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Deliverable D 6.2

Final Integrated Pest Management (IPM) Guidelines

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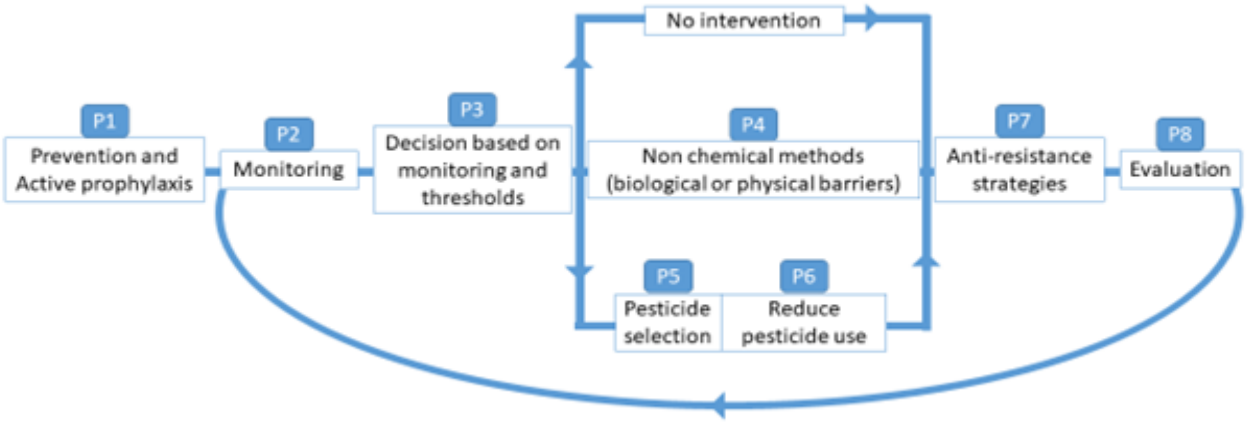
1 Key messages

The Agrowise project strengthens the practical implementation of Integrated Pest Management (IPM) across Europe by transforming general policy principles into concrete, verifiable farm-level actions. It introduces the concept of active prophylaxis to highlight the preventive value of agronomic practices and their contribution to crop protection. The project demonstrates that IPM implementation is most effective when prevention, monitoring, and intervention are treated as interconnected processes supported by a shared taxonomy linking the eight IPM principles to agricultural actions.



Through this approach, Agrowise provides a harmonised yet flexible framework for defining guidelines that reduce pesticide dependency while maintaining crop productivity. The Final IPM Guidelines and their associated Action Sheets offer Member States, advisory services, and farmers a practical tool to operationalise IPM within national and regional contexts, ensuring that sustainable pest management becomes an integral part of everyday agricultural decision-making.

2 Executive Summary

The Agrowise project contributes to the European objectives of reducing the environmental and health impacts of pesticide use while maintaining agricultural productivity and competitiveness. Building on the framework established by Directive 2009/128/EC on the Sustainable Use of Pesticides (SUD), Agrowise aims to translate the eight general principles of Integrated Pest Management (IPM) into operational, farm-level actions that can be adopted and verified in diverse agricultural contexts. Deliverable D6.2 presents the final version of the **Integrated Pest Management Guidelines**, which are conceived as concise, action-oriented statements guiding farmers towards practices that effectively protect crops while minimising dependence on plant protection products.

The development of these guidelines stems from an extensive dialogue with agricultural stakeholders, researchers, advisory services, and representatives of Member States. These consultations highlighted significant variability in how the IPM principles are understood and implemented across Europe. In particular, the project found that principles 5, 6 and 7—those relating to targeted pest control, the use of low-risk products, and the minimisation of pesticide application—are relatively well integrated into national frameworks. Their implementation is facilitated by the direct and observable relationship between the action (for instance, product selection or application timing) and its measurable impacts on human health and the environment.

Conversely, the **principles of prevention**, notably principle 1, pose greater challenges. Preventive measures are often embedded within standard agronomic practices, such as crop rotation, soil management, or varietal choice. Their contribution to pest suppression is indirect, cumulative, and context-dependent, which makes their regulatory framing and monitoring more complex. As a result, preventive actions are sometimes perceived as general good practices rather than specific pest management tools, leading to an underestimation of their strategic value within the IPM approach.

To address this gap, Agrowise introduces the innovative concept of **“active prophylaxis”**. This concept reframes preventive actions by identifying, within each agronomic practice, the specific characteristics that actively contribute to reducing pest pressure and the associated risks of crop damage. For example, rather than merely recommending the implementation of crop rotations, Agrowise proposes to define the types and sequences of crops that most effectively disrupt pest life cycles. Similarly, varietal selection should not simply encourage the use of resistant varieties, but provide criteria enabling farmers to choose varieties that offer optimal control of local bioaggressors while maintaining the durability of their resistance traits.

Through this lens, prevention becomes a proactive component of pest management rather than a background practice. It relies on a deeper understanding of agroecological processes and on the capacity of farmers to tailor their practices to local pest dynamics. By reinterpreting preventive principles as dynamic, measurable actions, Agrowise strengthens the operational link between agronomic decision-making and the objectives of sustainable pest control.

To operationalise this approach, the project developed a **taxonomy** that connects the eight IPM principles established by the SUD with the corresponding agricultural actions and decision criteria. This taxonomy provides a structured and evolving framework that enables the translation of general principles into concrete guidelines applicable at farm or crop level. It also facilitates the dialogue between European policy frameworks and on-the-ground implementation, offering a common reference for policymakers, advisory services, and farmers. In doing so, Agrowise contributes to the harmonisation of IPM interpretation across Member States while respecting the diversity of production systems and agro-climatic conditions.

