Reproductive Platform to Support and Scale Goat Breeding Programs: Ethiopia and Tanzania

Funded by MBoss project "Out scaling of community-based breeding programs: Attractive and innovative approach to improving the lives of smallholder goat producers in low input systems"

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Contents

Highlights

- A reproductive platform is established to support scaling and system delivery of goat breeding programs in Ethiopia and Tanzania
- Three low-infrastructure, mobile laboratories are operational delivering artificial insemination and other reproductive services
- A total of 43 researchers, vets and extension staff have received advanced, focused training on goat reproduction and reproductive biotechnologies
- Synchronizing with 2 injections of a prostaglandin analogue 7 or 11 days apart prior to fixed-time artificial insemination yields a high oestrous response and satisfactory conception rates
- Conception rates after fixed-time artificial insemination vary between 48 and 77%

Framework

In Ethiopia and Tanzania, goats are mostly kept by smallholders and the rural poor, including women headed households. The goat population is estimated at 24.1 million in Ethiopia and 15.4 million in Tanzania. Goats contribute substantially to the livelihoods of smallholder households as a source of income, food, and raw materials (skins). They also serve as a means of risk mitigation during crop failures, savings and investments in addition to other socioeconomic and cultural functions. However, the small ruminant industry in Ethiopia and Tanzania is faced with various challenges. Productivity per animal and flock off-take are low. For example, recent estimates of the average annual off-take rate from goat flocks for the years 2008 to 2010 indicate values between 30% and 38% for Ethiopia and 57 % in Tanzania.

Productivity is low for a range of reasons: high kid mortality, low growth rates, poor nutritional status resulting in infertility and long kidding intervals and disease prevalence. Controlled breeding is rare and there is limited culling of poorly performing does and breeding males.

A powerful tool for enhancing livestock productivity is genetic improvement; genetic changes are passed on to the next generation while changes in husbandry practices have to be sustained continuously. This tool, however, has been poorly utilized, and attempts in establishing straight breeding programs in developing countries—in particular for small ruminants—have often remained unsuccessful. In the past, most breeding programs were established centrally on governmental farms with little participation of the producers. This often led to wrong definition of breeding objectives or a loss of adaptation to challenging environmental conditions leading to poor productivity and high mortality rates.

Recently, a new approach—community-based breeding programs (CBBP)—has been suggested as an alternative to the conventional centrally managed and top-down breeding programs (Haile et al., 2014; Mueller et al., 2015). Programs that adopt this strategy take into account farmers' needs, views, decisions, and active participation, from inception to implementation. In this context, the MBoss project aims at out/up-scaling CBBPs for local goat breeds in Konso, Sekota and Abergelle in Ethiopia and in West Kilimanjaro in Tanzania. The scaling has two components: expanding the number of household members in current CBBP's and establishing new CBBP's in new villages of the different project target areas.

To meet the scaling scenario, there are at least 2 strategies that should work simultaneously. Under strategy 1, scaling is achieved with more males produced per CBBP and under strategy 2, scaling is achieved with more intense use of males. The second scenario requires additional technical, capacity building and financial investments in setting-up and implementing, at scale, efficient, low-cost synchronization and artificial insemination protocols for wider dissemination of improved genetics.

Definitions and geographical expansion

Artificial insemination (AI) allows using fewer males and/or allows an increase in the number of females served with improved males. This includes a number of associated techniques starting with appropriate synchronization protocols, semen collection, evaluation and processing as well as semen deposition. However, other reproductive interventions such as ultrasound-based pregnancy diagnosis, breeding soundness examination are likely to improve the effectiveness of AI and to increase the reproductive performance in the CBBP-based flocks. Such an improvement of the overall reproductive performance is appreciated by the farmers and consolidates their engagement in the breeding program. In what follows a brief definition of the terms and concepts around the reproductive component being developed to support scaling of CBBP's.

Reproductive Platform

The reproductive platform is a very generic term designating the infrastructure put in place, the technologies being developed and the development of the national capacities in the field of goats' reproductive technologies and biotechnologies. It also encompasses functional procedures on how it can support the breeding program, how it contributes to the data flow, how it establishes linkages between relevant national institutions (research centers, universities, national AI centers, private veterinarians…) and how it synergizes exchange of knowledge between the different project target areas. The reproductive platform is therefore a concept across breeds, across sites, across countries and represents a dynamic space for the enhancement of CBBP's. The concept of reproductive platform can further grow to become a hub from which bundled services (reproduction – selection – health – nutrition) are provided to the communities enrolled in CBBP's.

Low-infrastructure artificial insemination laboratory

This is related to the physical structure ICARDA and its partners jointly developed, and these structures are embedded in the national collaborating centers: Amhara Region Agricultural Research Institute (ARARI), Tigray Agricultural Research Institute (TARI) and (South Agricultural Research Institute) SARI in Ethiopia and Tanzanian Livestock Research Institute (TALIRI) West Kilimanjaro from Tanzania (Figures 1 and 2). The high resolution versions of the maps can be accessed at https://mel.cgiar.org/reporting/report/activity_id/1671/id/6754/del_id/15517.
The national centres engaged in providing and upgrading the physical premises to host the labs. They also provided some of the key needed equipment such as a contrast-phase microscope, a water bath, a heating plate, a refrigerator a generator (for field AI's) and common laboratory glassware and supplies. They also secured electricity and running water. ICARDA investment into these labs was materialized by the supply of a spectrophotometer for the evaluation of bucks' semen, an ultrasound machine for routine transabdominal pregnancy diagnosis, precision micropipettes and specific supplies for goats' AI including artificial vaginas and accessories, AI guns, speculum, straws and sheath, extender, lighting sources, extender… We are here in presence of a co-investment partnership. One major feature of these low-infrastructure labs is their mobility. This feature is imposed by the current structure of the AI system. So far, we are using fixed time AI's after synchronization with semen collected, processed and deposited at 35 °C. This requires a setting of the lab in proximity of the community superior bucks and the community goats to be inseminated. Out of the equipment and supplies described above, we have established a "mobile kit" which can be easily transferred, installed and used under full field conditions.

