



## Let's capitalize on global warming: New limits for vineyard vines in Europe

<sup>1,2</sup>I. Valentin Petrescu-Mag, <sup>1</sup>Ioan G. Oroian, <sup>1</sup>Claudia Balint, <sup>2</sup>Florin L. Criste, <sup>2</sup>Remus O. Stoian, <sup>2</sup>Florian D. Tăut

<sup>1</sup> University of Agricultural Sciences and Veterinary Medicine, 3-5 Calea Mănăştur Street, Cluj-Napoca 400372, Romania; <sup>2</sup> University of Oradea, 1 Universităţii Street, Oradea 410087, Romania. Corresponding author: I. V. Petrescu-Mag, zoobiomag2004@yahoo.com

**Abstract.** The global warming is 0.6°C over the past three decades and 0.8°C in the last century. If between the ends of the XIX<sup>th</sup> century and since 1975 has been a slow global warming with large fluctuations in recent years, especially after 2000, it has accelerated considerably. In the first half of the decade of the XXI<sup>st</sup> century, this warming has a growth rate of 0.2°C / decade. Climate change felt in the viticulture presents some advantages in terms of expanding the northern limits of vine cultivation. It is likely that many countries will be able to produce wine in the future amid global warming, and this fact must be capitalized. The digitization age together with international cooperation makes possible re-drawing accurately the northern limit of vine cultivation in the context of climate change. Use of high performance software in forecasting/prediction and identification of new potential productive areas for vineyards will improve the classical methods because, as it is normal, it operates much faster than the human resource, it uses the same set of primary information as human resource and it does not allow subjective interpretation, as it uses the same standards for each case.

**Key Words:** warming, *Vitis vinifera*, northern limits, climate change, new strategies.

**The limits of vineyard vines as they were described in old literature.** Northern limits of vine cultivation: according to Barry et al (1846-1866) the known limits of the vine in Central Europe are Bohemia, Moravia and Hungary. The Carpathian chain of mountains defines the vine limits in that part of Europe, and it does not extend beyond them, except eastwards under the 48<sup>th</sup> degree. From there it passes to Bucovina, where there are extensive vineyards in many localities, but there is no vineyard in Galicia. Kiev is not a good area for vines and there most often ripening is affected by weather. Descending the Dniester, the first vines are met with at Mohilov under the 48<sup>th</sup> degree, on the Dneiper under the 49<sup>th</sup> degree, on the Bug under the 47<sup>th</sup> degree. On the banks of the Don the culture of the vine is extensive from Axais to Tcherkask. On the Volga it is cultivated at Sarepta, lat. 48 1/3°, and probably as far north as 50J°.

In Southern Russia the production is poor and the frosts of September sometimes destroy the crop (Barry et al 1846-1866). We can see in Figure 1 the northern limits of vine cultivation, represented on the basis of data collected in 1948 (New Society for the Difussion of Knowledge). Figure 2 represents the same information at a global scale with the mention that it is based on a newer data collection (Global Economy, 2014).

Beside the latitude, the vine cultivation and productivity is largely influenced also by altitude (Mateus et al 2001; Failla et al 2004; Chaves et al 2010; Almanza et al 2010; Almanza-Merchán et al 2012). In fact, success in grape production is determined by the resultant of the two, along with other pedo-climatic factors.

**The global warming and vine cultivation.** The global warming is 0.6°C over the past three decades and 0.8°C in the last century. If between the ends of the XIX<sup>th</sup> century and since 1975 has been a slow global warming with large fluctuations in recent years, especially after 2000, it has accelerated considerably. In the first half of the decade of

the XXI<sup>st</sup> century, this warming has a growth rate of 0.2°C / decade (Hansen et al 2006a).

