Deliverable D 5.2 Report of the possibilities to consider the diversity of agro-climatic conditions in the definition of the binding and optional rules

Project acronym:	AGROWISE
Project title:	Guidelines for farm-specific or crop-specific rules for mitigating pesticide impacts while ensuring sustainable agriculture
Starting date:	01/05/2024
Duration (in months):	18
Call (part) identifier:	LIFE-2023-PLP
Grant agreement no:	101148740
Due date of deliverable:	Month 17 - September 2025
Actual submission date:	01-10-2025
Work package:	WP 5 – Interaction with European Commission, Member States and stakeholders
Lead beneficiary:	INRAE (https://ror.org/003vg9w96)
Responsible/Author:	Maud Blanck, INRAE Christian Huyghe, INRAE Maud Vezien, INRAE
Dissemination level:	PU (Public)
Language:	Eng
Version:	1

Co-funded by the European Union

Table of Contents

Co-funded by
the European Union

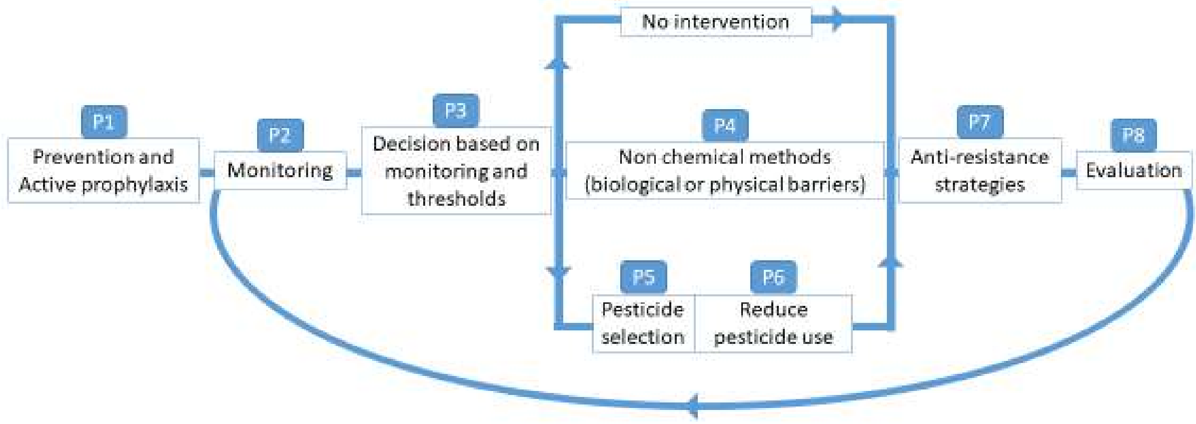
1. Executive Summary

2. Introduction

The AGROWISE project is designed to support the development and implementation of Integrated Pest Management (IPM) practices across European farming systems, with the aim of reducing the risks and impacts associated with plant protection products while ensuring sustainable agricultural production. The project operates within the broader framework of the EU Farm to Fork Strategy and the Sustainable Use of Pesticides Directive (SUD 2009/128/EC), which seek to promote sustainable use of pesticide and set ambitious targets for risk reduction.

Despite the Directive's objectives implementation in National Action Plan, the European Commission's 2020 evaluation reports and the European Court of Auditors' special report (ECA, 2020) indicate that progresses have been uneven. While some Member States have developed extensive National Action Plans (NAPs), implementation remains inconsistent, and measurable reductions in pesticide use and risks have been limited. **Key barriers include a limited integration of agro-climatic diversity, the lack of practical definition of the IPM general principle, and difficulties in assessing the implementation of preventive measures (Principle 1).** A common argument is regularly put forward, quoting that crop protection relying on pesticide use is economically viable, considering the chemical pesticides as a cheap economic input.

Agrowise proposed to revisit thoroughly the overall approach of Integrated Pest Management (IPM), away from the traditional IPM triangle concept, with a relation chart between principles and based upon the taxonomy of targets, levers and actions that could be used in the implementation of each principle.



