

Virtual Mobility Grant report

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Country-survey for France

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Introduction

The 2009/128 SUD directive has been translated in the French regulatory framework as the Ecophyto program. Its implementation since 2010 has mobilised all organisations involved in agriculture, from research, innovation, extension services and farmers and farmers' organisations. The ministries (agriculture, research, environment, health) have been very committed in the definition and implementation of Ecophyto and its various versions

(Ecophyto 1, Ecophyto 2, Ecophyto 2+, Ecophyto2030)¹. The topic of pesticide use is societally very acute and induces a lot of debates. The transition is taking place under a strong lobbying of farmers organisations and trade unions in order to preserve the use of pesticides, and avoid the phasing out of active substances under threat of withdrawal.

This lobbying which is not specific to France, is part of the national context of the French agriculture, where a very broad range of crops is produced by very contrasting types of farms and to using many active substances. The French context is also the peculiarity of the research (one large national public research organisation, Inrae and one research organisation for overseas, Cirad), of the applied research with a rich network of 17 agriculture technical institutes coordinated by ACTA, a network of chambers of agriculture with a key role of extension which they are all chaired by a farmer belonging to one of the trade unions and a rich network of cooperatives, each of them having its own technical and advisory service.

After 15 years of action in the Ecophyto plan, the crop protection in France still heavily relies on the use of chemical pesticides. However, several key elements arose over years: i) there has been emergence of a lot of innovations in biocontrol, even though the regulatory framework is slowing down the emergence of numerous innovation; ii) the awareness of the severe impact of pesticides on human health and environment has increased; iii) major scientific breakthroughs occurred for deeply revising the control of insect (chemical ecology) and fungi (plant microbiota); iv) redesigning the cropping systems contributes to more prophylaxis, but is difficult to implement; v) the need to anticipate the withdrawal of molecules, while avoiding the competition distortions with neighbouring countries.

The overall strategy of the French government and French agriculture could be summarized as the combination of actions at three timescales:

- Short-term: supporting farmers and farmers organisations in the transition towards less use of pesticides through the search of efficiency, while avoiding an unfair competition with neighbouring countries (Ecophyto, Comité des Solutions, Praam program)
- Mid-term: searching for alternatives to active substances through a substitution approach (Parsada, Grand Défi)
- Long-term: searching for disruptive innovations, through the exploration of fertile research frontiers (microbiota, chemical ecology) and redesign of crop production systems (PPR Growing and Protecting Differently)

Use of plant protection products over the last decades

Slightly less chemical pesticides, less toxic chemicals, more biocontrol

The trajectory of volume of products used for crop protection is scrutinized every year. The last data available are shown in Figure 1². Since the implementation of the Ecophyto plan, the volumes, expressed in tons, remain stable, except in 2018 and 2019 due to a tax issue.

¹ <https://agriculture.gouv.fr/strategie-ecophyto-2030>

² <https://www.notre-environnement.gouv.fr/themes/sante/la-pollution-des-sols-ressources/article/les-ventes-de-produits-phytosanitaires-en-france#Repartition-des-ventes-en-France>

However, behind the overall volumes, a significant transition occurred. Indeed, products usable in organic farming or related to biocontrol (solutions of natural origin) represented approximately 36% of sales in 2023, vs 14% in 2009 (Figure 2). These products primarily consist of fungicides (73%) and insecticides (23%), with herbicides being virtually absent, pelargonic acid being the only option with high price and low efficacy. After a strong growth until 2021, the sales slightly declined between 2021 and 2023. The innovation is critical in this domain. These significant volumes of 'organic farming' and 'biocontrol' products are mainly related to the use of i) copper sulfate, whose environmental impacts are more and more debated and ii) sulphur micronized powder. The increasing volumes are mainly related to this last class of compounds, whose range of approved uses has increased over the last years. Indeed, while it was mainly used on vineyard to control powdery mildew, it is now approved on cereals and wheat to control Septoria. These trends show that, up to now, in the French farming systems, the 'biocontrol' products are mainly increasing in substitution approaches.

A major change also occurred regarding the most harmful substances. Indeed, some active substances contained in pesticides are classified as CMRs, meaning they present particular risks to human health. This means they are:

- carcinogenic – they can cause cancer,
- mutagenic – they can damage DNA,
- toxic to reproduction – they can harm fertility or foetal development.

