



Atti del XXIII Convegno Nazionale di Agrometeorologia

Agricoltura 4.0 e cambiamento climatico: il ruolo dell'Agrometeorologia

On-line 30 giugno – 2 luglio 2021

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ISBN 9788854970564

DOI <http://doi.org/10.6092/unibo/amsacta/6713>

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Bologna, 2021



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PERCEZIONE DEI RISCHI CLIMATICI DA PARTE DEI VITI-VINICOLTORI ITALIANI E LORO LIVELLO DI ADATTAMENTO AL CAMBIAMENTO CLIMATICO

PERCEPTION OF CLIMATE RISKS BY THE ITALIAN WINEGROWERS AND WINE MAKERS AND THEIR LEVEL OF ADAPTATION TO CLIMATE CHANGE

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Abstract

This study reports the results of a survey disseminated to Italian winegrowers and wine makers to understand their perception of the main climate risks on grape and wine productions and their willingness to take action in facing the related problems. A general noticeable concern about the future effects of climate change and variability has emerged, even with some differences between stakeholders operating in different geographic and climatic areas. Current signals of adaptation have emerged, as some are switching from traditional to pest and drought resistant varieties, to water-saving irrigation methods, environmentally friendly and climate-smart cultural practices.

Parole chiave

cambiamento climatico, vite, adattamento, sondaggio.

Keywords

Climate Change, grapevine, adaptation, survey.

Introduction

According to OIV, Italian vineyards produced in the latest decade on average 17% of the entire world wine production, providing livelihoods to over 200.000 farmers and wine industry workers.

The wine sector is particularly exposed to climate changes (Santos *et al.*, 2020) and it is already called to implement strategies to deal with the future potential impact on productions. However, the sector is pegged at very old traditions and a major effort is needed for its adaptation to the increasing difficulties imposed by a changing environment (Santillán *et al.*, 2019; Fraga *et al.*, 2013).

The impacts of climate changes (CCs) are expected to be heterogeneous across vine varieties and regions (Jones *et al.*, 2005). The Italian grapevine cultivation area is expected to change further in the next century, being the Mediterranean region a climate “hot spot” (Fraga *et al.*, 2013). The temperature is expected to increase even more than in other world regions, leading to conditions that might turn out too warm for the production of specific PDO wines (Jones *et al.*, 2005). Several model simulations witness the interest in this prognostic exercise concerning the Mediterranean and particularly Italy (Malheiro *et al.*, 2010; Moriondo *et al.*, 2013; Eccel *et al.*, 2016; Alikadić *et al.*, 2019). Thanks to the economic importance and to the historical tradition, the wine sector, more than other agricultural ones, has always been characterized by a strong capacity of autonomous adaptation, due to the high attention

of winegrowers to the environment and, specifically, to climate (Battaglini *et al.*, 2009). This makes winegrowers and wine makers valuable allies in verifying the extent of CC impacts, either predicted or already occurring.

For this purpose, under the MEDCLIV project, a survey was disseminated to both winegrowers and wine producers in the Mediterranean, to get a feedback of the perceived risks due to CC and to investigate their willingness to take action in facing the problems. This work analyses the results of the Italian answers to the survey and aims to assess the priorities of the wine sector in the different national viticultural areas.

Methodology

The national dissemination of the survey lasted from May to November 2020 and was extended to all Italian regions. The questionnaire was submitted online via a platform managed by IBE – CNR. After common general questions (gender, age, region of production, farm altitude), participants complied different parts for winegrowing or wine making categories.

The questionnaire consisted of multiple-choice questions. Winegrowers were asked on vineyard size, type of viticulture (conventional, integrated, organic and biodynamic), choice of varieties, water resources and irrigation, pest and disease management, cultivation techniques, and insurance underwriting. For some

questions, farmers were allowed to choose more than one answer (i.e. vineyard management techniques, choice of varieties, irrigation method, cultivation techniques). This explains percentages higher than 100% for some answers.

