Deliverable 2.3

Complete taxonomy with metadata and pesticide reduction volume and evaluated impacts

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Executive Summary

With the intention of providing guidance to efficiently implement future regulations on Integrated Pest Management, the Agrowise project builds on the IPM toolbox Pilot project. It focuses on annual field crops and perennial crops, including vineyards and orchards.

The deliverable D2.3 is structured according to the following tasks and uses iterative methods:

1. Harmonisation and completed taxonomy of IPM practices

This task's aim was to harmonise the description of innovative practices and systems, using the IPM toolbox and data from the countries in the consortium (Deliverable 2.1).

2. ESR scoring and time of anticipation

This task's aim was to get a better understanding of IPM practices applicability and limitations from the harmonized completed taxonomy. The method used was to position IPM practices in two dimensions: ESR and time of anticipation, to test their suitability in farmer contexts with varying time and resources.

Has thus been produced an evaluation, for all practices of the taxonomy, of the level of redesign implied by these practices, and the time required before expected benefits from a practice implementation.

3. How to update practices in the IPM toolbox using relevant research projects from EU and national sources

This Task's aim was to identify and then review the whole EU and national research projects relevant IPM, and identification of complementary practices that could be added to the harmonized completed taxonomy.

From this screening and analysis of current literature, more than 500 concrete practices, with the links to their source project could be documented, linked to the taxonomy and proposed as extensions of the "Best practices" database of the Farmer's Toolbox for Integrated Pest Management.

4. Evaluating the efficiency of practices to reduce pesticide use and risk

This Task's aim was to develop a method for allocating an agronomic value to IPM practices in different cropping systems, thereby facilitating the dissemination of precise information to farmers regarding the efficiency of these practices.

In these documents, as appendices 5, 6 and 7, we produced three case studies consisting of the full evaluation of the two created metrics "Agronomic Service Provided (ASP)" and "Improvement of ASP (IASP)" on the problems of codling moth in apple trees, powdery mildew in vineyards, and weeds in arable crops. The IASP has been evaluated by experts from multiple countries of the consortium, and summary tables gathering all identified items (practices) of the IPM Taxonomy that could be used in these cases as well as evaluated metrics are to be found in the related appendices.

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The produced data have been aggregated in the website dedicated to the exploration of the created IPM Taxonomy and its metadata: https://agrowise-ipm.softr.app/.

The results of this deliverable help to better understand the limitations of the current IPM strategy and offer methods on how to enrich the toolbox and measure efficiency of practices. The work completed thus provides clarity on the IPM requirements and gives greater emphasis on multiple complementing preventative actions that can be taken in several Member States and different cropping systems. These methodological outputs will help ensure efficient coordination with national authorities and pave the road for the successful implementation of regulations targeting sustainable agriculture practices.

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Abbreviations and acronyms

Abbreviation / Acronym	Description
IPM	Integrated pest management
WP	Work package
ESR	Efficiency, Substitution, Redesign
ASP	Agronomic service provided
IASP	Improvement of agronomic service provided
EU-RAIL MAWP	Multi-Annual Work Plan of Europe's Rail Joint Undertaking
SUD	Sustainable Use Directive
SUR	Sustainable Use of Pesticides Regulation

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Background

The present document constitutes the Deliverable D2.3 "Complete taxonomy with metadata and pesticide reduction volume and evaluated impacts" in the framework of the Project Agrowise as described in the EU-RAIL MAWP.

The Sustainable Use Directive (SUD) was introduced in 2009 as part of the EU's broader effort to promote sustainable agriculture practices and reduce the risks associated with pesticide use. It required member states to develop National Action Plans and adopt Integrated Pest Management (IPM) practices. However, over time it became clear that the directive lacked enforcement power and led to uneven implementation across the EU. In response, and as part of the European Green Deal and Farm to Fork Strategy, the European Commission proposed the regulation on Sustainable Use of Pesticides Regulation (SUR) in 2022 to make the reduction targets legally binding and set out provisions on how to achieve them. The SUR proposal was, however, withdrawn by the Commission in 2023. The 2009 SUD (EU 2009/128/EC) remains the current standard.

The Agrowise project was set up to directly support the implementation of SUD by developing practical, crop-specific guidelines on integrated pest management (IPM), addressing one of the key shortcomings of the directive. By providing clarity on IPM requirements and facilitating coordination with national authorities, this project creates the framework for a smooth and effective rollout of improved follow-up of the directive and a solid foundation for future regulations. In addition, it provides a basis for efficient pest management and knowledge exchange in the EU.

Integrated Pest Management is often depicted as a pyramid, with preventative strategies such as crop rotation and cropping system design, forming the base. At the top of the pyramid are chemical pesticides reserved for use as a last resort. However, pesticides have become central to crop production. The EU efforts to reduce their use have largely fallen short. In this context, there is a growing concern for the increasing dependence on a diminishing number of approved active substances in Europe, which reduces flexibility in pest control and heightens the risk of resistance to certain compounds. To address this, greater emphasis is needed on the base levels of the IPM pyramid. We need to strengthen diverse, preventative practices that can reduce pest pressure and, in some cases, eliminate the need for pesticides. Curative measures remain necessary when economic thresholds are exceeded and substitutions for chemical pesticides and more efficient use of pesticides is needed.

The work package 2 of Agrowise focuses on the structure and content of the Farmer's toolbox for IPM commissioned by the European Commission and hosted by the JRC https://datam.jrc.ec.europa.eu/datam/mashup/IPM_BEST_PRACTICES. This repository compiles best IPM practices developed through a commissioned project that investigated the key drivers and barriers influencing the full adoption of IPM, aiming to significantly reduce pesticide dependency. As an add-on to the existing IPM toolbox, WP2 also involved creating a standardised metric for the reduction of use of pesticides which was relevant to all practices and systems across all Member States (Deliverable 2.2 led by INRAE).

The outcomes of WP2 lay the foundations for the other work packages in Agrowise that focus on additional aspects of the application and dissemination of the knowledge collected through the resulting upgraded IPM toolbox (Figure 1). These include: methods on the implementation of the taxonomy (WP3), the inventory of policy instruments (WP4), iterative engagement with

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groups of experts (WP5), and final recommendations (WP6).

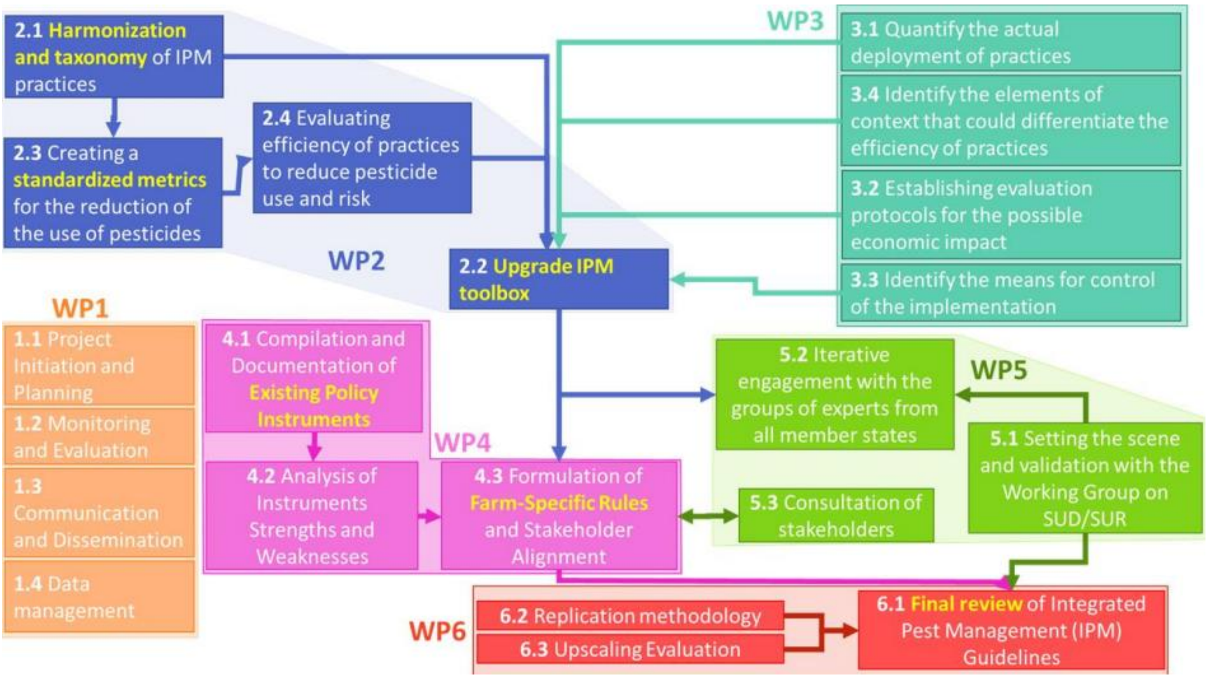

Figure 1. Relationships between the different Work Packages (WP) and nested Tasks

Objective

The outcomes of this deliverable present a methodology on how to structure an updated IPM toolbox and how to evaluate practices that can help build an integrated approach focused on keeping pests below economically damaging thresholds for crop production.

The deliverable includes a listing of the innovative practices, each associated with a description and a volume in the standard metric based on insights from FP7, H2020 and Horizon Europe projects. This deliverable contains technical proposals for collecting missing data, for instance using precision farming equipment.

It will focus on two main farm systems:

1) Annual field crops, including farms with dairy and cattle production (FADN code 832). This will make it possible to capture the situation of all annual crops either alone or in rotation with temporary grasslands. This includes 75% of the European Arable land and 80% of the pesticide use (in tonnage).

2) Perennial crops, including vineyards and orchards (FADN code 380). This will make it possible to capture the situation of most perennial crops, where only long-term modifications of the landscape structure are possible. Even though these cropping systems are limited in acreage (3% in Europe), they represent 16% of the pesticide volumes.

The deliverable contains the following sections:

1. **Harmonisation and completed taxonomy of IPM practices**

Harmonisation of the description of innovative practices and systems, using the IPM toolbox and data from the countries in the consortium (Deliverable 2.1).

2. **ESR scoring and time of anticipation**

Positioning of IPM practices from the harmonized completed taxonomy in two dimensions: ESR and time of anticipation, to test their applicability in farmer contexts with varying time and resources.

3. **How to update practices in the IPM toolbox using relevant research projects from EU and national sources**

Review of all EU and national research projects relevant IPM and identification of complementary practices to the harmonized completed taxonomy of IPM practices.

4. **Evaluating the efficiency of practices to reduce pesticide use and risk**

Development of a method for allocating an agronomic value to IPM practices in different systems, thereby facilitating the dissemination of precise information to farmers regarding the efficiency of these practices. This task also aimed to provide Member States and the Commission with a clear understanding of the potential for realistic pesticide reduction in specific systems and countries.

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Content

1. Harmonisation and completed taxonomy of IPM practices

We propose a novel, harmonised taxonomy of IPM practices, grounded in the European Commission's 8 IPM principles. This taxonomy classifies each IPM practice in 4 hierarchical levels, describing the on-farm management adaptations by farmers, the strategic goals of a practice, the practices itself, as well as specific cases of implementation.

1.1 Methods

We initially extracted the information on IPM projects added in the JRC´s toolbox for the 8 consortium countries: Sweden, Italy, France, Romania, Croatia, Poland, Germany, Ireland. All consortium members then separately reviewed the toolbox entries for their respective country and placed them, in their own words, into an initial hierarchical structure. **The initial hierarchical structure started from the 8 IPM principles**, and contained 4 added layers intending to place tool box entries along a gradient of resolution, ranging from broad concepts (low level of resolution) to exact actions to take (high level of resolution). SLU then reviewed, where consortium members saw the entities to be placed in terms of resolution of the projects and practices added in the current toolbox.

Following this initial assessment, we harmonised the language used to describe practices across consortium members, ensuring consistency in terminology. We carefully examined the entries to identify overlapping concepts and refine the levels of resolution across the different layers.

To further enhance clarity and usability, we classified and standardised the practices within the hierarchical layers, defining each layer to facilitate the operationalisation of the taxonomy. **We created the first layer as being the on-farm targets of management to increase** the applicability to farmers and advisors, **the second layer was chosen to describe the underlying strategic thinking for these sets of IPM practices. The third layer was used to give the overarching IPM practices**, and balancing precision about the IPM practices applied while still leaving this layer flexible. **The fourth, and last layer was added to illustrate the options that existed for each practice.**

Using this framework, we further refined the terminology to align with the purpose of each layer and improved practice descriptions across different levels of resolution. The exact structure and examples are detailed in the separate Deliverable D2.1.

During the development of this taxonomy, we also expanded the list of practices where necessary, drawing on expert knowledge. While the taxonomy is not exhaustive, we are committed to continuously improving its completeness throughout the project (see section below on linkages to other WPs and the quality check of the taxonomy in terms of

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completeness), allowing public to propose contributions via the website hosting the living taxonomy, pointed (as "link to data") by https://doi.org/10.57745/CA3AVE.

As a second step, the consortium scored all practices in the taxonomy along the axis of Efficiency, Substitution and Redesign "ESR" (a concept coming from Hill & MacRae http://dx.doi.org/10.1300/J064v07n01_07 qualifying the changes of practices in agriculture), and on a "Time of anticipation" score also detailed further in the document. This mapping of practices was done by scoring three replicate subsets of practices (*Layer 4* of the IPM taxonomy) across members in the consortium and calculating mean ESR scores for each listed practice. This adds another dimension to the taxonomy by highlighting the practices that can support a real system change and redesign the cropping system.

1.2 Result

As the final deliverable, we present here an upgraded version of Deliverable D2.1 after additions of information described in this deliverable. **Currently, the taxonomy consists of 17 management targets, 44 IPM strategic targets, 107 IPM practices and 202 options**.

Since the initial submission of the task deliverable 2.1 in October 2024, the taxonomy has been used in the project, to classify new EU, and national projects from the consortium countries on IPM. During this process, we also identified complementary practices from European and national (Appendix 4) projects that have been added to the taxonomy.

The final harmonized taxonomy, with the possibility for users to add suggestions online, is currently available in an interactive format[1] on the URL pointed by https://doi.org/10.57745/CA3AVE (currently the URL is https://agrowise-ipm.softr.app/).

Retrospective on the completeness of Agrowise toolbox around the taxonomy of IPM

Initially following the goal of sorting IPM practices between binding and optional, Agrowise consortium planned to document the following information related to practices (Table 1). We document here in Table 1 the current availability state of the different information, as well as a description of where to find the information and a comment on the nature of the information produced.

[1] The website lets visitors make comments for contribution to the refinement of this taxonomy. The comments and suggestions will be taken into account at the end of the project to publish an updated version, keeping for now the same version throughout the project to ensure consistency between the works of the different tasks using the taxonomy.

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Table 1. Information on IPM practices that should ideally have been collected

Information on the practice [text]	**Public availability** (*Yes / Yes partially / Yes for case studies / Yes partially for case studies / No*)	**How / Where** (*Taxonomy website / Deliverable X / Appendix X / …*)	**Comment** [text]
Description of the practice, including description of the reference system(s)	Yes partially	Taxonomy website (https://doi.org/10.57745/CA3AVE)	Descriptions of practices available for all practices. Description of the reference systems available for the practices evaluated in the case studies in Appendices 5, 6, 7.
Species or groups of species covered by the practice	Yes partially		Available for practices identified in research projects and linked to the taxonomy. + Available for the case studies in Appendices 5, 6, 7.
Target pests	Yes for case studies	Appendices 5, 6, 7 *[and soon on the Taxonomy website]*	
Family(ies) of pesticides whose use and impact are likely to be reduced as a result of the implementation of the rule	Yes for case studies	Appendices 5, 6, 7 *[and soon on the Taxonomy website]*	For case studies, the target pest (or pest family) is identified so the category of pesticides to be reduced also (insecticides, fungicides, herbicides)
Place in the taxonomy	Yes	Taxonomy website (https://doi.org/10.57745/CA3AVE)	
The IPM principle addressed by the practice	Yes	Taxonomy website (https://doi.org/10.57745/CA3AVE)	-
The level of ESR (Efficiency-Substitution-Reconception) in relation to the dominant agricultural system in the countries concerned as it is difficult to identify the reference system	Yes	Taxonomy website (https://doi.org/10.57745/CA3AVE)	In 5 levels. Available for the Layer 4 items averaged through evaluations across different countries of the consortium. Extrapolated to the above Layers through the mean. Plus, available for individual real life practices tested in research projects.

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Information on the practice [text]	**Public availability** (*Yes / Yes partially / Yes for case studies / Yes partially for case studies / No*)	**How / Where** (*Taxonomy website / Deliverable X / Appendix X* / …)	**Comment** [text]
The anticipation required to implement the practice	Yes	Taxonomy website (https://doi.org/10.57745/CA3AVE)	Understood as the time between the introduction of the practice and the delay to get its significant effects. In 5 levels.
The level of dependency to local conditions	Yes for case studies [incoming]	Deliverable D3.3 [incoming]	Evaluated for the practices identified to be applicable in the three case studies of Appendices 5, 6, 7. With sub-indicators related to the factors of dependency.
Intensity of the reduction in use and impact (define a reduction scale: from 0 to 5, with 5=-100%; the rating scale is not necessarily linear)	Yes for case studies	Appendices 5, 6, 7 *[and soon on the Taxonomy website]*	One of the dimensions of the Agronomic Service Rendered (ASP). see deliverable D2.2 for methodology
Share of production of crops already concerned by the implementation of the practice and potential future share	No	-	Data not available at practice level
The cost of implementation (is there an additional cost for the farmer compared with the prevailing agricultural system?)	Yes partially for case studies	Deliverable D3.2	In deliverable D3.2, available for arable crops in France, cereals in Ireland and codling moth in Croatia.
Relationship and synergies to other practices	Yes partially for case studies [incoming]	Deliverable D3.3 [incoming]	One of the dimensions of the Agronomic Service Rendered (ASP) (see deliverable D2.2 for methodology) Synergies depend on local conditions (see deliverable D3.3 for methodology)
Indicator for monitoring deployment	Yes [incoming]	A document will be produced in Task3.3	

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2 ESR scoring and time of anticipation

To enhance the efficacy of IPM and its associated principles in achieving their intended targets, we position IPM practices within a two-dimensional space.

