MANAGEMENT OF SANITARY AND ENVIRONMENTAL IMPACT OF AGRICULTURAL PHYTOSANITARY PRACTICES: CASE OF FARMS IN THE SOUTHWEST OF FRANCE

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STUDY CONTEXT

The extensive use of pesticides currently constitutes a major environmental and public health issue (Inserm, 2013; Berardi Tadié and Bonvarlet, 2019). These challenges have led successive French governments to make commitments to reduce the use of pesticides, such as the implementation of the 2018 and 2025 Ecophyto plan, by monitoring the evolution of pesticides use with pressure indicators: TFI, NODU and QSA have been used. Other generic, simple and flexible indicators are used: IRSA and IRTE (Mghirbi et al., 2015, 2018), to assess the potential risk of phytosanitary products and their impacts on human health and non-target organisms.

OBJECTIVE

The objective of this study is to analyse plant protection practices according to cropping and production systems (conventional/integrated and organic) to assess and manage the risk associated to diffuse phytosanitary pollution at field level located in the southwest of France, and to implement alternatives that are less toxic and pesticide-consuming.

STUDY AREA

South and southwest of France, 4 departments, 147 farms, 15 874 ha, 38 crops studied, conventional/integrated and organic farming

Table 1. Sample of farms surveyed

Department	Number of farm	Area (ha)
Tarn et Garonne & Gers	86	14 053
Gironde	39	914
Hérault	22	907
Total	**147**	**15 874**

Source: Field surveys (2009-2019)

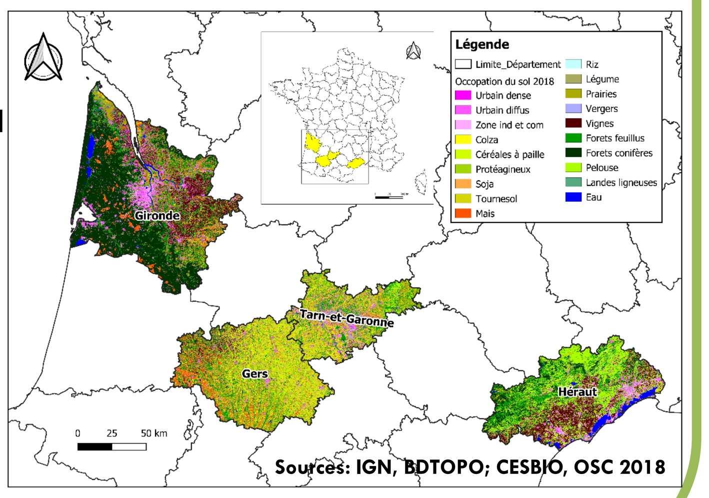

Figure 1. Location of study area

PHYTOSANITARY PRACTICES EVALUATION INDICATORS

This work aims to define a methodological framework for using and enhancing a database of agricultural phytosanitary practices collected between 2009 and 2019 in four French departments (Gironde, Tarn-et-Garonne, Gers and Hérault) in order to assess the impact of these practices in terms of phytosanitary pressure (TFI), health risk (IRSA) and environmental risk (IRTE) calculated by the EToPhy[1] software (Le Grusse et al., 2014). In addition, these indicators break down into acute and chronic IRSA sub-indicators and IRTE sub-indicators for terrestrial invertebrates, birds, and aquatic organisms (Mghirbi et al., 2015).