In 2023, these hazardous substances represented 16% of the quantities sold, compared to 32% in 2010 (Figure 3). The most dangerous of these, called category 1 CMRs, are those whose toxicity to humans is proven or highly probable. They are now used very little: only 0.1% of sales in 2023. This decrease is largely explained by the gradual withdrawal of certain substances from the market, such as phosmet, which was banned at the end of 2022.

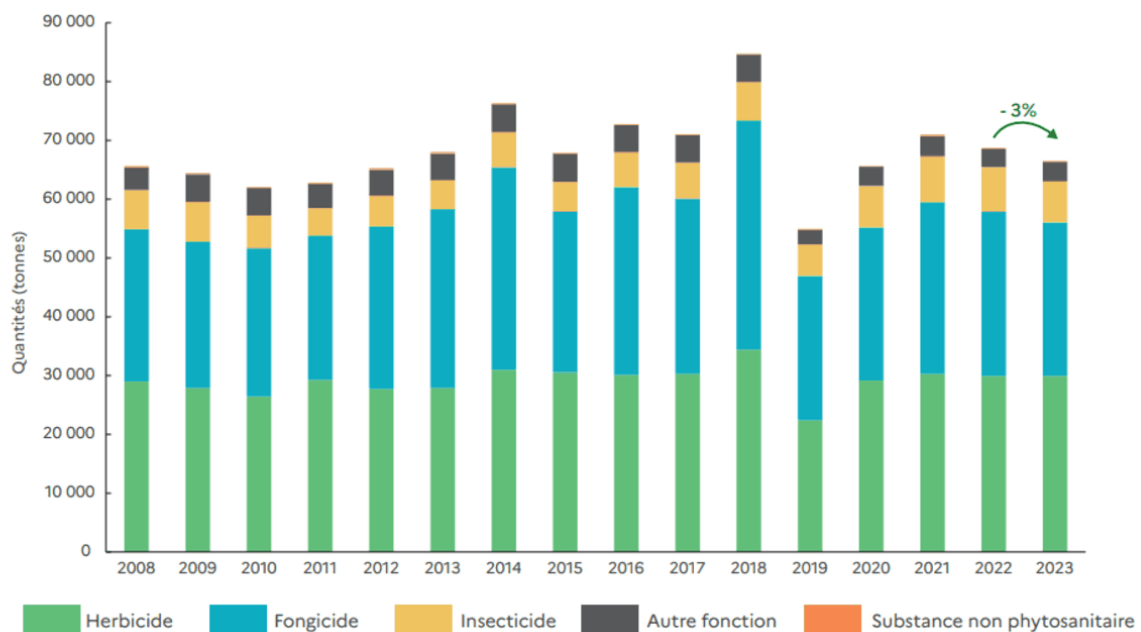


Figure 1: Annual quantities of active substances sold in France. The main three targeted functions are herbicides, fungicides and insecticides. Source: Ministry of Agriculture

