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What are the global effects of agricultural management on biodiversity? Research we know, research we need.

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Abstract

Agriculture, as the largest managed biome, represents both a land-use with great impacts on ecosystems and great potentialities to a better sustainability of climate mitigation, food security and biodiversity. Yet, its effects on biodiversity importantly vary among agricultural managements. Currently, no global synthesis analysing the available evidence of multiple individual or combined agricultural intervention on biodiversity exists.

Here, we systematically synthesise evidence of the published meta-analyses on the effects of: individual practices (fertilization, crop diversification, tillage, pest and disease management, residues management, water management), agro-ecological systems (agroforestry, conservation agriculture, organic agriculture) and landscape scale management (landscape complexity, land-use change), on various biodiversity groups in croplands. We searched through four online search engines on July 2021. We thereby identified more than 150 meta-analyses to create a database representing ca. 1500 effect-sizes. From this, we produce: (i) an evidence map highlighting the data availability and knowledge gaps, and (ii) a vote-counting analysis representing the positive/neutral/negative effects of agricultural interventions on biodiversity.

First, our results show that most of the meta-analyses focus on the effects of one individual agricultural practice: mainly fertilization (mineral or organic) and crop diversification. In contrast we gathered less meta-analyses on agricultural systems or landscape scale effects. All agricultural interventions highlighted micro-organisms as the most studied biodiversity group, followed by invertebrates (predominantly arthropods) and weeds. We notice that notably megafauna and avifauna are scarcely represented. For all biodiversity groups, the most studied metrics are biomass, abundance and taxonomic richness, while activity metrics are highly represented only in micro-organisms. Trait-based functional responses are very few represented.

Second, our results highlight that when several meta-analyses focused on the same intervention-biodiversity combination, they mainly yielded contradictory results (e.g. organic agriculture) suggesting a lack of statistical power or very variable effect according to environmental factors. Conversely, few intervention-biodiversity combinations lead to homogenous results (e.g. crop diversification benefits microorganisms).

We finally discuss the need for further research on (i) specific intervention-biodiversity combinations, and (ii) for balanced effects of agricultural management on biodiversity, thus opening perspectives in moderation effects from various factors such as biogeography, climate, soil characteristics, etc.