IVES Technical Reviews vine & wine

https://doi.org/10.20870/IVES-TR.2021.4893

Which routes for optimal yield sampling in viticulture?

Sourced from the research article "Is the optimal strategy to decide on sampling route always the same from field to field using the same sampling method to estimate yield?" (OENO One, 2021)[1].

>>> Estimating vineyard crop yield is important for preparing harvesting operations and vatting. Estimations are generally carried out by sampling shortly before harvest and observations are made on a limited number of sampling sites. The sampling process has obvious practical constraints, such as the time allocated to the operation, which determines both the number of sites to be sampled and the route to reach them? <<<

Professionals generally simplify sampling by going back and forth between two rows of vines making observations (number of bunches, number of berries, weight of bunches, etc.), the number of observations being defined by the amount of time allocated to the sampling operation.
But is such a sampling approach really optimal and applicable to all characteristics of the field? For a given sampling duration, would it be possible to make more observations by decreasing the operator's travel time and to ensure a more reliable estimate?
Surprisingly, these issues have received very little attention in the scientific literature. Recent work[2] has proposed a method to achieve better yield estimates by selecting suitable observation sampling sites while ensuring the shortest sampling route. These methods provide more robust estimates with a reduction in estimation errors (expressed as a percentage of the true value) by 5 to 10 points compared to random sampling approaches. Initially developed from high-resolution remote sensing images, this method was used on simulated yield data to see if the optimal sampling route matches the one commonly used by professionals in different situations. The findings of this experiment are summarised below.

■ Yield structured in zones

The way local yield varies within the field (Figure 1) affects the type of optimal sampling route. If the yield is structured into large areas of low and high yield (Figure 1A) then a traditional trip route in which two rows are completed is preferable. However, if the high and low yield areas are small and recurring (Figure 1B), a route that penetrates only parts of the rows near the field entrance is preferable.

■ Yields arranged in gradients

If the crop yield is structured along a gradient (e.g., it increases progressively from the top to the bottom of a slope), the optimal sampling route will naturally be organised along the gradient axis (Figure 2).

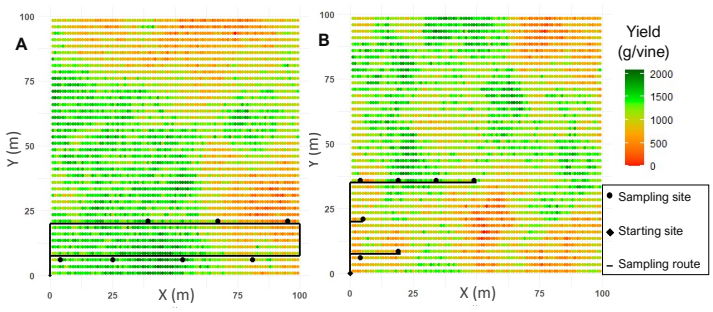


Figure 1. Optimal sampling route with seven sampling sites for two fields of dimensions 100 m × 100 m with yields structured in zones. A) Large zones, B) Small zones.

If the gradient is oriented in the direction of the rows (Figure 2A), the optimal sampling route will logically take the form of a classic round trip through two complete rows. On the other hand, if the gradient is oriented in the opposite direction to the rows (Figure 2.B), the optimal sampling will be conducted perpendicular to the rows, without completing the rows.

■ Row length

The length of the rows also affects the optimal sampling route (Figure 3). For fields with short rows, the optimal sampling route will be a standard route with sampling sites spread over two full rows (Figure 3A). However, in the case of long rows (Figure 3B), a sampling route which penetrates the field from one row edge is preferable. These routes limit the distances to be covered as row length increases.

■ Practical considerations for optimal sampling

The experiments on simulated fields show that the sampling routes via two complete rows, which are

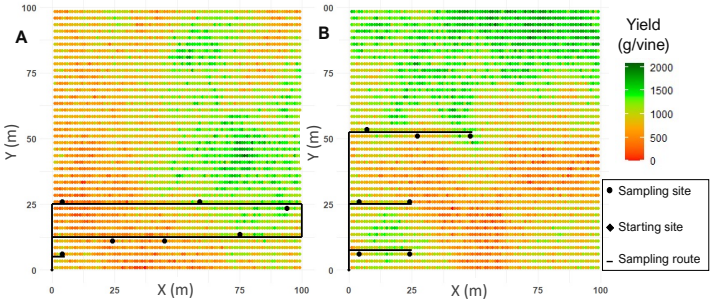


Figure 2. Optimal sampling route with seven sampling sites for two fields with yields structured along a gradient. A) Gradient oriented in the direction of the rows, B) Gradient perpendicular to the rows.

The set-up and launch of IVES Technical Reviews are supported by the LabEx COTE via its Transfer and valorization call for projects.
The translation of this article into English was offered to you by Moët Hennessy.

commonly used by professionals, are optimal for some fields; however, this design is not always the most efficient. Depending on the organisation of the yield zones, routes that stay close to one of the field edges can reduce travel time. This time saving can be used to increase the number of measurements and thus improve the quality of the estimates.