Principle 1, prevention, remains one of the most challenging components of IPM. However, when preventive measures are effective, the overall pest pressure is lower, making it possible, according to the biological thresholds that have to be included in redesigned Decision Support Systems (DSS), to use non-chemical methods or even to avoid any intervention. Preventive

Co-funded by
the European Union

measures may be non-effective when then prevention is achieved through measures whose the initial objective was not related to crop health, such as plant nutrition or meeting market demand. Preventive measures may also be designed to explicitly target crop protection. In this case, we propose to use the words ‘active prophylaxis’. Farmers often perceive preventive practices as costly or insufficient when used alone, as the benefits may not be immediately visible, in absence of adapted monitoring methods (P2) and the return on investment is difficult to quantify in the short term. Nevertheless, long-term sustainability in pesticide use critically depends on highly proactive and well-supported prevention strategies.
Indeed, the long-term strategy must consider two new context elements. The first is the decreasing number of approved active substances. Many of them are withdrawn at the EU level because of their high environmental and health impacts. These withdrawals are not compensated by new approved active substances. As an illustration, not a single new active substance was approved at the EU level in 2022 and 2023. The second is the evidence of increasing resistance to active substances. This is well documented for herbicides (weedscience.org), for fungicides and insecticides. This situation highlights the urgent need for implementing preventive measures to safeguard crop protection and ensure future food security.

Promoting harmonized prevention actions at European level seems complicated by the apparent strong dependency of outcomes on local agro-climatic conditions. Identical practices is deemed capable of producinf markedly different results depending on climate, soil characteristics, landscape structure, biodiversity, pest pressure, and management history. This variability is observed, even though not thoroughly documented. However, according to D3.3, it is possible to create guidelines that are science-based, robust and adaptable to local contexts. This clearly applies to preventive actions.

The present report examines the possibilities of integrating the diversity of agro-climatic conditions into the definition of guidelines for IPM practices. By combining the concepts of active prophylaxis — focusing on anticipatory prevention and the selection of appropriate means — and context dependency — capturing site-specific environmental and agronomic factors — AGROWISE aims to provide to the Member States, a framework for drafting IPM guidelines that is both effective and implementable across diverse European farming systems.

3. Conceptual framework

The conceptual framework underlying this report builds upon two interlinked pillars: active prophylaxis and context dependency. Together, these concepts provide a basis for designing IPM guidelines that are both scientifically sound and operationally relevant across Europe’s diverse agro-climatic conditions.

3.1 Active prophylaxis

Active prophylaxis is an innovative concept developed within the AGROWISE project to reframe the understanding of prevention in crop protection. **Unlike general preventive approaches, which often focus on broad recommendations, active prophylaxis emphasizes the anticipatory assessment of expected impacts at the time of implementation. It**

Co-funded by the European Union

encourages the strategic selection of appropriate means to achieve desired outcomes, taking into account both ecological, operational and economic factors.

An example of such practice could be: choosing a sowing time. For winter cereal, delaying the sowing date has an impact on the need to use fungicides during the season. If the sowing date is delayed, it is also easier to implement certain other practices such as false sowing. Another example on the same crop is the choice of the variety. For the same markets defined by the baking quality of wheat, it is possible to choose varieties that are either susceptible or resistant to leaf fungal diseases (rusts and septoria leaf spot). It is also possible to opt for a mixture of varieties. The incidence on yield and quality is null, but the impact on disease severity is contrasting leading to either no intervention, possibility to use biocontrol or urgent need to use pesticides.

From a policy perspective, active prophylaxis aligns with the principle of an obligation of means. This distinction is critical in plant protection, where the outcome of a measure is strongly influenced by factors beyond the farmer's immediate control. By focusing on the adequacy of the means, guidelines can provide actionable recommendations without penalizing farmers for results determined by local conditions. Furthermore, choosing the obligation of means requires the competent authorities to focus on the strength of the link between the definition of the action and its effect.

In addiction, from a policy perspective, the implementation of the IPM general principle, including active prophylaxis implies to thoroughly revise the syllabus of training of students in agricultural and vocational schools and during the life-long learning of farmers and advisors.