The first dimension corresponds to the ***degree of change required*** in the cropping system to implement a crop protection action. The action is placed along a gradient ranging from Efficiency (minor change), to Substitution (intermediate change), to Redesign (greater change). This gradient is referred to as ***ESR***.
The second gradient is the ***time of anticipation***, i.e. the time lag between the introduction of a practice to the point when noticeable results are expected to be observed. This time of anticipation can range from short term tactical considerations to long term strategic planning.

2.1 Methods

Following the harmonised completed taxonomy of IPM practices, we carried out a mapping of practices which included a range of tactical short term to strategic long term practices. The ESR-framework has been utilised in the last three decades to describe the transitioning of farming operations from conventional to sustainable arable practices (Hill and MacRae, 1996). A survey was carried out in order to classify each practice into the three categories: Efficiency, Substitution and (System) Redesign according to five scores (Table 2).

IPM practices classified under Efficiency describe practices that increase the efficiency of pesticides used by for example increasing pesticides efficacy or precision of application. Practices falling under Substitution are describing practices that replace the use of harmful pesticides with other alternative less harmful pesticides or measures such as bio products or mechanical control. Practices classified as System Redesign, require rethinking the current production practices and changing the agroecosystem in order to reduce pesticide use, and includes for example introduction of new crops, changes in crop sequences or cropping patterns.

Table 2. Explanation of ESR scoring and examples of practices

Level 5 - System Redesign	The entire system is revisited to ensure the success of the intended action. E.g. Redesigning the cropping system to rely on prevention and suppression instead of using pesticides
Level 4 - Redesign	The action replaces the original intervention method, requiring minimal system adjustments E.g. Changing frequency or threshold levels
Level 3 - Substitution	The action replaces the original intervention method with an identical one (without further system adjustments). E.g. Replacement of a pesticide with other biological, physical or non chemical controls
Level 2 - Improvement	The action integrates alternative practices but still aims for efficiency E.g. combination of biocontrol agents and fungicides to reach good control levels
Level 1 - Efficiency	The action optimizes Plant Protection Product use. E.g. low drift nozzles that reduce the amount of pesticides applied

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Average scores and variability for each practice across respondents are presented as a table at this address: https://doi.org/10.57745/CTRK1E.
As a complement to the ESR-scores, we added the variable "Time of anticipation" which refers to the anticipated time lag between the introduction of a practice to the point when noticeable results are observed, such as lower pest levels and improved crop performance. The anticipation time does not include the preparation time that leads to applying the practice, i.e. time spent on purchasing machinery or training.

The partners scored the Layer 3 of the Harmonized Completed Taxonomy according to the following "Time of anticipation" scale in Table 3.

Table 3. Explanation of Time of anticipation scoring and examples of practices

Time of anticipation score	Example of practice
Level 5 - Over five years and multiple cropping seasons, associated with systemic change	Composting manure or establishing ecological infrastructure to support long-term pest suppression
Level 4 - Within five years	Adopting intercropping or crop rotation strategies
Level 3 - Within one year	Autumn ploughing to reduce overwintering pest populations
Level 2 - Within one to three months	Implementing mass trapping during a critical pest period
Level 1 - Within one day to one week	Changing a nozzle setting in real time

The participants added their confidence score to each response, on a scale of 1-5 (1 no confidence – 5 high confidence) (full results presented as a table here : https://doi.org/10.57745/CTRK1E.
For each survey "ESR-score" and "Time of anticipation score", we obtained 20 responses from the overall 8 Member State project partners.

2.2 Results and discussion

The results show clear overlap between the following IPM principles (Figure 2):

- (Principle 1) Prevention and Suppression, (4) Biological, physical and other non-chemical methods
- (2) Monitoring, (3) Decision making
- (5) Pesticide selection, (6) Reduced pesticide use (7) Anti-resistance strategies.

Principle 8. Evaluation is mostly isolated in the ESR-time of anticipation space. It represents an overarching principle with practices ranging from efficient to system redesign and a large range (scores 1.5 to 4.8) of time of anticipation (scores 2.2 to 5).

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Overall the positioning shows that a majority of principles emphasise tactical measures, with most practices situated in the time of anticipation range less than level 2.5. Principles 1 and 4 clearly illustrate the baseline principle of IPM of relying on biodiversity generated services to prevent pest outbreaks in the first place and avoid using curative measures such as pesticides use. Principles 1 and 4 are positioned at the top-end of the ESR-scale and cover a large range of time of anticipation which strengthens the idea that they can support the transition to sustainable agriculture through a diversity of modes of actions. They are clearly separated from principles 5, 6 and 7. which rely on solely efficiency measures with short time of anticipation. Principles 2 and 3 are placed in the middle part of the ESR-time of anticipation space. Their overlap also indicates that they are similar to each other in the way they implement IPM measures.

Figure 2. *Scores of ESR vs. time of anticipation for detailed practices (Layer 4) of the harmonized completed taxonomy. Points represent the individual practices, with colors corresponding to respective IPM Principle and ellipses centered around mean scores for each IPM Principle.*

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Figure 3 below highlights specific practices in this ESR-time of anticipation space, emphasizing the diversity of options farmers can apply depending on the issue in their cropping system. Some practices sometimes have more than one position in the ESR-time of anticipation space (marked as dashed lines) because different variations have been registered and evaluated. The diversity of practices and the breadth of their distribution in these two dimensions show the potential to leverage IPM practices to target more long-term redesign strategies in the future.

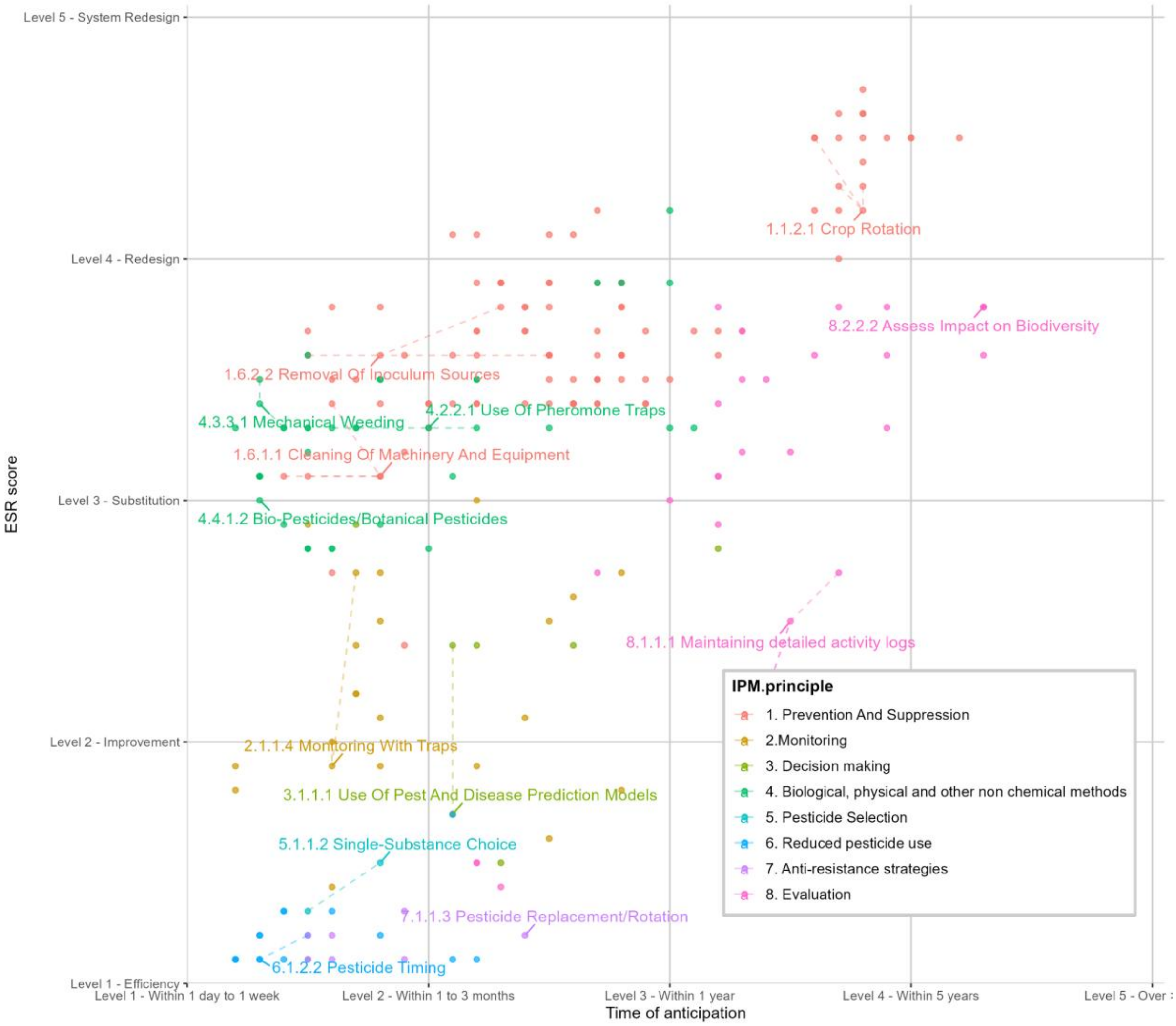

__Figure 3.__ Selected examples of IPM practices from the taxonomy, in the same previously defined ESR-time of anticipation space.

To appreciate the evaluations of all the practices on those two scales, Appendix 8 displays the different practices sorted according to these two gradings.

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3 How to update practices in the IPM toolbox using relevant research projects from EU and national sources

There are currently 1300 practices listed in the current IPM toolbox of best practices from the JRC. The objective of this task was to develop methods to identify existing additional practices to enrich the toolbox. This was done by selecting and analysing IPM-relevant research and innovation projects listed in Horizon, national and EIP databases. This work extended to the following crop categories: annual field crops (including grassland), and perennial crops (including vineyards and orchards).

This task has been structured into two steps:

1. establish a list of relevant European and national projects on IPM, crop protection, and agroecology (detailed in Appendix 1),
2. search the identified projects to identify and classify IPM practices according to the categories in the harmonized taxonomy defined in Deliverable 2.1 (detailed in Appendix 2, 3, 4).

Each project was analyzed individually to extract IPM practices. The practices were then classified according to the harmonized completed taxonomy. If no suitable category in the taxonomy was relevant for a practice, a new category in the taxonomy was proposed.

3.1 Methods

In step 1, projects with relevant practices to IPM or agroecology were collected by applying a list of keywords to the CORDIS, EU-CAP-NETWORK and national databases. The following primary keywords were searched in the title or description of the projects: IPM (Integrated Pest Management), Agroecology, Pesticide reduction, Crop protection. The projects were then manually reviewed to verify their relevance.

In step 2, Each project was then analyzed individually to extract IPM practices and classified according to the taxonomy defined in Deliverable 2.1. If no suitable category was found, a new one was proposed and reviewed if necessary. For identifying relevant practices, each team member was assigned a set of projects to analyze. The search for practices was conducted in the project deliverables, articles, reports, etc., which were available on the project's website, partner institutions, and European institution websites. Several lists of practice were identified, analyzed, and then classified according to the taxonomy for three project categories: European, EIP-AGRI, and national projects. For the latter, specific case studies were used from Croatia, France, Germany, Italy, Poland, Romania and Sweden.

The results were then analysed in relation to the following filters:

1. Country (only for EU Horizon projects and merged for all national projects)
2. Year of practice implementation
3. Crop category
4. Production systems
5. ESR scale
6. IPM principle

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7. Level 1, Level 2, and Level 3 of the taxonomy
8. Current level of development
9. Impact indicators

The results will mostly focus on the outcome from the filters 5. ESR scale, 6. IPM principle, as well as 8. Current level of development and 9. Impact indicators. The complete methodology for step 1 can be found in Appendix 1 and Appendix 2, and step 2 in Appendix 3.

3.2 Results and discussion

In the context of the ESR score analysis, the practices were evaluated for both Horizon EU projects and national projects. **The analysis revealed that national projects predominantly focused on substitution-level strategies, indicating a moderate progression beyond basic input efficiency but limited advancement toward system-redesign.** In contrast, EU Horizon projects placed the greatest emphasis on efficiency-level interventions and showed a broader adoption of mixed efficiency–substitution approaches, reflecting more diversified and advanced strategies. Additionally, redesign practices were more common in EU projects, demonstrating a stronger push towards transformative pest management solutions. **The relatively low presence of redesign strategies in national projects highlighted the need for further innovation and support to promote system-level changes within integrated pest management frameworks.**

When applying the IPM principle filter to the practices, the results showed that both national and EU projects prioritized prevention and non-chemical methods as the core of their Integrated Pest Management strategies, reflecting a shared commitment to sustainable approaches. However, EU projects placed greater emphasis on decision-making, indicating that they had developed more advanced and strategic integration of data-driven practices. In contrast, national projects focused more on monitoring, suggesting that they had concentrated on foundational data collection and observation. Both types of projects showed limited attention to pesticide selection and anti-resistance strategies, revealing gaps that needed to be addressed to prevent resistance buildup and promote sustainable pesticide use. Overall, the EU projects demonstrated a more balanced distribution across IPM principles, while national projects remained more heavily weighted toward early intervention and monitoring.

Regarding new ideas for IPM practices, all suggestions can be found in Appendix 4, and as a more detailed version here : https://doi.org/10.57745/8UDFQP.

Both EU and national projects yielded numerous examples of practices relating to the release of microflora and fauna (bacteria, fungi and nematodes). These belong to the following hierarchical layers of the harmonized completed taxonomy:

- 4. Biological, physical and other non chemical methods
- 4.1 Biological Control
- 4.1.1 Supplemental Release Of Live Beneficials

Table 4 below compiles the results for the level of implementation of the projects in both EU and national cases.

Table 4. Summary of results on the development stage of the IPM-related projects collected at both EU and national scale

Development Stage	**EU Horizon Projects (%)**	**National Projects (%)**	**Interpretation of results**
Research phase	11%	**44%**	National projects have a much larger share of early-stage research compared to the EU Horizon projects. This indicates national efforts are still heavily focused on initial innovation and exploration.
Testing phase	**55%**	37%	EU Horizon projects show more advanced validation/testing in real or semi-real conditions, while national projects have fewer practices at this stage, suggesting less progression beyond research.
Fully implemented	30%	19%	EU Horizon projects are often fully implemented and include more practices ready for or already in real-world application, compared to national projects where fewer practices have reached this stage.
Unspecified status	4%	0%	Some EU Horizon projects have unclear statuses, but national projects report none.

3.3 Limitations

The partners encountered the following limitations when completing this task that are listed below.

Step 1, selection of Relevant Projects
1. We had access to comprehensive lists of all European projects, which entailed a huge effort to identify those potentially containing relevant IPM practices. First challenge: Selecting projects based solely on keywords did not guarantee 100% accuracy. Some relevant projects may have been skipped due to the absence of appropriate keywords.

2. The resulting selection after applying keyword filters was not necessarily homogeneous, as each team member involved in the process had different areas of expertise and perspectives on project relevance.

3. Due to the considerable volume of remaining data, a secondary review by experts in IPM was not possible.

4. The use of AI in the selection process proved helpful, but human validation remained indispensable. AI-generated results were considered for informational purposes only.

Step 2, collection of Practices

1. Many of the newer projects are still ongoing, and their websites have not been updated with the latest deliverables.

2. In the case of older projects, many websites were either non-functional or no longer available.

3. Deliverables often lacked in-depth information on IPM practices, resulting in considerable time being spent for finding relevant data.

4. The continuous analysis of a large number of projects that ultimately result in no identifiable practices led to a general sense of inefficient effort.

4 Evaluating the efficiency of practices to reduce pesticide use and risk

Standardized metrics were developed for the comparison of integrated pest management (IPM) practices and systems in the European Union. The proposed metric informs national authorities and can support farmers. It enables the monitoring of the effectiveness of pesticide reduction practices and systems and facilitates the follow-up of implemented measures.
In this task, three case studies are used to assess the efficiency of practices previously identified.

1. Control of codling moth in apples
2. Control of powdery mildew in grapes
3. Control of weeds in grain crops

Based on expert knowledge, practices relevant for the control of the specific pests were identified and classified according to the harmonized completed taxonomy (Deliverable 2.1).

4.1 Methods

To assess the value of a particular IPM practice, several factors were considered, including pesticide use reduction, pest control effectiveness, impact on biodiversity and other relevant parameters. To quantify this value, a specific metric was developed, which is described in detail in Appendices 5, 6, 7 and in the dedicated Deliverable 2.2.

Each IPM practice was evaluated based on its Agronomic Service Provided (ASP) score, followed by an assessment of Improvement of Agronomic Service Provided (IASP), which compares the new practice to the reference practice for the same crop and pest in each country. The **ASR (Agronomic Service Provided)** is considered a robust indicator applicable across Europe to assess the intrinsic value of a practice under appropriate conditions of use. In contrast, the **IASR (Improvement of Agronomic Service Provided)** measures the added

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value of introducing a given practice within a specific system. This second indicator is therefore **system-dependent** and can be **adapted at the Member State level**. Such differentiation enables each Member State to identify which practices deliver the greatest benefits, taking into account their own reference systems and local contexts. Each parameter was determined based on a comprehensive literature review and on expert opinion and experience. The ASP of each practice was assessed based on the evaluations and discussion with the experts. The three case study reports can be found in Appendices 5, 6 and 7.

