SoilCare
SOILCARE FOR PROFITABLE AND SUSTAINABLE CROP PRODUCTION IN EUROPE

10 common practices and their harmful impact on soil

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Editorial

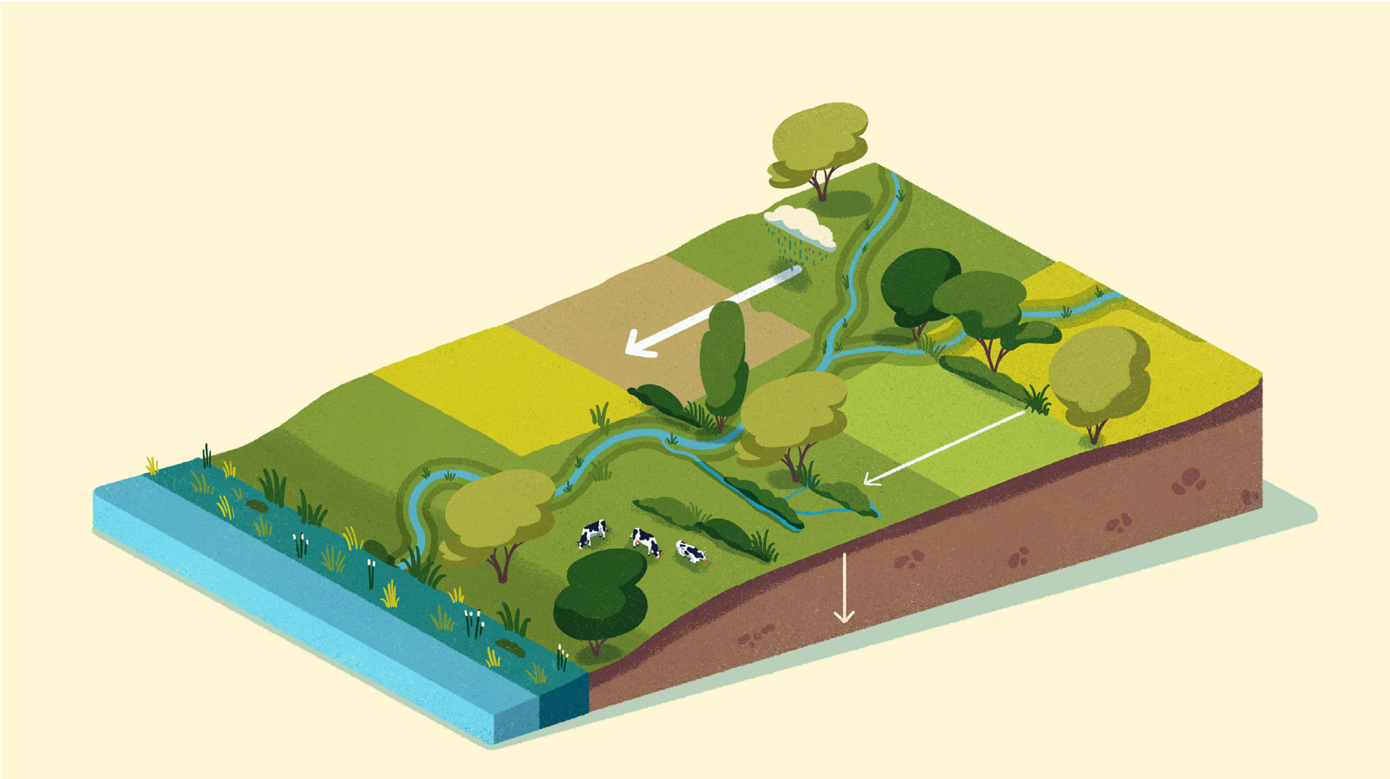
This booklet is designed to help you with 10 common problems that often happen on farm. The solutions provided here are tested by farmers and researchers as part of the SoilCare project. These handy tips are intended to improve the quality of your soil, save unnecessary expense and develop the sustainability of your farm.

SoilCare is testing a range of Soil-Improving Cropping Systems (SICS) throughout Europe. The SICS incorporate other practices being tested together such as longer rotations, minimum tillage and diverse cover & catch crops.

The project has been developed as a partnership between farmers, land managers and researchers. It also aims to inform policy for better soil management.

Find out more about the project here:
www.soilcare-project.eu/

1. Making observations of soil only at a plot scale, without considering the surrounding landscape and environment



A mistake, why?
Observation of your farm's landscape features e.g. slopes, rivers, woodland and the surrounding area provides useful information on the soil-water status. This can guide management decisions about preferential flow paths and potential wetlands.

Hedgerow network and water flow
Farming landscapes characterized by small irregular-shaped fields separated by hedges in some of Northern Europe have had a variety of functions:

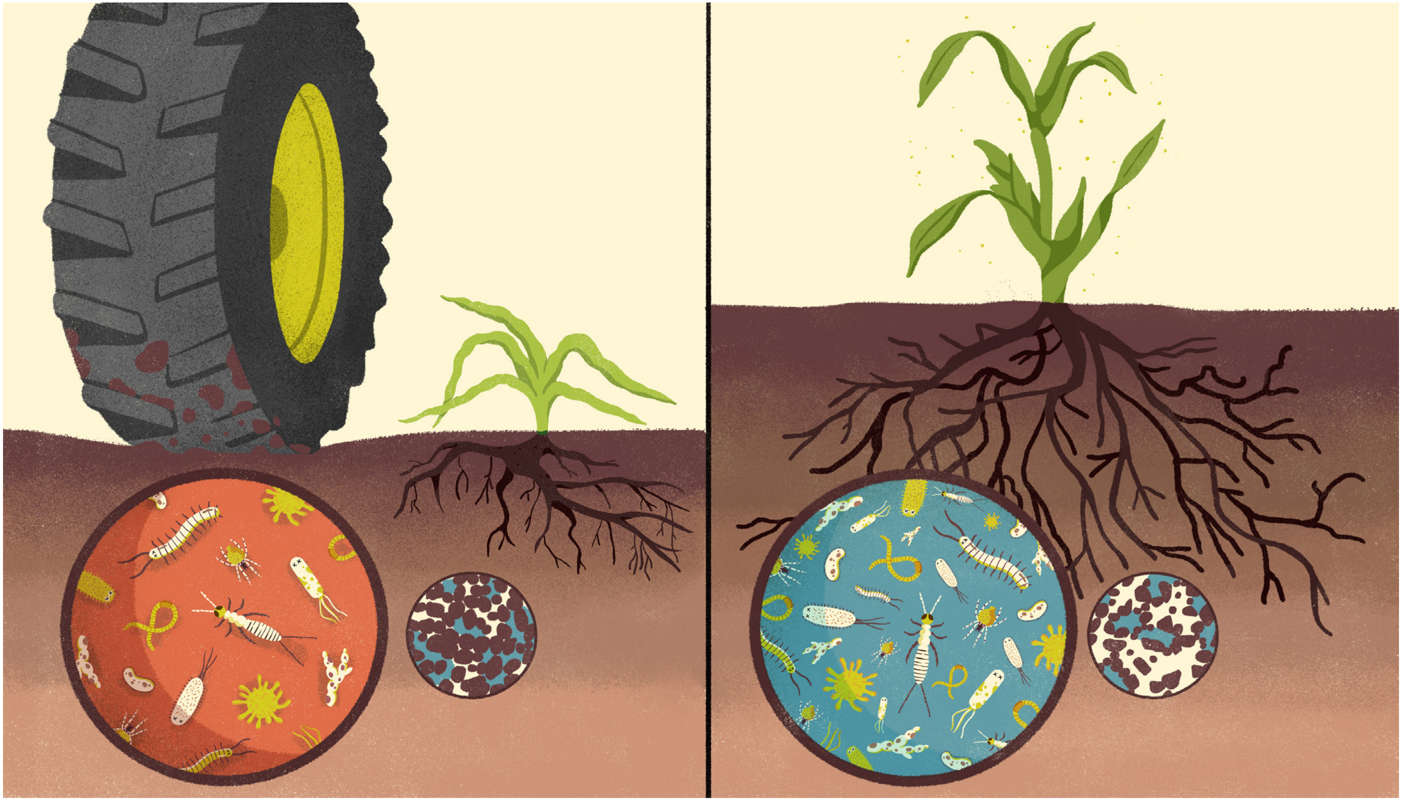
• Reducing the effects of flooding in winter and short droughts in summer through soil moisture regulation. This is especially relevant for shallow or sandy soils.
• Regulation of water run-off and protection from soil erosion.

Hedgerows have been removed for agricultural mechanisation, whilst surface drainage has been replaced by buried structures. With no landscape components to act as barriers in water flow, soil erosion events are increasingly frequent and intense. Water quality degradation is the first visible signal of soil erosion.

Did you know?
Good agricultural practice encourages the prevention of soil erosion. For example:

• Anti-erosive earth banks (perpendicular to the slope),
• Contour ploughing: a farming practice of ploughing and/or planting across a slope following its elevation contour lines.

