Focus on biodiversity

A series of articles addressing the importance of biodiversity in agriculture. Farming for a better future.

How farmers can measure biodiversity

Measuring is knowing

Scientific knowledge has taken agriculture to the impressive levels of production and efficiency we know today. Science is based on observation and measurement. In this article, we examine indicators farmers can use to measure the biodiversity of their farms to identify pressures, threats and opportunities for improvements. The indicators are based on information such as the quantity or quality of organisms on the farm. For instance, what does the number of worms in the soil tell the farmer? Or the number of butterflies on the farm?

Measuring is knowing. It enables farmers to compile data that provide valuable insights, such as the degree to which sustainable land management practices are working. These insights can facilitate decision-making about fertilizer usage, crop characteristics, and crop rotation. They can enhance the farmer's resilience to climate change and improve production results. Biodiversity indicators can be based on various sources, but in this article, we will focus on soil and pollinators.

Soil biodiversity indicators

Soil is the basis of sustainable agricultural business and the key to healthy, productive agriculture. The importance of soil led to an initiative by a group of companies in the Netherlands to develop the Open Soil Index, a scientifically underpinned, open-sourced soil assessment framework. It uses standarized soil measurements to indicate the quality of soil and how it can be improved.

Earthworms

One indicator used in the index is earthworms. The absence of earthworms can indicate soil degradation. For instance, earthworms are rare or even missing in waterlogged or overly acidic soils. The presence of earthworms, on the other hand, can have many benefits.

Research shows that on average, earthworm presence in agroecosystems leads to a 25% increase in crop yield and a 23% increase in aboveground biomass. The magnitude of these effects depends on the presence of crop residue, earthworm density, and the type and rate of fertilization[1].

Earthworms are "soil engineers" with a beneficial influence on soil structure, aeration, water infiltration, water holding capacity, litter decomposition and nutrient cycling. Earthworms increase soil fertility and promote good soil structure. If livestock, such as cows are compacting the soil, earthworms create breathing space and water canals in the soil.

Farmers can measure their soil biodiversity by taking soil samples in various locations on the farm, counting the number of earthworms in the samples, returning the worms to the soil, and repeating this procedure at set intervals. These measurements are an effective indicator of the farm's soil health.

Pollinator biodiversity indicators

Another indicator of biodiversity is pollinators. Pollination is a fundamental process in crop production and is necessary for biodiversity. The presence and abundance of pollinator insects such as butterflies and bees indicate the environmental health of the landscape.

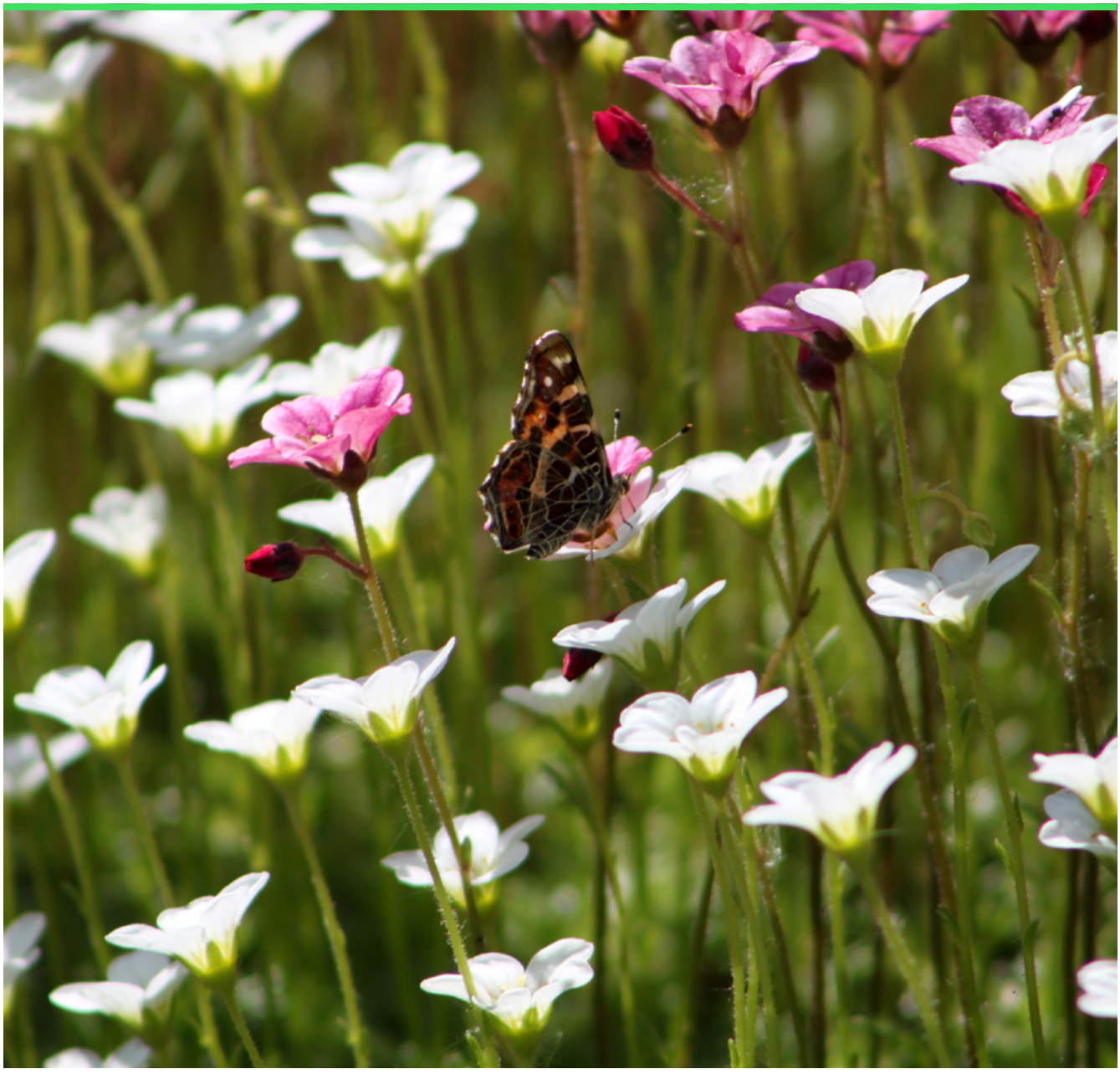
Insects are easy to see and count and are highly sensitive to changes in soil, plant, air and water conditions. Due to their short life spans, changes in the population occur quickly, often within a few months, which indicates if an action or change in the farming operations is influencing the biodiversity.

