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BioBio indicator factsheet

Nitrogen Input (NitroIn)

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

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Nitrogen Input (NitroIn)

Description

The **unit** of measurement is average input of nitrogen at the farm-level (kg N per ha UAA)

Subindicators are Organic nitrogen fertilizer input measured as kg N per ha UAA and Nitrogen Balance measured as N-saldo per ha UAA.

Nitrogen input is a **pressure indicator** that has proven useful for the assessment of land-use intensity in a series of studies in Europe and beyond. It largely determines the production intensity, e.g. the number of possible cuts for grasslands or the plant density in arable crops like cereals[1]. It affects the growth conditions for grassland species and arable weeds and, thus, the vegetation composition and density of flowering plants on managed farm fields. This trait, in turn, affects the occurrence of pollinators and other insects.

When recording 'Nitrogen Input', several fractions must be taken into account:

- organic nitrogen from housed or grazing livestock,
- organic nitrogen from plant compost or commercial organic fertilisers
- symbiotic nitrogen from biological fixation (leguminous crops)
- mineral nitrogen from synthetic fertilisers

Surveyor skills

Data collection can be implemented by technical staff (farm interviews, retrieval from databases). For data validation, skills in the interpretation of farm balances and background knowledge in agriculture are necessary to examine the plausibility of both the input and output variables.

Data collection method

In farm-level surveys, farmers must be interviewed using a structured questionnaire. Regional surveys can retrieve available data from official farm accounting databases**.**

Calculation method

BioBio used the tool DIALECTE for the agri-environmental assessment of farms to calculate the average nitrogen input on farm level. DIALECTE applies a soil surface balance looking at the nutrient flows in the parcels.

Input variables:

- Quantities of mineral nitrogen applied per crop (kg N/ha) (Nmin)
- Number and type of livestock to calculate the total organic nitrogen production (Norg)
- Import and export of organic fertilisers (Norg)
- N_2 fixation by legumes (crops, grassland) (Nfix)
- Yields of crops and grassland to calculate the exports of nitrogen of the parcels. Leguminous cover crops are taken into account.
- Total Utilized Agricultural Area (UAA)

Farmyard manure (top) and leguminous crops (bottom) are important sources of nitrogen in organic farms. Photos: M. Heinzinger, BOKU

Some of the variables cannot be assessed directly from interview data. For N_2 fixation and organic nitrogen approximations are made, as described below.

N_2 fixation is estimated as the equivalent of the nitrogen content of the harvest (grain or forage). The input data used are the yield of leguminous crops and the average nitrogen content of the plant material. For example, 1 ton of peas will fix 32.5 kg N and 1 ton of alfalfa 39 kg N. The nitrogen available in the soil is not assessed and there is, therefore, potential for under- or overestimation of the actual nitrogen input using this method.

Organic nitrogen production by farm livestock (manure) is calculated from standard reference values differentiated by livestock type. Example: The production of organic nitrogen for a milk cow producing 6000 kg of milk is 97 kg N/LU/year.

[1] Kleijn D. et al., 2009. On the relationship between farmland biodiversity and land-use intensity in Europe. *Proc. R. Soc. B* 276, 903–909

Production of organic nitrogen per livestock type. Exemplary data as applied by the DIALECTE model.		
Type of animal	Livestock unit (LU)	kg Norg produced per animal (excluding volatilisation)
Milk cow – 5000 kg of milk	0.9	93
Milk cow – 6000 kg of milk	1	97
Suckler cow	0.8	77
Heifer 1-2 years	0.6	54
Meat sheep	0.15	11

Nitrogen Input (NitroIn)
NitroIn = Nmin + Norg + Nfix
The N deposition is not taken into account.
Organic Nitrogen Fertilizer Input (Norg)
Norg = Norg from farm livestock + imported Norg – exported Norg
Nitrogen Balance (Nbal)
N balance = N input – N export by the crops – N exports by the forage (harvested or grazed).

