Transforming **U**nsustainable management of soils in key agricultural systems in EU and China

Developing an **i**ntegrated platform of alternatives to reverse soil degradation

Organic fertilization using animal manures

This project receives funding from the European Union’s Horizon 2020 Research and Innovation action under grant agreement No 101000224.

Short description

Organic fertilisation performed with non-commercial products includes the distribution of plant-based or animal-based products that decompose in the soil to supply plant nutrient demands. The most widely used materials are animal manures (solid or liquid), digestate (liquid) and composted plant debris (solid). These organic fertilisers are normally produced in the farm, or in a neighbour farm. The organic nature of their compounds provides the soil with slow-release nutrient sources, stimulates soil life and promotes the increase of soil organic matter content.

Target area

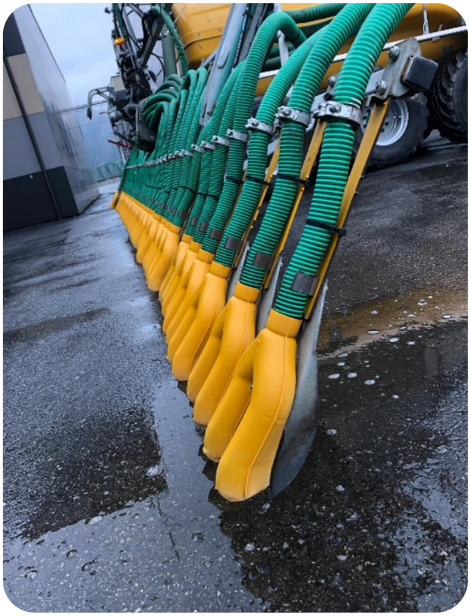
The correct use of animal manures for crop production and soil health maintenance/ improvement requires special attention, due to their variable composition, variable release rate, and low N:P ratio compared to crop requirements, that often results in a P accumulation in the soil. The use of manures in crop fertilisation is more efficient if manures are distributed in spring, they are soon incorporated into the soil, and they are distributed every year. All cropping systems can benefit of the use of manures, but specific machinery is needed to incorporate them into permanent crops where the soil is not tilled, such as in grassland and orchards.

Problem identification

Animal manures are not only source of nutrients, but they also improve the soil status. Therefore they are considered very valuable amendments, as they supply organic matter to the soil, allow nutrient recycling and promote soil life. Nevertheless, their use poses some problems to the calculation of the fertiliser supply, due to the great heterogeneity of the organic matrices, and to the sometimes unpredictable pattern of nutrient release. An evaluation of the actual fertilization management adopted in the farm can be supported by the TUdi soil fertilisation app (**dev-tudi.web.app**).

Detailed description of protection

Only part of the nutrients contained in manures are easily available, meaning that they can be used by the first crop following distribution. Part of N, in particular, is in the mineral form, mainly NH4+, and can be quickly used by the crop. Another part is in the form of organic molecules and becomes available to the crop after a mineralisation process, that requires some time. Ideally, the mineralisation should be synchronised with the plant uptake, otherwise it can be lost, for instance as leaching with drained water. However, the delay is also positive, as the slow release of nutrients can increase the plant use efficiency. In addition, another part



Special machinery can distribute liquid manure by injection below the soil surface

of N is contained in organic molecules recalcitrant to degradation, and the time to decompose them can be longer than one year. This legacy of N supply is typical of solid manures with a high C:N ratio, and is generally longer if the manure is spread not regularly, i.e. not every year at a single field. Conversely, P in manures is fully available and generally even more easily available than the corresponding amount in mineral fertilisers. Potassium also is normally considered as totally and immediately available to crops.

The use and management of animal manures requires special care to protect the environment

The organic compounds provide feed to soil microorganisms and promote the whole soil food web. In addition, year after year part of carbon supplied with manures remains in the soil as stabilized organic matter. More than 30% increase of soil organic C is expected after long-term distribution of solid manure, and 17% increase using bovine slurry, compared to a similar mineral fertilization.

