EXECUTIVE SUMMARY

Terroir Analysis of the Nova Scotia Wine Growing Region 2017

The wine industry in Canada has been growing steadily over time and Nova Scotia is an important region for growth. In our province, development in the wine sector has been increasing rapidly; since the beginning of 2000, many wineries have appeared on the scene with different varieties and wine styles. The main goal of the *Terroir Analysis of the Nova Scotia Wine Growing Region 2017 project* is to determine which varieties are more suitable for our environmental conditions, specifically for the targeted wine styles. Also, the project seeks areas where improved management decisions in the short and long term will make Nova Scotia more competitive in the market place. Overall, the goal is to make the industry more efficient and profitable. This project is funded by the provincial government of Nova Scotia and will have a term of three years to evaluate the evolution of different recommendations in management. This report involves the results of year one only.

This project has been developed by Perennia Food and Agriculture Inc. with two French consultants, Cecilia Grallert and Rodrigo Laytte. Both consultants are Agricultural Engineers and Agrarian Economists, plus have completed postgraduate studies in Master of Science in Viticulture and Enology from the prestigious university Ecole Nationale Superieure d'Agronomie (now called Montpellier SupAgro) in Montpellier, France. Additionally, they possess the Diplôme Nationale d'Œnologue (National Diploma of Winemaking). With extensive experience in Austria (Hillinger Winery and Schloss Halbturn), France (Château Margaux, Château Palmer, Château Latour and Château Kirwan), Chile (Vina Veramonte and Vina De Martino), Mexico (Sonora Innova and Uvas de Altura), etc. their recommendations and experience will be fundamental to this project.

Background

Historically, Nova Scotia's climate conditions are indicted for production of French-American hybrids mainly because they are best suited to local climate conditions with winter hardiness and their short vegetative growing cycle enables the elaboration of wines that are commercially accepted.

In recent years, an important and exciting evolution could be observed in the Nova Scotia wine industry. Firstly, the increasing acreage through new vine plantations made wineries grow in size but also in number: from 13 wineries seven years ago to over 20 wineries in 2017. Secondly, given the steady global warming effect which is changing local climate conditions vine growers have begun to plant *Vitis vinifera* varieties; cultivars that are prone to winter freezing, late spring frost damage and to diverse vine diseases. Nevertheless, the big potential and commercial interest in the resulting wines encourage growers to take these production risks.

The project

With an aim of supporting the Nova Scotia wine growing industry to improve vine grape growing conditions in the vineyard and, consequently, to improve wine quality for the local

and international consumer market, a medium-term wine growing improvement project was put in place in March 2017.

In order to handle specific technical recommendations for local vine growers and wineries the objective of the project's first year, namely, a *Terroir Analysis of the Nova Scotia Wine Growing Region*, has been to get a profound insight of the commonly used wine growing techniques, as well as the local climate and soil conditions. In this context, the French word *terroir* stands for the combination of the principal wine growing factors: the climate, the soil properties, the choice of grape cultivar and the human factor as for the applied vine cultural practices.

The results of this first-year terroir analysis and the respective technical recommendations based on these early results have been consolidated in this executive summary.

2017 Results

The experimental set up for the terroir analysis includes data measurements that have been collected during the complete growing period of 2017 for both vinifera and hybrid varieties that are today's most representative varieties within four wine growing areas of the Nova Scotia region. Based on these results, a detailed and integrated scientific research study has been completed.

The first year of this medium-term project has revealed that the Nova Scotia region has significant potential to produce high quality still white wines and sparkling wines and good quality still red wines.

The collected data and respective analysis enables the establishment of overall key factors that can be adopted in the current year, 2018, by vine growers who are looking to improve the quality of vine grapes.

The overall observations and recommendations are:

1 **For existing vineyards**:

1.1 An appropriate soil properties' enhancing strategy in relation to mineral and acid-base balance (a short and medium-term recommendation)

Most of the analyzed soils are principally sandy soils, which display a low quantity of coarse elements, important levels of organic matter, a low to high soil acidity and a generalized potassium deficiency. Additionally, a medium to high compaction could be observed in many soil profiles.

> *Therefore, it is recommended to implement, whenever possible, soil groundwork, which is essential for enhancing soil aeration, to improve mineralization of the organic matter and to prevent soil compaction.*

The soil acidity could be a problem when pH gets under 6.5 and dangerous when under 6.0. This has a notable impact on microflora quality and quantity; also, vine root growth is diminished and toxicities could appear, such as manganese toxicity.

