

Certification of rams and bucks from community- based breeding programs

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Abstract

This report attempts to assess the implementation of the sires' certification in the framework of Community-based breeding programs of small ruminants in Ethiopia. The existing sire certification system was appraised and areas that need to be strengthened are suggested.

Currently, the existing certification scheme is based on the genetic worth (Estimated breeding value-EBV) of the sire and other technical requirements for certification including physical examination, semen assessment, mating ability and vaccination against prevalent infectious diseases. To strengthen certification procedures, authors suggest:

- The estimation of EBVs should be strengthened by including the accuracy of the EBV in the ranking process, revising the inclusion of six-month weight in the certification process and doing genomic test at early age contributing to the accuracy of estimation based on GEBV;
- Physical examination should be improved by checking genetic defects when examining teeth and removing rams showing any degree of these defects. Some leg abnormalities should be taken into consideration, testis size need to be strengthened in the certification process and environmental factors should be taken into consideration when doing the mating ability test;
- Vaccine schemes and costs should be revised. Attention should be paid to other abortive pathogens in the project area;
- The choice of institutions involved in the certification process should be based on their location (having close working relationship with the CBBPs), capacities and technicity;
- The chronology of the certification process should be revised;
- The certification procedure should be improved by training few personnel on advanced ways of analysis and associated software. Training on other field examinations such as clinical evaluation (including semen evaluation) should also be taken into consideration;
- Depending on the purpose of using rams (AI/natural mating), the certification should indicate this difference;
- The certification procedure can be extended to other species for CBBPs such as swine and cattle;
- The need of formation of breed societies to be gradually involved in the implementation of certification;

Figure 1. Sekota goats herd in Ethiopia



I Introduction

Well designed and highly structured breeding programs, which are the convention in most developed countries, have resulted in huge improvement in productivity and production of meat, milk and eggs. The main contributor for such gains is the presence of well elaborated and sustainable breeding programs, backed by public as well as commercial sector. Breed societies, stud farms, research institutions, academic institutions have contributed to the existence of an elaborate recording system and its functioning. Unlike in the developed world the livestock production system in the developing countries is largely of subsistence type and the market aspect of the system is rudimentary. As a result the system functions in a low input and low output setting. Under such condition introduction of breeding programs, with similar design to those in the developed world, were not found to be successful. Programs and projects initiated to implement selective breeding and other systems of improvement (e.g. cross breeding) have invariably been unsuccessful or unsustainable in the long term due to incompatibility of the genotypes with the breeding objectives, management approaches and environmental conditions prevailing in low-input traditional production systems (Rewe et al., 2002; Ayalew et al., 2003; Kosgey et al., 2006).

Small herd/flock size, absence of collective action, the cost of recording and evaluation and the limited participation of the livestock keepers in the design and implementation of the breeding projects and the low level of extension support are among the major constraints which led to failure. As a way out of the maze, in the period of the last two decades, community-based breeding program (CBBP) has been advocated as a practical method of choice in the traditional livestock production systems, where the conventional type of breeding scheme is extremely difficult to implement. Within-breed selection through a community-based approach is believed to be a more appropriate breeding program for a low-input production system with poorly developed infrastructures (Sölkner et al., 1998; Gizaw et al., 2009; Mueller et al., 2015). The program has also been suggested to be appropriate for conservation of indigenous animal genetic resources (Gemed, 2010). The peculiar features of the CBBP include:

- taking into account the farmers' needs, views, decisions,
- ensuring active participation, from inception through to implementation,
- proper consideration of farmers' breeding objectives, infrastructure, participation, and ownership,