The questionnaire for winery owners included questions on winery property (uni-personal owned winery, cooperative or non-cooperative winery), wine production and change in quality in terms of pH, alcoholic content and aromatic profile. The final questions, posed to both, addressed long-term concerns and perceptions of the impact of climate change, now and in the future.

Responses were grouped within three main Wine Growing Zones (WGZs) as identified in Appendix I, Council Regulation (EC) No. 1308/2013: CI (Trentino-Alto Adige, Valle d'Aosta), CII (Abruzzo, Campania, Emilia Romagna, Friuli Venezia Giulia, Lazio, Liguria, Lombardia, Marche, Molise, Piemonte, Toscana, Umbria, Veneto) CIII (Basilicata, Calabria, Puglia, Sardegna, Sicilia). Such classification takes into account differences in terms of climatic conditions and of some physiological aspects, such as the required grape maturity at harvest and the levels of sugar reached.

Multiple-choice responses were processed with R software, applying ANOVA to find out significant differences in relative frequencies and Pearson's chi-square test to point out association between answers.

Results and discussion

Participant profiles

The respondents were 442, 364 of which fully completed the questionnaire (71.7% male, 21.4% female) (tab 1). Ages were mainly distributed within the range of 30-45 years old (32.7%) and 46 – 60 years old (46.2%). The highest number of responses came from farms below 400 m a.s.l., 40.7% from the plain and 45.9% from the hills; 75.5% of respondents were both winegrowers and wine producers.

The highest percentage of answers (76.6%) came from the zone CII, which includes the largest number of Italian regions (12), while 16.5% were from zone CIII (5 regions) and 6.9 % from CI, including only 2 regions.

The vineyard extensions were equally divided among 4 size classes (1-5 ha; 6-10 ha; 11-25 ha and > 25 ha), at around 20%; while only 1,8% of participants declared a size less than 1 ha. 47.7% of participants were primarily doing organic or biodynamic viticulture, 43.3% integrated, and 21.9% conventional.

Most of the wineries were uni-personal owned (79.7%), 12% cooperative and only 6.8% non-cooperative. Almost half of participants (42.6%) produced among 100 and 1000 hl/year, 28.7% among 1000 and 10000 hl/year while 13.2% were big producers with more than 10000 hl/year. The remainder produced less than 100 hl/year.

Varietal choice

Winegrowers were questioned if they had introduced new varieties in the last years in their vineyards, and, if so, which criteria drove the choice (pest resistance, drought

resistance, cold tolerance, late ripening, early ripening, market demand). It is well known that the introduction of well-adapted genotypes is a strategic tool for both adaptation and mitigation, as it leads to minimize chemical and agronomic inputs and water use (Van Leeuwen and Destrac-Irvine, 2017).

Tab. 1. Profilo dei partecipanti

Tab. 1. Profile of participants

<i>Gender</i>	<i>%</i>
Man	71.7
Female	21.4
No reply	6.9
<i>Age</i>	
< 30	4.7
30 - 45	32.7
46 - 60	46.2
> 60	16.5
<i>Farm altitude</i>	
0-200 m	40.7
200-400 m	45.9
400-900 m	12.6
> 900 m	0.8
<i>Wine growing Zone (WGZ)</i>	
ZONE CI	6.9
ZONE CII	76.6
ZONE CIII	16.5
<i>Typology</i>	
vineyard owner	18.6
winery owner	6.0
both	75.3

In all the investigated zones more than half of the farmers has introduced, or plan to do it soon, new varieties, without significant differences between the three WGZs ($p = 0.6826$). The market demand was the main criteria guiding the choice of new varieties for all zones (61.5%, 46.8% and 50.0% for CI, CII and CIII, respectively). Data collected clearly indicated a prevalence in the choice of drought-resistant varieties in the southern areas, with 32,4% of winegrowers in zone CIII opting for this choice. A considerable percentage of farmers has chosen pest-resistant varieties in zone CII (28.8%), while much fewer did in zones CIII (23.5%) and CI (23.1 %). As expected, late ripening varieties were preferred in the southern areas (11.8% in CIII), while early ripening varieties were the main choice in the northern areas (15.4% in CI).

