Deliverable D 6.2

Final Integrated Pest Management (IPM) Guidelines

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Executive Summary

The Executive Summary shall:

- outline the aim and conclusion of the deliverable
- include the methodology/approach
- highlight the major findings, results and recommendations
- mention the eventual shortcomings/limitations
- be written in an easy understandable language,
- with short and concise wording, so that it can also be used in other documentation or public websites to explain the content of the deliverable
- not be more than 1 page
- be readable separately from the rest of the document, so that those who read only the executive summary should get the essence of the document without the details
- not be a copy of the conclusions section

1 Abbreviations and acronyms

Abbreviation / Acronym	Description
IPM	Integrated Pest Management
SUD	Directive 2009/128/EC on the sustainable use of pesticides
DSS	Decision support systems
NAP	National Action Plan

Definitions:

Good practices phytosanitary : considering Recital 35 of Regulation (EC) No 1107/2009: the principles of integrated pest management, including the principles of good plant protection practice and non-chemical methods of plant protection, pest control, and crop management.

2 Background

3 Objective/Aim

The present document **provides practical guidelines for sustainable crop protection practices**, in line with the objectives of Directive 2009/128/EC on the sustainable use of pesticides (SUD). These guidelines aim to support agricultural production that is both sufficient and safe, while ensuring that ecosystems are preserved and, where possible, restored. Achieving this balance is essential to securing a resilient and sustainable food system for the future.

These guidelines can be understood as a medium that translates general principles into operational directions for farmers. They are conceived at an intermediate level of generality: between, on the one hand, the eight general principles of Integrated Pest Management (IPM) defined in Annex III of the SUD, and on the other hand, the multitude of practical modalities implemented by concerned operators (primarily farmers) within diverse agricultural systems across Europe. As such, they may position themselves at different levels of precision, depending on the need for clarity and applicability.

Guidelines are a medium describing the practical actions behind the general principles.

Based on taxonomy (D2.1), the Agrowise consortium has sought to establish criteria that ensure the application of the general principles of IPM through the implementation of concrete practices of farmers. The ambition of this report is to provide a coherent framework that does not constrain or "lock in" the range of possible actions, but rather enables farmers to adapt solutions to their specific contexts. Importantly, these guidelines are not only designed for implementation at farm level. While farmers are at the centre of their application, they also involve the broader ecosystem of innovation, transformation and market integration. **At a Member State level, their construction must therefore reflect on the responsibilities and contributions of these other actors, thus ensuring a shared and coordinated effort.** In this respect, the present deliverable resonates directly with Deliverable 6.1 (Agrowise recommendations), which is being produced in parallel.

The current **guidelines available in the Member States do not provide a clear framework that allow for a comprehensive understanding and effective field-level application of IPM**. As a reminder, IPM under the SUD is defined as a careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified and reduce or minimise risks to human health and the environment. 'Integrated pest management' emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms (SUD 2009/128/CE). This definition further elaborated in Annex III of the SUD, is complemented by 8 principles intended to assist Member States in fostering IPM implementation among farmers.

Despite the SUD ambitions, **cropping systems remain dependent on external inputs**, and display low resilience to emerging challenges whether stemming from climate change from the increasing pest pressure that is exacerbated by low landscape diversity. To address these challenges, **it is crucial to strengthen active prophylaxis** understood as the proactive identification of potential impacts of agronomic actions, with an emphasis on biodiversity preservation, ecosystem restoration, and therefore being able to strengthen the ecosystem services.

Guidelines presented here are targeting active prophylaxis actions but you can use the same method for updating any kind of guideline.

As highlighted in Deliverable 5.1, the current application of IPM tends to concentrate on compliance with principles 5, 6, 7 and 8, while principles 1 to 4 remain much less implemented, even though pesticide-free measures exist to protect crops. **Agrowise project propose to reinforce the application of principle 1 and the role of active prophylaxis, in order to mitigate the risks associated with pest pressure.** This preparatory approach enables the effective implementation of the foundational IPM principles. The cultural practices carried out by farmers—those that strengthen the resilience and long-term viability of cropping systems—must now be actively promoted and supported. They are the cornerstone of IPM success and a prerequisite for sustaining farmers' efforts.

The overarching purpose of this deliverable is to facilitate the understanding, adoption and development of IPM-based actions in agricultural systems. It seeks to provide Member States with concrete and practical elements that will support the drafting of national guidelines enabling farmers to effectively comply with the eight principles of IPM. To be practicable and impactful, these guidelines must allow for the commitment of all stakeholders, both upstream and downstream, ensuring that sustainable crop protection becomes a shared responsibility across the entire agricultural value chain.

4 Operational framework for guideline implementation

The agricultural sector in the European Union is facing increasing challenges linked to biodiversity decline, pesticide resistance, and the reduced availability of active substances. In this context, Integrated Pest Management (IPM) provides a comprehensive framework to safeguard crop productivity while reducing risks to human health and the environment. Within the AGROWISE LIFE project, funded by the European Commission, the objective is to develop recommendations and guidelines that can support Member States in reinforcing the implementation of IPM across diverse agro-ecological conditions.

The legal foundation of IPM is established in Article 14 of Directive 2009/128/EC on the sustainable use of pesticides (SUD)[1], which requires Member States to describe in their National Action Plans how they ensure that the eight general principles of IPM, as set out in Annex III, are implemented by all professional users. Regulation (EC) No 1107/2009 further complements this framework, and its Article 55[2] specifies that plant protection products must be used properly, in compliance with both good plant protection practice and the provisions of the SUD.

Today, the current implementation of IPM principles by Member States shows that some principles are applied more consistently than others. Principles 1 (prevention), 2 (monitoring), 3 (decision making), 7 (resistance management) and 8 (evaluation) have both tactical and strategic temporal dimensions, and this duality is not explicit in current instruments targeting those

[1]Article 14 of Directive 2009/128/EC: « *Member States shall describe in their National Action Plans how they ensure that the general principles of integrated pest management as set out in Annex III are implemented by all professional users by 1 January 2014* »

[2]Article 55 of Regulation (EC) No 1107/2009: "*Plant protection products shall be used properly. Proper use shall include the application of the principles of good plant protection practice and compliance with the conditions established in accordance with Article 31 and specified on the labelling. It shall also comply with the provisions of Directive 2009/128/EC and, in particular, with general principles of integrated pest management, as referred to in Article 14 of and Annex III to that Directive, which shall apply at the latest by 1 January 2014.*"

principles. As a result, the current application of IPM remains largely focused on the *good phytosanitary practices* described on principles 5, 6, and to some extent 7, limiting the strategic integration of preventive, monitoring, decision-making and evaluation measures. Results from the first Agrowise workshop held in Brussels in September 2024 support this observation. Participants estimated that, on average, only around 40% of farms have implemented the necessary changes for an effective application of Principle 1 (prevention), while approximately 60% have adopted good treatment practices corresponding to Principles 5, 6, and 7. These figures indicate an operational focus on pesticide use and management than on preventive and anticipatory measures. The survey also highlighted that in situ observations are considered the most important levers for Principles 2 and 3, while most respondents felt that more solutions derived from Principle 4 are needed to further reduce pesticide dependency. In addition, a majority agreed that crop diversification is central to advancing prevention, reinforcing the need to give greater prominence to prophylaxis within IPM implementation.

This report contains precision on the least regulated principles. Such precision was asked during the first workshop in Brussels as some principles seemed harder to regulate.

In the framework proposed in this report, the role of Member States is central, as they are responsible for ensuring that the eight principles of Annex III are effectively applied in practice. Achieving this requires a clear link between general principles and practical actions of the farmers. The guidelines defined in the SUD directive is a useful mean to make this link. Indeed, **the guidelines can ensure a shared understanding of how each principle should be implemented by being clear, scientifically robust, and being adapted to local contexts.** That is why the Agrowise project considers them essential items for the coherent and effective application of IPM throughout the European Union.

4.1 Agrowise's proposal

Agrowise aims to enhance the understanding of IPM principles amongst all relevant stakeholders. This includes farmers and advisors, who implement IPM practices in the field through targeted training programs (both initial and ongoing), as well as policymakers and Member States, who develop and enforce regulations by providing clear, actionable, and context-specific guidelines. By clarifying the objectives of each principle and demonstrating their application through practical on-farm actions, these efforts help ensure that IPM guidelines are applied effectively and consistently, as outlined in Part I.

Agrowise has identified existing guidelines that contain valuable information to enhance the implementation of IPM. By analysing these guidelines, Agrowise aims to provide agricultural stakeholders with standardized guideline. This approach can support both policy development and on-farm decision-making, ensuring that guidelines are scientifically robust and practically applicable.