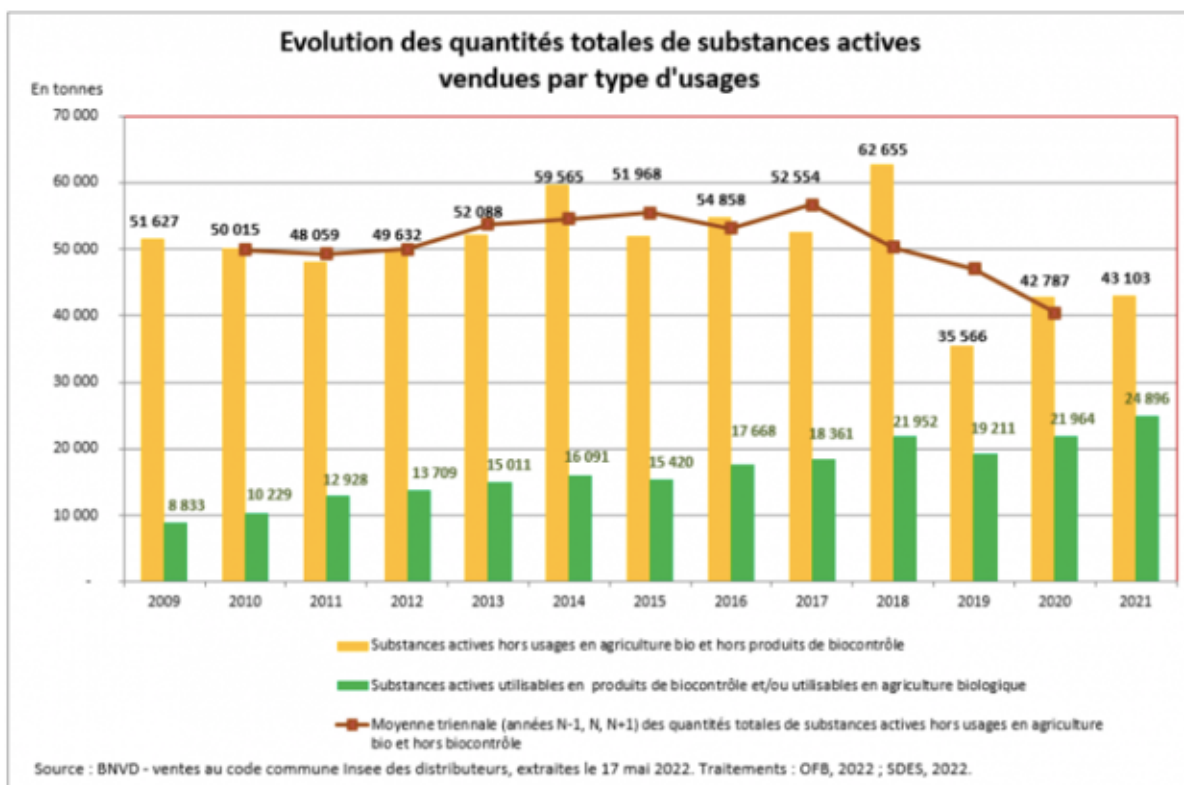


Figure 2: Annual quantities of active substances sold in France, being either (in green) or not (in orange) authorised as biocontrol or in organic farming.

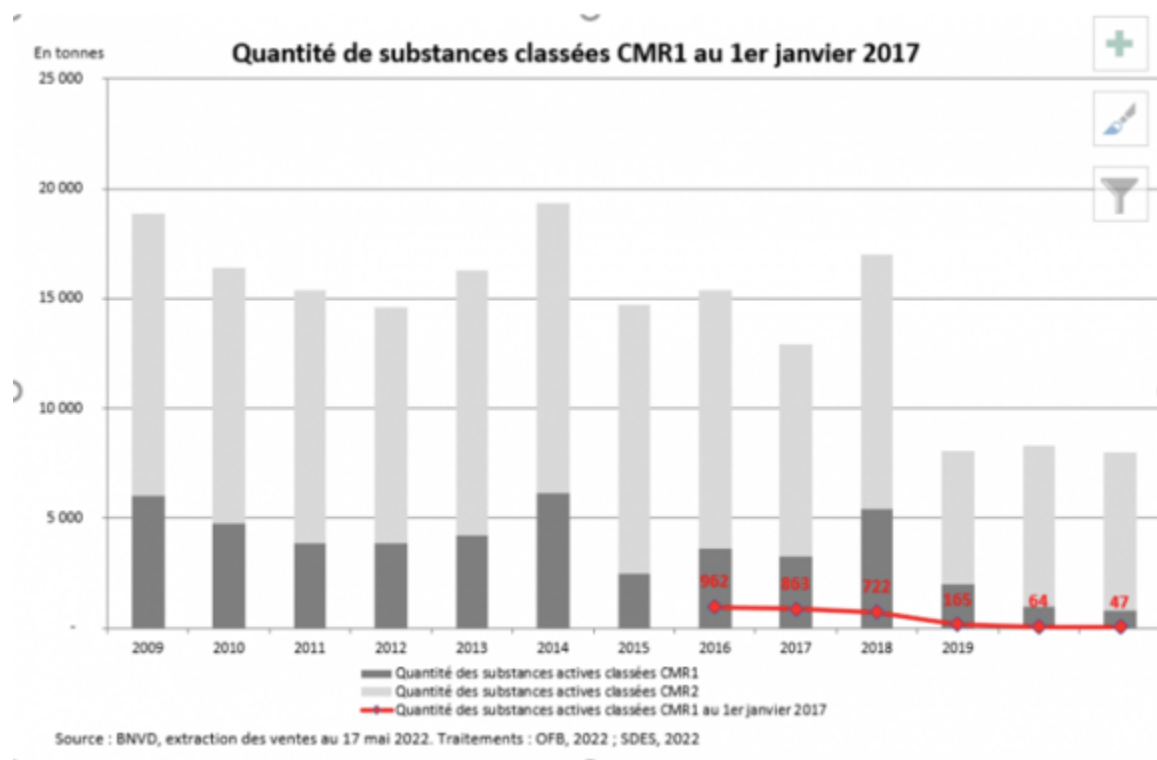


Figure 3: Sales of CMR products.

