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ENVIRONMENTAL COMPETENCES FOR SUSTAINABLE GRAPE AND WINE PRODUCTION IN ITALY

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ABSTRACT

This paper illustrates what has been done within a European project aiming at the elaboration of an on-line training program for the stakeholders of the grapes and wines value chain. This paper focuses on the Italian situation, with recent data from different sources. The project has elaborated a list of 15 Areas of Competence (Attitudes, Knowledge, and Skills), then submitted to evaluation by selected stakeholders, who have expressed their opinions and added some comments. The improvement of the human resources involved in all steps of the value chain is considered necessary, to face the challenges of the climate change, that will include both long-term and short-term innovations. The 15 Areas of Competence have been then grouped into four modules. The construction of the on-line training program, including power point presentations, case studies, short video clips, further readings, and self-assessment tools is presently under way.

KEYWORDS: Green Deal, Lifelong Learning, Sustainable Development.

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1. INTRODUCTION

This paper has been developed within the framework of the “Green Vineyards” project, financed by the European Commission with contract no. 2021-1-ES01-KA220-VET-33311. The project has been elaborated, submitted, and is being implemented by a consortium of six partners, in five countries: the International University of the Rioja in Spain (Project Leader), the Institute for Research in Environment, Civil Engineering and Energy in Northern Macedonia, the Spanish Wine Federation in Spain, the Lake Constance Foundation in Germany, the French Wine and Vine Institute in France and the Centre for Agricultural and Rural Development in Italy.

The aim of the project, initiated in February 2022 with planned conclusion in July 2024, is to raise the competences, including knowledge, skills, and attitudes, of workers in all steps of the wine sector, to address the challenges posed by climate change [1] [2].

The project objectives are:

- a) To identify the environmental competences required by the workers to ensure a positive ecological footprint of the activities carried out.
- b) To identify common gaps in the workers' knowledge, attitudes, and skills, to better address their training necessities.
- c) To provide personalized training for wineries sector staff, according to the identified skills gaps and making the required training available 24/7.
- d) To facilitate access to training, creating a friendly and accessible on-line learning environment for all workers of wine sector.
- e) To raise awareness of climate change impact in the key sector of wine production.
- f) To improve the climate literacy of rural communities.
- g) To disseminate the expected outcomes to transmit the created knowledge all over Europe, making the knowledge and technology transfer from the wine sector to other agri-food sectors as smooth as possible.

Within the framework of the so-called Green Deal [3], all productive sectors and all citizen of the European Union must increase their awareness of the serious challenges posed by climate change, and they will act to reduce the impact of human actions. For the agricultural sector, as clearly indicated by the “From Field to Fork” document [4], climate change is seriously affecting all crops and all forms of agriculture and animal productions, not only in Europe, but all over the world. In Italy, climate change determines various phenomena, affecting grape production in several aspects [5]. This situation requires that all human resources involved in the value chain become aware of the present and future challenges, modify their attitudes, increase their knowledge, and learn new skills.

For example, in Italy, the average air temperatures have increased by + 1.5 - 1.7 °C, compared to previous decades. Autumns and winters are milder and humid, but less rainy, with less or zero snowfalls on the mountains. For the vineyards, this determines shorter dormancy or even its disappearance. At root level, during the winter, there should be at least 90-110 days of temperature <1°C, and this lack of dormancy causes lower fertility and consequently fewer flowers and fruits.

Precipitations are more intense and violent: the so-called “water bombs” may happen throughout the year, destroy field crops and orchards, cause water floods and landslides, with huge damages also to civil infrastructures.

Hotter and very dry summers, accompanied by a minor availability of irrigation water, make less productive and even unfeasible all water demanding spring and summer crops. The natural pastures produce less grass and all grazing animals, from sheep to bovines, have a lower productivity. In Italy, vineyards were never irrigated, but this new climate makes necessary a careful canopy management. Nowadays some producers and technicians begin talking about the introduction of drip irrigation.

Every year, new and / or more fungi and insects are recorded, such as the cochineal, which “stings” the green parts of the vines, and consequently determines the appearance of the sooty mold, a fungus.