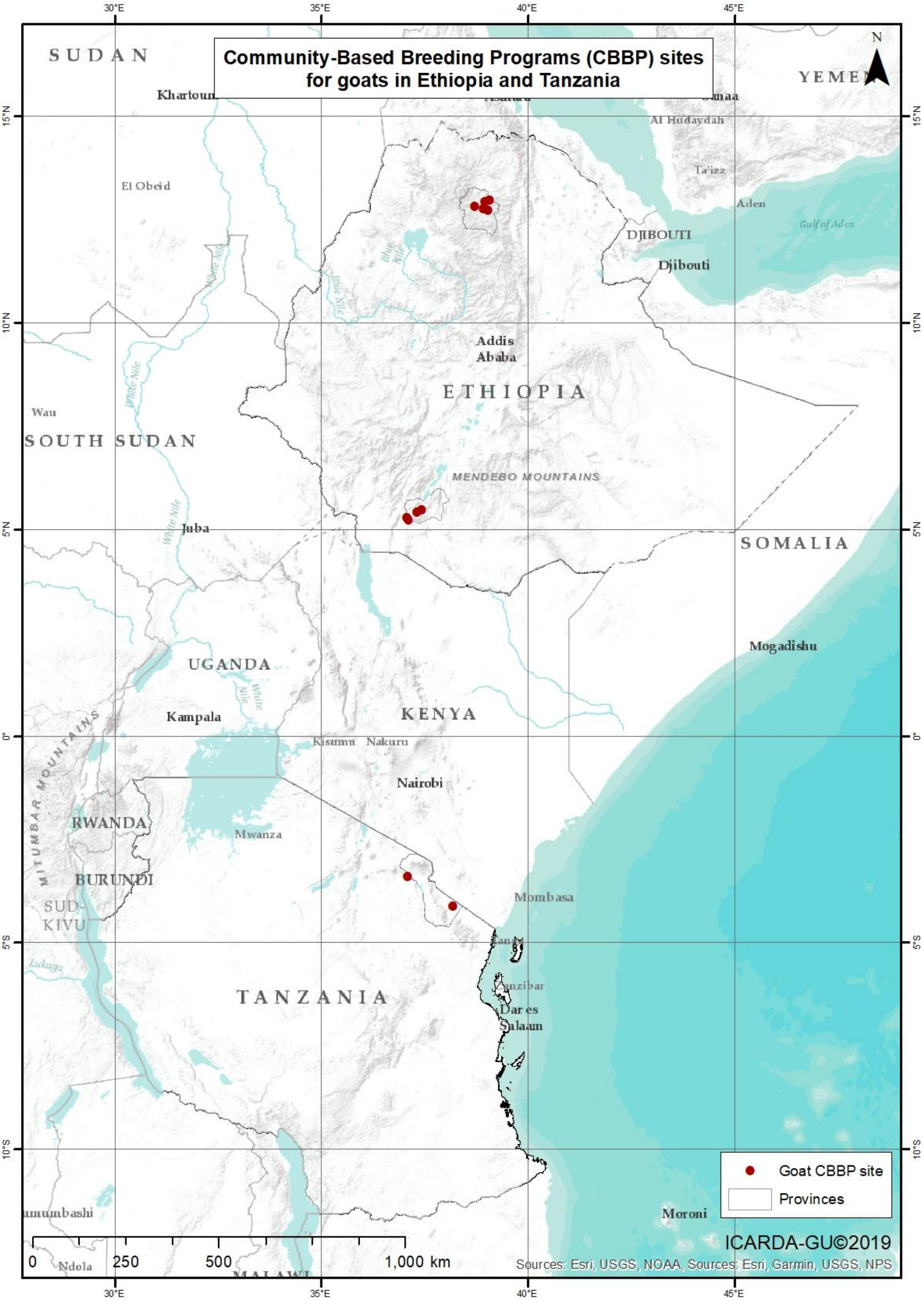


Figure 1. Project target areas in the provinces of Wag_Himra (Sekota) and Segen_Peoples (Konso) in North and South Ethiopia, respectively and Kilimanjaro in Tanzania

