SYNECO offers a nature-based solution for carbon sequestration in the Maltese soils

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The practices of discharging pig and cow slurry in Malta comes across as highly inappropriate. This is also the case for the way solid manures are handled. An important concern of current practices is that significant quantities of organic matter are lost at the cost of soil fertility and climate. The gravity of this is furthermore emphasised by the fact that Malta's crop farming happens entirely on mineral soils, since the country is without cropping patterns that would allow the accumulation of soil organic matter, as is the case in grasslands and forests.

Currently, slurries are disposed into the overloaded wastewater treatment plants. After a mechanical separation process, the liquid fraction is discharged to the Mediterranean Sea. In this way, significant amounts of organic matter in slurries are lost.

The conventional way of handling solid manures is to store it in a heap for some time and spread it on the fields in the late summer. In this way, there happens a (typically uncontrolled) compositing process, whereby up to two thirds of the organic matter is lost as carbon dioxide (CO_2) and methane (CH_4) (both are potent greenhouse gases), rather than being returned to the soils[1].

When speaking about carbon sequestration in soils, different parameters are used. Organic Matter (OM) constitutes typically 80% of Dry Matter (DM) in livestock manures. Soil Organic Carbon (SOC) constitutes 40-60% of manure's OM, most in solid manure, and less in liquid manures. Effective Organic Matter (EOM) is OM multiplied with a Humification Coefficient (HC), that represents the proportion of OM that is converted into stable, more resistant humus in soil. Soil humus contains about 50% Carbon.

The following table shows the amount of Effective Organic Matter and Effective C sequestration as Humus as an impact of three different scenarios:

1. the current situation,
2. with a country wide implementation of the SYNECO concept for liquid manures, and
3. with a country wide implementation of the SYNECO concept if extended to also handle solid manures.

[1] https://link.springer.com/article/10.1023/A:1015137922816

Table: Impact of a nation-wide use of the SYNECO concept for livestock manure handling on Effective C sequestration in Malta soils.

	Organic matter, ton	Destiny	Field spread, ton OM	Humification coefficient, HC, %	Effective Organic Matter (EOM)	Effective C sequestration
1 – Current situation						
Slurry	17,562	Lost in the sewer system	0	NA	NA	NA
Solid manure	13,720	Composing and alike	6,860	0.9	6.174	3,087
Total, ton						**3,087**
2 – SYNECO – only liquids						
Slurry	17,562	Anaerobic digestion[1]	15,805	0.55	8,693	4,346
Solid manure	13,720	Composing and alike	6,860	0.9	6,174	3,087
Total, ton						**7,433**
3 – SYNECO – all manures						
Slurry	17,562	Anaerobic digestion	15,805	0.55	8,693	4,346
Solid manure	13,720		12,348	0.55	6,174	3,396
Total, ton						**7,742**

Since Malta has around 9,800 ha of cultivated land, there is currently an Effective C sequestration of (3,087 / 9,800 =) 0.315 ton per ha per year, which the SYNECO concept potentially can raise up to 0.790 ton per ha per year.

The table shows an apparent small difference on Effective C sequestration between scenarios 2 and 3, namely 309 tonnes C. However, it shall be kept in mind that the SYNECO concept would mean that the loss of C from the solid fraction is changed from a loss as greenhouse gases (CO_2 and CH_4) to be a loss captured as renewable energy in the form of biogas. This means it would be a major achievement from a climate (and environmental) perspective to avoid the current practice of uncontrolled composting (or something like that) of the solid manures.

[1] A small share of the carbon is removed with the biogas. Digestates are separated and separation solids planned to be processed into manure granules via acidification and drying.

