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SUSTAINABLE ANIMAL
AND AQUATIC FOODS



Smart Reproduction for Better Flocks: Innovative Practices for the Reproductive Management of Sheep and Goat Flocks in Tunisia

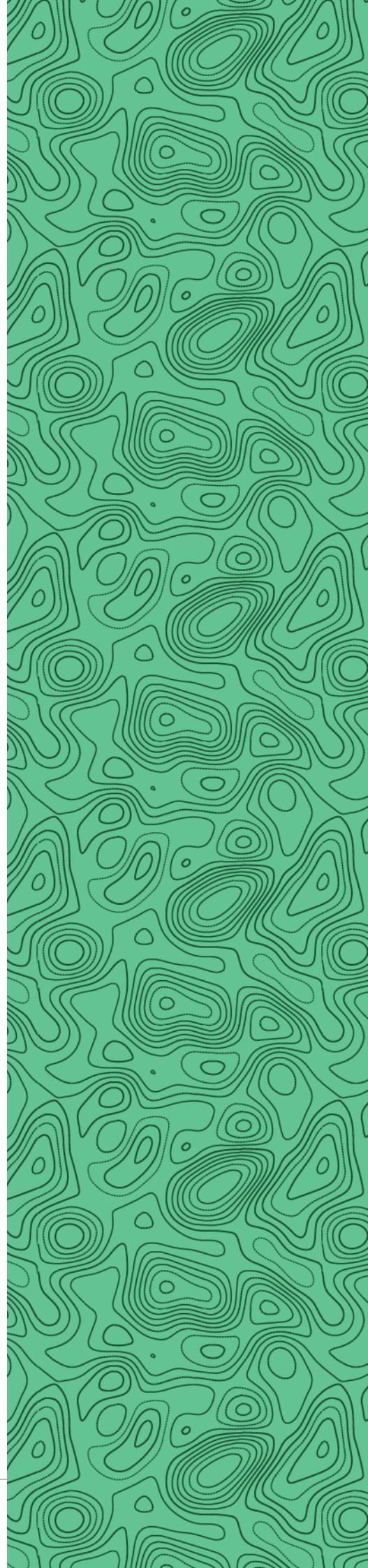
December 2025

Technical report



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Background

What is the need?

According to the National Institute of Statistics ([INS, 2022](#)), the population of small ruminants in Tunisia is estimated to **5,559,000 heads**, accounting to 4,637,000 head of sheep and 922,000 head of goats. Small ruminants are key contributors to food security in the country and this created an increased demand for their products in the market giving an optimal opportunity for small scale producers, belonging to the most dominant livestock production system in Tunisia, to valorise their products whether it be meat or dairy products. However, this opportunity is facing a major antagonistic driving force which is the global warming, resulting in extreme climate events, water scarcity, global rise in primary feed ingredients, acute feeding gaps, and more frequent outbreaks of diseases. Adding to these issues, Tunisian indigenous breeds of sheep and goats are not genetically improved and, therefore, are not competitive in intensive production systems. They are also facing the threat of genetic erosion as a consequence of introduction of/crossbreeding with exotic breeds that are not adapted to Tunisian context. The resilience of Tunisian breeds, their resistance to diseases and high adaptability potential are being lost and their performances in terms of fertility, prolificacy, and growth notably decreased.



Under which initiatives?

- Multifunctional Living Landscapes: The goal of this science programme is to promote diverse and healthy landscapes through holistic management approaches that support eco-agrifood, healthy diets and resilient livelihoods. Our work contributes to this science programme by conserving Tunisian biodiversity, with particular focus on indigenous breeds of sheep and goats, and by using environmentally friendly tools to improve small ruminant reproductive performance.
- Sustainable Animal and Aquatic Foods: The goal of this science programme is to boost access to nutritious food by addressing local challenges with context-specific and integrated solutions. Our work contributes to this science programme by optimizing small ruminant reproductive performance using low-cost, effective and locally-adapted reproductive biotechnologies.