In Ethiopia the program was under implementation, for a period of more than a decade, as pilot program on few sheep and goat breeds by CGIAR centers (ICARDA and ILRI) in collaboration with national partners. Success has been registered (Haile et al., 2020) in areas where partners were committed, and based on the experience gained from implementation of the program ICARDA has scaled up and out its work in places where the program was found to be successful and to other breeds and areas. Information from members of the collective CBBP scheme and results of evaluation have indicated presence of substantial gain from the selection for the traits considered in the selection program and other correlated traits. Use of selected sires, within the CBBP and sale of excess selected sires to others, have been the major modes of utilization of the selected animals. As such ensuring the sires are the right type of animals (superior genotypes) by way of sire certification has become an important component of the overall improvement program. Sire certification is a means intended to reduce the risk of communities using potentially unsuitable rams for breeding and to empower the communities producing improved genetics to be more competitive in the market for sires (Rekik et al., 2018). Additional benefits related to creating suitable condition for insurance policy pertaining to certified rams as high-value asset can also be accrued as a result of certifying the sires. Scheme for sire evaluation and certification has been designed and implemented for some time in some of the areas where CBBP was implemented. Evaluation of the existing scheme and identify areas which need strengthening is found worth attention. In addition to that, the experience gained from the pilot projects with regard to the implementation of sire certification can be of paramount importance and be adapted thereof in other areas and on other species. In this regard, preparation of a relevant policy brief which is based on the past experiences will be of critical importance and contributes in up-scaling and out scaling of the scheme. Therefore, this work was undertaken with the objective of:

- Appraise the existing sire certification system and identify areas which need strengthening suggest a way forward,

- Develop a policy brief on sire certification based on the experiences gained so far.

2 Current pilot certification scheme

The existing certification scheme is based on the genetic worth (Estimated breeding value-EBV) of the sire and other technical requirements for certification which include (i) Physical examination; (ii) Semen examination; (iii) Assessment of mating ability and (iv) Certificate of vaccination against known reproductive diseases.

2.1 Estimated Breeding value

One of the major activities of the CBBPs is record keeping. Records which include basic information related to pedigree (own identity, sire and dam), birth (site, date, sex, weight, type, parity) and growth (weight at six month and yearling) are being kept by CBBPs. Mainly two stage selection where the first stage of selection was based on adjusted 6-month weight of lambs and twinning rate of ewes (for Bonga and Horro) and a final selection based on yearling weight and conformation has been followed. Selection was then performed based on the estimated breeding values and an index constructed that involved more than one trait (Haile, 2020). To meet the demand for selected sires at early age mainly the EBV for six-month weight has been used.

Table 1. Descriptive statistics for the Estimated Breeding Value (EBV) and six month weight (SMWT) for rams/bucks with positive EBV

	EBV				SMWT		
	N	Mean (kg)	SD	Range (kg)	Mean (kg)	SD	Range (kg)
Menz	49	0.333	0.236	0.015-1.24			
Bonga	70	2.031	1.574	0.3-5.2			
Doyogena	90	1.06	0.897	0.0013-3.785	25.56	2.286	19-35
Konso	18	0.36	0.291	0.0213-1.07			

SD: Standard deviation

2.2 Physical examination

Male breeding soundness examination (BSE) is an important component of sheep and goat farming. This examination is meant to forecast the ability of a male to impregnate a given number of females within a defined period of time and is based on clinical and physical examination as well as semen quality (sperm abnormalities detection) (Tibary et al., 2018).

Figure 2. Physical examination of a ram



The physical soundness evaluation includes examination of the eye, teeth, feet, prepuce, penis, testicle size and epididymis for presence of abnormalities. Such physical abnormalities interfere directly or indirectly with the mating ability and well-being of the sire particularly when the sire is required to mate with large number of females (small male to female ratio) within a limited time to male ratio.