4.2 Results and discussion

For the case study on control of codling moths in apple orchards, 19 relevant practices were identified (Figure 4), with the majority and highest rated ASP belonging to IPM principle 4. Biological, physical and non-chemical methods.

In the case of control of powdery mildew in grapes, 22 relevant practices were identified (Figure 4), with the majority (6/22) and the highest rated ASP belonging to both IPM principle 1. Prevention and suppression and principle 4. Biological, physical and non-chemical methods.

Regarding the case study on control of weeds in grain crops, 43 relevant practices were identified (Figure 4), with a majority of 7 highly rated ASP practices belonging to IPM principle 1. Prevention and suppression. IPM principles 2. Monitoring and 4. were also included in highly rated ASP practices.

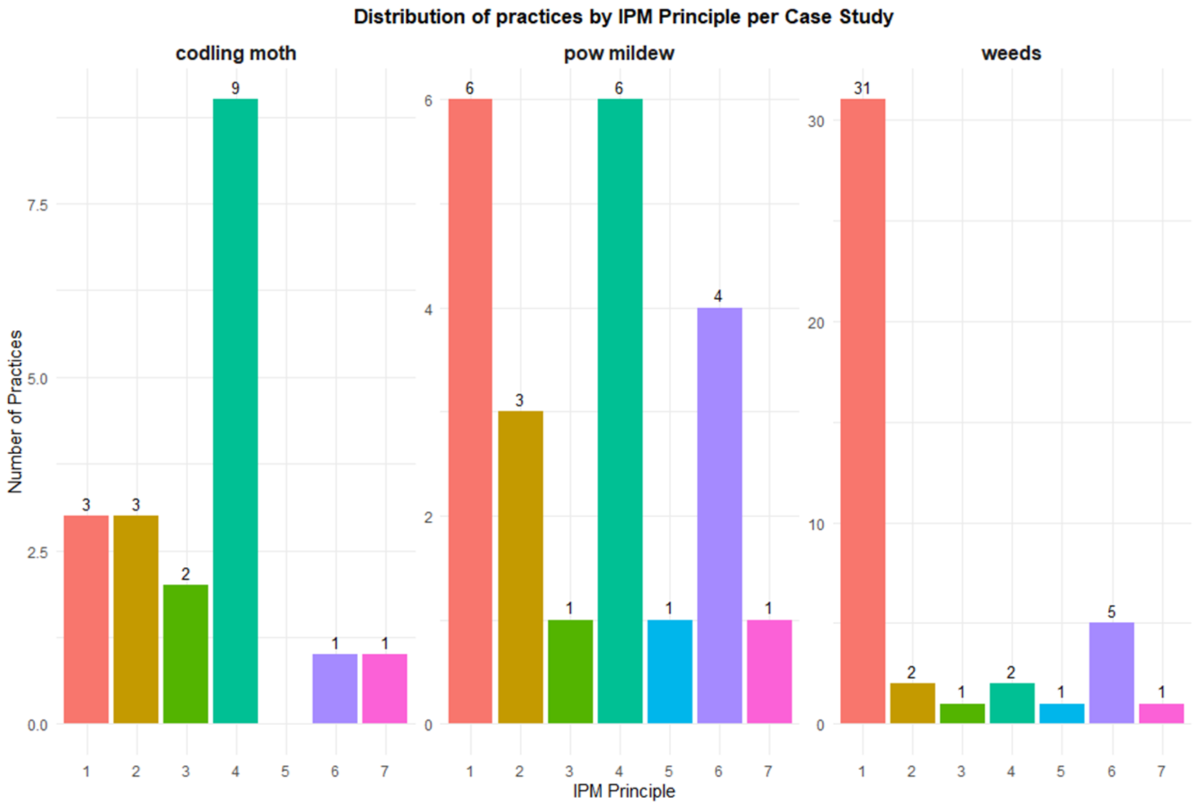

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Figure 4. Number of best practices according to their IPM Principle (1 to 7), for case studies on Control of codling moth in apple orchard, control of powdery mildew in grape vine and control of weeds in grain crops. Bars represent the number of best practices, colours indicate the IPM Principle.

The ASP and IASP ratings were carried out by three partner institutes, based on experts available to the consortium, and show the need for a better understanding of the effects of combinations of practices on the reductions in pesticide use that can be achieved. Figure 5 shows a slightly variable interpretation among the partners, but all of them classify the practices to be used in combination as such: the ASP vs IASP figure shows roughly the same core distribution of practices.

The IASP is used to sort the practices according to the benefits of adding them depending on the local context of a country; it therefore varies from state to state. Its rating shows the importance of detailed knowledge of reference systems by country and usage to illustrate the specific benefits of the practice.

See the precise practices and their notations for the three case studies in Appendices 5, 6 and 7.

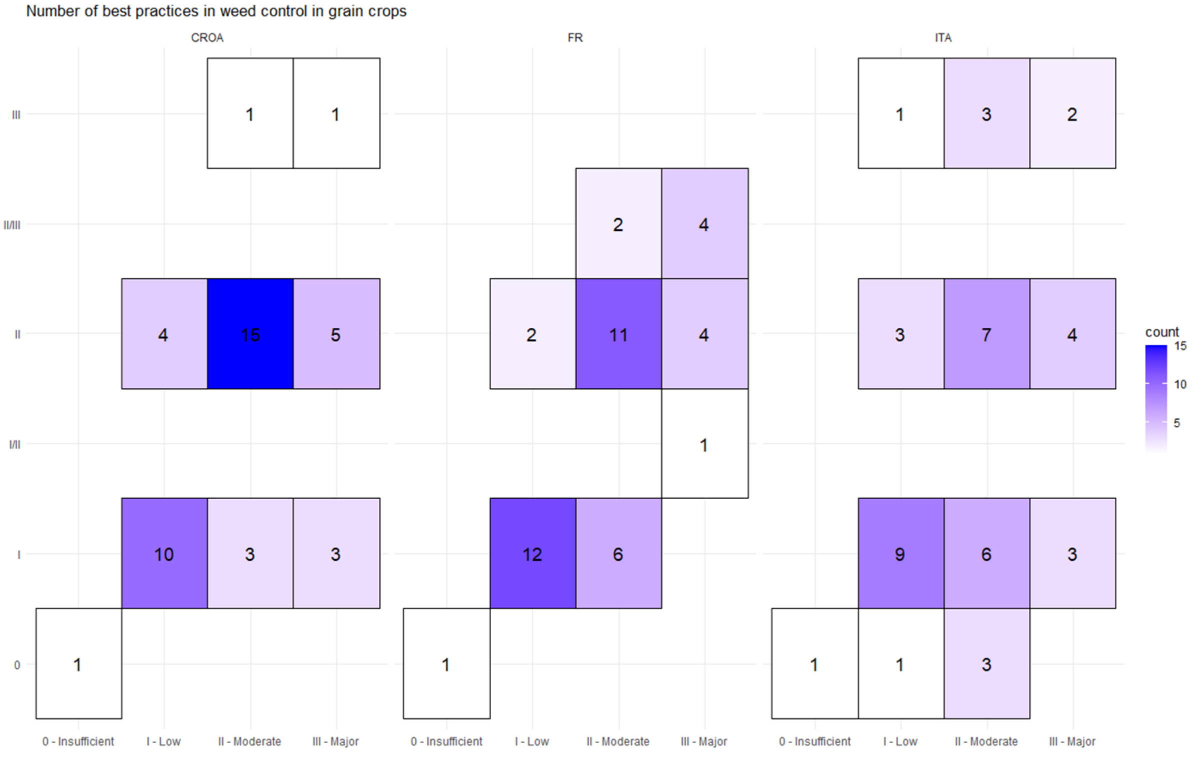

Figure 5. Number of best practices and their respective combinations of Agronomic Service Provided score (ASP) vs. Improvement of Agronomic Service Provided score (IASP) for the case study of Weed control in grain crops in Croatia, France and Italy.

On the x axis, ASP levels are 0 - Insufficient, I - Low, II - Moderate and III - Major

On the y axis, IASP levels are, 0 - Insufficient improvement, I - Low Improvement, II- Moderate Improvement, and III - Major Improvement, with the addition of mid-levels I/II - between Low and Moderate Improvement and II/III - between Moderate and Major Improvement. The color gradient represents the count of practices in each ASP/IASP combination.

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4.3 Limitations

The partners encountered the following limitations when completing this task that are listed below. One of the main limitations encountered was the selection of the most representative case studies to capture the broadest possible range of practices. It proved challenging to identify which individual practices contributed most significantly or to evaluate them in isolation. **This is because the effectiveness of these practices largely depends on their combined implementation within an integrated system**. Therefore, future research would benefit from identifying and quantifying combinations of practices that, when applied together, offer the greatest contribution to achieving the highest ASP.

Conclusions and prospects beyond the Agrowise project

The Agrowise project formed a basis for future work on integrating a harmonised completed IPM taxonomy into the efforts of reaching pesticide reductions in agriculture.

During the project, collaborations with the JRC have been initiated to use Agrowise taxonomy in the actual online tool of the “best practice IPM toolbox”. It could be used as a sorting tool allowing users to quickly find all the practices linked to a farming strategy. The JRC confirms that it is technically possible to upgrade the toolbox. We are building a web interface showing the possible links between the IPM taxonomy, the items present in the JRC toolbox and the European and national projects’ data on IPM practices.

We presented the taxonomy to policy makers, stakeholders and experts both in the Agrowise project and beyond (e.g. Cost Action). We received positive feedback (draws a link between IPM general principles and field actions, provide a structured list of plant protection actions) and believe that a promotion of this taxonomy to all member states/representatives will facilitate and improve uptake of IPM due to increased possibilities of all actors to operationalise IPM using the taxonomy. The different layers will facilitate communication and unify the level of resolution addressed when talking about different IPM practices.

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Appendices

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Appendix 1 : Procedure for collecting relevant projects

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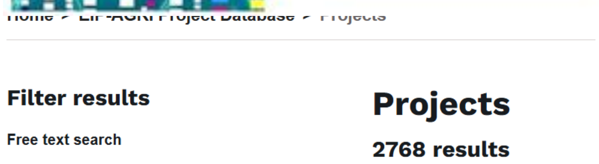
Description of the process for relevant project selection

The project selection was carried out in three stages:

1. Selection of European Horizon projects (including Horizon 2020, Horizon Europe 2021, FP7)
2. Selection of EIP-AGRI projects
3. Selection of national projects (made by each country individually)

Methodology description for projects in 1 and 2 category

Step 1: Database collection
The lists of European projects were downloaded from the CORDIS and EU-CAP-NETWORK websites.



This resulted in over 70,000 projects from all fields (IT, medicine, astronomy, etc.), from which we had to select those relevant to the IPM domain.

To make the work easier, the projects were grouped into multiple Excel files.

In this stage, the team conducted an additional review to fill in any missing project information. Some identified projects lacked an acronym, full title, or detailed description, requiring some research.

To verify and complete the data, we used the CORDIS website and other available online resources, searching by project name or acronym. This process ensured that all projects included in the analysis were fully documented, minimizing the risk of missing relevant information.

Step 2: Identifying relevant projects for IPM.

We proposed a list of keywords that was used to identify projects containing one or more of these terms in their title or description.

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To ensure an efficient and project filtering process, we proposed a set of primary keywords. This list was systematically expanded by adding additional terms that reflect various aspects of each primary concept. Primary Keywords: IPM (Integrated Pest Management), Agroecology, Pesticide reduction, Crop protection.

These primary keywords were chosen to represent the essential areas of interest for project filtering. For each primary keyword, the list was expanded by adding relevant secondary terms to cover the specific topics. We created a final complete list of keywords and used it for filtering the projects. This list, presented below, was periodically reviewed to add new terms.

IPM (Integrated Pest Management)	Agroecology	Pesticide reduction	Crop protection
Sustainab	Agroecology	Minimal pesticid	Pest manage
Prevent	Sustainab	Biological control	Biological control
Monitor	Ecolog	Organic farm	Chemical control
Biological control	Biodivers	Non-chemical	Integrated strateg
Chemical control	Resilien	Prevent	Sustainab
Cultural method	Soil health	Crop rotation	Monitor
Economic efficien	Community-based	Integrated manage	Prevent
Environmental safet	Cultural pract	Pest resist	Resilien
Risk reduct	Nutrient cycl	Environmental safet	Soil health
Ecological pract	Agroforestr	Ecological pract	Crop rotation
Integrated manage	Polycult	Risk reduct	Trap crop
Pest resist	Ecosystem servic	Trap crop	Beneficial insects
Continuous evaluat	Traditional knowledge	Beneficial insects	Companion plant
Long-term strateg	Participatory research	Companion plant	Cultural pract
Minimal intervent	Regenerat	Cultural method	Resist manage
Biodiversity protect	Perennial crop	Monitor	Non-chemical
Habitat manage	Synerg	Soil health	Ecological safet
Advanced technolog	Conservat	Economic efficien	Economic efficien
Adaptab	Food sovereignt	Sustainab	Risk reduct
Education and train	Resilien	Alternative method	Environmental protect
IPM	Climate adapt		
Integrated Pest Management			
Prevention and suppression			
Prevention			
Suppression			
beneficial organism			
Cultivation technique			
Pest monitoring			
Decision-making			

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Pesticide selection			
Reduced pesticide use			
Anti-resistance strategies			
impact evaluation			
beneficial			
diagnostic tool			
crop			
Thresholds			
Warning system			
Forecast prognosis system			
Modelling			
Physical measure			
Biotechnical measure			
pesticide timing			
pesticide mixture			
precision agriculture			
Spraying techniques			
Environmental assessment			
Economic assessment			
Societal assessment			
pest and disease			
Modeling			

The next step in the filtering process was applying the keyword list to identify relevant projects. To automate this task, we used the following Excel formulas, allowing us to check each project for the presence of the specified keywords:

The formula used to determine whether a project contains one of the keywords was:

=ARRAY_CONSTRAIN(ARRAYFORMULA(IF(SUMPRODUCT(--ISNUMBER(SEARCH(Keywords!$A$2:$A$406, Q2))) >0, "Contains Keyword", "No Keyword")), 1, 1)

This formula allows for the automatic identification of projects that include keywords from the defined range and returns 'Contains Keyword' if at least one keyword is found, or 'No Keyword' otherwise.

To detail which specific keyword was found in each project, a similar formula was used:

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```
=ARRAY_CONSTRAIN(ARRAYFORMULA(TEXTJOIN(",",TRUE,IF(ISNUMBER(SEARCH(Keywords!$H$2:$H$406,Q4)),Keywords!$H$2:$H$406,""))), 1, 1)
```

This returned the keyword(s) detected in each project.

In the project files, the relevant projects to IPM (the ones containing keywords) were marked in green, while non-relevant projects were marked in red.

The compilation of all projects along with the results of the keywords search are present in the following produced datasets:

CORDIS: https://doi.org/10.57745/ZVBCKR

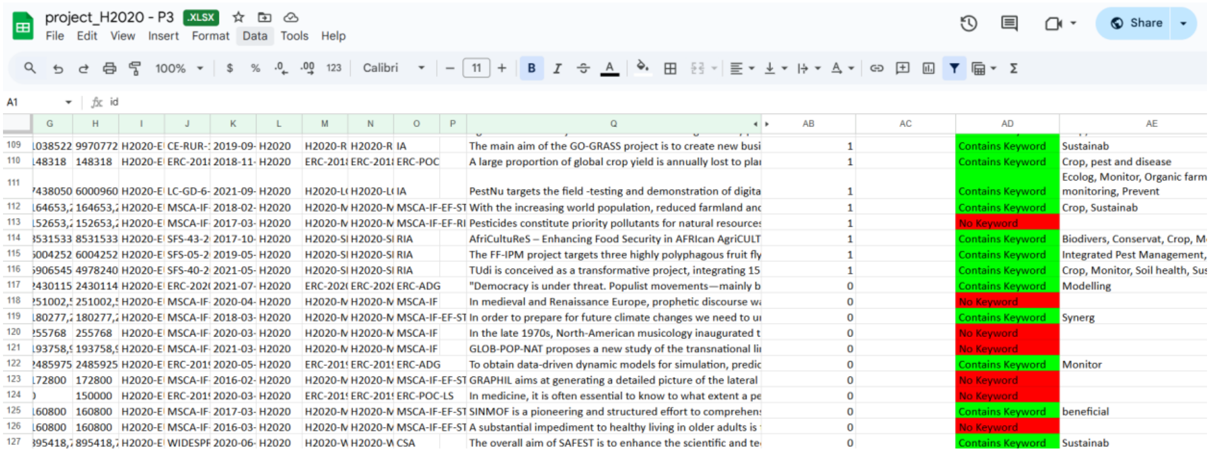
EU-CAP-NETWORK: https://doi.org/10.57745/BFZTRU

Step 3: Reviewing all projects.

The files were manually reviewed as follows:

- We read the descriptions of the 'green' projects (containing keywords) carefully. If they addressed IMP-related topics, they were marked with a **'1'** in a new column.
- The descriptions of the 'red' projects (without keywords) were briefly scanned. Since these were the majority, a large number of projects could be quickly reviewed by skimming their summaries and eliminating those from unrelated fields. These were marked with a **'0'**.

There were very few cases where a project without keywords had an IPM-related topic, in which case it was marked with **'2'**.



	G	H	I	J	K	L	M	N	O	P	Q	AB	AC	AD	AE
109	1038522	9970772	H2020-E	CE-RUR-:	2019-09-	H2020	H2020-R	H2020-R	IA		The main aim of the GO-GRASS project is to create new busi	1		Contains Keyword	Sustainab
110	148318	148318	H2020-E	ERC-201	2018-11-	H2020	ERC-201	ERC-201	ERC-POC		A large proportion of global crop yield is annually lost to pla	1		Contains Keyword	Crop, pest and disease
111	7438050	6000960	H2020-E	LC-GD-6-	2021-09-	H2020	H2020-L	H2020-L	IA		PestNu targets the field -testing and demonstration of digita	1		Contains Keyword	Ecolog, Monitor, Organic farm monitoring, Prevent
112	164653,2	164653,2	H2020-E	MSCA-IF-	2018-02-	H2020	H2020-M	H2020-M	MSCA-IF-EF-ST		With the increasing world population, reduced farmland anc	1		Contains Keyword	Crop, Sustainab
113	152653,2	152653,2	H2020-E	MSCA-IF-	2017-03-	H2020	H2020-M	H2020-M	MSCA-IF-EF-RI		Pesticides constitute priority pollutants for natural resources	1		No Keyword	
114	8531533	8531533	H2020-E	SFS-43-2	2017-10-	H2020	H2020-SI	H2020-SI	RIA		AfriCultuReS – Enhancing Food Security in AFRIcan AgriCULT	1		Contains Keyword	Biodivers, Conservat, Crop, M
115	6004252	6004252	H2020-E	SFS-05-2	2019-05-	H2020	H2020-SI	H2020-SI	RIA		The FF-IPM project targets three highly polyphagous fruit fly	1		Contains Keyword	Integrated Pest Management,
116	5906545	4978240	H2020-E	SFS-40-2	2021-05-	H2020	H2020-SI	H2020-SI	RIA		TUdi is conceived as a transformative project, integrating 15	1		Contains Keyword	Crop, Monitor, Soil health, Sus
117	2430115	2430114	H2020-E	ERC-202	2021-07-	H2020	ERC-202	ERC-202	ERC-ADG		"Democracy is under threat. Populist movements—mainly b	0		Contains Keyword	Modelling
118	251002,5	251002,5	H2020-E	MSCA-IF-	2020-04-	H2020	H2020-M	H2020-M	MSCA-IF		In medieval and Renaissance Europe, prophetic discourse wa	0		No Keyword	
119	180277,2	180277,2	H2020-E	MSCA-IF-	2018-03-	H2020	H2020-M	H2020-M	MSCA-IF-EF-ST		In order to prepare for future climate changes we need to u	0		Contains Keyword	Synerg
120	255768	255768	H2020-E	MSCA-IF-	2020-03-	H2020	H2020-M	H2020-M	MSCA-IF		In the late 1970s, North-American musicology inaugurated t	0		No Keyword	
121	193758,9	193758,9	H2020-E	MSCA-IF-	2021-03-	H2020	H2020-M	H2020-M	MSCA-IF		GLOB-POP-NAT proposes a new study of the transnational li	0		No Keyword	
122	2485975	2485925	H2020-E	ERC-201	2020-05-	H2020	ERC-201	ERC-201	ERC-ADG		To obtain data-driven dynamic models for simulation, predic	0		Contains Keyword	Monitor
123	172800	172800	H2020-E	MSCA-IF-	2016-02-	H2020	H2020-M	H2020-M	MSCA-IF-EF-ST		GRAPHIL aims at generating a detailed picture of the lateral	0		No Keyword	
124	)	150000	H2020-E	ERC-201	2020-03-	H2020	ERC-201	ERC-201	ERC-POC-LS		In medicine, it is often essential to know to what extent a pe	0		No Keyword	
125	160800	160800	H2020-E	MSCA-IF-	2017-03-	H2020	H2020-M	H2020-M	MSCA-IF-EF-ST		SINMOF is a pioneering and structured effort to comprehen	0		Contains Keyword	beneficial
126	160800	160800	H2020-E	MSCA-IF-	2016-03-	H2020	H2020-M	H2020-M	MSCA-IF-EF-ST		A substantial impediment to healthy living in older adults is	0		No Keyword	
127	895418,7	895418,7	H2020-E	WIDESPF	2020-06-	H2020	H2020-W	H2020-W	CSA		The overall aim of SAFEST is to enhance the scientific and te	0		Contains Keyword	Sustainab

This activity took several weeks to complete.

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Note: We conducted a parallel project selection using the ChatGPT LLM. However, manual selection proved to be more suitable, despite taking a long time. The selection made by ChatGPT included many general projects that would have needed to be manually filtered out later.

The projects directly resulting from this selection are published as a dataset here: https://doi.org/10.57745/PPZDY9, and just below as a unified definitive version.

Step 4: Creating the final list of selected projects.

A new set of Excel files was created, from which the irrelevant projects were removed, leaving only those marked with **'1'** or **'2'**. The final list was then created by concatenating these files. Duplicate projects were eliminated (based on the acronym and after manual verification to ensure they were not different projects).

After analysis, consolidation, and duplicate removal, we obtained a list of 965 projects with the potential to have useful practices.

The resulting table of the list of relevant European projects can be found here: https://doi.org/10.57745/7CDK75.

Step 5: Assigning the projects for identifying practices.

We duplicated the previous file in another working folder "Practices", and added two columns (Member and Observations).

This was done for assigning projects to team members and starting the search for IPM practices.

For identifying practices, each team member assigned a set of projects to analyze. The search for practices is conducted in the project deliverables, articles, reports, etc., which are available on the project's website, partner institutions, and European institution websites.

Each member identifies the practices, records them in their own file, following the proposed taxonomy. The file is then uploaded to their personal folder.

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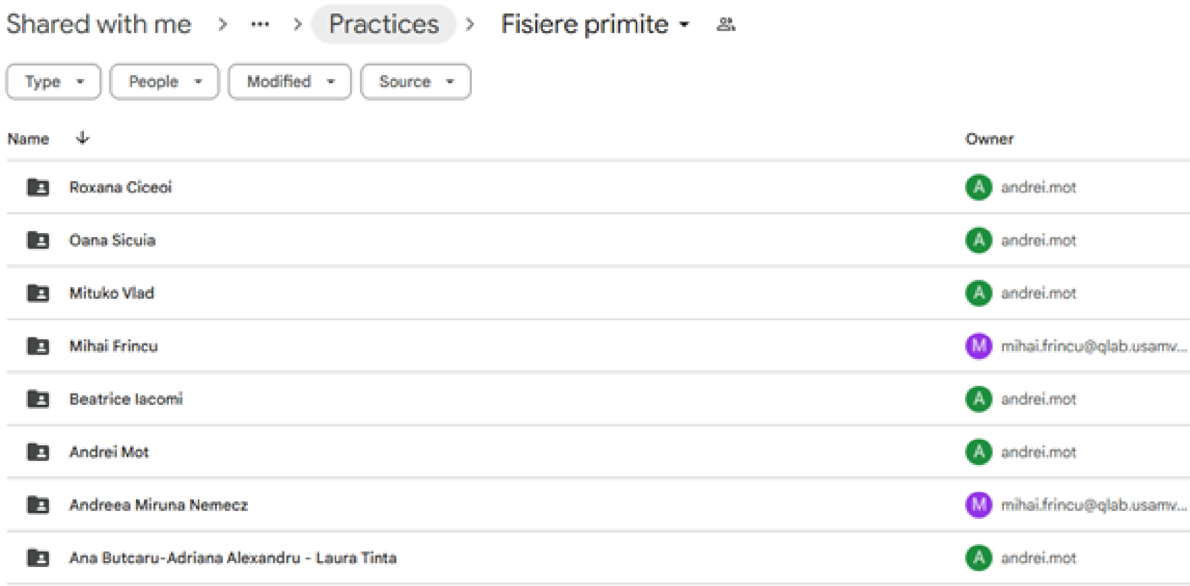


Shared with me > ··· > Practices > Fisiere primite

Name	Owner
Roxana Ciceoi	andrei.mot
Oana Sicuia	andrei.mot
Mituko Vlad	andrei.mot
Mihai Frincu	mihai.frincu@qlab.usamv...
Beatrice Iacomi	andrei.mot
Andrei Mot	andrei.mot
Andreea Miruna Nemecz	mihai.frincu@qlab.usamv...
Ana Butcaru-Adriana Alexandru - Laura Tinta	andrei.mot

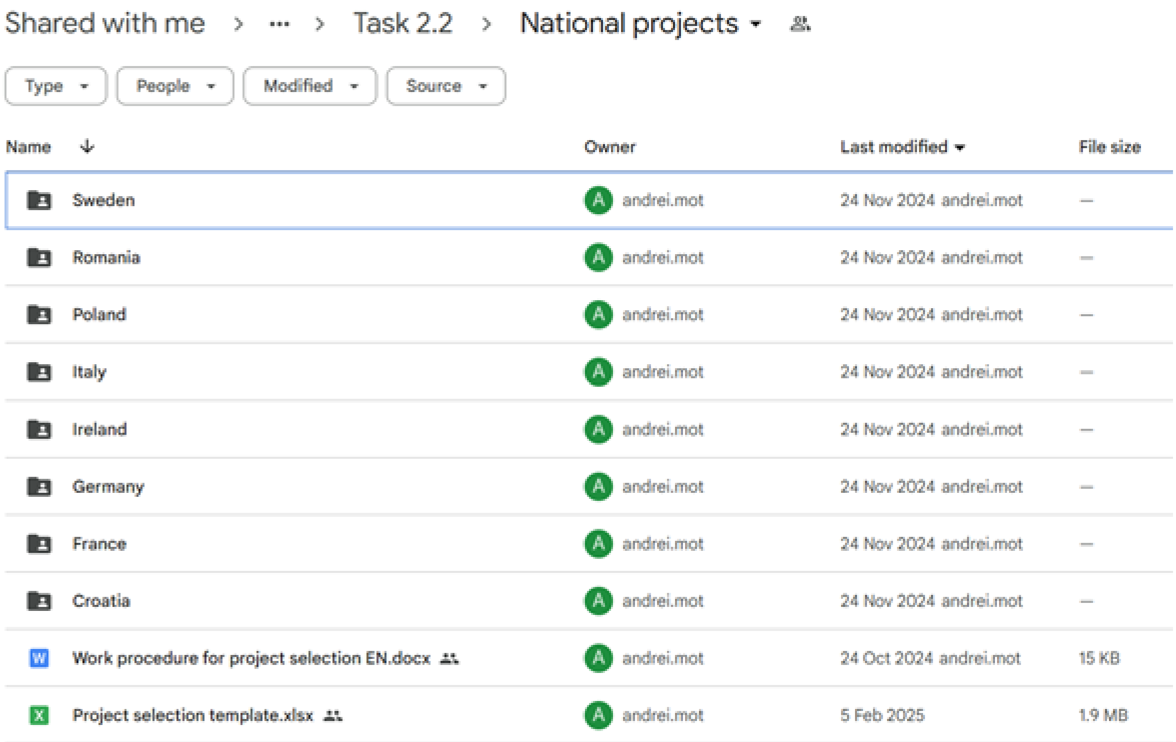
Note: Only a small number of these projects focused on IPM practices, while the majority addressed other agronomic topics.

Step 6. The extended search process to national projects.

We proposed the same approach outlined above to the partners for the lists of national projects.

A folder called **"National projects"** was created for this purpose.

In this process, each country has its own folder to upload the list of relevant national projects.



Shared with me > ··· > Task 2.2 > National projects

Name	Owner	Last modified	File size
Sweden	andrei.mot	24 Nov 2024 andrei.mot	—
Romania	andrei.mot	24 Nov 2024 andrei.mot	—
Poland	andrei.mot	24 Nov 2024 andrei.mot	—
Italy	andrei.mot	24 Nov 2024 andrei.mot	—
Ireland	andrei.mot	24 Nov 2024 andrei.mot	—
Germany	andrei.mot	24 Nov 2024 andrei.mot	—
France	andrei.mot	24 Nov 2024 andrei.mot	—
Croatia	andrei.mot	24 Nov 2024 andrei.mot	—
Work procedure for project selection EN.docx	andrei.mot	24 Oct 2024 andrei.mot	15 KB
Project selection template.xlsx	andrei.mot	5 Feb 2025	1.9 MB

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Initially, we proposed to work on a shared file with multiple sheets, one for each country.

Subsequently, this file was moved to each country's folder, and the sheets for the other countries were removed.

The description of the working process for partners to select relevant national projects can be found here:

To make the work easier, it is recommended that you bring your own project list into the template format (if you don't have all the required data, you can leave the columns empty, but the table headers must be respected).

- We used a list of keywords from the 'Keywords' sheet in the 'Project selection template.xlsx' file to filter the projects containing one or more keywords in their descriptions.
- After filtering, we obtained a list of projects containing keywords. If keywords were found, column X returned "Contains keywords" or "No keywords" if none were found.
- In column Y, the keywords found in the description are listed.
- X and Y columns are generated automatically if you paste the formula from any of the columns above;
- This list needs to be reviewed to confirm the filtering (we marked these projects with indicator '1'). To ensure no relevant projects were missed, we also checked the projects that did not contain keywords in description and marked them with indicator '2' (selected without keywords).
- Irrelevant projects have no indicator.
- Next, we removed the projects without indicators (irrelevant for IPM) and obtained a shortlist of projects from which we will extract the practices.

The practices will be classified according to the taxonomy we agreed upon.

Each project may contain one or more practices, which will be added to each country's list of practices, and at the end, a common list with all the collected practices will be created.

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Appendix 2 : Procedure for collecting plant protection practices

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PROCEDURE FOR COLLECTING PLANT PROTECTION PRACTICES

Edition I, Revision 1

Date 15.02.2025

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TABLE OF CONTENTS

1. Purpose

WP2 aims to harmonise and enrich the IPM toolbox of best practices (https://datam.jrc.ec.europa.eu/datam/mashup/IPM/index.html). The toolbox currently lists over 1300 practices ranging from highly specific (e.g., pheromone control of a specific pest species) to general (e.g., redesign of crop rotation) through to precision farming;
The analysis will focus on two main crop categories:

- 1) Annual field crops. This will enable capturing the situation of all annual crops alone or in rotation with temporary grasslands. This includes 75% of the European Arable land and 80% of the pesticide use (in tonnage).
- 2) Perennial crops, including vineyards and orchards. This will allow us to capture the situation of most perennial crops, where only long-term modifications of the landscape structure are possible. Although these cropping systems are limited in acreage (3% in Europe), they represent 16% of the pesticide volumes.

2. Objectives

Main Objective: Identify IPM and agroecology-based practices, update and enrich the list of best practices by analyzing relevant projects (past and ongoing Horizon projects, national databases, and EIP projects).

Specific objective 1: Relevant projects selection
The list of relevant projects on IPM, crop protection, and agroecology is established as step 1 of Task 2.2.
Results:
The lists of relevant projects across the three addressed directions: European projects & EIP-AGRI projects, and national projects (each country of the consortium with its own list of national projects).

Specific Objective 2: Collection of Practices

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Based on the project lists obtained from **Specific Objective 1**, each project will be analyzed individually to extract IPM practices and classify them according to the taxonomy defined in Task 2.1. If no suitable category is found, a new one will be proposed and reviewed if necessary.
Results:
The practice lists were identified, analyzed, and then classified according to the taxonomy for the three project categories: European, EIP-AGRI, and national projects.
See the results here https://doi.org/10.57745/LOZHYX.

3. Definitions and abbreviations

Collecting IPM practices considers 26 descriptors (see the table below). The main part of them are from the initial IPM Toolbox - IPM best practices (https://datam.jrc.ec.europa.eu/datam/mashup/IPM_BEST_PRACTICES/) completed and structured as a result of the process of analyzing, debate and concluding for the optimized set of information.
The descriptor set includes the ESR (Efficiency - Substitution - Redesign) concept defined in Task 2.1 of WP2 in the project.

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No.	Descriptors	Definition
1	Crop category	Aggregate crops, in accordance with the project target, are classified as: a. Annual crop, including grassland, b. Perennial crops, including vineyards and orchards
2	Crop	A plant or a plant product that is part of the above crop categories. Annual crops will thus include cereals (such as wheat, barley, maize, rice, triticale, sorghum etc), pulses, roots and tubers (sugar beets and potatoes); oil crops, fiber crops and fodder crops. Vegetables are excluded.
3	Production system	Agricultural production systems comprise multidimensional components and drivers that interact in a complex way in which a farmer uses available resources to create goods and services for sustainable production. In the context of the IPM Tool, the production system refers to open fields or protective space.