Each **Agrowise IPM Guideline** consists of a concise prescriptive statement that defines a recommended action together with an indication of how its correct implementation can be verified. These guidelines are complemented by **Action Sheets**, which provide a more detailed description of the practice, including implementation conditions, threshold values or performance indicators, and the means of assessment. The combination of a succinct rule and a corresponding Action Sheet ensures that each guideline is both understandable and operational. It allows farmers and advisors to identify not only what should be done but also how to evaluate whether the intended outcome has been achieved.

The construction of these Action Sheets relies on the active participation of agricultural stakeholders. Their expertise is essential for identifying which practices should be considered eligible for achieving a guideline and for defining the agronomic or technical conditions that ensure its proper implementation. This participatory approach enhances the relevance, acceptability, and credibility of the proposed rules, ensuring that they are grounded in both scientific evidence and practical availability of means of action.

In summary, Deliverable D6.2 provides a comprehensive framework for implementing IPM in a manner that bridges the gap between European-level policy principles and the realities of farm-level decision-making. By redefining prevention through the concept of active prophylaxis, by linking actions to measurable outcomes, and by engaging stakeholders in the definition of implementation criteria, Agrowise offers a practical and adaptive tool to promote sustainable crop protection across Europe. The Final IPM Guidelines thus constitute not only a methodological output but also a strategic contribution to the ongoing evolution of the European approach to pesticide risk reduction and sustainable agriculture.

3 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
EC	European Comission

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.

4 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)[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[2] (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 (see in Appendice 3)** understood as the proactive identification of potential impacts of agronomic actions, with an emphasis on

[1] Deliverable 2.1 – Agrowise : Harmonised taxonomy of the innovative practices and systems.
[2] Deliverable 6.1 – Agrowise : Strengthening IPM Policies : Recommendations for the European Commission, Member States and agricultural stakeholders, advisors and farmers.

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[3], 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.

5 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)[4], 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[5] specifies that plant protection products must be used properly, in compliance with both good plant protection practice and the provisions of the SUD.

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[3] Deliverable 5.1 – Agrowise : Report of the coverage of all the plant productions and supply chains in the definition of the biding and optionnal rules.

[4] 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* »

[5] 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.*"

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 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.

5.1 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”, and propose a template[6]. These “action sheets” created by research, innovation or the stakeholders involved, 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[7]), 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, because, in order to implement the eight principles in a consistent manner, it is necessary to ensure the robustness of the implementation of principle 1 and therefore give it priority when designing the system..

Agrowise define Active Prophylaxis in Deliverable 5.1[8] and in Appendice 3. 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[9] and 5.2[10]). This combination of active

[6] See Appendice 2
[7] Deliverable 2.1 – Agrowise : Harmonised taxonomy of the innovative practices and systems.
[8] Deliverable 5.1 – Agrowise : Report of the coverage of all the plant productions and supply chains in the definition of the biding and optionnal rules.
[9] Deliverable 3.3 – Agrowise : Context dependency of the implementation of the practices and systems.
[10] Deliverable 5.2 – Agrowise : Report possibilities to consider the diversity of agroclimatic conditions in the definition of the binding and optionnal rules.

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[11]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[12].

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.

[11] Deliverable 2.1 – Agrowise : Harmonised taxonomy of the innovative practices and systems.
[12] Deliverable 5.2 – Agrowise : Report possibilities to consider the diversity of agroclimatic conditions in the definition of the binding and optional rules,

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

6 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[13] 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.

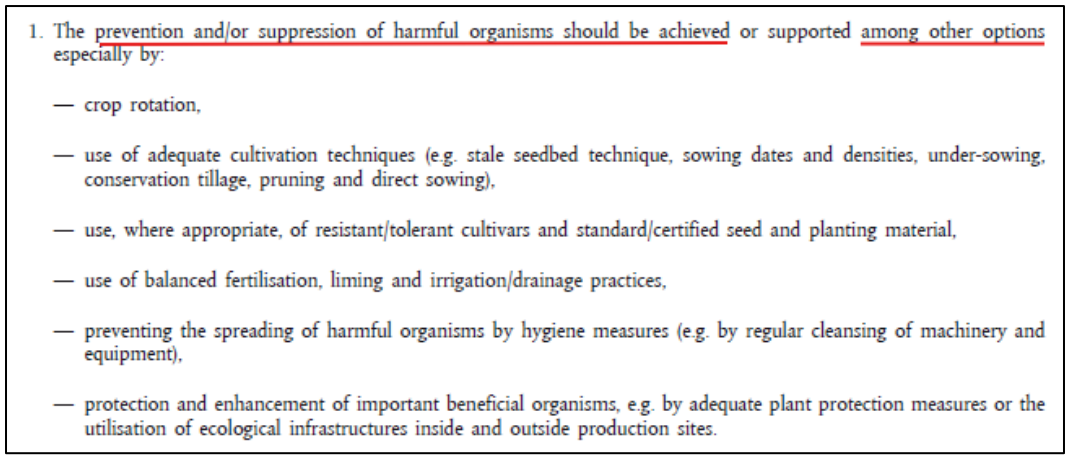
6.1 Principle 1: Prevention and suppression

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.

[13] "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[14] 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[15], "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

[14] Deliverable 3.1 – Agrowise : Actual and potential implementation of the available IPM and agroecology-based practices and system across Europe.
[15] Deliverable 5.1 – Agrowise : Report of the coverage of all the plant productions and supply chains in the definition of the biding and optionnal rules.

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.

