. Then the number of young rams selected is YM/s1. Since a proportion psv is selected on visual traits and a proportion psm on measured traits the number of male candidates should have been YM/s1/psv/psm. If survival from birth to measurement is s0 and considering that lambs of both sexes were born, the total progeny of breeding females should have been YM/s1/psv/psm/s0*2. Suppose reproduction rate at birth is r, then the total number of breeding females F needed to produce YM young replacement rams is F= YM/s1/psv/psm/s0*2/r.

For example if the above number of young replacement rams need to be produced (YM=2,841), survival from selection to breeding age is 95% (s1=0.95), 90% are selected on visual traits (psv=0.9) from the top 50% of measured candidates (psm=0.5), lamb mortality between birth and selection is 90% (s0=0.9) and reproduction rate at birth is 1.42 lambs per year, then F=2,841/0.95/0.9/0.5/0.9*2/1.42= 10,418 breeding females. Suppose that in an average CBBPs F=1,032 then a total of 10,418/1,032=10 CBBPs are needed to supply the required 2841 selected young replacement rams. This result can be seen in Table 4.

A list of symbols used is in Table 1.

Table 1: List of parameter symbols used throughout the text.

Parameter	**Symbol**
Mating ratio (ewes/ram)	mr
Reproduction at birth (progeny /ewe / year)	r
Nr of years rams are in service	y
Nr of male lambs born per year	n0
Nr of male lambs at measurement per year	n1
Nr of male lambs at selection per year	n2
Nr of male lambs selected on measurement per year	n3
Nr of young rams for breeding per year	n4
Survival from birth to measurement (n1/n0)	s0
Survival from measurement to breeding age (n4/n3)	s1
Survival of rams	s2
Proportion selected on measurement	psm
Proportion selected on visual traits	psv