4	ESR	The ESR (Efficiency-Substitution-Redesign) model allows for grouping crop protection practices according to their ability to act on environmental aspects/redesign the system involved. **E** - stands for practices aimed at increasing the Efficiency of pesticide application, **S** - for practices substituting pesticide use, and **R** - for practices aimed at redesigning cropping systems. There are also intermediate variants for the practices, namely **E/S** - Efficiency/Substitution and **S/R** - Substitution/ Redesign
5	IPM-principle	Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to the prevention and/or suppression of organisms harmful to plants that relies on available information, tools and methods on the life cycles of pests and their interaction with the environment. Eight principles, following prevention, monitoring, methods and tools, pesticide selection and evaluation, are first formulated in Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009, Annex III.
6	Layer 1 (target)	The first of the hierarchical layers of the systematization of IPM practices (in the ESR paradigm) carried out within the Agrowise project describes the target of adapted management. This serves as a general descriptor of families of practices that fall under the same target, highlighting the practical aspect of IPM.
7	Layer 2 (strategy)	The second of the hierarchical layers of the systematization of IPM practices describes the IPM practices and strategies for suppressing pests. This layer refines the description of the management target, explaining how the practices are used instead of or to reduce pesticides.
8	Layer 3 (practice)	The third of the hierarchical layers of the systematization of IPM practices describes the IPM practices *per se*. This

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9		layer is intended to be specific yet adaptable to the context of different member states and specific conditions at different locations.
9	Layer 4 (conditions)	The fourth of the hierarchical layers of the systematization of IPM practices describes the differences in options within layer three practices. This layer will add specifics to practices and refine the differentiation between different modes of action.
10	Practice description	This is a summary of the information that provides a specific pest and disease control solution, according to IPM principles, that can be used in the field or protective space for the specific crop mentioned.
11	Current level of development	It defines the level at which an IPM practice is applied, depending on its maturity, validation, and regulatory approval. This ranges from experimental research to full-scale farm implementation.
12	Level of benefit (1-5)	It estimates the actions' impact, ranking from localized to ecosystem-wide benefits.
13	Implementation cost (list to choose)	Costs related to the development and execution of the technical implementation strategy targeting the specific evidence-based interventions (e.g. analysis, planning, development, machinery costs, labour, and input costs).
14	Potential economic impact (list to choose)	It varies by adoption level and time frame, ranging from short-term farm-level benefits (cost savings and yield improvements) to long-term economic benefits (agriculture resilience, trade competitiveness, food security, and environmental sustainability).
15	Impact indicators (Climate, Biodiversity, Natural resources)	Estimating an IPM practice impact within the CAP framework (Climate, Biodiversity, and Natural Resources) to help monitor and optimize IPM contributions to sustainable agriculture.
16	Where it was tested	Country/ where the practice was developed/tested in controlled environments/ validated or adopted (implemented on farms).
17	Region, GPS	Area/ region where the practice was tested/ implemented. Where possible - GPS coordinates should be included.
18	When was tested/analyzed	The period specified in the project when the practice was developed/ tested/ implemented.
19	Best practice link	The specific web link for the practice (can be an individual website/ article/ etc.).
20	Project acronym/ Article/ …	The acronym of the project, as specified in the documents
21	Project link	Project website
22	Partner Data Operator/ Who introduced the data - Partner (list to choose)	The project partner acronym is the team that filled in the practice. In the end, there will be a database with all the practices.
23	Team Member Data Operator Who	Name and surname of the person who introduced the respective practice (from the partner team identified at 22)

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	introduced the data - Team Member name	
24	Verified	The initial/ identification of project team members that verified the original information included in the document (in some teams, it is possible to be double-checked).
25	Other countries/regions where the practice was tested	It helps assess the **practice's scalability, adaptability, and effectiveness** across different climatic zones, agricultural systems, and socio-economic conditions. It will be completed in the end, when similar practices will be combined in one, adding the country/region where they were also tested/ implemented.
26	Observations	If any

4. Best Practices Database Entry

No.	Descriptors	Categories	How to fill in
1	**Crop category**	Annual field crop (including grassland); Vineyards; Orchards. All	Select one of the options: Annual field crop (including grassland); Vineyards; Orchards. All (some practices are available for all of them)
2	**Crop**		Enter the crop (text) to which the practice applies.
3	**Production system (list to choose)**	open field greenhouses both	Choose one of the production systems from the list
4	**ESR (list to choose)**	E E-S S S-R R	Choose the ESR scale, where E stands for practices aimed at increasing the Efficiency of pesticide application, S for substituting pesticide use, and R for practices aimed at redesigning cropping systems. The practices have intermediate variants, **E/S** - Efficiency - Substitution and **S/R** - Substitution - Redesign.
5	**IPM-principle**	1-8	Choose one of the eight principles. You cannot add a new principle.
6	**Layer 1 (list to choose) (target)**	Separate file taxonomy (see link)	Target Layer 1 describes a broad set of practices that aim to change a common management target. It is a general descriptor for practices that target crop selection, biotechnical control, or physical pest control in the field. Try to find one that fits the practice. The addition is possible, but it will lead to changes that may affect the rows already entered. If you don't find a suitable layer, write it down and discuss the necessity of adding it. See **notes** at the end of the table.

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No.	Descriptors	Categories	How to fill in
7	**Layer 2 (list to choose)(strategy)**	Separate file taxonomy (see link)	Strategy Layer 2 adds a strategic description to the practices. For example, for the layer 1 practice of physical control, this layer specifies whether the control is achieved through physical barriers preventing pests from entering the crop or if machinery is used, such as for mechanical weeding. Try to find one that fits the practice. The addition is possible, but it will lead to changes that may affect the rows already entered. If you don't find a suitable layer, write it down and discuss the necessity of adding it. See **notes** at the end of the table.
8	**Layer 3 (list to choose) (practice)**	Separate file taxonomy (see link)	Practice Layer 3 describes the families of practices. To continue with the previous examples, a layer 3 descriptor for physical barriers could be using nets to protect crops from pests. For mechanical control, a specific practice in layer 3 might be mechanical weeding. Try to find one that fits the practice. The addition is possible, but it will lead to changes that may affect the rows already entered. If you don't find a suitable layer, write it down and discuss the necessity of adding it. See **notes** at the end of the table.
9	**Layer 4 (list to choose) (conditions)**	Separate file taxonomy (see link)	Conditions Layer 4 describes conditions within the layer 3 practices and adds further details within each "family of practices" specified in layer 3. For instance, if the target (layer 1) of implementing IPM is crop selection and the strategy (layer 2) is changing varietal diversity, and layer 3 specifies the use of resistant cultivars, then layer 4 can differentiate between using mixtures or monocultures of resistant cultivars. Try to find one that fits the practice. The addition is possible, but it will lead to changes that may affect the rows already entered. If you don't find a suitable layer, write it down and discuss the necessity of adding it. See **notes** at the end of the table.
10	**Practice description**	See the information below this table	Describe the practice (see below the protocol)
11	**Current level of development (list to choose)**	Research Tested Implemented	Select the current level of development between Research (similar TRL 1-3) Tested (similar TRL 4-6)

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No.	Descriptors	Categories	How to fill in
			Implemented (similar TRL 7-9)
12	**Level of benefit (1-5)**	not fill	Please do not fill it – it will be calculated from another perspective (2.4)
13	**Implementation cost (list to choose)**	not fill	Please do not fill it – it will be calculated from another perspective (2.4)
14	**Potential economic impact (list to choose)**	not fill	Please do not fill it – it will be calculated from another perspective (2.4)
15	**Impact indicators (Climate, Biodiversity, Natural resources)**	Climate Biodiversity Natural resources	Select the impact indicator.
16	**Country (where it was tested)**	Name of the country from the project description	Enter the country where the practice was tested.
17	**Region (where it was tested), GPS**	Name of the project from the project description	Please enter the region (name, cardinal direction, GPS coordinates etc.) where the practice was tested.
18	**The period when it was tested/ analysed**	ex. January 2023 - March 2024 or 2023 - 2024 or 01.01.2023 - 15.03.2024 or similar	Enter the period during which the practice was tested.
19	**Best practice link**	Http link	Enter the address where the practice is presented (link/DOI/ISSN/etc.)
20	**Project acronim/ Article/ …**	text	Enter the project acronym or the article name
21	**Project link**	Http link	Enter the project link.
22	**Who introduced the data - Partner (list to choose)**	The acronym, according to the Agrowise project description.	Select the partner who introduced the practice.
23	**Who introduced the data -Team Member name**	Initials or name and surname.	Enter the name of the person who introduced the practice.
24	**Verified**	Initials or name and surname.	Enter the name of the person who verified the practice.

Note 1. Where a new layer is proposed, all the upper layers must be completed with applicable values. For example, for proposing a Layer 3, it must be completed up to Layer 2 (i.e. IPM principle, Layer 1, Layer 2), while Layers 3 and 4 will remain empty. In the 'Observations' column, the following should be added: Layer 3: 4.4.1.4. Antimicrobial peptides, Layer 4: Replace traditional antibiotics.

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Note 2. If an upper layer is proposed (i.e., 1, 2, or 3), you must provide at least one proposal for all subsequent sub-layers as well. For the IPM principle, it is unlikely that proposals or modifications are needed.

Note 3. This list of proposals will be sent to the other partners for review. If their necessity is confirmed, the new layers will be added in the taxonomy.

Note 4: Pay close attention to layer numbering:

- Layer 1: consists of two digits and the name (x.x. Layer 1 Name).
- Layer 2 consists of three digits and the name (x.x.x. Layer 2 Name).
- Layer 3 consists of four digits and the name (x.x.x.x. Layer 3 Name).
- Layer 4 contains only the description.

5. Practice description

Very short title (max. 10-15 words) + Description (Maximum length = 250 words).

The practice description should provide specific details about the innovation, activity, or appropriate aspects of IPM, crop protection or agroecology.

When writing the synthesis, consider that you are communicating with a consultant or farmer, offering clear guidance on the identified best practice. Detailed information can be found in the links in the table's right column (best practices link/project link).

Maximum length = 250 words

For example:

1. **Living mulch system.** Over three years, at three locations and with rotating crops, at **cereals (wheat, oat, maize, barley, field bean, rape)**, a cultivation variant using clover as a permanent living mulch was compared to a variant without clover. Yield difference compared to conventional farming was cut to a third, while nutrient losses and use of fertilizers were minimized. **Results**: (1) Lower greenhouse gas emissions through reduced and more efficient use of production resources. (2) Enhanced soil health and biodiversity conservation by implementing a living mulch system. (3) Improved water retention and erosion control, contributing to environmental sustainability, also through reduced use of additional nutrients as documented in nitrogen reduction experiment. (4) Increased cost-effectiveness for farmers through lower input requirements and improved crop resilience. (5) Yield difference to conventional farming significantly lowered from 30-40% (as applicable to ecological farming) in the first year to 10-14% in the third. (6) The contribution margin is roughly comparable to conventional farming due to using fewer utilities e.g., diesel, fertilizer, and water. (7) Interesting findings on more sustainable use of pesticides may lead to viable solutions after further research in a different context. (8) Potential for long-term financial savings by adopting innovative and sustainable agricultural methods. (9) Enhanced market competitiveness by aligning with consumer demand for environmentally friendly products.