Access to water and irrigation

This part of the survey was dedicated to collect information on water use in the field: growers were asked if they had access to any water resources near or in the perimeter of their vineyards and, if so, whether irrigation was in place or not.

In chi-square test, significant differences between WGZs emerged both for water access ($p = 3.158e^{-07}$) and use of irrigation ($p = 0.0007231$). Zone CI mostly had total access to water and use of irrigation (94.8%). In CII only 60% of winegrowers had water access and, between them, 58% used water to irrigate. In zone CIII, despite a high access to water (74.6%), only half of those having access to water had irrigation on site. In all WGZs, only a small number of winegrowers considered the option to have, implement or modify the irrigation system in the future, even if some of them had water access.

Drip irrigation was the most used irrigation method in all WGZs, indicating a high willingness to efficiently use water. In zones CI and CII, a percentage of sprinkler irrigation is still persisting (11.1% and 16.1%, respectively), while surface (less than 6%) and flood irrigation types (2.2%) are negligible.

Pests and diseases

A list of the most common pests and diseases for viticulture in the Mediterranean as in EIP-AGRI (2019) was presented to winegrowers who were asked to rate each of them on a scale 1-5, where 1 corresponded to “no damage”, 2 to “low damage”, 3 to “medium damage”, 4 to “high damage” and 5 to “greatest damage”.

The results showed that damages caused by vine pests and diseases are currently low, never reaching level 3. However, in the analysis of variance, significant differences ($p < 0.0001$) were found between pathogens. Powdery mildew (*Erysiphe necator*) was the most damaging pest, followed by Downy mildew (*Plasmopara viticola*) and Grapevine trunk diseases. For all other pests and diseases in the list, a very low level of damage (< 2) was found.

When analyzed by WGZs, flavescence dorée (*Candidatus Phytoplasma vitis*) mainly affected zone CII; while grapevine trunk diseases was considered more harmful in zone CI and CII ($p < 0.001$), as well as grey mould (*Botrytis cinerea*) ($p < 0.05$).

Cultivation techniques

Winegrowers were asked to indicate, among a list of cultural practices, those currently applied versus those applied in the past. The cultural practices listed (thinning, use of antitranspirants, green pruning, leaf removal practices, row cover cropping, late shoot topping) have been recognized as capable to improve resilience in agriculture (van Leeuwen and Destrac-Irvine, 2017; Paliotti, *et al.*, 2013).

A general positive increase in the adoption of climate-smart cultivation techniques was recorded throughout Italy.

No significant differences emerged between WGZs in the current cultivation techniques ($p = 0.2401$): in all WGZs green pruning resulted one of the most used practices (89.5% in CI and CIII and 79.3% in CII), while row cover cropping was mostly used in CI (94.7%) and CII (77%), and less in CIII (45.6%). Late shoot topping and leaf removal practices were also highly exploited by farmers, especially

with respect to the past. These two techniques are obtaining a growing attention by winegrowers because, compared to the past, they are now more carefully modulated, allowing a slower ripening, with lower levels of sugars and a more marked acidity (Petrie *et al.*, 2003). The use of anti-transpirants was mainly adopted in zone CI, where 15.8% of the interviewed winegrowers confirmed its adoption, even if this technique could be particularly effective in the dry areas. In fact anti-transpirants reduce transpiration by forming a film that limits moisture losses and are effective in reducing sugar accumulation without significantly affecting the accumulation of phenolic compounds (Paliotti *et al.*, 2013).

Insurance

The survey asked winegrowers to indicate if they had any sort of insurance policies and, in case, which one among a list (hail, late frost, wind, excessive rainfall/flooding, drought, wild animals, pluri-coverage/multi risk). Although, with respect to the past, a significant increase in insurance coverage was recorded especially in CI and CII ($p < 0.05$), more than half (54%) of the interviewed winegrowers do not currently have any forms of insurance policies.

