Capacity development of field veterinarians in the field of small ruminant reproduction and artificial insemination

Progress report covering the period March 2019-August 2020

Advances in Managing Reproduction in Small Ruminants in the Context of Saudi Arabia (CEVA photo); Holiday Inn Meydan, Riyadh, 5-7 Feb 2019

Funded by:
CEVA SANTE ANIMALE

Conducted by:
The International Center for Agriculture Research in the Dry Areas

in collaboration with:
IMV Technologies, France
National Center for Agricultural Research, (NARC – Jordan)
College of Food and Agriculture Sciences, King Saud University

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Executive summary

Name of the project

Capacity development of field veterinarians in the field of small ruminants' reproduction and artificial insemination

Donor

CEVA SANTE ANIMALE

Partners

National Center for Agricultural Research and Extension (NCARE), IMV Technologies, King Saud University

Purpose

This agreement between ICARDA and CEVA focuses specifically on capacity strengthening: ICARDA scientists provide training modules and technical backstopping to private sector veterinarians. The selected trainees are key opinion leaders, field practitioners with an important portfolio in the area of sheep and goats or act as CEVA distributors. The trainings focus on reproductive fitness, ability and performance – core considerations that lie at the heart of the production processes. In 2019, new activities related to setting-up field trials in Jordan were added to the core capacity development work with the aim to assess the feasibility of the combined treatment using Melovin implants and progestogen impregnated sponges for the induction and synchronization of oestrus and ovulation in Awassi ewes outside the breeding season. Such a treatment would represent an alternative to the conventional association using equine chorionic gonadotropin (eCG) and progestogen impregnated sponges after CEVA decision to pull out PMSG from the market. Furthermore, the agreement in 2019 saw an expansion of the activities to East Africa (Ethiopia) with the aim to discuss technical and business opportunities for reproductive protocols targeting intertropical sheep and goats.

Deviations from the initial plan of work

The discussed and approved workplan between CEVA and ICARDA comprised 3 major activities and these were:

- Advanced training course on sheep and goat reproduction of field practitioners in Saudi Arabia (initially planned in 2018 and postponed to 2019);
- Design, conduct and assess synchronization protocols for Awassi ewes during seasonal anoestrus and during the breeding season;
- Assessment of current situation and design of interventions in the field of sheep and goat reproduction in Ethiopia which can be scaled to intertropical breeds of Africa.

With regards the synchronization trials for Awassi sheep, the first one aimed at testing the effectiveness of the protocol associating Melovin implants and progestogen impregnated sponges as an alternative to the eCG-sponges protocol for group mating (hand natural mating/AI) of Awassi ewes during the non-breeding season. Although initially planned to start early March, the

trial took place between April and late May corresponding to late anoestrus. The activity was delayed because we were waiting for the sub-agreement to be signed. The absence of differences (see below for details) between the tested protocol and the positive control prompted the joint ICARDA-CEVA team to drop the protocol during the breeding season and to repeat the out-of-season protocol in 2020 during a much earlier phase of the anoestrus season. Unfortunately, the two experiments did not only differ in the stage of anoestrus but also in the fact that most of the animals used in the second trial were nulliparous maiden ewes.

The other two activities e.g. the training in Saudi Arabia and the joint mission in Ethiopia were implemented as planned.

Specific objectives of the training courses and field trials

The main and specific objectives of the 2019 plan of work were as follow:

(1) To strengthen capacity of field veterinarians from Saudi Arabia in reproductive management of sheep and goats according to the various production systems through:
   (1.1) revisiting the basis of the control of the reproductive function in sheep and goats,
   (1.2) design reproductive protocols to support in-season and out-of-season sheep and goat product lines in Saudi Arabia (extensive, rangeland-based sheep systems, intensified sheep enterprises, goat flocks under various systems),
   (1.3) to promote ultrasound-based technology as an aid tool for the management of small ruminants' reproduction
(2) To conduct on-station trials for the reproductive management of Awassi sheep during seasonal anoestrus in Jordan,
(3) To share knowledge with the CEVA representative and her customers in Ethiopia and Uganda about small ruminant reproduction, to discuss ICARDA's work aiming at the development of reproductive tools for small ruminants in the context of East African conditions and to understand how sheep and goats' community-based breeding programs (CBBP's) are set, are functioning and what role can reproductive technologies have to support scaling.

Specific outputs

Thirty field veterinarians from Saudi Arabia were trained on strategic management of reproduction in sheep and goats according to the features of the production system; two on-station trials were designed and conducted in the sheep Khanassry station belonging to NARC (Jordan) and a team from CEVA and related customers in Ethiopia and Uganda received "à la carte" training on reproduction of intertropical breeds of sheep and goats, were exposed to the potential offered by CBBPs in terms of developing specific reproductive tools and were given the opportunity to meet and discuss with major stakeholders in Ethiopia in charge of national investment projects for further business expansion.

Main achievements and results

1. Strengthening the capacity of field veterinarians in the reproductive management of sheep and goats in Saudi Arabia.

1.1. Background and objective

The course is a follow-up to the initial basic training that took place in February 2018 (already reported) and aimed at providing the participating field veterinarians with advanced knowledge in managing reproduction of small ruminant reproduction based on the features and the characteristics of the production system. One very positive aspect of the training was that most of the participants had already attended the initial training in 2018 and received basic the required basic knowledge.

The objective of the training was to develop contextualized (based on the dominant production systems) integrated reproductive management strategies mainly based on simple, cost effective technologies which can be directly used to enhance reproductive outcome in the field (fertility maximization and litter size optimization). The training was an opportunity for the practitioners to discuss in relation to the main system where they are operating, current practices, their limitations and ways of improvement. The contextualized, participatory approach adopted was very much appreciated. The practical sessions (over 2 consecutive days) of the training were also meant to expose the participants as much as possible to advanced technologies for the management of sheep and goat reproduction with a particular focus on the importance of imagery (mainly ultrasound-based technology) to modernize the management of reproduction and reduce reproductive losses.

1.2. Target audience

The training held in Riyadh, Saudi Arabia gathered 30 field veterinarians from all over the kingdom with a professional interest in sheep and goat reproduction. Initially, the training was designed for only 15 participants. However, a tweet of the training event made by H.E the Deputy Minister of Agriculture in Saudi Arabia greatly increased the requests for participation, and it was a hard task to limit participation to only 30 vets.