Recent research provides robust evidence that biodiversity-based management is central to sustainable pest regulation. Perrot et al. (2023) demonstrated that long-term grasslands and crop diversification act synergistically to enhance natural pest and weed control, emphasizing the importance of heterogeneous landscapes integrating semi-natural habitats. Similarly, Tamburini et al. (2020) showed that diversification practices strengthen multiple ecosystem services—such as pest control, soil fertility, and water regulation—without compromising yields, thus confirming the potential of ecological intensification. Yet, as highlighted by Wyckhuys et al. (2025), intensive management practices continue to erode the beneficial spillover of natural enemies from surrounding habitats, underlining the need for on-farm biodiversity restoration and the integration of biological control into agroecological frameworks. This transition requires improved biodiversity monitoring, interdisciplinary collaboration, and supportive policy instruments to foster behavioral and systemic change. Global synthesis by Dainese et al. (2019) further demonstrates that species richness of pollinators and natural enemies directly sustains ecosystem services and crop yields, illustrating that biodiversity conservation is not only an ecological imperative but also a functional necessity for productive and resilient agroecosystems.

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*

6.2 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[16]: «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.

[16] Deliverable 5.1 – Agrowise : Report of the coverage of all the plant productions and supply chains in the definition of the biding and optionnal rules.

6.3 Principle 7: Anti-resistance strategy

Recommendation: Principle 7 should be implemented with the aim of promoting an anti-resistance strategy integrated into all principles of integrated pest management.

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.*

6.4 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 PRACTICAL 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.

7 Mapping IPM principles to SUD outcomes

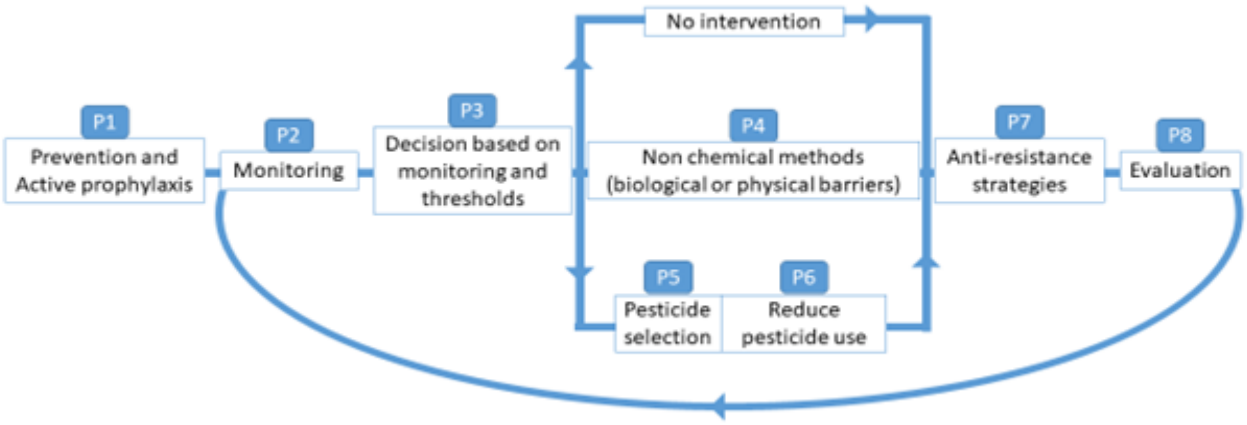


Figure 6 Advanced definition of the Integrated pest management by Agrowise

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:

8 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).

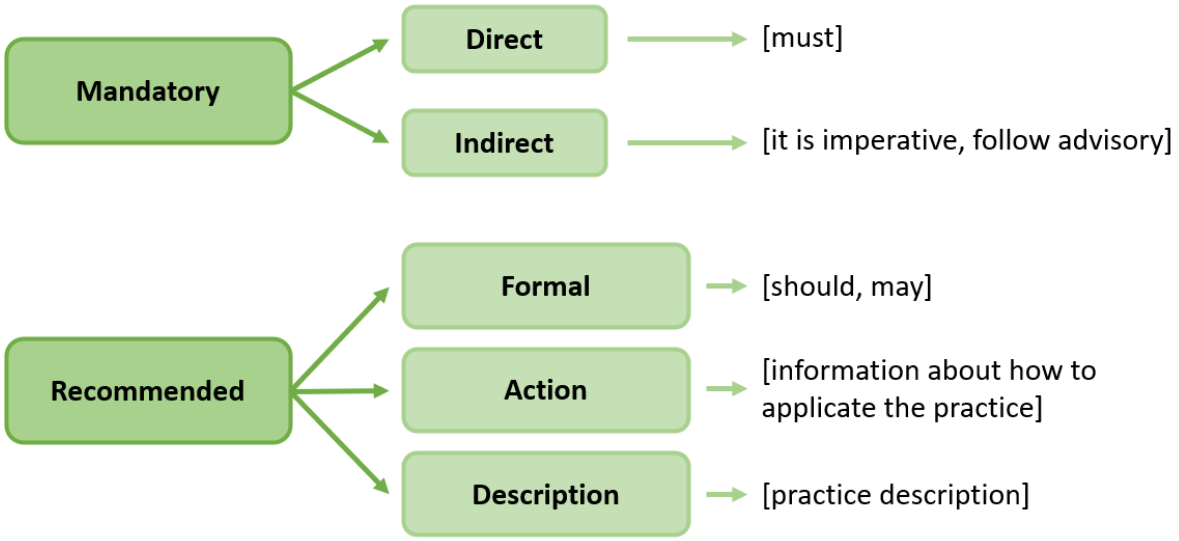


Figure 7 Analyses of the current guidelines

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. »

8.1 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[17] 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 2, ‘field observation: inspecting fields to assess crop health’, for principle 3, ‘use of an USS for a chemical pesticide’; for principle 4, ‘mating disruption’; for principle 5, ‘pesticide selection’; for principle 6 ‘equipment / pesticide application techniques or machineries’ 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.

The figure 8 shows that most of the guidelines encouraging the application of IPM principles are recommendations (in purple) rather than obligations (in green). While principles 5, 6 and 7 go beyond the guidelines supported by their respective Member States, offset by stricter European directives such as Directive 2009/128/EC[18], which establishes a framework for Community action to achieve sustainable use of pesticides, this is not the case for the first principles of IPM (Principles 1, 2, 3 and 4), which are most often represented by a descriptive recommendation for action that does not help or encourage the application of direct measures in the field.