All producers, of all types of value chains, are obliged to adapt their production systems to the challenges posed by the various aspects of climate change. For the wine industry [6] [7], actions are first required open air in the vineyards, where the grapes are produced, and then in the indoor cellars, where the grapes are processed, and the wines are then blended, aged, bottled, and marketed.

In the meantime, since all intensive forms of agriculture and animal productions contribute to environmental degradation, also the wine industry, like all other value chains, is invited to reduce its potential pollution and to contribute to mitigate the causes of climate change, in the fields, as well as in the cellars, as it will be explained in the next paragraphs.

Adaptation and mitigation are two sides of the same coin: they are strongly intermingled, and all likely measures should be implemented [8], in a coherent way, by permanently educated workers, from the rich landlords to the seasonal farmhands, from the farm manager to the sommelier in the wineries.

2. Viticulture and Wine Processing In Italy

Viticulture and wine processing represent one the most important value chain of the Italian agro industry (Table 1). At the same time, the environmental and aesthetic values are equally important, for soil protection, biodiversity, and tourism. Consequently, its short-term and long evolution is a matter of national relevance.

Table 1 – Basic data about the wine sector in Italy

Farmers with vineyard, no.	310,000
Total area, ha	674,000
Simple average, ha	2.1
Wine makers, no.	46,000
----- out of which, with “industrial size”, no.	1,800
Wines with Geographic Indications (GI), no.	526
Share of GI wines on total wine, %	55
Export, million euro	6,300
Share of export on total wine, %	43
Organic grape producers, no.	19,600
Organic grape and wine producers, no.	5,600
Organic wine producers, no.	1,307

Today, 310,000 farms are producing grapes for wine production, scattered all over the country. The total area is about 674,000 hectares, meaning an average of only 2.1 hectares per farm. This

arithmetic average hides a dichotomic distribution, with relatively few large and very large capitalist holdings, and a high number of small and very small producers, quite often part-timers.

This dichotomy impacts on the type of workers, employees, and managers. In the capitalist holdings, most workers are farm hands, with labour peaks during the pruning and harvest seasons, while a small number are permanent, with open ended contracts. This second group includes the field managers, and the people in charge of grape processing and marketing, who normally have good education, and might be fluent in foreign languages. In the family run families, most labor is provided by family members, relatives living nearby, and a few seasonal workers for the harvest of grapes; the educational level is generally low, and much labour is provided by recent immigrants from foreign countries, without any experience with grape growing.

This dichotomy also impacts on the second part of the value chain, because most smallholders do not have the facilities for wine making and supply with their grapes a processing cooperative or a profit-oriented processing firm. In some cases, several wine making cooperatives join for marketing in Italy and abroad.

The large capitalist farms, on the contrary, have their own winery, where they process their grapes, age the wines in silos, barrels and bariques and then bottle in different formats, for the domestic and foreign markets. In 2020, 106 large cooperatives and profit-oriented firms controlled 60% of the entire output value.

In the middle, we observe the appearance of medium size farms and wineries, with a 10 – 20-hectare size, which are setting up their own small winery and bottling plant. This category of producers is normally well educated, employs only one or two farm hands. Components of this group try to have their niche markets, with attractive marketing and other measures (agro tourism, for example) to differentiate their wines.

Other interesting data: there are about 46,000 wine makers, but only about 1,800 are considered “industrial firms”, with 13,000 employees. 55% of the Italian wine has a Geographical Indication (526 wines have a GI label). 43% of Italian wine is exported. The export has reached 6,300 million euro, while the import values less than 300 million.

Organic farming is the most advanced form of “greening”, and it represents nowadays about 107,00 hectares, 19,000 producers of grapes, 5,000 who are both producers and winemakers, and 1,307 operators who are only wine makers.

3. Greening the grape production in the field and the wine processing in the wineries

The entire grapes-wines value chain is stressed by the various aspects of climate change, with specific references to milder winters, extremely hot summers, and reduced water availability, erratic and violent rains. Several negative consequences have been reported, like for example water stress, sunburned or completely dried bunches, grapes poor in water and too rich in sugar, fewer aromas, too much alcohol, and consequent unstable musts. Private operators, as well as Research Centers

and Governments, are at work, to make grape and wine production more sustainable [9] [10] [11] [12].

