Brief Information on Nitrogen Fertilisation in Organic Farming

According to European Regulation (EC) 834/07*, the US National Organic Program (NOP), JAS, and CERES Policies

1. Introduction:

The Nitrogen (N) cycle in agricultural is complex. The following is only a simplified model:

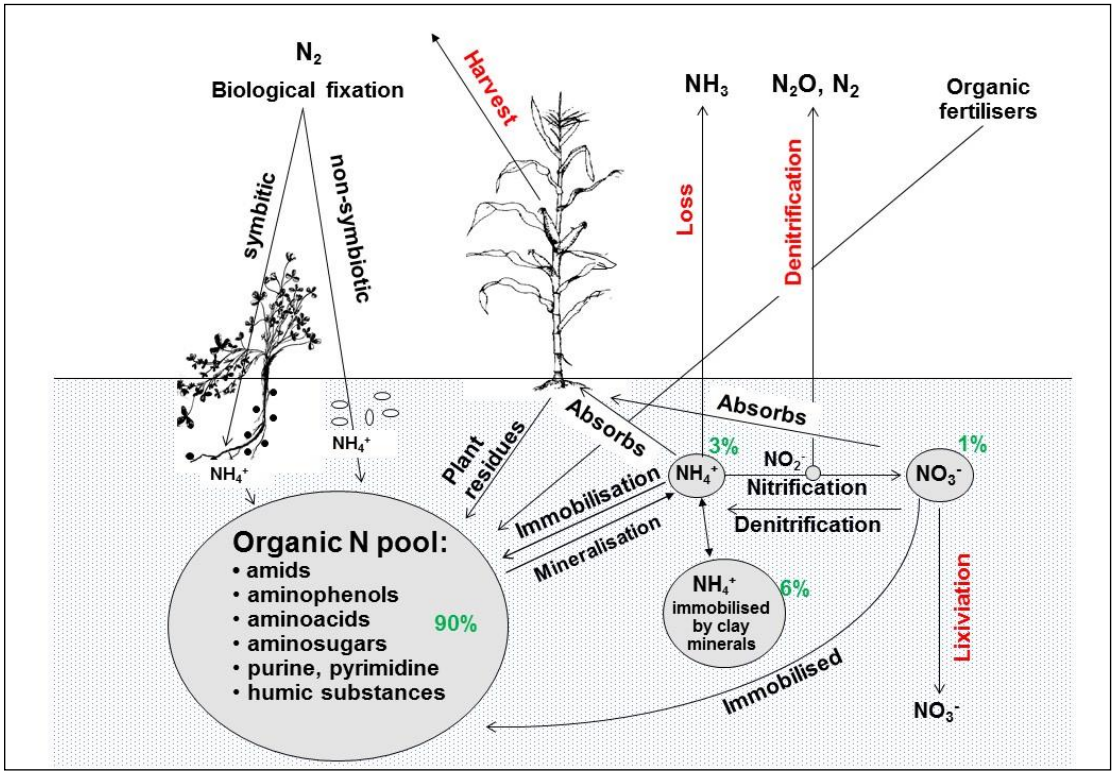


Fig. 1: Simplified N cycle in agriculture. Pathways of N losses are highlighted in red. The green figures give a rough idea of the quantitative importance of the respective N reserves in soils.

2. Basics of N management in organic farming:

While modern conventional farming relies on high quantities of synthetic N fertilisers produced with high fossil energy input, and has a heavy environmental impact through losses of N to the atmosphere and to water bodies, the principles of N management in organic farming are:

a. Maximising biological N **fixation**

b. Conserve and increase **soil organic matter**, as the main reserve of N

c. Maximising internal N **cycling**, minimising N **losses**.

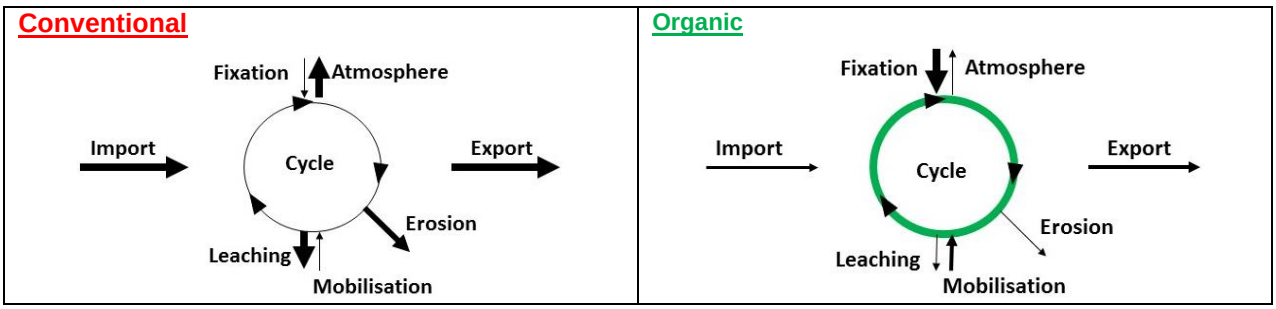


Fig. 2: N cycle in intensive conventional (left) and organic farming systems. Thickness of the lines corresponds to the importance of the respective process. (Biological N fixation; N losses to the atmosphere; Import of nutrients from outside the farm; Export of nutrients (with crops); Leaching of nitrate; N mobilisation from soil organic matter; Nutrient losses through soil erosion)

a. Maximising biological N fixation

The basic idea of organic farming is using the farm's internal resources, instead of bringing in fertilisers from outside the farm. A very powerful resource are leguminous plants living in symbiosis with **Rhizobia** bacteria. Rhizobia have the ability to convert N_2 from the air into ammonium (NH_4), which can be used by plants.