No significant differences emerged between WGZs in the kind of policies in use ($p = 0.4975$) between the claimed ones; insurance against hail damage, although decreasing with respect to the past, is still the most commonly present. The occurrence of insurances for excessive rainfall, drought, wild animals and multi risk increased in CI when compared to the past, while late frost insurance decreased slightly. CII showed a general increment of all types of insurances, with a major underwriting for wind and late frost policies. Current insurances for wind, wild animals and multi risk increased in zone CIII while insurance for late frost and flooding decreased. Drought insurance in CII remained unchanged.

Use of insurance policies is highly recommended by EU Common Agricultural Policies (CAP), as they are considered a valuable tool for fostering agricultural resilience and adaptation to climate change (Iglesias and Garrote, 2015). Our results underline an inadequate use of insurance policies in Italy, a lack that should be remedied by setting up appropriate national policies to encourage their use.

Wine quality

Warmer conditions, modifications in rainfall patterns, increase in temperatures, drought and incoming radiations influence plant development and physiology, including grape composition. More sugar, less organic acids, increase in phenolic content are all expected modification as a consequence of CC, with potential effects on wine quality and typicality (Van Leeuwen and Destrac-Irvine, 2017).

Table 2 reports the results of information collected from wineries about the perceived changes in some wine characteristics (increase of pH and alcoholic content and changes in the aromatic profile). In chi-square test no

significant differences in the increase of pH emerged between the WGZs ($p = 0.1007$), even if, when comparing zones CI and CIII, the increase was significantly more noticeable in CI (52.9% against 27.1%) ($p=0.07419$).

On the contrary, significant differences emerged among the three WGZs both for alcoholic content ($p = 6.995e^{-07}$) and changes of aroma profiles ($p = 0.03953$) of the wine. CI and CII resulted more characterized by an increase in the wine alcoholic content (64.7% and 67.5% respectively) with respect to CIII (31.3%), while zone CII proves to be the most affected by changes in the wine aromatic profile (46.8%).

Tab. 2. Percezione dei cambiamenti nelle caratteristiche del vino da parte dei WGZ. I dati sono in percentuale. Le differenze statistiche sono determinate in base al test del chi quadrato ($P > 0,05$)

Tab. 2. Perception of changes in wine characteristics by WGZs. Data are in percentages. Statistical differences are determined according to Chi-squared test ($P > 0.05$)

Wine quality	WGZ	CI	CII	CIII
pH	No	41.2	40.3	56.3
	Yes	52.9	44.2	27.1
	Not known	5.9	15.6	16.7
	p-value = 0.1007			
Alcohol	No	23.5	30.7	68.8
	Yes	64.7	67.5	31.3
	Not known	11.8	1.7	0.0
	p-value = $6.995e^{-07}$			
Aroma	No	76.5	45.5	62.5
	Yes	23.5	46.8	31.3
	Not known	0.0	7.8	6.3
	p-value = 0.03953			

Main future concerns

A list of potential problems related to the professional activity was posed both to winegrowers and wine producers. Respondents were questioned to rate their level of concern on a scale of 1 - 5 (1 “no concern”, 2 “low concern”, 3 “medium concern”, 4 “high concern” and 5 “greatest concern”). The list included economic and regulation issues (difficulties in finding skilled labour, reduction of public aid and increased regulation, economic crisis and decrease in wine demand, increased barriers to export) as well climate change related problems (reduction of profitability of grape and wine production, increased pests and diseases, water stress, climate change, reduction of quality and loss of typicality, unpredictable weather). The average values obtained for whole Italy are shown in table 3. Climate change, unpredictable weather, economic crisis and reduction of profitability of productions has been found to

be significantly greater concerns for the national wine sector. Conversely, the increasing barrier to export and the reduction of quality and loss of typicality have been found as the least worrisome concerns for the future among those proposed. Analyzing the average values per WGZs, no significant differences emerged, except for the concern linked to the difficulty in finding skilled labor, which is stronger in zone CIII than in CI and CII.