From the main source of nutrients for crops, as they were in the past, manures have become a problem in modern agriculture, when they have grown in excess to farm land surface area, and when livestock farms have started to import from outside large amounts of nutrients, mainly N and P, as feed. This has caused an overload of manured-derived nutrients, with alarming menaces to the water, soil and air ecosystems. There is an urgent need of revisiting the correct use of manures in plant production, also with the aim of reducing the use of mineral fertilisers in agriculture. Several techniques can be implemented to facilitate the good agricultural use of manures, and the simplest one is solid-liquid separation of slurry. While the solid fraction can be distributed as farmyard manure, or delocalized to other stockless farms, the liquid fraction can also be used for fertigation, at a high use efficiency.

The liquid fraction of slurry can be used to perform fertigation

Pros/Cons of technique, obstacles to implementation

The main pros of using manures are i) Saving of mineral fertilisers (saving of money and of environmental impact of fertiliser production), ii) SOM increase, iii) Soil life stimulation, and iv) recycle of nutrients within a farm. However, there are also some drawbacks, such as i) High cost for distribution, ii) Unevenness of distribution of nutrients across the field, iii) Uncertainty in their nutrient content, and iv) Low nutrient use efficiency in winter crops.

Effects/results/case studies

If distributed every year, at the right time and immediately incorporated into the soil animal manures can have approximately the same nutrient use efficiency as mineral fertilisers. Scientific evidence for this was provided by several research works all throughout Europe, although the influence of crop, climate and soil types is relevant. The positive effect of manures on the crop goes beyond the simple supply of the main nutrients, and provides important Ecosystem Services, among which the improvement of several soil health indicators.

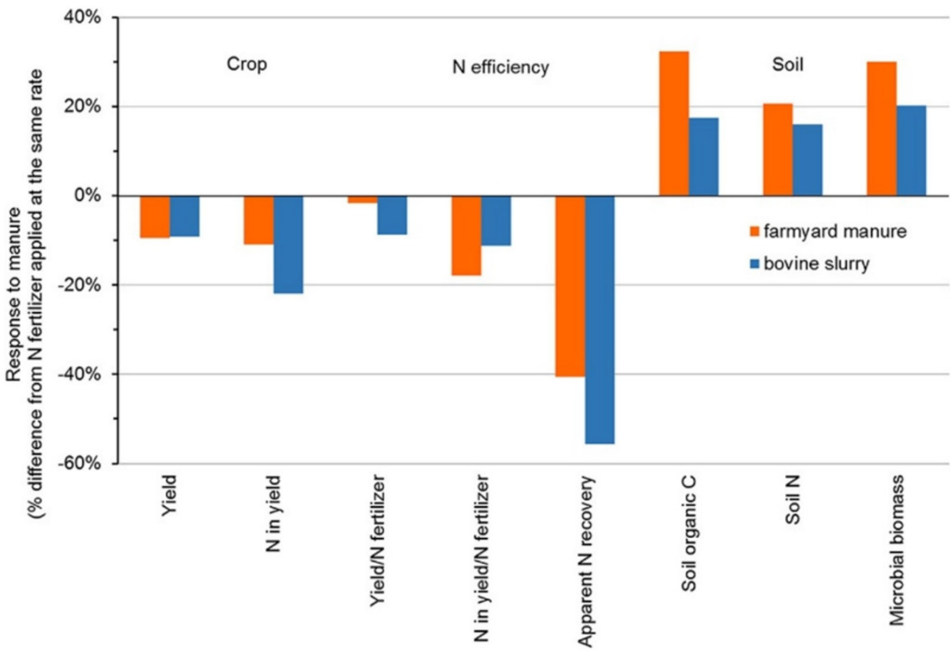
More literature

Additional information at **https://www.farmers.gov/conservation/nutrient-management**

Additional information at **https://www.fao.org/agriculture/crops/thematic-sitemap/theme/compendium/scpi-practices/integrated-nutrient-management/en/**

Additional information at **https://www.fao.org/partnerships/leap/news-and-events/news/detail/fr/c/1208627/**