This analysis highlights the importance of the written structure of the directive. A concise directive, accompanied by a ‘comprehensive guide or roadmap’, allows for better implementation in the field as it becomes easier to apply, especially if it is supported by various measures (subsidies, integrated pest management advisers).

[17] Deliverable 2.1 – Agrowise : Harmonised taxonomy of the innovative practices and systems.
[18] Link Directive 2008/128/CE : https://eur-lex.europa.eu/eli/dir/2009/128/oj/eng

Figure 8 Characteristics of IPM guidelines by general IPM principles

8.2 Linking IPM guidelines to Action Sheets: Ensuring field-level implementability

8.2.1 Variation in guideline precision

Analysis of Member States' IPM guidelines during Agrowise revealed considerable differences in precision. This is expected, as the Sustainable Use Directive (SUD) does not prescribe the format or level of detail for guidelines. Precision should therefore balance IPM general principles with the operational detail necessary for field implementation.

Agrowise distinguishes four levels of guideline precision:

Level	Description	Example
1	**Very general**; mirrors broad IPM principles	"Integrated plant protection includes all available activities and methods… including crop rotation, sowing dates, and plant populations to limit harmful organisms."
2	**Recommends actions while retaining flexibility**; deployment difficult to monitor	"Varieties and rootstocks identified as susceptible should not be used. Resistant varieties should be available. Where possible, varieties with resistance should be selected."
3	**Action Sheet level**; general action plus lists or proxies enabling verification	"Use a tolerant or resistant variety" combined with a list of eligible varieties to track deployment.
4	**Most precise**; farm-level checklist mandating some actions	Closed checklist monitored directly on-farm, distinguishing mandatory vs voluntary actions.

Agrowise recommends that national action plans ensure coherence between monitoring deployment and farmers' understanding of what each guideline entails. General statements such as "implement this practice if possible" rarely provide sufficient clarity, especially for actions like the use of tolerant or resistant varieties, where no rules exist for farmers to verify compliance (compliance with legislators' expectations).

8.2.2 Purpose of Action Sheets

Action Sheets bridge the gap between technical IPM guidelines and their practical implementation. They focus on technical and practical constraints, leaving economic, marketing, or contractual barriers to complementary strategies described in Deliverable 6.1.

Once technical constraints are identified, they can inform:

- Public policies to support adoption
- Multi-stakeholder strategies for resource provision, cost reduction, and alignment with IPM objectives
- Coordination of actors involved in both implementation and support

By documenting the action, its expected effects, and monitoring indicators, Action Sheets ensure alignment between support timing and the lag before effects are observed, particularly for preventive and prophylactic practices.

8.2.3 Relevance for preventive actions

Preventive or prophylactic actions often require early implementation and show benefits only after several seasons. Action Sheets provide a locally adapted, scientifically grounded basis to:

- Adjust national action plans
- Align with reference cropping systems
- Design support measures that ensure effectiveness under variable conditions, including weather fluctuations

8.2.4 Scope of Annex 2: Practical illustration

Annex 2 presents a step-by-step methodology for developing Action Sheets, illustrated with the example:

"Use of resistant or tolerant varieties"

This example demonstrates how a guideline can be translated into a concrete, measurable, and monitorable action, fully integrated with national strategies and support mechanisms. It ensures that farmers can implement the guideline unambiguously and effectively, and provides a template for other IPM actions.

9 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[19] 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[20] taxonomy, providing clear guidance, and establishing practical monitoring, guidelines can facilitate the consistent and operational application of IPM across diverse agricultural contexts.

9.1 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 (see Appendice 1). 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[21], are key determinants of whether the theoretical potential of IPM practices can

[19] Deliverable 2.1 – Agrowise : Harmonised taxonomy of the innovative practices and systems.
[20] Deliverable 2.1 – Agrowise : Harmonised taxonomy of the innovative practices and systems.
[21] Deliverable 6.1 – Agrowise :

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.

9.2 Action sheet for MS to draft guidelines supporting the guidelines

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

10 Conclusion

Deliverable D6.2 synthesises the conceptual and operational advances achieved by the **Agrowise project** in translating the general principles of **Integrated Pest Management (IPM)** into scientifically grounded and field-applicable guidelines. Anchored in **Directive 2009/128/EC** on the sustainable use of pesticides, this work contributes to strengthening the scientific and methodological foundations of IPM implementation across European agricultural systems.

The deliverable specifically addresses the recurring challenge of **operationalising preventive measures**, particularly those related to **Principle 1**. Through the introduction of the concept of *active prophylaxis*, Agrowise redefines prevention as an intentional, knowledge-based process that mobilises agronomic practices to anticipate pest dynamics and strengthen ecosystem resilience. This paradigm shift represents a major scientific contribution, aligning crop protection with the principles of functional ecology and promoting the integration of biodiversity into pest management strategies.

The adopted methodology combines a **comprehensive literature review**, **stakeholder consultation**, and **comparative analysis** of national guidelines with the construction of a **taxonomy linking the eight IPM principles to concrete agricultural actions**. This interdisciplinary and participatory approach ensures that the proposed guidelines are both scientifically robust and operationally relevant, while accounting for the diversity of European agroecosystems.

The results highlight a **persistent imbalance** in the implementation of IPM principles. While those related to the direct use of plant protection products (Principles 5, 6 and 7) are relatively well integrated into national regulatory frameworks, those concerning prevention, monitoring, decision-making, and evaluation (Principles 1–4 and 8) remain less formalised and difficult to verify. Agrowise therefore proposes a **hierarchical and harmonised interpretation** of IPM, in which **prevention and monitoring** form the strategic foundation of sustainable crop protection, complemented by integrated mechanisms for **resistance management** and **continuous evaluation**.

