Modelling as a tool to explore adaptation of Mediterranean sheep farming systems to climate change

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Mediterranean pastoral farming systems are increasingly subject to strong climatic constraints, which impact their access to grazing resources. To develop livestock farming systems adapted to climate change, combining resilient herds and an efficient use of various feed resources is central. Different combinations can be explored by modelling the impacts of climate change on feed resources and adaptation levers at the different levels of the farm organization (animal-herd-livestock system) however, this is methodologically challenging. This study aims at developing a simulation tool to represent, from animal to farm components, the multi-level implications of adaptation levers that can be mobilized by Mediterranean small ruminant farmers. These levers can be related to animal biology and/or management strategies. The simulation tool enables to evaluate relative and combined effects of levers on farm resilience and efficiency. It was developed with GAMA, an agent-based computer language, to allows the representation of each individual components (animals and areas) of the farming system. The simulator was calibrated on two contrasting pastoral sheep systems in the South of France: one grazing system uniquely based on rangelands and one complemented system with both rangelands and forage production. For these two contrasting situations, we tested the effects of three levers: (i) increasing the part of pastoral surfaces, (ii) shifting the grazing periods, and (iii) decreasing the flock size to better match with resources availability. The simulator was able to mimic the functioning of livestock farming systems and to evaluate for each situation the impact of adaptation levers on farm efficiency and resilience. Based on this prototype, other situations could be simulated according to climate change scenarios in the Mediterranean area and adaptation levers could be explored to address specifically these challenges at the farming system level.