1.3. Organizing committee and speakers

- Dr. Mourad Rekik, Senior Small Ruminant Production Scientist, The International Center for Agriculture Research in the Dry Areas
- Dr. Ahmed Hamdy, CEVA Ruminants Technical & Marketing Manager Middle East
- Prof. Ayman Swelum, Department of Animal production, KSU
- Dr. Misha Savic, Assisted Reproduction expert, IMV Technologies
- Mr. Bastian Mueller, Capacity Development Unit, The International Center for Agriculture Research in the Dry Areas – Amman, Jordan

In addition to CEVA and the private company MAS for Veterinary Services, we were honored this year to have the workshop hosted by King Saud University and the practical sessions took place in the animal research station of the university.

1.4. Workshop structure

Following introduction to the workshop and a general presentation on sheep and goat reproduction characteristics and for a better engagement of the participants, the first session of the workshop was dedicated to working groups. Participants were divided into three groups discussing main sheep and goat production systems in Saudi Arabia. The three groups were organized around: marginal sheep production, intensified sheep production particularly in the ranching system goat production.

The groups clearly defined the production systems, their importance in Saudi Arabia, the extent of their geographic boundaries and the proportion they represent from the total sheep and goat population in the country. In a second stage, average performance in each of the system were discussed (reproductive traits, meat offtake, milk production…) and participants laid out the main reproductive itineraries in each of the systems.

Photos from the training (left: theoretical and right: practical) in Saudi Arabia (CEVA Photos)

Based on the groups' feedback, we first illustrated basic practices needed for a successful management of reproduction (preparation of the animals to mating, nutritional and health care, selection of the best-fitted animals). These interventions are not system-specific and apply to all breeds under all management scenarios.

The second intervention was to go more specifically by production system into the control of reproduction and distinguish protocols for the maximization of fertility and those for the optimization of litter size.

Other presentations were then given on the importance of Q Fever and preventive and control measures as well as on the importance of pregnancy diagnosis as a tool to better manage reproduction and reduce reproductive losses.

1.5. Workshop implementation

The workshop agenda is reported in annex 1. The workshop progressed according to schedule

with no major changes to be mentioned. High level of commitment and presence was shown by the participants throughout the different sessions of the workshop.

1.6. Group Assessment

No formal assessment was conducted. Nevertheless, during the different workshop sessions the knowledge of individual participants on specific matters was assessed.

2. Assessment of current situation and design of interventions in the field of sheep and goat reproduction in Ethiopia which can be scaled to intertropical breeds of Africa

This activity was carefully planned with CEVA technical manager for Sub-Saharan Africa, Marjorie Bouchier and from the start, the objectives (stated above) were clearly defined and delineated. In the following, we shall report against each of the objectives of the mission. Special thanks are addressed to Dr. Aynalem Haile from ICARDA, Addis-Ababa office for arranging the meetings with the main stakeholders.

2.1. Knowledge sharing with CEVA representative and her customers in Ethiopia and Uganda about small ruminant reproduction

Large parts of the week mission (attached agenda in annex 2) were dedicated to providing CEVA technical manager and her customers in Uganda and Ethiopia with a specific training on the broad topic of sheep and goat reproduction and to address any specificities for breeds in intertropical Africa. The most important reproductive characteristic of such breeds is their non-seasonality or the very low intensity of anoestrus. The lectures covered a large spectrum of reproduction in these two species such as: basics of sheep and goat reproduction, exteroceptive factors and reproductive rhythms, fecundity improvement packages, genetic background of reproduction, interactions between nutrition and reproduction, biotechnologies of reproduction (AI – ultrasonography…) and specific results obtained by ICARDA on AI of sheep and goats in Ethiopia. All presented material was handed over as well as several other resource documents.

2.2. ICARDA's work aiming at the development of reproductive tools for small ruminants in the context of East African conditions

In the framework of CBBPs and sheep and goat value chain development, ICARDA has been working on a number of reproduction-related activities since 2013. These activities encompass certification of sires, synchronization of sheep and goats prior to AI, development of a low-infrastructure AI system and an ultrasound-based service delivery unit to improve reproductive management.

For direct relevance to CEVA is the work on synchronization protocols of sheep and goats prior to AI. A number of documents and resources were produced to validate synchronization protocols that suit the physiology of the animals (shallow or inexistent anoestrus), generate a level of synchrony that allows fixed-time AI, are easy to implement not requiring high technicity, financially affordable by small-scale sheep and goat owners, rely on products that are registered in the country for those who may want to take up the business and are in line with a 'clean' livestock industry. Several on-station and on-farm trials were conducted in various areas of the

country within Menz, Bonga, Doyogena and Horro sheep CBBP's and Konso and Abergelle goat CBBP's. Key milestone products are summarized here:

> ➢ Effectiveness of GnRH and prostaglandin-based synchronization protocols as alternatives to progestogen-based treatments in sheep: Journal article published in Reproduction of Domestic Animals
> https://repo.mel.cgiar.org/handle/20.500.11766/6041
> ➢ Field Synchronization of Ethiopian Highland Sheep for fixed time Artificial Insemination: Improvement of Conception Rate with a Double Injection of Prostaglandin at 11 days: Journal article accepted in Journal of Applied Animal Research (under press). The abstract of the paper is here[1]
> ➢ Estrus synchronization and artificial insemination technologies in Abergelle goat at station and on-farm conditions of Waghemira zone, Ethiopia. MSc thesis of the University of Bahir Dar. https://hdl.handle.net/20.500.11766/10153
> ➢ Establishment of a Low-Cost, Low-Infrastructure Reproductive Platform to Nurture Ethiopian Sheep and Goat breeding Schemes
> https://hdl.handle.net/20.500.11766/10835

2.3. Setting-up, functioning of sheep and goats, community-based breeding programs (CBBPs) and the role of reproductive technologies in supporting scaling

The sheep and goat sector in Africa is very extensive, there is very little organization of producers and the support provided by extension services is very weak. There have been attempts to establish breeding programs in various African countries but most of them failed because of their centralized design and their top-down approach. Recently, a more participatory approach started to gain global interest. Called 'community-based breeding', it combines farmer training to improve selection methods, pooling community flocks to create a larger gene pool from which breeding animals can be selected, scientific support to provide farmers with information on different breeding options, and data collection to monitor how well individual animals perform. This approach is inherently sustainable as it supports local-level decision making, focuses on locally adapted indigenous breeds, considers the constraints that smallholder farmers face and empowers farmers' organizations (cooperatives) in low input systems. In Ethiopia, CBBPs have generated measurable genetic gains and impacted the livelihood of rural communities, but we believe that they owe their popularity to the simple approach, the flexibility of the principles behind and the way they are implemented is culturally closer to the target communities. CBBPs not only generated genetic gain but they are today the portal for other management improvements like forage production, feeding, reproduction, health interventions, etc., all of which have had significant contribution to the overall