By developing a structured set of concise guidelines supported by **detailed action sheets**, this deliverable provides a scientifically robust tool to bridge policy objectives with agronomic practice. The focus on **measurable outcomes** and **contextual adaptation** strengthens the capacity of Member States to design and assess IPM implementation within their **National Action Plans (NAPs)**.

However, certain **limitations** must be acknowledged. The **ecological and socio-economic variability** of the European territory implies that some guidelines will require **local calibration** and **periodic revision** in light of emerging scientific knowledge. Moreover, the **large-scale adoption of active prophylaxis practices** depends not only on the mobilisation of **advisory systems** and the **commitment of farmers**, but also on the **active participation of the entire value chain**. The success of this transition relies on the **concerted involvement of upstream and downstream actors** — from research and production to processing, distribution, and consumption — to create an economic and regulatory environment conducive to the implementation of practices that are genuinely sustainable and consistent with IPM principles.

In conclusion, Deliverable D6.2 fully achieves its primary objective: to provide a coherent, evidence-based framework for the design of IPM guidelines that make **prevention** and **resilience** the cornerstones of sustainable crop protection. The proposed framework represents both a methodological and conceptual advancement, offering a reproducible model for future revisions of the **Sustainable Use Directive (SUD)** and for the integration of IPM principles into European agri-environmental policies.

Future work should focus on:

1. the **empirical validation** of active prophylaxis indicators across different cropping systems.
2. the development of **harmonised monitoring protocols** to assess IPM performance.
3. the **socio-technical evaluation** of adoption pathways.

By reinforcing the scientific foundations of IPM, Agrowise contributes to the emergence of a **new paradigm in plant health management** — one that is ecologically grounded, evidence-based, and supported by all actors along the value chain, paving the way for a more resilient, productive, and sustainable European agriculture.

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12 Appendices

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

APPENDICE 2 : Action sheet template

APPENDICE 3 : Definition of Active prophylaxis

12.1 Appendice 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 = Guideline	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.
	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, 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: January 1st to June 30th, period 2: July 1st to December 31th). If it is not agronomically possible to comply with the second part of the rule, farms must have a cover crop species (list of species concerned to be constructed)
		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* currently 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 is eligible 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) are 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.	Sowing parameters (sowing time, sowing density, sowing depth…) are hard to monitor without creating complementary burden for farmers because those parameters are decided on a tactical.
		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	Water/soil	x	x	x	x	*Manage water sanitation* **following the crop-specific guideline** to reduce	

	of resources to the pest	sanitation					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.	-005 Disruption mating in orchards : the list include all the items (diffusers) -009 Disruption mating in vineyards
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.	-030

12.2 Appendice 2: How to develop an Action Sheet: A step-by-step method illustrated with an example

12.2.1 Purpose of the Action Sheet

The Action Sheet is the operational counterpart of the *IPM guideline*.

While the guideline formulates a concise statement indicating what should be done to promote sustainable pest management, the *Action Sheet* explains how and under which conditions this action can be effectively implemented at farm level. It provides the technical and contextual information needed for practitioners and advisors to translate the guideline into practice, while also identifying the indicators that allow monitoring and evaluation of the action's effectiveness over time.

The drafting of Action Sheets can be undertaken by the same stakeholders involved in the development of the IPM guidelines themselves. A collaborative process is essential to ensure both technical accuracy and practical relevance. Researchers, applied research institutes, extensive services and advisory services play a key role in documenting the agronomic and environmental effects of practices within farming systems. Advisors and extension services contribute their field knowledge and experience in translating scientific principles into feasible actions.

Professional organisations, input suppliers, and farmers' cooperatives should also be associated, as they hold critical information on the tools, materials, varieties, and organisational innovations already available to farmers. Involving this wide range of actors from the outset ensures that each Action Sheet reflects not only scientific evidence but also the operational realities of agricultural systems across Europe.

12.2.2 The three core components of an Action Sheet

Each Action Sheet must include three complementary components that together make the proposed action precise, applicable, and verifiable:

1. a clear description of the action;
2. the expected effects on the farming system; and
3. the means available to monitor its implementation.

At the start of each Action Sheet, it should also be stated that **the content addresses primarily the technical limitations to implementation**.

Economic barriers, marketing constraints, or requirements set by buyers and processors are discussed separately in **Deliverable 6.1**, since these depend on decisions and negotiations among the relevant stakeholders.

Each component is presented below, together with guiding questions and an illustrative example.

12.2.3 How to clearly describe the action behind the guideline

12.2.3.1 .Purpose and rationale

The first step in developing an Action Sheet is to describe the action in precise, operational terms.

This description forms the foundation for the entire sheet: it clarifies what is done in practice, how it modifies the farming system compared to the reference situation, and why it contributes to Integrated Pest Management (IPM) objectives.

An accurate description enables practitioners, advisors, and policymakers to visualise what will change in the field and to anticipate the expected benefits and limitations.

The description also serves as a learning tool—helping readers to grasp how a generic IPM principle becomes a concrete, measurable practices.

12.2.3.2 Describing the reference system and the transformation

Every action must be situated relative to a reference system, i.e. the typical or average cropping system currently practiced in the region without adoption of the action. Describing the reference allows readers to understand the magnitude of change introduced by the new practice. 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.

The next step is to detail the transformation brought by the action—what is modified, replaced, or added in the cropping sequence or decision process. This may include adjustments in crop or variety choice, sowing or pruning dates, input management, or number and timing of interventions.

The description should remain synthetic—ideally no longer than half a page—but it must convey how the system changes and why this change contributes to crop protection. It should be written as if explaining the action to a farmer or advisor unfamiliar with it, avoiding overly technical jargon while maintaining precision.

