PhD School on Agriculture, Environment and Bioenergy

(http://sites.unimi.it/dottorato_aab/)

(XXXIX cycle, 2023-26)

Project draft

1. Field of interest

*Indicare **il/i** settore/i scientifico disciplinari: AGR/13*

2. Project title

Nutrient and carbon recovery from biomasses: environmental impact measurement by life Cycle Assessment

3.Tutor (membro del Collegio dei Docenti)

- Eventually: co-tutor/s

4. Relevance of the topic and state of the art:

The use of chemically produced N and mined P is modifying and misbalancing not only the agroecosystem but also the natural ecosystems, putting biodiversity at risk. The regular production and use of mineral fertilizers in agriculture have a long track record of impacts on the environment beyond the mere addition of nutrients to the soil. Fertilizer industry production and use causes about 2.5% (1203 Tg CO2 equiv) of global GHG emissions, and N fertilizers account for 33% of the total annual creation of reactive N, i.e., 170 Tg N y−1 (fertilizers and livestock manure), generating big environmental problems. In addition, the production of P and K fertilizers relies upon non-renewable and extracted resources that are becoming depleted[7] and are concentrated (e.g., P) in only a few countries.

Organic wastes, by products and residues can be exploited as raw materials to recover nutrients and organic matter, representing an example of Circular Economy. The recovery of nutrients allows the production of fertilizers able to substitute for synthetic ones, thus reducing the necessity to produce fertilizers using fossil energy (N and P) and fossil resources (P and K), and closing nutrient cycles. In addition, the recovery, also, of the organic matter represents a solution to the problem of low organic matter (OM) content in soils.Therefore, the assessment of environmental impacts of recovered fertilizers needs to be studied in details and in comparison with synthetic ones using an appropriate approach, i.e., life cycle assessment (LCA) fed by validated data (full-field data).

In order to assess the sustainability of a product in a new production chain, it is essential to rely on a standardised approach, by proceeding with completely validated evaluations. One of the tools used is the life cycle assessment (LCA). This procedure includes the calculation of all the inputs (energy and resources) and outputs (emissions) for each production step of the life cycle of the study. Using the Life Cycle Assessment (LCA) methodology has become increasingly widespread for the evaluation of products and services, with several studies evaluating the production of recovered fertilizers pathway. The LCA tool allows to precisely quantify emissions to the environment (physical quantities), highlight critical hot spots in the production process, compare production processes, and finally evaluate the opportunity to adopt an innovative production process in comparison to the already existing options.

To better understand recovery process,

5.1. Materials & Methods:

Different process to obtain recovered fertilizers will be evaluated, proceeding with the collection of activity data, mass balance and input/output products characterization. Data on agricultural waste, food waste, residues and sewage sludge. will be collected and analyzed. chemical and spectroscopic methods such as UV-Visible spectrophotometry, ICP-MS, and HPLC will be used to quantify the main feature. Data collection, including relavant literature on new innovations to reduce emissions (GHG eutrophication and acidification) related to nutrients management in fields will be systematically reviewed. Based on full scale data different elaboration and scnarios will be developed.

Environmental impact calculation: The environmental impact of the recovery of nitrogen, phosphorus, and organic matter from renewable sources will be calculated using LCA software. The software will calculate the energy consumption, greenhouse gas emissions, and other environmental impacts associated with the recovery process. Data interpretation: The data obtained from the chemical analysis and environmental impact calculation will be analyzed and interpreted to determine the impact of the recovery of nitrogen, phosphorus, and organic matter from renewable sources on the environment.

5.2. Schedule and major steps (3 years):

First Year: identification of the main recovery production chain, process flow and by products/residues involved. Identification of full-scale plants for data collection
Second year: data collection and materials characterization, review of relevant literature for innovative technologies in emissions saving for nutrients recovery and use, elaboration of scenarios
Third year: Environmental impact calculation, statistical elaboration, comparisons of scenario and sensitivity analysis elaboration. The environmental impact of the recovery of nitrogen, phosphorus, and organic matter from renewable sources will be calculated using LCA software. The software will calculate greenhouse gas emissions, and other environmental impacts associated with the recovery process.
Third years: Data interpretation: The data obtained from the chemical analysis and environmental impact calculation will be analyzed and interpreted to determine the impact, and the reliability, of the recovery of nitrogen, phosphorus, and organic matter from renewable sources on the environment.

6. Available funds

Bora autofinanziata prof. Fabrizio Adani

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H20_RIA17FADAN_01

H20_RIA16FADAN_M

7. Literature:

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