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[1] The study investigated, for fixed time artificially inseminated (AI) Menz ewes in field trials, the reproductive performance of prostaglandin-based treatments simultaneously to the standard "P_4+eCG" protocol. A total of 483 Menz ewes were assigned to either the "P_4+eCG" protocol, using progesterone impregnated intravaginal sponges in combination with equine chorionic gonadotropin (eCG) injection at sponge withdrawal, or the "PGF_s" treatment where sheep received a single injection of prostaglandin or "PGF_7" and "PGF_{11}" where ewes were synchronized with 2 injections of prostaglandin 7 or 11 days apart, respectively. AI was implemented with fresh semen at 55 ± 1 h after the end of the hormonal treatment. Conception rate (CR; 60.87 ± 4.2) was highest for PGF_{11} ewes ($P<0.05$); PGF_s ewes had the lowest CR (34.07 ± 4.1). Other factors did not affect variation in CR ($P>0.05$). A higher proportion of ewes in the P_4+eCG group yielded twins and triplets compared to the 3 prostaglandin-based protocols ($P<0.01$). Nevertheless, a higher ($P=0.02$) proportion (17.11 ± 4.3) of PGF_{11} ewes yielded twins by comparison to their PGF_7 counterparts (2.50 ± 2.5). PGF-based protocol with 2 injections 11 days apart, preceded by a careful selection of non-pregnant ewes for cervical fixed-time AI, is a feasible reproductive management for sheep breeding programs in Ethiopia.

improvement in performance. CEVA's technical manager and her guests had the opportunity to meet the whole ICARDA team in charge of the implementation of CBBPs in Addis, who made presentations and contributed to the overall discussion that took place. ICARDA's work on CBBPs is at the pilot level and the reproductive work related to synchronization and artificial insemination will not go beyond few thousand animals per year. Nevertheless, there are large initiatives in the field which have adopted CBBPs as a framework for sheep and goat breeding in Ethiopia. These initiatives target large areas and very high numbers of the sheep and goat population. In particular, we refer to the new project funded by the World Bank on Livestock and Fisheries Sector Development. A meeting was organized with the representative of the project and it was very clear that the prospects (cattle and small ruminants) for CEVA could be very large as a private company established in Ethiopia and working in the field of animal health and reproduction. It was surprising that no such links existed and CEVA was not aware of this project.

Dr. Katali Benda from Uganda presenting the potential for goat production in his country and discussing with ICARDA scientists the possibility of setting-up a pilot CBBP (CEVA Photo)

3. On-station assessment of Melovin®-based treatments as an alternative to eCG-progestogen protocol for the induction of ovulation and estrus for out-of-the breeding season

A brief overview of the data available in Jordan on the results that were obtained using Melovin implants was included in last year's report. In this report, we shall only describe the trials carried out in 2019 and 2020 and the main findings. The objective was to test if treatment of the ewes during anestrus with Melovin implants followed by synchronization with progestogen-impregnated sponges can produce the same mass, compacted estrous response as the conventional protocol based on the use of eCG and sponges; a response that would permit application of fixed-time artificial insemination. This is described in the following sections in a paper style.

3.1. Materials and methods

Study area

The trials were performed in Al-Khanasry Research Station, Mafraq, located in the eastern north of Jordan, at 32°24'17.04" N, 36°3'25.85" E and at an altitude of 860 m above sea level. Annual rainfall in the region is less than 180 mm during winter season and temperatures may go down to 0°C during the day and -2°C during the night. Summer temperatures may rise up to 42°C during the day, but the nights are relatively cool (average of 22°C). The station has a total area of 400 ha mainly natural pastures (Figure 1).
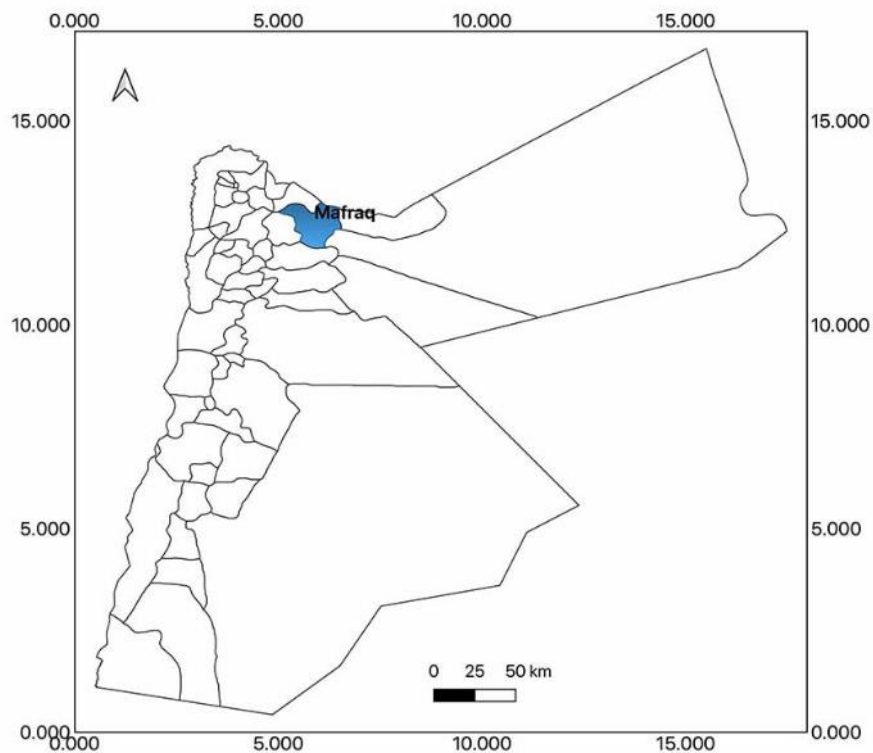

Figure 1. Study area

Experimental animals and experimental procedures

In both experiments, the animals grazed natural pastures for approximately 6 hours daily and received a daily supplement of 0.5 kg of straw and 1 kg of concentrate per head. The concentrate was composed of barley (85%), wheat bran (12%), limestone (1.6), salt (1.3%), and trace minerals (0.1). The animals had continuous access to fresh water and were exposed to natural daylight throughout the experiment.