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Objectives

The objectives of our work are to:

- Optimize reproductive performances of small ruminant flocks in Tunisia to improve productivity and sustainability
- Strengthen multi-stakeholder collaboration by engaging actors from different organisations and disciplines
- Build and sustain national capacities in line with national livestock development priorities

The biotechnologies

Natural tools to optimize oestrus synchronization

We evaluated, together with Higher School of Agriculture of El Kef (ESAK)'s team, the effect of the local wild plant "*Scabiosa atropurpurea* var *maritima*" on the reproductive parameters of Queue-Fine de l'Ouest ewes when combined to ram effect. The purpose is to test a cost-effective and hormone-free synchronization protocol out of the natural breeding season that is suitable to extensive systems and smallholders in the North-West of Tunisia. This work comes as a support to a graduation project of an engineer student enrolled in this same school.



Figure 1. *Scabiosa atropurpurea* var *maritima*
([Source](#))

Experimental design

To explore this effect, ESAK's flock of QFO females (n = 48) was divided into two equal groups, based on age and body condition score. All females were isolated from rams for six weeks, while being maintained under the same environmental and management conditions, including vaccination, internal and external parasite control, and shearing. During the final two weeks of this isolation period, only one group received a daily oral administration of an aqueous extract of *Scabiosa atropurpurea* var. *maritima*. The second group was a control group and did not receive any treatment.

Immediately before the introduction of sires (day 0), all females underwent transrectal ultrasonography to establish baseline ovarian activity. This examination was repeated daily for three consecutive days and once again on day 13 after ram introduction. The ultrasound evaluation of ovaries focused on follicular dynamics, including the total number of follicles, the emergence of new follicles, follicular growth and atresia, and the occurrence of ovulations as indicated by observed ovulation and/or the presence of a corpus luteum.

In parallel, sexual behaviour and receptivity were evaluated between the 16th and 76th hour following sire introduction. Observations were conducted every four hours to assess immobility, movements, and mating events. This allowed us to calculate individual receptivity index for each female.

Pregnancy diagnosis was performed using transabdominal ultrasonography 51-55 days after the introduction of sires.

Results

The reproductive response differed markedly between the two groups. A significantly higher proportion of females in the experimental group expressed oestrus behaviour compared with controls. Although not statistically significant, oestrus latency was shorter in control females. Follicular counts, for total, small, medium and large follicles, did not differ significantly between groups. However, the emergence of new follicles was higher in the experimental group, with significant differences observed on days 2 and 3 after ram introduction. The number of atretic follicles was higher in the control group, with statistical significance only observed on the first day. These differences in follicular dynamics translated into ovulatory outcomes. The total number of ovulations recorded during the three days following ram introduction was significantly higher in the experimental group. Nonetheless, this advantage did not result in higher fertility, as conception rates were slightly higher in the control group than in the treated group.

Conclusions

Taken together, these results suggest that the aqueous extract of *Scabiosa atropurpurea* var. *maritima* acts primarily at the early stages of reproductive reactivation. In normal conditions, the first response to the male effect is often marked by silent ovulations during the first two to three days. Therefore, the expression of oestrus behaviour, increased emergence of new follicles, reduced follicular atresia and higher ovulation rates here highly suggest that the use of this extract helps enable the rapid establishment of complete and expressed ovulatory cycles. The polyphenolic compounds present in the extract are likely contributors to this effect, possibly by supporting follicular viability and ovarian responsiveness at the onset of reproductive activity (Niama et al., 2025).

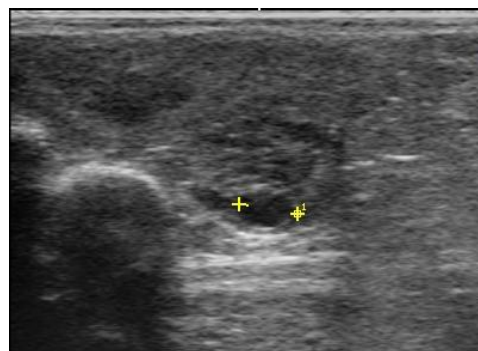


Figure 2. Pre-ovulatory follicle (6 mm)

