IVES Technical Reviews vine & wine
https://doi.org/10.20870/IVES-TR.2023.7486

CCAF: a framework to manage climate change adaptation for the wine sector

António Graça[1], Mark Gishen[2]

[1]Sogrape Vinhos, S.A., 4430-852 Avintes, Portugal
[2] Gishen Consulting, Adelaide SA 5000 Australia

Due to the recently changing climate and the impacts from severe events (smoke taint, heatwaves, droughts, frost, hail and floods) there is an urgent need for effective tools to tackle multiple risks and ensure higher levels of resilience. The Climate Change Adaptation Framework (CCAF), comprises a 5-stage process to help make climate-smart choices when considering competing adaptation options for grape and wine production. By applying CCAF to two different situations in Australia and Portugal, we demonstrate its potential for best practice in adaptation planning.

The framework

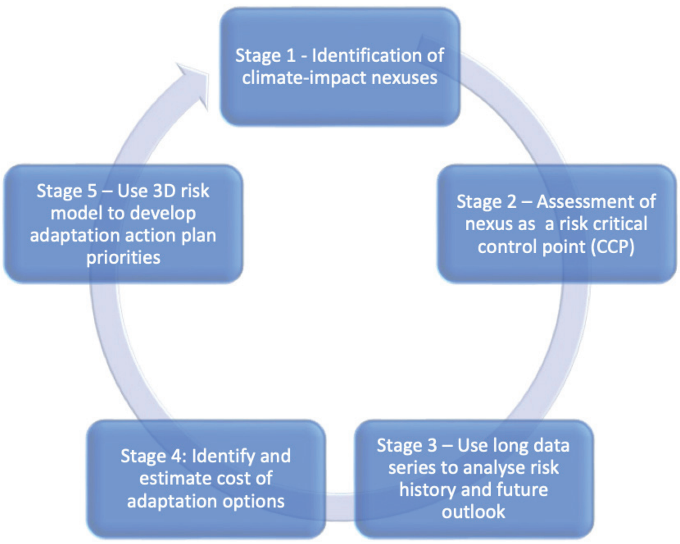

FIGURE 1. The 5 stages of the Climate Change Adaptation Framework (CCAF).

The CCAF (Figure 1) is cyclic and should be used for continuous improvement, implementing adaptations which will be evaluated in the next cycle to achieve resilience[1].

The problem

Using available historical datasets, it was possible to observe declining trends in net return (revenue from grape sales minus cost of production) for grape-growers in two very different regions producing very different wines (Figure 2). Figure 2a shows decreasing net returns (in Australian dollars per tonne of grape) from growing Shiraz grapes in a vineyard block in Barossa, Australia, due to quality penalties often applied by wineries to grapes not meeting 'optimum' specifications (14°Baume, pH 3.5 and TA 6.8 g/L) for typical red wines. Targeting 14°Baume has made it even more difficult to meet the pH/TA targets, as warmer maturation periods deplete grapes of their acidity, which causes a penalty to be applied to the price paid.

Figure 2b shows a plot of decreasing net returns from growing Touriga Francesa (TOF) and Tinta Roriz (ARA) grapes (for both fortified Port and dry Douro wines) in a vineyard block in Douro, Portugal due to yield loss caused by decreasing berry weight. Increased temperatures during the growth cycle have been shown to lead to increased dehydration and sunburn, thus reducing the weight of berries, bunches and the overall vineyard yield at harvest. Applying penalties related to berry pH or TA is not common practice in this region.

The nexuses of climate impact are thus well established for both cases (Stage 1 of the CCAF). As both pH and berry weight are affected by temperature[2], their respective nexuses in each region are critical for controlling[3] the risk of declining net returns (Stage 2 of the CCAF).