2.3 Mating ability and desire (libido)

Group mating may allow weakness in one ram be compensated by strength in the other. Under selective breeding, where controlled mating is a common practice, male fertility is a vital issue because numerous females are generally mated to a single sire. As such the sexual behavior of the ram or buck is an important factor for flock breeding efficiency and productivity. A genetically superior male for some important trait can't pass its superiority to large number of progenies unless it has the ability to successfully mate with large number of females. Therefore, testing the behavioral aspect, particularly the libido, of a sire should be part of the procedure to be followed in certifying rams/bucks. The behavioral aspects which are related to ability to mount, intromission and effective service (ejaculation) need to be observed. Recording and quantifying Latency to first reaction (s), Total activity time (min), Vulva sniffing, Flehmen, lateral approaches and mount attempts when the ram is placed with 2 females in Oestrus for 10 minutes has been suggested for certification of sires from CBBPs (Rekik et al., 2018).

Figure 3. Mating ability or libido test done on the presence of 2 estrous females



2.4 Semen evaluation

Seminal characteristics are highly correlated with the ability to impregnate ewes and semen evaluation can identify most rams of low fertility (Tibary et al., 2018). If the history and examination of the ram and semen show reduced fertility, treatment is not normally possible (Tibary et al., 2018).

Figure 4. Field arrangement for instant semen evaluation



Semen volume, density and motility have been identified as semen quality parameters that need to be considered in the certification process (Rekik et al., 2018).

2.5 Health status

In addition to the clinical evaluation, vaccination for the most important diseases of direct and indirect importance to reproduction, and for which vaccine is available is an important part of the ram certification process.

3 Aspects of current evaluation that need reconsideration

3.1 Estimated Breeding value

The current practice of using the EBV as one component of certifying rams/ bucks is based on ranking the EBV of the males at six months of age. There appears a need for refining this aspect of the procedure for estimation of EBVs and the following suggestions may need to be considered

- The accuracy of the EBV is very critical in determining the genetic worth of a sire and this information need to be part of the ranking process. Use of multiple traits (e.g. weaning, four, five and six month weight) in the analysis apart from providing information on effect of correlated traits it would improve the accuracy of the EBV estimate of potential sires.
- Progenies of production flock are likely to be sold after the age of six months (most likely at yearling) and the genetic correlation that exists between six month weight and weight at the commonest market age need to be determined to justify the inclusion of six month weight in the certification process.

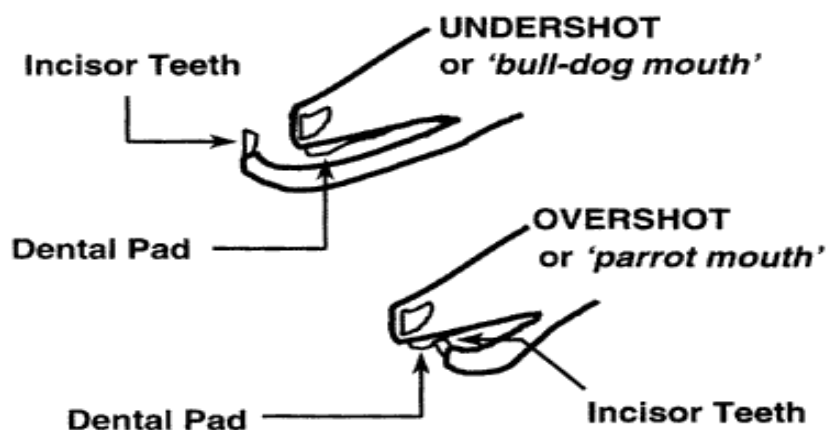
- Alternatively, genomic test at early age can contribute to the accuracy of estimation based on GEBV. The cost of such practice may be prohibitive to be covered by producers and ways the cost can be borne by the public sector (at least for rams to be certified for AI use) as investment on public goods can be advocated.

3.2 Physical examination

The current practice of the CBBPs on physical examination of rams for certification is well detailed and, except for the following few amendments, need to be maintained.