The drastic reduction achieved in the farms network Dephy-Ferme. What are the lessons?

As part of the Ecophyto plan, an action, named Dephy-Ferme, was dedicated to set and support groups of 8-12 farmers committed in the reduction of the use of pesticides. A total of 3000 farms was selected, covering all supply chains and scattered all over France, both metropolitan and overseas. Those groups of farms benefited from the technical advice and their practices and productive and economic results were recorded and made available on a common database, Agrosyst³. All data in Agrosyst are anonymized and may be used for research, public policies or for developing tools for supporting farmers.

The survey of this large group of farmers, over a period of 15 years, shows a reduction of use of pesticides which is beyond the average national value.

The last global synthesis, published in 2023⁴, showed that the reduction of pesticide use, measured by the FTI, ranged from -18% to -38% from the initial value (average of 2009/2010/2011) till the average of 2018/2019/2020. The reduction reached -29% to -46% for the year 2020 only. Doing so, all supply chains in the Dephy network achieved the objectives of the Ecophyto plan which was to reduce the FTI by 25% in 2020. The largest reduction was achieved in horticultural crops, and the smallest on annual crops.

It was also clearly documented that the reduction of pesticide use had absolutely no impact on the productive and economic performances of the farms.

The gap between these groups of farmers and the average of the France as a whole may be due to the fact that i) the Dephy farmers were volunteer and as such very committed in their crop survey and in the implementation of the best practices and ii) they received a close and intense dedicated technical support.

A continuous emergence of resistance to chemical pesticides

As it is the situation in all the countries where pesticides were massively used for achieving good sanitary situations of crops, France experiences a continuous emergence of resistance to active substances. The situation is particularly difficult for the weed control in cereals and for the control of insects.

For the weed control in cereals, the resistance of *Alopecurus myosuroides* and ryegrass to HRAC2 herbicides has dramatically increased, as documented in Figure 4 through a national survey. The emergence of these resistances was documented by the early works of Chauvel et al (2009)⁵. Resistance to ALS (HRAC group F2) was also observed on other crops, such as sunflower when aiming at controlling ragweed (*Ambrosia artemisiifolia*) which is an invasive and allergenic weed in annual summer crops. Number cases of ragweed resistance were detected in 3 different regions⁶.

The quick emergence of resistance to ALS inhibitors is due to the fact that 7 mutations on the targeted genes may induce a mechanism of resistance.

³ <https://agrosyst.fr>

⁴ <https://ecophytopic.fr/sites/default/files/2023-06/Synth%C3%A8se%20DEPHY%20FERME%202023.pdf>

⁵ Chauvel B., Guillemin J.P., Colbach N., 2009. Evolution of a herbicide-resistant population of *Alopecurus myosuroides* Huds. in a long-term cropping system experiment. Crop Protection 28, 343-349

⁶ <https://ambrosie-risque.info/lambrosie-est-elle-resistante-aux-herbicides/>

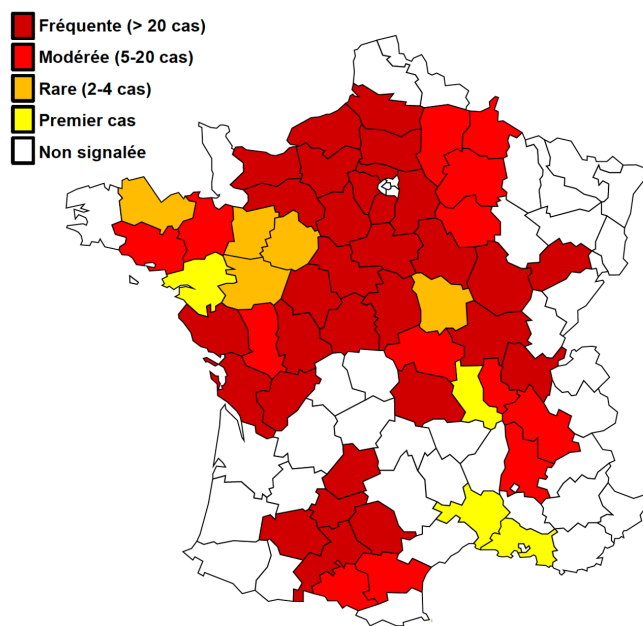


Figure 4: Geographic distribution of resistances of ryegrass to herbicides (HRAC2, ALS inhibitors). Source: R4P network, 2024⁷