2. Causing involuntarily soil compaction by unsuitable agricultural practices



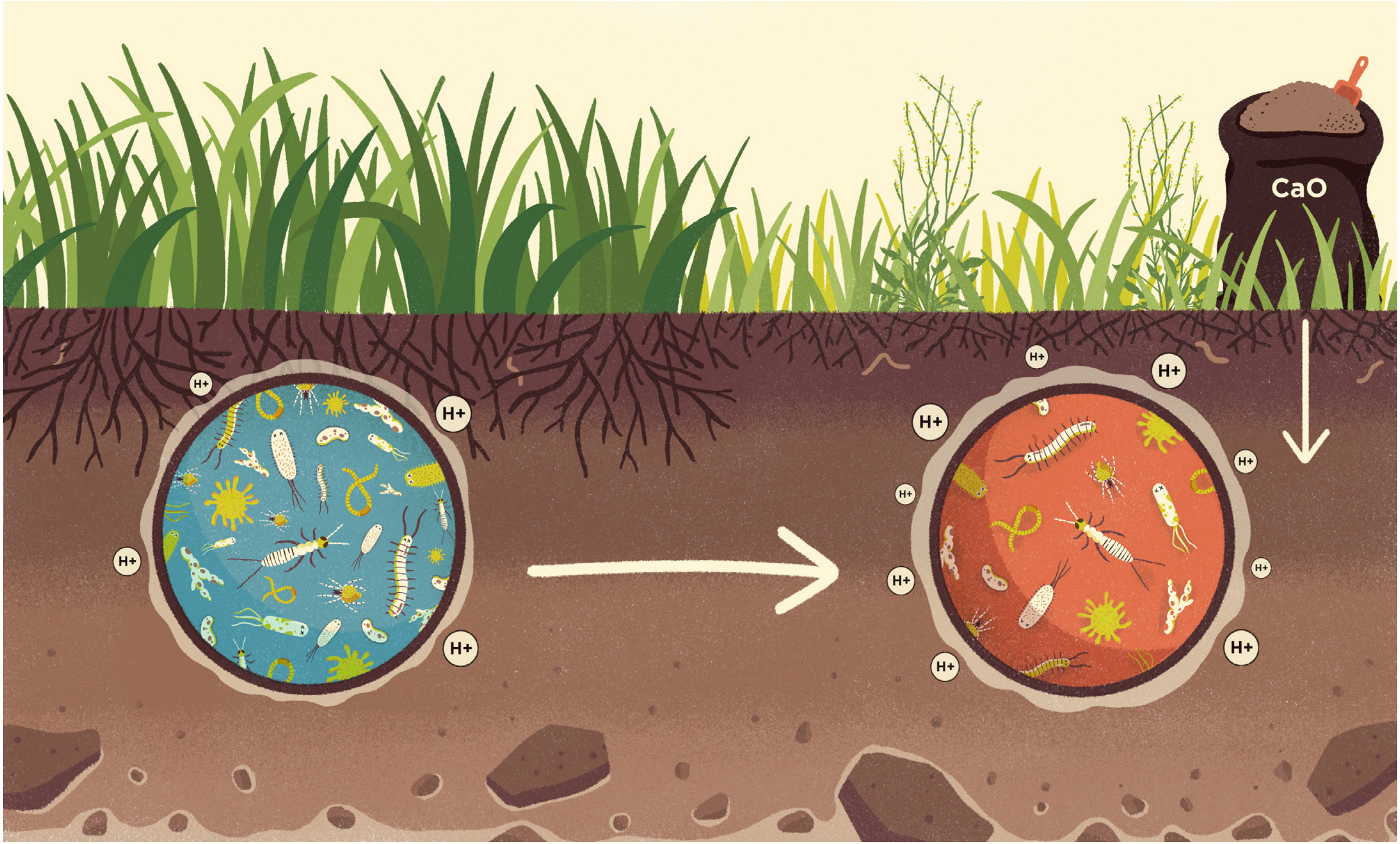
A mistake, why?
Porosity problems are the first signs of soil compaction. This change in soil structure can mean that oxygen and water in the soil are reduced. As a consequence, instead of soaking into the soil, water runs over the top causing it to erode. The lack of porosity and air also means that rooting is limited - restricting vital biological activity in this area (the rhizosphere).

What can I do on my farm?
Operations which use heavy machinery, such as tractors, generate compaction cycles in soils. Soils react differently depending on their nature. Some soils recover spontaneously from compaction as a result of the activity of worms, freezing and thawing, or wetting and drying cycles. Other soils, such as sandy soils, are inherently porous. In such situations, reduced or no-tillage can be a good way to reduce the amount of compaction given to soil.

In contrast, other soils do not recover spontaneously after compaction. In such situations, soil cultivation (mechanical means or plants with varied rooting depths) are good options to help the soil recover.

It is sometimes better to wait and see
Soil bearing capacity is mainly determined by soil moisture. Soil cultivation (mechanical) on a heavy / clayey soil (muddy soil, with a reduced bearing capacity) will generate soil compaction. In this case it is more profitable to wait as long as possible prior to tilling.

3. Not applying lime



A mistake, why?

As a natural phenomenon, crop cultivation can lead to soil acidification. This acidification constrains biological activity and as a consequence crop productivity. When soils are not naturally calcareous, they can't neutralise the acid, and it is necessary to add lime. Applications of lime need to be spread over the soil and not incorporated too deeply.

