

RE-LIVE WASTE- Improving innovation capacities of private and public actors for sustainable and profitable REcycling of LIVEstock WASTE

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1 Introduction - The problem

The development of intensive livestock farming throughout the European Union leads to environmental problems, such as soil, water and air pollution and contributes to climate change.

The concentration of a large number of animals indoors or in confined spaces, where animals are fed mainly on commercial feed, leads to waste and animal byproducts generation, both liquid and solid. Much of the quantity generated is disposed on the ground and around the farms. Despite legal restrictions and obligations, insufficient waste storage capacity often results in uncontrolled disposal. This often leads to higher pollutants concentration in sensitive environmental receptors than permitted.

The composition of livestock waste varies depending on the animal rear but, in general, it is characterized by high organic load, high humidity (above 80%), high concentration of nutrients (nitrogen, phosphorus, potassium), high electrical conductivity and increased boron concentration.

It is considered that agricultural activities, including livestock farming, are responsible for 50% of total nitrogen discharges into surface water. The impact affects both the areas around the farms and far away from them, making it a global problem.

Livestock and agricultural activities cause, among other things, emissions of ammonia (NH_4^+), which contribute to the soil acidification process, the eutrophication of water bodies and the pollution of the lower atmosphere with ozone together with other pollutants (sulfur dioxide, nitrogen oxides, volatile organic compounds).

Furthermore, all activities related to farming and the use of fertilizers cause the release of nitrous oxide (N_2O) and methane (CH_4), as well as greenhouse gases with global warming capacity 21 times higher than carbon dioxide (CO_2).

2 European legal framework

Directive 2018/851/EC which is amending Directive 2008/98/EC on wastes, is increasing the targets for preparing for re-use and recycling of waste, to make them better reflect the Union's ambition to move to a circular economy. According to 2018/251/EC, in order to provide operators in markets for secondary raw materials with more certainty as to the waste or non-waste status of substances or objects and to promote a leveled playing field, it is important that Member States take appropriate measures to ensure that waste which has undergone recovery operations is considered to have ceased to be waste if it complies with all the conditions laid down in Article 6(1) of Directive 2008/98/EC as amended by this Directive. Such measures may include the adoption of legislation transposing those conditions supported by procedures for their implementation, such as the establishment of material and application-specific end-of-waste criteria, guidance documents, case-by-case decisions and other procedures for the ad hoc application of the harmonized conditions established at Union level. Such measures should include enforcement provisions to verify that declassified waste following a recovery process complies with Union law on waste, chemicals and mixtures, in particular prioritizing waste streams that pose a higher risk to human health and the environment due to the nature and volume of such waste streams waste subject to innovative recovery procedures or waste recovered for subsequent re-use in other Member States.

Measures may also include the setting of a requirement on the operators recovering waste or holders of recovered waste materials to demonstrate compliance with the conditions laid down in Article 6(1) of Directive 2008/98/EC as amended by this Directive. In order to prevent illegal shipments of waste and to raise awareness among Member States and economic operators, there should be greater transparency in relation to Member States' approach to the declassification of waste, in particular with regard to case-by-case decision-making and the outcome of verification by the competent authorities, as well as the specific concerns of Member States and competent authorities regarding certain categories of waste.

The final determination whether the conditions laid down in Article 5 or in Article 6 of Directive 2008/98/EC as amended by this Directive are fulfilled remains the exclusive responsibility of the Member State based on all relevant information provided by the holder of the material or waste.

Furthermore, Directive 2009/1009/EC mentions that for certain recovered wastes, such as struvite, biochar and ash-based products, within the meaning of Directive 2008/98/EC, a market demand for their use as fertilizing products has been identified. Furthermore, certain requirements are necessary for the waste used as input in the recovery operation and for the treatment processes and techniques, as well as for fertilizing products resulting from the recovery operation, in order to ensure that the use of those fertilizing products does not lead to overall adverse environmental or human health impacts. For EU fertilizing products, those requirements should be laid down in this Regulation. Therefore, as of the moment of compliance with all the requirements of this Regulation, such products should cease to be regarded as waste within the meaning of Directive 2008/98/EC, and it should, therefore, be possible for fertilizing products containing or consisting of such recovered waste materials to access the internal market. To ensure legal certainty, take advantage of technical developments, and further stimulate the incentive among producers to make more use of valuable waste streams, the scientific analyses and the setting of recovery requirements at Union level for such products should start immediately after the entry into force of this Regulation. Accordingly, the power to adopt acts in accordance with Article 290 TFEU, should be delegated to the Commission in respect of defining, without unnecessary delay, larger or additional categories of component materials eligible for use in the production of EU fertilizing products.