Building on the insights from existing guidelines and those identified by the project, Agrowise recommends developing practical "action sheets". These are intended for policymakers, Member States, farmers and any other concerned stakeholders (such as advisory services, etc.) to facilitate the effective implementation of IPM principles in the field, aligned with each country's NAP. The "action sheet" would detail step-by-step procedures to implement a guideline, outline monitoring and reporting methods for its implementation, and offer recommendations for long-

term strategic planning to update the “action-sheet”. This approach aims to translate IPM principles from theoretical concepts into actionable practices on farms.

Agrowise proposes to focus on active prophylaxis practices actions in order to make the implementation of the prevention principle more operational and to ensure its clear and controllable transcription within the guidelines developed by Member States.

Thanks to the taxonomy produced as part of the Agrowise project (D2.1), it is clear that there are a large number of plant protection levers available. By applying these levers to all ‘pest-crop’ pairs and taking into account the variability of agronomic contexts, it would be possible to write an infinite number of guidelines. In order to make its framework operational and to ensure the most concise transcription of the principle of prevention in the guidelines controllable by Member States, the Agrowise project proposes to focus on active prophylaxis practices.

Agrowise define Active Prophylaxis in Deliverable 5.1. This notion forms a common foundation for all farms, ensuring effective pest prevention and crop resilience. At a first glance, most of the Active prophylaxis actions seem to be widespread. In fact, the premise of this framework is that practices such as choosing a crop rotation, variety, sowing depth or density are indeed, carried out by all farmers, but not always with the primary objective of integrating this choice into a crop protection strategy. Thus, most of the practices outlined in Principle 1 on prevention have to be carried out even if the terms of their implementation do not allow them to contribute to a sustainable crop protection. Examples for practices relevant for active prophylaxis include: cover cropping, species mixtures, certified seeds and planting material, non-chemical seed treatment, spatial arrangement of plants, establishment of a “false seed bed”, creation or restoration of habitats within and around fields, removal of non-crop hosts, cleaning of machinery and equipment, sanitation of water and soil, as well as elimination of inoculum sources. The success of some of these measures depends on the local context, including climate and weather, soil and hydrological characteristics, landscape structure and heterogeneity, biodiversity and ecosystem functions, pest pressure and biotic interactions, as well as temporal and historical effects of previous practices (Deliverables 3.3 and 5.2). This combination of active prophylaxis and contextual understanding enables the identification of robust, widely applicable actions suitable for all farms, alongside practices that require local adaptation, technical guidance and long-term monitoring.

That is why the application of Principle 1 practices must be intentional and strategic. For example, crop rotation becomes effectively preventive when planned to disrupt the biological cycles of pests and diseases, rather than solely for agronomic or economic purposes (see Chapter 6.1, “Principle 1”).

Certain biotechnological practices, such as the use of pheromones for mating disruption, can be considered anticipatory preventive measures, comparable to Principle 1 practices (see Deliverable 2.1, “Harmonization and taxonomy of IPM practices”), as their effectiveness depends on the installation of diffusers before pest pressure reaches the economic threshold calculated in the short term and at farm level. On the contrary, other products, including some biocontrol agents, having contact action with the pest, therefore, cannot always be applied preventively.

This distinction highlights the importance of anticipating the combination of practices that

can be implemented before problems arise, thus reduce future pest pressure on crops, crop system resilience and reducing reliance on chemical interventions, in line with the operational and contextual recommendations identified in Deliverable 5.2.

For the Agrowise project, this common foundation should represent the minimum standard for IPM, while additional measures adapted to local conditions or long-term effects should be supported and encouraged to maximise the overall sustainability and effectiveness of plant protection strategies of agricultural systems in Europe.

PART 1 - OPPORTUNITIES FOR STRENGTHENING INTEGRATED PEST MANAGEMENT AND ITS GENERAL PRINCIPLES

5 Focus on the least regulated IPM general principles from annex III

In this section, Agrowise will present improvements that can be done to achieve the objectives settled in the original text of the Annex III, based on the most updated knowledge. It is also to be noted that all the 8 general principles are mandatory, and appear to be designed to follow this order. As a reminder, the Agrowise consortium was asked to propose an upgraded set of guidelines in the context of the SUR discussion and even in the SUD context this task remain useful. Indeed, the SUD directive, in its article 14[3] allows for updates based on scientific and technical knowledge. This hasn't been done since 2009, despite the improvements at scientific and technical level. Therefore, the review of the methods facilitating the implementation of IPM and its general principles will be able to benefit from all scientific advances, which will be useful for future revisions of the National Action Plans (NAPs) of Member States.

This section focuses on principles 1, 2, 3, 7 and 8 because they seemed more difficult for Member States to regulate. According to NAPs, discussions with Member State representatives and the survey conducted at the Agrowise workshop on 24 September 2024, principles 4, 5 and 6 are better understood and implemented by Member States.

5.1 Principle 1: Prevention and suppression

Agrowise recommendation: Principle 1 should be achieved by promoting active prophylaxis - intending to prevent harmful organisms-, in the set of practice. Context-dependent practices must be supported as voluntary practices.

Agrowise recommendation: Practices that depend on the landscape and pest dynamics will be given priority support at regional level and by stakeholder groups/farmer's collectives.

Principle 1 has been designed to be the basis of the IPM. It aims to prevent and/or suppress harmful organisms. This is consistent with the fact that anticipating future population dynamics by reducing sources (management of uncultivated host plants, selection of healthy seeds) and reducing their presence on cultivated land (seed stock management, removal of inoculum, management of landscape infrastructure in or around cultivated areas) has the effect of mitigating the risk of massive attacks by these pests, including in the long term.

[3] "Measures designed to amend non-essential elements of this Directive relating to amending Annex III in order to take into account the scientific and technical progress shall be adopted in accordance with the regulatory procedure with scrutiny referred to in Article 21(2)."

1. The prevention and/or suppression of harmful organisms should be achieved or supported among other options especially by:

— crop rotation,

— use of adequate cultivation techniques (e.g. stale seedbed technique, sowing dates and densities, under-sowing, conservation tillage, pruning and direct sowing),

— use, where appropriate, of resistant/tolerant cultivars and standard/certified seed and planting material,

— use of balanced fertilisation, liming and irrigation/drainage practices,

— preventing the spreading of harmful organisms by hygiene measures (e.g. by regular cleansing of machinery and equipment),

— protection and enhancement of important beneficial organisms, e.g. by adequate plant protection measures or the utilisation of ecological infrastructures inside and outside production sites.

Figure 1 IPM general principle 1 as stated in the Annex III of the SUD

As stated in the annex III of SUD, this principle aims to prevent and/or suppress harmful organisms and has to be achieved through appropriate practices. But the list of practices cited in Fig.1 gives only suggestions to achieve this aim. Therefore, by promoting one or the other of these practices independently, a set of guideline doesn't consequentially fulfills the principle 1. The way in which the practices are implemented must enable the objective of preventing damage caused by harmful organisms to be achieved (see below). Agrowise has developed the concept of active prophylaxis, led by the intention behind a practice. The notion of active prophylaxis can be used as a tool by Member States to sort the priority practices to promote in order to achieve the aim of principle 1. This notion will shape the wording of the guidelines described in this report.

The results of Deliverable 3.1 indicate that it is currently difficult to precisely assess which practices are behind the implementation of Principle 1. This difficulty is not only due to a lack of monitoring tools but also because, as highlighted in Deliverable 5.1, "most practices and systems that claimed to be preventive were not initially designed for this purpose." Annex III of the SUD Directive illustrates this ambiguity: it lists a wide range of possible measures without specifying either the conditions for effectiveness.

The interviews conducted with SUD representatives in July and August 2024, in the context of Member States' involvement in WP5, confirmed this lack of adequacy. Principle 1 is often reduced to general statements by the interviewees. The following quotes were found in the interviews: "prevention, suppression? It's crop rotation. It's mechanical weeding, false seedbed and such kind of things", "Maybe just crop rotation?", "Try not to [...] introduce the [pests/fungi] so you don't have to arrive to the point that you need to use chemical PPP". Other quote are more focused on the difficulties of applying this principle: "it is impossible to answer [the] question [of 'what does it mean to apply the first principle?'] for the whole country, because it is different in each case, depending on the crop/pest combination and the biology of the specific harmful organisms". This diversity of responses illustrates that, without further clarification, Principle 1 remains difficult to give a practical interpretation and to implement consistently.