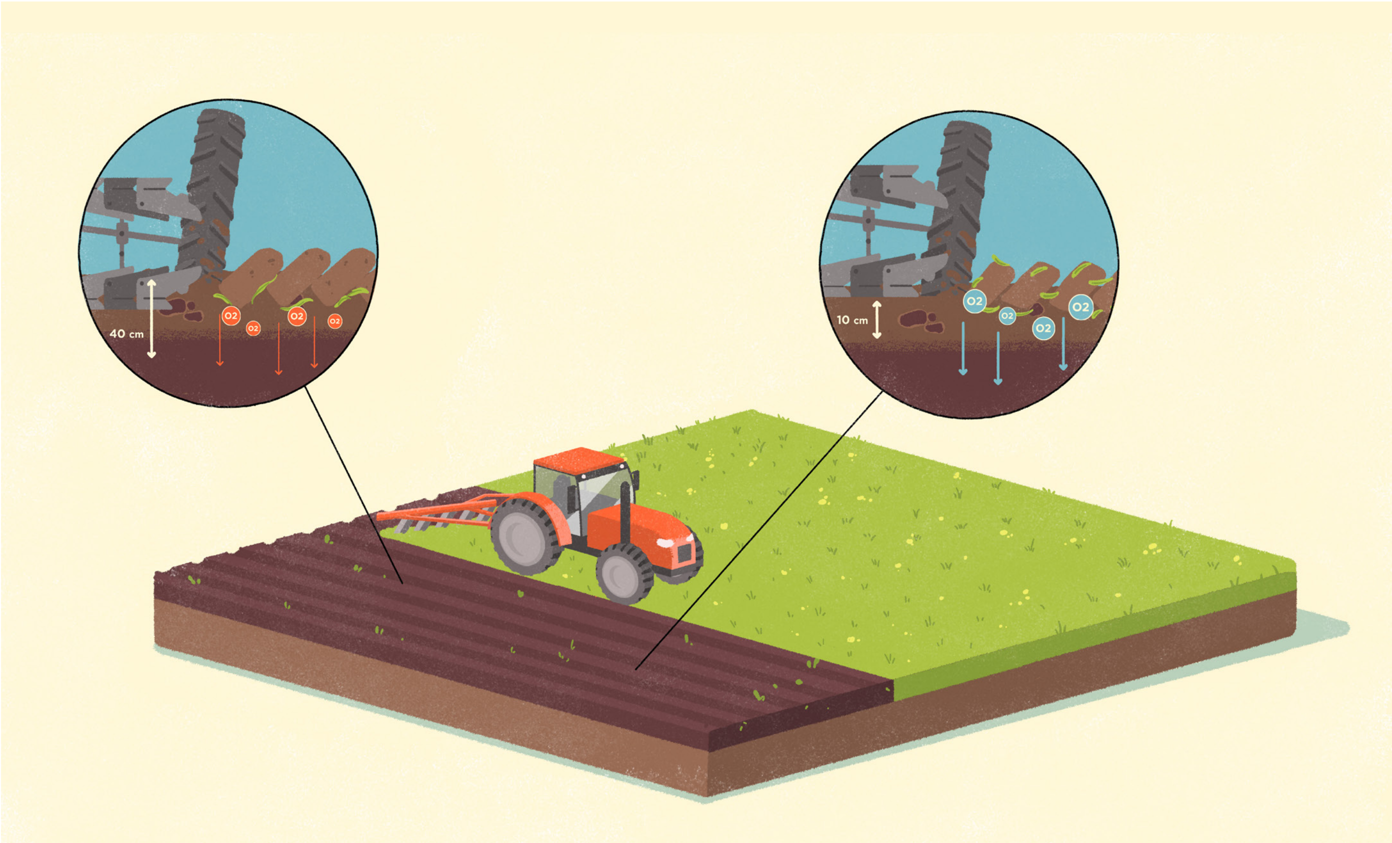
Calcium is not the base

Limestone degradation releases a base (OH-),carbon dixoide (CO_2) and calcium (Ca). The calcium released plays no role in the soil acid-base balance. Only the base (OH-) plays a role to limit soil acidity. As a consequence, soils with high calcium levels can be very acid!

Being debated

Marls and calcareous sea sand are the most used liming materials by organic farmers in north-west France. Extracted off the French coasts, this material is well adapted for liming acidic soils but its utilisation is questionable from a biodiversity point of view. Between local marls and below-ground limestone, which one is the most acceptable? Some alternatives can be identified (e.g. crushed oyster shells or scallops) but supply chains need to be established.