Article 42(2) of Regulation (EU) 2019/1009 requires the Commission to assess biochar without undue delay after 15 July 2019, and to include it in Annex II to that Regulation if that assessment concludes that EU fertilising products containing that material do not present a risk to human, animal or plant health, to safety or to the environment, and ensure agronomic efficiency. Such an assessment has been concluded by the Commission based on a report by the Commission's Joint Research Center ('JRC') on technical and market conditions for a possible legal framework for the manufacturing and placing on the market of specific safe and effective fertilising products derived from STRUBIAS. The report includes technical proposals on eligible input materials and process conditions for STRUBIAS production pathways, quality requirements for STRUBIAS materials, and quality management systems. The report also provides information on the added value that the STRUBIAS materials could provide for food security, food safety, environmental protection, and the EU fertilising and agricultural sector.

In a meeting held during 23 - 24 of November 2020, the scientific committee completed the evaluation of the report prepared by the Joint Research Center¹. The aforementioned report evaluated all

¹ <https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/technical-proposals-selected-new-fertilising-materials-under-fertilising-products-regulation>

STRUBIAS products (STRUvite, Blochar and AShes). The result of the meeting was the proposed amendment of the Directive 2009/1009/EC, which was expected to be approved officially in March 2021 but it wasn't. The amendment will be put in effect along with the rest of the Regulation on July 16, 2022.

The text of the amendment amends Annex II of the Regulation (EU) 2019/1009, which refers to the component materials and adds to the categories of component materials (Part I) precipitated phosphate salts and derivatives. It provides the materials that can be used as raw material for the production of these components, the terms of the production process as well as quality standards. Finally, it amends Annex IV of the Regulation, which sets out the procedure for checking compliance with the Regulation.

3 Purpose - Object of the Road Map

The purpose of this document is to support public authorities in the formulation of policies that recognize fertilizers deriving from livestock waste and incentive the adoption of innovations tested. In addition, this road map aims to:

- Raise awareness amongst policy makers about the economic and environmental benefits of the introduction of innovative technologies tested through the divulgation of the evaluation activities results.
- Raise awareness of local, regional and national public authorities about the strengths and weaknesses of actual policies in their influencing effect on the adoption by SMEs (Small and Medium Enterprises) of innovations for livestock waste management.
- Advocate public actors on the strategic policies they can set up in order to incentive the adoption of innovations for livestock waste management through their direct involvement in the formulations of policy guidelines and organization of regional thematic round tables.

4 The Road Map

As part of Action 4.5 of the program "Re-Live Waste - Improving the capacity of the private and public sector in innovative, sustainable and profitable use of livestock waste" on the transfer of knowledge to public and policymakers, a round table discussion was held on the promotion of the production of struvite in European Regulation 1009/2019/EC. The main conclusions drawn from that discussion have formed the framework of the roadmap presented in this document and includes the following:

- Need for further research;
- Promoting the production and distribution of struvite; and
- Utilization of available financial tools

4.1 Need for further research

For the inclusion of struvite in Regulation 1009/2019 as a fertilizer component, the following information on which a lack of information has been identified should be considered/ clarified:

- The evaluation of the terms and conditions set by the European Union;
- The quality characteristics of the product (if applicable);

- Whether a different inclusion procedure/characterization will be followed in the case of products including a higher content of struvite (as in Cyprus, more than 90%) in relation to products with a lower content (as in Spain); and
- The information required on the production process especially in relation to possible copyright issues and the problems that come with it.

In addition, the need for further research in the following areas has been recognized:

- Soil impact assessment. During the pilot study, struvite that was produced from livestock waste was evaluated on three types of vegetables in the laboratory, in greenhouse conditions and on a controlled peat substrate. The need for further research using local soil was pointed out. Further study is also deemed necessary to assess struvite's solubility on various soil types as well as the likely environmental impacts that may arise as a result of its use as a fertilizer.
- Further agronomic studies are required, in several species of horticultural, fruit, forest or ornamental plants to verify the effectiveness of struvite as fertilizer. Since such products may contain struvite in various contents, further research is necessary to determine whether the struvite content affects the efficacy of the final product.

4.2 Promoting the production and dissemination of struvite

4.2.1 Production of struvite

The production of struvite is a complex and a high-cost process that requires specialized expertise. Therefore, detailed information is required for farmers/entrepreneurs who intend to produce it. The experience gained during the pilot unit operation in Cyprus shall be used as a case study and as a tool for disseminating information to interested investors. In addition to the experience gained, which can be a guide for future actions, there are several alternative production methods, which are described in the international literature and can be used for local production if deemed appropriate.

4.2.2 Production cost

Struvite production cost is a determining factor and should be thoroughly considered. Production costs are a determining factor and should be thoroughly examined so that the production of struvite is economically viable. The types of chemicals and raw materials (e.g. by-products or recycled materials) used during struvite production process affect the product quality significantly; therefore more research is needed to identify the optimum cost-benefit solutions to achieve the required struvite quality characteristics.

In view of the fact that funds have already been earmarked for the research and development of innovative technologies in these areas, it is understood that part of these funds could be used both for further research needed for the development of struvite production technology and for the adoption of technology already tested on a pilot basis in livestock farms in Cyprus.

In addition to the income that struvite may bring, an important factor that may be used as a motivation for farmers towards the adoption of struvite production technology, is the compliance with waste disposal regulations and the avoidance of fines due to pollution incidents.