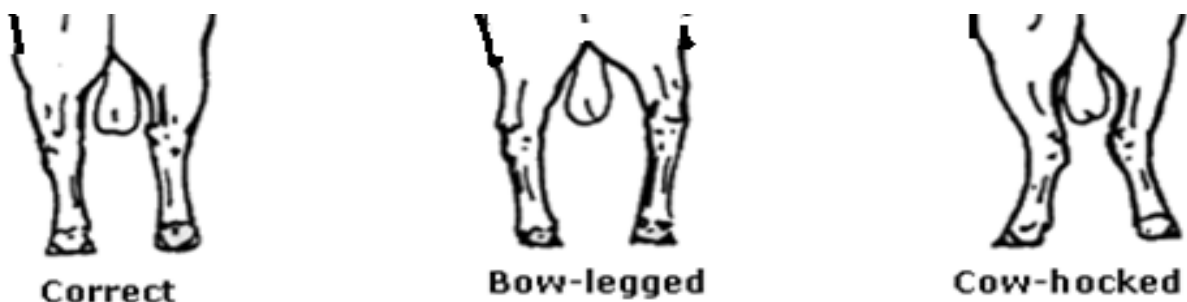
Teeth : A jaw is undershot if the incisor teeth extend forward past the dental pad; it is overshot if the teeth hit in back of the dental pad. These are genetic defects and rams need to be checked for such defects and when found to show any degree of these defects rams should be removed (ewes with slight defects may be kept while those with sever effects are culled).

Figure 5. Sketch showing under shot (above) and overshot (lower) jaw



Legs : In addition to the existing observations, leg abnormalities, of which are known as hocked and bowlegged types of legs, need to be considered. An animal is bowlegged if viewed from the rear, the hocks curve out away from each other. Hocked joint, as opposed to the bowlegged type, if when viewing the hind legs from the rear, the hocks, which are the hind leg joints, are turned inward or are placed too close together. This causes the toes to turn outward.

Figure 6. The variations in the structure of the hind legs at the hock



Testicle size : In addition to its function in the production of semen, testis size in sheep as measured by its circumference or volume, is related to ewe fertility. There is relationship between testis size of ram lambs and ovulation rate in their ewe lamb relatives (Schoemen et al., 1987). As such the importance to be given to testis

size in the certification process need to be strengthened. In breeds where sizeable multiple births exist the most important composite trait is weight of lamb produced per ewe and litter size is very critical in this regard.

Mating ability (libido) test: After doing the clinical evaluation pertaining to the reproductive organs (testis, epididymis, prepuce, penis) the libido test is required to ensure that the ram deposit semen in the female reproductive tract under natural mating or it can supply adequate semen for Artificial insemination. In addition to genetic factors, libido can be affected by environmental factors and care should be taken in comparing and certifying rams kept in different environments. In addition to that, temporarily rams may show lower ability to mate and repeated test within a specified period of time saves genetically superior ram from being rejected.

Health: Clinical evaluation of reproductive ability of rams is an integral part of ram soundness evaluation programs. The majority of problems adversely affecting the reproductive ability of rams can be easily detected during clinical evaluation (Boundy, 1992; Bruere and West, 1993). The procedure is easy to perform, has a small cost and doesn't require specialized support from a veterinary laboratory (Gouletsou and Fthenakis, 2010). However, past studies in the project area (Gebretensay et al., 2019) and elsewhere within the country (Tsfaye et al., 2020; Gezahegn et al. 2021) indicated that at least two or more of the organisms studied as responsible for reproductive failure, including abortion, (*Coxiella burnetti*, *Chlamydia abortus*, *Toxoplasma gondii* and, *Brucella* spp.) were found to be important in the study areas. As such a vaccination scheme against all, or some of the organisms, should be part of the certification requirements. Availability of vaccines and cost considerations when they are available need to be looked into and studies to determine the cost benefit of such vaccination scheme against addressing the issue through other options such as isolating the ram lambs at earlier age to avoid potential infection may need to be considered. In addition to the diseases of reproductive importance, certification of rams need to consider vaccination against the commonest diseases in that area for which vaccine is available. Options for the cost of vaccine to be borne by the public sector may need to be considered.