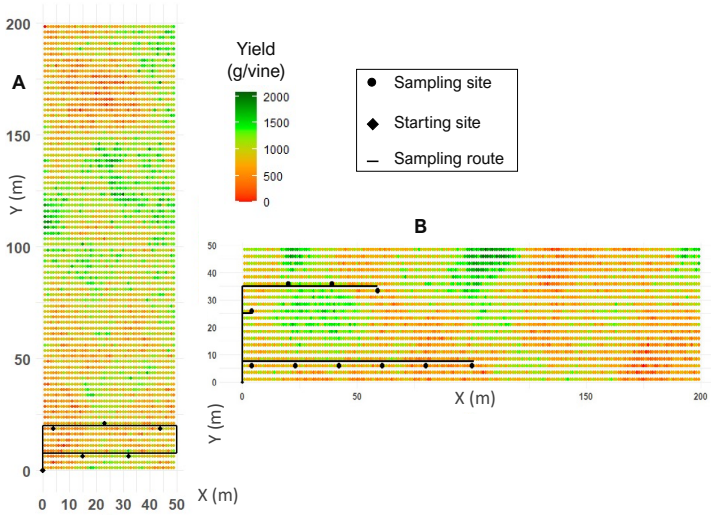


Figure 3. Optimal sampling routes for two fields with the same area but different dimensions. A) Field with short rows (50 m), B) Field with long rows (200 m).

In practice, professionals do not know the spatial organisation of their yield and it is thus difficult to choose the appropriate sampling route for each field. However, this information can be inferred from available data; for example, it is possible to identify a gradient from data related to topometry, vigour (remote sensing[3]) or apparent soil electrical conductivity, which is itself correlated with vigour[4]. Furthermore, to help select the best type of sampling route, the organisation of yield into small (< 10 % of the field) and large (> 25 % of the field) areas can be extrapolated from historical data (such as yield maps when available) or high-resolution vegetation indexes obtained through remote sensing to help select the best type of sampling route. Whatever the sampling route, rows and sampling sites should always be selected to represent the diversity of existing yields within the field. Determining the number of sampling sites is an area of research in itself and a recurring issue for professionals; it directly affects the quality of the estimate, travel time and preferred type of route. However, the number of sites to be sampled will depend mostly on practical constraints that need to be weighed up, such as available time versus desired accuracy, which is a function of within-field variability[5].

This variability will depend on the pedo-climatic context, but it is also specific to each field and its history. In the theoretical fields studied here, the estimation errors decreased significantly with increasing number of sampling sites; beyond seven sampling sites per hectare, the decrease was slower. However, the chosen optimal number of observations must necessarily result from a compromise between operational constraints and local characteristics. A high number of observations will tend to favour the classic two-row sampling route; conversely, a lower number of sampling sites will favour its distribution along the row edge. ■

Baptiste Oger[1,2], Cécile Laurent[1,3], Philippe Vismara[2,4], Bruno Tisseyre[1]

1 ITAP, Univ. Montpellier, Montpellier SupAgro, INRAE, France
2 MISTEA, Univ. Montpellier, Montpellier SupAgro, INRAE, France
3 Fruition Sciences, France
4 LIRMM, Univ. Montpellier, CNRS, France

1 Oger, B., Laurent, C., Vismara, P., & Tisseyre, B. (2021). Is the optimal strategy to decide on sampling route always the same from field to field using the same sampling method to estimate yield?. *OENO One*, *55*(1), 133–144. https://doi.org/10.20870/oeno-one.2021.55.1.3334

2 Oger, B., Vismara, P. & Tisseyre, B. Combining target sampling with within field route-optimization to optimise on field yield estimation in viticulture. *Precision Agriculture* (2020). https://doi.org/10.1007/s11119-020-09744-0

3 Matese A, Toscano P, Di Gennaro SF, Genesio L, Vaccari FP, Primicerio J, Belli C, Zaldei A, Bianconi R, Gioli B. Intercomparison of UAV, Aircraft and Satellite Remote Sensing Platforms for Precision Viticulture. *Remote Sensing*. 2015; 7(3):2971-2990. https://doi.org/10.3390/rs70302971

4 Trought, M. C. T., Dixon, R., Mills, T., Greven, M., Agnew, R., Mauk, J. L., & Praat, J.-P. (2008). The impact of differences in soil texture within a vineyard on vine vigour, vine earliness and juice composition. *OENO One*, 42(2), 67–72. https://doi.org/10.20870/oeno-one.2008.42.2.828

5 Wolpert, J. A., & Vilas, E. P. (1992). Estimating vineyard yields: Introduction to a simple, two-step method. *American Journal of Enology and Viticulture*, 43(4), 384-388.