3.2 Context Dependency

As described in D3.3, context dependency refers to the variability in performance of IPM and agroecological practices according to **local environmental and agronomic conditions**. As a summary, deliverable D3.3 framework distinguishes six biophysical factors groups that influence the efficiency of IPM measures:

1. **Climate and Weather** – seasonal patterns, temperature, rainfall, and extreme events.
2. **Soil Characteristics and Hydrology** – texture, structure, fertility, drainage, and moisture dynamics.
3. **Landscape Structure and Topography** – field configuration, presence of non-crop habitats (Agroecological infrastructures), and spatial heterogeneity.
4. **Biodiversity and Ecosystem Functions** – natural enemy populations, pollinators, decomposers, and functional diversity.
5. **Pest Pressure and Biotic Risk Context** – local pest populations, resistance profiles, and pathogen complexes. This factor relates to both long-term dynamics of pest pressure and short-term dynamics (during the season).
6. **Temporal and Legacy Effects** – historical land use, previous crop effect, and system memory influencing long-term resilience.

Each group encompasses sub-factors that differ in responsiveness to management (short-, mid-, long-term, or not changeable by the actions of a farmer), shaping which interventions

Co-funded by the European Union

can be influenced at farm level versus those requiring policy or collective actions. Understanding context dependency is essential to determine where harmonized rules can be applied and where adaptive or voluntary measures are to be preferred.

3.3 Linking Active Prophylaxis and Context Dependency

The integration of active prophylaxis and context dependency provides a transformative approach to guideline development**.** Active prophylaxis directs attention to the **means necessary for prevention including actions done without knowing the future seasonal pest pressure** while context dependency lists the factors needed to adapt the actions **local conditions**. Active prophylaxis actions are part of the farmers' strategy over long-term, they are implemented every season whatever the pest pressure is. This is essential as effect of prophylactic measures maybe cumulative over years. It is especially true for weeds as the weed seed bank is built from the accumulation over years of weed seeds from which a certain quantity disappears because of germination, of predation and of loss of germination rate, when the storage in soils is getting beyond the half-life duration of the weed species.

This combination allows guidelines to:

- Include biophysical indicator groups which make those guidelines controllable.
- Differentiate between measures suitable [1]for **widespread implementation** (significant agronomic service, low context dependency) and those requiring **voluntary or adaptive implementation** (high context dependency or long-term effects).
- Promote realistic and applicable recommendations through networks of advisers able of working with farmers to **define strategies** and **co-develop systems adapted to local agroclimatic conditions (average and variability over seasons)**.
- Support **farmer adoption and trust** by aligning prescribed practices with ecological realities and operational feasibility.

By embedding both concepts into IPM guidelines, AGROWISE aims to enhance the **effectiveness, feasibility, and sustainability** of crop protection strategies across Europe, providing a scientific and practical foundation for policymaking and regulatory frameworks.

4. Linking Active Prophylaxis and Context Dependency for Guideline Development

4.1 Guidelines in the Context of SUD 2009/128

The Sustainable Use of Pesticides Directive (SUD 2009/128/EC) defines guidelines as recommendations intended to support farmers in implementing Integrated Pest Management (IPM), specifying practices and measures that should be considered to reduce risks and

[1] To assess the suitability of active prophylaxis practices, we suggest disregarding factors related to pest pressure, as these are linked to strong dynamics during the season and these dynamics are not known at the time the decision to implement the practice is made. These dynamics occur during the season and do not influence the decision whether or not to implement the practice.

Co-funded by the European Union

impacts of pesticides. Guidelines under SUD are designed to provide practical, evidence-based advice while ensuring compliance with the IPM general principles.

Historically, the development of guidelines has focused on lists of recommended practices or actions. However, these lists often lack of a common method for developing guidelines because of the complexity to define the level of precision for those guidelines. In absence of a validated and stabilized taxonomy applicable to all crops and countries, the recommended practices and actions may have very contrasting granularities and address different levels of the 4-layers taxonomy (as shown by the practices listed in the IPM toolbox). This issue limits or even cancel the utility of guidelines in achieving both environmental objectives, relevance for farmers and the emergence of a shared definition of “basic IPM” versus top-up actions.

4.2 The transformative role of active prophylaxis

Active prophylaxis, as introduced by AGROWISE, emphasizes a proactive approach to prevention. It encourages the **anticipatory assessment of expected impacts** at the time of practice implementation, ensuring that the **selected means will deliver** desired outcomes. By focusing on the efficiency and suitability of interventions more than short-term results, active prophylaxis aligns closely with the SUD emphasis on the obligation of means, without forgetting the farmers’ expectations. Moreover, it potentializes the long-term efficiency of the crop protection strategy, reducing for instance the probability of emergence of resistances in the pest populations.