4 Institutional aspects of the certification process

The ram certification process has various technical and administrative components and relevant and mandated institutions need to be identified and alignment of the institutions be defined.

4.1 Institutions to be engaged

(Because of some restructuring in the livestock development sector institutions are not mentioned by name).

Technical evaluations, particularly the physical and behavioral evaluation, are somehow a routine practice and should be handled by an institution which is in the vicinity and also has close working relationship with the CBBPs. As such research and/or development institutions close by should handle the evaluation process.

Among the technical evaluations, the estimation of the breeding value can be done using diverse models of analysis and it is better done at a central institution (national level) where advanced capacity is built. Model differences can impact the estimation to be made and the accuracy thereof. Research development institutions/ centers periodically send all the necessary data to the central institution which will undertake the analysis using the most parsimonious model and do the estimation of the breeding value and give feedback to the institutions/centers. An improvement in the accuracy of the EBV estimate that arises from use of a better model can have non-trivial outcome in the field. Alternatively high level of advanced training provided to personnel at the institutions and centers can be considered.

Upon finalizing the evaluation and ranking of the rams, the certification process should start by the endorsement of the technical person who led the evaluation to be followed by the approval of the department/directorate/

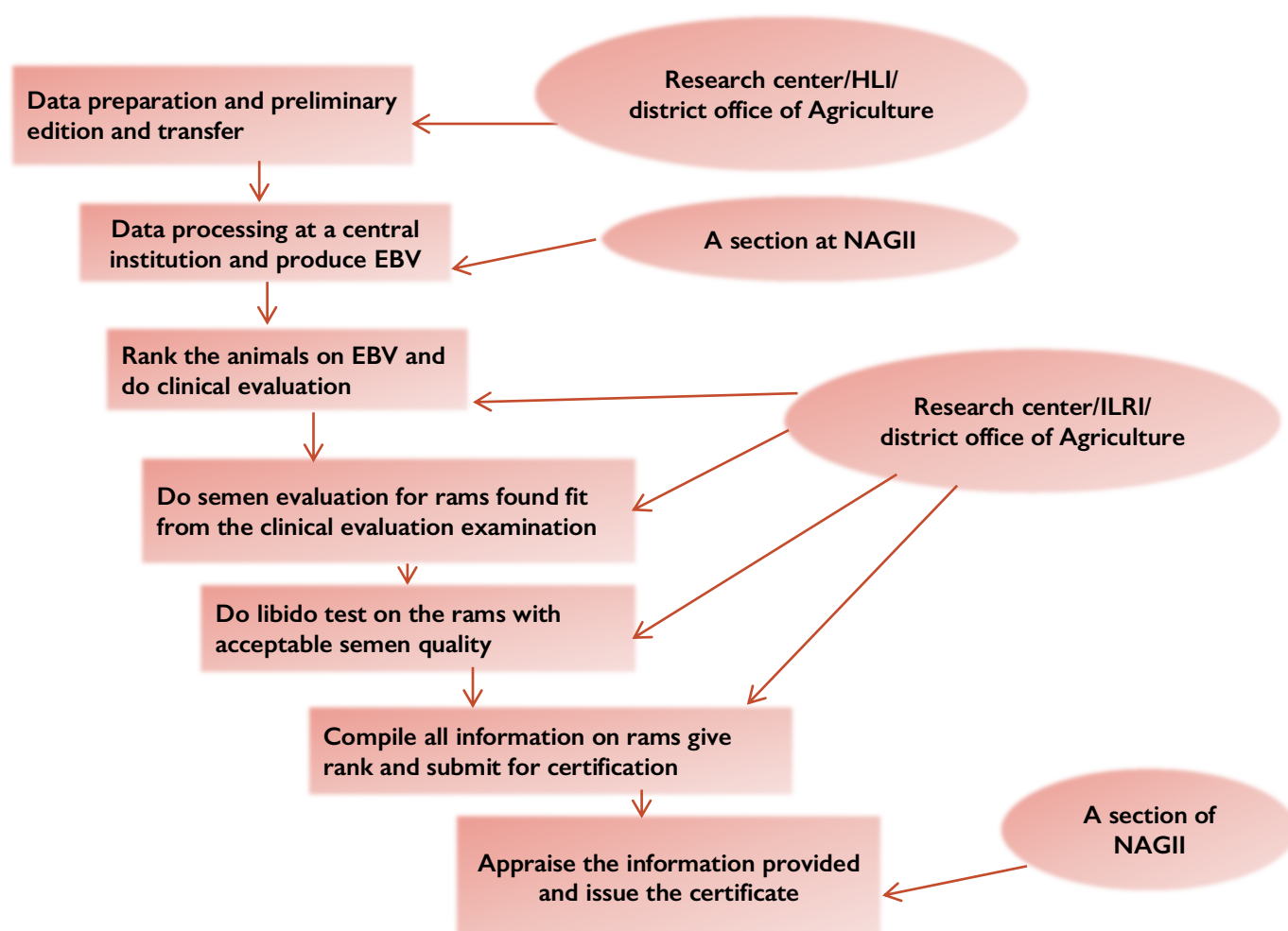
section head and the head of the institution/center. The approved document should be sent to the central institution for appraisal of the information provided for certification, decision on the grade and final issuance of the certificate.