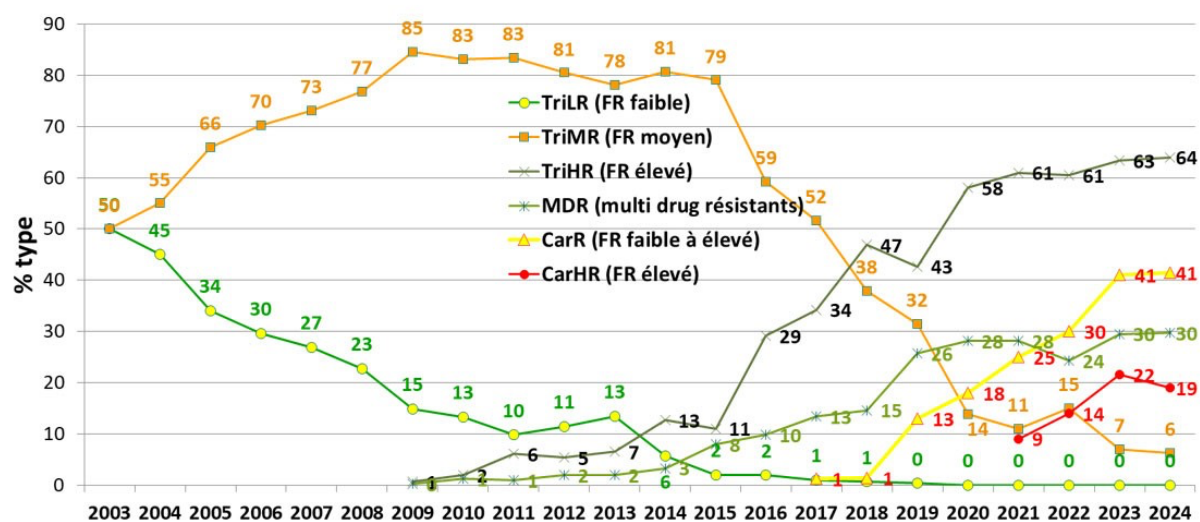


Figure 5 : Changes in the septoria populations in France according to the resistance phenotypes in samples of Performance network since 2003 (Inrae, Arvalis, Anses)

A similar situation was documented for the resistance of fungi to the various fungicides (Figure 5). This graph shows that resistances are emerging nation-wide as a consequence of the fact that all farmers are using a limited range of active substances, applying the recommendations of the technical institutes and using the most recent molecules. Doing so, farmers, extensionists and technical institutes forget the Principle 5 of the Integrated Pest Management which is the background of the SUD Directive.

⁷ <https://www.r4p.fr/le-reseau-r4p>

A continuous reduction but severe dead-ends induced by the withdrawal of some active substances

As it is the case when resistances emerge, the withdrawal of some active substances may induce severe difficulties for some crops, when they are relying on few or even one chemical for a given objective. In such a situation, the producers are facing dead-ends, which are often not anticipated. This was the case for some emblematic production, such as

- Control of fruit flies on cherry trees with dimethoate.
- Control of cabbage-stem flea beetle (*Psylliodes chrysocephalus*) and *Ceutorhynchus napi* carabids on winter rapeseed with phosmet banned in 2022
- Control of green aphids and viruses on sugar beet with neonicotinoids, banned in 2018.
- Control of nut weevil (*Curculio nucum*) and brown marmorated stink bug (*Halyomorpha halys*) on hazelnut, with acetamiprid, banned in 2024
- Control of weeds in Witloof chicory with benfluralin, banned in 2025

Those situations created a context which is very different of the one met when targeting a reduction of use and impacts. Indeed, instead of looking for more **efficient** protection methods, leading to the use of less active substances or for **substitution** by other chemicals, which is not possible when the withdrawn active substance was the last one, the producers have to redesign their production systems. This is not possible, if it has not been anticipated. In order to avoid unexpected dead-ends, the French Ministry of agriculture asked Inrae, in coordination with ANSES, the French agency in charge of the evaluation and delivery of approval of commercial products, to produce reports of the possible chemical or non-chemical alternatives to a range of active substances which are under revision. Such reports were produced for glyphosate on a series of crops (annual cropping systems, orchards, viticulture), S-metolachlor, prosulfocarb, diflufenicanil.

