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AN APPROACH FOR EVALUATION OF COMPATIBILITY BETWEEN GRAPE QUALITY AND ENVIRONMENTAL OBJECTIVES IN LOIRE VALLEY PDO WINE PRODUCTION

RENAUD Christel¹, BENOIT Marc², JOURJON Frédérique¹,

¹PRES L'UNAM, UMT VINITERA, ESA, Unité de recherche GRAPPE,
55 rue Rabelais, BP 30748, 49007 Angers Cedex 01 - France,
c.renaud@groupe-esa.com, f.jourjon@groupe-esa.com

²INRA-SAD Mirecourt
BP 35, 88501 Mirecourt – France,
Marc.Benoit@mirecourt.inra.fr

ABSTRACT

Social, economic and state increase their demand towards French viticulturists for reduction of their environmental impact, but not at the expense of the quality of the wine. This position paper presents the approach to evaluate the compatibility of grape quality and environmental objectives in Central Loire Valley PDO vineyards. The environmental quality of vineyard management will be assessed using the Life Cycle Assessment method. The relevance of replicating 3 years of measurements is explored.

KEYWORDS: viticulture, Life Cycle Assessment, grape characteristics, multi criteria rating, environment

RESUMÉ

La société, les marchés et l'état imposent à la viticulture française de réduire ses impacts environnementaux tout en produisant des vins de qualité. Ce document expose la démarche prévue pour l'évaluation de la compatibilité des objectifs qualitatifs et environnementaux de la production de raisins de cuve dans les vignobles AOC du centre Val de Loire. La méthode de l'Analyse du Cycle de Vie a été choisie pour l'évaluation de la qualité environnementale des itinéraires techniques. La pertinence du choix de trois années de mesure est discutée.

MOTS CLES : viticulture, Analyse du Cycle de Vie, caractéristiques du raisin, évaluation multicritères, environnement

INTRODUCTION

Social and economic pressure on the wine sector to adopt sustainability is growing. The key points of the French government's policy on ecological and sustainable development were formalized following an Environmental Round Table in 2007 (www.legrenelle-environnement.fr). The policy includes the new requirement for environmental information on mass consumption products from 2012 ("Act Grenelle 2", final version not published yet) and the target of a 50% reduction in the use of pesticides between 2008 and 2018 (ACT No. 2009-967). This is relevant to the wine sector.

French consumers embrace the tradition and natural aspects of wine and their affinity to it might be eroded by their evolving knowledge of production practices (Brugière, 2009). Protected Designation of Origin (PDO), wines embody the localized and traditional technical know-how (Lamine, 2005), but the PDO is only a guarantee of origin, but not environmental

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quality (Hirczak, 2007). As the French are very concerned of the risk of agrochemical spraying on food crops (Credoc, 2009), the image of wine could be jeopardised by the use of 20% of pesticides (in mass) on 3.7% of French UAA in viticulture (Aubertot *et etc.*, 2005).

The French PDO wine producers are thus faced with this new societal and institutional demand. Similarly, if they wish to strengthen their position in the world market, they must take into account the environmental requirements of key international markets. It is then necessary to assist the wine industry in addressing this risk through the evolution of its practices towards being more environmentally friendly. The grape growers of the Loire Valley are seeking support for such development in environmental practices without damaging the quality of their wines.

This paper introduces the approach implemented in order to provide, to wines sector agents, inputs useful for choosing viticultural technical paths that meet the objectives of product quality and environmental quality in Loire Valley protected denominations of origin vineyards. This research is implemented in the frame of the scientific programme of UMT Vinitera^{*}. The originality of this research is situated in product multi-criteria rating of quality and environment, which corresponds to a new research field emerging internationally, and in the adaptation of Life Cycle Assessment method to the wine grape production.

OBJECTIVES

This project aims to i) measure the levels of compatibility between indicators of grape quality (Qg) and of environmental quality (Qe) of the vineyard management technical paths[†] (TKPv) in these attributes ranging from antagonistic to synergistic relationships, and ii) to identify, within the TKPv, the techniques responsible for these situations, in order to assist wine industry stakeholders in the choice of TKPv.

The research strategy intends to i) identify the diversity of existing vineyard management practices, ii) establish a typology of TKPv, iii) chose existing vineyard plots representing this diversity as an experimental device, iv) characterize the soil and climate of these plots as co-variables, v) observe the TKPv on the plots for three years on the attributes of Qe and Qg, vi) confront Qe and Qg indicators of TKPv in a matrix structured in degrees of compatibility, vii) identify the parts of the process playing the main role on the TKPv position in the matrix, and viii) adapt the matrix into a tool for wine sector agents.