Experiment 1

A total number of 123 healthy adult Awassi ewes aged between 2 and 6 years (mean: 3.5 years), weighing between 32 kg and 76 kg (mean: 50.5 kg) and having a body condition score (BCS)

between 1.5 and 4.5 (mean: 3.1) were included in the trial. They were randomly divided into two homogenous groups balanced for age, live weight and BCS. The first group (M+S, n=61) received melatonin ear-implants (18 mg; Regulin-Mélovine CEVA Santé Animale, Libourne, France) on 3rd April 2019. Thirty-three days later, the same ewes received intravaginal polyurethane sponges impregnated with 30 mg fluorogestone (Syncro-part®; CEVA laboratories, Libourne, France) which were placed in the vagina for 14 days. On the same day, the second group (S, n=62) received intravaginal polyurethane sponges. All ewes were checked twice daily (morning and evening) to ensure that sponges remained in place during the treatment period. At sponge withdrawal (hour 0), 6 aproned rams (3 rams per group) were introduced and estrous control was carried out every 6 hours for 108 hours. In fact, every 6 h, ewes were individually teased with the aproned males for up to 30 min. When a ewe was in oestrus, she was assigned to the correspondent ram selected for natural mating and mated twice. Twelve rams (6 per group) were used for mating and only the six rams introduced with the M+S group received melatonin ear-implants (18 mg; Regulin-Mélovine CEVA Santé Animale, Libourne, France) (3 implants per ram) on the same date as the M+S ewes. For breeding purposes imposed by the station routine management, each group of ewes (10 ewes) were assigned to only one ram in order to record paternity. Pregnancy diagnosis was done one month later. To ensure mating of the ewes at the return estrus, 1 ram for each treatment group was reintroduced 16 days after the 6-day period of the induced estrus and stayed with the ewes for another period of 33 days. The schedule of implementation of experiment 1 is summarized in figure 2.
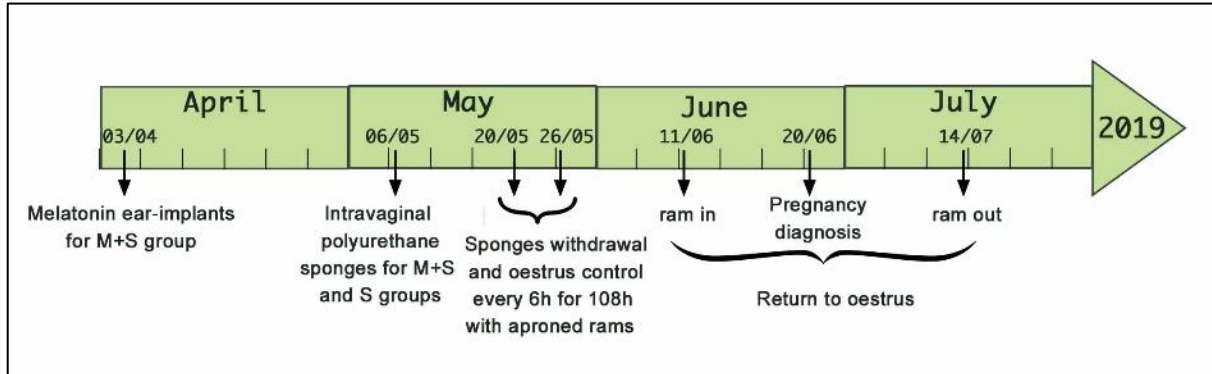

Figure 2. The schedule of implementation of the experiment 1

Experiment 2

A total number of 159 healthy adult Awassi ewes aged between 1 and 7 years, weighing between 23 kg and 70 kg (mean: 42.4 kg), having a body condition score (BCS) between 2 and 4.5 (mean: 3.4) and a parity between 0 and 5 were included in the trial. In this second experiment, 90.5 % of the females were maiden and had a null parity. In January 2020, only replacement maiden ewes and some adult animals from those that did not lamb for various reasons during the previous lambing season were available to be included in the trial.

Animals were randomly assigned to three homogenous groups balanced for age, live weight and BCS. The first group (M+S, n=62) received melatonin ear-implants (18 mg; Regulin-Mélovine

CEVA Santé Animale, Libourne, France) on 15th January 2020. We anticipate that this period is the earliest for seasonal sheep and goats to be treated with Melatonin as a minimum of 3 weeks exposure to increasing photoperiod is indispensable for animals to respond to melatonin or short photoperiodic treatments. Twenty-six days later, the same ewes received intravaginal polyurethane sponges impregnated with 30 mg fluorogestone (Syncro-part®; CEVA laboratories, Libourne, France) that were placed in the vagina for 14 days. On the same day, the second group (S, n=61) received also intravaginal polyurethane sponges. The third group (C, n=36) was a control group and did not receive any treatment. Ewes in groups M+S and S were checked twice daily (morning and evening) to ensure that sponges remained in place during the treatment period. At sponge withdrawal (hour 0), rams were introduced for all 3 experimental groups and repeated heat check (every 6 hours for 144 hours) was carried out only for ewes belonging to M+S and S groups. When a ewe was in oestrus, she was assigned to the correspondent ram selected for natural mating and mated twice. For every treatment group, the ewes were divided into subgroups of 6-7 females and each sub-group was assigned to one ram and housed in a separate box from other sub-groups. The ewes in all sub-groups remained indoor with the ram for a total of 30 days. All the ewes were diagnosed for pregnancy 40 days after removal of the rams and the schedule of implementation of experiment 2 is depicted in figure 3. For the 2 experiments, data about estrous expression, pregnancy diagnosis, lambing data and the number of lambs were recorded for estimation of fertility and litter size.
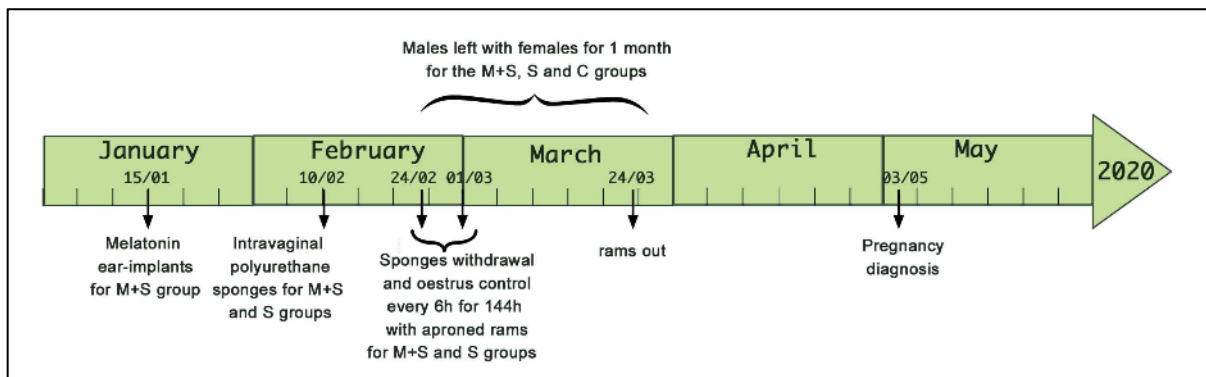

