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Part 1. Evaluation of the overall performance of winegrowing systems in the Bordeaux region and of agroecological transition scenarios (Background and Methodology)

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The agroecological transition is an essential issue for vineyards, given the high pressure surrounding the use of pesticides to protect the crop. Major changes are required in winegrowing systems in order to achieve sharp reductions in the use of these inputs. With the aim of providing technical and practical benchmarks on the performance of agroecological systems, we have built and evaluated scenarios using multiple-criteria decision analysis.

Introduction, background

Driven by European Union regulations, the various Member States have set themselves the goal of significantly reducing the use of pesticides. In late 2012, the French Minister for Agriculture launched the national agroecological project[1], aiming to return agronomy to the heart of the process, closely tied to ecology, in order to achieve a move from conventional systems to agroecological models[2 3], and thus hope for a sharp reduction in pesticide inputs. We conducted research in the Bordeaux region on the use of pesticides in winegrowing systems, their transfer and impact on related ecosystems, and the effects of a change in practice[4]. We then evaluated the agro-environmental and socio-economic performance of around forty professional winegrowing systems (winegrowing facilities on a farm) in the Bordeaux region, as well as the performance of three scenarios based on an agroecological model, by implementing multiple-criteria decision analysis[5]. In this paper, we outline the main methodological aspects and present the results.

Methodological approach: holistic multiple-criteria decision analysis to evaluate the performance of winegrowing systems

The study area is located in the Blaye wine region (10,000 ha) of Bordeaux. It includes an experimental catchment of 830 ha, which serves as a base for environmental chemistry and ecotoxicology analyses and agronomy interviews. In order to broaden the representation of the various modes of production present in the experimental catchment (conventional, different levels of integrated farming, with environmental certification, and organic, biodynamic and agroecological), we met other winegrowers in the study area outside this small experimental catchment. As a result, 38 professional winegrowers were investigated (7 organic, 1 agroecological-organic, 2 with environmental certification, 28 conventional with varying levels of good practice).

The aim was to assess the agro-environmental and socio-economic performance of each winegrowing system (vine cultivation on a farm) according to the practices implemented. To do this, we compared them with "standard values" corresponding to four performance categories (very good, good, average, poor) based on seven weighted criteria (Table 1) in collaboration with the professionals concerned, using SRF software[6].

TABLE 1. The seven criteria adopted and their weighting.

	Criterion	Weight (%)
CR1	**Economic profitability (REN)**	22
CR2	**Crop protection pressure (PPS)**	20
CR3	**Risk of product ecotoxicity (IRE)**	15
CR4	**Agroecological practices (PAE)**	13
CR5	**Sprayer quality (PUL)**	13
CR6	**Workload (TRA)**	10
CR7	**Complexity of the system (SYS)**	7

Green: agro-environmental criteria; orange: socio-economic criteria.

In this study, we have chosen the ELECTRE family of outranking methods for multiple-criteria decision analysis, developed by Roy (1985) and his team at the Université Paris-Dauphine (France)[7]. Team members have been using these methods for around fifteen years in other agro-environmental contexts. They offer several advantages, such as the possibility of including both qualitative and quantitative criteria, and of weighting them. In addition, they allow for the equality or incomparability of alternatives (in this case, winegrowing systems), as well as the concept of weak preference for one alternative over another, or over a benchmark alternative. For this study, we first chose a method that could be used in the context of an alternative sorting problem: ELECTRE Tri-C[6] in order to sort and assign each winegrowing system to one of the predefined performance categories. We also used the ELECTRE III classification method to rank the various systems assigned to the same category. Figure 1 presents the overall methodology. The detailed configuration of the models is explained in the published papers[8 5]. We first evaluated the agro-environmental and socio-economic performance of the 38 professional winegrowing systems surveyed.

Then, in consultation with the professionals concerned, we drew up three ambitious yet realistic scenarios for changing practices. They take into account methods and practices that already exist in the study area, but which are not found within the same winegrowing system.