> *Correction of the soil pH is crucial; therefore, it is highly recommended to undertake soil liming adapted to the actual soil pH and repeat liming the next two to three years until soil pH in neutral ranges is achieved.*

1.2 A nutrition strategy adapted to local conditions

A nutrition strategy adapted to local climate and soil properties seems to be crucial to promote an early as possible vegetative development, to enhance sugar content in grapes and to increase yields (if low yields are the case). At the same time, an appropriate nutrition strategy can help to achieve better lignification of seasonally produced wood, hence, can improve bud-hardiness during the following winter.

Due to the rainy weather conditions in 2017, only one water status measurement could be completed and the registered vine water status reflected 'no water deficit' for 93% of the vines measured. In addition, these results were confirmed through the Delta ^{13}C analysis that showed that none of the 14 study plots underwent water stress during the whole growing season 2017.

For all vinifera varieties and for most of the hybrid varieties, these results meant that there is not sufficient water stress to permit vines to reduce vigor, in order finish the shoot growing phase before harvest and, consequently, to improve the ripening process and wine grape quality, especially for red vinifera varieties.

> *Nitrogen amendments should be applied only early in the season (at the stage of 4 to 5 opened leaves) to permit fast vegetative growing in the very beginning of the growing season. Nevertheless, tissue analysis should be done later in the season during flowering and veraison to reveal nitrogen status, which is recommended to be maintained at rather normal to low levels.*

The generalized low to very low vine potassium content during the whole vegetative period confirms results of soil analysis with low potassium availability. The good soil magnesium availability makes this deficiency more important.

> *Given the importance of potassium in the wine grape development process, regular potassium soil amendments and, additionally, sulfate foliar applications on the canopy are recommended.*

The given normal (and in some cases, high) rates for phosphorus are correlated with its generally high availability in the soil.

If soil analysis shows phosphorus deficiency soil amendments should be made preferably after harvest or during the growing season if soil can be cultivated.

The generally observed low iron content in the vines is in contrast with the revealed high iron availability in the soil. This incongruity could be explained by an inefficiency of the root system in the uptake this element; probable reasons for this could be poor development of the secondary roots or anaerobic soil conditions due to high soil water content.

It is recommended to make foliar applications of iron during the early vegetative stage and again after harvest in order to enhance photosynthesis and the vine's reserve process before leaf fall.

Also in case of deficiency, foliar applications of boron and zinc could be made during flowering, as these elements are important for a proper vine plant development and to help improve vine grape quality.

1.3 Cultural practices that promote balanced vine vigour and a shorter growing period in vinifera varieties

The dates for the end of the shoot growing phase revealed a rather vigorous growth pattern for all vinifera varieties (with shoot growth continuing past September 26th). This tendency might indicate that these vinifera varieties exhibit a locally influenced long growing cycle as terroir conditions are favorable to continue shoot growth. High nitrogen levels found in tissue analysis during veraison may be a contributing factor, although this is not positive for the lignification process and reserve's absorption to trunk and roots, as mentioned above.

For many hybrids, shoot growth stopped prior to September 26th showing that their growing behavior is more adapted to local climate and soil conditions or perhaps nitrogen input was lower in comparison to amounts applied to vinifera varieties.

Regarding results obtained for phenological stages, the tendency of vinifera varieties is to have an average growing cycle (from bud break to harvest) of 158 days compared to hybrids that exhibit for the same time spread an average growing cycle of 148 days.

Besides the nitrogen strategy recommended above and in order to optimise bud burst date of the different varieties (with longer or shorter growing cycles), a specific pruning priority could be put in place: begin to prune red vinifera, following by white vinifera, then red hybrids and ending with white hybrid varieties.

There are no significant differences in bud break rates between vinifera and hybrids; both show bud break percentages around 90%, which is a relatively good value considering the regional climatic conditions.

Having this in mind, and in cases of normal to low vine vigour, it is preferable to adjust bud per plant number during pruning to the desired level plus 20% to avoid additional labour in de-budding and unnecessary stress of the vine plant.

When de-budding or shoot thinning practices are foreseen, it should be accomplished before onset of bloom in order to avoid competition between canopy and fruit. If the objective is to reduce vine vigour, these practices can be also done after blooming.