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2. **Alternative to copper-based fungicides.** Larch extracts derived from the bark of *Larix decidua*, containing active compounds such as larixyl acetate and larixol, offer a sustainable alternative to copper-based fungicides in combating grapevine downy mildew (*Plasmopara viticola*). This practice involves scalable extraction methods using ethanol and ethanol-water mixtures, followed by the formulation of emulsifiable concentrates for easy application. Field tests have demonstrated up to 82% efficacy in reducing disease severity in low-copper strategies, highlighting its potential to reduce copper accumulation in soils, safeguard biodiversity, and maintain soil health.

6. Best Practices Submission and Project Selection Guidelines

- Submission Deadline**:** On the 25th of each month for the files containing best practices contained in the selected projects.
-

Time table

No.	Activity	Deadline	Responsible
1	Monthly collected IPM practices Submission, including double-checking	Monthly/ on the 25th of each month (February, March, April, May)	Each partner/ member of the team working on 2.2. task
2	Monthly update and consolidation of received IPM practices	30th of each month	Andrei Moț
3	Methodology completion (including IPM tools checking, comparative analysis for two countries etc.)	01.03 - 15.03.2025	Ana Butcaru Mituko Vlad Andrei Moț Mihai Frîncu
4	Preparation of the intermediate report on collected practices and applied methodology	01.04 -15.04	Gina Fîntîneru Andrei Moț Mihai Frîncu Ana Butcaru
5	Transmission of the interim report on collected practices and applied methodology to the WP leader	16.04.2025	Ana Butcaru
6	Review and correction of collected practices – Stage II (April - May)	01-15.06.2025	Each partner responsible
7	IPMToolbox Checking	16.06-	Each partner

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No.	Activity	Deadline	Responsible
		15.07.2025	responsible
8	Final report for Task 2.2.	16.07 - 31.07.2025	Gina Fîntîneru Andrei Moț Mihai Frîncu Ana Butcaru
9	Publish database with collected practices in Agrowise	01. 10. 2025	

Additional Notes:

- **'Target Pest' Column:** An extra column for target pests will not be added at this stage. Instead, please include this information within the practice description.
- **Managing very large list of projects**: to ensure coverage across the dataset, we propose the use of a systematic sampling:
    - Select projects at regular intervals (e.g., every 10th project or another random pattern) until the shortlist is filled. This selection can be adjusted throughout the project.
    - Focus on the list of selected projects and extract the best practices to be uploaded to the drive;
    - If the number of practices collected from the extracted sample is reduced, additional projects can be selected from the initial list using the same random pattern.

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Appendix 3 : Procedure for analysing plant protection practices

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Work Package 2: Harmonized and upgraded IPM toolbox with taxonomy of evaluated practices

T.2.2 Upgrade IPM toolbox

(Period for report May 2024 – June 2025)

TABLE OF CONTENTS

Crt.no.	Component name within the procedure

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1. Objectives

The objectives pursued within Task no. 2.2. aimed at:
- Establishing the lists of the most relevant past and ongoing European projects (FP7 and Horizon 2020, Horizon Europe), EIP projects and national projects on crop protection;
- Scrutinizing relevant projects to identify the IPM and agroecology-based practices;
- Enriching the toolbox with new collected IPM practices;
- Contributing to the consolidation of the harmonised taxonomy built in T.2.1. (see annexes with new layers proposals).

2. Databases

2.1. The new entries for the taxonomy database, the results of the project consulting process: Practices that could not be classified under the existing taxonomy have been grouped into proposals for new layers, presented in Appendix 4. Detailed information on the practices assigned to these new layers is available as a table here: https://doi.org/10.57745/8UDFQP.

2.2. Best practices databases extracted from the analysis of the selected projects, split into Horizon/FP7 projects, EIP-AGRI projects and national projects from Agrowise consortium's countries have been published and can be found here: https://doi.org/10.57745/LOZHYX.

The development of the best practices database was based on two core activities: (1) identifying relevant IPM-related projects and (2) extracting practices from those projects. See previous Appendices 1 & 2 to learn about the full procedure, including the project selection methodology and the practice collection process.

3. Normalization of the newly created best-practices database

The best-practices database (BPD) results from the co-creation and collaboration process in the Agrowise team, with different professional backgrounds and topic understanding (which brings a high value in the project results).

3.1. Phase 1. Content validation.

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One regular phase before BPD dissemination is double-checking the records by a plant pathologist and an entomologist team.
They check the information included in the BPD for correct taxonomy placement and a relevant practice synthesis. This is a loop activity until it is done according to the requirements.

3.2. Phase 2. Eliminate potential duplicates.
During the best practices identification process, duplicate entries may occur, although at a low rate.
To address this, a filtering step will be applied at Layer 3 and cross-checked with Layer 4, the best practice content, project name, and thematic area to detect and remove overlaps. If only Layer 4 and the practice content are identical, while the project names or areas differ, one of the entries may be removed — but only after the remaining entry is completed in column Z, indicating that the practice was tested in other countries or regions.

4. Analysis of the BPD
The newly developed databases provide a rich foundation for multiple types of analysis, including the following:
1. **Distribution analysis** of identified best practices by project type: Horizon, national, and EIP-Agri projects.
2. **Taxonomy mapping** of best practices: number of practices assigned to each IPM principle and each individual taxonomy layer (Levels 1–4), both in total and by country. New principles and layers identified require a short descriptive explanation.
3. **Country-specific filter** for Horizon projects, indicating the number of best practices identified in each participating country.
4. **Implementation year filter**, showing how many best practices were identified based on the year of application.
5. **Crop category filter**, reflecting the distribution of best practices across crop groups.
6. **Crop detail analysis**, providing specific species information where available.
7. **Production system filter**, to assess how many best practices are associated with each type of production system.
8. **ESR scale filter**, identifying the number of best practices within each ESR classification.
9. **IPM principle filter**, showing how many best practices correspond to each specific IPM principle.
10. **Layer-specific filters** for Levels 1, 2, and 3, indicating the number of best practices assigned to each taxonomy level.
11. **Development stage filter**, reflecting the current level of maturity or implementation of each best practice.

All 11 analysis criteria are applied both to best practices extracted from European projects (see point 5 below) and those collected from national projects (see point 6 below).

5. Results of the BPD analyses based on the Horizon projects

5.1. Crop category filter (share the best practices identified in each category).

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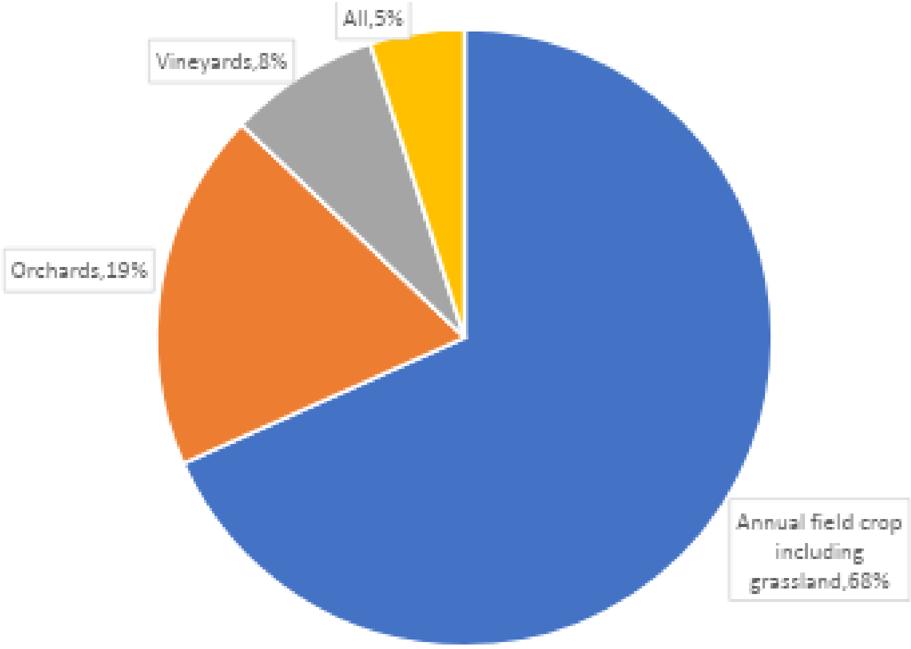

Figure 1. Crop category-wise distribution of practices

The distribution of analyzed practices by crop category reveals a clear predominance of annual field crops, including grassland, which account for 68% of all reported practices. This category significantly outweighs orchards (19%) and vineyards (8%), suggesting a stronger focus on research or implementation in extensive agricultural systems typical of annually cultivated land. The "All" category, representing only 5%, indicates a limited number of practices with general applicability, independent of crop type. This distribution highlights the need to expand further and adapt integrated pest management practices in the fruit and wine sectors, where adoption still appears limited.

5.2. Production system category filter (share the best practices identified in each category).

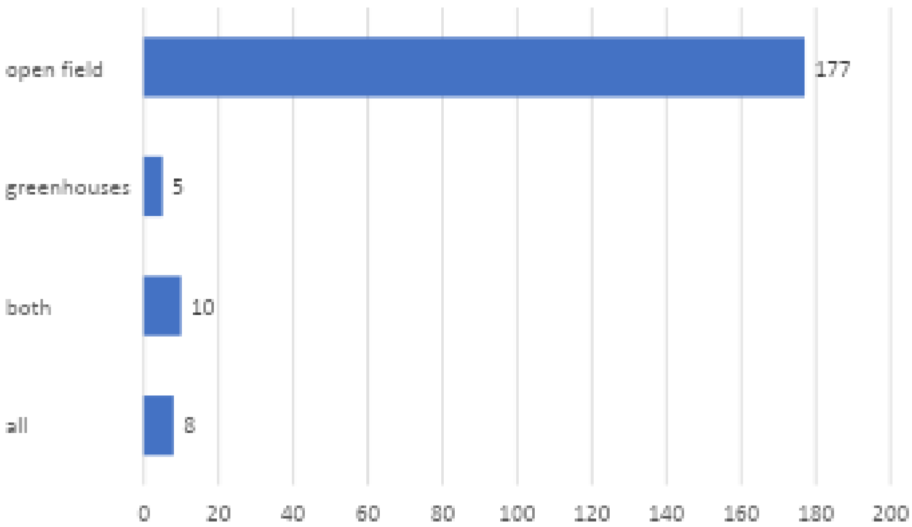

Figure 2. Practice distribution based on a production system

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The distribution of practices by production system shows that most are associated with open-field conditions (177 practices). A smaller number of practices are reported for protected systems such as greenhouses (5 practices), while 10 practices apply to both open-field and protected environments. Additionally, 8 practices are generally applicable, regardless of the production system. This distribution provides an overview of the contexts in which the analyzed practices have been applied, without implying preference or greater effectiveness of one system over another.

5.3. ESR scale filter

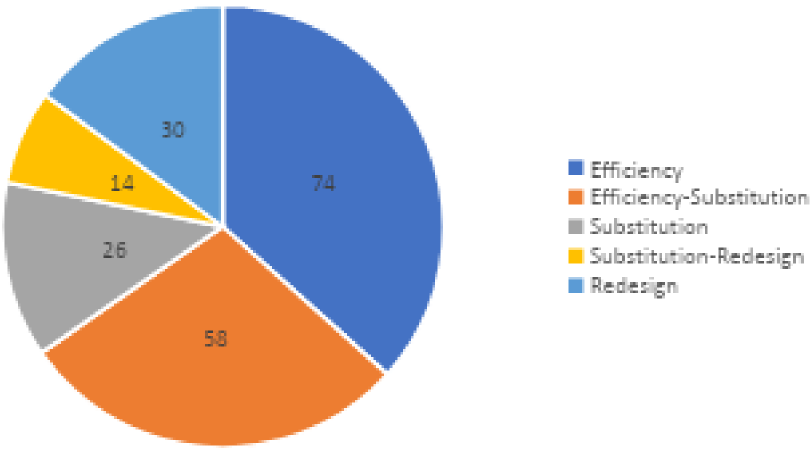

Figure 3. Distribution of practices by ESR scale

The chart shows the distribution of analyzed practices according to their level of intervention on the ESR scale. The highest share corresponds to practices categorized under Efficiency, with 74 entries. These are followed by mixed-category Efficiency–Substitution practices (58) and those strictly within the Substitution level (26). Redesign practices account for 30 cases, while Substitution–Redesign practices number 14. This distribution reflects the diversity of strategic approaches, without implying any hierarchy or prioritization among the levels.

5.4. IPM principle filter

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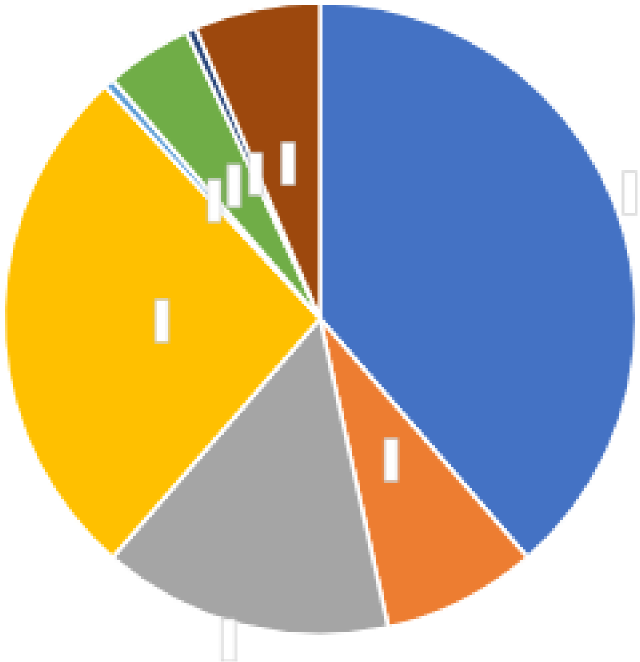

Figure 4. Practices grouped by IPM principles

The distribution of analyzed practices across the eight Integrated Pest Management (IPM) principles reveals a predominant focus on Principle 1 – Prevention and suppression, accounting for 39% of all entries. Principle 4 – Biological, physical, and other non-chemical methods is the second most represented, with 27%, followed by Principle 3 – Decision making (15%) and Principle 2 – Monitoring (8%). The remaining four principles – Reduced pesticide use (4%), Evaluation (6%), Pesticide selection (1%), and Anti-resistance strategies – appear less frequently. This distribution indicates a prevailing orientation of the measures towards prevention and alternative, non-chemical approaches, which align with the core objectives of IPM.

5.5. Level 1 filter

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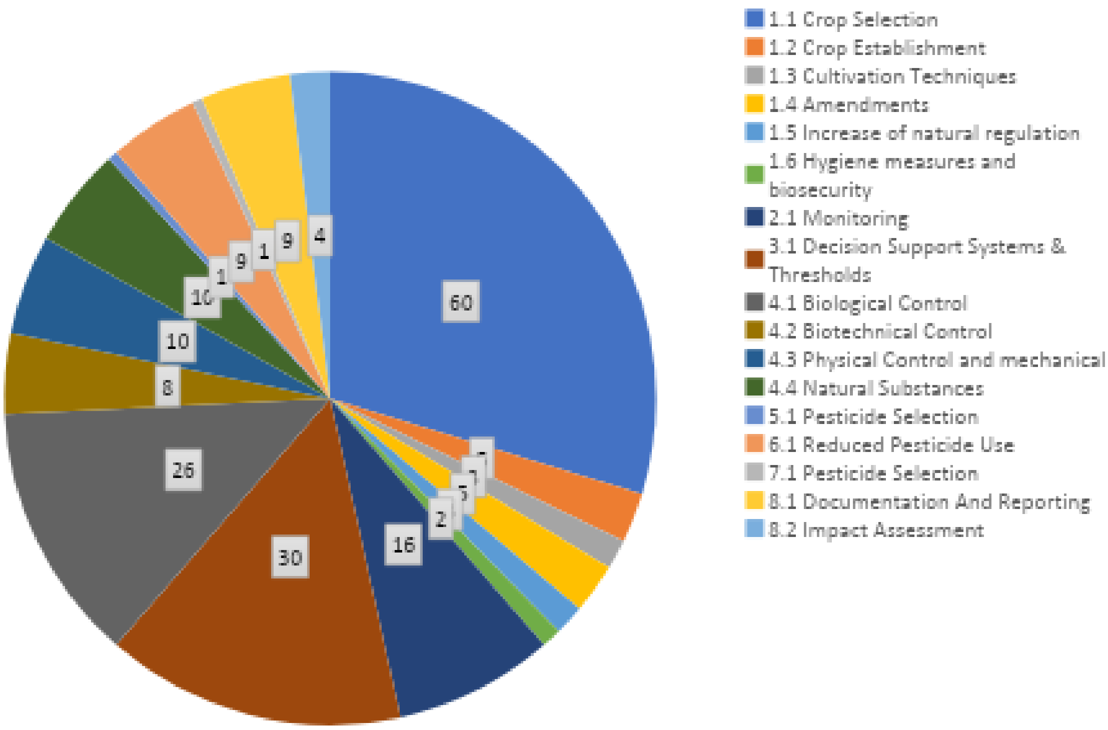

Figure 5. Categorical distribution of IPM practices (Level 1 classification)

Regarding the distribution of IPM practices across Level 1 categories, the dominant area is clearly 1.1 Crop selection, which includes no fewer than 60 practices, highlighting the central role of selecting crop material adapted to specific growing conditions. The second most frequent category is 3.1 Decision support systems and thresholds, with 30 practices, reflecting the increasing reliance on decision-making tools in integrated pest management. This is followed by 4.1 Biological control, with 26 practices, demonstrating a strong interest in environmentally friendly alternatives. Other well-represented areas include 2.1 Monitoring (16 practices), 4.3 Physical and mechanical control (10 practices), and 6.1 Reduced pesticide use (9 practices). Conversely, the least represented categories are 5.1 and 7.1 Pesticide selection, with only one practice each.

5.6. Year of practice implementation filter

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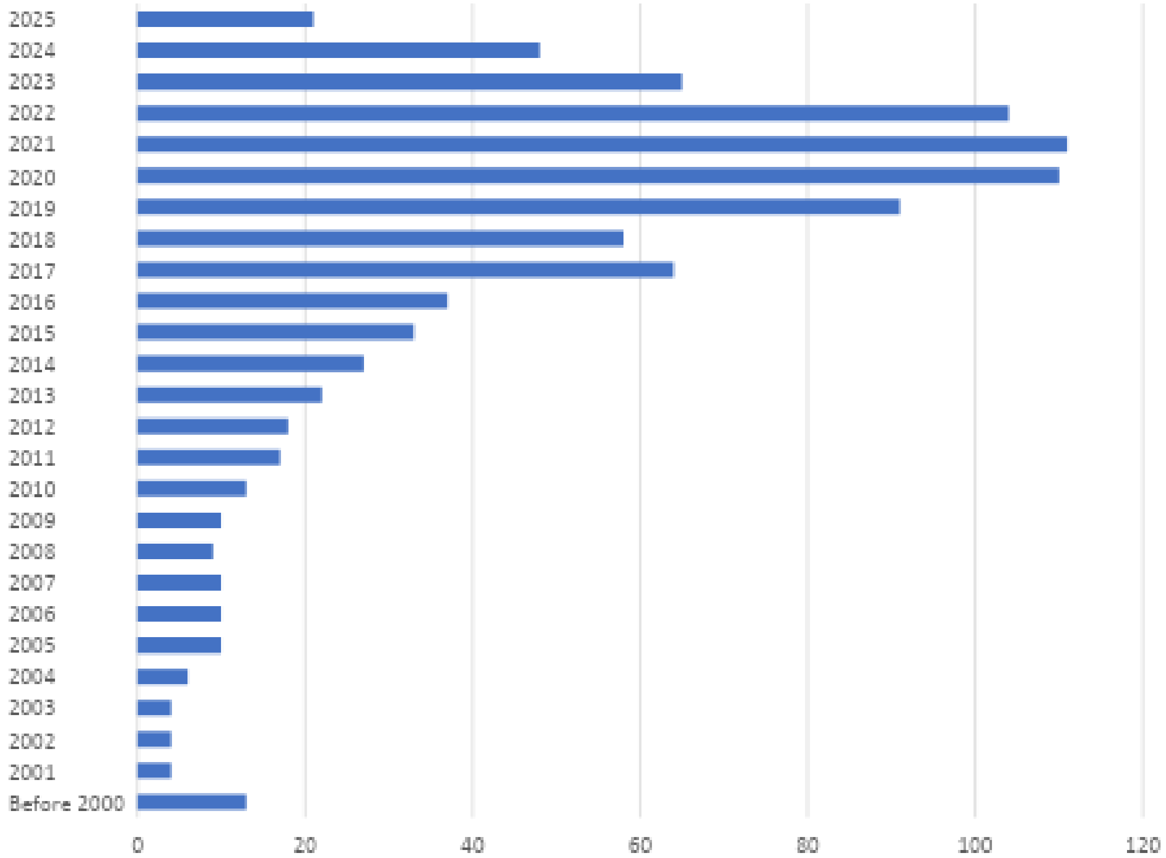

Figure 6. Distribution of practices by year of implementation

Regarding the year of practice implementation, the data shows a clear upward trend starting in 2014, reaching a peak in 2020 and 2021 with 110, respectively 111 reported implementation cases. Between 2017 and 2022, consistently high values suggest an intensive validation phase and adoption of the analyzed measures. From 2023 onward, there is a moderate decline, although the number of implemented practices remains substantial, including those planned for 2025. Practices implemented before 2000 are relatively few, highlighting the' recent and innovative nature of most documented approaches. This structure is likely to change slightly until the final report is drafted, taking into account that the scanning of projects funded in H2020 and FP7 projects continues.