On the other hand, there is no blanket recommendation that could be applied in all cases. Ecological and varietal variables are of enormous importance. The location of the vineyards (plains, hills, and mountains, proximity to lakes or seas, South / North orientation) plays a very important role. The quality of the soils, in their physical and chemical aspects, has a great relevance.

The producers have a wide range of possible actions, which have different impacts and different costs. Some changes can be classified as long-term innovations, which might require heavy investments, whereas other innovations are relatively cheap and only require some light and easy modifications [13] [14].

Large capitalist wine makers, capable of important investments, are “moving” their vineyards upwards. The richest companies purchase already existing vineyards and / or barren fields, where to plant new vineyards, on higher altitudes. For example, in Piedmont, North-western Italy, white grapes like Chardonnay and Pinot have been planted at 800 meters above sea level, from the traditional 250.

Another interesting phenomenon is the search for cooler areas, with lesser solar exposition. On the hills of Central Italy, like in Tuscany or Umbria, the vineyards on slopes oriented towards North are nowadays more appreciated and have higher values than those looking south. Twenty years ago, it was exactly the opposite.

Vineyards are rejuvenated with new varieties and / or new graft holders, selected for drought resistance. Lower plant density is experimented, 5 - 8 thousand plants per hectare, instead of 9,000 as usually done, to reduce the water stress.

New training systems of the vines, with careful pruning, are being experimented, to calibrate the number of leaves.

The richest farmers and / or cooperatives and associations also invest in high tech innovations, like drones, meteorological stations and sensors, and then develop, with the assistance of qualified advisors, site specific algorithms for the management of irrigation, and for other treatments against pests.

Water saving drip irrigation systems are put on place, to support the vineyards through the hottest months, if there is enough water and if the specifications for the Geographical Indications allow it. In all cases, much attention is paid to avoid that the roots do not remain too superficial.

The control of competing grasses, that could subtract water from the vines, is now performed with lighter and more “intelligent” mechanical means, while useful plants are sown, like for example several types of Leguminosae (trifolium, for example) and other herbs, possibly from local seeds.

Farmers looking for higher level of neutrality are experimenting the introduction of free ranging animals, like geese and sheep, until the leaves appear, to eliminate the competing grasses and enrich the soil with their droppings. These animals are then sold and this income - although relatively small - increases the farm income.

In recent years, an increased use of bio stimulants – allowed by the EU regulations, has been observed, to reduce or eliminate the use of chemicals, for defending the vineyards against parasites like mildew and powdery mildew.

To reduce the energy impact of the grape production, the most advanced and large producers are replacing their machinery with new generation E4 and E5 tractors that are lighter and have lesser consumptions of fuels.

On the other side of the spectrum, some producers, either organic or conventional ones, have re-introduced animal traction for the operations in the vineyards. Horses and mules are used in areas with steep slopes and narrow paths, where tractors could be too dangerous to operate, and the manure is then used as fertilizer. Secondly, these animals represent a powerful image for the marketing strategy of the wines.

The last component of the adaptation strategies of the farmers relies on an early, careful, and manual harvest that in most cases has been anticipated by one month and more. This attention towards the selection of the best bunches requires a proper planning to ensure the presence of the best workers, who are becoming very difficult to find. In some cases, farmers must rely on service providers, like labor cooperatives and private firms, and are consequently obliged to accept unskilled and inexperienced temporary personnel, who need to be rapidly trained about the type of bunches to be harvested. All these aspects clearly increase the stress and the costs for a good harvest [15].

At the harvest, the grapes often have an adequate technological maturity, in terms of acidity and sugars, but a more focused analysis of the polyphenols (anthocyanins for color and tannins for structure) reveals a delay.

Small and medium size producers, wishing to pursue the highest quality for their wines, are introducing post-esteeming sorting tables, manual or with optical reader, to discard the bunches of lesser qualities, which are then processed separately.

In presence of high levels of sugar, yeasts suitable for carrying on the fermentation are selected, and in some cases the tanks are open to let the excess alcohol evaporating in the air.

Another step, possible for those producers with a strong financial situation, is the building of underground cellars, either using the natural slopes within the farm, or realizing artificial hills, that shelter the cellars from the hot rays in the summer months.