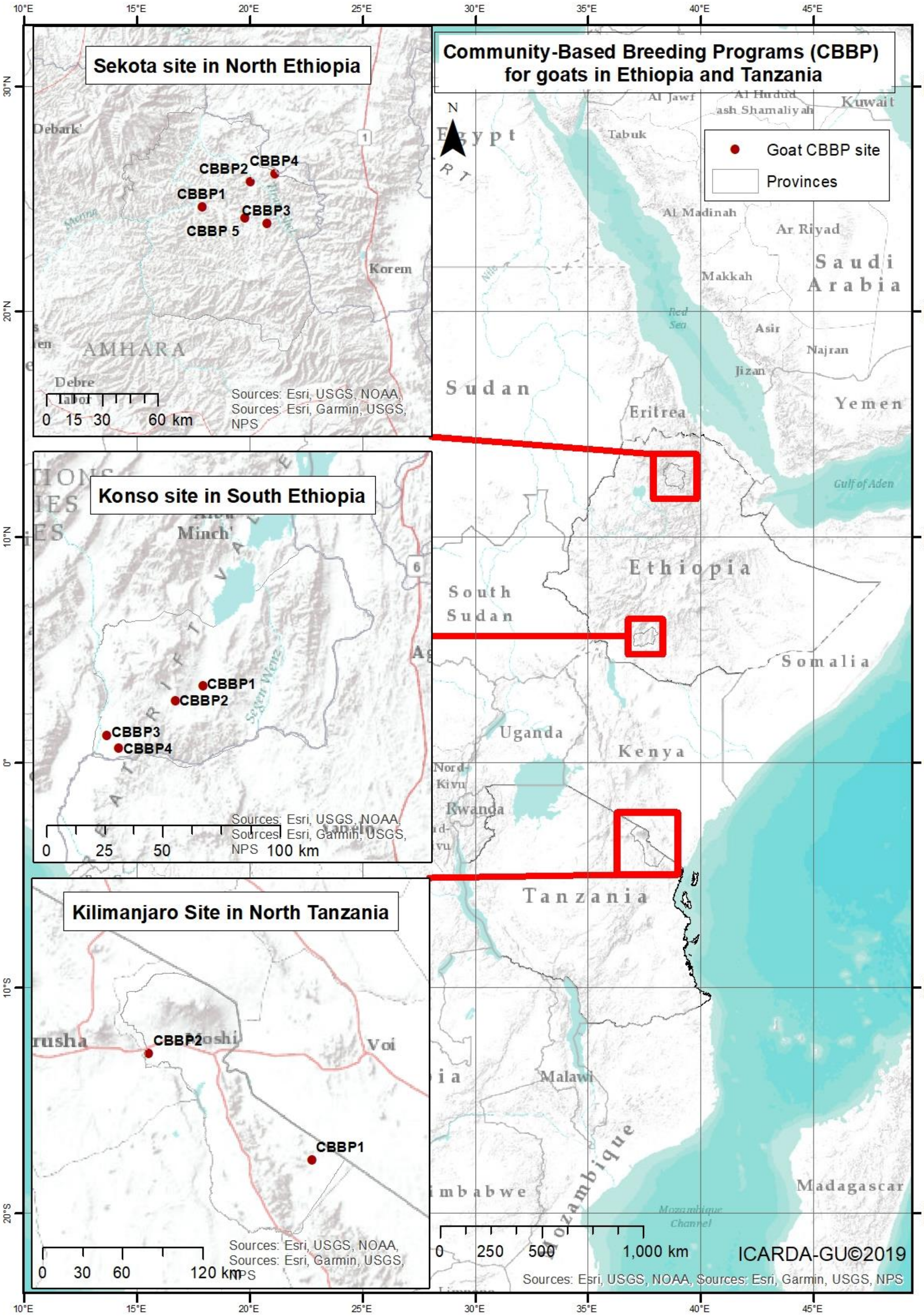


Figure 2. Location of the different CBBP's in the different project areas

Currently, the project is targeting 12 CBBP’s across the 3 locations (Figure 2). Number of CBBP’s is higher in Ethiopia because the concept of CBBP is newly established in Tanzania. Table 1 describes the current expansion of the different CBBP’s and sets a scaling ambition for the different locations. A scaling ambition is a long-term goal and critical preliminary questions need to be asked in this regard:

- Why are we scaling goat CBBP’s? What is the problem we are trying to solve;
- For whom are we scaling? Who are benefiting from scaling along the value chain;
- By whom? Who is driving the scaling process;
- Where are we scaling? Country boundaries, provinces, villages;
- How many CBBP’s, households, flocks, number of goats are we scaling? What is a realistic target given the resources;
- When are we scaling? What is a realistic timeline.

Realistic scaling road maps must be developed for each target area and should be carefully assessed by an objective analysis of the main scaling ingredients: Technology /Practice; Awareness & Demand; Business cases; Value Chain; Finance; Knowledge & Skills; Collaboration; Evidence & learning; Leadership & Management; Public Sector Governance.

Table 1. Current and future expansion of goat CBBP’s in the different target locations

CBBP Site	**Physical location**			**Current expansion**			**Potential expansion (scaling)**		
	Altitude (m)	N	E	Villages	HH’s	Goats	Villages	HH’s	Goats
Konso - Ethiopia									
Baide	1202	05°28'14"	037°26'00"	2	210	1050	1	50	210
Arfaide	1565	05°24'49"	037°19'35"	4	125	500	1	15	300
Masoya	605	05°16'39"	037°03'49"	3	170	2800	-	30	800
Tebela-Kuchale	594	05°13'42"	037°06'31"	8	184	1800	2	100	900
Jarso	901	NA	NA	4	76	910	1	40	400
Sekota - Ethiopia									
Bilaqu	1308	12º48’ 41.39’’	38º43’22.02’’	NA	130	2605	NA, 12 CBBP’s to be reached	480	8880
Saziba	1331	12º55’56.91’’	38º57’22.15’’						
Addis Mender	1960	12º43’44.64’’	39º02’01.12’’						
Workadivno	1425	12º 58’ 12.97’’	39º 04’17.70’’						
Alikozu	1864	12º45’28.6’’	38º55’36.12						
Kilimanjaro - Tanzania									
Same		04º 07’ S	37º 71’	NA	107	317	NA, 4 CBBP’s to be reached	500	6,000
Hai		3º S 24’ S	37º 5’			1030			

Partnership and human capacity development

In addition to the co-investment in infrastructure, ICARDA has also extensively invested in the human capacity development of the human resources part of the platform. In 2018 and early 2019, four short-term trainings were implemented as per the following schedule:

- March 28 – April 1st: Training of 11 SARI staff in Konso in conjunction with the first round of AI’s;

- June 28 – July 4: Training of 13 ARARI and TARI staff in Sekota in conjunction with the first round of AI's;
- November 6 – November 8: Advanced training in ultrasound-based pregnancy diagnosis in sheep and goats https://mel.cgiar.org/capdev/capdev/id/2900 for 13 site level coordinators of sheep and goats CBBP's in Ethiopia; 4 staff members represented CBBP's for goats;
- January 4 – January 6 (2019): Training in Kilimanjaro of 15 staff members of TALIRI and other Tanzanian institutes.

