# PhD School on Agriculture, Environment and Bioenergy

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

***(XXXVII cycle, 2021-24)***

## Project draft

**1.Field of interest**

*Indicare **il/i** settore/i scientifico disciplinari:* **AGR/09**

**2.Project title**

**Sustainable production of innovative biofuels in agriculture**

**3.Tutor** (membro del Collegio dei Docenti): **Marco Fiala**

**- Eventually: co-tutor/s Dr. Mattia Ferrari (AdR)**

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

The agricultural sector, in all world scenarios, is an indispensable link for the implementation of the biomass-to-energy supply chain. The role of farmers can be twofold, both as producers of raw material (biomass) as well as producers of energy.

The essential objective of environmental sustainability - recently evolved towards the concept of a "circular cycles production" - has now definitively identified the residual/waste biomass, the only materials that can be used in the realization of these supply chains.

This assumption - in addition to providing precise indications on the ethical priority of agricultural production (food and feed) - is (even if slowly) also directing the legislation and technological aspects related to the generation of energy from biomass.

In this context, still very dynamic and still looking for the right balance between profitability and sustainability - the study and transfer of complete profitable chains able to provide alternative energy products compared to those generated by the use of sources fossils, (biofuels, such as biomethane, biodiesel and biohydrogen) is still partly unfinished and is likely to make great progress.

Based on the huge experience gained in the recent past on the application of biomass-to-energy technologies in Italian and European farms (with particular reference to anaerobic digestion, combustion and gasification), it is now necessary to revisit the overall design, identifying integrated solutions, perfectly suited to the specific operating contexts and able to correlate - with a view to overall sustainability - the segments of: (i) production and management of residual raw materials (agronomic phase), (ii) transformation into energy product (plant phase) and its (iii) final destination (delivery phase).

**5. Layout of the project (draft)**

**5.1. Materials & Methods:**

The project presents the following main logical steps:

1. Bibliographic analysis and identification of innovative and potentially most promising biomass-to-energy supply chains with a view to overall sustainability and circularity of the biofuels production, with reference to the farm and current legislation/regulations.
2. study and identification of the technological solutions applicable in the three fundamental phases of the chain (agronomic, plant engineering, energy delivery). Identification - with the involvement of stakeholders (associations, confederations,

institutions) - of the set of parameters on the basis of which to formulate the biofuels production-chain sustainability;

3. experimental data collection (mechanical, energy, economic, environmental parameters) related to different solutions implemented in representative operating contexts (Case Studies). Organization and processing of the collected data, evaluation of the results also by means of modelling tools;
4. interpretation and discussion of the results. Generalization of the analytical approach with the development of a decision support system (DSS) usable within the farm and by sector operators (technicians, public decision-makers).

**5.2. Schedule and major steps (3 years):**

With reference to the structural design shown at the previous point:

**1 year** - Implementation point 1, point 2. Scientific products: n.1 review paper

**2 year** - Implementation point 3. Scientific products: n.2 scientific papers

**3 year** - Implementation point 3, point 4. Scientific products: Ph.D. Thesis, n.2 scientific papers

## 6. Available funds (source and amount)

Marco Fiala, CTE_INT17RCONF_01F2, Ecophysiological modelling and life-cycle assesment as part of Barplus, 25210,00 €

## 7. Literature:


1. Safieddin Ardebili, S., Khademalrasoul, A. (2020), **An assessment of feasibility and potential of gaseous biofuel production from agricultural/animal wastes: a case study**. *Biomass Conv. Bioref.*. https://doi.org/10.1007/s13399-020-00901-z
2. **Biofuels from Agricultural Wastes and Byproducts, (**2010), Editors Hans P. Blaschek, Thaddeus C. Ezeji, Jürgen Scheffran, ISBN 9780813822716, https://doi.org/10.1002/9780813822716
3. Pattanaik, L. et Al., **Chapter 5 - Biofuels from agricultural wastes**, In: Basile A., Dalena F. (eds) *Second and Third Generation of Feedstocks*, Elsevier, 2019, ISBN 9780128151624, https://doi.org/10.1016/B978-0-12-815162-4.00005-7
4. Mehmood A. et Al., (2019), **16 - The use of crop residues for biofuel production**, In: Verma D., Fortunati E, Zhang X. (eds) *Biomass, Biopolymer-Based Materials and Bioenergy: Construction, Biomedical and Other Industrial Applications*, Elsevier**,** ISBN 978-0-08-102426-3, https://doi.org/10.1016/C2017-0-00839-X
5. Hirani A.H. et Al., (2018), **A Review on First- and Second-Generation Biofuel Productions**. In: Kumar A., Ogita S., Yau YY. (eds) Biofuels: Greenhouse Gas Mitigation and Global Warming. Springer, https://doi.org/10.1007/978-81-322-3763-1_8
6. Banerjee S., Kaushik S., Tomar R.S., (2019), **Global Scenario of Biofuel Production: Past, Present and Future**. In: Rastegari A., Yadav A., Gupta A. (eds) *Prospects of Renewable Bioprocessing in Future Energy Systems. Biofuel and Biorefinery Technologies*, vol 10. Springer, Cham. https://doi.org/10.1007/978-3-030-14463-0_18
7. Saowaluck Haosagul, Siriorn Boonyawanich, Nipon Pisutpaisal, (2019), **Biomethane Production from co-fermentation of agricultural wastes**, International Journal of Hydrogen

Energy, Volume 44, Issue 11, 5355-5364, ISSN 0360-3199, https://doi.org/10.1016/j.ijhydene.2018.09.080

8. Koonaphapdeelert S., Aggarangsi P., Moran J., (2019), **Biomethane: Production and Applications**, Springer Nature, 183 pages, ISBN 9811383073

9. Ilgi Karapinar Kapdan, Fikret Kargi, (2006), **Bio-hydrogen production from waste materials**, Enzyme and Microbial Technology, Volume 38, Issue 5, 569-582, ISSN 0141-0229, https://doi.org/10.1016/j.enzmictec.2005.09.015