> **TIPS:** The action described in an Action Sheet must not correspond to the baseline practice. If the practice is already standard in the region, its potential to further reduce pesticide use or impacts is limited.

12.2.3.3 Understanding context dependency

Agronomic practices do not exist in isolation; their effectiveness depends on the context in which they are applied.

In the Agrowise framework, context dependency refers to the degree to which the efficiency of a practice—in terms of pest suppression, pesticide reduction, and yield stability—is influenced by local biophysical and management conditions.

Six main groups of parameters determine this dependency:

- climate,
- soil characteristics,
- landscape configuration,
- biodiversity,
- pest pressure, and l
- legacy effects of past management.

A good description should therefore identify which of these parameters most strongly influence the performance of the action.

Recognising context dependency allows users to determine whether the action can be replicated in other environments or whether it requires site-specific adaptations.

Rather than being a limitation, this transparency is key to building confidence in the guideline's scientific robustness and practical credibility.

12.2.3.4 Considering the time dimension

The temporal dimension is another essential aspect of the action's description. Authors should clarify when in the production cycle the action is decided and implemented, and over what period its benefits can realistically be observed. This understanding is crucial both for interpreting the expected effects of the practice and for designing suitable monitoring indicators.

Within the Agrowise project, this relationship between decision timing, implementation, and observable effects has been conceptualised as the IPM Triangle. It emphasises that each action can be positioned according to the time lag between the moment it is undertaken and the moment its effects become measurable. Preventive actions occupy a specific place in this framework: they must be implemented before knowing whether pest pressure will eventually be low, moderate, or high. Such actions represent a long-term investment in system resilience rather than an immediate response to a known threat.

Because their effects may only become apparent over several seasons, these preventive measures often seem to offer a limited short-term return on investment. However, they are fundamental to reducing the structural vulnerability of agroecosystems and to avoiding the progressive escalation of pest pressure. For this reason, the Agrowise consortium has placed particular emphasis on promoting these prophylactic or anticipatory actions, which, although sometimes undervalued, are central to the sustainability of IPM strategies.

Acknowledging these temporal aspects ensures that each action is assessed in a fair and realistic timeframe, reflecting both its immediate effects and its long-term contribution to sustainable pest management..

12.2.3.5 How to clearly describe the action behind the guideline? Guiding questions for Action Sheet's authors

To support a systematic and consistent drafting process, authors may rely on the following guiding questions. These questions ensure that the action is described comprehensively, including its technical requirements, context dependency, and temporal dimension:

Action definition and transformation

- What exactly is the action, and what concrete changes does it introduce in the farming system?
- What is the reference system, and why is it relevant for understanding the impact of the action?
- Which operations, inputs, or decisions are modified by the action (e.g., crop or variety choice, planting density, timing of interventions)?

Context Dependency

- Which biophysical, agronomic, or management parameters influence the success of the action (e.g., climate, soil, landscape, biodiversity, pest pressure, legacy effects)?
- How transferable is the action to other regions or systems, given its context dependency?

Temporal Dimension

- When in the production cycle must the action be decided and implemented?
- What is the time lag between implementation and the appearance of measurable effects, particularly for preventive or anticipatory actions?
- Over what period should support, monitoring, or incentives be maintained to ensure the action's effectiveness and adoption?

By systematically addressing these questions, authors ensure that the Action Sheet provides a clear, operational, and realistic description of the practice, highlighting both its short-term feasibility and long-term contribution to sustainable Integrated Pest Management.

12.2.4 How to assess the expected effects?

12.2.4.1 Purpose and rationale

After describing the action in Section 1, it is essential to define and document the expected effects of its implementation. These effects reflect how the practice contributes to Integrated Pest Management (IPM) objectives, including the reduction of pesticide use, mitigation of environmental impacts, and maintenance of crop productivity. Importantly, the Agrowise taxonomy of practices enables the explicit linkage of each action described in the guideline and detailed in the Action Sheet to the broader IPM principle it supports. This connection ensures that farm-level practices are directly aligned with the strategic objectives of IPM and facilitates the evaluation of their contribution to sustainable pest management at both regional and European scales.

In this stage, authors should emphasise that the **variation in effects** depends on context parameters. These parameters are not strictly geographical; they correspond to **pressure levels** (e.g., pest or disease pressure), **climatic or soil indicators**, water availability, or prior agronomic actions. Considering these variables allows practitioners and policymakers to assess the **transferability** of a practice across different farming systems, beyond simple regional mapping.

12.2.4.2 Field trials and evidence collection

To accurately assess the expected effects, field trials are necessary. The objectives of these trials include:

- Identifying which varieties, machinery, or organisational changes can deliver the intended agronomic and pest management services.
- Quantifying the magnitude of effects in different contexts and management systems.

- Collecting evidence that can support national and regional implementation of guidelines, tailored to major crops, prevalent pests, and reference farming systems.

The results of these trials feed into the agronomic service indicator (see deliverable 2.1), which allows evaluation of the contribution of each action. Practices providing a high service can nearly eliminate pest damage while producing minimal negative side-effects. Practices providing moderate service are equally important to maintain system resilience, especially under Principle 7 of IPM: Anti-resistance strategy, as they help preserve the effectiveness of major interventions by preventing overuse and resistance development.

12.2.4.3 Combining practices for resilience

Even highly effective practices with minimal negative impacts must be **strategically combined** within the cropping system. Over-reliance on a single "ideal" practice can accelerate the selection of resistant pest populations, reducing long-term effectiveness.

Thus, Action Sheets should distinguish between:

- **High-service practices**: core measures that provide substantial protection but require careful management to maintain durability.
- **Moderate-service practices**: complementary measures that enhance overall resilience and support the durability of high-service interventions.

This strategic combination ensures sustainable pest management across diverse contexts while reducing pesticide dependence.