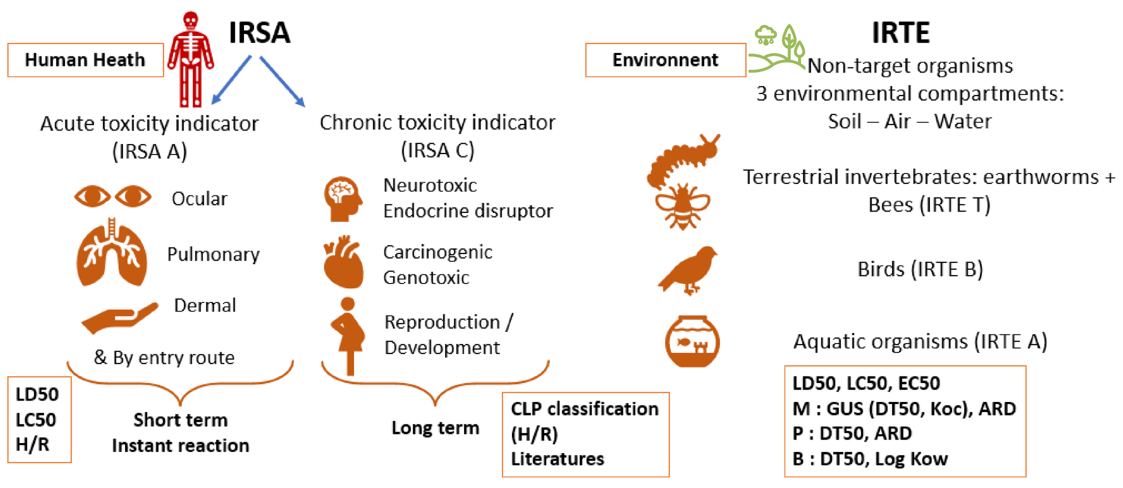

Figure 2. Risk indicators to assess plant protection practices

LD: Lethal Dose; LC: Lethal Concentration; EC: Exposure Concentration; GUS: Leaching potential index; ARD: Applicated Reference Dose
M: Mobility; P: Persistence; B: Bioaccumulation

[1]**EToPhy software (2020)**, APP deposit n°: IDDN.FR.001.090003.000. S.P.2020.000.31500

METHOD OF PHYTOSANITARY PRACTICES ASSESSMENT

The impact assessment method of crop treatment practices is carried out in two stages (Figure 3): the first consists in developing a global analysis correlation between the different indicators and studying the variability of the indicators and sub-indicators for each crop, across all departments. The second stage consists in analysing the phytosanitary practices of crops between departments, followed by an interregional comparison of the south and southwest of France. In addition, an inter-annual analysis of phytosanitary practices is carried out to assess the results of the Ecophyto plan at farm level which are part of the *FERME DEPHY* network. Based on this analysis, a repository of phytosanitary practices was developed to compare the use of pesticides between crops and production systems (conventional, integrated and organic) according to a typology of phytosanitary practices which makes it possible to define 3 levels of crop treatment practices (low input, moderate input, high input). This methodological approach leads us to analyse the origin of the difference between the crop treatment practices of the same crop on the same territory. Based on this analysis, we end the process by putting forward alternatives through the management of pesticide choices to reduce the potential health and environmental risk of phytosanitary products applied by farmers.

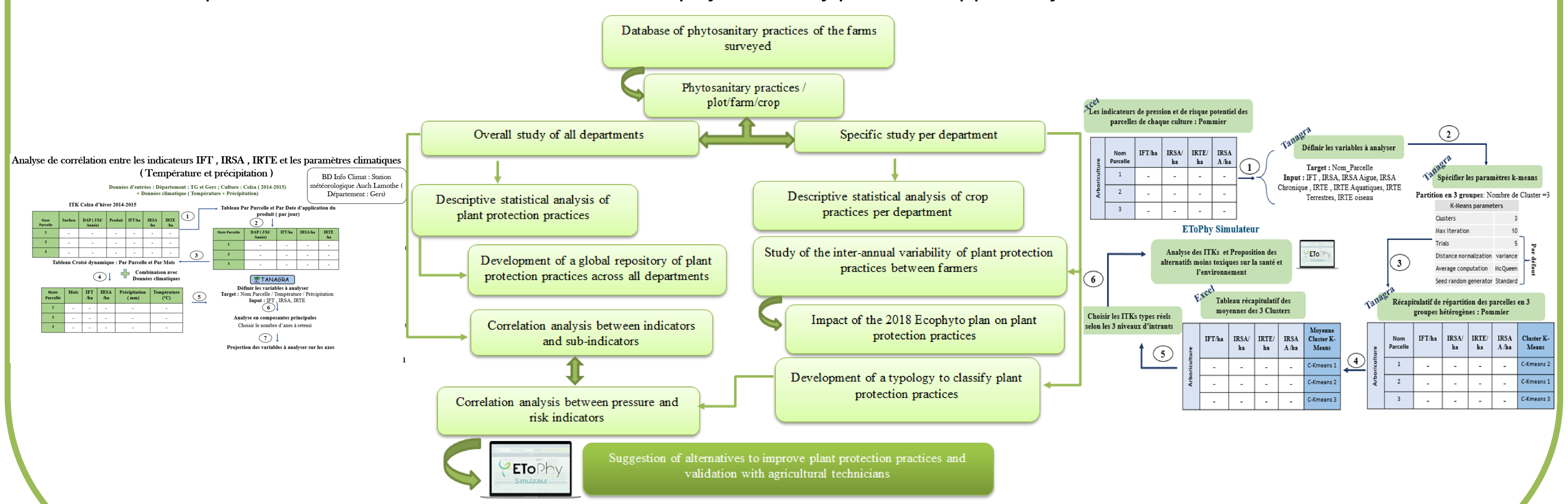

Figure 3. Process of phytosanitary practices assessment

RESULTS & DISCUSSION

The results of the global correlation analysis between the different indicators according to the crops show a medium or even strong correlation between phytosanitary pressure (TFI) and risk (IRSA and IRTE) (Figure 4.A). Overall, the more the TFI increases, the greater the risk to human health and the environment, but at equivalent TFIs, risk levels may vary greatly depending on the products or active ingredients used. These results lead us to the analysis of the variability of crop protection practices and their relationship with climatic factors to justify the choice of the crop treatment practices applied at field level in the different departments.