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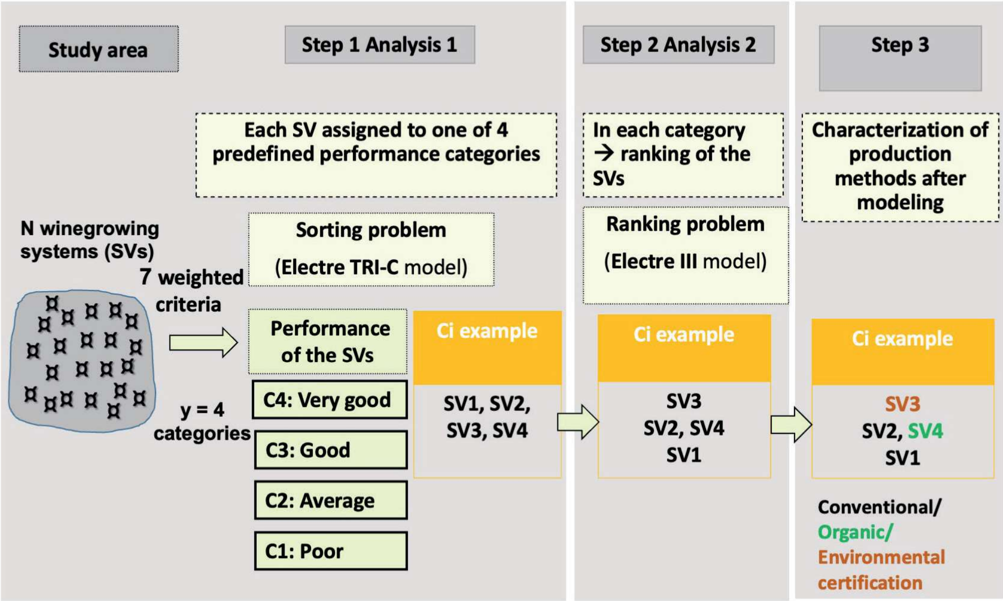

FIGURE 1. Overall methodology for evaluating the performance of winegrowing systems.
C1 to C4 are the four categories in the virtual example.

The survey carried out at the start of the project identified their technical and economic constraints, as well as their needs in terms of changing practices. One of the most important points to emerge from the various consultations was the technical feasibility of new practices in terms of equipment and, above all, workload.

We optimized the integrated farming practices of conventional winegrowers as much as possible (scenario SC1: Max-Integration) and adoption of good agroecological practices in the other two, but with the possibility of using synthetic crop protection products (excluding those that are Carcinogenic, Mutagenic and Reprotoxic – CMR) and herbicides in scenario SC2 (Agroecology). Scenario SC3 is organic (Agroecology-Organic), using the least ecotoxic copper-based formulations (sulfates). The crop protection strategy in these scenarios consists in eliminating all CMR products (types 1 and 2), herbicides between rows and under the vines, anti-*Botrytis* fungicides, as well as insecticides against grapevine moths in scenarios 2 and 3. These are replaced by agroecological practices, so long as the system is holistically designed to (i) optimize the biological quality of the soil, (ii) limit disease by practicing a green harvest, and (iii) use biological control of pests. Empirically, observations made at one of the winegrowers using a systemic agroecological approach show that this admittedly complex management of living organisms bears fruit. It should be remembered that the comparative multiple-criteria analysis of the various systems is carried out at time T, and that the scenarios should be modified if necessary in the event of a very significant change, e.g. in climatic conditions and their anthropogenic consequences, or the arrival of new potential pests. In these scenarios, we thus included a single spray with insecticide against the grapevine moth in scenario 1 (optimized conventional). Soil management is based on maintaining plant cover: green manure sown with a mixture of grass and pulse seeds, then rolling the cover to ensure the longevity of the species, in scenarios 2 and 3. For scenario 1, green manure is sown in every second row, and the other row has natural cover. In all three cases, the agroecological infrastructure includes turning areas (borders) that are grassed over and planted with flowers. In addition, scenarios 2 and 3 include the planting and upkeep of hedges and trees of various species, as well as the installation of bird nesting boxes, bat shelters and insect hotels. Adopting these agroecological practices restores natural biological regulation and eliminates the need for insecticide sprays (with the exception of the compulsory spray against the leafhopper *Scaphoideus titanus*, the vector of flavescence dorée).

The aim of this approach is to provide decision support to the advisors in charge of promoting best practice, and to pragmatically raise awareness among the winegrowers themselves, who alone can decide whether to change their practices and move towards an agroecological transition.
The results of the performance of the agroecological systems are presented and discussed in Part 2[9]. ■

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