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DEVELOPMENT OF A TRAINING PROGRAM FOR ENHANCING THE USE OF ICT TOOLS IN THE IMPLEMENTATION OF PRECISION AGRICULTURE

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Training Package 4

Case 4 South Europe: Selective Harvesting of Grapes (SHG)

Tutor instructions

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Note to the teacher: This document contains mainly the same information as the document 'Student guidelines', except for the answers and clarifications in blue color.

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1 Objective

The aim of Case 4 of Training Package 4 on Information and Communication Technologies (ICT) Devices is to present a great example of Precision Agriculture (PA) technologies; Selective Harvesting of Grapes (SHG). This example allows farmers to identify the potential use SHG and the benefits and drawbacks to select this strategy on wine production.

This activity will present the theory behind the selective harvesting of grapes and the expected benefits. Through a reading of a paper students will go in deeply on the methodologies that allows this SHG.

2 Guidelines

2.1 Practical information

- **Main target group**: Agricultural advisers, extension workers, farmers and other agricultural professionals who are interested in SHG and how to benefit from it.
- **Expected duration**: 4 hours
- **Student preparations before the course**:
  - Bring a personal computer with internet access to download the document to read and answer the questions.
  - If you want to work on specific farm, bring your field characteristics (size, rows orientation, varieties, and variability) and harvesting configuration (type of harvesting machinery, operational time, forward speed harvesting)
- **Homework after the course**:
  - Exchange practical experience with other participants: Did they have pre-experience on SHG? Did anybody work with SHG afterwards, and with which results?

2.2 Suggested agenda

1. Welcome and presentation of participants (*10 mins*)
2. Brief presentation of the AgrICT e-training Platform, of the five training packages (TPs) of the platform, and of this case study as part of TP4 (ICT) (*10 mins*)
3. The program of today and alignment of expectations (*10 mins*)
4. Lecture: The theory behind Selective Harvesting of Grapes (*60 mins*)

5. Review of the instructions to the exercise and composition of groups (1-3 persons) for the exercise (*15 mins*)
6. Exercise (*105 mins*)
7. Questions, clarifications and conclusion (*30 mins*)

2.3 Learning goals

- The participants will be able to understand the procedure to obtain the opportunity index of SHG.
- The participants will learn about the main benefits and drawbacks of implementing SHG.
- The participants will understand when the use of SHG is suitable according the winery structure.
- The participants will understand which main parameters that allows SHG are.

3 Exercise

3.1 Goal

Introduce student to selective harvesting of grapes, its technical requirements and procedure to determine the opportunity to introduce this methodology when harvesting.

3.2 Instructions to the exercise

To reach the learning goals of the exercise, students has to read the document available on the following link and answer the questions proposed on this guidelines:

Assessing opportunities for selective winery vintage with a market-driven composite index

From: *Jaume Arnó & José A. Martínez-Casasnovas | (2017) Assessing opportunities for selective winery vintage with a market-driven composite index, Cogent Food & Agriculture, 3:1,1386438, DOI: 10.1080/23311932.2017.1386438*

Questions:

1. What is the minimum row distance for the same grape quality that justifies SHG? How can it be calculated?

The minimum row distance for the same grape quality is the minimum distance that the harvester go across the field without changing the configuration of the harvester due the quality of the grape.

The following text extracted from the document clarifies the answer:

In the case presented, the winery uses grape harvesters with side discharge belts in combination with two tractor-trailer units moving in parallel to the harvester. This operating procedure is adopted for selective vintage that separates only two grape qualities corresponding to two vigour (NDVI) classes. The threshold is set at a distance of 50 m. This value was agreed upon with the winery staff. In European winegrape production systems (particularly in Spain and Portugal), grape harvesters normally operate at speeds ranging between 0.8 and 1.4 m s^{-1}, achieving operating times from 1.5 to 2 h ha^{-1}. For selective vintage, this operating time normally increases, since it is necessary to stop the grape harvester and then change the position of the tractors every time the harvester moves from an area of one grape quality to another of a different grape quality. In order to limit operating costs, the most valuable fields are those that can be harvested with fewer changes. Assuming that the operating time of a selective harvest should not exceed a certain percentage (α) of the time of a conventional harvest α = 0.1, since 10% was suggested by managers for the case study winery), the maximum number of stops (changes in position) per hectare due to changes in grape quality can be determined using Equation (4),

$$N \leq \frac{\alpha \times T_{Ocv} \times 3600}{t_{Csv}}$$

where α is the percentage assumed (0.1, in the present case), T_{Ocv} is the operating time (h ha^{-1}) for conventional vintage, and t_{Csv} (s) is the time required (~10 s) to change the position of the tractor to begin collecting grapes of a different quality. Unlike the previous component (spatial variability), this threshold value is totally conditioned by the specific harvesting system used in the winery under study.

It is suggested that students calculate their own number of stops according to specific farm characteristics.

2. How can we determine the quality of the grapes to be harvested?

The quality of grapes can be determined by data processing, but often it is necessary to make observations in the field to support the determination of this quality.

The following text extracted from the document clarifies the answer:

The idea of using NDVI values to differentiate grape quality is well known, assuming that less vigorous vines produce higher quality grapes. However, there are some drawbacks. The often-assumed negative correlation between grape yield (vine vigour) and quality is not always true, and thus, special care should be taken when making management decisions based on a single layer of spatial data such as the NDVI. Moreover, remote images should be complemented with sampling in order to properly delineate areas with oenological significance at harvest times. Despite these difficulties, there have been many successful experiences in the use of vegetation indices in viticulture, and wineries tend to appreciate the spatial classification of remote sensing images, as it is simple, fast, and affordable.