The trainings focused on the theoretical aspects of goat reproduction and physiology, the control of the oestrus cycle, tools to deliver improved genetics in small ruminants and steps of artificial insemination. An important time frame was also dedicated to the practical aspects of semen collection, evaluation and processing, the organization and the management of AI campaigns as well as bucks' breeding soundness examination and ultrasound pregnancy diagnosis.


Low infrastructure setting for semen evaluation and processing in Konso (Photo credit: ICARDA)

In terms of long-term degree training, Bekahegn Wondim from TARI is completing his MSc on comparing different synchronization protocols for their efficiency to carry out AI in goats. He is registered in Bahir Dar University College of Agriculture and Environmental Sciences. The field work was completed in June-July and kidding data is being collected for both on-farm and on-station trials.

It is also worth reporting the collaboration between sites, the reproductive platform has created. In Konso, the newly established team on goat reproduction was technically supported by the staff of Areka in charge of the Doyogena sheep CBBP who have been already exposed to sheep AI and associated reproductive techniques for the last 4 years and who have acquired a very good field experience. Similarly, the team in Sekota were technically backstopped by the staff of Debre Birhan Sheep Research Centre who are in charge of the sheep CBBP in Menz.

On the partnership, it is also interesting to report on the synergy and collaboration between TALIRI in Kilimanjaro and the National Artificial Insemination Centre (NAIC) with a very long experience in cattle AI; this collaboration could be very useful in developing AI in goats.

Services provided through the platform

The reproductive platform provides the communities with services aiming at a wider dissemination of improved genetics, hence representing a crucial link in the chain of events leading to scaling of CBBP's. Following selection of the best community bucks based on both the acceptable phenotype and the breeding value responding to the breeding objective of the CBBP, young bucks are systematically screened for their breeding capacity. The artificial insemination protocol has several steps such as the selection of recipient goats, synchronization, semen processing and deposition and the post-AI management. Ultrasound-based service delivery of pregnancy diagnosis is also an important intervention through the platform. A brief description of the different services provided by the platform is given in what follows.

Breeding soundness examination

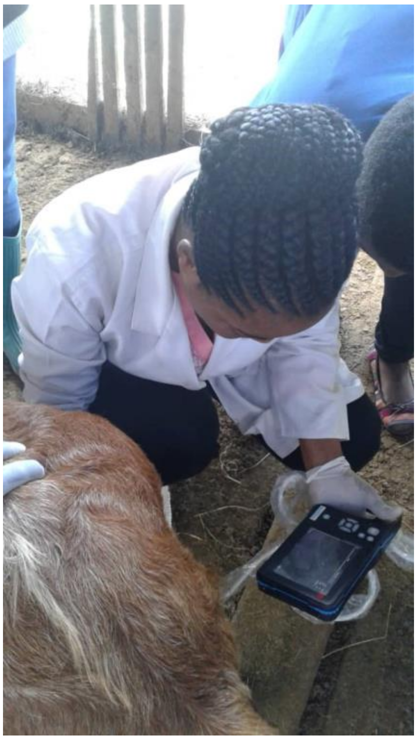
The breeding soundness currently developed comprises 3 aspects: the physical/clinical examination, semen examination and assessment of the mating ability. Details of the technical certification of sheep and bucks can be found at https://cgspace.cgiar.org/handle/10568/77701. Further to the general clinical check-up, a very thorough examination of the reproductive organs (scrotum, testicles, penis, prepuce…) is carried out. Under current conditions of CBBP in Ethiopia, semen evaluation is restricted to a straightforward gross density and gross motility assessment. For the time being, the mating ability is limited to whether the buck has been observed displaying normal service behaviour and intromission when presented with females in oestrus. Ultimately, the teams are capacitated to undertake an objective assessment of the libido and semen fertility.

Collecting semen from bucks for evaluation in Konso (Photo credit: ICARDA)

Service delivery of ultrasound pregnancy diagnosis

Ultrasound-based solutions fit into the broader concept of clean, green management of sheep and goat reproduction and are effective in managing reproduction of small ruminants (https://cgspace.cgiar.org/handle/10568/80981). Nowadays, ultrasound-based solutions are available as easy-use, high resolution, portable machines; prices are going down and they are more accessible to suit even the most extensive, low input systems. In addition to screening for pregnant females and litter size, ultrasound-based solutions can be used to:

- Check on repeat breeders;
- Check on females with recent reproductive pathologies;
- Discard pregnant females prior to synchronization and AI, particularly when the synchronization protocols rely on the use of prostaglandin analogues;
- Prevent slaughter of pregnant females (very common in Ethiopia).



Pregnancy diagnosis of goats in Tanzania (Photo credit: ICARDA)

Oestrus synchronization

Fixed-time artificial insemination works only when females are synchronized. Technically and economically, this is the universal method to practice AI's in sheep and goats. The AI field solution which is being promoted to scale the different CBBP's also relies on synchronizing goats followed by a single AI. It was therefore very important to work on finding out the best synchronization protocols which consider the physiology of the goats, which lead to a synchronization that allows use of fixed-time AI, which can be affordable for farmers and which use hormones that are locally available if business models are to emerge from this activity. In the 3 different locations where we are working, there is no data at all formally describing seasonality of reproduction of the existing goat breeds. Such studies are expensive to undertake and time consuming (at least 15 months of weekly observations and sampling). Therefore, we opted to use secondary information, interviews and existing literature to approach the reproductive seasonality of the goats.