12.2.4.4 How to assess the expected effects? Guiding questions for Action Sheet's authors

To support a systematic assessment of expected effects, authors may consider the following questions:

Field Evidence

- How can context dependency inform transferability to other regions or farming systems?
- What field trials or empirical studies are necessary to evaluate the action's effectiveness? Which are already available?
- Which varieties, machinery, or organisational modifications should be tested and documented?

Agronomic service provided

- What is the agronomic service provided by the action ? Should it be considered as a core action in our national cropping systems?
- How can this action be combined to prevent resistance development?

Integration with monitoring of the action implementation

- What indicators or data sources can document the deployment and performance of each action?
- How will the list of effective items be maintained and updated over time?

Assessment of expected effects is closely linked to the **identification of monitoring indicators**.

Field trials and consultations with researchers, applied research institutions, extension services, and advisors are essential to establish a **transparent and validated list of items** that demonstrably deliver the intended agronomic service.

In France, the example of the pesticide savings certificates (CEPP in French) shows that those lists can be regularly updated through voluntary contributions from innovation actors, reflecting new varieties, tools, or organisational practices. It highlights a **range of options** that farmers can access through their usual suppliers, thus bridging the gap between scientific evidence and practical implementation.

Once the expected effects of an action are defined and documented, the next step is to specify **how to monitor its implementation in practice**. Section 3 focuses on the methods and indicators necessary to track deployment, measure compliance, and ensure that the action delivers the intended agronomic service over time.

12.2.5 Questions for monitoring and revising guidelines at national level

12.2.5.1 Purpose and scope

Once the expected effects of an action have been defined (12.2.4), it is crucial to assess how the action is actually implemented in practice.

This section provides a set of guiding questions for Member State representatives to consider when revising their guidelines. The focus is on identifying available data sources, monitoring deployment, and understanding potential barriers to adoption.

It is important to emphasise that relevant data can come not only from regulatory audits directly linked to IPM compliance, but also from the items and evidence collected during the development of the Action Sheets (Section 1 and 2). This includes information on the availability, use, and effectiveness of varieties, equipment, and decision-support tools, as well as advisory support for farmers.

12.2.5.2 Questions for assessing the deployment of IPM Actions

Varieties (Resistant or Tolerant)

- Where can quantities of eligible varieties be tracked (multiplication, sales, certified seed data)?
- Do these varieties represent the majority of those actually used by farmers? If not, what practical barriers limit adoption?
- Eligible varieties should be at least as productive as reference varieties, and so, why are they not widely deployed?

Equipment

- Are eligible machines or tools widely used, including through shared services or group ownership?
- Is it feasible for farmers to construct or adapt some equipment themselves?
- Are advisors familiar with these tools, and are they easy to set up and operate?
- Could targeted support or incentives for equipment acquisition facilitate deployment,

particularly in the context of IPM Principle 4?

Decision-Support Tools

- Is the tool adapted to local parameters (climate, soil, pest pressure)?
- Are pest or disease dynamics models reliable and robust?
- Can the tool be used both for optimal pesticide timing and for triggering biocontrol or mechanical interventions?
- Does the interface inspire confidence, and can field observations easily validate its recommendations?
- Are advisors trained in the use and dissemination of the tool?

12.2.5.3 Engaging stakeholders for deployment monitoring

The answers to these questions highlight that many actors are involved in implementing actions at farm level:

- Suppliers and cooperatives provide the varieties, equipment, or inputs.
- Advisors assist with setup, calibration, or timing of interventions.
- Innovation actors contribute new tools and practices.

These stakeholders can serve as valuable sources of information, helping not only to quantify the deployment of actions but also to document challenges and support needs. This **feedback loop** ensures that guidelines and Action Sheets remain practical, evidence-based, and responsive to real-world constraints.

12.2.6Illustrative Example: Use of Tolerant/Resistant Vine Varieties

12.2.6.1 Purpose and Rationale

This Action Sheet illustrates how the generic 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"

can be operationalised for a specific crop/pest combination. Here, the focus is on **grapevine**, targeting the major diseases **powdery mildew and downy mildew**. The practical objective is to prevent damage and reduce pesticide use by selecting and deploying varieties that provide effective resistance while supporting a durable IPM strategy.

The action is highly effective on grapevine, with the potential to reduce pesticide use for these diseases by up to 80%. This case demonstrates the process of translating a guideline into a concrete, monitored practice.

Link to the Agrowise taxonomy: 1.1.1.1 – *Use resistant and/or tolerant cultivars*

Crop concerned: Vine

Type of lever: Plant breeding

Pests concerned: Powdery mildew and downy mildew

12.2.6.2 Description of the Action

Practical implementation:

- Planting **tolerant or resistant vine varieties** based on a national list of eligible varieties linked to resistance profiles.
- These varieties are used as the foundation for an IPM strategy integrating preventive, monitoring, and responsive measures.

Reference system and transformation:

- All vines are grown in nurseries and renewed approximately every 25 years.
- The Action Sheet highlights the transformation from baseline practice (random or market-driven selection) to a **structured selection based on resistance scores**, integrating both farmer preferences and regulatory guidance.

Current selection criteria for varieties:

- Local appellation requirements
- Market and contractual specifications
- Yield potential
- Resistance profile against powdery and downy mildew

Active prophylaxis approach:

- Disease resistance is integrated into the variety choice alongside quality and yield considerations.
- The French CEPP system provides an annual list linking varieties to **estimated pesticide savings**, calculated from field trials and variety resistance profiles, enabling a **quantified connection between variety choice and pesticide reduction**.

12.2.6.3 Context Dependency

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.

This demonstrates that **variety choice is largely context-independent**, facilitating transferability across regions, although it remains influenced by regulatory and market constraints.

12.2.6.4 Expected effects and Agronomic Services Provided

- **High-service effect:** Nearly complete reduction of mildew damage, enabling significant pesticide reduction with minimal negative impacts.

