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Presentation of the ADAPT-HERD project

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Abstract. The main effect of climate change on livestock production systems in the Mediterranean area is to induce changes in feed resource availability. In face of constraining and changing environmental conditions, the challenge is to find practical solutions for herd management to minimize farmer's risk. These solutions should be good enough in terms of efficiency (E), to ensure sufficient income, and good enough in terms of resilience (R), to ensure farm sustainability. The objective of the ADAPT-HERD project is to develop simulation tools capable of evaluating the consequences of management strategies at the herd level, under contrasting and varying environments (Egypt, France, Spain and Tunisia). Our approach considers that biological adaptive capacities of small ruminants can be fully integrated within management strategies to improve R and E by: (i) using reproduction practices that provide the best match between herd demand and feed supply; (ii) managing groups of animals based on their adaptive capacities (targeting interventions) and (iii) managing herd demography to adapt animal numbers to future feed resources. The project will implement data acquisition at animal level (fine-grained experiments on adaptive capacities and phenotyping of local breeds) and at production system level (herd management, feed resource, climate and market conditions). Data will be combined and used in computer simulations to explore different climate change scenarios and management strategies and evaluate their effects on herd R and E. Interfacing modelling tools will be a key aspect of the project, fostering knowledge exchange and collaboration, especially with ongoing projects focusing on genetic selection and breeding solutions to improve R&E in small ruminants.

Keywords. Resilience – Efficiency – Climate change – Modelling.

Stratégies de gestion reposant sur la maitrise des capacités d'adaptation des petits ruminants pour améliorer l'efficacité et la résilience des troupeaux. Présentation du projet ADAPT-HERD

Résumé. *Un des principaux effets du changement climatique sur les systèmes d'élevage dans la zone Méditerranéenne est de modifier la disponibilité des ressources alimentaires. Face à ces conditions environnementales contraignantes et variables, l'enjeu est de trouver des solutions pratiques de gestion du troupeau pour minimiser les risques pour l'éleveur. Ces solutions doivent être satisfaisantes à la fois en termes d'efficacité (E), pour assurer un revenu suffisant, et en termes de résilience (R) pour assurer la durabilité de l'exploitation. L'objectif du projet ADAPT-HERD est de développer des outils de simulation permettant d'évaluer les conséquences de différentes stratégies de gestion du troupeau, dans des environnements contrastés et changeants (Egypte, France, Espagne et Tunisie). Notre approche considère que les capacités biologiques d'adaptation des petits ruminants peuvent être intégrées dans les stratégies de gestion du troupeau pour améliorer l'E et la R : i) en*

utilisant des pratiques de reproduction qui permettent une bonne adéquation entre la demande du troupeau et l'offre alimentaire ; ii) en gérant des groupes d'animaux basés sur leurs capacités d'adaptation (interventions ciblées) et iii) en gérant la démographie du troupeau pour adapter le nombre d'animaux aux futures ressources alimentaires. Le projet reposera sur l'acquisition de données au niveau de l'animal (expérimentations fines sur les capacités d'adaptation et phénotypage des races locales) et au niveau du système de production (pratiques de gestion, ressources alimentaires, conditions de marché). Les données seront combinées et intégrées dans des outils de simulation informatique pour explorer différents scénarios de changement climatique et de stratégies de gestion et ainsi évaluer leurs impacts sur l'E et la R du troupeau. L'interfaçage des outils de modélisation sera un aspect clé du projet, pour favoriser les échanges de connaissances et les collaborations, en particulier avec les projets en cours sur la sélection génétique pour améliorer l'E et la R des petits ruminants.

Mots-clés. *Résilience – Efficacité – Changement climatique – Modélisation.*

I – Introduction

The main effect of climate change on livestock production systems is to induce changes in resource availability. Rising temperatures and lower or unpredictable rainfall patterns decrease primary biomass production and thus forage availability. Changes in seasonality and the increasing occurrence of extreme events also greatly reduce the predictability of seasonal variations in food availability. These impacts of climate change will strongly affect performance of small ruminants' production systems, especially efficiency (E) as feed costs are one of the main element determining economic performance. Further the dynamic dimension of climate change impact implies that systems have to be able to recover from perturbations, that is to say have to be resilient (R). To face climate change impacts, the challenge is therefore to find solutions that improve both R and E of farms. The overriding concept behind the project ADAPT-HERD is that improving R&E at herd level will contribute to improve R&E at the farm level and therefore will be a key element of adaptation of small ruminant systems to climate change. The role of the herd as a key regulating element of farming system has already been demonstrated (Nozières *et al*., 2011). Focusing on this particular element of the farming system makes sense in the Mediterranean context where the herd may be the only source of income and a major capital reserve for farmers (Aboul-Naga *et al*., 2014). Given the complex balance of mechanisms giving rise to efficiency and resilience, there is no single solution that fits all and that will maximize both efficiency and resilience in a range of situations. The challenge is to find strategies that are good enough in terms of efficiency, to ensure sufficient income for farmers, and also good enough in terms of resilience, to ensure farm sustainability. In other words, the challenge is not to find an optimal strategy for R&E, but to explore how management strategies impact the relationship between R&E. Simulation tools, allowing "what if" scenarios to be evaluated would be extremely useful to assess the R&E costs and benefits of different management strategies under current condition, and also under future changing conditions.