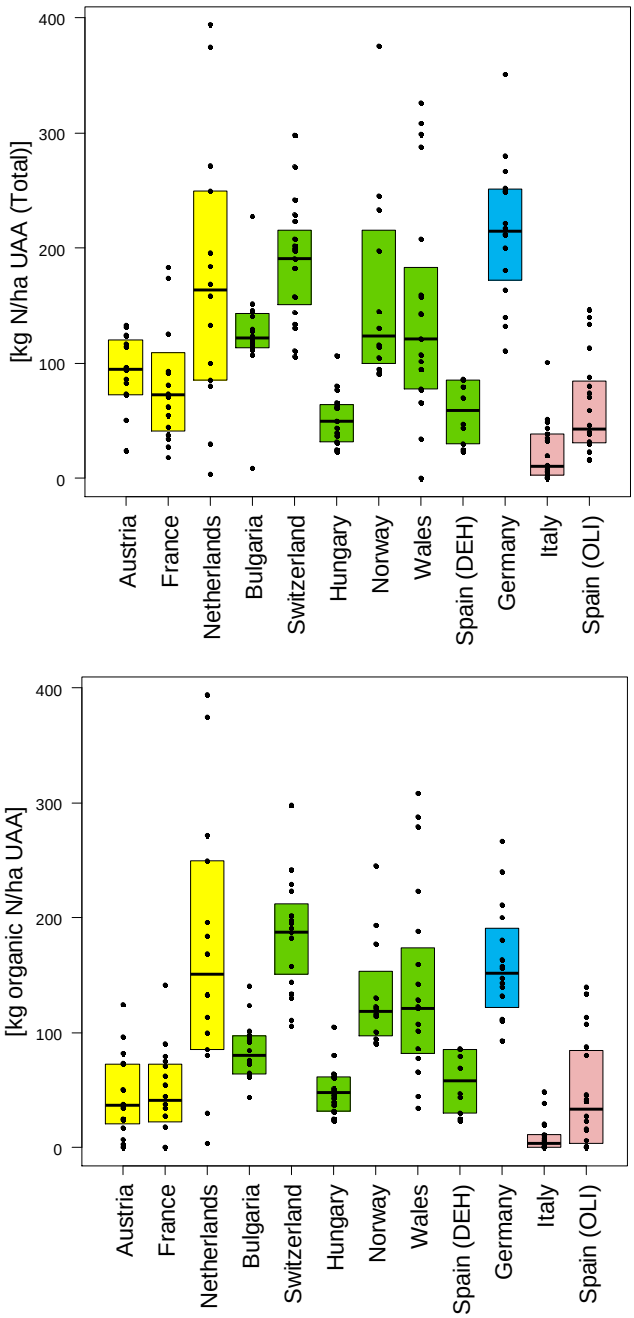
A nitrogen balance has been calculated for all farms in the tool DIALECTE. Despite the fact that it is of less relevance for the interpretation of biodiversity data, DIALECTE proved to be very useful for controlling the plausibility of input variables. Balances with a striking bias to either the negative or positive side were re-examined with regard to input data. A main difficulty concerns the estimation of grass production which can be harvested or grazed. To estimate the grass production, DIALECTE calculates a fodder balance taking into account the total livestock units, the need of fodder per livestock unit and the grassland production to verify that the grassland can feed all the animals.

Results from BioBio case studies

The boxplots for nitrogen input show the highest average nitrogen input in German mixed farms, Dutch horticulture farms and Swiss grassland systems, suggesting a high farming intensity on these farms. The lowest median was measured in Italian vineyards.
A large range in indicator values for 'Organic Nitrogen' was observed for the farms in the Netherlands and this is reflected by a highly variable 'Nitrogen Input' and 'Nitrogen Balance' (graph). This suggests that there are large differences in fertilisation intensity among the farms in this case study.

Synergies with other indicators

In interviews, data collection for a nitrogen soil surface balance can be combined with the recording of other management practices required for 'Pesticide Use' and 'Field Operations'. It is also possible to calculate the data for 'Area with Use of Mineral N Fertiliser' from the Nitrogen input data. Reducing the input variables to 'Mineral N fertiliser' only, is sufficient. Therefore, no full soil surface balance is required for this purpose.



Range of total nitrogen input (top) and organic nitrogen input (bottom) in BioBio case study farms (kg N per ha UAA)
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.

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 farm 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).

As the indicator “Average Stocking Rate” uses the same input data for the estimation of livestock on the farm, it can be derived in a separate calculation.

Correlation with other indicators

Correlations were negative with ‘Vascular Plants’ in the Austrian (arable farming), German (mixed farming), and Swiss (grassland) case studies. For the other case studies, no significant correlations were observed. Negative correlations were also established between this indicator and ‘Wild Bees and Bumblebees’ in France (arable farming), Germany and the olive farming systems in Spain and with ‘Spiders’ in the Swiss case study. The indicator ‘N-input’ was positively correlated with ‘Earthworms’ in grazing systems of Wales and Hungary.

Habitat indicators had no consistent relationship with ‘Nitrogen Input’ among the case studies. In Bulgarian grassland, higher N-inputs are positively correlated with an increase in indicators for ‘Habitat Diversity’, ‘Tree Habitats’ and ‘Percentage of Semi-natural Habitats’. For ‘Habitat Richness’, there was a negative correlation in France and a positive correlation in the Dehesas. Thus, the relationship of ‘Nitrogen Input’ with habitat indicators need careful case by case interpretation.

Nitrogen Input change as an indicator

Increased levels of nitrogen fertilisation boost productivity on farms and are often accompanied by other changes in the management of livestock or field crops. Rising values for nitrogen input indicate that intensification on the farm is in progress. Potential causes for intensification (e.g. raised stocking rates, changes in land-use) and the threat to biodiversity can be examined using a combination of other farm management indicators or habitat indicators.

Driving forces for a decrease in nitrogen input to farmland may be a change in the management system (e.g. conversion to organic farming) or extensification measures within the framework of agri-environment schemes.

Strengths and weaknesses

‘Nitrogen Input’ is an indicator that can be applied and compared across all farm types..

In the EU, farm-level nitrogen data become increasingly available due to the documentation requirements in the implementation of cross-compliance rules.

Compared to other BioBio farm management indicators, the data needs are quite demanding. In addition, quality control and data checks are essential and require a good understanding of the farming systems and their management.

A main difficulty in the use of the soil surface balance is the need to estimate the yield of grassland (fodder, silage and grazing). However, alternative approaches, such as the farm gate balance, have the disadvantage that the nitrogen content of all purchased feedstuff must be quantified.

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 N-fertiliser
NitroIn:	Total nitrogen input
FieldOp:	Field operations
PestUse:	Pesticide use
AvStock:	Average stocking rate
Graze:	Grazing intensity