By looking at the geographical locations, one may think that, globally, the 3 locations are very close to the equator and therefore, one may expect that goats are not sensitive to photoperiod and could be classified as year-round breeders. This statement is very theoretical and field experience has shown that even though sheep and goat breeds may not be sensitive to photoperiod, other environmental factors can have a large influence on determining clear patterns of reproduction during the year (feed availability, rainy season, temperatures, migration patterns…).

We relied on the existing natural kidding distribution in the 3 locations to depict any clear seasonal pattern in mating activity. These patterns are shown in figures 3 and 4 for Ethiopia and Tanzania, respectively.

Figure 3. % kidding distribution in Ethiopian sites

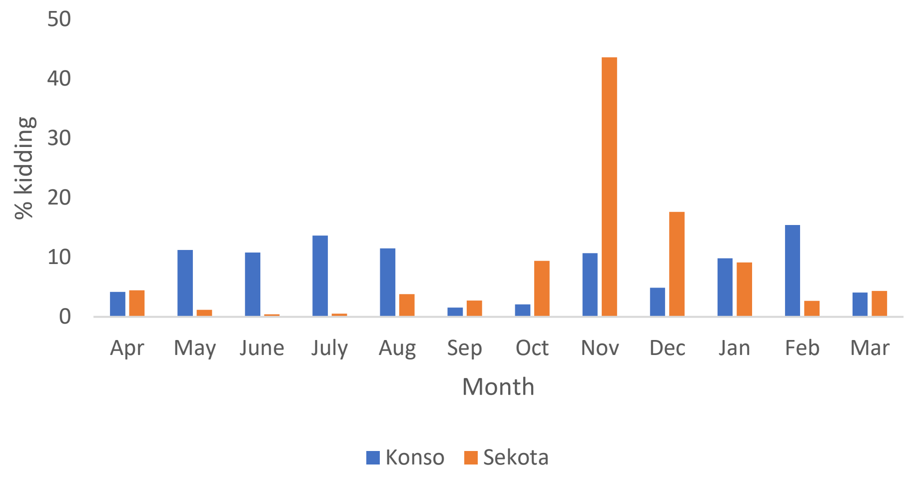
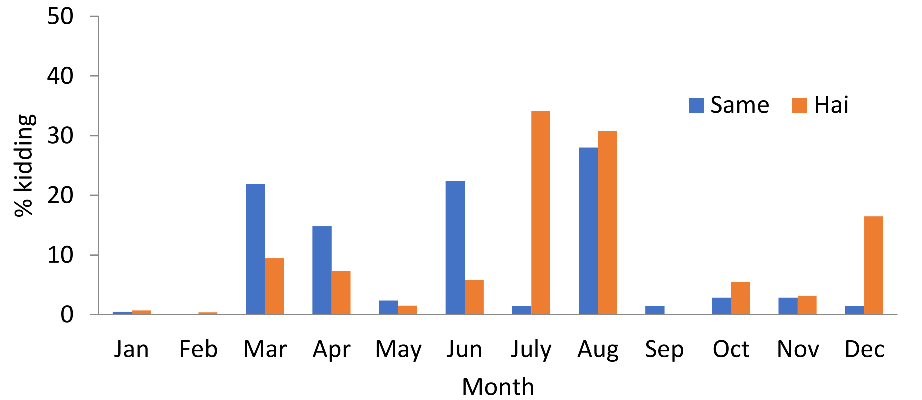


Figure 4. % kidding distribution in the 2 project sites in Kilimanjaro



In Konso, there is no clear pattern of seasonal distribution of births in the flocks; most of the births occur during 2 main long seasons. The first kidding season extends from May to August corresponding to a mating activity between December and March. There is another less marked birth season in January and February which corresponds to a second mating season between August and September.

In the very dry environment of Sekota location, 80% of the births occur between October and January (that is the wet season) and this corresponds to a very restricted breeding season between June and July.

Kidding season is extended between March and August in Kilimanjaro with a high concentration between June and August. Little differences can be depicted between the 2 sites. The kidding pattern indicates that goats in both sites can invariably mate between October and March.

Such data is important to design appropriate synchronization protocols and to schedule the main AI campaigns in the different locations.

There are many synchronization protocols of oestrus and ovulations in goats which can allow fixed-time artificial insemination; in other words, the level of compactness of oestrus behaviour among a group of goats allows a fixed-time AI on most of the synchronized females. These are summarized in figure 5. Some protocols can only work when the goats are in the state of anoestrus, others are more specific to the breeding season when the goats are spontaneously ovulating and there are universal protocols which can work anytime in the year and for all breeds.

When the goats are in anoestrus, goats can be induced to breed with the buck effect. However, with the buck effect, the oestrus response is usually dispersed over 9 days following introduction of the bucks and does not allow the use of AI (Protocol 1; Figure 5). With a single injection of natural progesterone (20 mg in 2 ml oil), the spread of oestrus is considerably reduced, and most goats display oestrus between days 3 and 4 after introduction of bucks. Such a protocol can be used for fixed-time artificial insemination but requires an additional control of oestrus with a harnessed buck (Protocol 2; Figure 5).

During seasonal anoestrus (but also during the breeding season), goats can be synchronized with the progestogen-based long protocol. Progestogen-based intravaginal sponges are inserted and left in-situ for 16-17 days. At sponge removal, goats receive and I.M injection of equine chorionic gonadotrophin (eCG) and fixed-time artificial insemination is carried out within 48 hours after the end of the hormonal treatment (Protocol 3; Figure 5). If the goats are in their natural breeding season, satisfactory results can still be obtained by removing the injection of eCG. However, a slight spread of the moment of ovulation is expected.