To remedy this situation, **Agrowise proposes to upgrade Principle 1 around the concept of *active prophylaxis*.** This approach is a set of actions, agronomic practices and cultural combinations that are intentionally implemented in order to reduce weed, pests and diseases pressure as much as possible and ideally under the harmfulness threshold without further intervention. The notion of intentionality is the key element added to the current framework: the

objective is not simply to apply a crop rotation, but to design strategic rotations aimed at breaking biological cycles (for instance, 3 crops either distributed over two sowing periods, or including a "stifling" crop). Beyond crop diversification, this approach enables the mobilisation of efficient actions when the pest pressure is low or moderate and expands the range of available preventive measures.

Building on **recent findings underscoring the contribution of functional biodiversity to the resilience of farming systems**, it appears essential to control pest pressure at a low level to enable the eco-systemic benefits to materialise. By reducing pest pressure at its source, active prophylaxis provides the foundation for re-establishing the strategic intent of Principle 1. The IPM guidelines appears to be a great way to disseminate practical criteria for successful practices, by prioritising measurable agronomic and ecological outcomes.

EXAMPLES OF CONCRETE ACTIONS IN THE FIELD TO APPLY PRINCIPLE 1:

***Grow resistant varieties**: Wheat resistant to septoria, brown or yellow rust; potatoes resistant to late blight, included in the list according to their resistance scoring.*

***Grow mixed rapeseed varieties**: Include a trap variety that flowers 10 days earlier (against* meligethes aeneus*).*

***Rotation**: Incorporate a rotation that aims to prevent the arrival or establishment of a pest: at least 3 species and sow them in at least two separate sowing periods: January to June and June to December. If this is not possible, then the farmer must implement a cover crop*

5.2 Principle 2: monitoring and Principle 3: decision making

Agrowise recommendation: Support the establishment of detailed monitoring systems to know,identify and track precisely pest dynamic over major crops . Indeed, these systems provide farmers with accurate information to anticipate risks, guide intervention decisions, and promote the development and implementation of innovative non-chemical methods.

Agrowise recommendation: It is necessary to adapt or establish specific thresholds for the full range of intervention methods (including threshold for mechanical actions, for the use of micro-organism, as well as for sowing strategies and the tailored selection of service plants). The sharing of intervention thresholds amongst farmers and even amongst countries is to be sought. Attention must be given to ensuring that hidden costs and long term effects are incorporated into threshold calculations.

Principle 2 has been designed in the aims of monitoring the presence and the dynamics of pest population evolution.

2. Harmful organisms must be monitored by adequate methods and tools, where available. Such adequate tools should include observations in the field as well as scientifically sound warning, forecasting and early diagnosis systems, where feasible, as well as the use of advice from professionally qualified advisors.

Figure 2 IPM general principle 2 as stated in the Annex III of the SUD

According to the Figure 2, **continuous crop monitoring allows for the early detection of pest presence and development**, forming the basis for decision-making regarding following interventions. Some countries already have advanced systems in place: Poland, Croatia and Germany use national interactive maps integrated into-decision-support tools (DST) for advisors or farmers, while France relies on weekly or monthly national bulletins (BSV).

Understanding pest/crop interactions is essential for preparing monitoring programs and guiding management decisions. It allows for better risk anticipation and the identification of high-impact interactions for which predictive models are lacking or existing tools are insufficient. This approach encourages innovation through the development of new models and early-warning systems adapted to local conditions and high-risk interactions, thereby enhancing the precision and effectiveness of IPM.

Principle 3 has been designed in the aims to to make the best decision (do nothing or take action) based on the results of monitoring the dynamics of the pest populations observed. The decision must be made according to scientifically studied thresholds adapted to local conditions.

3. Based on the results of the monitoring the professional user has to decide whether and when to apply plant protection measures. Robust and scientifically sound threshold values are essential components for decision making. For harmful organisms threshold levels defined for the region, specific areas, crops and particular climatic conditions must be taken into account before treatments, where feasible.

Figure 3 IPM general principle 3 as stated in the Annex III of the SUD

According to the Figure 3, **the determination of these thresholds is critical, as it directly affects the ability to prioritise non-chemical methods under Principle 4 before any use of chemical pesticides (Principles 5 and 6)**. If the threshold is set too high, pest pressure may exceed the crop's inherent resilience, leading to premature chemical intervention. On the contrary, if the threshold is set too low, unnecessary or costly interventions may be carried out, undermining the sustainability of the production system.

A shared understanding of the **definition of "measures" and "treatments" in Annex III** is therefore crucial to ensure that the methods under Principle 4 are fully applicable and given priority. As noted in Annex III: "Sustainable biological, physical and other non-chemical methods must be preferred to chemical methods if they provide satisfactory pest control." For this prioritisation to be effective, thresholds should be tailored to non-chemical interventions, including the use of micro-organisms, pheromone deployment, mechanical weeding, field scouting and drone-based mapping, all of which contribute to optimising the efficiency of these practices.

As outlined in Deliverable 5.1: «The harmfulness threshold is the pressure that the crop can withstand without consequences on yield and quality and economic viability over long term. The thresholds will be intermediate if non-chemical methods are to be used (Principle 4), where the main action modes rely upon biological regulations. And the thresholds will be the lowest if no pesticide is to be used. Thus, turning the story in the opposite direction, an Active Prophylaxis strategy that makes it possible to achieve low pressures, corresponding to the lowest harmfulness

thresholds, is leading to a major reduction of pesticide use, and thus pesticide impact. As a consequence, there is likely to be a decrease in profitability for the farmer, which then should be a consideration for support. »

Thus, the combination of continuous monitoring and appropriately defined intervention thresholds, as set out in Annex III of the SUD Directive, supports a hierarchy of actions that prioritises “do nothing” or the application of non-chemical practices first, reserving chemical treatments only for cases that are strictly necessary. The development and refinement of DSS, the modelling of pest/crop interactions, and innovation in monitoring are essential to ensure that these decisions adhere to the recommended hierarchy, allow for practices other than the use of products, optimise the effectiveness of integrated pest management, and reduce pesticide use.

EXAMPLES OF CONCRETE ACTIONS IN THE FIELD TO APPLY PRINCIPLE 2 AND 3 :

Principle 2 and Principle 3: *Knowledge of pests and diseases that may be harmful to crops, strategies implemented by other farmers under the same local conditions.*

Carry out regular field observations: *Observe population dynamics, number of pollen beetles on rapeseed, number of bites by weevils on peas, etc.*

Monitoring using traps (visual or olfactory) that are often specific to pests: *Observe the dynamics of Mediterranean fruit fly populations in orchards using specific traps.*

These observations enable decisions to be made and are supplemented by:

Modelling prediction: *Climate or pest (life cycle, presence).*

Use of thresholds adapted to innovative measures: *Inform your decisions, learn about the decisions of other farmers subject to the same pressures.*

Need to establish/use thresholds adapted to innovative active prophylaxis techniques.

According to national action plans, discussions with Member State representatives and the survey conducted at the Agrowise workshop on 24 September 2024, principles 4, 5 and 6 are better understood and implemented by Member States. Agrowise has no specific recommendations for these principles.

5.3 Principle 7: Anti-resistance strategy

Recommendation: Principle 7 should be amended to mandate an anti-resistance strategy integrated across all IPM principles.

Principle 7 has been designed in the aims to implement anti-resistance strategies when using plant protection products. It is the only principle which explicit that principle are asking for strategic.

7. Where the risk of resistance against a plant protection measure is known and where the level of harmful organisms requires repeated application of pesticides to the crops, available anti-resistance strategies should be applied to maintain the effectiveness of the products. This may include the use of multiple pesticides with different modes of action.

Figure 4 IPM general principle 7 as stated in the Annex III of the SUD

The formulation of the principle 7 establishes a direct link with Principles 5 and 6, which focus on the use of chemical pesticides, but it overlooks interactions with the other IPM principles. As such, it defines a primarily tactical response aimed at limiting the loss of efficacy of existing products, rather than a comprehensive strategy that seeks to proactively reduce the emergence of resistance risk.

Resistance prevention must be addressed across all IPM principles. From Principle 1 onwards, active prophylaxis plays a key role in reducing pest pressure, therefore lowering the likelihood of resistance development. The use of resistant or tolerant varieties follows the same motive and requires increased investment in research and in the development of a structured market for these solutions. Principles 2 and 3 strengthen this preventive framework: detailed monitoring of pest-crop interactions and the establishment of suitable agronomic thresholds help steer decisions towards non-chemical practices, delaying the ned for synthetic treatments.

Principle 4, which prioritises biological, physical and biotechnological methods, should likewise be mobilised. Solutions such as pheromones or specific biocontrol agents are valuable tools, as they tend to induce little or no resistance in target organisms. However, careful monitoring remains necessary for certain biological products, where resistance may still emerge. Finally, research and the implementation of biological or biotechnological control strategies should be actively supported, as they broaden the range of effective “good practices”.

