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Agroecological food webs: modelling a missing piece to climate change adaptation

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Agricultural models have progressed significantly over the past decades with regards to their representation of interactions between water, atmosphere, soil dynamics and plant genetics, and these insights have allowed for the generation of many hypothetical analyses and recommendations for food systems adaptation to climate change. However, none of these models currently incorporates interactions between pest and beneficial insects in fields, even though the FAO estimates that poor pest and disease management causes losses of 20-40% of global agricultural output each year. And, even when they are considered, pests are generally treated as exogenous inputs to models, though in reality their pressure on crops is highly modulated by other insects and organisms within the agroecosystem, which may make the difference between a low and unnoticed pest presence in the field and a serious outbreak. This research gap is likely due to the high complexity of such systems and inconvenient properties (high number of variables, missing data for many parameters, and inherent instability) that make their mathematical representations extremely difficult to model and, in particular, successfully calibrate.
However, when climate change is expected to increase pest pressures on crops worldwide as well as to introduce new ones, the development of modelling tools to provide predictions and analyses of integrated pest management scenarios for informed decision making becomes increasingly important. We here present a framework for modelling agroecological food webs based on a combination of mechanistic and stochastic population dynamics equations and automated calibration of key agroecological parameters. Using field data from previous studies, we show that the model can represent population dynamics previously observed in the field and could therefore be used in future scenario studies or as a decision support tool for integrated pest management. The tool could also contribute to an increased understanding of and appreciation for the natural biodiversity in agricultural fields that often, but not always, silently prevents pest outbreaks. This research was conducted with Tiko'n, a Python library that automatically manages the more technical of food web modelling and allows users to rapidly build, calibrate and simulate their own food webs based on field data or hypothetical experiments.