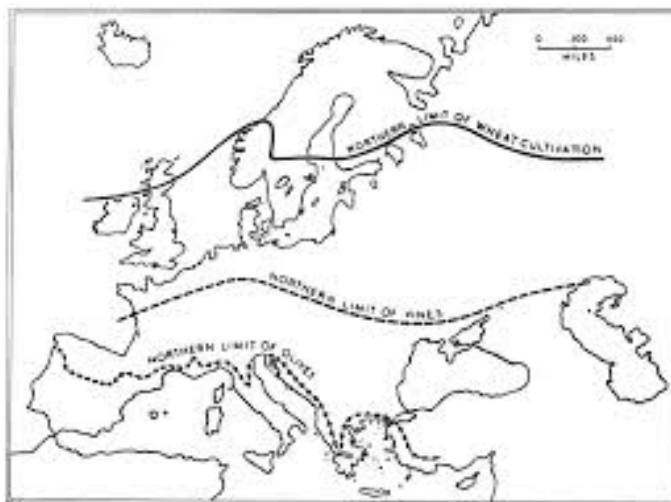


Figure 1. Map of Europe (Northern limits of wheat, vine and olive cultivation) 1948; (source: New Society for the Difussion of Knowledge, <http://www.probertencyclopaedia.com/> ).

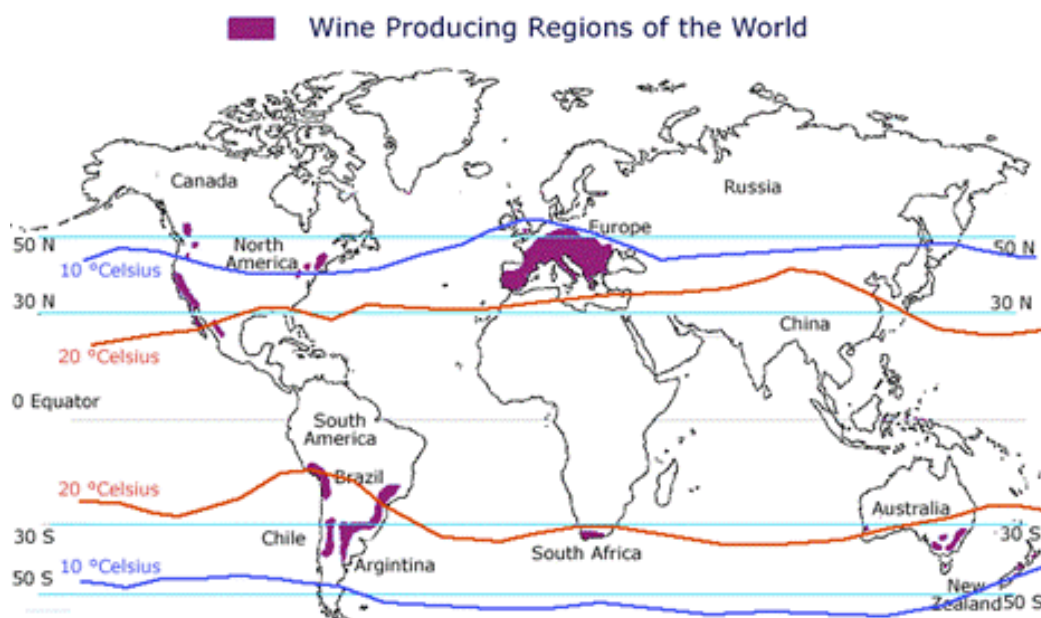


Figure 2. Wine producing regions of the world (Source: Global Economy, <http://www.thirtyfifty.co.uk/images/World-wine-map.gif> ).

Climate change felt in the viticulture presents some advantages (Hansen et al 2006b). A vine region, with an average temperature during the growing season of 15.0°C, which is warmed by 1°C, may experience more varieties suitable for fast ripening (Jones 2006).

Climate change and the problem of impact on vineyards is an issue of utmost importance for researchers from different fields. These climate changes concerned viticulture specialists because vineyards producing quality wines are extremely sensitive to any change to the pedo-climatic conditions (Butrose 1974).

General warming of the climate has disturbed the evolution of natural factors in the vine ecosystem: summers became increasingly hot and dry, the autumns are longer, the winters are shorter and rarely excessive, the periods of drought are more frequent and wet ones are excessively rainy. The consequences on vine are obvious: this change has been extended the vegetation period and vines entering more poorly prepared in winter; high heats of August and early September "burn" grapes and blocks the accumulation of sugars, grape maturation making it "forced" the grapes are impoverished by natural components that give quality wines (primary aromas, polyphenols, hydroxyacids etc, Rotaru et al 2009ab).

