NBS CASE

Crop rotation and plant-based fertilizers

Situated on the SPNA experimental farm Kollumerwaard, from 2012 up to 2020 the Planty Organic experiment was run as an organic arable farming system based on 100% nitrogen input by means of leguminous plants. Soil, crops, green manures and Cut&Carry* fertilizers were measured. In 2019 and 2020 six more fields were monitored from the Kollumerwaard organic business unit, the Kollumerwaard Conventional business unit and a nearby situated organic farm, thus enabling system comparisons.

Planty Organic is a system research were no traditional fertilizer was applied to the field since 2012. On a parcel six crops are grown: grass-clover, pumpkin, oats, carrot, stem beans and seed potatoes. Every crop is grown on an equally large part of the parcel. The part of the parcel were a crop is grown rotates every year. In this system the grass-clover is mown and put in silage to use as fertilizer for the other crops next year. The grass-clover can bind nitrogen out of the air, therefore it is highly suitable as NBS fertilizer.

Planty Organic has been carried out on a parcel which was cultivated organically before for around 20 years. There are no pesticides used on this parcel and it is no till cultivated. Season row path are used for the tractor to drive trough the field, this means that the soil stays unridden during the growing season.

*Cut&Carry fertilizer is a mixture of leguminous species or grassclover mixture harvested as if it were fodder but used as 'green fertilizer' without passing through an animal. From the perspective of NUE Nitrogen Use Efficiency this has several advantages.

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Challenges addressed by the NBS

This NBS addresses a nutrient challenge with the aim of reducing **nitrate leaching**, **nitrogen substitution** and **improving soil P availability on farmland**.

Nitrogen will be added to the system by means of leguminous plants. The internal nitrogen flows imply partly an above-ground redistribution by means of Cut&Carry fertilizer and partly a soil-bound handover by the root mass of the Cut&Carry fertilizer crop and the use of leguminous catch crops. The basic process nevertheless is the mineralisation of the present and continuously supplemented soil organic matter. The nitrogen present in the system will be as much as possible bound in organic matter to prevent losses due to leaching and denitrification from inorganic nitrogen. To realise this target, fertilization is done with a green herbal fertilizer with almost no mineral nitrogen content (the farm-internal Cut&Carry fertilizer). The aim is a maximum presence in time of growing plants and a green cover in winter.

trans4num's main research questions and ambitions

- Balance and maintain soil health throughout the entire cultivation cycle of a crop, but also over several years.
- Create awareness among conventional growers about the consequences of over-depleting the soil.
- Investigate whether a fully closed cycle of fertilizer use is feasible. Is it possible to grow crops profitably by using cut & carry.
- Over the years it has become apparent that the available P in the soil is difficult to maintain, how can this be solved?

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Which biophysical, agronomic, and farm management implications does the NBS have at field and farm level?

- **Nitrogen Efficiency:** The plant-based nitrogen input is characterized by relatively slow availability, which is advantageous in preventing nitrogen losses. Planty Organic achieves a nitrogen efficiency of 75%, compared to 60% for conventional systems.
- **Soil Health:** The structural stability of the soil will be expected to improve due to the non-tillage in NBS trails. Further, the improved crop rotation practice will reduce the need of chemical pesticides. Finally, the biodiversity of agricultural ecosystem and soil health will be improved in NBS trials.
- **Crop Yields:** Planty Organic's physical yields are on average 6% lower than conventional organic systems, with significant variations depending on the crop (e.g., seed potatoes have an 11% lower yield).
- **Agronomic:** Despite lower yields, the overall economic performance of Planty Organic can be competitive, especially when considering the savings on fertilizer costs. However, there is a noted loss per hectare when compared to other systems that sell grass clover and purchase manure.
- **Sustainability:** The system has the potential to support regional nutrient cycling by integrating regional residual organic supplies like compost and bokashi, thus maintaining nutrient equilibrium.

Which indicators/criteria are used to assess the success of the NBS in addressing the challenge?

The success of the NBS in addressing its challenges is assessed using the following indicators/criteria:

- **Data on N inputs and outputs** in regard to amount of mineral N that can be replaced via the plant-based fertilizer.
- I**mprovement on available P** content in the soil.
- **Better N/P use efficiency by target crops (seed potatoes)**
- **Total yield and nutrients from the crops (seed potatoes)**
- **Soil health assessment**

These indicators provide a comprehensive assessment of the NBS's success in addressing its challenges.

What methods/tools are used for the NBS assessment?

- **Soil physical properties** (eg. bulk density and aggregates)
- **Soil biological properties** by assessing microbial activity.
  - Soil microbial biomass carbon, nitrogen and phosphorus (SMBC, SMBN and SMBP)
  - The structures of soil bacterial and fungal community were assessed using high-throughput sequencing of total DNA.
- **Soil chemical properties** (pH, SOC, NO3--N and NH4+-N, Osen-P, total Nitrogen and total Phosphorus)
- **Total yield** of seed potatoes, their marconutrients (N, P, K, Mg, S, Ca) and micronutrients (Si, Al, Fe, Zn, Cu, B, Mn)
- **Soil Health Score** assessment (Soil physical, chemical and soil biological properties) based on the Cornell Comprehensive Assessment of Soil Health (CASH) scoring functions

NBS site and scale

Contact NBS team

STICHTING PROEFBOERDERIJEN NOORDELIJKE AKKERBOUW
westerhof@spna.nl
Henk Westerhof

WAGENINGEN UNIVERSITY
coen.ritsema@wur.nl
Prof. Dr. Coen Ritsema

trans4num is a four-year project funded under the Zero Pollution call as an EU-China international cooperation action on nature-based solutions (NBS) for nutrient management in agriculture.
trans4num ambition is to broadly enhance the NBS implementation in Europe with an integrative and tested multi-level approach, in dialogue with academic partners, practice partners and societal stakeholders.

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