PhD School on Agriculture, Environment and Bioenergy
(http://sites.unimi.it/dottorato_aab/)

(XXXVI cycle, 2020-22)

Project draft

1. **Field of interest**

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

   AGR13: nutrient recovery, biomass, anaerobic digestion, circular economy.

2. **Project title: Innovative Biofertilizers form organic wastes promoting the Circular Economy**

3. **Tutor** (Fabrizio Adani)

   - Eventually: co-tutor/s

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

Although more than 90% of manure produced in EU27 is currently returned to agricultural fields (either through the spreading of collected manure or directly by grazing), this is not being done in the most efficient and less leaky way.
At present, the trend in manure management shall consider it as a transformation process to obtain products with market value, whether economic, environmental, agricultural or other. With this tendency, framed within policies related to a circular and innovative economy, in the future we will talk about valorisation techniques instead of treatment techniques.
The livestock sector is currently responsible for 14.5% of all human-induced greenhouse gas (GHG) emissions (Sakadevan and Nguyen, 2017). Moreover, it generates large nutrient surpluses of on-farm nitrogen (N) and phosphorus (P) that may lead to a pollution of water bodies. To protect European watercourses, the Nitrates Directive (91/676/EEC) was implemented in 1991 with the aim to limit the application of N from animal manure up to 170 kg N ha^{-1} y^{-1} in Nitrate Vulnerable Zones (NVZs) (European Commission, 1991). These zones are mostly located in European regions known for high livestock density, such as Flanders (Belgium), the Netherlands, Denmark, Brittany (France), Po Valley (Italy), Ireland, Aragon and Catalonia (Spain).
Therefore, current on-field manure management has to be considered more as a disposal alternative rather than an efficient use of its nutrients and valuable compounds.

5. Layout of the project (draft):

In the framework of FERTIMANURE H2020 project, this Ph.D project aims to develop sustainable innovative manure management processing technologies to produce valuable fertilising products

5.1. Materials & Methods:

5.2. Schedule and major steps (3 years):

Months1-12: Production of biological activated organic amendments. Organic amendments recovered in WP2 (e.g. compost, biodried manure, digested material).

Organic amendment will be recovered from full scale plant operating in Lombardy Region. Compost, solid fraction of manure and solid fraction of digested material will be considered, and completely characterized for biological and chemical parameters.

Month 8-15. biomass selected will be improved by activating them biologically with mixed micro-organism cultures. The main verified functions of these micro-organisms are to facilitate nutrient availability and uptake, to biostimulate plant for better growth and to boost specific resistance to biotic and abiotic stress. Ph.D project will exploit the synergy of effective organic amendments enhanced with functional microorganisms, developing tailored products suitable for different range of high-level fertilizers demand (e.g. cash crop, greenhouse crops, fruits) in the PFC of (i) soil improver, (ii) Plant Growth-Promoting Rhizobacteria and (iii) plant biostimulants. The microorganisms to be used in the project belong to several microbial species that are linked to specific needs farmers (e.g. enhanced microelements uptake, drought resistance, biotic resistance), the microorganism that will be used are: Bacillus sp., Lactobacillus sp. Pseudomonas sp., Methylobacterium sp., Rhizophagus sp., actinomycetes (Streptomyces sp.),hyphomycetes (Trichoderma sp.), yeast (Pichia sp.), and algae (Cyanobacteria).

Month 15-30. The biological activated consortia obtained in WP3 will be tested in vitro and in simple model substrate (sterile peat) in WP4 in order to check their compatibility of the microbial components before the application. Moreover,in greenhouse environment on selected crops it will be monitored the population of microbes applied with the aim of proving the persistency/stability with the acceptable level in the time of different beneficial population in the organic fertilizer supplemented by microbial consortia.

Months 30-36: Evaluation of the results and data elaboration.

Literature

1. Ledda, C., Schievano, A., Salati, S., Adani, F. (2013). Nitrogen and water recovery from animal slurries by a new integrated ultrafiltration, reverse osmosis and cold stripping process: A case study Water Research 47, 6157 - 6166 doi: 10.1016/j.watres.2013.07.037.
2. Ledda, C., Schievano, A., Scaglia, B., (...), Acién Fernández, F.G., Adani, F. (2015). Integration of microalgae production with anaerobic digestion of dairy cattle manure: An overall mass and energy balance of the process. Journal of Cleaner Production, 112, 103-112.
3. Ovejero, J., Ortiz, C., Boixadera, J., Serra, X., Ponsá, S., Lloveras, J., Casas, C. 2016. Pig slurry fertilization in a double-annual cropping forage system under sub-humid Mediterranean conditions. Europ. J. Agronomy, 81, 138-149.
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5. Tambone F., Orzi V., D'Imporzano G., Adani F. (2017). Solid and liquid fractionation of digestate: Mass balance, chemical characterization, and agronomic and environmental value. Bioresource Technology, 243, 1251-1256, doi.org/10.1016/j.biortech.2017.07.130
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