Climate Change

Respondents to the survey were finally asked to express their opinion about the effects that climate change currently has, and will have, on their activity. The Chi-squared test showed no significant differences between the WGZs in perception of effects of climate changes both in short term ($p = 0.1282$) and in long term ($p = 0.7921$).

Tab. 3. Valori medi delle preoccupazioni future (scala 1-5, 5 molto importanti) per l'Italia. Le differenze statistiche sono determinate in base all'ANOVA unidirezionale; i valori seguiti da lettere diverse sono significativamente differenti secondo il test di Tukey.

Tab. 3. Average values of future concerns (1-5 scale, 5 very important) for Italy. Statistical differences are determined according to one-way ANOVA; values followed by different letters are significantly different according to Tukey's test.

Future concerns	Average value
Climate change	3.70 a
Unpredictable weather	3.66 a
Economic crisis and decrease in wine demand	3.57 a
Reduction of profitability of grape and wine production	3.24 a
Reduction of public aid and increased regulation	3.19 bc
Increased pests and diseases	3.15 bc
Water stress	3.12 bc
Difficulty in finding skilled labour	3.05 bc
Increased barriers to export	2.94 c
Reduction of quality and loss of typicality	2.34 d
p-value	<0.0001

There is a general prevalence of a negative perception of short term effects of CCs in all WGZs. A more pronounced perception was noted for CII and CIII (60%), even if a high percentage of respondents still claims that CCs have no effect (31.6%, 21.9% and 29.4% for CI, CII and CIII respectively) or a positive effect (31.6%, 17.6% and 9.8% for CI, CII and CIII, respectively) on their activities.

In the long term, the percentage of respondents who believe that CCs will have no effect or a positive effect drop

drastically, registering a consequent increase of those believing that CCs will have a negative effect on their activities (94.7%, 88.0% and 90.2% for CI, CII and CIII respectively).

Conclusions

Although operating in different geographic and climatic areas, the perception and the concerns about the future effect of CCs on the Italian wine value chain actors did not show significant differences. The state-of-the-art identifies water scarcity as one of the greatest risks due to CC, especially for the southern areas. Our survey showed that currently, even if access to water is limited in some areas, the need for irrigation is not felt as an urgency yet. In fact in all the WGZs only a low percentage of winegrowers having water access has irrigation on site and only a small number declares to consider having, implementing or modifying the irrigation system in the future. Climate changes are also expected to modify the distribution and severity of pests and diseases. Current damages caused by pests and diseases are not high in Italy, and, accordingly, also a potential increase of pests and diseases yielded a medium-level future concern. In general, however, concerns related to climatic condition (climate change and unpredictable weather) have been found to be the main future worries for the Italian wine sector, in parallel to economic apprehensions (economic crisis and reduction of production profitability). Additionally, the negative effect of CC is already highly perceived by more than half of the farmers and wineries surveyed, but the long-term vision appeared definitely worse. In this study important signals of adaptation already in place emerged. A high percentage of farmers switched from traditional to pest and drought resistant varieties, although the choice of marketable varieties prevailed. Likewise, the prevalence of water-saving irrigation methods, such as drip irrigation or sub-surface irrigation, compared to the traditional one, is indicative of the farmers' commitment in water use efficiency. An evident implementation of cultural practices recognized as environment friendly and climate-smart, such as row cover cropping, late shoot topping, leaf removal, use of anti-transpirants, also emerged as an important sign of adaptation of the wine sector. The increase of the adoption of management practices that contribute to reducing sugar accumulation, reflects the wine producers' perception of a modification in wine characteristics, particularly regarding an increase of alcohol content and a change of the aromatic profile. Conversely, the risk associated with a scarce use of insurance as a tool for fostering adaptation to climate change, as revealed by the survey, should not be overlooked.

Acknowledgements

This study was carried out in the framework of project MEDCLIV, co-funded by EIT Climate-KIC.

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