12.2.6.5 Monitoring implementation

Sales and certification tracking:

- Use nursery and certified plant sales data to monitor the deployment of eligible varieties.
- Collect information from farm-saved plants through surveys to capture full adoption.

Variety service evaluation:

- Link resistance scores to actual reductions in pesticide use.
- Maintain a transparent, annually updated list of eligible varieties reflecting current plant breeding and innovation.

Stakeholder engagement:

- Researchers and innovation actors validate the resistance scores and expected services.
- Advisors and extension services support farmers in choosing and implementing varieties.
- Certification bodies, nurseries, and suppliers provide data on adoption and distribution.

12.2.6.6 Key questions for authors (Illustrative Example)

1. **Action Definition**
    - Which resistant/tolerant varieties are eligible for deployment in the targeted crop?
    - How does variety choice modify the cropping system and contribute to disease control?
2. **Context Dependency**
    - Are there regional or climatic limitations to variety effectiveness?
    - How can transferability be assessed for different vineyard contexts?
3. **Expected Effects**
    - What level of pesticide reduction can be realistically expected per variety?
    - Which combinations of high- and moderate-service varieties ensure both effectiveness and resistance durability?
4. **Monitoring**
    - How can sales, certification, and farm-saved plant practices be tracked to quantify adoption?
    - Which stakeholders provide reliable data on implementation and practical challenges?

12.2.6.7 Conclusion

This example illustrates the **full Action Sheet process**, from guideline interpretation to practical implementation, expected effects assessment, and monitoring. It demonstrates how a complex technical action—variety selection—can be translated into a measurable, farm-level practice that supports sustainable pest management while integrating multiple stakeholders and data sources.

12.3 Appendice 3: Definition of Active Prophylaxis

Active prophylaxis is a **concept that guides the strategic planning and implementation of preventive agricultural practices** encompassed by Principle 1 ("Prevention and suppression") of Integrated Pest Management (IPM). Rather than only introducing new practices, it also redefines how existing measures are applied, ensuring that prevention is treated as a **primary objective in crop management and that practices are intentionally applied in order to reduce pest pressure**.

Central to this concept is the principle that preventive actions are **implemented before any information on the possible pest pressure for the coming season**, relying on general agronomic principles and validated technical references. This anticipatory approach justifies the establishment of **obligations of means**, emphasizing the **method of implementation rather than the achievement of specific outcomes**.

Active prophylaxis encompasses all practices under Principle 1 that can be **executed in a way that demonstrably reduces initial pest pressure**, including soil preparation, inoculum management, crop rotation, varietal choice, sowing date and density, irrigation management, border maintenance, and management of pest reservoirs.

By orienting the implementation of preventive measures upstream of pest emergence, active prophylaxis **reduces the likelihood of severe infestations and infections, limits reliance on curative interventions**, and **safeguards the long-term effectiveness of control methods**, notably by mitigating the possible emergence of resistances when they are not yet widespread.

In summary, active prophylaxis represents a **knowledge-based, measurable, and conceptually robust pillar** of sustainable crop protection, rooted in the rational, intentional, and **scientifically validated adaptation** of preventive practices within the IPM framework. Moreover, it increases the services provided by all other principles and avoids occurrence of dead-ends, such as emergence of resistances.

12.3.1 Explanatory note

The concept of active prophylaxis formalizes a proactive and measurable approach to prevention within Integrated Pest Management, in line with Directive 2009/128/EC.

It recognises that **prevention is the cornerstone of sustainable protection systems**, acting in advance to reduce pest populations and, consequently, to preserve the effectiveness of curative methods over time.

Intentionality is based on the **application of agronomically validated practices** known to produce preventive effects, as defined by technical guidelines or operational frameworks.

12.3.1.1 Official framework reminder (Principle 1 – Directive 2009/128/EC, Annex III)

Principle 1 of the Directive on the Sustainable Use of Pesticides (SUD) establishes that:

"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. sowing dates, sowing densities, under-sowing, conservation tillage, pruning and direct sowing), use of resistant/tolerant cultivars and standard/certified seed and planting material, use of balanced fertilisation, liming, irrigation/drainage practices, hygiene measures and protection and enhancement of important beneficial organisms."

This principle therefore defines a **set of agronomic levers** contributing to the **prevention and suppression of harmful organisms** within the overall framework of **Integrated Pest Management (IPM).**

12.3.1.2 Conceptual positioning of Active Prophylaxis relative to Principle 1

The notion of Active Prophylaxis **does not introduce extra obligations** beyond those stated in the SUD.

Rather, it provides a **conceptual and operational framework** that aims to:

- **Organise, qualify and valorise** the practices listed under Principle 1 through an intentional and measurable lens;
- **Clarify implementation conditions** by relying on harmonised technical references and evidence-based guidelines;
- **Reinforce user adoption** by structuring preventive actions as a deliberate management strategy rather than a set of routine measures.

In essence:

Active Prophylaxis does not redefine Principle 1; it articulates its underlying rationale.

It highlights the **strategic and intentional dimension of prevention**, recognising that sustainable crop protection begins with proactive, knowledge-based decision-making.

12.3.1.3 Complementarity of the two concepts — from a list of possible actions to an operational concept

Aspect	Principle 1 (Directive 2009/128/EC)	Active Prophylaxis
NATURE OF THE FRAMEWORK	Regulatory principle (identifies recommended practices)	Conceptual and agronomic approach
MAIN OBJECTIVE	Define *which* preventive practices exist	Define *how* and *why* they should be implemented
CORE DIMENSION	Inventory of preventive actions	Intention-driven and evidence-based management strategy
EVALUATION BASIS	General references	Enables *obligations of means* through validated technical guidelines
RELATION TO SUSTAINABILITY	Implicit through prevention	Explicit through reduction of pest pressure and resistance risks