

FERTILISATION IN AGROFORESTRY SYSTEMS

Increasing the productivity of agroforestry systems



THE WHAT AND WHY

Fertilisation and productivity of agroforestry systems

In the agroforestry systems the short-term production is often limited due to an inappropriate soil fertility management. The use of inorganic and organic fertilizers can enhance the soil fertility at the same time that the productivity of the agroforestry systems (of both the understory and the woody perennials) is increased. The main difference between inorganic and organic fertilizers is the amount of fertilizer that should be added into the soil to fulfil crop needs that is usually higher with organic fertilizers due to the lower nutrient content they have compared with the main

inorganic fertilizers. One option adopted in many countries around the world is the use of manure or sewage sludge as organic fertilizers due to their low cost compared with mineral fertilizers and their specific organic matter and macronutrient content, particularly nitrogen. Moreover, the use of this type of residue as fertilizers contribute to the Circular Economy strategy adopted by the European Commission, which proposes that when a product reaches the end of its life, it should be used again to create further value.



Pasture production in silvopastoral systems established with *Pinus radiata* D. Don in acidic soils of Galicia (NW Spain) fertilised with dairy sludge
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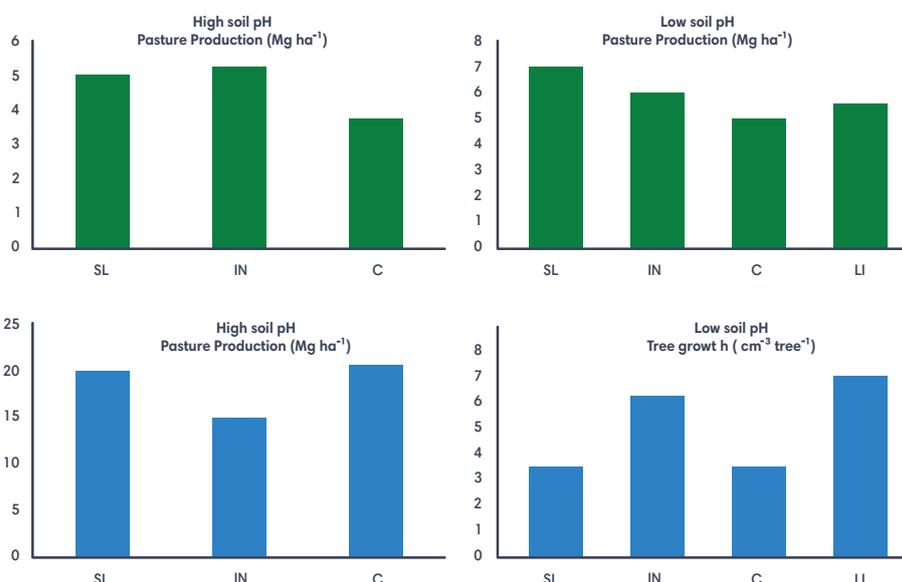


Figure 2. Pasture production and tree growth after sewage sludge (SL), inorganic fertilizer (IN) and lime (LI) applications compared with the control treatment (C) in soils with high and low pH. Mosquera-Losada, M.R.; Ferreiro-Domínguez, N.

HOW IS THE CHALLENGE ADDRESSED

Impact of fertilisation on the crops and tree production

In the agroforestry systems the impact of inorganic and organic fertilizers on crops and tree production mainly depends on the type of soil. Inorganic fertilizers are usually associated to soil acidification as it promotes the extraction of cations. In acidic soils, organic fertilizers generally increase soil pH of acidic soils due to its high level of cations and the long term nutrient release increasing both pasture and tree production. In agroforestry systems established in soils with water pH close to 7, mineral fertilisation tends to increase the pasture production that is in detriment of tree growth. However, when organic fertilizers such as the sewage sludge are applied both tree and pasture increase

their growth due to the inputs of nutrients and organic matter to the soil (enhance of the water holding capacity). In very acidic soils, the fertilisation with mineral usually enhances tree growth but not pasture production which increases when the organic fertilizers are applied because this type of fertilizers reduce soil acidity that make possible for the pasture to use the applied nutrients. In silvopastoral systems, the inorganic and organic fertilizers also modify the pasture biodiversity as those pastures with increased production have a higher proportion of monocots (grasses) than those where pasture production is low, which has a higher proportion of dicots.