Measuring insect populations is straightforward. The farmer simply selects a spot close to the crop, counts the number of butterflies or bees in the area for a set number of minutes, and repeats this action in the same spot at defined intervals, for instance, every few weeks or months. The stability or lack of stability in the insect population is an indicator of the farm's biodiversity.

Series on biodiversity

This article is part of a series on biodiversity that addresses the following topics:

- A general introduction to biodiversity for productive, sustainable, resilient farming
- Biodiversity compliance and productive farming go hand-in-hand
- How farmers can improve the biodiversity in their production systems
- Measuring biodiversity in production systems



Collecting data

Biodiversity Guidance Compliance Tool

Digital tools, such as the Biodiversity Guidance Compliance Tool[2], are critical for farmers to collect data in reliable and transparent ways that prove the impact of their practices. Digital farm measurement tools collect, store and analyze biodiversity data indicators. They can also be used to compile data regarding the amount of carbon stored in the farm's soil as well as emissions, water quality and crop yield.

According to a World Economic Forum study published in April 2022, 60% of farmers indicate they use farm management software to track and optimize crop protection products and 57% to measure fertilizer usage. However, there is lower use of management software to track and optimize biodiversity-related factors. Only 25% of farmers use digital tools to measure irrigation, 18% to measure energy efficiency and 43% to measure soil analysis.

There is room for growth in measuring biodiversity to achieve more resilient, compliant, productive and profitable farming. It is advisable for farmers to measure the biodiversity indicators of their operations and the results of their efforts. These measurements can be necessary to prove compliance with local and international regulations, to acquire market labels or certifications, and to access available subsidies or financial services.

Examples of soil bioindicators

Indicators	What do they indicate
Earthworms	Earthworms are indicators of biodiverse, preserved habitats. They are sensitive to anthropogenic disturbances (environmental pollutants originating from human activity) which can indicate soil degradation. Their abundance and composition indicate the state of the soil.
Beetles	Beetles have a high sensitivity to environmental variations and ecosystem deterioration, making them excellent bioindicators to evaluate the level of anthropogenic disturbances. Depending on the ecological niche the beetles occupy, they are indicators of the conservation status of the ecosystem.
Termites	Termites are opportunistic organisms with high resistance to induced disturbances. Their presence indicates habitats with a certain level of degradation. Termites are important ecological indicators thanks to their sensitivity to environmental or anthropogenic disturbances in biotic systems.
Snails and slugs	Snails and slugs are sensitive to sudden changes in humidity and temperature associated with vegetation cover and the entry of residues. They are excellent indicators of humidity and temperature changes, and of disturbances in the soil environment.
Centipedes and millipedes	Centipedes and millipedes can be used to indicate the state of disturbance in the soil environment. Like snails and slugs, they are also extremely sensitive to sudden changes in humidity and temperature.
Enquitraeid worms	Enquitraeid worms are drought-sensitive organisms that indicate the level and intensity of drought. They are also bioindicators of soil stability and fertility.
Collembola	Changes in the abundance and composition of collembola are bioindicators of soil contamination and the influence of agricultural practices, such as the use of herbicides. With their soft, whitish bodies, and high sensitivity to chemical products and environmental disturbances, they are indicators of the fertility and stability of the edaphic environment.

Information based on articles from the Journal Ecological Indicators.

Recommended Reading:

Biodiversity Indicator Framework Review, May 2021, International Climate Finance Evidence Project. JNCC, Peterborough
Connecting Nature, Nature-based solution evaluation indicators: Environmental Indicators Review July 2020
Journal of Ecological Indicators, 2021
The Open Soil Index 0.3, Open Bodemindex, 2019,Gerard H Ros, Yuki Fujita
Transforming Food Systems with Farmers: A Pathway for the EU, World Economic Forum, 2022
[1] Earthworms increase plant production: a meta-analysis, Van Groenigen, J., Lubbers, I., Vos, H. et al. 2014
[2] NOP Biodiversity Guidance Compliance Tool, United States Department of Agriculture, 2018.