Figure 3. The schedule of implementation of the experiment 2

3.2. Statistical analyses

For each experiment, the following reproductive parameters were calculated according to the formulas:

Estrous expression=100 x [(number of ewes in estrus)/(number of total ewes)]

Pregnancy diagnosis= 100 x [(number of ewes diagnosed as pregnant)/(number of ewes in estrus)]

Overall lambing rate= 100 x [(number of lambing ewes) / (number of total ewes)]

Twinning percentage= 100 x [(number of ewes having multiple litter size) / (number of lambing ewes)]

All reproductive parameters were presented as % (± standard deviation). Estrous expression, pregnancy diagnosis, lambing data and twinning percentages were compared using Epi Info 6 (Dean et al., 2011). A chi-square Mantel-Haenszel test was performed. A probability less than 0.05 was used as a threshold for statistical significance (Schwartz, 1993).

3.3. Results

Estrous expression

In the first experiment, the percentage of animals that expressed estrus at the induced estrous cycle was 91.8 ± 3.5% in the M+S group *vs.* 87.1 ± 4.3% in the S group. There was no statistical difference between the two groups (p=0.4). In the second experiment, the estrous expression percentage was 50.0 ± 6.3 and 41.0 ± 6.3% respectively in the M+S and S groups (p=0.3) (Figure 4). This parameter was not quantified for C animals. The estrous response during the intensive control period in M+S and S groups is presented in figure 5.
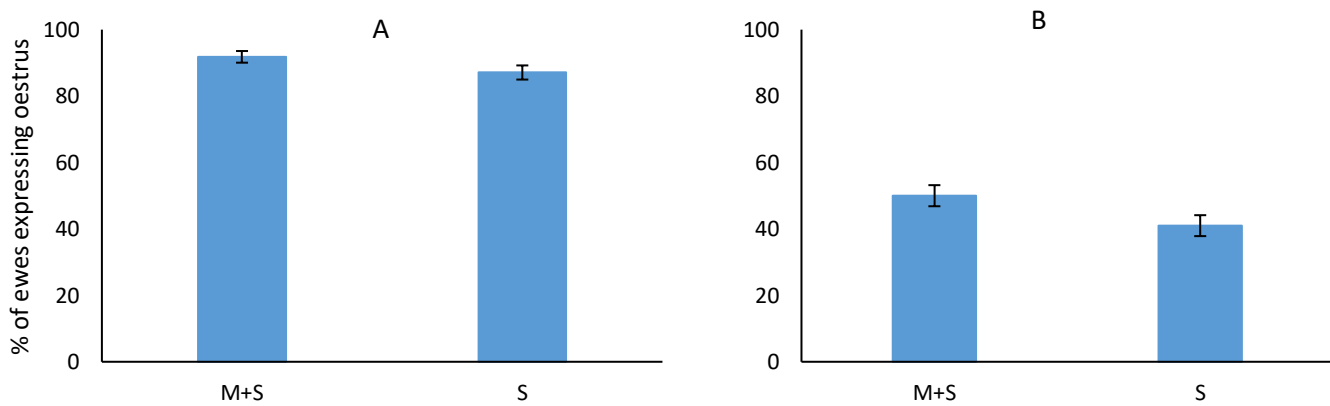

Figure 4. Percentage of ewes expressing estrus in M+S (Melatonin and sponges) and S (Sponges only) groups in A: experiment 1 and B: experiment 2
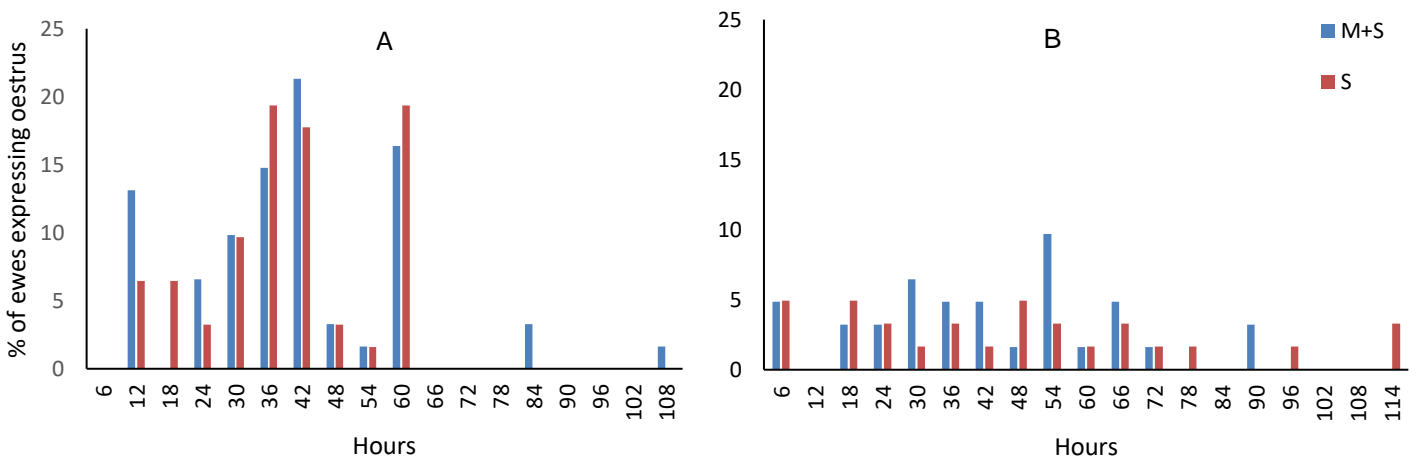