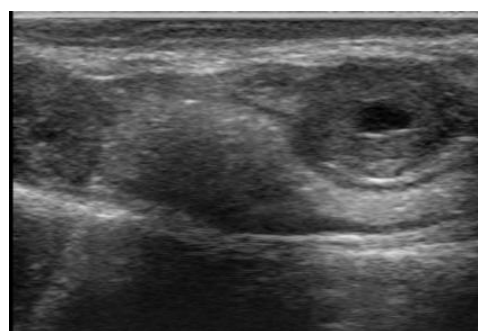


Figure 3. Corpus luteum



Figure 4. Estimation of lambing date in pregnant ewes

Resumption of reproductive function in ewes raised in halophyte-based rangelands

In collaboration with the team of the Higher Agronomic Institute of Chott Mariem (ISA-CM), and under the project “[Halosheep](#)”, we assessed post-partum resumption to sexual activity in Barbarine × QFO ewes raised on halophyte-based saline rangelands in Kerkennah islands in the Center of Tunisia. This was done by monitoring uterine involution, assessing milk quality and recording pre-weaning growth of lambs. Our purpose was to help establish an effective reproductive management by avoiding reproductive failures in the next breeding seasons, thus securing an optimal fertility.

Experimental design

Our study was conducted on a group of 24 QFO ewes from a flock of a total of 250 females. These ewes were selected because they mated during the natural autumn breeding season. Their average age was 10 years and average parity is 13.9. During pregnancy, the ewes grazed on natural halophytic rangeland, then were housed in a shelter following lambing.

Rectal temperature was monitored every 10 days, starting from lambing until 40 days postpartum, to detect potential post-partum uterine infection and to monitor the resumption of ovarian activity. In Parallel, ewes were observed daily for external signs of estrus, including vaginal discharges and changes in vulvar coloration. Body condition score was also assessed after lambing.

Colostrum and milk samples were collected manually, visually evaluated then transferred into sterile vials for physiochemical analysis (fats, proteins, lactose, SNF). Analyses were performed using an ultrasonic Lactoscan*. These measurements will provide insights into the nutritional value of ewe milk to ensure an optimal lamb growth.

Lamb growth was monitored from birth at a regular 10-day interval until 40 to 45 days of age. Body weights were recorded using an electronic scale. These data provide information on early postnatal development of the lambs.

Uterine involution was assessed by transrectal ultrasonography. The evaluated parameters included the diameter of the whole uterus and uterine horns, lumen diameter, thickness of myometer and presence/absence of luminal content. When present, ovarian follicles were measured; However, follicular dynamics were not assessed, as only a single evaluation was performed.

Results

At lambing (day 0), ewes showed high rectal temperatures, with an average of 40.2°C in experimental ewes. This could be explained as an immediate postpartum hyperthermia. On day 10 postpartum, 80% of ewes presented a dark pink to red vulvar mucosa with visible mucus discharge, coinciding with an average rectal temperature of 40.5°C. Similar vulvar signs were observed on the 30th day postpartum. Following the introduction of rams, many ewes showed a red vulvar mucosa with visible mucus, although no mounting or clear behavioural signs of estrus were recorded. Body condition score (BCS) was also assessed twice: at 1 – 5 days then 20 – 26 days postpartum. During the first assessment, 50% of the ewes had BCS below 2. By the second assessment, 70% of ewes had BCS above 2. BCS above 2, indicating an improvement in body condition. This positive evolution suggests effective nutritional support during postpartum period, which is known to favor earlier ovarian resumption (Lassoued, 1998).



Figure 5. Halophyte grazing land in Kerkennah



Figure 6. Ultrasonic image of uterine horns

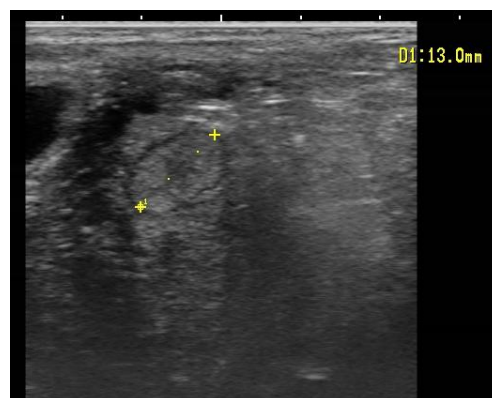


Figure 7. Measurement of the diameter of one uterine horn

Colostrum analysis showed stable milk physiochemical composition across the different postpartum periods. This stability could be explained by the breed's primary aptitude for meat production rather than milk.

