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IVES Technical Reviews vine & wine

https://doi.org/10.20870/IVES-TR.2024.8318

Study of pesticide-use pathways during the agroecological transition of DEPHY-Vigne farms

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Created in 2010, the DEPHY-Vigne network is formed of winegrowers who are committed to reducing the use of pesticides, and thus aims to demonstrate that such a change is possible using currently available techniques. The DEPHY-Vigne network showed an average reduction in pesticide use of 32 % over 10 years, with high inter- and intra-annual variability indicating a wide range of pesticide reduction pathways[1].

Purpose of the study

This study aims to characterize the diversity of individual pesticide-use pathways in DEPHY network vineyards over 10 years. Our study is based on 161 wine estates in 11 French wine regions (Alsace, Bordeaux, Bouches-du-Rhône, Bugey-Savoie, Champagne, Burgundy, Charente, Côtes-du-Rhône, Gaillac, Provence and the Loire Valley).
The data used comes from the AGROSYST database, which compiles data on the environmental, economic and technical practices and performance of wine estates in the DEPHY-Vigne network. The change in pesticide use was measured using the Treatment Frequency Index (TFI) excluding biological control (biocontrol).
Initially, TFI pathways were described using various indicators to measure the degree of reduction in the TFI and its regularity from one vintage to the next. Clusters of TFI pathways were then established using Principal Component Analysis followed by hierarchical clustering of the principal components.
Secondly, the change in plant protection strategy and the levers used by winegrowers over time for each cluster were identified and compared. The different database indicators used to describe changes in plant protection strategy were: **type of product used** (Carcinogenic, Mutagenic, Reprotoxic (CMR) products, biocontrol products, and copper and sulfur products), **dose of plant protection products applied** (fungicides, herbicides and insecticides, calculated from the TFI) and **production method** (conventional, in conversion or organic).

Description of the different TFI reduction strategies

The statistical analysis identified three clusters of TFI pathways (Figure 1), distributed across all the wine regions studied. All three clusters show a significant reduction in TFI, but the degree of reduction differs.
Cluster 1 represents wine estates with an initial TFI close to the regional average. These wine estates **did not significantly reduce** their TFI over 10 years. Cluster 2 comprises wine estates that joined the DEPHY network with low pesticide use compared with the regional average. These estates reduced their TFI by 48 % on average, from an average TFI of 8.2 to a TFI of 4.2 (i.e. a 4-point reduction in TFI). Cluster 3 represents wine estates with high initial pesticide use (a little over the regional average). These wine estates saw the biggest reduction over 10 years, with an average 63 % reduction in TFI, from a TFI of 20.8 to a TFI of 7.7 (i.e. a 13.1-point reduction in TFI).

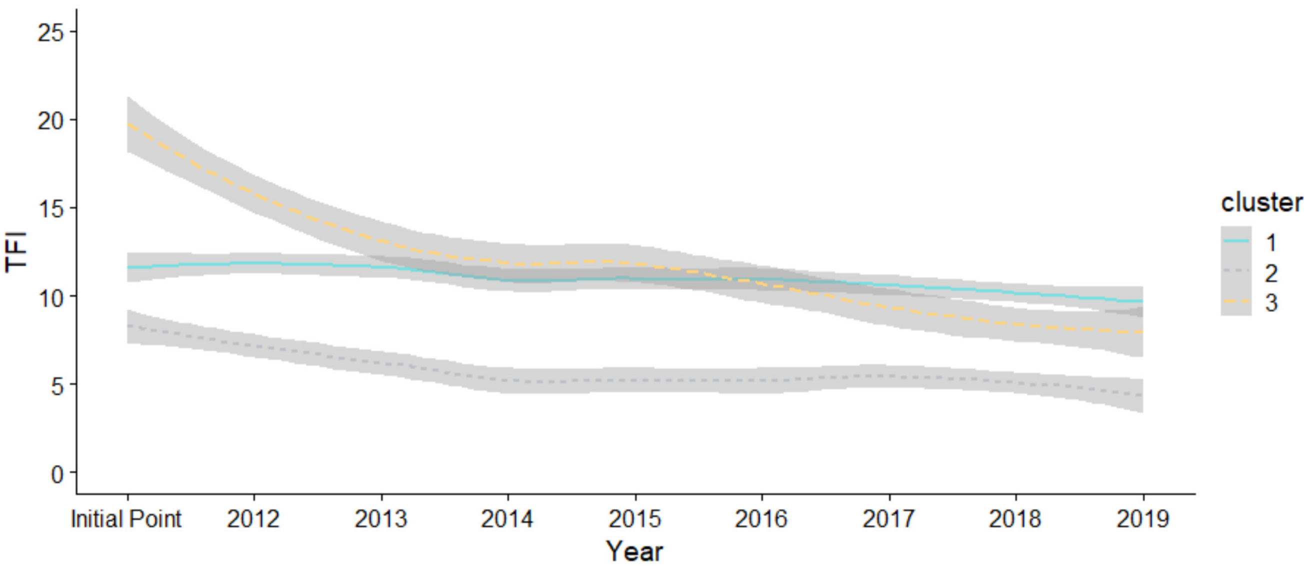
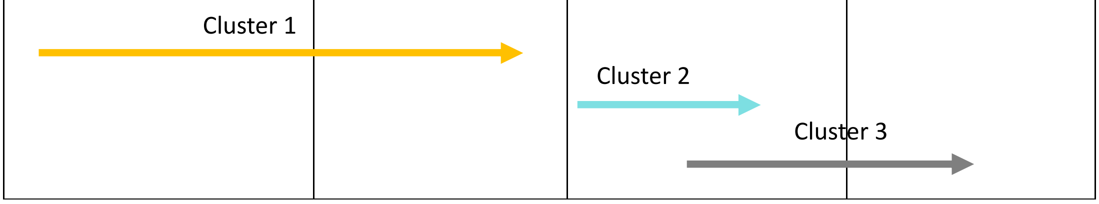