METHOD

This research focuses on grape production, which represents both a significant part of the environmental impact of wine (Gazulla *et etc.* 2010) and is a crucial aspect of the quality of the product. The two main cultivars of the central Loire Valley: cv. Chenin Blanc and cv. Cabernet Franc will be utilised. Measurements are planned for 3 consecutive vintages (2010-2012) and will be performed at the plot level (a single unit in the vineyard with homogeneous characteristics). The project will be conducted in conjunction with key stakeholders so it has strong application in the wine sector.

^{*} UMT Vinitera : Unité Mixte Technologique Vins, INnovations, Itinéraires, TERroirs et Acteurs : research unit including staff from INRA-UEVV Angers, ESA- GRAPPE and LARESS research units, IFV- Pôle Val de Loire-Centre and CTV around a common research programme « Construction of terroir wines quality, from producers to consumers ».

[†] Logic succession of techniques applied on the vineyard by the producer

LCA has been chosen for the evaluation of the environmental quality of the TKPv because it is the most complete tool in the field of global and multi-criteria assessment of environmental impacts (Boeglin *et etc.*, 2005). It has recently been chosen, in a simplified form, to assess and display the environmental impact of consumer products in France, which directly concerns the wine industry. However, this method only deals with potential impacts (Jolliet and Crettaz, 2001). Appropriate models for impacts on biodiversity and soil quality are still under construction. Currently, estimation of the uncertainty of results remains difficult in agricultural LCA (Payraudeau *et al.*, 2005).

The method is currently applied and adapted to agricultural systems (Audsley *et etc.*, 2003, Brentrup *et etc.*, 2004) and of particular interest to this research, perennial fruit production as well (Mouron *et etc.*, 2006). Research utilising LCA in viticulture and oenology has been published (Aranda *et etc.* 2005; Petti *et al.*, 2006; Pizzigallo *et etc.* 2006; Gazulla *et etc.* 2010), but have not addressed the method in detail for application in vineyard management.

This research is broken down into five stages:

Stage 1: Establishment of the experimental and observational network representing the diversity of TKPv of central Loire Valley PDO vineyards.

The diversity of TKPv existing in the region is identified by:

- A survey of 100 grape growers with diverse socio-economic profiles, different production systems, from different PDO, in order to describe their TKPv on 300 plots.
- A typology of TKPv from this survey and existing databases on 100 variables using the data mining platform CORON (Ducatel *et etc.* 2010), and Factorial Multiple Correspondence Analysis (FMCA).

The sample of plots used for the study will be selected by TKPv types in order to contrast potential Qe and Qg. Two networks will be designed: one comparing TKPv in the same environment (soil, climate) and the other observing TKPv in various environments.

Stage 2: Evaluation of Qg and Qe on the selected plots TKPv

The evaluation of Qg requires the following:

- The choice of grape quality criteria (biochemical, sensory, physical, microbiological, xenobiotics) through a survey with expert winemakers.
- The measure of grape quality on the chosen criteria at harvest.

The evaluation of Qe requires the following:

- Adaptation of the LCA method for wine grape production (functional unit, impacts, completion of Eco-invent data base) following the iterative process of LCA.
- Calculation of environmental impacts using LCA (Simapro software, Ecoinvent database).

An inventory of flux data will be made with grape growers once or twice a year depending on their practices traceability.

Stage 3: Evaluation of the compatibility of Qg and Qp for each TKPv

The environment (soil and vintage climate) will be characterised as co-variables through existing detailed cartography and annual weather data.

Qe and Qg datasets will be crossed using Multiple Factorial Analysis (Escofier and Pagès 1998) and including environmental co-variables.

TKPv will be positioned in a matrix crossing Qg and Qe following the design of:

- A typology of Qg and Qe through a combination of criteria
- A matrix of compatibilities between Qg and Qe using this typology

Stage 4: identification, within TKPv, of vineyard management techniques responsible of TKPv position in QgXQe matrix

The key techniques influencing grape quality will be identified through literature review. The techniques causing the main environmental impacts will be identified both by LCA results on the experimental network and literature.

Stage 5: Development of a tool to assist the wine sector agents in their TKPv choices.

The tool will be developed from the matrix.