There is also the shift towards lighter bottles, with thinner glass, that require less energy and inputs to be produced. High quality new corks are becoming less frequent, being replaced by corks made with recycled cork powder, sugar cane and by crown caps. Simultaneously, there is a trend towards corks made with recycled plastic that can be recycled again and again.

There is a growing attention towards the use of low impact packaging and media. The labels on the bottle and the printed information media for consumers, like leaflets and booklets, are made with recycled paper, while the boxes for two, three and six bottles are made with recycled cardboard.

Several studies and recent experiences focus on the utilization of by-products, which must be valorized, to reduce wastes, to avoid polluting effects on the surroundings of the farms, and to increase the income of the producers [16].

Other actions implemented by a growing number of wine producers regard the on-farm production of energy, with solar panels, small hydro plants and small windmills, and the recycling of water, especially in the cellars.

All these efforts can be formally recognized with a system of certifications that have been developed in the last years, by different bodies, both private and public ones (see Table 4). The criteria used by each certification body are different and this heterogeneity creates some confusion to the producers and consumers alike. The presence of the certification facilitates the positioning in some markets (Northern European countries) and some segments of consumers - organic and vegan ones, for example [17] [18].

4. The Italian best 100 sustainable wines

The Guide to “The best 100 wines and wine makers in Italy 2023” – How to drink well, pay a correct price, and find the producers looking for sustainability” has been recently published [19], where for each farm the reader finds a rapid description of the location, history, main wines, profile of the producer, and a box with a “green action”, implemented by the producers in the vineyards and / or in the winery. Much information in a small space, that can be systematized, to understand the trends taking place nowadays in this small group of leading producers, distributed all over Italy, from the Alps in the Northern part of the country to the Islands in the South.

Beginning with the greening of activities in the field (Table 2), the overall picture that emerges is a progressive abandonment of the intensive conventional approach, for a more natural way of production, with more attention to nature and biodiversity.

Table 2 – Greening the field (no.)

Organic management	37
Out of which, biodynamic	7
Integrated management	19
Soil fertility	14
Ancient varieties	7
PIWI varieties	1
Precision farming	4

Introduction of bees	3
Stone walls	3
Introduction of birds	2
Biodegradable ties	2
Horses in the vineyards	1
15% of farm area for biodiversity	1

It is not surprising that 37 farms have been already converted, or they are in the transition period, to organic farming. Out of them, seven producers are also certified by the biodynamic movement and have the Demeter logo. The adoption of the organic methods of production means a holistic approach that includes the choice of adapted varieties, the refusal of chemicals, higher attention to biodiversity, and so on. 19 Farmers are not yet organic, but they declare to have an “integrated approach” to the control of pests, and for the enhancement of soil fertility. The protection and improvement of soil fertility is declared by other 14 farmers, who use mixtures of seeds to produce grass as green manure, red worms, and other natural produces. Other green actions indicated by these producers include the retrieval of ancient varieties; the implementation of precision farming, also with drones and meteorological stations, the rehabilitation of stonewalls to favour biodiversity, the introduction of hives for bees and of nests for birds, the use of biodegradable ties, etc.

Moving to the wineries (Table 3), the most frequently indicated green action is the introduction of systems to produce energy, with solar cells, pellets, and fuel wood, and in one case a small waterfall. Four producers have moved their cellar underground or have expanded the underground space. A similar number has adopted lighter bottles. Only two have introduced systems for the depuration of water coming from the winery. Other actions include more ecological caps and capsules, the recycling of packages, while one producer declares to have a “plastic free” operation.

Table 3 – Greening the cellar (no.)

Production of energy	16
Lighter bottles	4
Bottle caps and capsules without metals	1
Bottle caps made with sugarcane fibres	1
Underground cellar	4
Depuration of water used in the winery	2
Recycling of packaging	1
Plastic free farm	1

A final reflection is due to the aspect of Certification (Table 4), that is a relevant tool for improving the management of the firm and can be also used as an instrument of marketing. 37 farmers have the organic certification that is also compulsory to receive the decoupled subsidy from the European Union Common Agricultural Policy. Seven have the voluntary Demeter certification too, that makes their wines attractive for the followers of the Anthroposophical movement. At large distance, there are other voluntary certifications, like VIVA, SOSTain, EQUALITAS, Biodiversity friends, FAIR&GREEN, ISO 14001, all of which assess the adoption of behaviors more ecology friendly. Two certifications (SA 8000 and that of Benefit Company) have an ethical value, without technical

contents, while the calculation of the water and carbon footprint is just the first step toward the implementation of proper water use and less polluting production systems.