4. Ploughing the organic matter too deeply

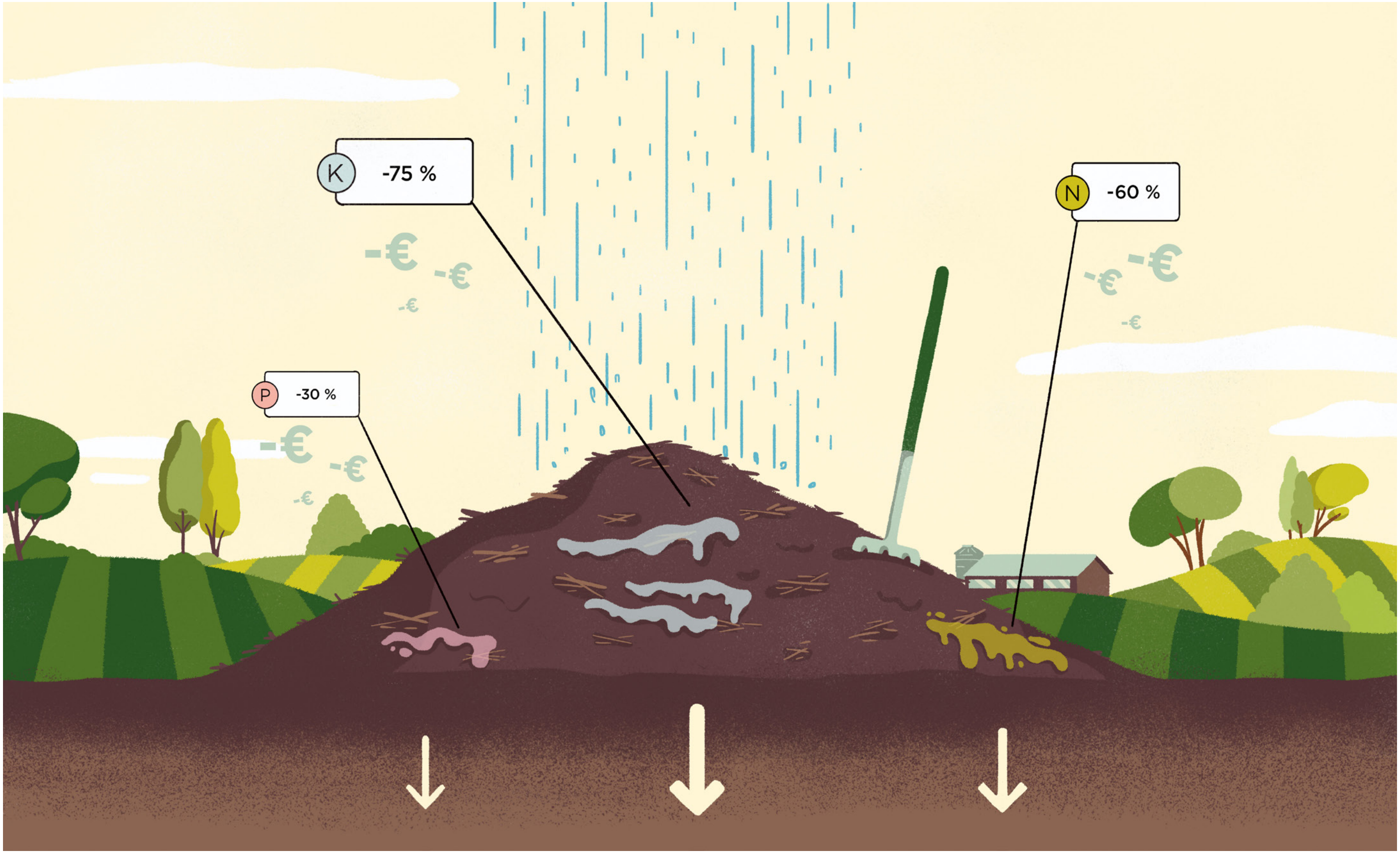


A mistake, why?
Whatever the nature of organic matter provided to the soil, the degradation of that organic matter will enhance soil processes. The conditions of its degradation need to be optimised. The incorporation of organic matter by deep ploughing can have negative impacts on gas exchange at the soil surface. Ploughing in late autumn or winter will generally manage poor soil moisture conditions in the plough furrow. Anaerobic conditions will lead to poor quality humus and will cause considerable nitrogen losses from denitrification. Ploughing can also mean that organic matter is distributed heterogeneously in the soil which can form hollows and cavities unfavourable for rooting and conducive to pest establishment.

Focus on… the shallow plough
This equipment allows a reduced working depth, up to 25 cm, and provides efficient turning of the soil and burying of trash, whilst enabling large working widths and, therefore, high working yields.

Although ploughing buries organic trash deeply in the plough furrow, shallow ploughing ensures that organic matter is well distributed on the surface. In this way, organic matter is held under aerobic conditions, favouring biological activity and thus mineralisation - key for crop growth.

5. Storing manure under unsuitable conditions



A mistake, why?

First and foremost, make sure that there are no nutrient losses! Field storage of manure in winter presents a high risk of nutrients leaching. These losses can be masked in manure analysis which are provided in kg of nutrient (N, P, K) by ton of manure. Most of the time an aged manure presents a higher nitrogen content than a fresh one but this observation is biased by a strong reduction in the overall weight of the manure pile. In other words, this apparent gain hides a nitrogen loss that can reach 60%!

How does a manure pile work?

A manure pile is like a sponge. It soaks up water until saturated during the fermentation process. This water absorbs inorganic nutrients (N, P, K…). As a consequence this nutrient dense water will be released as soon as the first raindrop reaches the manure pile. The first rains are the most responsible for nutrient leaching.

What can I do on my farm?

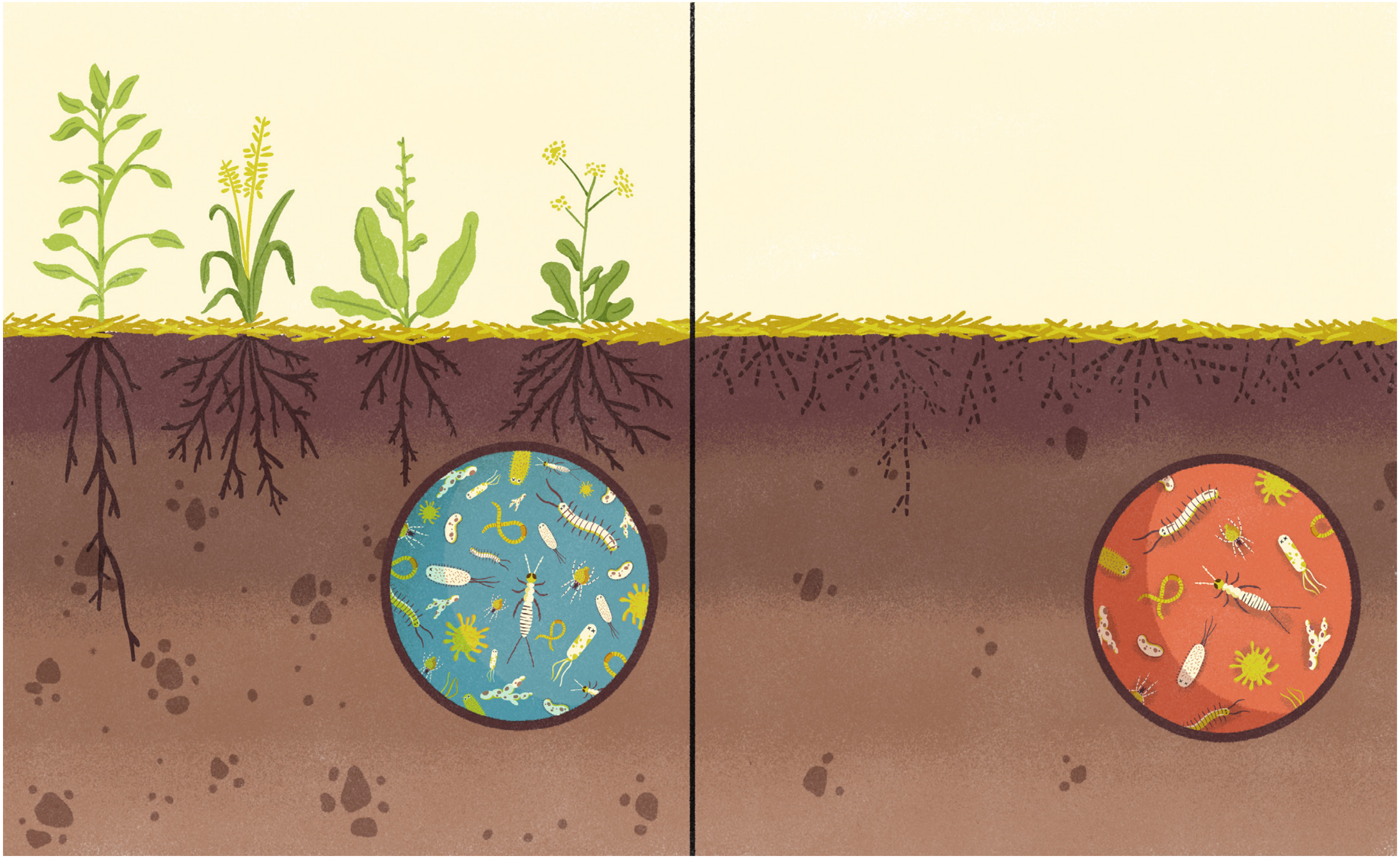
Protecting the manure piles from the rain is an efficient solution to prevent nutrient losses. There are two possibilities:

- Covering the manure pile with a tarp which is permeable to air
- Storing the manure in a shed

These nutrient losses have an economic impact!

Several studies have been led in France to quantify nutrient leaching from manure piles. These losses can reach 60% for nitrogen, 75% for potassium and 30% for phosphorus depending on rainfall intensity. In addition to environmental damages these losses have an economic impact. An experiment on two catchment basins in north-west France provides an estimation of this economic loss: calculated for a middle organic dairy farm, the shortfall could reach 2500 euros a year.

6. Leaving soil exposed in a bare uncultivated field



A mistake, why?

A functional soil needs organic matter. The use of organic matter by biological activity leads germs/microbes to create an aggregation of particles. By consuming organic matter fungi produce various organic substances which act as a 'soil glue' that holds soil mineral particles together. Roots of cover plants will provide nutrients to enhance fungal activity. In the absence of a cover plant or crop, as is the case after a summer harvest, soil fungi will lack the nutrients and the ability to incorporate organic matter into aggregates with soil glue. So, during autumn, soil biological activity in bare soil will break particle aggregates apart and disturb the soil structure, increasing soil erosion risk. Further, mineralisation processes carried out by soil microbes release mineral nitrogen which will inevitably be leached if not covered.

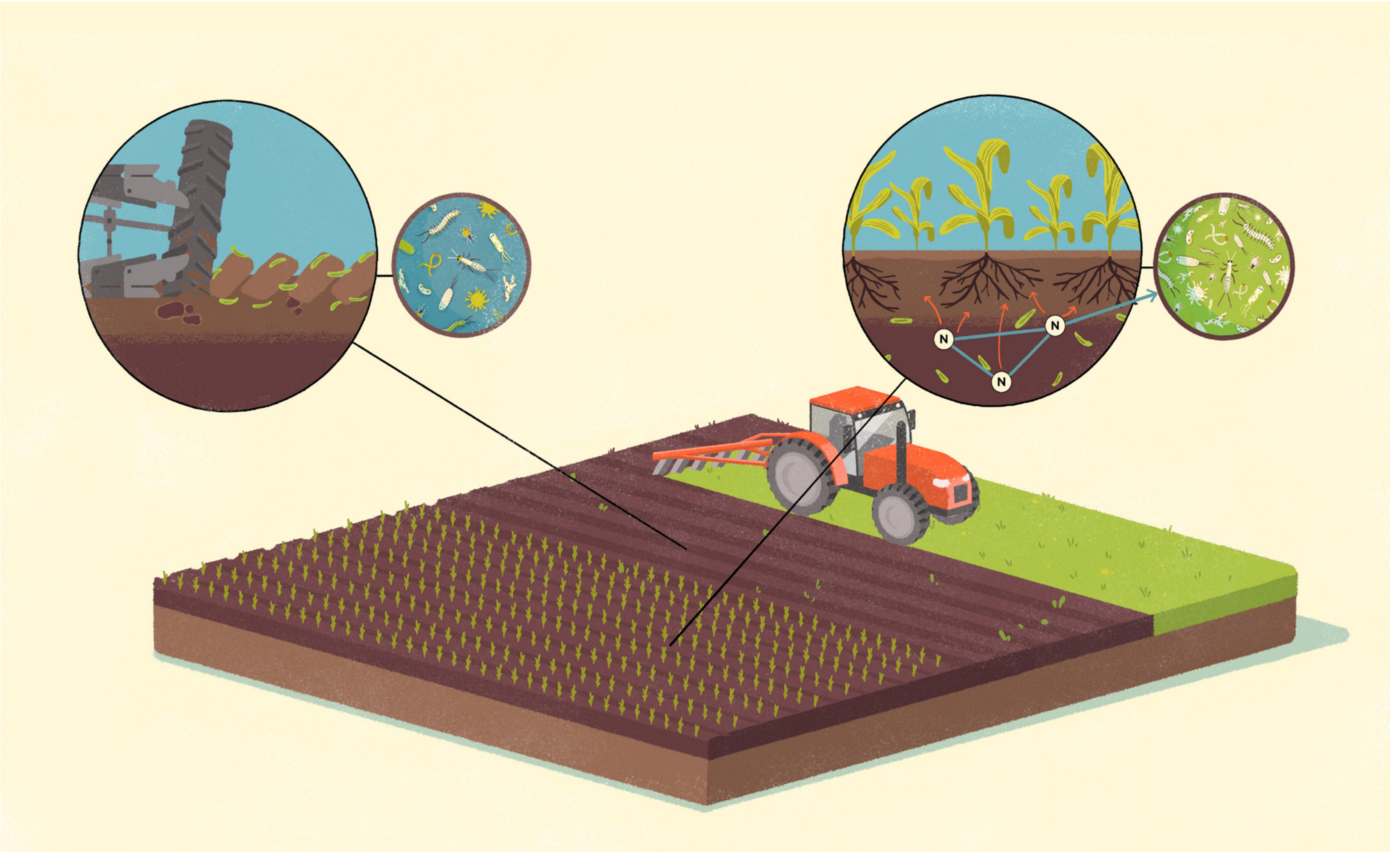
Regulations

In winter, the absence of plant cover increases runoff and soil erosion risk. Consequently, in north-west France, soil cover is compulsory as a minimum from 10 September to 1 February except in specific cases (for example: intercrop after maize).