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5.7. Quantify best practice analysis on each IPM principle and level.

IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
1. Prevention And Suppression	1.1 Crop Selection	1.1.1 Cultivar and Rootstock Diversity	1.1.1.1 Use Resistant And/or Tolerant Cultivars	Cultivar mixtures	29
				Cultivar monoculture	5
		1.1.2 Crop Species Diversity	1.1.2.1 Crop Rotation	Crop sequences	2
				Relay cropping	0
				Service/cover crop (sequential)	0
				Fallow (pest suppression through fallow)	0
			1.1.2.2 Intercropping	Crop species mixtures	19
				Service/cover crop (spatial)	1
		1.1.3 Adaptation To Site Conditions	1.1.3.1 Crop selection based on Soil Conditions	Agrochemical	0
				Soil texture	0
				Soil structure	0
				Microbiology	0
			1.1.3.2 Crop selection based on Climatic Region, Conditions, or Factors	Climatic maps/tools/instruments	0
				Winter hardiness/early versus late cultivar	1
			1.1.3.3 Crop selection based on Infested Area	Phytosanitary risk	0
		1.1.4 Seed/Planting Materials	1.1.4.1 Use Of Certified Seed	Use of a certified standard	0
				Physiological value (quick emergence)	0
				Phytosanitary quality (absence of pathogens and weed seeds)	0
			1.1.4.2 Use Of Certified Planting Material	Use of a certified standard	0
			1.1.4.3 Seed Treatment	Microbial inoculants	2
				Steeping	0
				Thermic	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
				Botanicals	0
				Seed clusters	0
				Electron treatment	0
	1.2 Crop Establishment	1.2.1 Sowing	1.2.1.1 Sowing Time	Early/late sowing/delayed sowing	2
	1.2 Crop Establishment	1.2.1 Sowing	1.2.1.2 Seeding Depth	Shallow or deep sowing	0
	1.2 Crop Establishment	1.2.1 Sowing	1.2.1.3 Seed Density	Low density (disease prevention)	1
	1.2 Crop Establishment	1.2.1 Sowing	1.2.1.3 Seed Density	High density (weed prevention)	1
	1.2 Crop Establishment	1.2.1 Sowing	1.2.1.4 Sown plant spatial arrangement	Sowing in raised beds	0
	1.2 Crop Establishment	1.2.1 Sowing	1.2.1.4 Sown plant spatial arrangement	Sowing three densified rows	0
	1.2 Crop Establishment	1.2.1 Sowing	1.2.1.4 Sown plant spatial arrangement	Sowing positioned on the row and perpendicularity	0
	1.2 Crop Establishment	1.2.2 Planting (Cuttings/Seedlings)	1.2.2.1 Plant Spatial Arrangement	Row spacing	0
	1.2 Crop Establishment	1.2.2 Planting (Cuttings/Seedlings)	1.2.2.1 Plant Spatial Arrangement	Plant density	1
	1.2 Crop Establishment	1.2.2 Planting (Cuttings/Seedlings)	1.2.2.1 Plant Spatial Arrangement	Precision seeding/(patch cropping)	0
	1.3 Cultivation Techniques	1.3.1 Soil Cultivation	1.3.1.1 Reduced Tillage (Non-Inversion)	Cultivator (Tine or S-Tine Cultivator)	0
	1.3 Cultivation Techniques	1.3.1 Soil Cultivation	1.3.1.1 Reduced Tillage (Non-Inversion)	Shallow Cultivator	0
	1.3 Cultivation Techniques	1.3.1 Soil Cultivation	1.3.1.2 Direct Seed/ Direct Sowing	Drill Planters	0
	1.3 Cultivation Techniques	1.3.1 Soil Cultivation	1.3.1.2 Direct Seed/ Direct Sowing	Seed Drills	0
	1.3 Cultivation Techniques	1.3.1 Soil Cultivation	1.3.1.2 Direct Seed/ Direct Sowing	No-Till Seeders	1
	1.3 Cultivation Techniques	1.3.1 Soil Cultivation	1.3.1.2 Direct Seed/ Direct Sowing	Air Seeders	0
	1.3 Cultivation Techniques	1.3.1 Soil Cultivation	1.3.1.3 Plough (Inversion)	Moldboard Plough	0
	1.3 Cultivation Techniques	1.3.1 Soil Cultivation	1.3.1.3 Plough (Inversion)	Chisel Plough	0
	1.3 Cultivation Techniques	1.3.1 Soil Cultivation	1.3.1.4 Stale Seed Bed	Power Harrow	1
	1.3 Cultivation Techniques	1.3.1 Soil Cultivation	1.3.1.4 Stale Seed Bed	Cultivator (Tine or S-Tine Cultivator)	0
	1.3 Cultivation Techniques	1.3.2 Crop management	1.3.2.1 Pruning	Appropriate time and weather condition	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			1.3.2.2 Crop topping	Mechanical Topping	0
				Topping with Flail Mowers or Mulchers	0
		1.3.3 Harvest Management	1.3.3.1 Advanced Harvest Technology	Seed destruction	0
				Low impact harvest	0
			1.3.3.2 Optimal Harvest Timing	Early/late harvest	0
	1.4 Amendments	1.4.1.Suppressive Amendments	1.4.1.1 Mulching	Organic Mulch (e.g., straw, compost, wood chips)	0
				Inorganic Mulch (e.g., plastic film, gravel)	0
				Living Mulch (e.g., cover crops or ground cover)	1
				Temperature Regulation Mulch	0
			1.4.1.2 Organic Fertilisation	Compost (animal)	0
				Compost (plant)	0
				Green manure (cover crops)	2
				Vermicompost	1
				Animal Manure (Raw)	0
			1.4.1.3 Mineral Fertilisation	Optimised Nutrient Dosing	0
				Use of Slow-Release Fertilisers	0
				Split Applications	0
		1.4.2 pH Management	1.4.2.1 Liming	Type of Lime (Calcium Carbonate vs. Dolomitic Lime)	0
				Application Timing	0
				Lime Particle Size (Fineness)	0
				Lime Incorporation (Depth of Application)	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
				Interaction with Fertiliser Application	0
		1.4.3 Water Management	1.4.3.1 Irrigation	Drip irrigation	0
				Automated Irrigation Systems	0
				Sensor-Based Irrigation Management	0
			1.4.3.2 Drainage	-	0
	1.5 Increase of natural regulation	1.5.1 Management Of Ecological Infrastructure	1.5.1.1 Creation Or Restauration Of Habitat For Beneficial Organisms Outside The Production Area	Hedges	0
				Beetle banks	0
				Field margins	2
				Semi natural habitat (SNH)	0
				Buffer zones	0
				Introduction of man made structures (e.g. bird poles, stone mounds, polinator shelter)	0
			1.5.1.2 Creation Or Restoration Of Habitat For Beneficial Organisms Inside The Production Area	Flower strips	1
				Preserving grass clover between row	0
				Provision of nesting sites (permanent herbaceous spots…)	0
				Provision of nesting sites (natural)	0
				Provision of nesting sites (artificial)	0
				Introduction of man made structures (e.g. bird poles, stone mounds, pollinator shelter)	0
		1.5.2 Management Of Resources To The Pest (landscape)	1.5.2.1 Removal of non-crop hosts around the parcel	-	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
	1.6 Hygiene and biosecurity measures	1.6.1 Cleaning Of Machinery And Equipment	1.6.1.1 Cleaning Of Machinery And Equipment	Frequency of Cleaning	1
				Cleaning Techniques	0
				Water and Detergent Use	0
				Legal and Biosecurity Requirements	0
		1.6.2 Management Of Resources To The Pest (materials in field)	1.6.2.1 Water/Soil Sanitation	-	0
			1.6.2.2 Removal Of Inoculum Sources	Removal of plant debris	1
				Removal of infested plant parts	0
				Plant debris management	0
				Mulching/cutting of debris	0
			1.6.2.3 Suppression Of Pest And Disease Reservoirs	Weed Hosts	0
				Crop Residue Management	0
				Alternate Hosts (Non-Crop Plants)	0
				Soil Reservoirs	0
				Water Sources	0
		1.6.3 Soil Disinfection	1.6.3.1 Removal Of Nematodes, Soil Pathogens	Sowing plant species with Soil disinfection/ disinfection effect	0
			1.6.3.2 Soil fumigation	-	0
Principle 1 – **Prevention and Suppression** – includes a total of 75 practices, making it the most comprehensive IPM principle documented. The largest contribution comes from 1.1 Crop Selection, with 59 practices, highlighting widespread implementation of genetic and functional diversification strategies. Key examples include cultivar mixtures (29 cases), crop species mixtures (19 cases), and crop rotation (2 cases). The remaining practices are more evenly spread. Crop Establishment (1.2) and Cultivation Techniques (1.3) account for 7 practices, mostly related to seeding density and timing. Amendments (1.4) include 4 entries (e.g., green manure, vermicompost, living mulch), and Increase of natural regulation (1.5) adds 3 more, such as removal of non-crop hosts and flower strips. Hygiene and Biosecurity (1.6) contributes 2 practices. Overall, the distribution emphasizes crop selection as the main preventive measure, supported by targeted practices aimed at enhancing agroecosystem resilience.					
2. Monitoring	2.1 Monitoring	2.1.1 Monitoring	2.1.1.1 Drone-Based Crop And Pest Monitoring	Drone Type and Specifications	1

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
				Flight Planning and Scheduling	0
				Integration with Other Monitoring Systems	1
				Calibration and Maintenance	0
			2.1.1.2 Field Observations	Visual inspection of plants	0
				Soil survey	0
				Visual inspection of plant debris	0
			2.1.1.3 Remote Sensing	Remote Sensing Technology and Sensors	2
				Resolution and Scale	0
			2.1.1.4 Monitoring With Traps	Visual attractants	1
				Olfactory attractants (pheromones and feeding attractants)	0
				Smart traps	1
		2.1.2 Assessment	2.1.2.1 Monitoring Reports	Country level	1
			2.1.2.2 Advisory Service	Expertise and specialisation	0
				Customisation and recommendations	0
				Follow up and support	0
			2.1.2.3 Molecular detection tools	DNA-based analysis	5
				Enzyme based analysis	1
			2.1.2.4. Identification of pests and diseases	pest ID keys	0
			2.1.2.5 Geo-morphometric analysis for pest management	-	0
		2.1.3 Prognosis and forecast	2.1.3.1 Disease forecast models	weather conditions	1

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			2.1.3.2 Disease prediction models	-	1

Principle 2 – **Monitoring** includes 15 reported practices grouped into three core components: monitoring, assessment, and forecasting. The 2.1.1 Monitoring category accounts for 4 practices, including the use of drones (1 case), remote sensing technologies (2), visual attractants (1), and smart traps (1). Traditional field observation techniques (e.g., plant or soil inspections) are not reported. The 2.1.2 Assessment category contains the highest number of practices – 7 in total. The most common are molecular detection methods, especially DNA-based analysis (5 cases), enzyme-based techniques, and national-level monitoring reports (1 case). Advisory services and pest identification tools are not present in the current data. The 2.1.3 Prognosis and forecast section includes 2 practices: one based on weather conditions and one using disease prediction models. Overall, this principle shows a clear trend toward digital monitoring tools and predictive modelling to support integrated pest management decision-making.

IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
3. Decision making	3.1 Decision Support Systems & Thresholds	3.1.1 Prediction And Warning (Seasonal)	3.1.1.1 Use Of Pest And Disease Prediction Models	Thresholds	2
				Warning and Alert Systems	14
			3.1.1.2 Use Phenological Prediction Models	Growth stages prediction according to local climatic conditions	1
			3.1.1.3 Use Water Monitoring And Prediction Modelling	Real time monitoring of field water capacity	0
		3.1.2 Predictive Farm Systems (Long Term/Systemic)	3.1.2.1 Modelling And Risk Assessment (Long Term)	Risk Factor Analysis (more detail required to which pest or risk it is)	0
		3.1.3 Thresholds	3.1.3.1 Thresholds	Thresholds for biological intervention	0
				Thresholds for chemical intervention	11

Principle 3 – **Decision making** includes 28 practices, structured around the use of predictive models and intervention thresholds. The most populated subcategory is 3.1.1 Prediction and warning (seasonal) with 117 entries, primarily focused on warning and alert systems (14 cases), followed by intervention thresholds and the use of phenological models. No practices are reported for water monitoring and prediction. The 3.1.2 Predictive farm systems (long-term/systemic) category contains no reported practices, highlighting a gap in long-term risk modeling within IPM decision support strategies. Within 3.1.3 Thresholds, 11 practices refer exclusively to chemical intervention thresholds. There are no entries for thresholds related to biological control. This distribution suggests a strong emphasis on seasonal predictive tools and chemical thresholds, with room for expansion toward systemic and biological decision-making approaches.

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
4. Biological, physical and other non-chemical methods	4.1 Biological Control	4.1.1 Supplemental Release Of Live Beneficials	4.1.1.1 Release of Macrofauna (e.g. above ground arthropod predators)	-	2
			4.1.1.2 Release of Microflora and Fauna (bacteria, fungi, nematoda)	entomopathogenic nematodes	3
	4.2 Biotechnical Control	4.2.1 Attractants And Repellents (natural)	4.2.1.1 Planting Of Repelling/Disturbing Plants	Strips	0
				Spots	0
				Push-pull strategies	0
				Trap crops	0
		4.2.2 Attractants And Repellents(other)	4.2.2.1 Use Of Pheromone Traps	Mass trapping	0
				Mating disruption	2
				Pheromone sticky traps (colourless)	0
			4.2.2.2 Other (Olfactory) Attractants/Repellents	Ultrasound	0
		4.2.3 Stimulation And Interference	4.2.3.1 Plant Resistance Activation	Induced resistance	4
				Use of Elicitors	0
			4.2.3.2 Ozon treatment (abiotic interference)	different exposures levels	0
			4.2.3.3 UV light (abiotic interference)	different exposures levels	0
		4.2.4 Engeneering of biocontrol agents	4.2.4.1 Release of sterilised insect pest or organism	Mating interference	0
	4.3 Physical Control and mechanical	4.3.1 Barriers	4.3.1.1 Barriers: Natural Materials	Straw barrier	0
				Chalk barrier	0
				Salt barrier	0
			4.3.1.2 Barriers: Other Physical	Electric fences	0
				Nets	0
				Insect capture channels around fields to prevent	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
				walking insects from entering	
		4.3.2 Thermal Control (Excluding Thermal Seed Treatment)	4.3.2.1 Heat Killing Of Pests And Diseases	Thermal weed control	0