Table 4 – Green certification (no.)

Organic	30
Organic - biodynamic	7
VIVA	4
SOStain	3
EQUALITAS	3
FAIR & GREEN	1
Biodiversity friend	3
ISO 14001	2
SA 8000 Ethical Certification	1
Benefit Company	1
Carbon Footprint	2
Water Footprint	1

5. The survey within the Project

During the initial phase of the Project, based on a desk research and individual contacts with various stakeholders, the consortium partners have elaborated 15 Competences (Table 5) considered to be the most appropriate for the sector.

These Competences have been evaluated and validated by a group of stakeholders, through an on-line questionnaire, with a scale from 1 to 5, where the value 1 was ‘Not important’ and 5 was ‘Critical’. The individual responses were then elaborated into a group average.

In the questionnaire, there were also two open questions, where respondents were invited to indicate their comments and suggestions about the 15 Areas of Competence, and if they had other suggestions about best practices in the implementation of green Competences.

The Italian partner CESAR – Center for Agricultural and Rural Development has initially contacted, by e-mail and telephone, more than 40 potential participants in the survey, to verify their willingness to cooperate. After this initial screening, CESAR has sent the questionnaires, in Italian language, to 30 selected stakeholders involved in the wine sector, with an introductory letter and the link to the survey. In a second time, the non-respondents have been contacted again, to stimulate their reply.

Table 5 - Green competences for grapes and wines production in Italy

Rank	Competences	Score
1	4. Water management: To make efficient use of the resource, by reducing the water footprint and protecting its quality.	4,654
2	5. Soil management: To support the proper use and management of agricultural soils and implement measures to prevent their loss.	4,577
3	9. Biodiversity: To have a broad understanding of agricultural ecosystems in order to protect them and build resilience to current and future threats.	4,462

4	2. Climate change adaptation: To take action to prepare for and adapt to a changing climate.	4,423
5	7. Waste management: To understand the circular economy process and to apply the waste hierarchy: reduce, reuse, recycle, recover, and dispose of waste.	4,385
6	11. Sustainable wine production: To identify sustainable wine production practices and implements strategies to achieve it.	4,360
7	1. Climate change awareness: To understand the causes of climate change and reflect on its impacts in the wine sector and vice versa.	4,346
8	8. Emissions reduction: To understand the sources and impact of emissions, while implementing energy-efficient solutions to reduce the carbon footprint.	4,346
9	10. Local & historical knowledge: To acknowledge the historical importance of wine culture and its benefits for the local environment, society, and the economy.	4,346
10	3. Valuing sustainability: To reflect on personal values; identify and explain how values vary among people and over time, while critically evaluating how they align with sustainability values.	4,308
11	6. Energy efficiency: To have a broad understanding of the efficient use of energy, different energy sources and their impact on the climate.	4,250
12	13. Futures literacy: To envision alternative sustainable futures by imagining and developing alternative scenarios and identifying the steps needed to achieve a preferred sustainable future.	4,154
13	15. Problem framing: To formulate current or potential challenges as a sustainability problem in terms of difficulty, people involved, time and geographical scope, to identify suitable approaches for anticipating and preventing problems, and to mitigating and adapting to already existing problems.	4,154
14	12. Critical thinking: To assess information and arguments, identify assumptions, challenge the status quo, and reflect on how personal, social, and cultural backgrounds influence thinking and conclusions.	4,077
15	14. Systems thinking: To approach a sustainability problem from all sides; to consider time, space, and context to understand how elements interact within and between systems.	3,962

By the end of the survey, on 30th November 2022, CESAR had received 26 answers; one above the target of 25 respondents set by UNIR, the Partner responsible for this phase of the Project.

