A simulation-based approach for evaluating the effects of farm type, management, and rainfall on the water footprint of sheep grazing systems in a semi-arid environment

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Abstract

Central Chile has a semi-arid, Mediterranean-type climate, characterized by mild temperatures and irregular and unreliable winter rainfall. Meat sheep production managed in extensive systems is an important agricultural activity of the area. A dynamic, stochastic, simulation sheep model was developed with the objective of assessing the water footprint of extensive lamb production in relation to factorial combinations of annual rainfall, stocking rate, and rate of supplementation of ewes and lambs. The simulation model includes two sub models that estimate grass and lamb growth respectively. The model allows estimation of the water footprint of sheep production, its partitioning into green-blue-grey water, and of tradeoffs in physical outputs. Dry (424 mm) and very dry (380 mm) years occurred in 40% of cases reported for the 1972–2014 period. Green, blue and grey water footprints were significantly affected by the variables studied. The lowest water footprint was found in average years (702 mm; 5369 L·kg of LW−1 sold) and increased to 7741 L·kg of LW−1 sold in dry years when ewes were supplemented with grain. Numerous significant interactions between yearly rainfall and feeding strategies were found that are indicative of the management challenges faced by the system. The simulation model proved to be a powerful tool to examine a variety of climatic and production scenarios in order to infer possible future trends in response to climate change and production strategies..

Keywords

Simulation model, Climate change, Sheep meat, Water footprint.