METHODOLOGICAL ISSUES

This approach identifies five main methodological issues. LCA adaptation to the grape production process and the treatment of complex data have been developed in previous articles (Renaud *et etc.*, 2010 (a) and (b)). The relevance of considering 3 vintages for this study is the focus of this paper. The choice of grape quality indicators to be considered for Qg evaluation and construction of a tool to aid decision making will be developed in a subsequent paper.

In order to validate if a sample of 3 consecutive years will be sufficient to explore the potential variability of grape quality according to the climatic conditions, the CV of two grape quality indicators have been calculated on series of 2 to 30 consecutive vintages (1979-2009). This longitudinal data has been obtained from a sample of Loire Valley Cabernet Franc grapes from the same plot (Data sourced from INRA EU-1117 in the framework of UMT VINITERA). The indicators utilised are sugar (figure 1) and anthocyanins content (figure 2).

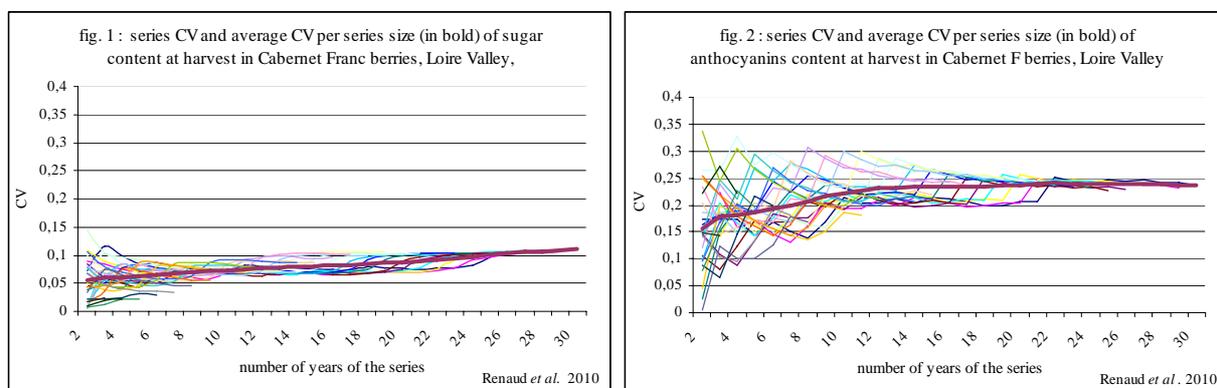


Figure 1 and 2: CV of sugar and anthocyanins contents for 3 to 30 consecutive vintages series, cv. Cabernet Franc, Montreuil Bellay, Loire Valley (INRA EU-1117 in the framework of UMT VINITERA data)

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The average CV for both criteria is stable and this increases with the number of years utilised.

Whilst affected by climatic variation, the sugar content's natural variation appears to be limited and most likely regulated by the grower's choice of harvest date. Even if the individual Sugar CV values vary 5 times more for a 3 year series than for an 8 years series, the average CV remains low (under 0.12).

Anthocyanins are subject to uncontrolled variations, with an average CV reaching 0.25, but with lower individual CV values variation than sugar. A consecutive sample of three vintages might not be sufficient to get results consistent with a longer period (i.e. 30 years). Concerning the proposed measurements for this research, the 3 vintages will need to be tested in comparison to present data and charts in order to determine if the sample is representative.

CONCLUSIONS

The expected results are i) the identification of TKPv diversity, ii) a built typology of Loire Valley TKPv for the studied cultivars, iii) an operational method to characterize TKPv by the relationship between Qe and Qg, iv) the positioning of each TKPv type within the QeXQg matrix, structured in increasing degrees of compatibility, v) a list of the vineyard management techniques responsible for this position in the matrix TKPv QeXQg, vi) an advisory tool developed with the actors from this matrix, vii) adapted LCA method for grape production processes in the Loire Valley, viii) results of methodological development on LCA which should benefit viticultural scientists and technicians wanting to use LCA for wine grape production. This work should also contribute to improve multi criteria methods for production processes evaluation.

These results should provide the wine industry the opportunity to increase its awareness of environmental issues and to further increase the environmental quality of grape production processes. The findings could contribute to changes in viticulture towards more environmentally friendly practices. This research could propose new tools for actors in charge of advising the wine sector and enable them to better integrate environmental objectives into the specifications of labelled productions, including PDO, in line with consumers and societal expectations.

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