The most used protocol across the world is the progestogen-based short protocol (Protocol 4; Figure 5). In addition to a shorter period of sponge insertion (only 11 days), the protocol associates eCG and prostaglandin at day 9 after sponge insertion therefore targeting both anoestrus and spontaneously ovulating goats in the flock. Because of acting on all goats irrespectively of their physiological status, we call it the universal protocol. The protocol is very effective in inducing a highly synchronized oestrus and ovulations and AI's are usually carried out between 43 and 48 hours after removal of sponges.

In spite of the advantages associated with the use of the progestogen-based protocols, there are many drawbacks like disturbance in the luteinizing hormone (LH) secretion patterns, altered follicular dynamics, production of eCG antibodies and impaired sperm motility inside the female reproductive tract thus reducing the possibility of achieving a good synchronization between the time of ovulation and the time of spermatozoa reaching the ovum. Additionally, it has been reported that intravaginal devices decrease sexual attractiveness in ewes due to alterations in the vaginal flora, thus, limiting the effectiveness of a teaser ram in detecting ewes in oestrus.

During the breeding season and this is also valid for non-seasonal breeders at any time of the year, synchronization can be achieved by a double injection of a prostaglandin analogue 7 or 11 days apart. The most common protocol is 11 days interval between the 2 injections, but it has been shown that the quality of the growing follicles can be superior if the second injection is given after 7 days. Goats are inseminated between 45 and 48 hours after the second injection (Protocols 5.1 and 5.2; Figure 5). The advantage of such a protocol is its reduced cost compared to progestogen-based protocols, the availability of the hormone (most countries in Africa have more than one prostaglandin analogue registered and available in the market). This is not the case for progestogen-impregnated vaginal sponges. In addition, synchronization with prostaglandins yields a “clean” oestrus, hence promoting higher conception rates after AI. Under field conditions, extreme care should be taken not to synchronize goats which are already pregnant. In goats, pregnancy is maintained by progesterone secreted by the corpus luteum throughout gestation. The use of prostaglandins on pregnant animals (at any stage) causes lysis of the corpus luteum and an immediate abortion ensues. In the protocol we have developed for goats in both countries, farmers are first asked the question if their goats are pregnant or not before being selected for AI and then, the technical team double checks using ultrasound pregnancy diagnosis.