In guidelines development, active prophylaxis shifts the perspective from a **prescriptive list of measures** to a framework that helps member states to choose **which actions are most likely to be effective given the local conditions** (soil, climate, markets, farmers population). This framework is based upon 3 components:

- The validated and regularly updated taxonomy,
- The assessment of the agronomic services provided by each practice (and options within the practice)
- The quantification of the context-dependency, induced by each of the six biophysical factors. A peculiar attention must be paid to biotic risks, as the active prophylaxis will contribute to significant reduce the possible incidence of this factor.

This approach enables policymakers and advisory services to prioritize practices that are operationally feasible, ecologically sound, and compatible with a significant reduction in dependency on pesticide.

4.3 Integrating context dependency

Context dependency captures the variability in IPM practices performance across different environmental and agronomic conditions. AGROWISE identifies six biophysical factors groups—climate and weather, soil and hydrology, landscape and topography, biodiversity and ecosystem functions, pest pressure and biotic risk, and temporal/legacy effects—each

Co-funded by
the European Union

containing sub-factors with various response times (short-, mid-, long-term, or not changeable).

Understanding context dependency allows guideline developers to:

- Identify actions that are **robust across multiple conditions** and suitable for general implementation. This includes the actions that ensure high agronomic services and show little dependency to two[2] biophysical factors (climate, soil and hydrology) and that would make the agroecosystems more robust towards invasive pest species.
- Recognize measures whose performance is **highly context-specific** and could be improved by decisions made by the farmers. This includes two biophysical factors (landscape heterogeneity and ecosystem functions). They should be recommended as voluntary and adapted to local conditions.
- Incorporate **time horizons** for effects as part of measuring the implementation of practices, ensures that support also targets actions with long-term ecological benefits (rarely supported) as well as those with visible short-term results.

List of the active prophylaxis action linked to context dependency scoring (done by expert during Agrowise T3.4) is in Annex 1. By combining context dependency with active prophylaxis, guidelines can **prioritize actions according to their feasibility, effectiveness, and adaptability**, providing actionable advice that aligns with both ecological realities and farmer capacities.

4.4 Implications for guideline drafting

The integration of active prophylaxis and context dependency transforms the drafting of IPM guidelines in several key ways:

1. **Evidence-based prioritization of actions**: Guidelines can prioritize actions with high expected impact and feasible implementation at the farm level, focusing widespreading effort on actions with low context dependency.
2. **Adaptive recommendations**: Actions whose implementation or incidence are sensitive to site-specific conditions or only exhibit long-term effects can be recommended as **voluntary**[3]. Their dissemination must also be supported by advisory services for local adaptation.
3. **Alignment with the obligation of means**: By emphasizing the selection of appropriate and well-supported preventive actions, guidelines remain compliant with IPM general principles while acknowledging the fact that context may reduce the final impact of some practices even when and where they are well implemented.
4. **Enhanced farmer adoption**: Guidelines that take into account local agro-climatic variability and provide clear rationale for preventive measures improve farmer trust and uptake, mitigating the risk of resistance build-up and supporting sustainable crop

[2] those that cannot be changed by the farmer alone

[3] The number of crop protection practices is often quite large. Recommending certain practices can introduce a bias, making them more visible and therefore perceived as more reliable than others. Among the recommended practices, Member States have an interest in identifying priorities. Deliverable 3.3, focusing on context dependency, supports Member States in establishing this prioritization. This, in turn, helps them design strategies and incentives to encourage professional users to adopt the practices highlighted in the guidelines.

Co-funded by the European Union

protection. Moreover, mitigating the risk of resistance build-up has to be put forward as they secure the long-term efficiency of the whole IPM strategy, and not only the principles related to pesticide use (Principles 5 to 7)

5. **Support for policy coherence**: The framework allows regulatory authorities to design IPM guidelines that are both applicable across Member States and adaptable to local agroecological contexts, reducing implementation gaps observed under previous evaluations of the SUD. It also reduces the perception by the farmers of discrepancies among countries.

In summary, integrating active prophylaxis with a systematic understanding of context dependency enables the development of more precise, actionable, and ecologically informed guidelines. This approach provides a transformative pathway to improve IPM adoption, enhance preventive capacity, support the sustainable use of pesticides across Europe, and altogether improves the short-term and the long-term efficiency of crop protection.