Mineralization and immobilisation

To preserve the environment and save inputs and time, it is important to get a good appropriation of the mineralisation process in soil. The most important advice is to enhance mineralisation (in late winter and spring) and immobilisation (early winter) at the right time to prevent leaching by winter rains.

7. Ploughing organic matter just before sowing



A mistake, why?
The application of organic matter to the soil enhances biological activity. In this case, microorganisms consume and immobilise high amounts of nitrogen at the expense of crops. So, all organic amendments, even rich in nitrogen, will lead to a competition effect between crop and microorganisms for nitrogen. For example, the application of a dairy manure just before maize sowing will immobilise soil nitrogen for 2 to 6 weeks.

What can I do on my farm?
Three solutions can be used (in order of relevance):

- The application of an aged manure: nitrogen starvation from the organic amendment is limited.
- The application of an organic nitrogen-rich fertiliser (liquid manure, poultry manure) alongside manure.
- The application and incorporation of a fresh manure 6 weeks before sowing: the nitrogen starvation time has passed and nitrogen immobilised by microorganisms will be released at the right time for the crop.

Combining soil cultivation and organic matter application: the good choice
Soil cultivation can enhance biological activity, but it results in soil structure breakdown, leading to erosion. To stabilise soil structure it is necessary to promote soil particle aggregation by the production of the soil glue provided by fungal activity. As a consequence, combining soil cultivation with organic matter amendment is an interesting way to stimulate soil biological activity. This organic matter has to be rich in nutrients (sugars, starch, hemicellulose) and nitrogen (legume green manure, young composted manure).

8. Betting on a miraculous soil amendment

A mistake, why?
This easy solution for soil management is not an option as there is no miracle in soil management. Most biological activity stimulators are made up of sugars, nitrogen, calcium and some magnesium, sulphur and sometimes phosphorus. It is probably exactly what soil needs in late winter! However the efficiency of these products still need to be demonstrated. A farmer can do just as well and even better through the adoption of suitable soil-improving cropping systems and agronomic practices, resulting in savings.

Soil is a complex ecological system characterised by a diversified fauna and flora
Richness in soil life is made up of a range of living organisms encompassing diverse taxonomic groups and various roles in soil biological processes. Plant growth is highly dependent on the activity of biodiversity as it produces plant nutrients. Soil life also plays an important part in soil physical (soil structure) and chemical (soil organic matter dynamics, nitrogen cycle) properties which ensure the durability of cropping systems. Soil is not a growing medium exclusively. It is a complex ecosystem based on biological interactions.

Efficiency of soil biological activity boosters
These amendments whose composition is kept secret would enhance soil fertility over several years. Their efficiency is generally supported by sellers but still needs to be demonstrated carefully. The French Arvalis Institute has recently realised a synthesis based on 20 years of field trials involving these products. It concludes that the use of such stimulators do not allow a reduction of traditional NPK fertilizers without penalizing crop yield. Some yield gains are occasionally noticed but can be explained by the substantial proportion of fertilising elements in their composition. Besides, the outcome of this slight increase in crop productivity is not sufficient to balance the cost of these products.

9. Composting manure: a good solution but do not wait too long!

A mistake, why?
Manure composting is an aerobic fermentation process by which raw materials (straw litter + cattle waste) are turned into compost (nitrogen + humus) by biological activity. Fungal activity is enhanced by the consumption of nutrients. This process includes a rise in temperature in the manure pile.

Composting is often promoted in organic agricultural practices. There are many benefits in composting - it can eliminate weed seeds and germs in manure. Fungi consumes nutrients (sugars, cellulose) during the process. As a consequence, these nutrients will not be available for soil microorganisms anymore. The more composted the organic matter is, the less it will stimulate soil biological processes.

What can I do on my farm?
Composting manure over short periods is a good option to sanitise the pile; benefiting from the quick rise in temperature and preventing total nutrition consumption.

To sum up!
- Mineralisation processes begin more slowly than a young composted manure but more quickly than an aged (and composted) one.
- Nutrients are released too late with the application of an aged manure. An aged manure also releases undesirable residual soil nitrogen at the end of the season.

10. Basing your soil observations only on laboratory results

A mistake, why?

A laboratory diagnosis is not sufficient to realise an efficient soil diagnosis. It provides mineral status in soils but does not give information on soil health. Furthermore, soil sampling can be questionable because the analyses are carried out on small soil samples. Only a field assessment can provide a good interpretation of soil laboratory diagnosis.

Focus on... Soil field analysis

A soil profile is a vertical cross section of the soil. This method is useful to observe a soil and its evolution and provide a good understanding of the impact of agricultural practices. A soil profile can be made in different ways: with a soil pit; a bucket or a fork; or with a spade or auger. You can firstly look at the soil structure and any soil compaction, then observe the different soil layers (from topsoil to the parent rock). The top layer provides more information: rooting activity, groundwater infiltration, biological activity, soil colours, and other key points (orange/red mottling due to iron oxidation, soil macroporosity, plough pan, etc.).