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Keywords: Soil fertility, production, biodiversity, inorganic fertilizer, organic fertilizer

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HIGHLIGHTS

- The fertilisation increases the productivity of agroforestry systems
- The use of organic fertilizers (e.g. sewage sludge, manure) allows the adoption of the circular economy concept in the agroforestry farms
- The impact of inorganic and organic fertilizers on crops and tree production depends on the type of soil
- The integration of trees in agricultural areas could be a solution to the problem of excess nitrogen in the environment due to the addition of organic and inorganic fertilizers to soils



Silvopastoral system established under *Fraxinus excelsior* L. and fertilised with different types of sewage sludge (anaerobic, composted and pelletized).

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FURTHER INFORMATION

Rigueiro-Rodríguez A, Mosquera-Losada MR, Ferreiro-Domínguez N (2018) Use of sewage sludge in silvopastoral systems under *Pinus radiata* D. Don: soil, tree growth, and pasture production. *Agroforestry Systems*. <https://doi.org/10.1007/s10457-018-0293-8>

Ferreiro-Domínguez N, Rigueiro-Rodríguez A, Mosquera-Losada MR (2018) Fertilisation with biosolids in a silvopastoral system established with *Pseudotsuga menziesii* (Mirb.) Franco in Galicia (NW Spain). *Agroforestry Systems*. <https://doi.org/10.1007/s10457-018-0291-x>

Mosquera-Losada MR, Ferreiro-Domínguez N, Daboussi S, Rigueiro-Rodríguez A (2016) Sewage sludge stabilisation and fertilizer value in a silvopastoral system developed with *Eucalyptus nitens* Maiden in Lugo (Spain). *Science of the Total Environment* 566: 806-815.

Ferreiro-Domínguez N, Rigueiro-Rodríguez A, Bianchetto E, Mosquera-Losada MR (2014) Effect of lime and sewage sludge fertilisation on tree and understory interaction in a silvopastoral system. *Agriculture, Ecosystems and Environment* 188: 72-79"

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ADVANTAGES AND DISADVANTAGES

Aspects to bear in mind

When the inorganic and organic fertilizers are applied in agroforestry systems several aspects should be considered:

Agronomic aspects: in the agroforestry systems, both organic and inorganic fertilizers provide plants with the nutrients needed to grow. However, each type of fertilizer supplies these nutrients in a different way (organic fertilizers are characterized for a slow release of nutrients) and therefore its effect on the components of agroforestry systems is also different.

Environmental aspects: environmental restrictions play a role in the practical application of inorganic and organic fertilizers because an application rate that exceeds the crop needs could result in nitrate contamination of the ground-water by leaching. However, in agroforestry systems the nitrate-leaching risk tends to be lower than in areas with conventional agricultural systems due to the different localisation of tree and crop roots which enhance nutrient uptake. Therefore, the integration of trees in agricultural areas could be a means of addressing the problem of the excess of nitrogen in the environment resulting from the addition of organic and inorganic fertilizers to the soils. Moreover, when the sewage sludge or other types of residues are used as fertilizers, their heavy metal concentration must be considered to avoid an increase in inorganic soil pollutants. Indeed, this heavy metals concentration, mainly Zn and Cu, is higher than normal levels in soil and it is regulated by the European Directive 86/278/EEC.

Economic aspects: one of the main disadvantages of the use of inorganic fertilizers in the agriculture is their price which has increased in the last years as consequence of the lack of resources of some of them (Phosphorous) but also the high economic and environment cost they have (Nitrogen). For this reason, the inorganic fertilizers are promoted to be replaced by organic fertilizers (e.g. sewage sludge, manure) which provide a cheaper source of main nutrients (N, P) as well as organic matter. Moreover, it is important to be aware that in the agroforestry systems the amount of fertilizer needed is generally lower than in conventional agricultural systems due to the recycling of nutrients through trees which reduce the production costs of the farms. Moreover, the use of organic fertilizers such as sewage sludge allows the adoption of the circular economy concept in the agroforestry farms in order to achieve a more sustainable consumption and production.

Management aspects: inorganic fertilizers offer the advantage of coming in several easy to use formulations, which also makes them much easier to transport, storage and spreads than organic fertilizers like sewage sludge or manure. These organic fertilizers have a high proportion of water which can be reduced by 98% through thermic treatments, thus facilitating its management through the production of pellets.