5. Operational relevance of context parameters

Understanding which context factors can be influenced, and over what timeframe, is critical for translating the concepts of **active prophylaxis** and **context dependency** into operational guidelines and policy recommendations. Not all factors shaping IPM performance can be easily modified at the farm level; some require collective or policy-level interventions over a long period of time, while others are inherently resistant to change. These collective actions or those targeting stakeholders other than farmers will be described in deliverable 6.1 and will be the subject of Agrowise recommendations. This dependence on factors beyond the control of farmers (actions requiring territorial measures or over long periods of time) is one of the reasons why actions that have low context dependency are not yet widespread (it is one of the key barriers identified in the final report of the Farmer's toolbox for IPM (JRC, 2023[4])).

5.1 Influenceable parameters and response times

AGROWISE categorizes sub-factors within the six biophysical factors groups according to their **responsiveness to management interventions**: short-term, mid-term, long-term, or not changeable. This classification informs which measures can realistically be promoted as **binding** rules versus **optional/adaptive** recommendations:

- **Short- and mid-term responsive factors** are typically actionable at the farm level. Examples include:
  - Soil properties and biological activity, which can be improved through fertilization, organic amendments, and tillage management.
  - Beneficial organisms and pollinator populations, which respond to habitat enhancements such as flower strips or reduced pesticide use.
- **Long-term responsive factors** generally require extended management periods or landscape-level coordination. These include:

[4] Page 211, https://knowledge4policy.ec.europa.eu/publication/farmers-toolbox-integrated-pest-management-final-report_en

Co-funded by the European Union

- Soil erosion control, organic matter accumulation, and biodiversity functional interactions.
- Temporal or legacy effects stemming from historical land use and crop rotations.

- **Not changeable factors at the farmer level**—such as regional climate patterns or topography—cannot be directly influenced by farmers alone but have a major effect, both on the possibility to implement practices and on their efficiency, including through cascading effects.

5.2 Prioritization for guideline development

By combining context dependency with response time, guideline developers can prioritize parameters that are both operationally feasible and ecologically significant:

1. **Actions worth generalizing**: Focus on short- and mid-term sub-factors with low to moderate context dependency for implementation and effect, which can be influenced effectively at the farm level and implemented consistently across an entire Member State.
2. **Voluntary Actions**: Include sub-factors with high context dependency of implementation and effect or long-term responsive indicators. These measures require site-specific adaptation, advisory support, or landscape-level coordination. Regarding the role of advisory services for supporting these voluntary actions, it must be quoted that the syllabus for training the advisors and extensionists will have to be reviewed in order to ensure the quality of the support.
3. **Adaptive management and resilience planning**: However, certain practices that appear to be only slightly dependent on context cannot be generalised because they depend on other factors such as market dynamics (rules for introducing a new crop) or the ability to be defined simply by a single rule (mixed species crops). They are nevertheless relatively easy to consider in a variety of contexts. It is therefore not the context that justifies their non-generalisation. If a State decides to make them a priority because they have a major impact, the effort to deploy them should focus primarily on actors other than farmers.

5.3 Linking operational relevance to active prophylaxis

Active prophylaxis emphasizes the **selection of appropriate preventive means**. Understanding which context parameters are **influenceable within the relevant time frame** ensures that guidelines:

- Recommending **practices where farmers can realistically achieve the intended preventive effect**.
- Avoiding prescribing actions that are ineffective under certain local conditions, thereby reducing frustration and increasing uptake.
- Integrating **temporal and cumulative effects**, acknowledging that some preventive benefits manifest only over multiple seasons or through coordinated landscape-level measures. Such practices should be explicitly supported, as voluntary actions, through multi-years supports

Co-funded by
the European Union

5.4 Implications for policy and practice

Operationalizing context parameters in guideline development provides several advantages:

- **Consistency across regions**: Parameters that are short- to mid-term responsive and low in context dependency can be harmonized as worth generalizing at the EU level.
- **Flexibility for local adaptation**: High dependency or long-term factors are flagged as voluntary actions, encouraging farmers to adjust practices according to site-specific conditions.
- **Evidence-based evaluation**: This framework enables policymakers and advisors to prioritize interventions with the highest likelihood of achieving desired outcomes, while respecting both ecological variability and farm-level constraints. Agrowise recommends keeping these evaluations up to date periodically in order to benefit from scientific advances as frequently as possible.