In this context, Principle 7 cannot be limited to addressing chemical resistance risk alone; it must be framed as a strategic connection across all IPM principles, with preventive and non-chemical measures taking a central and leading role. Accordingly, the Agrowise project advocates for repositioning this principle at the centre of integrated production strategies. Monitoring under Principle 8 complements this strategy by ensuring ongoing evaluation of measure effectiveness, both seasonally and annually, taking into account the variability of biological processes and agronomic conditions.

EXAMPLES OF CONCRETE ACTIONS IN THE FIELD TO APPLY PRINCIPLE 7 :

Principle 1: *Introduction of resistant varieties (cf. principle 1) and other active prevention measures.*

Principles 2 + 3: *cf. Principle 2 + 3 -> reinforces anticipation.*

Accessibility of Principle 4: *Use of non-chemical solutions.*

When using biocontrol products: *comply with principle 7. Respect the dosage, be careful when using active substances, which must be changed regularly.*

Evaluation*: Evaluation of the strategy used in terms of its anti-resistance functions.*

5.4 Principle 8

Recommendation: Principle 8 should enable regular evaluation of the effectiveness of applied measures, both throughout the annually and in the longer term (every five years), taking into account technical results as well as the farmer's satisfaction with the interventions carried out

Recommendation: The tactical evaluation do not rely solely on observing the number of pests to assess these dimensions. The evaluation differs from an observation of the plot as defined in Principle 2.

8. Based on the records on the use of pesticides and on the monitoring of harmful organisms the professional user should check the success of the applied plant protection measures.

Figure 5 IPM general principle 8 as stated in the Annex III of the Sud

Principle 8 has been designed in the aims to assess the effectiveness of pest monitoring and control methods used

While the principle 8 may appear to be limited to a technical verification of treatment outcomes, it, in fact, opens the door to a much broader reflection on the evaluation and adaptation of agricultural systems. Its implementation should go beyond merely assessing pesticide effectiveness and become a strategic lever for advancing towards truly sustainable integrated protection.

The Agrowise project highlights the important of structuring this evaluation on two complementary levels. The first level involves a strategic audit conducted, ideally, on a quinquennial basis, aimed at redefining the cropping system, particularly through rotation planning and the integration of Principles 1,2,3,4 and 7. This framework enables a reconsideration of the system's foundation rather than solely optimising operational details. It could be legally framed and entrusted to certified IPM advisors who would serve both as facilitator (i.e.: disseminating scientifically validated innovations and agronomic combinations) and as oversight bodies, reducing the need for direct farmer supervision.

The second level consists of ongoing advisory support, delivered multiple times throughout the growing season, to adjust decisions according to climatic conditions, pest dynamics and observed outcomes. This approach embeds Principle 8 within a dynamic and adaptative framework, reflecting the inherent variability of biological systems.

This dual-level evaluation aligns with the ESR (Efficiency/Substitution/Redesign) conceptual framework proposed by Hill and McRae (1998). Progressive improvements through efficiency (E) and substitution (S) have structural limits. Only the stage of system redesign (R), enabled by regular strategic evaluation, can overcome these constraints and achieve a genuine reduction in pesticide dependency. In this perspective, Principle 8 becomes central: it is not merely about verifying individual actions but also about creating the conditions for a structural transformation of crop protection systems.

EXAMPLES OF CONCRETE ACTIONS IN THE FIELD TO APPLY PRINCIPLE 8:

Farmers must evaluate their strategy, what are the strength and weaknesses of it?

Are they satisfied with their crops and the control methods used, incorporating all principles from start to finish?

Adaptation of new strategies and advice from third parties.

6 Mapping IPM principles to SUD outcomes

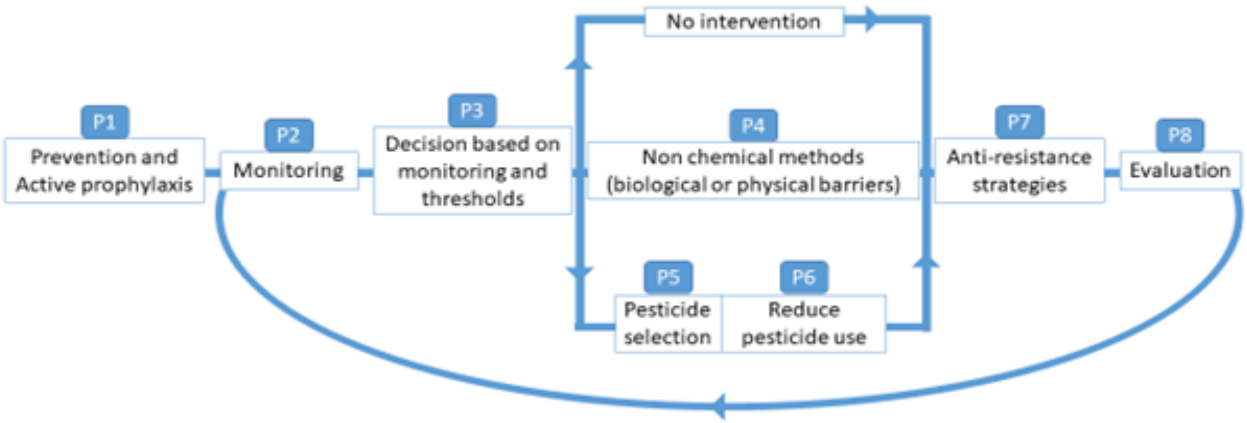

Figure 6 Advanced definition of the Integrated pest management by Agrowise

The Agrowise consortium proposes an advanced definition of Integrated Pest Management (IPM) that builds upon Article 14 of the SUD directive and Annex III, while addressing current implementation gaps and long-term sustainability challenges.

According to Agrowise, correct application of IPM begins with the fundamental implementation of Principles 1 (Prevention), 2 (Monitoring) and 3 (Decision), and extends through compliance with Principles 7 (Limiting resistance) and 8 (Evaluation). This sequence ensures that pest pressures are anticipated and addressed strategically, rather than being managed primarily through reactive chemical interventions.

Prevention (Principle 1) is central to this approach. Effective preventive measures, including the concept of active prophylaxis, reduce overall pest, disease, and weed pressure, thereby enabling the use of non-chemical methods or, when possible, the avoidance of intervention altogether. However, preventive measures may be ineffective when originally designed for objectives unrelated to crop protection, such as soil fertility or market demands. Monitoring (Principle 2) and decision-making (Principle 3), supported by redesigned Decision Support Systems incorporating biological thresholds, are essential to ensure that preventive practices translate into measurable reductions in pest pressure and allow informed, timely interventions.

Principle 4 (Biological control) is prioritized whenever intervention is necessary, with chemical methods (Principle 5) used only as a last resort. When chemical interventions are applied, Principle 6 ensures that they are executed in a manner that minimizes risks, including resistance development, off-target impacts, and environmental consequences. Principle 7 extends beyond pesticide resistance management to integrate all measures aimed at reducing the likelihood of resistance across the full suite of IPM actions, including prophylaxis, biological control, and agronomic practices. Finally, Principle 8 emphasizes systematic evaluation, both annual and during the season, to verify the effectiveness of implemented measures and justify any necessary interventions, thereby supporting continuous improvement and adaptive management.

Agrowise also proposes going beyond the traditional “IPM triangle” by representing the

relationships between principles, targets, levers, and actions. This approach highlights the interconnected nature of IPM, demonstrating that proactive prevention, rigorous monitoring, and strategic decision-making enable more sustainable, diversified, and resilient pest management systems. Long-term sustainability is increasingly critical given the decreasing number of approved active substances in the EU and the documented rise in resistance across herbicides, fungicides, and insecticides. Effective IPM, as defined by Agrowise, therefore relies on highly proactive prevention strategies, integrated monitoring, and adaptive evaluation to ensure crop protection and safeguard future food security.

PART 2 - RECOMMENDATIONS FOR DRAFTING GUIDELINES TO IMPLEMENT THE FUNDAMENTAL IPM PRINCIPLES WITH ON-FARM PRACTICES:

7 Analysis of the current guidelines

As each guideline is intended to support farmers in implementing IPM practices, an assessment was conducted to determine whether they effectively fulfil this function. To this end, the official guidelines provided by Consortium members in the guidelines table were analysed, to identify passages supporting the adoption of practices outlined in the Agrowise's Taxonomy: "Use of resistant varieties", "Mating disruption", "Establishment of ecological infrastructure: flower strips", "Carry out crop rotation", "Limiting resistance: Selection of pesticide, active substance and control agent", "Use of an Decision support systems (DSS) for a chemical PP".

An analysis of the guidelines' wording was conducted to classify them as incentive-based, descriptive, compulsory, or as supporting the concrete and comprehensive implementation of practices. : mandatory (direct, indirect) and recommended (formal, prescriptive, descriptive).

