Enhancing biodiversity in crop production: Cost-benefit analyses of six measures in Germany

The overall objective of EcoStack is to develop and support ecologically, economically and socially sustainable crop production via enhancement of ecosystem services provision and protection of functional biodiversity.

Introduction and context

A loss of biodiversity in agricultural landscapes has been observed in the last decades. To counterbalance the negative effects of some conventional agriculture practices, the maintenance of semi-natural landscape elements such as hedgerows, buffer and flower strips is promoted and funded by the European Union as Agro-Environmental and Climatic Measures and the new Eco-schemes. Semi-natural habitats and agro-ecological measures have the potential to support ecosystem services by providing a wide range of food resources, habitats for numerous species, biological control, pollination and soil conservation.

However, their implementation could lead to additional costs such as the purchase of specific machinery or additional farmer workload. This joint study by JKI, UKA, KÖN and LLH aims to determine the costs and benefits of several measures enhancing functional biodiversity in order to determine whether or not they are viable for farmers in Germany.

Methodology

Research issue

Six measures were chosen according to their practicability and their effectiveness concerning protection and support of biodiversity.

Off-crop measures

Grass margins, buffer strips
Field margins with sown or natural vegetation dominated by grasses and herbs

Flower strips
Agricultural land sown with seed mixtures of flowering plants

Hedgerows
Lines of bushes and small trees planted between fields or along roadsides

In-crop measures

Intercropping, mixed cropping
Mixing two species

Undersowing
Catch crops / cover crops are established with the main crop

Organic mulching
Organic material (straw, clover-grass, triticale-vetch) is applied between the main crop

Methodology

Data was gathered from several studies in Germany between 2020 and 2023 and included organic farms in Hesse and Lower Saxony as well as conventional farms in Brandenburg and Saxony specializing in arable crops. The main crops grown were cereals, potatoes, oilseed rape, pulses and soybeans. Data on the costs of the measures were obtained from production cost calculations from the KTBL database and from input suppliers. Benefits were estimated based on available research results and experts or farmers views. To understand the incentives that affect farmer decision making, each cost-benefit analysis was conducted for 1 ha. Machinery costs include workload and fuel costs.

Results

Costs-benefit analysis

Measure	Costs	Benefits from the farmers' point of view	Drawbacks from the farmers' point of view
Grass margins Buffer strips	40-250 €/ha	200-900 €/ha subsidy; Used as buffer strip for erosion control and as hunting lane; Use of low yielding land	Not recommended when problem weeds occur
Flower strips	110-590 €/ha	700-1,480 €/ha subsidy; Same functions as buffer strips ; Attraction of pollinators and other wildlife; Good for aesthetics and farmers' image	Complex regulations; Not recommended when problem weeds occur
Hedgerows Agroforestry Tree lines	20,000 - 47,000 €/ha	Up to 35,000 €/ha subsidy for installation and maintenance; Same functions as buffer strips plus windbreak effect, fuelwood Field separation Biodiversity increase	High installation costs; Permanent landscape elements
Mixed cropping e.g. OSR and winter pea	ca. 120 €/ha	If used for feed, no sorting needed; Decrease in pest pressure; Weed suppression (60€/ha); Improving soil fertility; N-fixation/fertilizing effect (up to 30 kg N/ha)	For marketing, harvest must be sorted (10 €/t); Seed costs; Different maturation times
Undersowing e.g. cereals with clover mix	ca. 150 €/ha	550-810 €/ha subsidy (AN2, LS) Use of clover as a catch crop and for forage production possible; N-Fixation, fertilizer savings (up to 30-50 kg N/ha); Less labor; More soil life, plant and insect biodiversity	Possible yield decline due to competition; Possible wireworm problems when potatoes follow
Organic mulching of potatoes e.g. with triticale-vetch-mulch	580-1,870 €/ha	Yield increase (on average 15 %, 3.3 t/ha), better product quality; Less aphids (virus vectors!) and other pests; Weed control (50 €/ha) Erosion control, soil moisture; Fertilizing effect (up to 880 €/ha)	Obtain mulch material; Spreading labor intensive and requires own machinery; Legal restrictions (fertilizer laws)

Costs and benefits for implementation are presented per hectare. Opportunity costs are not included.
For in-crop measures, the result presented is the difference from the costs of the respective common practice.

Conclusions

For **off-crop measures**, costs increase as diversity increases in terms of species and vegetation layers. Grass margins are a low-cost measure, but provide less species diversity than the somewhat more costly flower strips. Hedgerows are the most costly measure, but with multiple habitat layers (tree, shrub and herbaceous layers) they offer high species and micro-habitat diversity.

For **in-crop practices**, mixed cropping and undersowing add little costs - compared to the common cultivation of pure stands - but improve soil fertility and reduce pest and disease pressure. Organic mulching is costly but profitable and benefits plant and soil health, especially in extreme weather conditions.

Farmers statements for implementation

The willingness of farmers to apply the targeted measures varies. The most important statements of the farmers about these measures are:

- Buffer strips, grass margins are common practice along waterways and useful in areas that are difficult to cultivate or sensitive to soil erosion
- Flower strips are popular among farmers to support pollinators and improve the image of farming
- Hedgerows are maintained when present but expensive to plant; lately gain interest as “agroforestry”, wind breaks and shelterbelts
- Mixed cropping – an old idea, but now interesting to control difficult pests
- Undersowing – increasing interest to diversify crop rotations and increase soil organic matter and boost biodiversity
- Mulching is attractive for organic farms without livestock, where material (clover grass) is available at low transport costs.

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EcoStack

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