More and more financial claims after health problems due to exposure to pesticides

In the case of health issues due to exposure to pesticides, it is possible to claim from the Fonds d'indemnisation des victimes de pesticides (FIVP)⁸. This fund became fully operational in 2021. The volume of claims has dramatically increased in 2024 and reached more than 1000 cases in 2025, mainly arising from farmers, with 92.5% of the claimers being men. They mainly work or worked in mixed crop-animal production systems (30%), annual grain crops (13.4%) or in viticulture (12.6%).

The impact on human health, and especially when children are involved, has induced a major concern in the French society and explains the strong mobilisation of the population.

In 2025, the total of the claims reached 25 M€.

Many research projects have been carried out, analysing the impact of active substances on human health.

Debates on the indicators of pesticide use and impact

Since the early implementation of the French Ecophyto plan, and again in the last years, a strong debate occurred on the best indicator or indicators to be used to measure the use and

⁸ <https://fonds-indemnisation-pesticides.fr/>

impacts of plant protection products and its changes over years. Indeed, the initial objective of Ecophyto was to reduce the use of pesticides by 50%, if possible. But the indicators to measure this reduction was not precisely defined.

Alongside with the volumes (figures 1 to 3), France made the choice of NODU, which is documenting the number of doses applied, a dose being the quantity which is legally approved for a given crop against a given pest at a given phenology. The choice of NODU was a matter of long debates (Urruty et al, 2015)⁹. Its major weaknesses were i) its complexity as an active substance may be used on different crops at different doses and ii) the strong influence of a change in the approved doses. This occurs for instance in the case of glyphosate in 2021 and 2022, where despite a 30% reduction in tonnage of glyphosate, the number of NODU slightly increased as the approved doses had been drastically reduced. On the other side, NODU has the major advantage to be closely related with farming practices, as the approved dosage was the basis to measure the TFI (Treatment Frequency Index). In 2024, in order to answer to farmers request and to increase the link with the EU indicator, the French government proposed to adopt the HRI-1 (Harmonized Risk Indicator). An expertise analysis was provided by Inrae¹⁰ which identified the severe limits of this indicator, especially as the classes of risk were very broad and the coefficients applied to every class were not relying on any scientific or technical basis. Instead of HRI-1, the expertise work proposed to adopt and adapt the ATAT (Aggregated Total Applied Toxicity), where the toxicities to a range of organisms measured at the approval of the active substances are used and where the weighing of the various toxicities may be decided as a result of political choices and priorities.

Major national research and innovation programs

Ecophyto

The Ecophyto plan is funded through a tax collected on the sales of pesticides. This tax volume reaches annually 150-180 M€. As part of the plan, an action was dedicated to the support of research and innovation. This, in particular, included the Dephy-Expé programs (from Dephy-Expe 1 to on-going Dephy-Expé 3), where, for all supply chains, experiments were implemented for low pesticide use systems (Emonet and Rougier, 2018¹¹; Emonet et al, 2024¹²). Every project, when concluded, is presented, with its major achievements in a dedicated paper, published in the *Innovations Agronomiques* journal.

In addition, dedicated calls for proposals were launched to select research projects contributing to production of knowledge and innovations in order to support the reduction of pesticide use and impact. Among the most recent calls, it is important to note calls dedicated to i) cropping systems redesigning, ii) pest surveillance and iii) prophylaxis.

⁹ Urruty N., Boiffin J., Guyomard H., Deveaud T., 2015. Usage des pesticides en agriculture : effets des changements d'usage des sols sur les variations de l'indicateur NODU. NESE 39, 165-185

¹⁰ Référence du rapport Inrae

¹¹ Emonet E., Rougier M., 2019. DEPHY EXPE, un réseau d'expérimentations pour des systèmes économes en pesticides. *Innovations Agronomiques* 76, 1-2

¹² Emonet E., Chabert A., Jacques R., Malot L., Hirschy M., 2024. DEPHY EXPE 2 : Expérimentations de systèmes agroécologiques pour un usage des pesticides en ultime recours. *Innovations Agronomiques* 98, 1-7

PPR Cultiver et Protéger Autrement (Growing and Protecting Differently)¹³

Launched by the Ministry of Research in 2019, this program selected in 2020 a total of 10 research projects and supported a very active animation with scientific conferences and presentation of conclusions to practitioners. It also supported a foresight exercise named 'European pesticide-free agriculture in 2050'.