Uterine involution progressed normally, with a continuous reduction in uterine dimensions. Mean uterine diameter decreased from 34.8 mm during the first week to 19.88 mm during the second week PP. A similar trend was noted for uterine wall thickness, decreasing from 1 mm to 0.53 mm within five weeks, while uterine lumen diameter decreased from 3.35 mm during the first two weeks to 1 mm by the 6th week. Primordial and small ovarian follicles were observed throughout the postpartum periods, indicating gradual resumption of follicular activity. Notably, few ewes presented large follicles starting from 2nd week, and corpora lutea starting from 5th week. This suggests that ovarian cyclicity has been re-established.

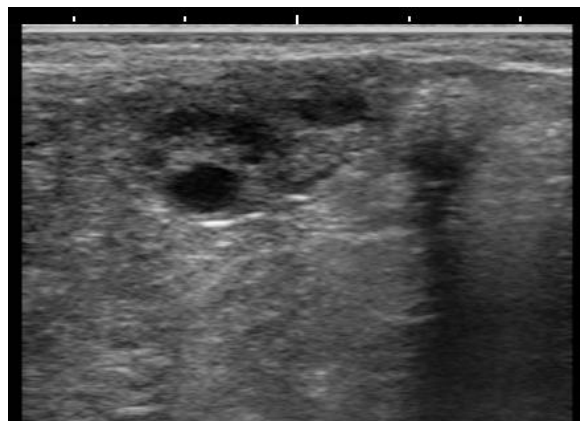


Figure 8. Pre-ovulatory follicle (6 mm)

Lamb growth showed a steady increase over time. Average birth weight was at 4.36 ± 1.18 kg, then a notable increase was recorded at 10 days age (6.34 ± 1.18 kg), then 7.96 ± 1.38 kg at 20 days, and 8.68 ± 1.38 kg at 30 days. By the age of 40 to 45 days, average body weight of lambs reached 10.24 ± 1.78 kg (Figure). Correspondingly, average daily gain of lambs was 193 ± 96 g between 0-10 days; 124 ± 108 g between 10-20 days, 78 ± 40 between 20-30 days and 130 ± 14 g between 30-45 days. The drop in average daily gain observed between days 10 and 30 could be explained by the occurrence of diarrheal episodes in some lambs.

