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Cost-effectiveness of measures which promote pollination services in boreal agricultural landscapes

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Species diversity on arable land and associated ecosystem services have decreased due to intensified agricultural production and loss of non-crop habitats in boreal agricultural landscapes. There have been attempts to mitigate this negative trend by agri-environmental schemes, but applied measures have often proved to be both ineffective and expensive. Research on the cost-effectiveness of measures is therefore required.

We considered three biodiversity measures in southern Finland: A) a biodiversity zone established on the margin of a forest abutting on a field, B) a biodiversity strip on a field at a forest border and C) an environmental fallow. In our study, a forest biodiversity zone (measure A) consists of a 5-m wide meadow-like treeless strip and a 20-m wide transitional zone which is managed by repeated selection cuttings to create a mixed-species uneven-aged stand structure. A biodiversity strip on the margin of a field (measure B) refers to a 5-m wide uncropped strip covered by wildflowers or perennial grasses. An environmental fallow (measure C) is either a biodiversity field established by a meadow-plant seed mixture or a grass field established by perennial grasses.

The effectiveness of measures in promoting pollination services was determined by the achieved increase in bumblebee abundance compared with the prevailing land use. Control areas of measure A were managed according to the recommended good practices in forestry (even-aged management). Control treatments of measures B and C were the corresponding areas of a field in conventional feed-barley production. Costs of measures incurred to a private landowner were calculated by subtracting the present value of a net income stream obtained from an area where the measure is applied from the present values of net incomes received from the corresponding forests and fields managed according to current practices and recommendations.

The results indicate that the cost-effectiveness of the measures applied on fields is better than those applied in forests even though the price of cereals is assumed to retain its current high level. The best outcome with least costs was obtained by using a meadow-plant seed mixture including brown and wig knapweeds (*Centaurea jacea* and *Centaurea phrygia*), daisy (*Leucanthemum vulgare*), white clover (*Trifolium repens*) and common bent (*Agrostis capillaris*). For a landowner, the use of field measures is also supported by the fact that, on fields, land use can be changed quickly if necessary.

Keywords: agri-environmental scheme, biodiversity strip, biodiversity zone, bumblebee, environmental fallow, uneven-aged management