Diversity of model-based scenario approaches of biodiversity evolution in agricultural landscapes. A review

Pierre Chopin, Laure Hossard

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ABSTRACT BOOK

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Diversity of Model-based Scenario Approaches of Biodiversity Evolution in Agricultural Landscapes. A Review

Pierre Chopin[1], Laure Hossard[2]
[1]*Sverige Lantbruksuniversitet (SLU), Sweden,* [2]*INRA, France*

Abstract: Increase in intensity of cropping systems, landscape homogenization and the disappearance of off-field habitats threaten biodiversity in agricultural landscapes. In order to increase the abundance and diversity of species in agricultural landscapes, many scientists develop different model-based scenario approaches of biodiversity evolution. In this study, i) we characterized 77 studies describing model-based scenario approaches, obtained from the WebofKnowledge , ii) we grouped them to identify common approaches based on these variables, and iii) we developed a methodological framework to guide further developments of this type of study. For each paper, we determined qualitative variables related to i) biodiversity (species, processes driving biodiversity change, addressed issues), ii) spatial characteristics (spatial extent, scales), iii) scenario characteristics (involvement of stakeholders, type of scenario), iv) landscape (change in landscape, precision in agricultural land use), and v) models used (to design landscapes, and to assess biodiversity evolution). Results show a large diversity of model-based scenario approaches of biodiversity evolution. The type and range of species studied goes from one single species to multiple taxa. The spatial extents varies from <1 km2 to continental extent with different use of information at multiple scales from pixels to field/farm and landscape level. New landscapes are produced from field-scale management change to combination of spatial and technical re-organization of agricultural land uses, with description of agriculture ranging from aggregated land cover to cropping system description. Models for designing new landscapes and assessing the state of biodiversity encompass optimization tool, statistical models, mechanistic representation of landscape and agent-based models (ABM). Most scenarios are defined based on few variables rather than participatory building of narratives. Based on multiple correspondence analysis (MCA) and hierarchical clustering analysis (HCA), we obtained several groups of studies. Groups can be summarized as "Optimization of agricultural habitats in medium extent landscapes", "ABM studies coupling behavioural model of biodiversity with farmer´s choices", "Statistical assessment of abundance evolution coupling field and landscape metrics", "Habitat evolution of biodiversity in biomass based studies" and "Integrated assessment of agricultural impacts and habitats change for biodiversity with storylines". Based on these studies, we elaborated a methodological framework to help formalizing model-based scenario approaches of biodiversity evolution that encompasses the description of model inputs (real landscape, data, drivers, scenarios), processes (simplification of landscape, process driving biodiversity change, numerical models) and outputs (system knowledge, visualization).

Keywords: biodiversity, agricultural landscapes, landscape design, landscape assessment, scenario

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The Effect of Contrasted Perennial Flower Strips on the Parasitism of Oilseed and Faba Bean Herbivores

Antoine Gardarin[1], Dominique Le Floch[2], Muriel Valantin-Morison[2]
[1]*UMR Agronomie, France,* [2]*UMR INRA-AgroParisTech Agronomie, France*

Abstract: The implementation or management of habitats to improve functional biodiversity is known to increase natural enemies of herbivores, but it does not necessarily lead to a significant reduction in crop herbivores. The performance of flower strips and natural enemies in terms of biological control depends on many factors and we need to understand why some mixtures of plant species perform better than others.

During a four-year field experiment, we compared the effect of eight contrasting floral mixtures comprising native and perennial plant species. We have varied the proportion, the species and functional diversity of plant species providing resources toward natural enemies. These mixtures were compared with control plots consisting of a strip sown with the crop species each year. Each flower mixture was sown on a 6×45m strip and replicated on three blocks. Vegetation relevés were carried out in the spring to determine the amount of plants providing easily accessible nectar to parasitoids, based on flower morphology. In the adjacent crop, at 5 and 20m from the strip, we evaluated parasitism levels of (1) larvae of *Meligethes aeneus* (caused by *Tersilochus heterocerus*) collected from rapeseed flowers, (2) *Dasineura brassicae* by dissection of pupae collected in the soil after the rapeseed harvest and (3) *Bruchus rufimanus* within faba bean seeds by examining exit holes of B. rufimanus and of their parasitoids. These parasitism rates were also compared to those found in control fields at least 250m away from our experimental field. No insecticide was used in any field.

Parasitism of *M. aeneus* larvae was generally very low. It was 8% on the control plots and varied between 8 and 19% at 5m from each flower strip. At this distance, the parasitism rate increased with the amount of flowering species in April providing easily accessible nectar, but this effect was less clear at a distance of 20m. For *D. brassicae*, 55% of pupae were parasitized without any effect of flower mixtures or distance to the strip in the field. In faba bean seeds, parasitism of *B. rufimanus* was 25% in the control field, 33% in the control plots and 47% in front of the flower strips, without any distance effect. The parasitism rate increased with the amount of flowering species providing easily accessible nectar in May. At the same time, the proportion of seeds damaged by *B. rufimanus* was lower at 5 than 20m from the flower strips (54 vs 70%). No effect was found on crop yield as the parasitism occurs after the damage has been caused to the crop.

For two of the three herbivores studied, we demonstrate (1) that the composition of plant communities near crops influences their parasitism rate and (2) that this biological control can be strengthened by the establishment of flower strips providing food resources in April and May, i.e. during the parasitoid activity period. The differential effects of flowering strips were related to the quantity of plants providing easily accessible nectar.

Keywords: Conservation biological control, Meligethes aeneus, Dasineura brassicae, Bruchus rufimanus