Anticipating disruption

From the projected trendlines in both cases and when considering the available climate projections[4], it is easy to understand that, if no adaptation is made, net returns will likely continue to steadily decrease until economic viability is lost and the business disrupted. We anticipate that business disruption could happen even before net returns reach zero; despite both areas producing world-renowned wines, losses compared to past values are already a reality today. Therefore, we adopted the criterion of business disruption being expected when 50 % of current net return value is lost. For Barossa, this would occur in around 2033, and in Douro between 2052 and 2056, depending on the variety. This provides insights[1] into (i) the number of years during which adaptation investments are to be made (10 years for Barossa, 30 years for Douro), (ii) operational (pH and berry weight) and economic (net return) metrics for monitoring adaptation progress, and (iii) how investment costs compare with the cost of inaction (Stage 3 of the CCAF).

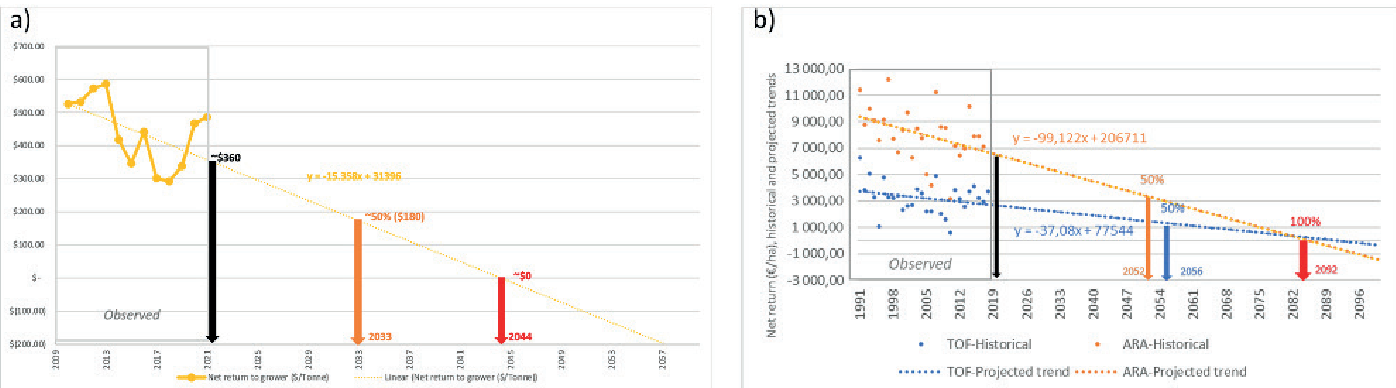

FIGURE 2. Projection of past observed trends for net return in a) Barossa Shiraz, and b) Douro Touriga Francesa – TOF and Tinta Roriz - ARA

TABLE 1. CCAF 3D risk analysis matrix (adapted from Weiss, 2003)[5].

Score	Likelihood	Severity	Degree of Intervention
1	**Unlikely**: Impossible	**No impact**: no change to wine products or profit	Collective long-term investment programs
2	**Improbable**: Hunch	**Very low**: small increase in processing COGs	Collective comprehensive multi-annual investments
3	**Remote chance**: Suspicion	**Low**: changes in processing required to maintain profit	Collective investment measures
4	**Possible**: Belief	**Slight**: changes in processing; profit margins decreased by <2%	Costly measures against more serious aspects
5	**Low likelihood**: Clear indications	**Marginal**: changes in processing; profit margins decreased by 2-5%	Formal plans for strong measures
6	**Occasional**: Preponderance	**Moderate**: changes in products required; profit margins decreased by 5-20%	"No regrets" measures, low-investment measures
7	**Probable**: Credible	**Strong**: change products & processing; profit margins decreased by 20-50%	Ban low-benefit, high damage actions
8	**Likely**: Clearly showing	**Severe**: only just profitable; change products & processing; profit margins decreased by 50-80%	Research & monitoring
9	**Highly likely**: Clearly convincing	**Critical**: approaching unprofitable / unviable; profit margins decreased by 80-90%	Research only if stakeholders demand it
10	**Certain**: Doubtless	**Catastrophic**: unable to produce wines	Reassure stakeholders

TABLE 2. Risk analysis and adaptation for both case-studies. Adaptation score obtained by multiplying values of the 3 dimensions of risk.