On the other hand, on the background of climate warming in 2011, following research conducted by Popescu et al (2012), it was found that red grape varieties: Merlot, Pinot Noir, Cabernet Sauvignon and Syrah can be grown in north-western Romania, this area being specific for white vine varieties.

The climate changes should be seen also from economic point of view. The grapes productions start to no longer be constant each year, provides a reduced accumulation of sugars in the grapes from soil drought, they become poorer in chemical compounds, compounds which provide quality wine (polyphenols, primary aromas), leading to production of poor quality (Popescu et al 2010).

In order to preserve the quality of wines, Popescu et al (2012) proposes a strategy that involves the introduction of new varieties (south) on the old sites and traditional varieties move further north (within the pedo-climatic conditions offered by the new land). Van Leeuwen & Seguin (2006) specifies that early ripening grape varieties should be chosen for cold climates in order to achieve their full ripening and late ripening varieties should be grown in warmer climates so that the ripening grapes would not occur the warmest part of the summer.

"European agriculture has always had to cope with variability in the weather, but climate change will likely produce more permanent shifts in temperature and precipitation that will require more robust actions. A range of strategies is available to adapt to climate change, with different levels of complexity, cost and commitment to change"... "Farmers across Europe are currently adapting their practices to climate change, despite less predictability in seasonal trends. Simple, no-cost adaptation options such as advancement of sowing and harvesting dates or the use of longer cycle varieties may be implemented although such options may become less successful in a more variable climate" (Climate Smart Agriculture - Call Announcement, 2013). A rigorous data pack for each crop needs to be up-dated. However, there is no recent evidence on vine compatibility with some theoretically suitable geographic areas in Europe.

**Recent signs of movement of the northern limits of vine cultivation.** The number of professional Danish wine producers is continuously increasing, as is the quality of Danish wine. It is interesting to produce wine at the limit of where it is possible from a purely climatic perspective (Aagaard 2012). Such an example is the suburb Avedøre, located very close to Copenhagen. There is a plantation of vines with light green leaves, about 9,000 vines altogether, stretching over three hectares of land. Founded in 1999, Dansk VinCenter in Avedøre was one of the first vineyards to be established in Denmark. Just three years later, it marketed its first 7,000 bottles of wine under the name 'Nordlund'. In the last 10 years they have produced between 2,000 and 7,000 bottles per year. Today there are some 55 commercial winegrowers around the country and the professional winegrowers have recently organized themselves in an industry association, Danske Vingårde (Danish Vineyards) (Aagaard 2012). At present, at the small scale, Denmark exports wine to countries such as Japan.

Denmark is only one case, and the situation might be similar for many other countries or parts of countries. It is likely that many countries will be able to produce wine in the future amid global warming, and this fact should be capitalized.

**Conclusion and perspectives.** The digitization age together with international cooperation (literature surveys, research projects, isolate case studies, reports) makes possible re-drawing accurately the northern limit of vine cultivation in the context of climate change. Use of high performance software in forecasting/prediction and identification of new potential productive areas for vineyards will improve the classical methods because, as it is normal, it operates much faster than the human resource, it uses the same set of primary information as human resource and it does not allow subjective interpretation, as it uses the same standards for each case.

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Authors:

Ioan Valentin Petrescu-Mag, University of Agricultural Sciences and Veterinary Medicine, 3-5 Calea Mănăştur Street, Cluj-Napoca 400372, Romania; University of Oradea, 1 Universităţii Street, Oradea 410087, Romania, zoobiomag2004@yahoo.com

Ioan Gheorghe Oroian, University of Agricultural Sciences and Veterinary Medicine, 3-5 Calea Mănăştur Street, Cluj-Napoca 400372, Romania, neluoroian@yahoo.fr

Claudia Balint, University of Agricultural Sciences and Veterinary Medicine, 3-5 Calea Mănăştur Street, Cluj-Napoca 400372, Romania, viliche\_claudia@yahoo.com

Florin Leontin Criste, University of Oradea, 1 Universităţii Street, Oradea 410087, Romania, florinleontincriste@gmail.com

Remus Octav Stoian, University of Oradea, 1 Universităţii Street, Oradea 410087, Romania, remusoctav@yahoo.com

Florian Dumitru Tăut, University of Oradea, 1 Universităţii Street, Oradea 410087, Romania, taut.florian@yahoo.com

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