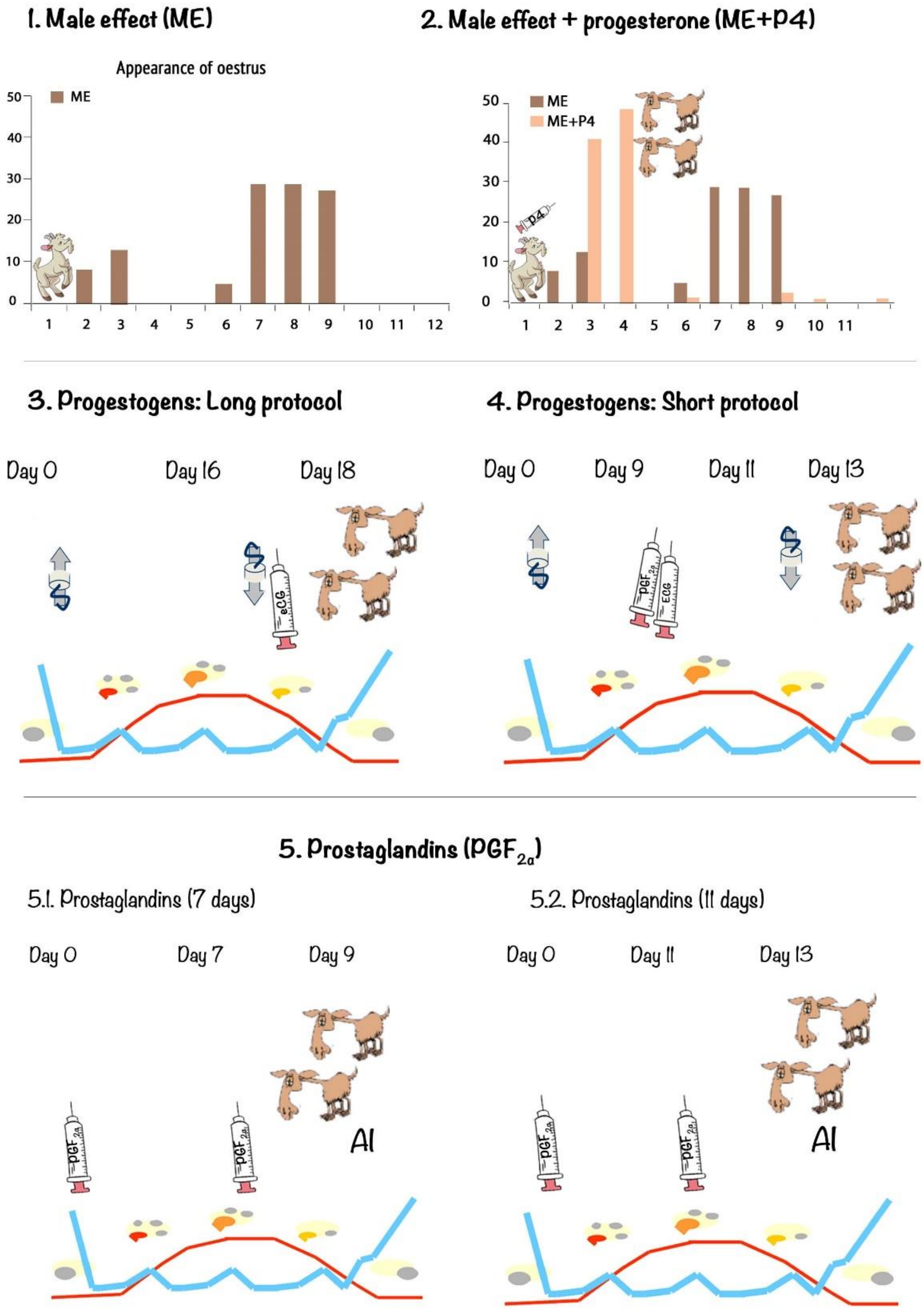


Figure 5. Various synchronization protocols of oestrus and ovulation in goats

Field solution for artificial insemination

Artificial insemination is the main universal method to disseminate improved genetics in livestock species. AI is a staged technology with various levels of infrastructure, semen technology, technicity and field organization. AI using fresh semen collected in the field and relying on basic infrastructure is a promising technology for wider delivery of improved genetics (selected rams in community-based breeding programs) under low input systems. It facilitates reach more farmers within the communities and also reach out to new communities in the framework of scaling breeding programs (https://cgspace.cgiar.org/handle/10568/80980).

Cervical insemination of goats (Photo credit: ICARDA)

The working environment in the different target areas refers to extensive production systems where central laboratories for semen production do not exist or are very distant from the villages and the communities where the inseminations are to be carried out. For these reasons, we have developed mobile, low-infrastructure labs relying on the use of generators to provide electricity and using fresh non-cooled semen from the top ranked rams (https://cgspace.cgiar.org/handle/10568/77704). Ultimately, the different labs will produce fresh-cooled semen at 15 ˚C and this will extend to 4-6 h the time lag between semen collection and insemination, hence providing more opportunities to reach out far-off communities and villages. Semen collection and the insemination acts include the following steps:

- Semen collection using an artificial vagina in the presence of a female induced in oestrus;
- Measurement of the ejaculate volume and appreciation of the colour and the consistency of the ejaculate. Volumes less than 0.5 ml are generally not used and watery ejaculates (low concentration) or with a distinct yellow colour (suspicion of inflammation) are also discarded;

- Quick assessment of mass motility under a microscope. Ejaculates with mass motility scores less than 3 should be discarded;
- Measurement of the sperm concentration using a portable spectrophotometer pre-calibrated for ram semen (ovine-caprine *accuread photometer*; IMV®, France). Ejaculates with a concentration less than 3 10^9 sperm ml^{-1} are discarded;
- While being processed, ejaculates are placed in a thermos flask containing water at 35-37 ˚C;
- Ejaculates are then diluted to a final concentration of 150 10^6 sperm in each straw (straw volume 0.25 ml) using a commercial extender for sheep semen (Ovixcell; IMV®, France) or a tris-based extender (homemade) kept at 35-37 ˚C. Final concentration can be further reduced to 100 10^6 sperm if the initial quality of the ejaculate is high;
- Diluted ejaculates are then checked for individual motility under a microscope. Ejaculates with a low proportion of spermatozoa moving rapidly on a straight line (less than 40%) are not used;
- Straws are filled, then sealed with inert packing powder and immediately immersed in a thermos flask filled with water at 35-37 ˚C;
- Inseminations should be carried out immediately after packing and sealing. On average, time lag between semen collection and insemination should not exceed 10-12 minutes.

Current results of AI campaigns

Four insemination trials were so far carried out. All were in Ethiopia, in Sekota and Konso. The AI lab in Tanzania was established in early January 2019 and field AI trials are scheduled for June and October of the same year. In what follows, we shall be reporting on the protocols which were implemented in Ethiopia.

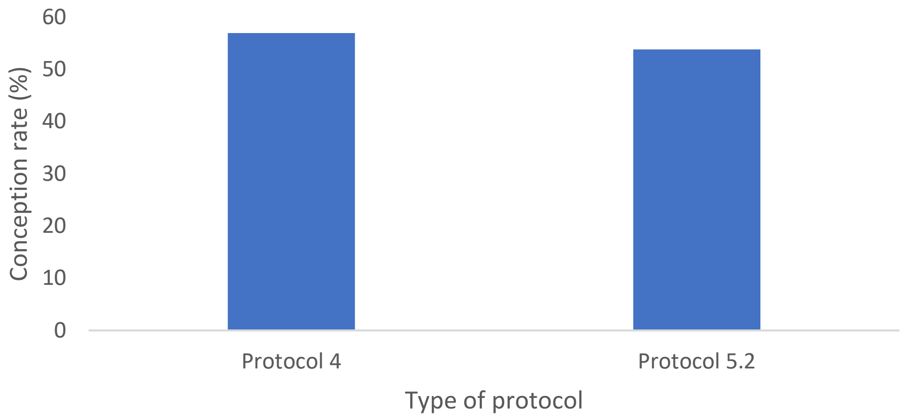
AI results of the on-farm trial in Konso

The trial was carried out in March 2017 in the flocks of the CBBP communities. Two hundred mature goats were selected for insemination. Goats were selected as having successfully produced kids in the previous season, have no history of abortions or other apparent diseases, are not suckling at the time of insemination and not pregnant based on the farmers' statements and after being checked with ultrasound pregnancy diagnosis. At the same time, the best 10 ranked bucks in the community were selected and trained to ejaculate in artificial vagina in the presence of a doe induced in oestrus. The goats were randomly allocated to two treatment groups. In the first group, oestrus was synchronized as per the protocol 4 (Figure 5). Goats in the second group were synchronized according to protocol 5.2 (Figure 5) with an interval of 11 days between the 2 injections of a prostaglandin analogue. Goats belonging to the same flock were subjected to the same synchronization protocol.

In average, the collected ejaculates had a mean volume of 0.85 ml varying between 0.5 and 2.1 ml while the mean concentration was 4.7 10^9 spermatozoa/ml. Mass motility of the used ejaculates ranged between 3 and 4.25 and the % of lives spermatozoa was high exceeding 60% for all used ejaculates. In average, 22 straws were prepared from each ejaculate. Goats were inseminated immediately after processing the ejaculates and the time between collection of the ejaculate and insemination did not exceed 25 minutes while the straws were kept at a constant temperature of 35 °C.