Figure 5. The estrous response during the intensive control period in M+S (Melatonin and sponges) and S (Sponges only) groups in A: experiment 1 and B: experiment 2

Pregnancy diagnosis

In experiment 1, the percentage of animals diagnosed as pregnant was 60.7 ± 6.4% and 59.3 ± 6.7% in the M+S and S groups, respectively. For the second experiment, the percentage of animal diagnosed as pregnant was 83.9 ± 6.6% in the M+S group vs. 48.0 ± 10.0% in the S group. This percentage was significantly higher in the M+S group (p=0.004) (Figure 6). As heat control was not done in the C group, it was therefore not possible to quantify this parameter and only lambing and twin births data were collected.
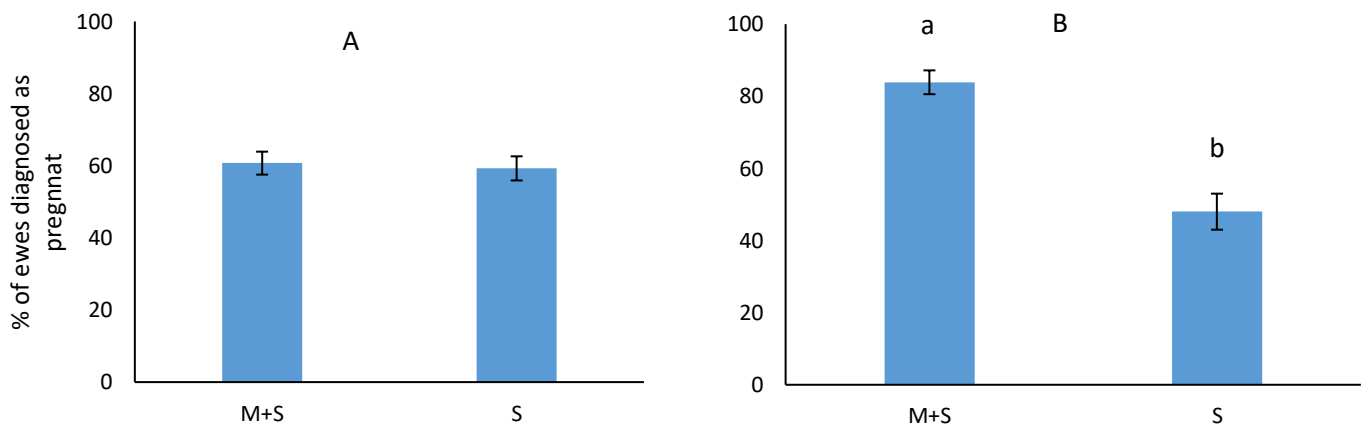

Figure 6. Percentage of ewes diagnosed as pregnant in M+S (Melatonin and sponges) and S (Sponges only) groups in A: experiment 1 and B: experiment 2

Lambing data

In the first experiment, the overall lambing rate was 75.4 ± 5.5 and 74.2 ± 5.6% in M+S and S groups, respectively. There was no significant difference between the 2 groups of animals (p>0.05). For the M+S group, the overall percentage of ewes lambing from the first cycle was 55.7 ± 6.4% *vs* 19.7 ± 5.1% from the second cycle. For the S group, the overall percentage of ewes lambing from the first cycle was 54.8 ± 6.3% *vs* 19.4 ± 5.0% from the second cycle. There were no statistical differences in this parameter neither between groups nor cycles (p>0.05).

For the second experiment, the overall lambing rate was 38.7 ± 6.2, 16.4 ± 4.7 and 13.9 ± 5.8%, respectively in the M+S, S and C groups. Significantly higher lambing rate was recorded for the M+S group (p=0.004) (Figure7).
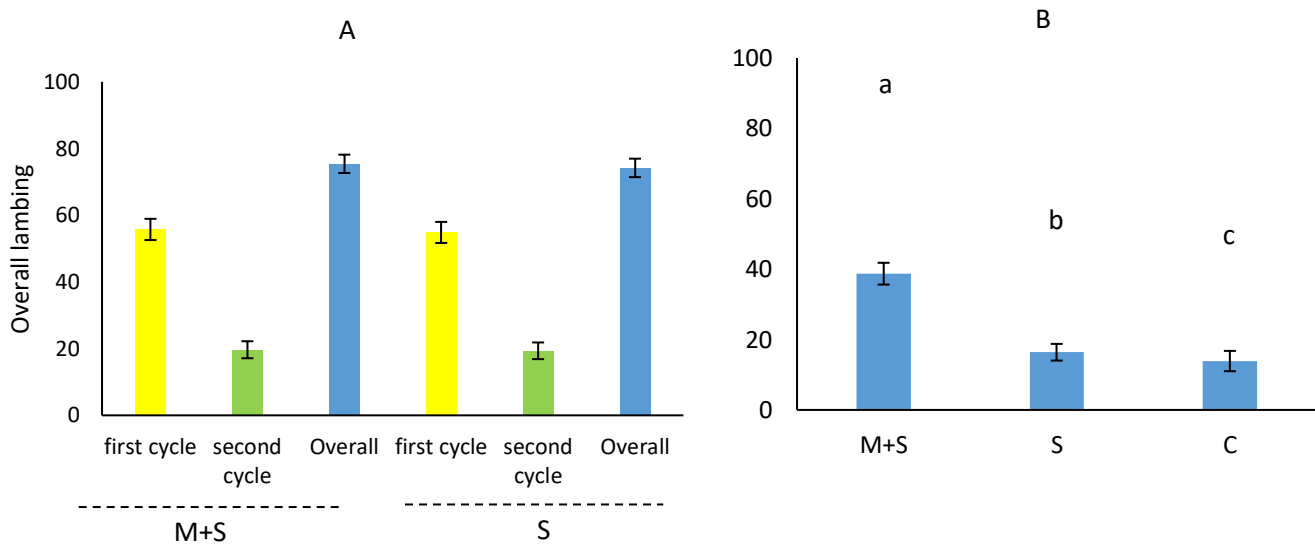
Figure 7. Overall lambing rate in M+S (Melatonin and sponges), S (Sponges only) and C (Control) groups in A: experiment 1 and B: experiment 2

Twinning

For the first experiment, the percentage of animals giving twin births was 23.9 ± 6.3 and $15.2 \pm 5.3\%$ in M+S and S groups, respectively. These two percentages were not statistically different (p=0.8). For the M+S group, the overall percentage of ewes lambing twins from the first cycle was $23.9 \pm 6.3\%$ *vs* $0 \pm 0\%$ from the second cycle. For the S group, the overall percentage of ewes yielding twins from the first cycle was $10.9 \pm 4.6\%$ *vs* $4.4 \pm 3.0\%$ from the second cycle. There was no statistical difference in this parameter neither between groups nor cycles (p>0.05) except a higher percentage of twins recorded in the first cycle for the M+S group (p=0.02).

