



Knowledge description for the suitability requirements of different geographical regions for growing wine

Bernard Kamsu-Foguem^{a,*}, Aurélie Flammang^b

^a Laboratory of Production Engineering (LGP), EA 1905, ENIT-INPT University of Toulouse, 47 Avenue d'Azereix, BP 1629, 65016, Tarbes Cedex, France

^b Wines and Plus: 10 rue René Huet, 51100 Reims, 5 France

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ABSTRACT

The production of wine has progressed on every main continent. The knowledge modeling can support the sharing of expertise, methods and good practice concerning international grape vine growing and wine production while maintaining a high level of quality. Our research focuses specifically on the development of a support system for knowledge formalization. We describe some procedural rules to represent experienced knowledge in the viticulture domain and plant pathology. We use a graphical software for rules management. The visual representation is a step toward the improvements of interaction between Artificial Intelligence methods and domain experts to make interpretable learning models for concrete decisions. This implementation enables us to make valuable visual reasoning to search whether the Chinese regions are capable of receiving a production of French vineyards. In particular, one outcome is that two Chinese regions appear more favorable and consistent for the development of wine from the Bordeaux region.

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Introduction

The practice of grape cultivation and fermentation to produce wine is the part of Eastern and Mediterranean civilizations. The production of wine has progressed into a greatly structured scientifically detailed process that yields outstanding wines on every main continent around the world (Luca, 2011). Culture of wines is the part of French heritage and is synonymous with quality in the world (Charters, 2006). Here we seek to support the export of know-how, methods and good practice concerning international grape vine growing and wine production while maintaining a high level of quality. Many varieties of wine have been made over the millennia and there is a comprehensive assortment of particular and typical wine styles (Jackson, 2000). Wine is sometimes associated with health promoting properties. Some molecules (e.g. resveratrol, hydroxytyrosol and melatonin) naturally present in wine have showed antioxidant, cardioprotective, anticancer, antidiabetic, neuroprotective and antiaging activities (Fernández-Mar et al., 2012). These health benefits and social media have some influences on consumer behavior in emerging markets (e.g. sustainable/organic wines) (Lockshin and Corsi, 2012). However, numerous consumers drink mainly wine for enjoyment of the flavors. Wine tourism also has a significant role

in inter-continental relationship marketing chain (Hojman and Hunter-Jones, 2012.)

The quality of wines demanded by consumers is on the increase and this is becoming a major concern for winemakers and grapevine growers all around the world. The notion of wine-growing area represents the best combination of 'soil-climate-vine', respecting the possibilities for resources and services supplied by the natural environment. The wine grower expertise is transformed into association rules covering a wide range of factors relating to the full development of a vineyard from site selection to successful vine growing and they are: in a specific geographical location and under specific human actions, regional climate or microclimate, the chemical and physical parameters of the target soil with its water at field scale. The advances in technology and research give us the directions to follow: factors associated with "terroirs", which have the greatest influences on the quality of the grapes and, therefore, the quality and specificities of the wine.

We focus on this project to study an implementation project of French wines on Chinese territory. It is essential to judge the relevance of the grape production in Asia. The purpose of our researches focuses specifically on the development of a support system for decision-making. Indeed we see that the actors of the wineries do not effectively use all available information for decision making. In order to obtain a good product for a good wine, we focused on how the quality of grapes could be improved for producing refined premium wine labels.

* Corresponding author. Tel.: +33 624302337; fax: +33 0562442708.
E-mail address: Bernard.Kamsu-Foguem@enit.fr (B. Kamsu-Foguem).

In our study, we sought to address the following issues:

- Is it possible to plant vineyards with vines of European type in China? The climatic and geological conditions in China are they similar or compatible with European varieties? We examined the adaptability of China's potential wine growing areas under different climate regimes, with a view to describing the common features of adaptive viticulture-making? Are these areas more likely to be developed into vineyards/more suitable for grapevine growing when compared with other regions? Analyze the criteria based on which the currently developed Chinese vineyard sites were chosen and developed and where they are located?
- Potential vineyards will they be able to meet the requirements: quality, legislative, environmental exigencies of local or global market?
- What are the exact conditions that make European and Chinese vineyards similar? Are they the same expectations on the local Chinese market and the world market?
- What are the factors reflected by the identified parameters that show similarities, and on which ones we should act?
- What are the intrinsic and extrinsic factors in grapevine growing the wine production? How climate and geology factors affect the development of the vine? Is it possible to promote biological treatment? And to what extent can we meaningfully formalize the domain knowledge? To what extent can we possibly draw generalizations on other practices' approach to viticulture without running the risk of misunderstanding and misrepresenting others?