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Policy recommendations for Malta

- Livestock manure management in Malta should prioritise the return of organic matter to soils to promote effective carbon sequestration and enhance humus content. This objective can be achieved by processing livestock manure into bio-based fertilisers that are suitable for local agricultural conditions.
- Since 2016, SYNECO has conducted analysis, testing, pilot studies, and demonstrations of various solutions. The findings indicate that in Malta, processing all livestock manure through anaerobic digestion followed by conversion of digestates into bio-based fertilisers is a cost-effective and feasible approach that aligns with local crop farmers' fertilisation practices and requirements.
- Raw digestate does not meet local fertilisation requirements, so SYNECO suggests processing the solids into manure granules, which can be packaged in bags of varying sizes and applied using standard pot disc spreaders. Processing through acidification and drying helps retain organic matter and plant nutrients with minimal loss.
- Farmers in Malta commonly use fertigation through drip irrigation systems under plastic mulch. To substitute inorganic nitrogen and sulphur in fertigation, Ammonia Sulphate Solution (ASS), which is obtained in the processing of digestate, would be ideal. In addition, reject water, another by-product from this process, may serve as an alternative to limited water resources for crop irrigation.
- The points outlined above would necessitate revised policies. It is suggested that public funds currently allocated for disposing slurry at wastewater treatment plants, as well as the immense costs of treating the manure there, are diverted into support for continuation of SYNECO activities and eventually a country wide dissemination of the SYNECO concept. Likewise, capitalised social value of the positive environmental and climate impact that the SYNECO would generate, should be used for sustaining SYNECO's concept for manure management. It would further require amendments of the local nitrate legislation, which with its current formulation does not foresee any processed products of livestock manures to be used for fertilisation in Malta.

Importance of soil organic matter

According to the EU's Soil Strategy, soil organic matter is recognised as a fundamental factor in promoting environmental sustainability. It plays a key role in supporting biodiversity within the soil and providing essential ecosystem services, particularly those related to fertility. In addition, it enhances the water retention capacity of soils, contributing to their overall functionality and productivity. Furthermore, soil organic matter acts as a reservoir of carbon that has been extracted from our atmosphere. A concerning observation is the noticeable decline of organic

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matter in European soils. This decline isn't just alarming due to the associated loss of fertility and the looming threat of desertification but also due to the greenhouse gas emissions it results in.

Researchers advocate that soil organic matter should ideally be within the range of 3-6%[1]. However, recent analyses undertaken by SYNECO have unveiled a rather unsettling statistic: the local average soil organic matter content is a mere 2.7%, corresponding to about 1.6% soil organic carbon. For further insights on this topic, the European Environment Agency provides a detailed report[2]. Recognizing the gravity of this situation, SYNECO's concept for livestock manure handling is developed in support of COP21 conclusions to work for reversing the current average decline of soil organic carbon (SOC) in European croplands (i.e., 5‰ year^{-1}) to a 1‰-4‰ annual increase[3].

SYNECO

SYNECO is establishing good practices for manure management and fertilisation in Malta, benefitting rural societies that can use their own resources for fertilisation rather than importing expensive chemical fertilisers, thereby improving competitiveness of crop production in Malta.

SYNECO works for improving the environment, including reducing impacts on air and water, improving soil quality and reducing greenhouse gas emissions. The project also trains farmers to use a smart app for managing their farms with respect to fertilisation and crop production and includes their knowledge on the soils of their fields using AI-interpreted satellite data. Furthermore, SYNECO employs innovative technologies to process livestock slurry into useable products rather than continuing to treat this slurry at the urban wastewater treatment facilities (UWWTP) in a costly and completely unacceptable process. The project prioritises gender equality and employment of young people, whenever possible.

Project website: https://synecomalta.com/

Project owner: Farmers Central Cooperative Society Ltd. (FCCS)

Project coordinator: Dr Ing Christopher Ciantar

Project partners: Nordic BioEnergy, Organe Institute, Novaflow, AlfaLaval, PlanET Biogas Group, VCM vzw

[1] https://franklin.cce.cornell.edu/resources/soil-organic-matter-fact-sheet

[2] https://www.eea.europa.eu/publications/soil-carbon

[3] https://op.europa.eu/en/publication-detail/-/publication/4ebd2586-fc85-11ea-b44f-01aa75ed71a1/language-en

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