FIGURE 1. Average TFI pathway by cluster – cluster 1 in blue (initial TFI normal), cluster 2 in gray (initial TFI low) and cluster 3 in yellow (initial TFI high).

The translation of this article into English was offered to you by Moët Hennessy.

TABLE 1. Summary of changes observed between 2010 and 2019 for each cluster, classified by their magnitude according to the ESR framework[4].

Conventional	Efficiency	Substitution	Redesign
Example			
Use of CMR product s No dose adjustments Chemical weeding	Dose adjustments Increase in the biocontrol rate	Use of biocontrol products (sulfur, mating disruption…) Increase in the biocontrol rate	Conversion to organic farming Stopping the use of herbicides



The plant protection strategies of each cluster are positioned on an Efficiency/Substitution/Redesign (ESR) gradient, with the addition of conventional practice (i.e. with no adaptation the plant protection strategy). Practices corresponding to each strategy have been listed under each heading (conventional, Efficiency, Substitution and Redesign).

Factors explaining the differences in the degree of pesticide reduction between clusters

Differences in the degree of TFI reduction between clusters depend on the initial TFI when joining the network. Our results confirm that it is easier for wine estates with a high TFI to reduce their pesticide use than for those starting out with a TFI below the regional average. For winegrowers with high initial pesticide use (cluster 3), modifying the plant protection strategy (dose reduction, change of product) is based on levers that have little impact on the organization of the estate but a high and rapid impact on the TFI. Conversely, those in cluster 2, which have implemented levers with a more far-reaching impact on the organization of the estate (mechanical weeding under the rows, conversion to organic farming), have a high percentage reduction in TFI, but lower in terms of TFI points. In 2019, most of the cluster 1 and cluster 3 estates were conventionally farmed (98 % for cluster 1 and 91 % for cluster 3). Of the winegrowers in cluster 2, 36 % were already practicing organic farming when they joined the network, and more than half (55.2 %) were organic by 2019. Some were still in conversion in 2019.

All wine estates used the same levers at the start of their transition to reduced pesticide use: these levers focus mainly on improved efficiency (e.g. reducing doses according to the phenological stage of the vine, using Decision Support Tools) and substitution (replacing CMR products with non-CMR or biocontrol products).

Changes in the plant protection strategy of cluster 2 systems that go further in terms of reduction

While the pathway followed by cluster 3 winegrowers is essential to reduce pesticide use quickly and strongly without a paradigm shift, the pathway followed by cluster 2 winegrowers seems to us to be particularly inspiring if reduction is to go further. These winegrowers are already ahead when it comes to efficiency, with careful calculation of the doses applied. To go further, these growers are rebuilding their strategies using copper-based sprays as well as mating disruption and biocontrol. These changes have been accompanied by a shift to organic farming at estate level. The technical levers associated with this mode of production are the use of copper and sulfur, the elimination of systemic pesticides, and the introduction of tillage to eliminate the use of herbicides. At the same time, prophylactic practices are being incorporated into technical procedures, with increasingly preventive pest control strategies and the installation of agroecological infrastructure.

Conclusion

This study shows that it is possible to significantly reduce the use of plant protection products (an average 32 % reduction in TFI) through a combination of known levers that do not require a radical rethink of technical procedures. The reduction in pesticide use is even greater when the initial TFI is high. The clusters identified provide a solid basis for more in-depth studies on the transition to less pesticide-intensive production systems, for more precise identification of the levers used and their implementation over time. The database does not enable further analysis of the progress made by growing systems that are changing their practices more radically (cluster 2). Surveys have been carried out to trace them in greater detail[2]. In addition, work on the same database, looking at the impact of pesticide reduction on economic, technical and production performance (yield), showed that reducing the use of herbicides and fungicides had no impact on yields[3]. ■

Acknowledgement: *This research is part of a thesis project funded by the Occitanie Region (France) and the ECOPHYTO Plan (ARPHY - OFB No. 4147). The authors gratefully acknowledge the support of the Agence Nationale de la Recherche (ANR) under grant 20-PCPA-0010 (VITAE). The authors thank the DEPHY National Coordination Unit and the AGROSYST team for their support.*

Sources: *Sourced from the research article: "Diversity of Pesticide Use Trajectories during Agroecological Transitions in Vineyards: The Case of the French DEPHY Network" (Agricultural Systems, 2023).*

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