For the second experiment, the percentage of animals giving twin births was 8.3 ± 5.6, $0 \pm 0\%$ and $0 \pm 0\%$, respectively in M+S, S and C groups (p=0.5).

3.4. Preliminary conclusions

Here we give a quick interpretation of the main obtained results in a few bullet points; deeper analysis is required if the data is to be valorized elsewhere:

- Comparison between the two experiments should be considered with caution because the variation is not only related to the stage of anoestrus but the age of the experimental ewes is also an important source of variability of the response that should be accounted for;
- With relation to this latter point, the limited response in experiment 2 may be caused by the presence of a high proportion of maiden, nulliparous ewes. Animals of this category are known to be far more sensitive to the effects of seasonal anoestrus than adults. Male counterparts of the Barbarine breed in Tunisia treated with Melovin implants at a similar stage, showed an extraordinary response in terms of improved libido and sperm production (https://onlinelibrary.wiley.com/doi/10.1111/asj.12350);
- Lambing rate for the melatonin-treated ewes was significantly higher than for S and C ewes, but the observed levels of fertility are still too low for farmers to adopt it as a management practice for the early reproduction of young replacement ewes;
- The high level of synchronization observed in experiment 1 was not reflected in lambing rate and this may be attributed to an overuse of the rams during the induced estrus in each sub-group of females. It was not possible to use a higher number of rams because of unavailability and it was not possible to place more than one ram in each sub-group because of the requirement to control paternity (a compulsory procedure on the farm);
- In any case and irrespectively of the lambing rate, the levels of estrous grouping in the 2 groups (M+S vs. S) are very similar and confirm the efficiency of the ram effect when coupled with a prior progestogen impregnation of the ewes in inducing a highly compacted estrus during late anoestrus; current results do not support, at this stage of the year, the combined use of melatonin-based implants with progestogen-impregnated sponges as an alternative to the conventional PMSG + sponges;
- For both M+S and M ewes, the peak of estrus between 24 and 48 h after the removal of the sponges is sufficient to allow fixed-time artificial insemination for a good proportion of the synchronized ewes.

3.5. Acknowledgement

Conclusions, implications and recommendations for ICARDA and CEVA

After three consecutive years (2017-2019) – including a no-cost extension for 2020 - of collaboration between CEVA and ICARDA on the broad topic of sheep and goat reproduction, we would like to summarize some achievements, and share recommendations and some insights for continued collaboration:

- Nearly 110 field veterinarians and practitioners operating in several countries of the Middle East and Arabian Peninsula (Jordan, Lebanon, Palestine, United Arab Emirates, Saudi Arabia, Egypt) were trained (theory and practice) on various aspects of sheep and goat reproduction including a thorough understanding of the basics of this function, exposure to contextualized ways and means to modify, improve and optimize reproductive performance in the field and to introduce trainees to reproductive biotechnologies as tool aids to support existing breeding programs or as smart methods to manage reproduction.

- Some of the vets in Palestine or Saudi Arabia are counted twice but at each time, the information delivered was not the same and trainings were designed so that participants are exposed to increasing level of knowledge for them to tackle field complexities and to reposition their businesses.

- Private clinics operating in Palestine, Lebanon, United Arab Emirates and a CEVA team in Ethiopia also received "à la carte" and on-the-job coaching in the same field.

- Instead of relying on general (usually irrelevant) and course-based material in the trainings, ICARDA provided its invaluable legacy knowledge in the areas of characterization and management of reproduction of sheep and goats that was generated over many years in countries of the Middle East and North Africa as well as East Africa;

- Apart from very few exceptions, it was in general perplexing to note the poor perception and ill-understanding field veterinarians have of sheep and goat reproduction and it was clear from the conversations and feedback during the training sessions that this has led to all sorts of interventions which are counterproductive, often complemented by hormone-based protocols that bring more harm than solutions to the farmers;

- Who should be blamed? It is difficult to answer the question but for sure the universities curricula need deep revisions. Our individual and group discussions also revealed that in most of the Middle East countries, there are simply no opportunities for field practitioners to acquire knowledge and they end up elapsing into inherited, inappropriate and adverse practices. To some extent, pharmacological companies share some of the responsibility putting more focus on their marketing strategy and not doing enough to capacitate their customers and distributors.

- After three years of active presence in the field, CEVA and ICARDA have a unique opportunity to establish a community of practice for the rational management of reproduction of sheep and goats in the Middle East. Sheep and goats have always been and will remain a corner stone of the livestock sector in the region. Reproduction is the most determinant step to generate profit from livestock and its mismanagement will continue to hamper global efforts (public and private) to lift the sector. It can be called SHOATS MEA REPRO and it can be an initiative to produce and disseminate communication material, on-line and ICT provision of advisory services and remote coaching of field specific interventions. Such initiatives are not expensive, but they require careful design and planning and a large diary of end users;

- CEVA is the only company in the world producing and selling the whole range of hormones that are universally used to control sheep and goat reproduction. Decades of success of using the combination progestogen-impregnated sponges and PMSG have overshadowed the role that other products (Melovin implants, prostaglandin and GnRH analogues) may play to rationally manage reproduction of small ruminants;

- Products for the control of the reproductive function in sheep and goats have been in the market for some time. There is, nevertheless, a void in terms of packaging reproductive technologies and products to support clear product lines towards intensifying reproduction and increasing output and revenues from goat and sheep herds. Hormonal therapies should come in integrated packages including prophylactic measures, adjustment of nutrition and ultrasound-based imaging for more targeted interventions. Our knowledge of the region clearly shows a misunderstanding (by field practitioners and extension services) of the way the available products act, hence leading to improper use in controlling reproduction and the results are often not up to farmers' expectations.

