SCIENCE FOR ENVIRONMENT POLICY

Do improved pollination services outweigh the economic disadvantages of farming smaller fields?

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With the current intensification in agricultural activity there has been an expansion in field sizes and the loss of permanent green field edges and other semi-natural habitats. From an economic perspective, the increase in field size improves agricultural efficiency — mainly due to cost savings. However, recent evidence suggests that increasing field size may decrease the ecosystem services provided by farmland biodiversity — but this trade-off is rarely considered. This study quantifies the economic and ecological effects of field-size changes for an agricultural region in Germany.

This study's results show a substantial decrease in flower visitation in oilseed rape when field sizes increase and permanent green edges are lost. This also leads to a decrease in pollination from wild bees and affects yields and farm economics. However, this loss in agricultural gross margin is overcompensated by economic gains of field enlargement. Maintaining fine-grained agricultural landscapes with permanent field margins in the long term may require incentives to farmers, as well as innovations that allow economic farming of small fields.

The margins and edges of fields — commonly grassy strips, hedges, walls or ditches — provide refuge for beneficial plants and animals, act as 'wildlife corridors', offer resources for wild pollinators and pest-controlling species, and provide agricultural benefits, such as reducing soil erosion by wind or water. Farms are trending towards larger field sizes to allow for more efficient management of crops, lower production costs per hectare of land and an increase in the productive area of a given field, potentially making these habitats economically unproductive.

While increased field size may bring economic benefits for farmers, removing field edges decreases biodiversity and its provision of ecosystem services to crops. It reduces the resources available for wild pollinators, for example, and increases the distance between crop and service-providing habitats. Large tracts of semi-natural habitat within a landscape can reduce the extent to which agricultural land-use change affects species' communities in cropland, suggesting that farms could maintain small field sizes (which have proportionally longer lengths of field edges) to conserve biodiversity. However, research is lacking on the ecological and economic impacts of farmland configuration and composition — and this is essential to inform policy that simultaneously considers agricultural production, flow of ecosystem services and biodiversity conservation.

Source:
Kirchweger, S., Clough, Y., Kapfer, M., Steffan-Dewenter, I., and Kantelhardt, J. (2020) Do improved pollination services outweigh farm-economic disadvantages of working in small-structured agricultural landscapes? – Development and application of a bio-economic model. *Ecological Economics*, Volume 169: 106535.

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Do improved pollination services outweigh the economic disadvantages of farming smaller fields? (continued)

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To help fill this gap, this study explores the economic and ecological effects of increasing field size and the decreasing area dedicated to permanent field edges. It establishes a bio-economic model with which to assess the influence of structural landscape aspects on pollination and estimates the contributions of these pollination services to agricultural production (in terms of oilseed rape yield and gross farm margins per landscape type and area).

The researchers utilise a simulation-based land-use modelling framework founded on spatially explicit data from an intensively cultivated agricultural region in northern Bavaria, Germany. The region is dominated by arable land (90% of the utilised agricultural area) that produces crops including winter wheat, sugar beet and barley. The average farm and field size are respectively 45 and 1.5 hectares and semi-natural habitat types comprise dry chalky grasslands, abandoned vineyards and forest. Using study areas of two square kilometres across 13 landscapes, the researchers analysed land use, pollination, yield, economic and multiple diversity sub-models. The study simulated a realistic land consolidation process by which neighbouring fields were merged to form a single larger field (as long as they were not separated by streets, watercourses or ditches).

The study finds that small fields and permanent green edges are essential in arable-dominated landscapes to support farmland biodiversity — when field sizes increased and green edges were lost, flower visitation in oilseed rape decreased substantially, as did wild bee pollination. However, in the study region, insect-pollinated crops only contribute small fractions of the overall margin in arable farming. As a result, the value of biodiversity-based ecosystem services to arable crops were slightly outweighed (by about €19 per hectare of arable land) by the economic benefits to farmers of expanding the size of their fields, due to both the opportunity cost of not including green-edge space in their crop production and the increased input required to farm smaller fields.

In other studies[1], however, agri-environmental measures have been shown to increase crop yield, thereby offsetting the costs. One example is an increase in grain legume crops, of which several species are dependent on pollinators.

Overall, the study finds that reducing field size for crops that are not insect-pollinated may thus not be cost-effective in the current market — despite the ecological advantages of this ecosystem service[2]. Based on these findings, the researchers suggest that greater incentives and investment in innovation would enable and encourage farmers to maintain agricultural landscapes with green edges and to maintain smaller fields (which are more costly to farm)[3].

The researchers also highlight that the study assumes existing farming and management patterns; however, changes in agricultural management and practices may increase the importance of ecosystem services. The study region also saw only small contributions from pollinator-dependent crops. In regions that rely mainly on natural pest control, such as organic crop production, or where pollinator-dependent crops, such as legumes, play — or are to play — a greater role in future, the ecological-economic trade-offs driven by field-size change and permanent-edge density would likely be quite different.

1. For example: Pywell, R.F., Heard, M.S., Woodcock, B.A., Hinsley, S., Ridding, L., Nowakowski, M. and Bullock,J.M. (2015) Wildlife-friendly farming increases cropyield: evidence for ecological intensification. *Proc.R.Soc.BBiol.Sci. 282.*

2. However, looking at more ecosystem services would alter this assertion, which is made considering the short-term context. Furthermore, the timeframe should be considered in the long term. Intensive production is degrading agroecosystems, which, in future, will have impacts on yields and public goods, as well as their resilience to the ever-changing environmental and climatic conditions.

3. More comprehensive research is required into incentives to encourage farmers to maintain agricultural landscapes with green margins; and innovations to assist economic farming of small fields.