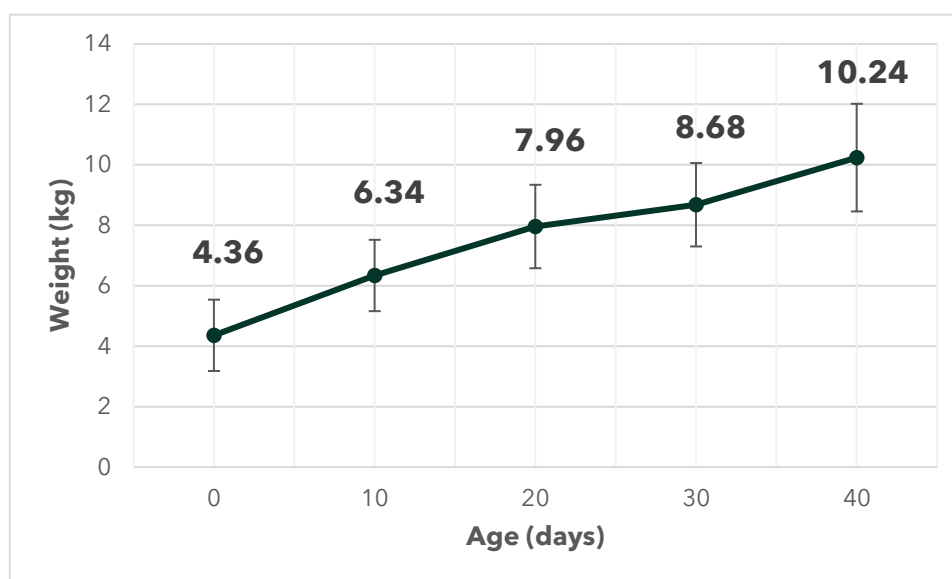


Figure 9. Evolution of lambs' live weight

Overall, the obtained results indicate that ewes managed under a halophyte-based grazing system showed satisfactory post-partum recovery, characterized by normal uterine involution, gradual resumption of ovarian activity, and improved body condition score after provision of adequate nutritional support. Milk composition and quality remained stable, and supported an acceptable lamb growth. In conclusion, combining proper post-partum nutrition, close reproductive monitoring and improved management of young stock can enhance both reproductive efficiency of ewes and optimize lambs' growth.

Artificial insemination

In collaboration with ISA-CM and OEP teams, a “best-to-best” mating scheme was implemented in the Noire de Thibar (NT) sheep breed to support the farmers’ cooperative GDAEBN in improving flock productivity. Lamb growth, as well as ewe productivity and reproductive performance, were first evaluated to identify the best female candidates for artificial insemination (AI). Growth performance data from 913 lambs born to 500 ewes over two lambing seasons (2023–2025) were analyzed. Based on these results, 136 elite ewes were selected for AI using high-quality semen from genetically superior NT rams provided by the OEP AI laboratory. This collaboration demonstrated the effectiveness of AI as a tool to enhance productivity through the strategic selection of both males and females within a national genetic improvement programme.

In parallel, a goat AI programme was implemented to improve the performance of local goat populations reared under extensive systems in northern (Ariana), central (Kairouan), and southern Tunisia (Kebili and Tozeur). The programme relied on crossbreeding with Alpine and Boer breeds using semen from bucks of high genetic merit. In Ariana, pre-ovulatory follicular dynamics were monitored to assess the effectiveness of the oestrus synchronization protocol prior to AI. This work was conducted in collaboration with OEP, within the context of establishing community-based breeding programmes (CBBPs) in Tunisia. Across the four governorates, the overall AI success rate in goats was 34.7%. AI outcomes were significantly influenced by geographical location, buck identity, buck breed, and female age, highlighting the importance of both environmental and animal-related factors as major sources of variation in success rates.

Cross-cutting biotechnology: Ultrasonography

Ultrasonography was a key tool used throughout the development of the above-mentioned innovations, serving both research and development objectives.

For research, it allowed accurate assessment of reproductive parameters and estimation of conception rates after artificial insemination as well as natural mating. This included: (i) evaluation of conception rates in Queue-Fine de l'Ouest ewes in Dahmani (El Kef) using a specific AI protocol within a PhD research work; (ii) assessment of ovarian activity then conception rates following feed supplementation with a native wild plant combined with the male effect for out-of-season oestrus synchronisation; (iii) characterization of postpartum uterine involution and ovarian resumption in Barbarine × QFO ewes in the Kerkennah islands; and (iv) evaluation of conception rates in Noire de Thibar ewes following AI campaigns in the north of Tunisia.

For development, ultrasonography supported the estimation of AI success rates in goats during national campaigns in the north, centre and south of Tunisia. It also allowed the optimization of reproductive management in OEP sheep flocks in Saouef (Zaghouane) and Fritissa (Bizerte). The results directly informed practical recommendations for flock management in Barbarine, QFO, D'man, Noire de Thibar and Sicilo-Sarde sheep breeds.



Figure 10. Insemination of a Noire de Thibar ewe in Beja



Figure 11. Performing ultrasound pregnancy diagnosis in ewes

Multi-stakeholders Co-Developed Innovations

The development and deployment of these innovations relied on a board, coordinated network of stakeholders, ensuring strong scientific grounding, institutional support and field implementation across many governorates in Tunisia.