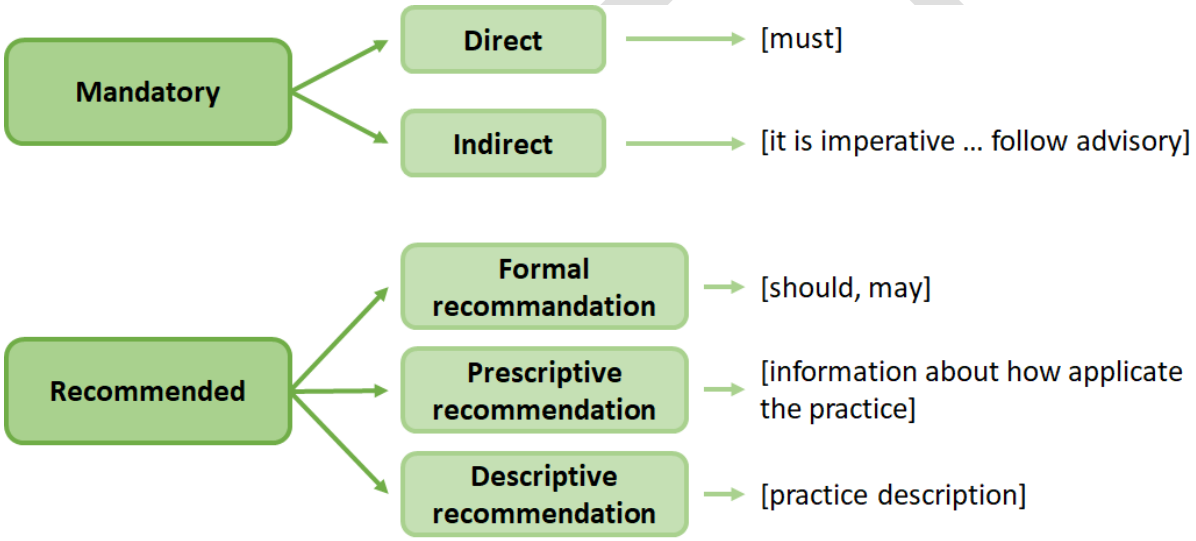

Figure 7 Analyses of the current guidelines

In the « **mandatory** » category, two principal formulations have been identified:

- The direct obligation

Ex. : « *The use of chemical plant protection products must be limited to what is necessary. The possibilites of reduced application rates [...] anti-resistance strategies must be introduced if there is a risk of pest becoming resistant to plant protection products. Recommandations and guidelines from advisors and manufacturers of plant protection products for the prevention of resistance and the implementation of anti-resistance strategies must be observed* »

- The indirect obligation.

Ex. : « *It is imperative to take into account the emergence of pest resistance to certain agents and the waiting period. Follow the recommandations of the advisory service ».*

In the « **recommended** » category, three principal formulations have been identified:

- The formal recommendation

Ex. : « *In areas infested by harmful organisms, varieties and rootstocks that are identified as susceptible should not be used, provided that marketable, resistant or less susceptible varieties and rootstocks are available [...] where possible, varieties with resistance or low susceptibility to disease should be selected*. »

- The prescriptive recommendation

Ex. : « *Cydia pomonella Linnaeus [...] the use of sex pheromone traps to capture adults in order to reduce population level, but also to warn of treatments (1 trap/ha, at least 50m apart).* »

- The descriptive recommendation

« Rotation is the main prophylactic measure against diseases. It has an effect above all on the populations of bio-agressors that are infelicitous to the plot, such as eyespot [...]. The aim is to reason out the length of time it takes for crops to return to the same plot, and the effect of the preceding crop on each crop, to enable an alternation between host and non-host plants for diseases. »

7.1 Review of the incentive effect of compliance with the IPM general principles under the current guidelines

Given that each selected guideline concerns a layer of the IPM practices taxonomy from deliverable 2.1 and therefore a principle, we sought to determine whether certain principles were more often represented by “recommended” or “obligation” type guidelines.

As a reminder, the guidelines studied were as follows: For principle 1, ‘Use of resistant varieties’, ‘establishment of ecological infrastructure: flower strips’, ‘carry out crop rotations’; for principle 3, ‘use of an USS for a chemical pesticide’; for principle 4, ‘mating disruption’; and finally for principle 7, ‘limiting resistance: selection of pesticide, active substance and control agent’. These guidelines were selected for their relevance or their presence in the various IPM guides provided by the different members and countries of the consortium.

Using our data, we can see that principle 7 (closely linked to pesticide use in Annex III in the SUD) is supported by stricter guidelines and directives than principles 1, 3, or 4, which are more often recommended by descriptive guidelines.

Important note: Still under review. Other principles or practices will be reviewed by October 31.

This review highlights the importance of the written structure of the guideline. A concise guideline, accompanied by a “complete notice or roadmap,” allows for better implementation in the field because it becomes easier to apply, especially if it is supported by various measures (subsidies, IPM advisors).

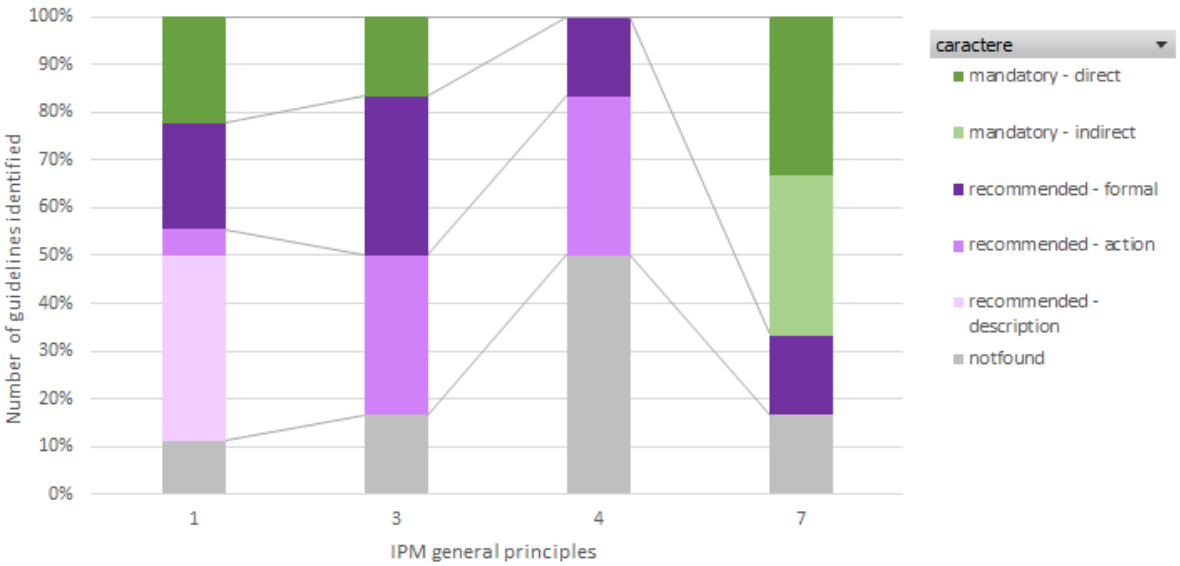

Figure 8 Characteristics of IPM guidelines by general IPM principles

7.2 Case study

Resistant varieties – Deliverable 4.2 Case

+ Include the examples of wording that we found on it.

+ What are the strengths and weaknesses of each of the formulations?

presentation of the levels of precision of the guidelines according to the March 2025 presentation in Brussels

8 Approach to drafting new guidelines

An effective National Action Plan (NAP) should explicitly link the general IPM principles to the practical actions considered most important for crop protection. Guidelines serve as a framework for highlighting the practices supported by a Member State, ensuring that farmers and advisory services understand how to operationalize the principles on the ground. To be effective, guidelines should focus on addressing a major crop protection challenge, rather than attempting to cover all production situations exhaustively, as per the SUD definition. They should comprehensively address all IPM principles, with clear documentation of the connections between each principle and the corresponding on-farm actions. Implementation must begin with Principle 1 (Prevention), establishing a proactive foundation for the entire IPM strategy. Finally, guidelines should be designed so that their uptake and application can be monitored at the level of agricultural sector actors, not necessarily limited to individual farmers.

The development of effective IPM guidelines should always aim to ensure that farmers apply the general IPM principles, with particular emphasis on preventive measures, resistance management, and evaluation, alongside the judicious use of chemical interventions. The taxonomy of practices developed in Deliverable 2.1 provides a solid foundation for this process, translating each principle from Annex III into practical, on-farm actions. Guidelines should then be drafted with a clear level of ambition and precision, reflecting the hierarchical structure of this taxonomy: broader layers provide general guidance, while deeper layers offer specific, actionable recommendations for field implementation.