Conception rates were calculated after recording kidding dates. Overall, conception rate was 55.3% with no difference between protocols 4 and 5.2 (Figure 6).

Figure 6. Conception rates of inseminated goats in Konso



AI results of both the on-station and on-farm trials in Sekota

In Sekota, 2 on-station trials and one on-farm trial have son far been implemented. The results out of these trials are summarized in tables 2, 3 and 4. We can only draw general conclusions as the individual data has just been collected (kidding season just ended) and a more accurate analysis of the data needs to be undertaken.

In the first protocol (on station, Table 2), goats were inseminated after being synchronized with protocol 4 or protocol 5.1 using a double injection of a prostaglandin analogue 7 days apart. Conception rate was slightly higher for the goats inseminated with protocol 5.1 but it was statistically different from conception rate in protocol 4. Overall, conception rates are satisfactory. Twinning rates were low for both treatment groups.

Table 2. Conception rates after AI of goats comparing protocols 4 and 5.1 for synchronization (on-station)

Protocol	N	Oestrus response (%)	Conception rate (%)	Twinning rate (%)
Association of progestogens, eCG and prostaglandin (Protocol 4)	25	24 (96)	15 (62.5)	2 (8.3)
Two injections of prostaglandin at 7 days interval	52	45 (86)	30 (66.6)	1 (2.2)

The second on-station trial in Sekota compared 3 synchronization protocols: 4, 5.2 and a challenging protocol when goats are inseminated after one single injection of prostaglandin. Conception rates

(Table 3) show that the highest conception rates are obtained when goats are synchronized with a double injection of a prostaglandin analogue 11 days apart. A higher kidding rate was recorded for goats receiving eCG.

Table 3. Conception rates after AI of goats comparing protocols 4, 5.2 and a challenging protocol using a single injection of prostaglandin for synchronization (on-station)

Protocol	N	Oestrus response (%)	Conception rate (%)	Twinning rate (%)
Association of progestogens, eCG and prostaglandin (Protocol 4)	25	23 (92)	12 (52)	8 (34)
One single injection of prostaglandin	25	18 (72)	9 (50)	4 (22)
Two injections of prostaglandin at 11 days interval	25	22 (88)	17 (77)	3 (14)

For the on-farm protocol, preliminary collected data (Table 4), shows the satisfactory oestrus response and conception rate obtained with protocol 5.2 as compared to the universal protocol 4. The challenging protocol using only one single injection of prostaglandin yielded a low oestrous response and cannot be retained as a promising way to synchronize goats.

Table 4. Conception rates after AI of goats comparing protocols 4, 5.2 and a challenging protocol using a single injection of prostaglandin for synchronization (on-farm)

Protocol	N	Oestrus response (%)	Conception rate (%)
Association of progestogens, eCG and prostaglandin (Protocol 4)	72	65 (90)	34 (52)
One single injection of prostaglandin	60	26 (43)	11 (42)
Two injections of prostaglandin at 11 days interval	73	66 (90)	32 (48)

Even though preliminary, the champion protocol based on conception rates and cost seems to be the double injection of a prostaglandin analogue. Further detailed analysis of the data should enable more accurate conclusions. Further on-farm trials with higher number of goats are also needed to confirm these preliminary results.

Future developments

The established reproductive platform will grow and will foster more exchanges of knowledge and practical know-how. It will grow simultaneously to the scaling of the CBBP's across the countries and covering more regions within each of the countries. While Sudan is not part of this MBoss project, ICARDA (within the framework of other initiatives) together with the Agricultural Research Council in

Sudan have established a women-led CBBP on goats in North Kordofan. We therefore anticipate the platform to expand in this direction and to support expansion of goat CBBP's in Sudan.

Services delivered by the platform are also expected to diversify in order to respond to the farmers' needs, to facilitate operationalization of the AI campaigns and to improve the overall offtake from the flocks. This latter point can be a major driver increasing adhesion and commitment of the farmers and the communities to CBBP's. In this regard, we expect:

- Artificial insemination to shift gradually towards the use of fresh semen cooled at 15 °C. this move will introduce a lot of flexibility in organizing the AI campaigns and will allow the production of insemination doses under more standardized conditions. Such a move needs to be carefully studied because it means that the community bucks need to be placed for some time within the premises of a central AI lab for semen production and it implies that inseminators will have no constraints in moving cooled semen doses from the production lab to the insemination sites within a reasonable interval of 4 to 6 hours;
- One of the reasons behind the low reproductive performance and low offtake from the flocks is the poor management of feeding during the critical stages of the reproductive function. Females approach the mating season at low body condition, suckling periods are very long and hamper the reproductive function and very importantly, pregnant females are very commonly poorly fed leading to metabolic accidents, abortions, low birth weights and early post-natal mortalities. The ultrasound tool for the monitoring of the reproductive function can be valuably used in linkage with the management of feeding to reach a better adequacy between feed provision and reproductive requirements. This is the concept of precision feeding which has the advantages of saving feed resources and promoting reproductive performance.
- Breeding programs rely on the wide dissemination of high-quality genes from selected sires. This should happen while ensuring that superior males used for natural mating or their semen are not also transmitting diseases. The platform should very quickly establish linkages and collaboration with animal health services to first screen selected bucks for sexually-transmitted diseases (with a focus on those representing a serious zoonotic threat) and to protect these bucks from these threats through an adequate vaccination program. In a broader horizon, the platform can evolve to provide general animal health services for all flocks enrolled in CBBP's.