We seek to formalize knowledge in order to be more easily transmitted to future growers, whether European or Chinese. We sought a relation between various factors and the proper development of the vine, it emerged that these links were not clearly established at this time and that winemakers acted mainly by application and transmission of know-how and experience.

State of the art: key factors in the vineyards domain

The vineyard location and planting choices (e.g. vine variety) have the biggest impact on reducing vulnerability, and may also provide considerable adaptive capacity to enhance agricultural resilience to climate change (Nicholas and Durham, 2012). For instance, adaptive strategies have allowed buffering climatic effects on grapevine performances in certain Mediterranean areas (Ripoche et al., 2011).

The literature first presents the different stages of development of the vine, the main vine diseases such as blight, botrytis (gray mold) or mildew and few treatments. It was learned that the diseases do not address all the same parts of the vine (leaves, vines or seeds), they are dependent on seasons and climate, and all varieties are not affected to the same extent. Subsequently, through a study of the different regions of China, we could compare the conditions for the proper development of vineyards. This study focused on the precipitation and the possibility of water areas, as well as sunshine and temperatures in particular through the Huglin index, as we will explain later in this report. We also mentioned varieties implanted in French and Chinese regions. We also analyzed the influence of the soil, its minerals, and climate on the growth of the vine. Finally, we have deepened their study of some French appellations, through three characteristics regions, which are the Loire Valley, Bordeaux and Côtes du Rhone. There are varieties implanted, regional average temperatures and geological features (presence of sand or gravel etc.).

The expertise of the culture of the vine, to try to apply it to parts of China, is not owned by one person but by a group of actors who share their knowledge for the good development of vine

and wine production. During our researches we had information from various trades: winemaker, winery technical director, analyst taster or engineer in a laboratory of oenology.

After researching analysis of existing practices we realized that some factors were essential to the development of varieties. Here the main factors on which we based our research and studies are geology, climate, diseases and treatments, driving mode and irrigation.

Geology

Soil definition: the rock is at the origin of the formation of the basement that we know today. It is characterized by physicochemical alteration over time provided the elements that constitute the ground. Its rocks can be of three types: sedimentary, igneous or metamorphic rocks.

The soil itself has four layers:

- *Litter:* this layer is closer to the surface which is in direct contact with air. It consists of leaves decaying.
- *Humus* is the intermediate layer that is composed of organic matter in a state of advanced decomposition. We find the presence of living organisms such as bacteria, unicellular organisms, fungi, etc.
- The *mineral* layer: it is mainly composed of rock.
- The *soil* is not inert; it will evolve through the action of micro-organisms, insects but also climate (wind, frost, sun, etc.) that will permanently transform its composition.

Indeed, the land on which the grapes grow is going to affect the resistance of varieties, size, etc. On this criterion, several parameters are involved directly. First, the type of soil: the case of limestone, sandstone, clay or another. For example, a clay soil will improve water retention which will prevent the vines suffer water stress (lack of water), while a gravelly soil is rather dry and arid. The soil type is generally related to the following parameters: the content of trace elements and macronutrients (e.g. sandy soil will often be deficient in boron or copper). However, only a scientific analysis of the soil will determine how effectively the soils are rich or poor.

The soil provides all the nutrients and water that the vines need to grow and produce grapes. Nutrients are essential in the life of the vine. They are mostly found in minerals. There are two broad categories, macro-nutrients and micro-nutrients.

1. Macronutrients:

- *Nitrogen effects elements:* it allows the plant to grow for the proper development of the plant;
- *Magnesium:* it has the same role as nitrogen, but its action is much more specific in the chlorophyll;
- *Calcium:* it helps nourish the root system of the plant and promotes the rise of sap;
- *Potassium:* it is a factor of vigor and yield, it facilitates the accumulation of sugars in the grapes, it can also regulate the opening and closing of stomata;
- *Phosphorus:* it allows root development and ripening berries.

2. Micronutrients:

- *Boron:* it plays an important role in cell wall structure and formation of grapes and in the metabolism of proteins and carbohydrates. Boron deficiencies occur mostly in alkaline soils or sandy soil.
- *Copper:* it plays a role in the production of chlorophyll. It may also intervene in the control of certain diseases. Copper deficiency is rare in mineral soils, except in very sandy soils. It involves sensitivity to dehydration.

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