Implementation and monitoring mechanisms are essential to guarantee that the guidelines are applied in practice. Guidelines may take different forms, from simple checklists for farmers to comprehensive systems ensuring on-farm application. Regardless of the format, processes must be established to verify and support implementation without overburdening the farmer. This can involve certified advisors overseeing practice deployment, ensuring that IPM principles are prioritized, or establishing monitoring systems such as CEPP (France). Member States have the flexibility to determine the level of detail in their guidelines, but they must ensure that a robust system is in place to confirm effective on-farm application. By leveraging the Deliverable 2.1 taxonomy, providing clear guidance, and establishing practical monitoring, guidelines can facilitate the consistent and operational application of IPM across diverse agricultural contexts.

8.1 Guidelines should imply an intention.

Applying a practice within the framework of Integrated Pest Management (IPM) must be done in coherence with the objective of the principle to which it belongs. Each practice should be understood not as an isolated action, but as part of a strategic continuum serving the broader goal of risk prevention and system resilience. For example, crop rotation—anchored in Principle 1 of IPM—aims not only to diversify crops at the farm level but also to ensure a succession or co-cultivation of different species within the same field over time. When the overarching objective is to reduce crop damage and dependency on pesticides, rotations must be designed according to agronomic criteria that directly contribute to these outcomes, such as alternating crops with differing rooting systems, nutrient demands, and pest-host compatibilities.

However, in practice, the implementation of such measures often faces conflicting challenges of two kinds. The first is technical, since farming systems must be designed to reduce pest-related damage while adapting to the environmental and agronomic constraints of the local context—certain crops simply cannot be grown everywhere. The second is socio-economic, as the feasibility of crop diversification or system redesign is influenced by market access, input availability, and labour or equipment constraints. These socio-economic barriers, more extensively addressed in Deliverable 6.1, are key determinants of whether the theoretical potential of IPM practices can be fully realized in the field. Recognizing and addressing both dimensions is therefore essential to ensure that the application of IPM principles remains both technically sound and economically viable.

In appendice 1, ...

8.2 Action sheet for MS to draft guidelines supporting the guidelines

These sheets (Appendice 2) enable the creation of guidelines that support the correct application of the principles as understood by Agrowise throughout this deliverable. Here we provide an action sheet for creating a guideline that supports the integration of resistant grapevine varieties to limit dependence on phytosanitary inputs.

...

9 Conclusion

10 References

LastName1 X. Y., LastName2 X. Y. – *Title* – YEAR, Publication (Vol., Issue)

11 Appendices

APPENDICE 1 : Use of “Practice” to reduce over dependency on pesticide use

APPENDICE 2 : Action sheet template

11.1 Annex 1 - Recommended wording for a precise guideline “Use of “Practice” to reduce over dependency on pesticide use”

The purpose of this Annex is to propose wording for guidelines concerning active prophylaxis actions. The wording should include an action verb, the name of the practice (layer 3 of the taxonomy), a reference to a rule explaining when the action is considered to be accomplished, and the objectives for which the rule was developed. For example : Use the “Practice” following the crop-specific rule or using an eligible item listed on the list in order to reconcile two conflicting objectives.

Variation for a pair (crop; pest). Pair that may consist of one pest affecting several crops or several pests affecting a single crop, or even several pests affecting several crops.

Please note: according to the directive, compliance with the guidelines is one way of implementing the various principles of IPM. It is therefore up to farmers to use these guidelines to develop their systems and thus ensure that they comply with the principles of IPM. According to the directive, it is also possible to achieve compliance with these principles by other means, either by complying with other specifications deemed equivalent to IPM standards or by justifying the means used and their ability to achieve the principles of IPM. Agrowise considers the practices in Principle 1 to be a priority, as they form the basis for reducing pest pressure, which benefits the success of all the crop protection practices in the other principles. Deliverable 6.1 describes the elements relating to the organisation of stakeholders that facilitate the implementation of these guidelines for farmers. The participation of other stakeholders is essential to the success of the SUD Directive's objective; this is the subject of the recommendations in document 6.1.

Level 1 (target)	**Level 2** (strategy)	**Level 3** (practice)	Annual crops	Vineyards	Orchards	Vegetables	Active prophylaxis action	Example of eligible list or practical guideline. Extract from Guidelines arising from the rules in force in the CEPP system in France
1.1 Crop selection	1.1.1 Varietal diversity	Use resistant tolerant cultivars	x	x	x	x	*Use of tolerant/resistant cultivars* **listed on the list of eligible varieties** while preserving resistance genes and reduce over dependency on pesticide use	Test parameters and scoring defined by the CTPS and carried out by GEVES. Thresholds decided by crop specific working groups *-017, The list includes potato varieties* rated 7 and 8 (low susceptibility) for tolerance to leaf blight, or varieties rated 6 (fairly low susceptibility). *-029, The list includes winter wheat varieties* that are resistant to fungal diseases:

								• **For late-heading varieties (overall score <= 6)**: resistance to septoria (CTPS rating >= 5.5 or 6 depending on profile) and resistance to brown rust (CTPS rating >=4 or 5 depending on profile) and resistance to yellow rust (CTPS rating >=6 or 7 depending on profile) and resistance to take-all disease (>=5) and resistance to fusarium head blight or DON (>=3.5) • **Mid-early to early varieties at ear emergence (score = 6.5 and 7)**: resistance to septoria (>= 5 to >=6 depending on profile) and resistance to brown rust (>=5 or 6 depending on profile) and resistance to yellow rust (>=6 or 7 depending on profile) and resistance to take-all disease (>=5) and resistance to fusarium head blight or DON (>=3.5) • **Very early to early varieties at ear emergence (overall score = 6.5 and 7)**: resistance to septoria (>= 5) and resistance to brown rust (>=5 or >=6 or >=7 depending on profile) and resistance to yellow rust (>=4 or 5 depending on profile) and resistance to take-all disease (>=5) and resistance to fusarium head blight or DON (>=3.5) *-047, The list includes rapeseed varieties* that exploit their resilience to insect attacks (mainly beetles). This 'insects' rating also takes into account three types of measured variables (vigour, low number of larvae found in the Berlese test, bushy growth ratings), considering that they contribute equally to describing the resilience of the varieties. On the other hand, a 'disease' rating takes into account the TuYV virus resistance rating and the cylindrosporiosis resistance rating. -067 List of barley varieties, -119 list of sunflower varieties, -137 List of fibre flax varieties
		Use resistant tolerant cultivars in mixture	x	x	x	x	*Use mixture of tolerant/resistant cultivars* **listed on the list of eligible combination** while preserving resistance genes and reduce over dependency on pesticide use.	*-011 The list includes early-flowering rapeseed varieties* selected based on the flowering score obtained in GEVES nurseries: Early flowering date between ES Alicia variety minus 10 days and ES Alicia. For variety pairs, the rule adopted is to have an average difference of 10 days between the trap variety and the variety of interest (statistical indicator used: median) and no difference of less than 7 days among all the data observed.

								The data used will be that observed in nurseries during Distinction-Homogeneity-Stability tests (2 years, 2 locations, 2 repetitions, i.e. 8 data points). This data may be supplemented by data from the Terres Inovia technical institute and the seed producer submitting the application. -049
	1.1.2 Crop species diversity	Crop rotation	x			x	*Design crop succession* **following the crop-specific guideline** to reduce over dependency on pesticide use.	*-120: The Shannon diversity index calculated on species proportions must be increasing in order to receive a reward.* The Shannon index is a species diversity index that is highly sensitive to increases in the number of minor species, making it an interesting indicator for monitoring initiatives to introduce new crops. The Shannon index is calculated annually and the increase is calculated over four years by comparing the average index for years 1 and 2 with the average index for years 3 and 4. In France, data is collected at the level of the collecting organisation as part of the strategic collection of data on the production collected, stored and sold by these organisations. This data collection is called 'Etats II'. *Rule currently being defined: measurement of the time elapsed between two identical crops on the same plot.* It has been demonstrated (https://doi.org/10.1038/s41467-023-43234-x) that extending this return period has a significant impact on reducing pesticide use, particularly for potato and rapeseed crops and, to a lesser extent, for winter wheat. This does not argue for a reduction in the absolute area of these crops, but rather for optimising their positioning in space. The implementation of this rule requires the use of the national graphic register linked to the Common Agricultural Policy. *Rule currently being defined: Farms must have at least three species and sow them in at least two separate sowing periods* (period 1: 1 January to 30 June, period 2: 1 July to 31 December). If it is not agronomically possible to comply with the second part of the rule, farms must have a cover crop species (see list of species concerned)
		Intercropping	x			x	*Design Intercropping* **listed on the list of eligible combination** to reduce over dependency on pesticide use.	*-091 The list of multi-services intercropping* takes into account four rating criteria (to which a 30% bonus is added if the mixture contains more than three botanical families):