The 10 research projects are described in the webpage of the program.

The main achievements of the program have been

- The emergence and consolidation of scientific communities on emerging topics related to a pesticide-free crop protection in biology (microbiota, chemical ecology,...) and social sciences. These communities are a strength for the emergence of high-level European projects
- Efficiency of the newly-built scientific communities was possible because of the duration of the program and of each individual research projects. Indeed, every project lasted 6 years, which is much longer than the classical duration of research projects. This is clearly a lesson from and a proof of concept made by the PPR.
- The demonstration that a non-prescriptive and disruptive scenario (pesticide-free agriculture) was a very fruitful situation to foster the production of fundamental knowledge which is the basement for disruptive and efficient innovations. However, it has been a permanent challenge to convince stakeholders of the relevance of this choice.
- A strong and active animation i) of the research community to foster the link with the international community and ii) of the link between research and end-users. The animation also relied on the governance and various committees, where representatives from academia, ministries, the French food and safety agency (Anses) and with more complexity from farmers' organisations were associated
- The foresight exercise was very productive, and was run with an international approach, including European experts and implementing the foresight scenarios in various European contexts. However, it proved difficult to make the link with the individual research projects.

Grand Défi 'Biocontrol and Biostimulation for Agroecology'¹⁴

The Grand Défi was launched in 2023 to foster the emergence and adoption of innovations in the domain of biocontrol and biostimulants, with the overall objectives to reduce the use and impact of pesticides as well as the use and impact of mineral fertilizers. It is animated by an association named 'ABBA', which gathers more than 120 members, from academia, technical institutes, extension services, and, in majority, private companies.

This Grand Défi was established to fill a major gap that was obvious as a consequence of the numerous small projects and initiatives run on this domain. It was indeed visible that i) only a small share of the possibilities offered by biocontrol and biostimulants was covered by these small projects, ii) these projects were focussing on the less beneficial part of the domain

¹³ <https://www.cultiver-protoger-autrement.fr/>

¹⁴ <https://www.bcbs-asso.com/le-grand-defi/>

mainly search for efficiency in pesticide-dominated cropping systems and iii) only a few stakeholders were involved.

The Grand Défi explicitly showed the ambition to explore complementarities with long-term projects (PPR) and delivery to farmers in easily adoptable cropping systems (Parsada). Doing so, it was contributing to the creation of a favourable environment to facilitate commitment of private companies. The favourable environment also holds true for facilitating the integration at the European level, through the link with the network of infrastructures and living labs and as a mirror of the Partnership Agroecology and Living Labs and Agroecology Crop protection initiative.

However, after three years of action, some lessons on the weaknesses already emerged. It must first be mentioned that the transition towards agroecology thanks to biocontrol and biostimulants is not in the immediate interest of many stakeholders who are looking for the stability of the existing situation with pesticides as a major pillar. This has a strong impact on the governance. Another lesson is the difficulty to foster interdisciplinarity which is compulsory to achieve adoption of new crop protection approaches, but difficult for the members, especially companies who are fully committed in a single discipline, i.e. biology.

It is worth mentioning that a similar program dedicated to Agriculture Robotics was set at the same time and is working in collaboration with the Biocontrol and Biostimulants Grand Défi.

PARSADA¹⁵

Parsada (Plan d'Anticipation du Retrait de Substances Actives et Développement d'Alternatives – Plan for Anticipating Withdrawal of Active Substances and Development of Alternatives) was initiated in 2023 in order to avoid situations of dead-ends for farmers when pivotal active substances are withdrawn. This initiative was taken, based upon the lessons from the situations on i) sugar beet after withdrawal of neonics and setting of a research and innovation program dedicated to the solving of this situation (PRNI betterave) and ii) rapeseed after withdrawal of phosmet and setting of a dedicated program (Plan Phosmet). The lessons learnt from these 2 situations were the need to anticipate (it is a drastic change in mindset and overall policy), the need of a 360° research in order to identify individual levers and to combine them in innovative systems, the need for long term actions and eventually significant budget (more than 225 M€ in 3 years) in order to gather all possible contributors to innovation, beyond the public research organisations and the technical institutes. Doing so, the regulatory requirement (possibility of active substance withdrawal) has become a motivation to act, instead of a permanent threat.