3. Is there a minimum area that justifies using Selective Harvesting of Grapes?

Yes there is. The following text extracted from the document justifies the need of a minimum area based on profit arguments mainly.

The reasoning for the selection of the threshold is simple. The market plays a decisive factor, and the additional costs resulting from selective harvesting and product streaming should be balanced by higher selling prices. From this economic point of view, a minimum area of high quality grapes is required considering the volumes of the fermentation tanks in the winery. Bramley et al. (2011) provided very interesting results in this respect. They demonstrated that selective harvesting is economically viable in Australia even when the tanks are not used to full capacity. Adopting the same approach for scenarios of increasing demand for quality wines in Europe, the mapping of low NDVI areas (higher quality grapes) should exceed 3 ha, since this is the minimum area required to fill the tanks in Raimat (40 t ferment) to two-thirds of their capacity for winemaking. The fixed threshold, the quality component of the OI_{SV}, is finally computed as shown in Figure 2. Wineries with other capacities are free to adopt another area as threshold value.

As a result, it is not possible to apply the index to smaller areas growing quality fruit unless many such small-sized plots are combined to exceed the required threshold for grape quantities. In fact, Bramley et al. (2011) referred to this limitation, which is a real possibility in many wineries; depending on the employed winemaking strategies and consumer preferences, wineries may harvest grapes separately even for small

areas within a field with the condition that the set of plots (of the own wine cellar or from different vine growers supplying it) offer a minimum quantity of quality grapes.

4. Is it easy to apply SHG in an SME farm?

It depends on many factors such as:

- Skills of the farmer on data management and operator skills
- Size of the farm
- Availability of data processing and images acquisition
- Availability to sell the grapes to a winery that value the high quality of the grape obtained.
- Otherwise, when the production is processed on its own winery, the benefits are defendable from a quality point of view, and of course, economically.

The following text extracted from the document clarifies the answer:

The OI_{SV} has shown good preliminary results. However, there are some unresolved issues such as whether the OI_{SV} can be used in small plots of small- and medium-sized grape growers who usually supply the fruit to large wineries. The OI_{SV} is designed to be applied discretely; that is, it considers each vineyard block individually. As a result, it is not possible to apply the index to smaller areas growing quality fruit unless many such small-sized plots are combined to exceed the required threshold for grape quantities.

5. According to the case study, does the final value of Opportunity Index always match the conditions of the specific field? Is it necessary to adjust the OI_{SV} value according the grower's experience?

The proposed OI_{SV} is flexible to use in that some of the parameters adopted in this study can be modified to better suit the requirements of other wineries.

The following text extracted from the document clarifies the answer:

Some fields, like P09 and P20 (Table 2), showed no opportunity, because they narrowly failed to meet the threshold value for one of the parameters of the OI_{SV}. In other cases (e.g. P29), a similar situation occurred for two of the thresholds. To avoid disregarding plots that could be favourable for selective harvesting, the possibility of reducing the respective thresholds and recalculating the OI_{SV} for such fields was considered. Probably, this post correction may seem lacking in robustness. However, we believe that the grower should be able to review the initial results of the OI_{SV} and, based on the experience of previous campaigns, finally decide which plots are eligible for selective harvesting. In this way, it was arbitrarily decided to reduce the relevant

threshold value by 20% when the fields failed to exceed the threshold for only one of the parameters and by 10% for each parameter when the corresponding values feel short for two of the thresholds. This procedure added seven new fields to those previously selected as being appropriate for selective harvesting.

There is little doubt that selective harvesting can provide economic advantages for a more sustainable and competitive viticulture. Hence, an expert system that includes an OI_{SV} allowing the efficient manipulation and analysis of remote sensing data is much needed to make it easier for the wine sector to decide on selective vintage.

6. Considering the images of Figure 5 of the document, describe the main reasons that explains null OI_{sv} index, medium OI_{sv} index and high OI_{sv} index.

Null OI_{sv} index. Value = 0

- Not suitable for SHG
- Difficulties to change the destination tank of the different qualities
- SHG is only relevant for manual harvesting when high profit is expected on the winery process

Medium OI_{sv} index. Value = 5

- Suitable for SHG
- An adaption of the harvesting machine is needed (a separate hopper should be installed)
- Time consumption for changing the destination hopper will be high

High OI_{sv} index. Value = 11

- Suitable for SHG
- Few changes of hopper are needed. High and low quality grapes will be produced
- Time consumption for changing the destination hopper will be very low.

4 Final considerations

Through the lecture of a Case Study, student will learn that the authors propose an opportunity index that can be useful as a first approximation given the numerical and graphical information it provides. With that information, winery managers can then identify those fields suitable for selective harvesting but containing small-sized areas of quality grapes.

In practice, the Opportunity Index must be viewed only as a support tool for decision-making; harvesting decisions should not be based solely on the OI_{SV}. Any decision resulting

from the use of remote high-spatial resolution images must be supported with appropriate ground-truthing and sampling.

The OI_{SV} is designed to be used mainly by wineries. Since winemakers need to plan production according to grape varieties and quality, it is of great importance to have advanced information about which fields are homogeneous and can be harvested evenly and which are non-homogeneous and prone for selective harvesting.