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BioBio indicator factsheet

Pesticide Use (PestUse)

Refers to Chapter 8 ‘Management related indicators’ of the Guidebook ‘Biodiversity Indicators for European Farming Systems’

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Pesticide Use (PestUse)

Description

This indicator measures the frequency of pesticide use on the farm. The **unit** of measurement is the area-weighted average of numbers of pesticide applications on a farm.
Sub-indicators differentiate specific classes of pesticides: 'Herbicide Use', 'Insecticide Use' and 'Fungicide Use'.

It is a **pressure indicator**. The use of chemical pesticides is significantly restricted in organic farming according to the organic regulations EC 834/2007 and EC 889/2008. This restriction results in a reduced input of pesticides in organic systems compared to conventional systems, e.g. a 97 % reduction was found by Mäder et al. (2002)[1]. Organic systems rely on a variety of practices (e.g. crop rotation, biological control, mechanical weed control) to manage weeds and invertebrate pests instead[2]. This avoids direct and indirect pesticide effects, as follows.
Direct effects: Herbicides are a significant factor in the declines of many common arable flowers in Europe[3]. Insecticides have a major negative influence on invertebrates[4].
Indirect effects: Weed communities were found to have a higher diversity on organic farms than on conventional ones[5]. Chemical pesticides lead to a reduction in plant food resources and invertebrate abundance[6]. This is a factor in the declines of a range of farmland bird species[4].

Surveyor skills

Data collection can be implemented by technical staff (farm interviews, retrieval from databases). No specific expert knowledge is required for indicator calculation.

Data collection method

In farm-level surveys, farmers must be interviewed using a structured questionnaire (farm visits or telephone).

Calculation method

Categories of pesticides (P_i):

- Herbicide – Number of Treatments
- Fungicide – Number of Treatments
- Insecticide – Number of Treatments
- Retardant – Number of Treatments
- Molluscicide– Number of Treatments
- Nematicide– Number of Treatments
- Other Measures (to be specified) – Number of treatments
- Area for each crop or grassland type (A_i)

In practice, farmers may apply different types of pesticides as mixtures. In the interviews, such operations are recorded as separate treatments.
e.g. 1 application with a combination of a fungicide and an insecticide = 2 pesticide treatments
but: 1 application with 2 different fungicidal substances = 1 fungicide treatment
The pesticide treatments are recorded for each crop or grassland type. They are summed up for each crop/grassland. Eventually, an **average weighted by the area** that each crop/grassland covers on the farm is calculated.

$$PestUse = \Sigma N_i A_i / A_{UAA},$$

where N_i is the number of treatments with a certain pesticide type (P_i) and A_i is the area on which this type of treatment is applied. A_{UAA} is the total Utilized Agricultural Area.

Results from BioBio case studies

The graph depicts average pesticide treatments applied on BioBio case study farms. The indicator is of relevance for arable and mixed farms as well as for some permanent crops systems (vineyards, orchards). In grassland case studies, pesticides were only applied occasionally as spot treatments. Certain specialist permanent crop systems are demanding with regard to pest and disease management. In this group, olives are an exception, requiring few interventions with pesticides. Most striking is the treatment frequency in Italian vineyards (15 applications per year on average) and in certain horticultural systems (production of fruits and field vegetables).

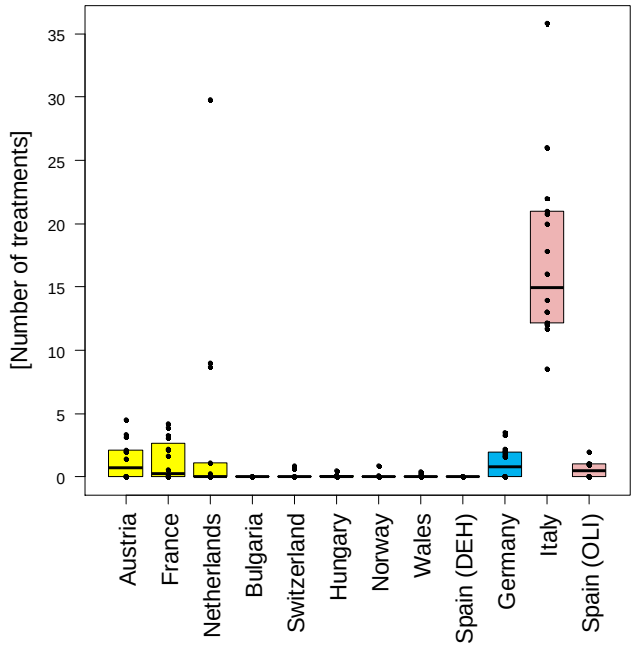
Synergies with other indicators

In interviews, data collection can be implemented in a joint questionnaire form along with the appraisal of BioBio Indicator 'Field Operations'.