By explicitly linking **parameter influenceability** to guideline design, AGROWISE ensures that IPM recommendations are both scientifically robust and operationally realistic. This alignment enhances the effectiveness of preventive measures, fosters farmer adoption, and ultimately supports the sustainable use of pesticides across Europe

6. Implications for policy design

The operational insights gained from the analysis of context dependency and response times provide a foundation for designing IPM-related policies that are both effective and adaptable. Translating scientific knowledge into efficient policies requires differentiating between measures that can be standardized across Member States and those that need site-specific adaptation.

6.1 Quadrant classification of context parameters

AGROWISE classifies context parameters using a two-dimensional framework that considers **context dependency** (percentage of variability explained by local conditions) and **system response time** (short-, mid-, long-term, or not changeable). This classification generates four primary quadrants, each with distinct policy implications:

1. **Short-/Mid-term, Low Context Dependency**: These parameters are the most actionable at the farm level and are strong candidates for binding rules. Examples include soil physical and chemical properties, biological activity, water dynamics, beneficial organisms, and certain pest and pathogen characteristics.
2. **Short-/Mid-term, High Context Dependency**: These parameters require adaptive, site-specific management. Policies should encourage **optional measures**, supported by guidance and advisory services tailored to local conditions.
3. **Long-term, Low Context Dependency**: While less sensitive to local variability, these parameters require extended timeframes to achieve measurable outcomes. They are suitable for **optional measures**, with incentives or long-term programs facilitating adoption.

Co-funded by the European Union

4. **Not Changeable Parameters**: Regardless of context dependency, these factors (e.g., topography, regional climate) cannot be directly influenced. They are outside the scope of binding regulations but remain critical for **resilience planning** and adaptive strategies.

6.2 Integrating active prophylaxis in policy design

Active prophylaxis emphasizes the **selection of preventive means appropriate for achieving desired outcomes**. When combined with the quadrant classification, this approach allows policymakers to:

- Focus binding regulations on parameters where farmers can realistically influence outcomes in the short to mid-term.
- Provide clear guidance on optional measures for parameters that are highly context-dependent or require long-term interventions.
- Ensure that preventive strategies are both **scientifically sound and operationally feasible**, aligning with the SUD principle of obligation of means.

6.3 Differentiation across production systems

The application of this framework across production systems (e.g., apple, grapevine, cereal-based systems) highlights that **binding and optional measures may differ according to system-specific vulnerabilities and local environmental conditions**.

For example:

- Pest pressure may be a high-priority, short-term responsive parameter in cereals, warranting binding measures.
- In perennial systems such as vineyards or orchards, biodiversity and landscape structure may require adaptive measures due to longer response times and higher context dependency.

This differentiation ensures that policies remain **flexible and context-sensitive**, supporting the adoption of IPM practices while respecting ecological variability.

6.4 Strategic implications for IPM Guidelines

By explicitly incorporating context dependency and active prophylaxis, policy design can achieve several key objectives:

- **Harmonization and consistency**: Binding rules can be applied where variability is low and interventions are operationally feasible across multiple Member States.
- **Flexibility and adaptability**: Optional measures allow farmers to tailor practices to local conditions, fostering higher adoption rates and more effective prevention.
- **Long-term sustainability**: Recognition of temporal and legacy effects ensures that policy frameworks account for cumulative benefits, ecosystem resilience, and gradual ecological improvements.

Co-funded by the European Union

- **Evidence-based decision making**: The integration of scientific indicators with policy instruments enhances transparency, predictability, and alignment between regulatory goals and practical outcomes.
- **Individual and collective actions**. Even though most of the policies target the farmers individually, it is also that policies facilitate the cooperation among farmers at the landscape level, as this is essential to ensure the implementation of some critical prophylactic measures, such as management of pest reservoirs.

In summary, the combination of **active prophylaxis**, **context dependency**, and the **quadrant-based classification** offers a structured approach to designing EU-level IPM guidelines. This framework allows policymakers to distinguish between binding and optional measures in a scientifically justified, operationally realistic, and context-sensitive manner, supporting the sustainable and effective use of pesticides across Europe.