Prior to the launch of the calls, a list of active substances at risk of withdrawal was established, the actors of the supply chains were invited to define the situations which were the most at risk of dead-end for them and to prioritize the topics in action plans. This is a major originality of this program and was very much appreciated by the farmers organisations. The critical situations identified by the supply chains are mainly oriented

¹⁵ <https://agriculture.gouv.fr/lactualite-du-plan-daction-strategique-pour-lanticipation-du-potentiel-retrait-europeen-des>

towards weed control and incidence of the reduction of herbicides After selection by a scientific and technical committee, a total of 44 research and innovation projects have been selected up to now, with the target of 55 by the end of 2026. A good balance among supply chains and action plans has been achieved. In the selected and funded projects, the combination of levers at the scale of the protection systems is the rule, while the operational vocation of the projects imposed to involve partners covering all the chains of production of knowledge and innovation down to the support to farmers for implementation. These features had a significant influence on the evaluations run by the scientific and technical committee and the ministry of agriculture. However, it is noticeable the tech companies are often only included as third-parties.

The governance includes i) a scientific and technical committee in charge of the evaluation which is co-chaired by Acta and Inrae members and is composed 50/50 by members from academia and from applied research and extension services and ii) a funding committee for the final funding decision.

Program PRAAM

Praam is the acronym for ‘Prise de Risque Amont Aval et Massification de pratiques visant à réduire l’usage des produits phytopharmaceutiques sur les exploitations agricoles’ (“Upstream and Downstream Risk-Taking and Scaling Up Practices Aimed at Reducing the Use of Plant Protection Products on Farms”).

To accelerate the scaling up of practices aimed at reducing the use of plant protection products on farms across a given territory, this program, run through calls of projects intends to support, on an experimental basis, the transition from applied research to the generalization of proven methods. This program is closely connected to Grand Défi and to Parsada.

It aims to support projects led by economic actors, mainly cooperatives, involved in the processing of agricultural products and directly linked to the upstream agricultural sector, which will enable the reduction of plant protection product use by the farmers who supply them, without jeopardizing the activity of these farmers or, more broadly, the value chains in which they participate.

The projects include the following points:

1. One or more combinations of levers
2. A large-scale deployment of the implementation of these combinations among farmers
3. A validation process for the combinations and the support system by a trusted third party
4. A commitment from key stakeholders in the sectors
5. An experimental support system for risk-taking through economic and/or insurance mechanisms
6. A support program through training and advice
7. Ambition over all the duration of the project regarding the reduction in the use of plant protection products and monitoring of the action plan
8. A system for acquiring shared data on the deployed combinations

Conclusion

The country-survey run for France shows that there is an on-going trajectory of reduction in the conventional chemical pesticides used for plant protection, especially the most dangerous for environment and human health, and of increasing use of biocontrol products. This transition is supported by many research and innovation programs funded at the national level and connected with European partners. However, the transition is not smooth and easy. Indeed, while it meets a major demand from the society especially concerned by the risk for human health, it faces i) real reluctancies of the farmers and farmers organisations because of the lack of easy-to-use, 100% efficient and cheap levers fitting into the present production systems and ii) the need to meet regulatory framework established in a context where pesticides were first. The transition is thus facing a typical lock-in situation, where it is compulsory to mobilise both disruptive innovations (substitution and redesigning) and a strong push from the socio-technic landscapes (regulations, policies).

Experts and Participants to the preparation of the country-survey

- Ministry of Agriculture, DGAL, SAS/SDSPV: Olivier Prunaux, Olivier Printz, Xavier Langlet, Frédérique Olivia-Perrin
- Dr J.N. Aubertot, Inrae, chair of the scientific committee of Ecophyto plan
- Dr Christian Lannou, Inrae, Deputy Scientific Director Agriculture, Chair of the ABBA association, Co-Chair of the Parsada Scientific and Technical Committee
- Dr Laure Latruffe, Inrae, Scientific Coordinator of the PPR Cultiver et Protéger Autrement
- Dr Thibaut Malausa, Inrae, French Member of the COST CA21134 Management Committee
- Dr Mehdi Siné, General Director of ACTA, Co-Chair of the Parsada Scientific and Technical Committee