The crop repository shows the variability of phytosanitary practices according to the cropping and farming system (conventional, integrated, organic). The tree crop consumes the most pesticides, especially apple trees (Figure 4.B & C). In addition, organic farming poses a higher risk to the environment than sustainable or conventional farming due to the excessive use of copper and sulphur (Figure 4.D & E). The analysis of crop treatment practice makes it possible to deal with the most toxic products to human health and the environment by determining the contribution of each product to risk and pressure, and the target that it corresponds to. This analysis leads to the identification of less toxic alternative products using the EToPhy tool via Dephyto[2] platform which offers the possibility of proposing a list of alternative products according to the target and crop, with a view to improving the choice of pesticides and validating their effectiveness with agricultural technicians.

	IRTE/ha	TFI/ha	IRSA/ha	IRTE A/ha	IRTE B/ha	IRSA C/ha	IRTE T/ha	IRSA A/ha
IRTE/ha	1	0,8719	0,84191	0,9516	0,93503	0,74486	0,71805	-0,04802
TFI/ha	0,8719	1	0,92642	0,84378	0,7979	0,87987	0,62041	-0,12659
IRSA/ha	0,84191	0,92642	1	0,79838	0,80084	0,97341	0,58841	-0,07798
IRTE A/ha	0,9516	0,84378	0,79838	1	0,85749	0,68445	0,54353	-0,04229
IRTE B/ha	0,93503	0,7979	0,80084	0,85749	1	0,69006	0,55921	-0,11406
IRSA C/ha	0,74486	0,87987	0,97341	0,68445	0,69006	1	0,59967	-0,08067
IRTE T/ha	0,71805	0,62041	0,58841	0,54353	0,55921	0,59967	1	0,05116
IRSA A/ha	-0,04802	-0,12659	-0,07798	-0,04229	-0,11406	-0,08067	0,05116	1

High correlation | Moderate correlation | Low correlation

A

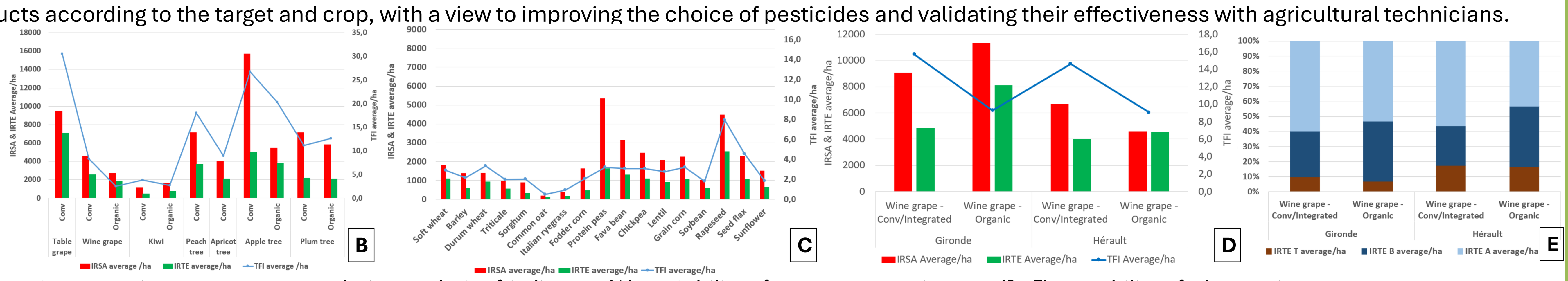

Figure 4. Results of phytosanitary practices assessment: correlation analysis of indicators (A), variability of crop treatment impacts (B, C), variability of phytosanitary treatment impacts of wine grape in organic and conventional farming (D), the toxicity proportion of phytosanitary practices on wine grape in each environmental compartment (E)

CONCLUSION

Agri-environmental indicators are used to build tools for the analysis and management of phytosanitary practices. These tools make it possible to study the relationship and the variability between the pressure and the potential risk of pesticides according to crops. They also help define priorities for the implementation of other levers to reduce the use of pesticides and improve the health and environmental performance at farm level. This work also shows the importance of developing a repository that takes stock of the difference within phytosanitary practices between crops and farming systems (conventional/integrated and organic) at a regional level.

[2]**Dephyto platform: https://www.dephyto.com/**

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