Obviously, the clinical evaluation component should be done by a veterinarian/ or assistant veterinarian using standard procedure and a separate format. The format which would also follow the same procedure of authorization will be attached and submitted along the other certification request format. The clinical evaluation, as it is intensive in nature, only rams which have ranked higher in the other evaluation procedures should be considered.

4.2 Chronology of the certification process

Stepwise data preparation and preliminary edition should be done at the beginning and then followed by analysis at the central institution. Based on EBVs provided by the central institution ranking of the animals will be done and those with positive breeding value will be considered for other physical examinations. Those, which are found to be fit by the preliminary physical examination, will be exposed to detailed clinical and semen evaluation. The last procedure will be the mating ability or libido test. The results to be obtained from the various tests should be compiled, endorsed and submitted for authorization of a certificate. Except the work for EBV estimation the research and or development centers/institutions should develop the capacity and the capability to do the other evaluation processes.

Figure 7. Flow chart of a ram certification process



5 Capacity gaps identified and needs for training

The procedures to be accomplished within the certification process need to be done meticulously so that the right types of animals are certified. The consequence of certifying a wrong animal will be immense as it affects the trustworthiness of the certification process on top of the loss of what should be gained. As such personnel to be involved in the certification process need to be well trained. However, the types of trainings to be offered are simple and can be addressed with a few days of training and practical exposure.

5.1 Existing capacity gaps

As has been indicated earlier, the analysis of the data with the objective of getting the EBV with the best accuracy, a level of training which is more advanced is required. Currently, simpler models are being used and such models may compromise the accuracy of EBV. On the other hand clinical evaluations should be done by someone with a veterinary background and based close to the CBBP sites. In some cases there could be alternative procedures (e.g. body condition score with increments of 1 or 0.5; libido test) or individuals may follow a habitual procedure (e.g. position of a measuring tape for scrotal circumference measurement) of their own for the same parameter. Standardization of the procedures to be followed within and between CBBPs require some level of training along with the development of clear and detailed guidelines. Semen evaluation facilities may lack for each CBBPs and the existing mobile facility may need to be strengthened and a similar facility be made available at each CBBP.

5.2 Training needs

The first step in the preparation for certification is the analysis of the data to obtain EBV. The suggestion is to do the analysis for EBV at a central institution and training few personnel on advanced ways of analysis and associated software would suffice to meet the capacity requirement. Topics to be covered may include, inter alia, multivariate, random regression, Bayesian statistical analysis and bioinformatics. The training for the clinical evaluation should include procedures on examination of eye, mouth, legs, and the male reproductive organs; and the types of abnormalities that may exist. The same or different personnel should be trained on semen evaluation.