Small ruminants are recognized for having strong biological mechanisms to deal with constraining and fluctuating environmental conditions, particularly with respect to feeding resources (Silanikove, 2000; Atti *et al*., 2004). Our approach considers that such adaptive capacities can be fully integrated within management strategies to improve R&E at the herd level by:

– Using different reproduction practices to manage the temporal distribution of herd size and herd make-up (proportions of young and adult animals) that provides the best match between feed supply (itself varying in time depending on quantity and quality dynamics of the local resources such as grasslands, rangelands, crops, by-products) and overall herd demand (depending on the sum at any given time of individual requirements).

– Managing groups of animals in the herd based on their types of adaptive capacities and thereby targeting interventions to face resource shortage (e.g. extra feed distribution) to groups with the greatest potential to respond, reducing the total cost of intervention.
– Managing herd demography and adapting animal numbers to feed resource with locally-tailored replacement and culling practices that consider not only market conditions but also the continued viability of the herd.

II – Project overview

ADAPT-HERD is a 4-year project organized around 4 research work packages (WP), one outreach and dissemination WP and one management WP (Fig. 1). This structure facilitates the assembly of research results at two levels of organization, animal and herd, into operational tools to evaluate the impact of fluctuating resource due to climate change on R&E of small ruminants farming systems. The project contributes significantly to having a solid biological building-block at the animal level: WP1 provides knowledge on the mechanisms at the biological function level that give rise to adaptive capacities and WP2 provides knowledge on local breed phenotypes. The animal building block will be further used as the basis of individual variability when upscaling to herd level. WP3 provides information on herd management practices, feed resource diversity and dynamics, representative of the current context in the Mediterranean area. This information is integrated in WP4 to develop and implement herd models. Data collection and partners' expertise are used to build and simulate scenarios relevant in the PRIMA context. WP5 involves all partners and the broader networks of stakeholders in a participatory approach. It will manage the dissemination of models and simulation results by developing a user-friendly modelling toolbox. This interfacing component of the project will facilitate the use of deliverables as tools for educational objectives (understanding the complexity of herd functioning in changing environments) and strategic objectives (relevance of proposed solutions, improvement of models). It will also facilitate the diffusion of the protocol of data collection implemented in WP2 and WP3 to further extend the project approach to other potential Mediterranean partners.

III – Expected impacts

ADAPT-HERD will improve the ability of Mediterranean sheep and goat systems to adapt to climate change by providing herd management solutions based on animal adaptive capacities. The project will deliver locally tailored practical solutions for herd management to optimise production and resilience of the herd to minimize farmer risk in the face of constraining and changing environmental conditions. The project will also provide scientific knowledge on animal resilience. Experiments will quantify the impact of interactions between genotype and early-life environment on adult adaptive capacity. Phenotyping of local breeds will contribute to preserve longevity and optimize trade-offs in life functions (production vs survival). This will allows improving production while preserving local breeds' capacity to cope with constraints. "What if?" simulations of climate change and technical options scenarios will provide understanding costs and benefits of strategies in the current and future changing conditions, therefore supporting decision in rural development pathways. Finally, the project will deliver tools to enhance innovation capacity: protocol for data collection, common modelling architecture and user-friendly interface. Such tools will facilitate exchange and knowledge transfer between farmers, extension services, breeding organizations and policy makers.

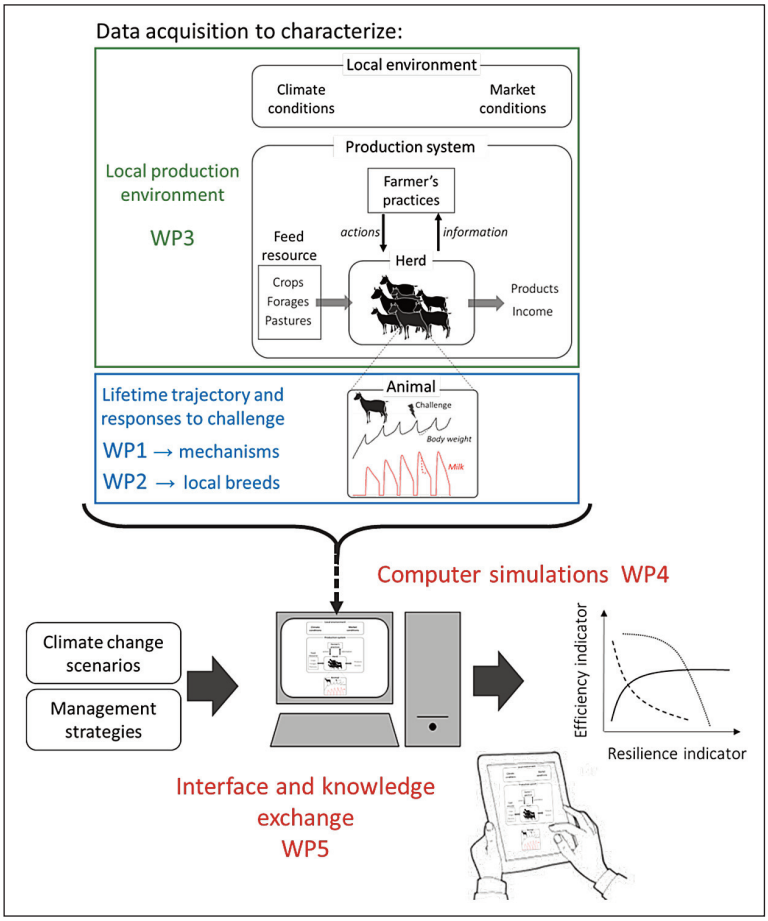

Fig. 1. Schematic of ADAPT-HERD workflow.

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