As shown in the table in Appendix 1, the dependency scores obtained from our three case studies do not differ greatly from one another when it was possible to evaluate the same action several times. These data will be made more reliable in the future by new research results. In any case, it appears that actions that are not very context-dependent can nevertheless be difficult to implement because they involve actors other than the farmer (this is the case with harvesting cereal straw, which reduces seed stocks but slows down the work rate and requires an outlet for the straw, or with species mixtures, which also require profitable outlets). Others are known for their effects but are highly dependent on local conditions (choice of sowing date and density, implementation of false sowing). These can be implemented in many situations with the support of an advisor and assistance with reseeding for the farmer. Finally, certain actions are dependent on ecosystem services and their infrastructure. In this case, the dynamic must be collective and territorial, and implementation cannot be decided at the level of a single farmer.

These obstacles are therefore no longer technical in nature and will be addressed in deliverable 6.1 concerning the recommendations of the Agrowise project.

7. Conclusion

This report demonstrates that it is both feasible and necessary to adapt a coherent set of Integrated Pest Management (IPM) practices to the diversity of local agroclimatic contexts across the European Union. Such adaptation does not weaken the common objectives of the Sustainable Use of Pesticides Directive (2009/128/EC). Indeed, it provides Member States with a clear framework to set national priorities for action, focusing on the crops and pest combination that represent the greatest challenge for sustainable crop protection in their territory.
The literature review underpinning Deliverable D3.3 shows that the main groups of context-defining parameters—climate and weather, soil and hydrology, landscape structure, biodiversity and ecosystem functions, pest pressure and biotic risk, and temporal or legacy effects—can be systematically assessed. When these parameter groups are combined with knowledge of practices that reduce long-term pest pressure regardless of annual fluctuations, Member States have the analytical keys to decide which preventive practices deserve the strongest support and which should be promoted as voluntary or adaptive.

Co-funded by the European Union

Today, this task is particularly urgent. The number of effective active substances is steadily declining because of growing resistance phenomena and the regulatory withdrawal of active substances that are hazardous to human health or the environment. While the safe use of synthetic pesticides has improved since the original SUD was adopted, long-term crop protection will increasingly depend on preventive strategies that operate at the landscape scale, require collective approaches, and deliver benefits that are sometimes slow to become visible and effective in purely economic terms.

For these reasons, public policies must now concentrate their efforts on supporting prevention. This includes fostering cooperation at landscape and regional levels, creating incentives that extend beyond the individual farms, and investing in advisory services capable of sustaining actions whose effects are measurable after several seasons. The concept of **active prophylaxis**, developed within AGROWISE, provides a scientific and operational framework for such policies. By linking this concept to the quadrant-based analysis of context dependency established in Deliverable D3.3, Member States and the European Union gain a robust tool to identify the practices that can be generalized, the ones requiring adaptive management, and the areas where collective, long-term investment is indispensable.

In sum, the combination of active prophylaxis and a structured understanding of context parameters offers a pathway to sustainable, evidence-based crop protection. It enables Member States to prioritize preventive measures that remain effective despite annual pest variability and to channel support where it will yield the greatest long-term benefit for farmers and environment, while securing the resilience of European agriculture.

Co-funded by
the European Union

8. Annexe 1: Table of active prophylaxis practices linked to dependency context scores.

The following table illustrates that most active prophylaxis practices have little or no dependence on local conditions. In other words, in conditions where they can be implemented, contextual factors will not significantly alter their effect. In most cases, at the farm level, there is a way to implement the practice. Identifying this depends on fruitful exchanges between farmers and the easy dissemination of research and innovation information to farmers through knowledge networks. It also appears that certain practices whose success is not highly dependent on local conditions cannot be made mandatory because they depend on factors beyond the farmer's control. This is particularly the case for intercropping and species mixture practices, which require distribution channels to sell the produce.

This table is a tool that shows the dependencies identified by experts during the Agrowise project. They may be updated as scientific knowledge is acquired. We propose that this table be used to assess the interest of promoting these practices by Member States.

To assess the suitability of active prophylaxis practices, we suggest disregarding factors related to pest pressure, as these are linked to strong dynamics during the season and these dynamics are not known at the time the decision to implement the practice is made. These dynamics occur during the season and do not influence the decision whether or not to implement the practice.

