PhD School on Agriculture, Environment and Bioenergy

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

(XXXVII cycle, 2021-24)

Project draft

1.Field of interest

AGR/01

2.Project title

Analysis of the economic and environmental benefits of Precision Viticulture. A case study from Montefalco Sagrantino DOCG.

3.Tutor (membro del Collegio dei Docenti)

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- **Co-tutor:** Stefano Corsi

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

During the twentieth century, the introduction of large-scale mechanization in the agricultural sector and the switch to capital-intensive farming enabled producers to manage larger fields (Finger et al., 2019). Moreover, genetically improved varieties and innovations in synthetic fertilizers and pesticides made it ideal for farmers to develop larger and uniformly managed fields. However, this came at the expense of an efficient control of spatial and temporal heterogeneity of farm fields (Finger et al., 2019). Furthermore, agriculture is now responsible for the consumption of 70% of fresh water worldwide (National Geographic, 2020), and world's food systems have been found to be responsible for more than a third (34%) of total greenhouse gas (GHG) emissions, with the largest contribution coming from agriculture and land use/land-use change activities (71%) (Crippa et al., 2021).

For these reasons, it is important that even the agricultural sector adopts new more sustainable instruments, while trying to not undermine productivity. One solution could come from the so-called precision agriculture (PA): it can be implemented by applying spatial information technologies to crop production (Griffin and Lowenberg-DeBoer, 2005). Some of these are the Global Positioning System (GPS), geographic information system (GIS), in-field and remote sensing, etc (Zhang et al., 2002). The data collected are then elaborated and used to optimise the use of resources in the management of fields.

Specifically for Italy, precision agriculture was applied to around only 1% of the total cultivated land (as of 2015), even though there are no accurate official statistics for more recent years. For this reason, we can also assume that PA applied to viticulture (that is, precision viticulture) is still largely unexploited in Italy. However, precision viticulture could help in cutting costs while preserving quality; it may then be interesting to study the impact of these new technologies from both an economic and an environmental perspective in the production of wine. It may also be useful to try to assess the level of readiness in embracing these emerging agricultural technologies. Consumers could also be taken into consideration, given the recent trends in their willingness to pay premium prices for products obtained through sustainable practices.

5.Layout of the project (draft)

5.1.Materials & Methods:

The main aim of this project is to assess the presence of benefits in applying precision agriculture techniques, in particular to viticulture, from an environmental and economic perspective. In particular, we will collaborate with the Arnaldo Caprai winery in Montefalco (PG), in central Italy, a renowned producer of Sagrantino DOCG wine. We would have access to the information pertaining the company's costs and their field management with the application of different precision technologies throughout production, during a time span of around 10 years. Eventually, we could also try to collaborate in a similar way with other wineries that are part of the "Consorzio Tutela Vini Montefalco" (like Arnaldo Caprai winery itself), in order to increase the sample of the research.
In order to carry out both an economic and environmental evaluation of the use of precision viticulture, we mainly have two options. On one hand we could implement an econometric model to measure the economic impact relatively to different precision technologies, while also taking into account both qualitative and climate variables related to wine production. On the other hand, we could use two distinct but similarly structured functions: one strictly related to costs, and another one strictly related to "environmental variables". In both cases the precision technologies used will always be taken into account, in order to see their effects from both an economic and an environmental point of view.
Regarding the second part of the project, the aim is to assess the so-called "readiness-level" of wine producers, specifically the ones part of the already mentioned "Consorzio Tutela Vini Montefalco", with respect to the adoption of precision technologies. Different types of assessment can be found in literature: one example is the Balance Readiness Level assessment (BRLa) developed by Vik et al. (2021). In their study, the authors conceive a five-dimensional readiness assessment by combining the concepts of i) TRL – technology readiness level; ii) MRL – market readiness level; iii) RRL – regulatory readiness level; iv) ARL – acceptance readiness level; and v) ORL – organisational readiness level. Each of these five different dimensions is then assessed on a 9-point scale through a questionnaire given to the evaluators (Vik et al., 2021).
In the case of this PhD project, it would be interesting to develop a model similar to that of Vik et al. (2021), but also taking into consideration the opinions of wine consumers about the employment of precision viticulture and their willingness to pay for a premium price for products obtained through the use of such technologies.

5.2.Schedule and major steps (3 years):

- **Year 1:** The first 6 months will be spent conducting the literature review and following specific courses that will enable me to understand and develop a specific econometric model for the research. The next 3 months will be spent at the Arnaldo Caprai winery, where I will start collecting the necessary data. During the last month at the winery, and for the following 3 months, I will start developing and assessing the econometric model for the project.
- **Year 2:** The main objective for the second year will be to start processing the data and testing the application of the economic and environmental model developed during the previous year. I will also start developing the "readiness model" for wine producers and a questionnaire for evaluating consumers' preferences, both related to the second part of the project.
  During the second part of this year, it could also be useful to spend a visiting period of around 6 months abroad, possibly in an institution where I could acquire additional useful knowledge for the assessment of my model.

- **Year 3:** During the third and last year, I will spend again 3 months at the Arnaldo Caprai winery, in order to complete the assessment and application of the econometric model. At the same time, I will also conduct the analysis pertaining to the "readiness assessment level" and consumers' preferences. After that, I will spend the last 4 or 3 months of the PhD course to complete writing the thesis and to rewrite the results in order to make them available and easily exploitable by the winery and other stakeholders involved in the project.

6. Available funds

Funding from Borsa PON "Ricerca e Innovazione". Annual amount: €16,350.00

7. Literature:

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