Some examples:

Under favourable conditions, **clover** or **lucerne** (alfalfa) crops can contribute 200 kg N/ha in one year. If the crop is left for two or three years, this amount can increase up to 300 kg N/ha or more.

If the clover or lucerne is mixed with one or several grass species, the grasses absorb excess N and prevent it from leaching. For organic cattle farms, the **grass-clover-mixture** is the basis for feeding. Farms without livestock normally keep the grass-clover-mixture only for one year. For both types of farms, it is the basis for the fertility of their soil and sustainability of their farming system.

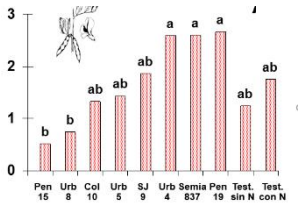
Short term leguminous **green manure crops**, as part of the crop rotation, can contribute between 30 and 80 kg N/ha within 2 to 4 months, depending on environmental conditions. Appropriate species and varieties exist for most climatic conditions, including e.g. vetch (*Vicia*) species for temperate climates or *Crotalaria* for tropical conditions.

Grain legumes, such as beans, soybeans, faba beans, peas, chickpeas, lentils etc. are an important part of organic crop rotations. In most cases, however, most of the nitrogen fixed by these crops, is then removed from the field with grain harvest. If a farmer harvests e.g. 2.5 tons soybeans/ha, approximately 150 kg N are removed.

Leguminous shade trees, as e.g. *Inga*, *Erythrina, Leucaena, Albizia* or *Acacia* can substantially increase the productivity and sustainability of coffee or cocoa plantations and other crops, especially in tropical and subtropical conditions.

Leguminous cover crops, for soil cover in between perennial crops, e.g. white clover, vetch, lucerne, etc.

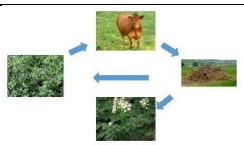
N fixation by certain legumes can be significantly increased by **inoculating** seeds with Rhizobia adapted to the species, variety, and to local conditions. In soils with poor phosphorous supply, a small amount of rock phosphate can help to improve biological N fixation.



b. Conserving and increasing soil organic matter (SOM)

The most effective measure for increasing SOM, is integrating "**ley crops**" (grass-clover-mixtures, grass-lucerne-mixtures, or even only grass) for 2 to 3 years in arable crop rotations.	
Keep soil covered by vegetation (**cover crops**) or **mulch** whenever possible!	
Manure and/or **compost** application. "Ripe" compost and compost with a wide C/N ratio, have a better effect on SOM conservation, while "young" compost and compost with a narrow C/N ratio, have a stronger short term fertilisation effect.	
Leave all **crop residues** on the field! Never burn weeds, straw, or other organic residues – always return them to the soil!	
Reduce soil **tillage** to a minimum! Especially deep ploughing leads to decline in SOM.	

c. Maximising N cycling and minimising N losses

Integration of livestock farming and crop production, instead of separate specialised farms	
Provide animals with **bedding** (straw, sawdust). The mixture of manure with bedding material leads to a wider Carbon / Nitrogen **(C/N) ratio**, and thus prevents N losses to the atmosphere and through leaching.	
Storing manure on a **concrete platform**, not only protects the environment, but also prevents N losses. Under very rainy conditions, a cover may be advisable.	
Whenever possible, incorporate manure quickly into soil after application, using shallow tillage, to prevent N losses to the atmosphere.	

Applying manure or slurry on **sunny days** may lead to heavy N losses to the atmosphere, while application during **heavy rain** may lead to N leaching!	
If climatic conditions allow, after a leguminous crop, farmers can plant a short cycle **cover crop** (preferably a "heavy feeder") that absorbs remaining N, instead of exposing it to leaching.	

3. Rules for N fertilisation according to organic standards

a. All the organic standards require farmers to give **priority** to the measures explained under (2) above!

b. Only **after making significant efforts** for increasing biological N fixation, improving soil organic matter, and minimising N losses, farmers can use **commercial organic N fertilisers** for certain crops (e.g. fruits and vegetables). Such fertilisers are often based on slaughterhouse by-products, or hydrolysed proteins. **CERES** has set a rule of thumb, that such fertilisers should not make up for more than **20% of the crop's total N demand**!

c. The **EU** Regulation on organic farming establishes a maximum of **170 kg N/ha from livestock manure** per year. This is far more than most farmers use.

d. **NOP** is the only relevant organic standard that allows use of **sodium nitrate** ($NaNO_3$) from mined sources, up to 20% of the crop's N demand. But be careful: if you apply for EU or other organic certifications at the same time, use of sodium nitrate will compromise the organic status of your land!

e. Under **NOP**, use of **fresh** livestock **manure** or slurry is restricted:

- For crops with a **risk of contact** between the edible part and the manure, fresh manure may be used only up to **4 months** before harvest
- For crops with **no risk** of contact, fresh manure may be used up to **3 months** before harvest
- Manure applied after these dates, must be **composted at high temperatures** under controlled conditions, to avoid microbial contamination of organic food (e.g. *E. coli*)

f. Per NOP, **liquid fertilizers with more than 3% N** can be approved only if **the fertilizer manufacturer is inspected twice per year.** There are two options for complying with this requirement:

- A confirmation issued by an NOP accredited certification body. The confirmation must clearly state that the "two annual inspections" requirement is complied with.
- If such a confirmation does not exist, CERES must inspect the fertilizer manufacturer. The farmer interested in using the fertilizer, must agree with the manufacturer concerning payment for the annual inspections.