								• Nematocidal biofumigation: based on the French rating for this criterion (and possibly the German rating). H1 variety are eligible for a nematode species in cases where no other component of the mixture multiplies the same nematode. (The BSA does not apply the same testing protocol for nematodes. As a result, there is equivalence between Level 1 BSA and Level H1 GEVES, but no consensus on other comparisons). For compatibility: If there is brown mustard in the mixture, no nematicide value is possible at this stage; if there is an H1 variety, the mixture obtains 0.1 CEPP/ha if the other varieties are non-multiplicative or if no information is available. • Biofumigation excluding nematodes: each proven biofumigation target is eligible. • Resistance to a harmful pest during the target rotation (in particular *Aphanomyces euteiches* and clubroot). Is eligible
		Species mixtures	x				*Combine crop species* **listed on the list of eligible combination** to reduce over dependency on pesticide use.	An action sheet is being developed as part of the CEPPs, and several research projects demonstrate the benefits of species mixtures, particularly in facilitating the introduction of legumes while maintaining satisfactory yields for both wheat and legumes. The question is rather how to monitor this while limiting the burden on farmers. One avenue being explored is the possibility of promoting sorting equipment for these crops among collectors, which would facilitate the adoption of this practice by farmers by opening up markets for these crops.
		Crop selection: fallow	x			x	*Use fallow* **following the crop-specific guideline** as a tool to reduce over dependency on pesticide use.	
	1.1.4 Planting materials	Use of certified seeds	x			x	*Use certified seeds* **following the crop-specific guideline** to reduce over dependency on pesticide use.	This practice is promoted indirectly through lists of eligible tolerant varieties. It can be supplemented on a case-by-case basis (for pests that are transported by seeds). These specific cases are often subject to quarantine rules and bans on introduction into the territory, which are already very strict measures and do not necessarily require additional general guidelines.
		Use of		x	x		*Use certified planting materials*	

		certified planting materials					**following the crop-specific guideline** to reduce over dependency on pesticide use.	
	1.1.5 Seed selection	Seed treatment	x			x	*Use non-chemical seed treatment* **following the crop-specific guideline** to reduce over dependency on pesticide use.	*-121 The list includes seed disinfection services using steam*. The list of services has been compiled in collaboration with the technical institute that developed the practical disinfection methods (species, exposure time, temperature, process) and the service providers who follow these processes, which are recognised for their disinfecting effect without posing a risk to the seeds.
1.2 Crop establishment	1.2.1 Sowing	Sowing time	x				*Determine sowing time* **following the crop-specific guideline** to reduce over dependency on pesticide use.	
		Seed density	x			x	*Determine seed density* **following the crop-specific guideline** to reduce over dependency on pesticide use	
	1.2.1 Planting (cuttings/ seedlings)	Plant spatial arrangement		x	x		*Determine plant spatial arrangement* **following the crop-specific guideline** to reduce over dependency on pesticide use	
	1.3.1 Soil cultivation	Direct seed/ direct sowing	x				*Use direct sowing* to reduce over dependency on pesticide use	
		Plough	x			x	*Determine ploughing frequency* **following the crop-specific guideline** to reduce over dependency on pesticide use	
		False seed bed	x			x	*Use false seed bed* **following the crop-specific guideline** to reduce over dependency on pesticide use	

	1.3.2 Crop cultivation	Pruning		x	x		*Design pruning* **following the crop-specific guideline** to reduce over dependency on pesticide use	
	1.3.4 Harvest management	Harvest technology	x	x	x	x	*Destroy or collect small straw during harvest* using an equipment **listed on the list of eligible equipment** to reduce over dependency on pesticide use	
1.6 Management of ecological infrastructure	1.6.1 Protection and enhancement of beneficial organisms	Creation or restoration of habitat outside the production area	x	x	x	x	*Design or restore habitats outside the production area* **following the crop-specific guideline** to reduce over dependency on pesticide use	
		Creation or restoration of habitat inside the production area		x	x		*Design or restore habitats inside the production area* **following the crop-specific guideline** to reduce over dependency on pesticide use	
	1.6.2 Management of resources to the pest	Removal of non-crop hosts		x	x		*Remove non crop host* **following the crop-specific guideline** to reduce over dependency on pesticide use	
1.7 Hygiene measures	1.7.1 Cleaning of machinery and equipment	Cleaning of machinery and equipment	x	x		x	*Clean machinery and equipment* **following the crop-specific guideline** to reduce over dependency on pesticide use	

	1.7.2 Management of resources to the pest	Water/soil sanitation	x	x	x	x	*Manage water sanitation* **following the crop-specific guideline** to reduce over dependency on pesticide use	
		Removal of inoculum sources	x	x	x	x	*Remove inoculum sources* **following the crop-specific guideline** to reduce over dependency on pesticide use.	
4.2 Biotechnical control	4.2.2 Biological, physical and other non chemical methods	Attractants and repellents (other)	x	x	x	x	*Use Attractants and repellants* **listed on the list of eligible references** to reduce over dependency on pesticide use.	
4.3 Physical Control and mechanical	4.3.1 Barriers	Mechanical weeding	x	x	x	x	*Use mechanical weeding* **listed on the list of eligible references** to reduce over dependency on pesticide use.	
	4.3.2 Thermal Control (Excluding Thermal Seed Treatment)							
	4.3.3 Mechanical removal of pests							

11.2 Annex 2: Exemple of an action sheet describing a guildeline

An action sheet is the complete description of an action.

It brings together :

- a description of the action,
- the expected effects following its implementation in the field, and
- the means of monitoring its implementation over time.

Scientific knowledge is required to develop such Action-sheet, and this document summarises the points to be addressed when developing such Action-sheet. It can be used as a template for updating guidelines. The originality of this document lies in the fact that it is not limited to the implementation of the practice by the farmer, but considers that the practice requires the participation of other stakeholders who, as such, can become sources of information.

General Guideline

Use tolerant/resistant varieties listed on the list of eligible varieties in order to reconcile resistance genes management and significant reduction of the damage.

In order for this guideline to be implemented, several questions must now be answered:

- How is the sufficient level of resistance defined?
- Which varieties are going to be eligible?
- How can this list be compiled, taking into account the problem posed by the risk of resistance being circumvented during uncontrolled deployment of the varieties?

All the questions addressed here are technical. Organisational and socio-technical obstacles are presented in Deliverable 6.1 and must be addressed according to the types of stakeholders involved.

To be more specific, the following template will apply to a specific case involving a particular pest/crop combination, and this example will be illustrated throughout the document.

Use *tolerant/resistant varieties* of vine.

For this application of the guideline, the practical action consists of preventing damage caused by major diseases: **mildew and powdery mildew on vines** by using **tolerant or resistant varieties** as a foundation for an IPM-based strategy. This action is highly effective on grapevine with potential to reduce by 80% pesticide use (concerning those two diseases).

- Link to the taxonomy: 1.1.1.1 Use resistant and/or tolerant cultivars
- Crop concerned: Vine
- Type of lever: Plant breeding
- Pest concerned: Powdery mildew and downy mildew

To use this document as a template for drafting other action sheets and updating your guidelines, you can follow the questions asked in each section. Each section is dedidated to a specific aspect

of the knowledge needed to build a Action-shee and determine the key points necessary for the deployment and monitoring of this deployment.

Section 1: How to clearly describe the action behind the guideline?

Item 1.1	**Write a synthetic description of the action** *no more than half a page to help quickly understand what will be achieved in the field*

In our case the action is selecting and planting varieties that are genetically resistant or tolerant to specific pests, diseases, or environmental stresses. This action is possible and complementary for multiple major and minor crop species with pest challenges.

The selection of resistant or tolerant varieties is an active prophylaxis measure implemented by the farmer, who ultimately chooses and plants the varieties that best fit local agronomic and environmental conditions, while being fully cognisant of market requirements in quality.

Item 1.2	**Explicitly describe the cropping system without using the action (reference system).** *It should be as close as possible to the average cropping system that most farmers follow in your country without the adoption of resistant/tolerant varieties. (Considering that the practice described is not the benchmark practice, as in this case the future reduction in usage or impact associated with its further development will not be very significant.*

Reference cropping system for concerned usage

As presented in deliverable 2.1 concerning the agronomic service provided, the reference system can be identified in various ways. The most robust method is a regular survey of all farmers' practices, including a section on crop protection measures. This reference practice is not a quantity of active substance; rather, it consists of interventions relating to all eight principles that farmers implement for the management of the pests and harmful organisms concerned.