	Likelihood	Severity	Degree of intervention	**Adaptation driver score**
Barossa				
▸ Misting	9	9	6	486
▸ Shading	9	9	4	324
▸ Early harvest	9	9	8	648
Douro				
▸ Irrigation	9	9	6	486
▸ Regrafting	9	9	7	567
▸ Transfer	9	9	2	162

Planning for adaptation

When considering adaptation, several possibilities can be identified[1], and it can be hard to decide which ones to address first. In Barossa, retaining acidity may be achieved using methods such as (i) misting systems, (ii) shading structures to decrease heat and evapotranspiration, or (iii) harvesting earlier to target acidity instead of Baume. For the specific ruggedness and aridity of Douro, options include (i) the use of irrigation systems (only feasible if a source of water is available), (ii) regrafting using sturdier varieties, or (iii) moving the vineyard to a higher elevation or to less sun-exposed slopes. The investment cost for each adaptation option will be different and should be estimated (Stage 4 of the CCAF).

Financial, social, organisational and contextual costs play a role in choosing options and priorities for adaptation. Complementing the classic risk assessment factors of "likelihood" and "severity" with "degree of intervention" in a 3D risk analysis matrix (Table 1) allowed for the integration of adaptation costs in the decision. "Degree of intervention" is the level of commitment required to mitigate the risk. Multiplying the score values corresponding to the responses in each column then provides an "adaptation driver score" ranging from 1 to 1000. To make it easier, we grouped scores to create adaptation priority intervals: less than 200 as low-priority, between 200 and 600 as medium-priority, and above 600 as high-priority[1].

We then applied the 3D risk matrix to both our case studies in Barossa and Douro (Table 2) to calculate the adaptation driver scores of each option.

The adaptation driver score provides a rational base for ranking the adaptation options and creating an adaptation plan (Stage 5 of the CCAF). The higher scoring options are the ones that should come first. In our case studies, Barossa seems likely to best respond by moving to an earlier harvest, whereas in the Douro, regrafting is more likely to be the first option to try.

Conclusion

The CCAF is a simple stage-wise framework drawing on historical information to make informed decisions to shape the future. It should be noted that while it is simple, it is not simplistic; it will be as good as the available historical datasets and the capacity to demonstrate climate impact nexuses affecting economic variables associated with the business of producing wines. Like any good framework, its main objective is to provide a basis for organising existing data and information into practical knowledge that can drive educated risk management decisions in a challenging context that will have little in common with the past. Additionally, it has the advantage of comprising a common method that can be shared among grapegrowing regions or countries depending on the context, thus increasing inspiration and knowledge and speeding up the adaptation process around the world. ■

1 Graça, A., & Gishen, M. (2022). Making sense of available information for climate change adaptation and building resilience into wine production systems across the world. *IVES Conference Series: terclim2022 - XIVth International Terroir Congress, 2nd ClimWine Symposium*, pp. 1-6. https://ives-openscience.eu/13192/

2 Costa, C., Graça, A., Fontes, N., Teixeira, M., Gerós, H., & Santos, J.A. (2020). The Interplay between Atmospheric Conditions and Grape Berry Quality Parameters in Portugal. *Applied Sciences, 10*(14), 4943. https://doi.org/10.3390/app10144943

3 Corlett, D. A., & Pierson, M. D. (1992). HACCP: definitions and principles. In *HACCP* (pp. 6-7). Springer, Boston, MA. https://doi-org.libproxy.viko.lt/10.1007/978-1-4684-8818-0_2

4 IPCC (2021). Summary for Policymakers. In: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press. https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf

5 Weiss, C. (2003). Expressing scientific uncertainty. *Law, Probability and Risk, 2*(1), 25-46.