- The decision of CEVA to pull out PMSG from the market is sovereign but has left a major void in managing out-of-season reproduction and highly compacted synchronization for application of fixed-time artificial insemination. We will not repeat ourselves and our vision on all possible alternatives to manage sheep and goat reproduction in Middle East and Gulf countries have already been forwarded to CEVA in a technical brief after the meeting held in Beirut in October 2018. We would like however to note that feedback we have from our partners in Jordan and Palestine clearly indicates that access in the market for eCG is now ensured by other Argentinian, Dutch and Spanish brands.

- Melovin implants coupled with the use of progestogen-based sponges do not seem to be an alternative to the conventional PMSG + progestogen-based sponges for mass synchronization and fixed-time AI of Awassi sheep in the Middle East. Early during anoestrus (March-April), the percent of induced females (which should be mostly replacement maiden ewes) is not high enough to justify investment and later during the anoestrus season (May-June), the ram effect and sponges can produce an equally high

response supporting earlier data from North Africa and Australian Merinos located under a Mediterranean latitude.

- ICARDA has ready packages that suit sheep and goat breeds in Intertropical Africa. There is a demand that is linked to scaling up/out breeding programs and the use of AI. Such a demand remains fragile because of the novelty of the technologies, the lack of infrastructure, the lack of trained specialists and the weakness of the private sector. We foresee a synergistic long-term collaboration between ICARDA and CEVA to unlock some bottlenecks which would unveil real business opportunities in sheep and goat reproduction in this area of the world.

Ceva Animal Health KSA, International Center for Agricultural Research in Dry Areas (ICARDA)

Honored to invite you for the workshop

ADVANCES IN MANAGING REPRODUCTION IN SMALL RUMINANTS IN THE CONTEXT OF SAUDI ARABIA

Holiday Inn Meydan, Riyadh, 5-7 Feb 2019

With the Collaboration of

Department of Animal production, College of Food and Agriculture Sciences, King Saud University,

IMV Technologies

MAS Vet Services

Speakers

Prof. Mourad Rekik: ICARDA Small Ruminants Reproduction Senior Scientist.

Prof. Ayman Swelum: Department of Animal production, KSU

Dr.Misha Savic : Assisted Reproduction expert, IMV Technologies

Dr. Ahmed Hamdy: Ruminants Technical Manager, Ceva Middle East.

Holiday Inn Meydan, Riyadh

08:30 - 09:00: Brief Introduction to the workshop & collaborators
o Welcome Statement

o Introduction of the Participants

o Briefing of the Agenda

09:00 - 09:45: Basics of Sheep and Goat Reproductive physiology (specific mention of Local Breeds in Saudi Arabia) (Dr. Ayman Swelum)

09:45 - 10:15: Product Line Workshop (Group work)

- o Extensive Sheep Systems

- o Intensified sheep systems

- o Goat farms

10:15 - 11:00: Coffee Break

11:15 - 13:15: Product Line development for Sheep & Goat repro management (Dr. Mourad Rekik)

- o Fertility Management

- o Litter Size management

- o Synchronization protocols suiting fixed-time AI

13:15 - 13:45: Q fever, An immersing zoonotic impactor of Animal & Human Health (Dr. Ahmed Hamdy)

13:45 - 15:00: Lunch Time

15:00 - 16:00: Steps for establishing an AI system in Sheep & Goat

16:00 - 16:30: Group Management of Sheep & Goat Reproduction (Dr. Ayman Swelum)

16:30 - 17:00 Ultrasound-based pregnancy diagnosis as a tool for higher reproductive efficiency (Dr. Mourad Rekik)

Day2: Wednesday 6th Feb (Practical Session 1)

Location: Research Farm Animal Production department, KSU

09:00 - 11:00: Synchronization of sheep & goat herds
- Melatonin based protocols
- Progestogens Based Protocols
- GnRH & PGF Based Protocols

11:00 - 11: 30: Coffee Break

11:30 - 14:00: Semen handling
- Semen Collection
- Semen assessment and processing
- Dose calculation

14:00: Lunch & departure

Day3: Thursday 7th Feb (Practical Session 2)

Location: Research Farm Animal Production department, KSU

09:00 - 11:00: Artificial Insemination
- Straw preparation
- Semen deposition

11:00 - 11:30: Coffee Break

11:30 - 14:00: Ultrasound pregnancy diagnosis

14:00 - 14:30: Training assessment

14:30: Lunch & departure

Further Information

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ICARDA
Science for resilient livelihoods in dry areas

ceva

Joint ICARDA – CEVA Mission in Ethiopia

6 - 11 October 2019

Participating:

Mourad Rekik (ICARDA), Marjorie Bouchier (CEVA), Yohannes Guetinet (CEVA country representative in Ethiopia), Katali Benda (National Animal Genetic Resource Center & Data Bank in Uganda)

Objectives of the mission:

- Knowledge sharing with CEVA representative and her customers about small ruminant reproduction
- Development of reproductive tools for small ruminants in the context of East African conditions and constraints
- Understand and see how sheep and goats' community-based breeding programs are set, are functioning and what role can reproductive technologies have to support scaling

Agenda

Sunday 6th of October
- Arrival to Addis, accommodation on ILRI campus

Monday 7th of October
- Morning period: Meeting with ICARDA team led by Dr. Aynalem Haile (sheep and goat community-based breeding programs)
- Meeting with ILRI team led by Dr. Barbara Wieland (small ruminants health)
- Afternoon period: Coaching on small ruminants' reproduction (ICARDA meeting room)

Tuesday 8th of October
- Whole day: Visit to Debre Birhan research center (standardization of the synchronization protocol for sheep AI in Ethiopia – Overview of the national program in sheep and goats research (coordinator Dr. Ayele Abebe)

Wednesday 9th of October
- Morning period: Meeting with Dr. Asrat Tera, head of the animal breeding center (opportunities for cattle and sheep AI)
- Afternoon period: Coaching on small ruminants' reproduction (ICARDA meeting room)

Thursday 10th of October
- Part of the morning period: Meeting with Dr. Thomas Cherenet, head of the World Bank project for livestock development
- Rest of the morning period: Coaching on small ruminants' reproduction (ICARDA meeting room)
- Afternoon period: Coaching on small ruminant' reproduction (ICARDA meeting room)

Friday 11th of October
- Morning period: Coaching on small ruminants' reproduction (ICARDA meeting room)
- After lunch (up to 15:00): Wrap-up and way forward