Which tests can I use?

Worm count: Earthworms are most active during the spring and fall, which are the best times to observe their activity. To facilitate extraction of deep burrowing earth-worms, a mustard solution can be applied.

Carbonates in soil: A dilute HCl solution is used to assess carbonates in the field. A drop of HCl is placed on a soil sample to assess different effervescence classes according to the amount of limestone in soil.

Soil aggregate stability (slake test): Soil aggregate stability is widely recognized as a key indicator of soil quality and health. The slake test measures the stability of soil when exposed to rapid wetting and should be measured on air-dried soil fragments or aggregates (peds).

The Soilcare project

To address current issues on soil health several European projects are taking place. The SoilCare project aims to trial and identify agricultural practices for improving soil health. It has received funding from the European Union's Horizon 2020 research and innovation programme.

Why SoilCare?

European crop production is facing the challenge to remain competitive, while at the same time reducing negative environmental impacts. Currently, production levels in some cropping systems are maintained by increased inputs (e.g. nutrients and pesticides) and technology, which masks losses in productivity due to reduced soil quality. Such increased use of agricultural inputs may reduce profitability due to their costs, while also negatively affecting the environment. Soil improvement is necessary to break the negative spiral of degradation, increased inputs, increased costs and damage to the environment.

What is the role of FRAB in this project?

SoilCare brings together a multidisciplinary team of 28 partners from 18 EU countries, including universities, research institutes, SMEs and Federations. FRAB, and their regional partner Agrobio35, is the French partner of the project. FRAB is a farmer association and network, which acts as a link between the SoilCare project and farmers in Brittany (north-west France) through supporting field experiments on their farms. It is thanks to the FRAB network and farmers that this booklet arose.

Aim and key objectives

The overall aim of SoilCare is to assess the potential of Soil-Improving Cropping Systems (SICS) and to identify and test site-specific SICS which will have positive impacts on the profitability and sustainability of farming in Europe.

The project is addressing this challenge by:

- Reviewing which cropping systems can be considered as soil improving, identifying current benefits and drawbacks, and assessing current and potential impacts on soil quality and environment.

- Selecting and trialling soil improving cropping systems in 16 study sites across Europe.

- Developing and applying an integrated methodology to assess benefits and limitations, profitability and sustainability of soil improving cropping systems in the study sites.

- Studying barriers for adoption and analysing how farmers can be supported through appropriate incentives to adopt suitable soil improving cropping systems.

- Developing and applying a method to upscale study site results to European level.

- Developing an interactive tool for selection of soil improving cropping systems across Europe.

- Analysing effects on agricultural and environmental policies on adoption of cropping systems.

Further information

GAB-FRAB network references

Fiche culture et agronomie n°1 : Construire une rotation en agriculture biologique.

Fiche culture et agronomie n°10 : L'approche Herody

Fiche culture et agronomie n°11 : Le compost assaini

Fiche culture et désherbage n°4 : Les engrais verts

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Yves Hérody, 2015. La première goutte de la première pluie - Editions BRDA

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FNAB, 2017. CTS en agriculture biologique.

Websites

http://www.gissol.fr

http://www.sols-de-bretagne.fr

http://observatoire-agricole-biodiversite.fr

http://www.supagro.fr/ress-pepites/sol/co/Sol.html

https://www.produire-bio.fr/

Video links

Spade test (in french)

https://www.youtube.com/watch?v=qd62cjFHMz0

P.Lemanceau, 2015. La biodiversité des sols : un fantastique patrimoine à préserver et à valoriser

Glossary

Aggregate: soil aggregates are made up of soil mineral particles, organic matter, air and water. These are held together by organic soil glues.

Soil glue: this organic glue is produced by microorganism activity - essential for the aggregation of soil particles.

Aerobic / anaerobic: an aerobic environment contains oxygen, an anaerobic environment does not.

Fermentation: a process by which microorganisms convert sugars for energy, releasing heat.

Immobilisation: the conversion of inorganic nutrients such as ammonium or nitrate by soil organisms into organic compounds. This makes the nutrients temporarily immobile in the soil and unavailable to plants.

Mineralisation: the consumption of organic compounds by soil microorganisms and excretion of them as inorganic plant-available compounds such as ammonium, (the opposite to immobilisation).

Leaching: the loss of water-soluble plant nutrients from the soil to rivers or groundwater tables.

Nitrogen starvation: soil microorganisms consume nitrogen held within organic matter in the soil, which means that organic matter applications to soil can result in nitrogen starvation for plants / crops.

Porosity: the portion of the soil's volume that is not occupied by solid material. These pores retain the water, oxygen and nutrients that plants need for their growth.

Soil compaction: the physical consolidation of the soil by an applied pressure that damages structure, reduces porosity, limits water and air infiltration, and decreases plant root penetration.

Soil structure: defined by the way individual particles of sand, silt, and clay are assembled.

10 common practices and their harmful impact on soil

All agricultural practices have positive or negative impacts on soil. A better awareness of soil sensitivity to human activity is a first step in the improvement of soil management practices.

As every farm and area of soil varies, all management practices need to be adapted to their specific situation. A range of good practices are needed to ensure a healthy soil and farming system. Improving your understanding and observation of soil will help!

Ten unsuitable management practices for soils across Europe have been highlighted in this short booklet. These ordinary mistakes in soil management are explained and alternative practices are proposed to preserve soil health.

This document has been created within the framework of the SoilCare project:

https://soilcare-project.eu

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