Network of stakeholders

This network included research organizations (ICARDA), academic institutions (ESAK, ISACM), governmental institutions for extension services (OEP), and farmers' cooperatives (GDAEBN). ICARDA played a central coordinating role, working closely with all partners to ensure coherence across research, development, and field implementation.

Geographical distribution of the stakeholders

The geographical footprint of these collaborations was extensive, covering Ariana, Bizerte, Beja, El Kef, Siliana (previously within Agroecology initiative), Zaghouane, Kairouan, Sfax (Kerkennah islands), Tozeur and Kebili. Consequently, this enabled large-scale dissemination of innovative reproductive biotechnologies across diverse landscapes, from the north to the south of Tunisia. ESAK (El Kef) and ISACM (Sousse) contributed through research and capacity building, while OEP (Tunis/Sidi Thabet) ensured field implementation. Additionally, the farmers' cooperative GDAEBN played a key role in community engagement, particularly in Beja and Bizerte.

Capacity Building

Beyond field implementation, this multi-stakeholder framework also supported capacity building, allowing the successful completion of three engineering graduation projects, in close collaboration with ESAK and ISACM, thereby strengthening national expertise in reproductive biotechnologies.

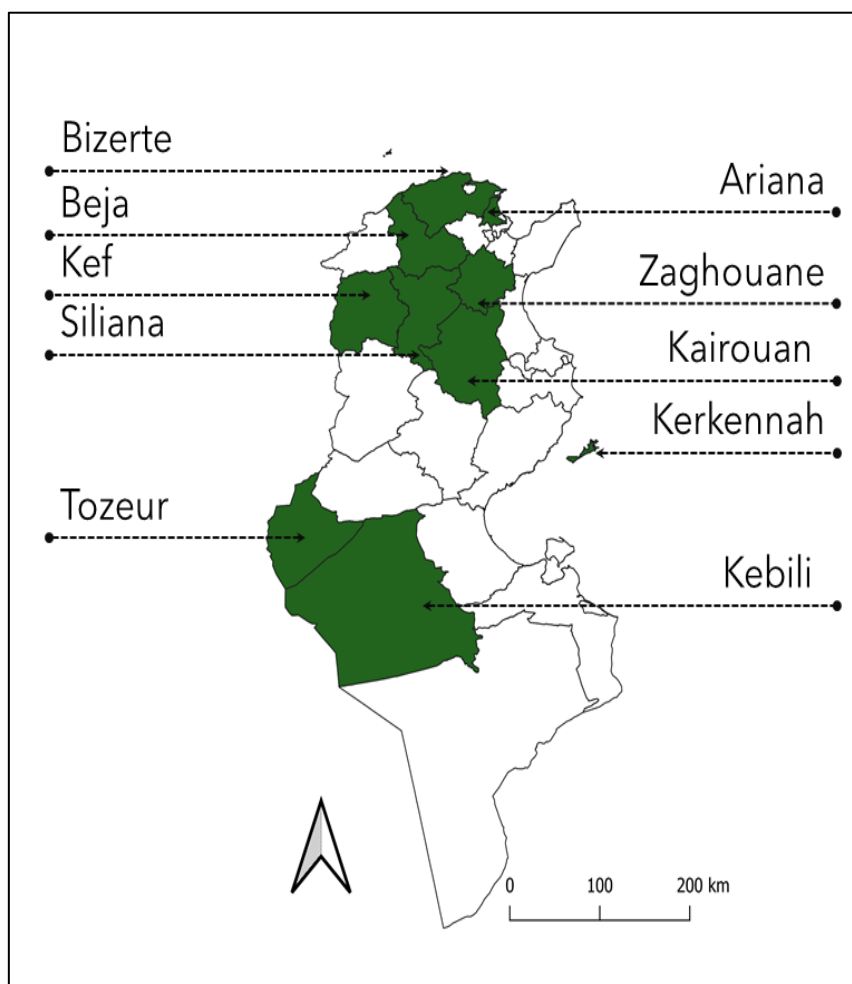


Figure 12. Geographical distribution of ICARDA's contribution to reproductive innovations in small ruminants in Tunisia



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