This table also suggests a challenge for each practice in terms of its implementation, putting into perspective the desire to maximise damage reduction to crops while preserving another technical element. (Please note that this challenge does not take into account challenges related to stakeholder interactions, but only the technical challenge of effective long-term use of the practice.)

This table also shows that active prophylaxis practices have in common the general ability to be generalised without risking a short term resistance to the practice. This is true for all practices except resistant varieties, for which this is the major challenge.

Level 1 (target)	Level 2 (strategy)	Main technical challenge of the guideline	Level 3 (practice)	Agronomic Service Provided	Climate & weather	Soil	Landscape	Bio-diversity	Temporal effect	In season Pest pressure
1.1 Crop selection	1.1.1 Varietal diversity	Reconcile resistance genes management and significant reduction of the damage.	Use resistant tolerant cultivars	Low	G-Low C-Low	G-Low C-Low	0 0	0 0	G-Low C-Medium	
			Use resistant tolerant cultivars in mixture	Low	C-Low	C-Low	0	0	C-Medium	
	1.1.2 Crop species diversity	Reconcile local agronomic constraints and significant reduction of the damage.	Crop rotation	Major	C-High	C-High	C-Medium	C-Low	C-Medium	
			Intercropping	Major	C-Low	C-Low	0	0	C-Low	
			Species mixtures	Moderate	C-Low	C-Low	0	0	C-Medium	
			Crop selection: fallow	Major	C-Low	C-Low	0	0	C-Low	
	1.1.4 Planting materials	Reconcile biodiversity preservation, resistance genes management and significant reduction of the damage.	Use of certified seeds	Low	0	0	0	0	0	
			Use of certified planting materials	Low	0	0	0	0	0	
	1.1.5 Seed selection	Reconcile biodiversity preservation, resistance genes management and significant reduction of the damage.	Non chemical seed treatment	Low	C-Low	C-Low	0	0	C-Low	
1.2 Crop establishment	1.2.1 Sowing	Reconcile availability favourable conditions of sowing and significant reduction of the damage.	Sowing time	Major	C-High	C-Medium	C-Medium	0	C-Medium	
			Seed density	Moderate	C-High	C- High	0	0	C-Medium	
	1.2.1 Planting (cuttings/ seedlings)		Plant spatial arrangement		C-High	C-Medium	0	0	C-Medium	
	1.3.1 Soil cultivation	Reconcile	Plough	Major	C-Low	C-Low	0	0	C-Low	

Co-funded by the European Union

		biodiversity preservation and significant reduction of the damage.								
		Reconcile availability favourable conditions of sowing and significant reduction of the damage.	False seed bed	Major	C-High	C-Low	0	0	C-Medium	
	1.3.4 Harvest management	Reconcile biodiversity preservation and significant reduction of the damage.	Harvest technology	Moderate	0	0	0	C-Low	0	
1.6 Management of ecological infrastructure	1.6.1 Protection and enhancement of beneficial organisms	Reconcile Pest proliferation management and significant reduction of the damage.	Creation or restoration of habitat outside the production area	Moderate	C-Low	C-Low	C-High	C-High	C-Low	
		Reconcile Pest proliferation management and significant reduction of the damage.	Creation or restoration of habitat inside the production area	Moderate	C-Low	C-Low	C-High	C-High	C-Low	
	1.6.2 Management of resources to the pest	Reconcile biodiversity preservation and significant reduction of the damage.	Removal of non-crop hosts	Major	C-Low	C-Low	C-High	C-Low	C-Low	
1.7 Hygiene measures	1.7.1 Cleaning of machinery and equipment		Cleaning of machinery and equipment	Low	0	0	0	0	0	
	1.7.2 Management of resources to the pest	Reconcile biodiversity preservation, and significant reduction of the damage.	Water/soil sanitation	Moderate	0	0	0	0	0	
		Reconcile biodiversity preservation, and significant reduction of the damage.	Removal of inoculum sources	Moderate	0	0	G-Medium A-Medium C-Medium	G-Low A-Low C-Low	G-Medium A-Medium C-Medium	

G: Grape/powdery mildew

A: Apple/coddling moth

C: Cereals/weeds

Co-funded by the European Union