1. **(for perennial crops) Plant use and renewal dynamics**

Seeds and plants can be farm-saved or certified. Here the question is to understand the current situation. what proportion of plants are certified? How do farmers select the seeds they will use the following year? (What are their criteria for farm seeds as well?)

- **All** the plants are grown in vine nurseries**.**
- **The vines are renewed on average every 25 years.** This duration implies a very slow renewal of varieties and also indicates an opportunity for long-term planning.

2. **Standard interventions concerning this usage**

The definition of standard interventions for a given usage (crop-pest combination) could be defined by several sources:

- Official definition of these standard:
  - National regulation and recommendation (for example for quarantine organism)

- Agency assessment
- Extension services official guidelines
- Advisory systems official guidelines

- When those definitions do not exist:
  - Expert consensus
  - Evidence-based practices
  - Field trials

Currently, in the majority of cases the second situation will apply.

downy mildew and powdery mildew on vine

(National Standard intervention IASP case study on *powdery mildew*)

3. **Variety selection criteria**
   - Primary drivers of choice :
     - Grape variety according to local appellations
     - Market and contractual influences: Some **procurement contracts or product specifications** provide a preferred range of varieties to secure processing quality and marketability.
     - Yield potential
     - Resistances of the varieties

4. **Prophylaxis active = fostering integration of disease management into variety choice**
   - While quality (and yield) are the dominant criteria, disease resistance plays an increasing role due to both agronomic and regulatory pressures.

Since 2021, the CEPP (Certificats d'Économie de Produits Phytopharmaceutiques Action 2020-076) scheme is providing a national list :

▪ an annual update linking vine varieties to an estimated pesticide savings value (the value is linked to each plant and based on savings per hectare).

▪ This value is calculated based on variety resistance profiles (types and levels of resistance) and field trial data from technical institutes across French production contexts.

▪ This tool allows for a **quantified link between variety choice and potential pesticide reduction**, supporting active prophylaxis approaches.

5. **Implications for active prophylaxis**
   - This reference system illustrates a progressive renewal of the varietal landscape, combining farmers' own plant practices and market incentives.
   - Leveraging the **eligible variety list** makes it possible to **identify and monitor varieties that contribute to pesticide-use reduction**, even in a context where farm-saved plant could represents half of the sown area (for example wheat in France).

Item 1.3 — Explicitly describe the transformations of the cropping system

Type and number of intervention, planting density, type and date of pruning, chose of varieties…

This item describes the system in which the action takes place.

Depending on the changes involved in adding the action, the practice is considered to be efficiency (the system is almost identical except for the effectiveness of one of its components), substitution (the system is identical except for the action that replaces one of the actions performed in the standard system), or redesign (several actions in the system are transformed to achieve identical objectives in a manner that is at least as effective as the reference system).

Item 1.4 — How is the sufficient level of resistance defined? And which items are going to be eligible?

After defining the standard system and the changes in the system implied by the action, it is time to focus on determining a threshold that will allow us to consider, from an agronomic point of view, that the guideline has been achieved.

Based on the experience of developing eligibility rules for the various action sheets drafted as part of the CEPPs in France, the following criteria may be taken into account:

- The ability to distinguish eligible actions from the standard system. (Where it is not possible to differentiate the standard system from the most effective system in terms of crop protection, the guideline may not be a priority.)
- The ability to update the list regularly (this can be based on all existing mechanisms, certification, inclusion in a catalogue with a grid assessing effectiveness in terms of plant protection use, a national list for other types of support, etc.).

In our case, for varieties, there is both a european catalog and a national catalog. Certain varieties are recognised with specific ratings for nationally defined tests based on priority uses (pest/crop). Consultation between stakeholders can lead to agreements on scores indicating a significant ability to reduce pesticide use and impact in the field. It is this type of consultation that led to the determination of the rules presented in Annex 1.

To create a list of eligible items to be able to monitor the action

1. **Linking resistance scores to services provided** *(involving actors from research and innovation)*
    - Correlate the resistance ratings of varieties (recorded at the time of their registration in the EU Plant Variety Catalogue) and the actual reduction in pesticide dependence they deliver.
    - Build a reference system that translates resistance scores into expected

"services," such as the anticipated decrease in disease pressure or the reduction in required pesticide treatments.

- Establish a parallel pest monitoring network/system to survey for strains in the environment with capability to breakdown the resistance source. This is key to ensuing the durability of the genetic resistance deployed in the varieties to farmers.

2. **Creation of a service-oriented variety list** *(involving actors from research and innovation)*
    - Develop and maintain a transparent list of varieties along with the services they provide for crop protection.
    - Update this list annually to reflect the availability of new varieties and innovations in plant breeding.
    -

Item 1.5 Parameters influencing efficacy of the action climatic conditions, past actions, services ecosystemic availability, …

There are six groups of parameters. Each action has a specific dependency to those parameters. Knowing the level of dependency to those parameters allows to determine if the action can easily be transferred from a place to another (region to region).

Context dependency in this framework refers to the extent to which the efficiency of a practice — in terms of pest control, pesticide reduction, and yield stability — is shaped by site-specific biophysical conditions such as climate, soil characteristics, landscape configuration, biodiversity, pest pressure, or legacy effects.

Information about the context dependency for "grapevine varieties against powdery and downy mildew"

1) Climate & Weather	Low dependency
2) Soil Characteristics & Hydrology	Low dependency
3) Landscape Structure & Topography	0
4) Biodiversity & Ecosystem Functions	0
5) Pest Pressure & Biotic Risk Context	Low dependency
6) Temporal / Legacy Effects	Not applicable, as the variety must be chosen before the pressure variations of pests are known and therefore before it is possible to anticipate what may happen in the coming years.

Item 1.6 Agronomic services provided

The agronomic service provided of a practice can be defined as the capacity of the given practice to fit into a farmer's technical itinerary, enabling him/her to effectively protect his/her crops, while:

1) **Maintaining** comparable quality and yield.

2) **Maintaining** similar or better income.

Add information from the powdery mildew case study (and the ASP parameters)

Item 1.7 Timeframe of the practice

(anticipation and duration)

Add information about the taxonomy scoring of anticipation

Section 2: How to monitor the implementation of the action?

To monitor the adoption of a practice, one must first consider the available sources and data.

Item 2.1 Where to find information about action's deployment?

To track the adoption of **resistant or tolerant varieties as part of active prophylaxis**, a distributed monitoring framework can be implemented, including certified plants. Where applicable, a complementary system can be built for farm-saved plants.

Monitoring the deployment of the action

3. **Tracking deployment through certified plant sales** *(involving sellers, nursery operators or plant certification bodies)*
    - Use the current selling process to implement a system to record sales volumes of varieties that contribute to pesticide reduction at the time of purchase.
    - Aggregate this data to monitor adoption dynamics at local, regional, and national scales.

4. **Incorporating farm-saved plant practices** *(involving official and periodical survey)*
    - Complement sales-based monitoring with surveys or specific questionnaires targeting farmers' practices regarding the selection and use of farm-saved plants.
    - Collect information on the varieties maintained, renewed, or multiplied on-farm to capture the full picture of variety deployment.

This combined approach allows authorities to **quantify the effective adoption** of resistant and tolerant varieties, regardless of plant origin, and to **assess the actual contribution** of this action to reducing pesticide dependence.

Item 2.2 Current deployment of the action

area where the practice is already implemented

Add available information of the deployment of this action

Item 2.3 Potential deployment of the action

potential area where the practice could be implemented

The potential deployment must take into account the risk of resistance genes collapse and the necessity to support agronomic actions that support durability of the resistance genes via adoption of a landscape approach

See Oscar https://observatoire-cepages-resistants.fr/en/resistant-varieties/

Pyramided grapevine varieties are indicated for reducing fungicide use against downy and powdery mildew, with an expected reduction of approximately 80% compared to conventional varieties. Their use should remain limited at the territorial level and guided by coordinated deployment strategies, such as observatories monitoring vineyard implantation, in order to protect resistance durability. A minimal level of phytosanitary protection should be maintained to control secondary diseases and to reduce selective pressure on mildew and powdery mildew populations. Wider adoption is constrained by the organoleptic characteristics of the available varieties, which may limit their acceptance for high-quality wine production. Otherwise, their use is not subject to major restrictions.

Item 2.4 Useful combination with other actions

(Use of Part of the ASR method)

Item 2.5 Economic assessment

Change in operating costs between the reference system (Item 2.1) and the new system (Item 2.2), impact on yield and quality, impact on other inputs (fertiliser, fodder, etc.) and beyond the farm gate.

Add a paragraph from D4.1

Bloc 5 : Bibliography

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