4.2.3 Struvite distribution/product safety

In addition to the process/methodology and production costs, an important factor is the research regarding the final product and the potential effects from its use. Briefly, the safety of the final product and its agronomic behavior must be carefully considered, in order to avoid possible negative impacts or weaknesses of use in environments with specific soil / climatic conditions or in certain grown plant species. It is therefore important to evaluate struvite, taking into account both the greenhouse substrates and all soil types. At the same time, the experimentation should be extended to numerous plant species, in order to clarify and evaluate the impact on their growth.

Another factor to consider is the possible nutrient fluctuations of struvite. The final composition of the product is of major importance and should be carefully considered, since the final applied quantity is expected to vary depending on the concentration of the product in nutrients and the grown plant species. Struvite's composition will determine the way and the quantities of application, same with chemicals, organic chemicals and organic fertilizers that are already distributed in the EU.

As long as all the above is taken into account, struvite can be placed on the market and compared with the already commercially available fertilizers. It is important here to precede a comparative study with commercial fertilizers so that the consumer can choose the application of struvite based on the advantages/disadvantages arising from the above comparative study. At the same time, it is important to classify the product and inform the final consumer about the permitted uses of struvite (organic farming).

In general, informing the public about the product should be an important part of promoting its uses, as it has not only the characterization of the fertilizer but also a way of protecting the environment through waste utilization , which would otherwise burden the environment through pollution, surface water, aquifer but also through greenhouse gases.

4.2.4 Use in organic farming

Regarding the possibility of using struvite in organic agriculture, on January 1st 2021 the new Regulation on Organic Production (EU) 2018/848 came into force. Article 54 of this Regulation provides for the Commission to be authorized to adopt acts, including amending Part I of Annex II on crop production and products, which may be used for fertilization in organic farming.

So far, Regulation (EU) 2018/848 prohibits the use of inorganic nitrogen fertilizers, allows the use of manure from livestock farms, but does not mention organo-mineral fertilizers or STRUBIAS products of any origin.

4.2.5 Utilization of available financial tools

Promoting the production of struvite in European Regulation 1009/2019/EC requires the utilization of all relevant available financial instruments. The main financial instruments available are the following:

1. The “Sustainable Europe Investment Plan”, which focuses on tackling climate change and will mobilize public investment and help to free up private capital through EU financial instruments, in particular InvestEU, will lead to investments of at least EUR 1 trillion. Euro.
2. The European Innovation Council (EIC), which supports pioneers with innovative ideas, small businesses and scientists by guiding them to funding opportunities, providing advice and networking opportunities to promote innovative ideas and develop them into global scale.

3. The European Institute of Innovation and Technology, which will coordinate innovation initiatives for the circular economy in collaboration with universities, research organizations, industry and Small and Medium Enterprises (SMEs) within the communities of knowledge and innovation.
4. The new program “Horizon Europe”, which will support the development of innovation, including waste recycling and raw material recovery.
5. The actions of Marie Skłodowska Curie, which will be able to support the development of skills, training and mobility of researchers in the fields of circular economy.
6. The program “Life”, which will continue to be an EU funding tool for environmental research.
7. The European Regional Development Fund for the period 2021-2027, which will continue to support two policy objectives: supporting innovation, the digital economy and SMEs through a smart specialization strategy (policy objective 1) and a greener one; cyclical low carbon economy (policy objective 2).
8. The European Social Fund + will support the skills upgrading and retraining of around 5 million people for green jobs and a green economy.
9. The European Investment Bank, which is becoming the EU's climate bank.
10. Government subsidy
11. The Common Agricultural Policy (CAP)

5 Conclusions

5.1 Legislation

The modification on Regulation (EC) 2019/1009 prepared by the European Commission answers the questions related to the technical specifications for the production and the quality characteristics of the struvite as a fertilizer component. Thus, by law, at European Union level, the framework has been set and the way is open to produce struvite and distribute it to the European market under the EU brand.

5.2 Struvite as a fertilizer ingredient

The whole production process, as tested in Cyprus, constitutes a holistic management of livestock waste, which produces, in addition to struvite, biogas and compost, giving the farmer the income potential that will enhance his capacity for sustainable production, both economically and environmentally. The first analyses allow optimism in terms of the use of struvite as a fertilizer, as it has proven to be as effective as commercial fertilizers in the tested plant species.

5.3 Future actions

The main future actions required to achieve the goal of promoting the production of struvite in European Regulation 1009/2019 / EC are summarized as follows:

Further research regarding:

- the development of struvite production technology (e.g. finding chemicals used in the production process at a lower cost),

- the environmental impact and behavior of struvite in various soil types (e.g. in the calcareous soils of Cyprus),
- the effectiveness of struvite in different plant species

Training/Awareness

- Of interested parties on the technology, its potential and the benefits of its adoption
- Of interested parties on the characteristics of struvite as fertilizer, its use and effectiveness in relation to other commercial fertilizers.

Financing

- Livestock units for the installation and production of struvite and
- Farmers for the use of struvite