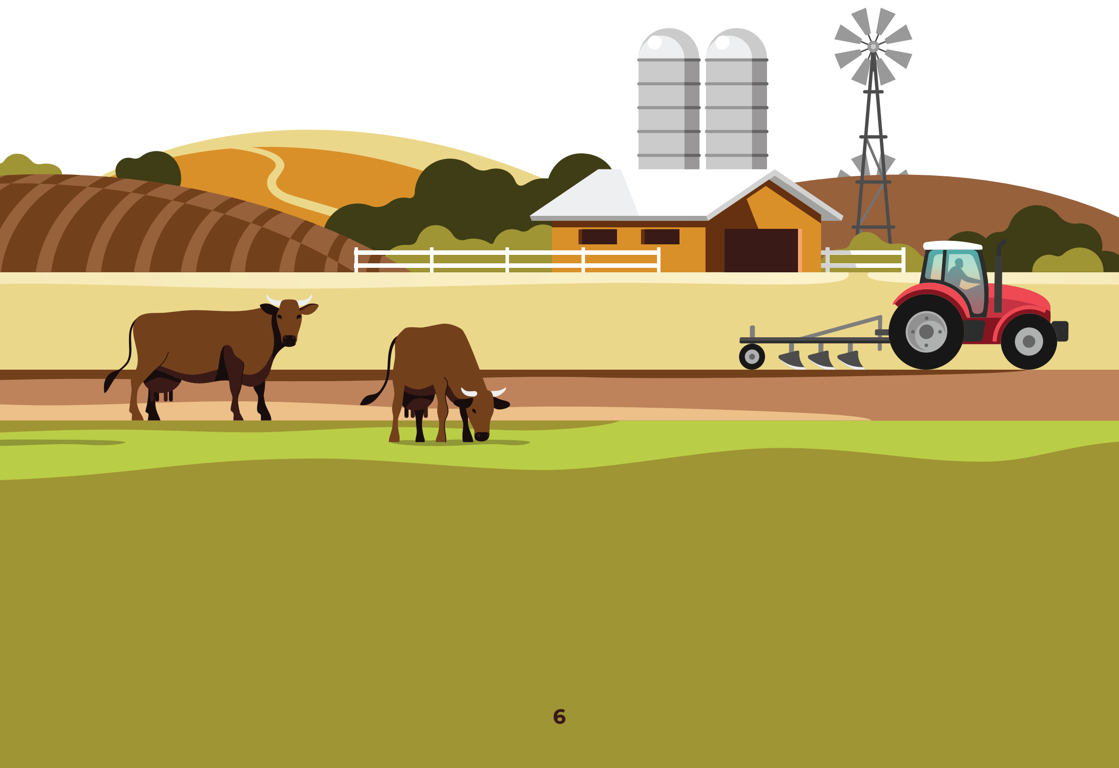
Scientific publication
doi.org/10.1016/j.eja.2017.07.010



The long-term use of manures instead of mineral fertilisers causes an increase of soil C and N contents, and of soil microbial biomass, up to 20% (Zavattaro et al., 2017)

Summary

Animal manures not only valuable fertilisers, but also amendments that improve soil status, enhance soil life and ameliorate soil health status. In addition, they help sequester C into the soil, reduce GHG emissions due to mineral fertilizer production, and contribute closing nutrient cycles in the farm. Their use requires specific attention to reduce the potential harm to the environment caused by their organic nature that causes a slow release of some nutrients, sometimes not synchronized with the crop uptake, and by nutrient unbalances that may arise from the incorrect calculation of plant requirements. Farmers should be aware of the high nutrient value of animal manure, and correctly evaluate their contribution to the crop nutrition, through a fertilizer management plan.



Summary table

	Rating	Comments
Soil health overall	***	
Water budget	-	
Soil structure	***	
Erosivity	*	
Nutrient balance	**	
Soil life	***	
Practicability	**	Depending on local availability of manures
Economy	***	

Consortium

Agrisat; Beijing Forestry University; Beijing Normal University; Centre for Agricultural Research; China Agricultural University; Czech Technical University in Prague; Lincoln University; New Bulgarian University; Northwest A&F University; Northwest UNIVERSITY; Pensoft Publishers; Spanish National Research Council; University of Lancaster; BOKU University, Vienna; University of Turin; Federal Agency for Water Management, Austria

Project coordinator

José A. Gómez
Institute of Sustainable Agriculture of the Spanish Council for Scientific Research
joseagomez@ias.csic.es

Duration

July 2021 – June 2025

Follow TUdi

@Project_TUdi

TUdi Project

TUdi Horizon 2020

tudi-project.org