1.4 A cover crop strategy adapted to soil properties and desired wine style

A portion of the soil profiles observed showed a significant presence of roots belonging to the cover crop. This root presence in some cases was very invasive and could go up to 80 cm in depth. This means competition for space and nutrient uptake for the vine roots and could provoke low nutrient availability to the vine. In some cases this was confirmed as plots showed low vine vigor, smaller canopies and diminished yields.

Having this in mind and unless the vine vigor is very important, the choice of the cover crop strategy should be made carefully in order to avoid high nutrient uptake by the cover crop. It is recommended to select a less demanding and less aggressive growing cover crop that will not affect the long term nutrient balance of the vine and compete with the vine root presence in the soil profile.

2 **For new vineyard plantations**:

2.1 The most suitable vinifera and hybrid varieties

Given the dominant Nova Scotia climate conditions that have been confirmed as *cool climate* based on the calculated Huglin and Winkler climate indexes, the varieties recommended as being better adapted to local conditions and at the same time producing commercially interesting wines, are as follows:

- White Hybrid Varieties: L'Acadie, New York Muscat, Frontenac Blanc
- Red Hybrid Varieties: Lucie Kuhlmann, Leon Millot, Marechal Foch, Regent, Baco
- White Vinifera Varieties: Riesling, Chardonnay, Grüner Veltliner, Gewürztraminer, Pinot Gris, Pinot Blanc, Chenin, Sylvaner, Sauvignon Blanc
- Red Vinifera Varieties: Pinot Noir, Pinot Meunier, Zweigelt, Blaufränkisch, Sankt Laurent, Portugieser, Dornfelder.

Together with choosing to plant wine grape varieties that are best adapted to the terroir conditions and commercial objectives, choosing clones that allow a shorter growing cycle it is highly recommended.

2.2 The importance of a complete soil study before planting

Each soil has specific physical, chemical and biological characteristics that need to be studied before the planting decision in order to optimize vine behaviour and yield in the long term. It is crucial to make the right decisions regarding lime addition, soil aeration, mineral

deficiencies or toxicities, soil water table and other factors for the soil at every location before planting. Also, the drainage system properties will depend on the soil study as mentioned below.

In order to assure good vine development and optimal production of the vineyard in the long term and, additionally, to optimize the soil's wine-making potential, it is recommended to undertake a complete soil study to a depth of about 1-1.5 metres in order to have appropriate tools to make optimal planting decisions.

2.3 The implementation of a drainage system

Significant snow-melt in springtime, together with low water evaporation rates, results in excess water draining through the soil profile to the groundwater. These conditions, in addition to a low subsoil permeability, reduce the ability of the installed drains to remove water in a timely way. The result is soils that remain saturated for quite a long time, affecting significantly affecting vine root development, the soil microflora and soil mineralization.

Considering the above mentioned issues, it is highly recommended to plan and install an efficient long-term drainage system with the aim of removing surplus soil water content and to lower the water table within the soil profile.

A good and efficient drainage system that works correctly after many years is adapted to the specific soil characteristics of the property and needs to be based on a previous soil study.

2.4 Row orientation and slope exposure

The generally observed NW – SE (North/West – South/East) row orientation is appropriate for this wine growing region as it permits good sun exposure in the morning hours, but an even better exposure during the after-midday hours. This row orientation improves photosynthetic activity of the vine plants.

Accordingly, new vine plantings should consider a NW – SE row orientation, which should only be avoided when the slope is too steep.

Regarding the slope exposures, it is recommended to plant vinifera varieties, if possible, on South (especially South West) orientated slopes, as these varieties are less adapted to cool climate conditions; and leave flatlands for hybrid varieties.

2.5 Planting density in order to improve wine quality

Field results confirmed a low photosynthetic canopy surface per soil surface, as the "**C**anopy Height / **R**ow Spacing" (C/R) index is low or very low.

Considering the above-mentioned climate conditions and the short growing period, the sunlight exploitation by the foliar surface of vines (canopy volume) should be very high which is the case of vine spacing with a C/R rate between 0.6 to 0.8.

> *Therefore, a minimal planting density of 4,500 plants per hectare would be highly recommended. This means that, if there is an opportunity to adapt the existing vine grape machinery to a new row spacing, the distance between rows could be established around 2 metres and the plant spacing in the row at 1.1 metres. The optimal corresponding canopy height for this plant spacing should be at 1.8 metres.*