5.3 Level of training and resource persons

Training on advanced data analysis and software is suggested to be a hands-on short term training of 3 to 4 weeks. The training on clinical evaluation (including semen evaluation) may need a hands-on training of 3 to 5 days. The advanced data analysis training can be offered by a local trainer or expatriate who is considered to be an authority in the area. The clinical evaluation training can be offered by a local trainer who has rich experience and adequate expertise in the area.

6 How to certify sires meant for Artificial insemination and natural mating?

Rams to be certified may need to be categorized into two: those to be used for AI purposes (Grade A) and those to be used for natural mating (Grade B). Those rams which are at the top of the overall ranking are better used for AI and need to be priced differently. As such, the certification should also indicate this difference and

there should be an entry in the certification format that shows the grade the ram is assigned to. Depending on the situation on the ground about the top 25% of the certified rams can be categorized as Grade A and the next 75% as grade B. Some rams, which are found to be superior for most of the parameters and show slight defects for a single physical appearance (e.g. slightly overshoot or under shot jaw), may also be assigned under the category grade B. For grade A category any type and level of defect may not be tolerated as the ram is likely to produce large number of progenies through AI.

7 Ways to up-scale and out-scale the certification process

The institutional arrangements, to be put in place for the estimation of the breeding values and the processing of the issuance of certificates of breeding soundness, can be similarly used for other sheep and goat breeds. Due to the need for record keeping and commitment from producers formation of CBBPs will be an important requirement for the extension of the certification procedure. Similarly, the procedures can be employed for CBBPs in swine and cattle. The practicality of such certification procedure for cattle may need further work as the number of bulls that may be available for evaluation from potential CBBPs is likely to be small. However, the potential advantage of the high value of a breeding bull and the possibility of working through GEBV may favor the use of similar certification procedures.

8 Formation of breed societies

In the long run formation of breed societies, which will handle the registry and certification, need to be established. At the initial stage public support need to be provided but through time the support can be withdrawn as the society gets strong and self-sustaining. The roles of the breed societies will be:

- Guide breeding practices: The society will strengthen record keeping, and initiate a breed registry which would provide information on merits of breeding animals and on their optimal use.
- Shows and competition: The society will introduce shows and competition so that breeders benefit by getting the chance to advertise their superior breeding animals. In addition to that participating breeders get experience on the type of animal they should look into in their breeding activities.
- Sales and promotion (market support): The society publishes and provides information on the breeder animals which are available at the various breeding farms and this will link them with the market.
- Breed standards: The society sets breed standards that contribute to maintain the merits of the breed. Additionally with increase in the level of improvement of the breed the standard may contribute to germplasm market at international level.
- Create awareness: The breed society shall play a crucial role of creating awareness on the importance of breed societies in the development of the breeds.