Concerning the place of work, several respondents are active in two or three components of the value chain. For this reason, the total of the various percentages exceeds 100. 58% are active in a winery, while 46% are engaged in the vineyards. Another 23 % work in Academia, mainly universities and vocational training centers. 3% of the respondents belong to the category “other” (Farm manager, Sales Agent, President of Cooperative).

The respondents have an average of 23, 6 years of experience in the sector, ranging from one year to fifty.

Table 5 contains the results of the survey, with the final average score obtained by each one of the 15 Areas of Competence individuated by the project.

It can be observed that all Areas of Competence receive very high values, with only competence 14 “System thinking” receiving an average score of 3.962. The technical competences “Water management” and “Soil management” receive the highest scores, respectively 4.654 and 4.577.

The respondents also had the opportunity to provide their views on the competences included in the survey. Five respondents did not indicate anything, while the other comments have been as follows:

- Networking,
- Change the mentality of the consumers,
- Being able to modify own behavior, better understanding of the historical and territorial context,
- Energy management,
- Knowledge about biodynamic agriculture,
- More training,
- More advice about agronomic management of the vineyards,
- Grouping with other firms to be more competitive,
- Capacity to analyze what is happening, to take appropriate counter measures,
- Adequate education,
- Evaluate sustainability also from the economic and social point of view,
- Microbiological life in the soils,
- Vocational training,
- Better knowledge of ecological indicators for a better evaluation of climate change,
- Better education, with a focus on climatology,
- Skills to use high tech machines and tools,
- Better communication toward the consumers, to get their support for solving environmental problems,
- Winemaking should consider two major commercial aspects that allow the various wineries to operate according to the needs of the wine loving people: produce local traditional wines to keep the roots alive, do not copy and paste wine types, remain authentically and clearly identifiable. 2 - Produce wines for the market; explore your capabilities of penetrating markets before challenging yourself and all your structure without any guarantee of success. Planning is paramount when it comes to winemaking - the time for trials and exploring is over.

It can be observed that the quality of human resources has been mentioned several times, under different names and points of view: better education, better training, more advice, etc. whereas a second group of respondents indicates the need for better communication towards the consumers, whose support is necessary for a sustainable system.

The 15 Areas of Competence have been then grouped in four Modules:

- Overall knowledge about climate change that includes Climate change awareness and Climate change adaptation.

- Environmental management focused on climate change, that includes Water management, Soil management, Biodiversity, Waste management, Emissions reduction, Energy efficiency.
- Wine culture and society from a climate change perspective, that includes Local and historical knowledge and Sustainable production.
- Green comp competences relevant to the sector, that includes Valuing sustainability, Systems thinking, Critical thinking, Problem framing, and Futures literacy.

The Project partners are now developing the contents of all Competences, that will include power-point presentations, case studies, video clips, further readings, lists of websites, and self-assessment tools, in English and in the national languages of the partners (Spanish, Italian, French, German and Macedonian). By the conclusion of the Project, next July 2024, all these modules will be open on-line and accessible worldwide to all interested stakeholders at the website: <https://greenvineyards.eu/>.

6. Conclusions

The challenges posed by the climate change to grape and wine production in Italy, in terms of both adaptation and mitigation, are multiple and complex. They can be faced with a variety of technical innovations and organizational modifications, in the open fields as well as in the wineries, but their successful implementation requires conscious, well-trained, and continuously updated human resources.

Technical schools and universities are producing the future generations of workers, for all layers of the many stakeholders of the grapes – wines value chain, but internet already provides a powerful tool for reaching people already at work, scattered in the countryside, sometimes in remote areas, who could find difficult and even impossible, to attend training programs in presence. Distant learning, provided with appropriate language and with easy to manage programs, can facilitate the acquisition of new information, the modification of attitudes, and the improvement of skills.

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Author Profile

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Fabio M. Santucci graduated in agriculture with majors in economics and policy at the University of Perugia in 1978 and then specialized in agricultural extension and farm management. After five years at the Agricultural Studies Center “Borgo a Mozzano”, he was researcher and then associate professor at the Universities of Ancona and Perugia, both in Italy. Throughout his career, he has been active in Italy and in developing countries, with missions and consultancies for Italian NGOs, FAO, CIHEAM, European Union, and the World Bank. Retired from the University in 2019, collaborates with CESAR and other entities.