Estimated effort and costs (labour effort required, analysis)

An average of 8 hours per farm must be calculated for the collection of the BioBio farm management indicators This includes the interview, data processing and data check. However, there is considerable variation in time effort depending on the complexity of farms and the implementation (telephone interviews or farm visits).

[1] Mäder P. et al., 2002. Soil fertility and biodiversity in organic farming. Science, 296, 1694-1697
[2] Lampkin N., 2002, Organic Farming. Ipswich, Old Pond.
[3] Andreasen C., et al., 1996. Decline of the flora in Danish arable fields. Journal of Applied Ecology, 33(3), 619-626.
[4] Hole D.G. et al., 2005. Does organic farming benefit biodiversity? Biological Conservation, 122(1), 113-130.
[5] Tyser G.W. et al., 2008. Community structure and metabolism through reconstruction of microbial genomes from the environment. Nature, 428(6978), 37-43.
[6] Dubois D. et al., 2003. Influence of organic farming and different cultures on the earthworm fauna. In: Freyer, B. (Ed.) Contributions to the 7th Scientific Conference on Organic Farming: Organic farming in the future. Vienna, University of Agricultural Sciences, 24 to 26 February 2003, pp. 445-446.



Average number of pesticide applications per farm
Legend: the colour of the bars signify the type of land management. Yellow: arable including horticulture; green: grassland; blue: mixed arable and grassland; pink: tree-based systems.

Correlation with other indicators

In BioBio cases studies, PestUse was negatively correlated with 'Vascular Plants' in arable and mixed case studies as well as in Spanish olive plantations and Dutch horticulture farms. Relationships with other species indicators were negative as well but these were not consistent across case studies: correlations with 'Wild Bees and Bumblebees' in French arable and German mixed farms, with 'Spiders' in German mixed farms and 'Earthworms' in olive farms.
Italian vineyards were the only case studies that intensively applied pesticides, however the indicator did not show a relationship with any of the species diversity indicators.

Pesticide Use change as an indicator

Major shifts in pesticide use on the farm-level may indicate if pressure on organisms is changing for better or worse. Such changes would mainly originate from shifts in the crop rotation and land-use on the farm: a change to more or less intensive forms of agriculture with regard to pesticide treatments.

Interpretation

Certain specialist permanent crops require high inputs of pesticides (fruit production, vineyards). Even organic farmers frequently apply substances that constrain organisms e.g. fungi in grapes. These systems are often characterised by high application frequencies.
In annual crops pesticides are applied less frequently. However, crops vary from very demanding ones such as potatoes to crops that are easier to handle, particularly if farmers can rely on well-adapted, resistant cultivars (e.g. many cereals).
The indicator is not useful in grassland systems where pesticides are seldom used. Herbicides spot-treatments are only applied to problematic herbs (e.g. Rumex sp.).

Strengths and weaknesses

This indicator is easy to calculate. At farm level, the indicator measures the intensity of land-use, rather than the actual application rate of biologically active compounds. Unlike the treatment frequency index, it does not require knowledge about specific substances (ration of applied and recommended standard dose).
It is an aggregated indicator summarising substances with different target organisms. Thus, the actual effect on species groups will depend on the pesticide type applied.

This factsheet is part of the Guidelines **Biodiversity Indicators for European Farming Systems**.
More detailed information on the set of indicators developed in the EU FP7 research project BIOBIO (Biodiversity indicators for organic and low input farming systems, KBBE-227161) is given in a printed report, published as ART Publication Series Nr. 17. The report can be downloaded from the BIOBIO website.
Printed versions can be ordered at www.agroscope.admin.ch or at Agroscope, Reckenholzstrasse 191, 8046 Zurich, Switzerland

BIOBIO Indicator Factsheets

Genetic diversity	
Breeds:	Number and amount of different breeds
CultDiv:	Number and amount of different varieties
CropOrig:	Origin of crops

Species diversity	
Plants:	Vascular plants
Bees:	Wild bees and bumblebees
Spiders:	Spiders
Earthworms:	Earthworms

Habitat diversity	
HabRich:	Habitat richness
HabDiv:	Habitat diversity
PatchS:	Average size of habitat patches
LinHab:	Length of linear habitats
CropR:	Crop richness
ShrubHab:	Percentage of farmland with shrubs
TreeHab:	Tree habitats
SemiNat:	Percentage of semi-natural habitats

Indirect management indicators / parameters	
EnerIn:	Total direct and indirect energy input
IntExt:	Intensification/Extensification - Expenditure on inputs
MinFert:	Area with use of mineral nitrogen fertiliser
NitroIn:	Total nitrogen input
FieldOp:	Field operations
PestUse:	Pesticide use
AvStock:	Average stocking rate
Graze:	Grazing intensity