9 References

- Alemayehu G, Mamo G, Alemu B, Desta H, Tadesse B, Benti T, Bahiru A, Yimana M and Wieland B. 2021. Causes and Flock Level Risk Factors of Sheep and Goat Abortion in Three Agroecology Zones in Ethiopia. *Front. Vet. Sci.* 8:615310. doi: 10.3389/fvets.2021.615310
- Ayalew, W., Rischkowsky, B., King, J.M., Bruns, E., 2003. Crossbreds did not create more net benefits than indigenous goats in Ethiopian smallholdings. *Agric. Sys.* 76, 1137–1156.
- Boundy, T., 1992. Routine ram examination. *In Pract.* 14, 219–228.
- Gebretensay, A., Alemayehu, G., Rekik, M., Alemu, B., Haile, A., Rischkowsky, B., Aklilu, F., Wieland, B. 2019. Risk factors for reproductive disorders and major infectious causes of abortion in sheep in the highlands of Ethiopia. *Small Ruminant Research* 177:1-9
- Gemeda Duguma. 2010. Participatory definition of breeding objectives and implementation of community-based sheep breeding programs in Ethiopia. A PhD thesis, University of Natural Resources and life sciences, Vienna.
- Gizaw, S., Komen, H. and Van Arendonk, J.A.M., 2009. Optimal village breeding schemes under smallholder sheep farming systems. *Livestock Sciences* 124, 82-88. <https://doi.org/10.1016/j.livsci.2009.01.001>.
- Gouletsou P.G., Fthenakis G.C. (2010). Clinical evaluation of reproductive ability of rams. *Small. Rumin. Res.* 92: 45-51.
- Haile, A., Getachew, T., Mirkena, T., Duguma, G., Gizaw, S., Wurzinger, M., Soelkner, J., Mwai, O., Dessie, T., Abebe, A., Abate, Z., Jembere, T., Rekik, M., Lobo, R.N.B., Mwacharo, J.M., Terfa, Z.G., Kassie, G.T., Mueller, J.P. and Rischkowsky, B. 2020. Community-based sheep breeding programs generated substantial genetic gains and socioeconomic benefits. *Animal* 14(7):1362–1370.
- Kosgey, I.S., Baker, R.L., Udo, H.M.J., Van Arendonk, J.A.M., 2006. Success and failures of small ruminant breeding programs in the tropics: a review. *Small Rumin. Res.* 61, 13–28.
- Mueller, J.P., Rischkowsky, B., Haile, A., Philipsson, J., Mwai, O., Besbes, B., Valle Zárate, A., Tibbo, M., Mirkena, T., Duguma, G., Sölkner, J. and Wurzinger, M., 2015. Community-based livestock breeding programmes: essentials and examples. *J. Anim. Breed. Genet.* 132, 155–168.
- Rekik, M., Haile, A., Rischkowsky, B., Getachew, T., Wieland, B. 2018. Guidelines on Institutional and Technical Certification of Breeding Rams in Ethiopia. ICARDA (Tools and Guidelines). Addis Ababa, Ethiopia: ICARDA.
- Rewe, T.O., Ogore, P.B., Kahi, A.K., 2002. Integrated goat projects in Kenya: impact on genetic improvement. 7th WCGALP, August 19 – 23, 2002, Montpellier, France
- Ridler A.L., Smith S.L., West D.M. (2012). Ram and buck management. *Anim. Reprod. Sci.* 130: 180-183.
- Schoeman, S.J., Heleen C. and Combrink, G.C. 1987. A preliminary investigation into the use of testis size in cross-bred rams as a selection index for ovulation rate in female relatives. *S. Afr. J. Anim. Sci.* 17(3): 144-147.
- Silvio, R. O. M., Júlio O. J. B., João B. S. B., Maria E. A. C., Vanessa P., Celso K. J., Flávio G. L. and Heitor J. C. 2014. Breeding soundness examination: Understanding the causes of examination failure in young and mature Rams *International Journal of Plant and Animal Sciences* 2 (2):098-104.
- Sölkner, J., H. Nakimbugwe, A. Valle-Zárate. 1998. Analysis of determinants for success and failure of village breeding programmes. *Proceedings of the 6th World Congress on Genetics Applied to Livestock Production*, Armidale, Australia, 12–16 January 1998.
- Tesfaye, A., Sahele, M., Sori, T., Guyassa, C. and Garoma, A. 2020. Seroprevalence and associated risk factors for chlamydiosis, coxiellosis and brucellosis in sheep and goats in Borana pastoral area, southern Ethiopia. *BMC Veterinary Research* 16:145.
- Tibary, A. and Boukhliq, R., and El Allali, K. 2018. Ram and Buck Breeding Soundness Examination. *Rev. Mar. Sci. Agron. Vét.* 6 (2):241-255.