				Soil sterilisation: steam	0
				Decontamination of amendments (of soil, planting materials, compost etc)	0
			4.3.2.2 Temperature Management	Temperature control/ plasticulture	0
				Cold storage temperatures to kill pests in fruit storage	0
		4.3.3 Mechanical removal of pests	4.3.3.1 Mechanical Weeding	Hand or machine	5
				Physical removal, electrical, burning	0
				Burning between rows	1
			4.3.3.2 Robotic removal of pests and weeds	-	0
		4.3.4 Visual Attractant	4.3.4.1 Mass Trapping	Coloured traps	0
				Pan traps	1
				Light traps	0
				Coloured sticky traps	0
	4.4 Natural Substances	4.4.1 Natural Substances	4.4.1.1 Essential Oils And Plant Extracts	Seed treatments	0
				Foliar/plant protection	3
			4.4.1.2 Bio-Pesticides/Botanical Pesticides	-	2
			4.4.1.3 Bio-Fertiliser/ Bio Products	-	3

Principle 4 – **Biological, physical and other non-chemical methods** – a total of 26 practices were identified, indicating a moderate diversity of non-chemical interventions in integrated pest management. The largest share was attributed to physical and mechanical control (7 practices), especially mechanical weeding and robotic pest removal. Natural substances were also frequently represented (8 practices), primarily through the use of biopesticides and biofertilizers. Biological control accounted for 5 practices, while biotechnical

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
control included 6, both related to induced plant resistance. These findings suggest that although interest in non-chemical alternatives is increasing, their development and practical application remain uneven across sub-principles.					
5. Pesticide Selection	5.1 Pesticide Selection	5.1.1 Pesticide selection	5.1.1.1 Mixing Substances	-	1
			5.1.1.2 Single-Substance Choice	Choosing least harmful pesticide	0
				Choosing most specific pesticide	0
Principle 5 – **Pesticide selection** – one practice founded here, under the Pesticide selection – Mixing substances category.					
6. Reduced pesticide use	6.1 Reduced Pesticide Use	6.1.1 Adapting spraying technology	6.1.1.1 Equipment/pesticide application techniques/machineries	Nozzle Selection and Calibration	0
				Spray Drift Control Technologies	1
				Automatic Section Control (ASC)	1
			6.1.1.2 Mode Of Application	Seed treatment/spraying	0
				Foliage application	0
			6.1.1.3 Precision Application	Band application	1
				Overall application	1
				Variable rate	0
				Spot spraying- green on brown selection of weeds	0
		6.1.2 Spray applications	6.1.2.1 Pesticide Dosage	Amount of spray liquid adapted to the crop	1
			6.1.2.2 Pesticide Timing	Weather conditions	1
				-	0
			6.1.2.3 Pesticide Frequency	Pest Population Dynamics	0
				Crop Growth Stage	0
				Environmental Conditions	0
			6.1.2.4 Pesticide And Adjuvants Placement	Pesticide only sprayed on the outside of orchard	0
Principle 6 – **Reduced pesticide use** – a total of 6 practices were identified belonging to Spray Drift Control Technologies, Automatic Section Control (ASC), Band application, Overall application, Amount of spray liquid adapted to the crop and Weather conditions.					

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
This profile highlights a stronger emphasis on technical optimization of application methods rather than frequency or spatial targeting of pesticide treatments.					
7. Anti-resistance strategies	7.1 Pesticide Selection	7.1.1 Choice Of Active Substance And Control Agent	7.1.1.1 Pesticide dosages (substance choice)	Appropriate dosages to kill sufficient level of pest and pathogens to avoid resistance	0
			7.1.1.2 Timing of pesticide application	Targeting Early Pest Stages	0
				Timing Based on Pest Thresholds	0
				Avoiding Late Application	0
			7.1.1.3 Pesticide Replacement/Rotation	Rotating different mode of actions in active ingredients	1
			7.1.1.4 Pesticide Mixtures (Mixtures Of Moa)	Compatibility of Active Ingredients	0
				Dosage adjustment	0
Principle 7 – **Anti-resistance strategies** – only one practice was identified, focusing on the rotation of active substances with different modes of action. This indicates a limited implementation of a key strategy to prevent resistance development, while other measures such as appropriate dosage, timing, or pesticide mixtures were not reported among the analysed practices.					
8. Evaluation	8.1 Documentation and Reporting	8.1.1 Record Keeping	8.1.1.1 Maintaining detailed activity logs	Fertilizer applications documentation	0
				fungicide application documentation	0
				pesticide application documentation	0
				IPM measure implementation	0
			8.1.1.2 Maintaining Pest Monitoring Records	On farm monitoring records	0
		8.1.2 Reporting Systems	8.1.2.1 Use of standardised reporting format	Standardised reporting across regions/countries	0
			8.1.2.2 Use of digital reporting systems	Farm internal use	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			8.1.2.3 Risk assessment reports	-	0
			8.1.2.4 Data Sharing Platforms	-	8
	8.2 Impact Assessment	8.2.1 Efficacy Evaluation	8.2.1.1 Performance measurement	Pesticide efficacy	0
				Fungicide efficacy	0
				Herbicide efficacy	0
		8.2.2 Environmental Assessment	8.2.2.1 Assess Long-Term Environmental Sustainability	-	0
			8.2.2.2 Assess Impact on Biodiversity	Biodiversity asessment on farm	0
			8.2.2.3 Assess soil Health and Structure	Soil health and structure asessment on farm	0
			8.2.2.4 Assess Ecosystem Services	Ecosystem service asessment on farm	0
			8.2.2.5 AssessWater Quality	Water quality asessment on farm	0
		8.2.3 Societal Assessment	8.2.3.1 Assess Equity and Access	Equity and Acess assessment to IPM implementation across farms	0
			8.2.3.2 Assess Cultural and Social Values	Soietal asessment of IPM uptake	0
			8.2.3.3 Education and Awareness	Farmers round tables	0
			8.2.3.4 Education and Awareness	IPM workshops	0
		8.2.4 Economic Assessment	8.2.4.1 Assess Labour Costs and Expertise	-	0
			8.2.4.2 Availability of Subsidies and Support	Comprehensive list of subsidies	0
			8.2.4.3 Environmental Impact and Regulation	-	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			8.2.4.4 Assess Long-Term vs. Short-Term Costs (Investments)	On farm IPM cost asessment	0
			8.2.4.5 Market Prices and Economic Conditions	-	0
			8.2.4.6 Crop Value and Yield	Market evaluation of crop and crop quality	1
			8.2.4.7 Cost of Control Measures	Effectivve on farm IPM implementation cost	3

Principle 8 – Evaluation – a total of 12 practices were identified, with the majority focused on economic impact assessment and reporting. These include Data Sharing Platforms, Market evaluation of crop and crop quality and Effective on farm IPM implementation cost. However, no practices were identified in areas such as pesticide efficacy, biodiversity assessment, or societal inclusion, indicating a gap and the potential need for broader evaluation tools in these aspects.

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5.8. Current level of development category filter

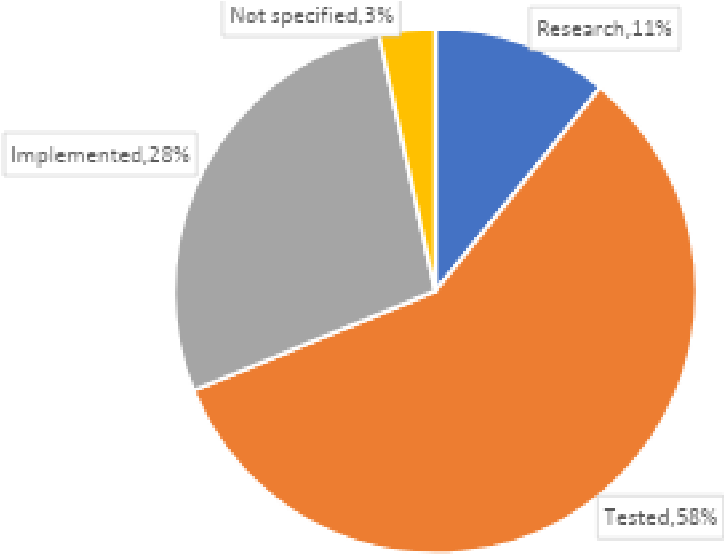

Figure 7. Classification of practices by development stage

Regarding the current level of development of the analyzed practices, the majority (58%) are tested, indicating that they have already been validated under experimental or semi-practical conditions. Around 28% are fully implemented, which demonstrates a high degree of maturity and readiness for real-world application. In contrast, only 11% are still in the research stage, pointing to a smaller share of early-stage innovations. A limited percentage, 3%, have an unspecified development status.

5.9. Impact indicators category filter

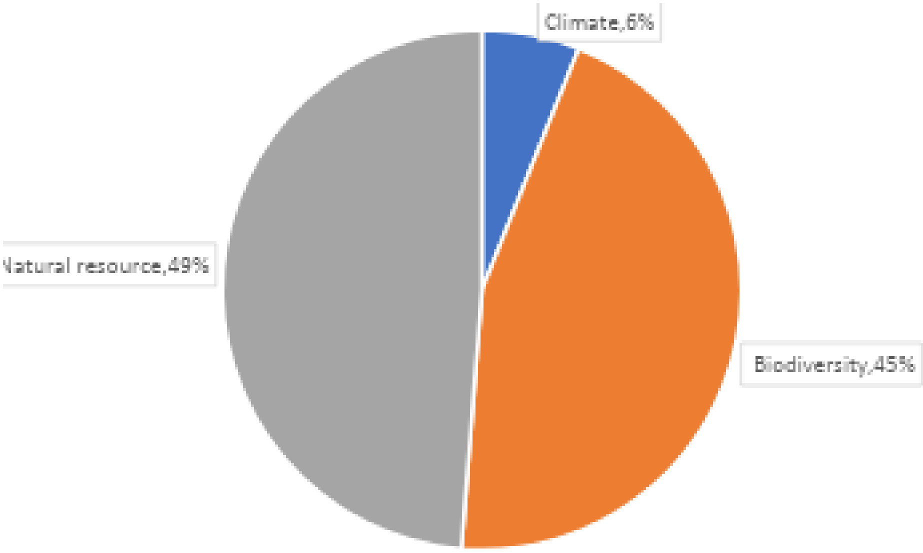

Figure 8. Classification of practices according to impact domains

Regarding the impact indicators, most of the analysed practices focus on preserving biodiversity and ensuring the sustainable management of natural resources. Some practices also address climate-related impacts, reflecting an overall commitment to environmental

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sustainability. More specifically, 49% of the practices primarily target biodiversity, reflecting a strong concern for preserving or enhancing biological diversity in agricultural systems. Another 45% are aimed at safeguarding and sustainably managing natural resources (such as water, soil, or energy), while only 6% are directly linked to climate impact. This distribution highlights that while ecological sustainability is a key focus, the integration of climate-related interventions could be further strengthened in future developments.

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6. Results of the BPD analyses based on the national projects (ITALY, GERMANY, CROATIA, SWEDEN, ROMANIA, FRANCE and POLAND)

6.1. Crop category filter (share the best practices identified in each category).

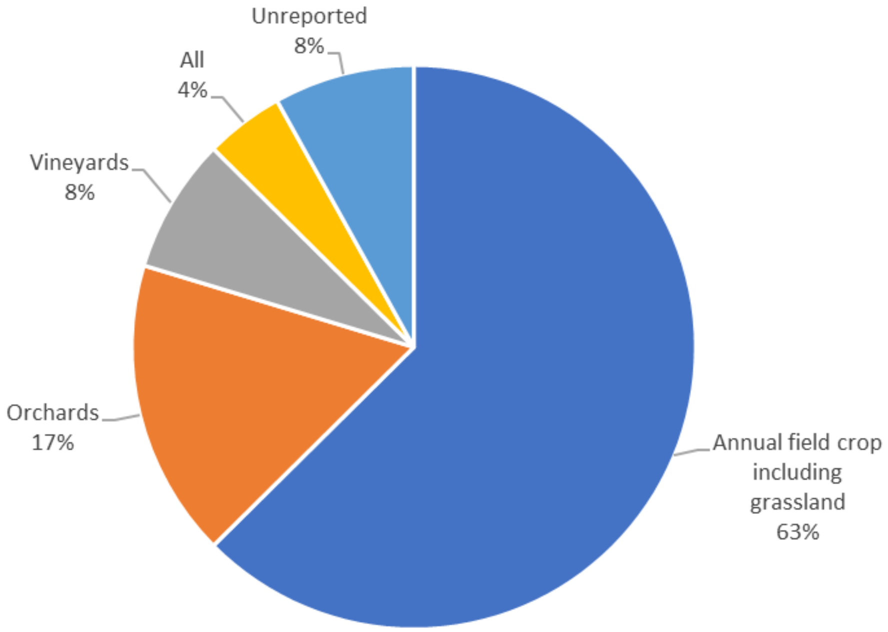

Figure 9. Crop category-wise distribution of practices

The distribution of analyzed practices by crop category reveals a clear predominance of annual field crops, including grassland, which account for 63% of all reported cases. This category significantly outweighs orchards (17%) and vineyards (8%), indicating a stronger emphasis on practices suitable for broad-acre, annually cultivated systems. The "All" category, representing only 4%, points to a very limited number of practices with general applicability across crop types, while 8% were marked as Unreported. This distribution underscores the opportunity to develop and promote integrated pest management strategies tailored to perennial systems such as orchards and vineyards, where current adoption remains relatively limited.

6.2. Production systems filter (how many best practices were identified in the production system).

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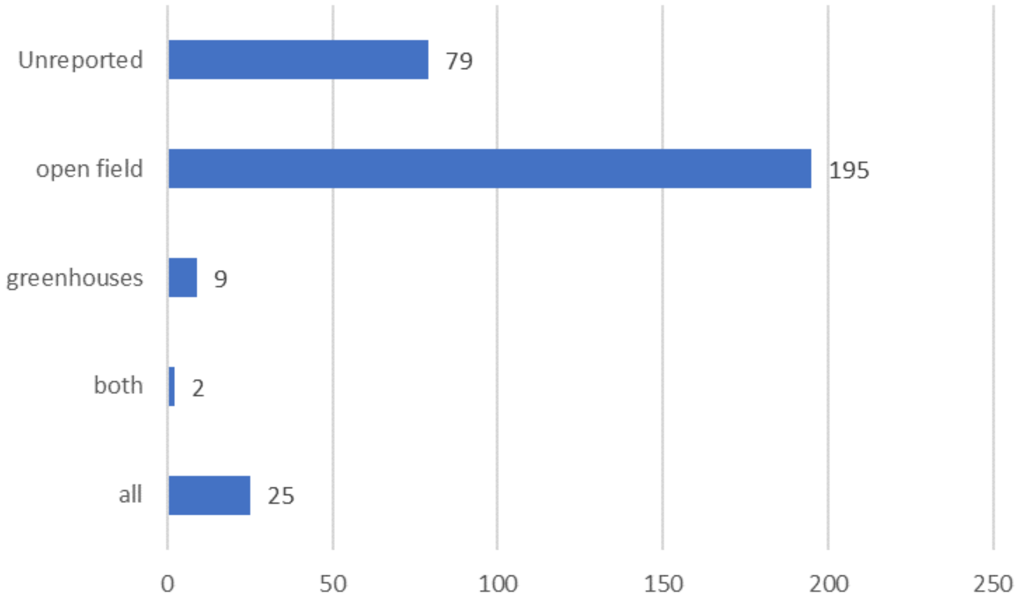

Figure 10. Practice distribution based on the production system

The distribution of analyzed practices by production system shows a striking predominance of the open field category, with 195 practices. In contrast, those targeting greenhouses (9), both systems (2), or generally applicable to all production types (25) remain scarce, while a notable number (79) were left Unreported. This overwhelming focus on open field systems likely reflects the broader extent of open-air agricultural production in Europe and the higher diversity of pest challenges in these environments. However, the limited representation of greenhouse-specific and versatile practices highlights a need to invest more in research and adaptation of integrated pest management approaches for protected and mixed cultivation systems.

6.3. ESR scale filter (how many best practices were identified in each class).

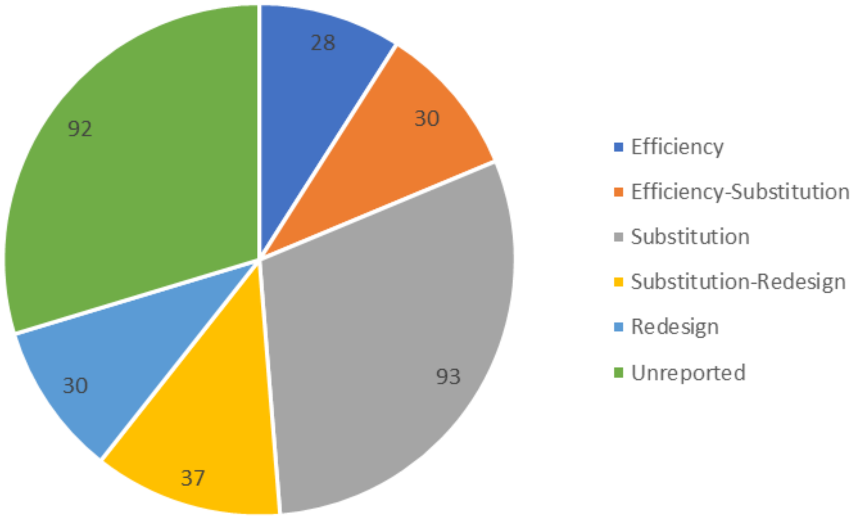

Figure 11. Distribution of practices by ESR scale

The analysis of reported practices by the ESR (Efficiency–Substitution–Redesign) scale reveals a predominance of substitution-level strategies, which account for the highest proportion (93 cases). This is followed by transition-level practices such as substitution–redesign (37 cases), efficiency–substitution (30), and redesign. In addition to the 28 practices categorized under efficiency, a substantial share (92) remained unreported.

This distribution suggests that although a growing number of practices go beyond basic input efficiency (embracing substitution or transitional approaches), few reach the system redesign stage. This underscores the need for further innovation and targeted support to promote holistic, redesign-based solutions within integrated pest management frameworks.

6.4. IPM principle filter (how many best practices were identified in each IPM principle).

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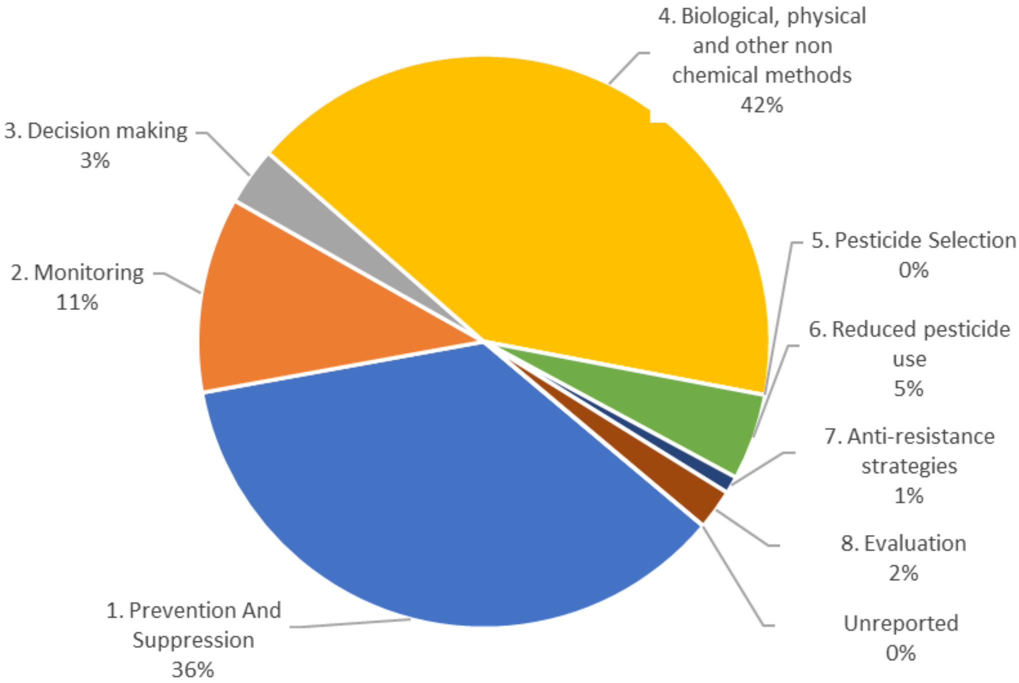

Figure 12. Practices grouped by IPM principles

The distribution of practices across IPM principles highlights a dominant focus on biological, physical, and other non-chemical methods, which account for 42% of all recorded cases. This is closely followed by prevention and suppression (36%) and monitoring (11%), indicating a strong emphasis on proactive and environmentally friendly strategies. In contrast, principles such as decision making (3%), reduced pesticide use (5%), evaluation (2%), and anti-resistance strategies (1%) are significantly less represented. Notably, pesticide selection is entirely absent, and no practices were left unreported. This imbalance suggests a strong preference for early intervention and non-chemical control within integrated pest management, while also revealing underexplored areas, especially those related to resistance management and strategic pesticide use, that warrant further attention and development.

6.5. Level 1 (target) filter (how many best practices were identified in this layer).

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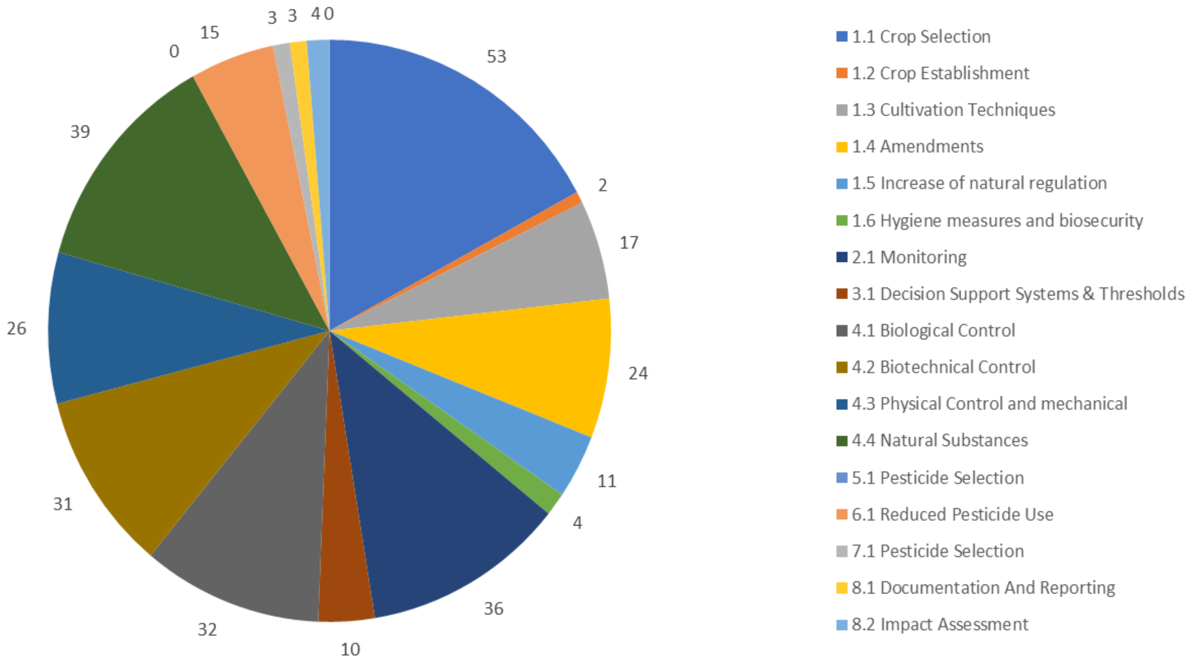

Figure 13. Categorical distribution of IPM practices (Level 1 classification)

The analysis of targeted IPM measures at Level 1 reveals a clear concentration on 1.1 Crop Selection, which accounts for 53 entries - the most frequently addressed target area. This is followed by 4.4 Natural Substances with 39 entries, 2.1 Monitoring with 36, and 4.1 Biological Control with 32, indicating a strong emphasis on agronomic and ecological prevention strategies.

Other well-represented areas include 4.2 Biotechnical Control (31 entries), 1.4 Amendments (24), and 4.3 Physical Control and mechanical (26), confirming the focus on non-chemical interventions. 1.3 Cultivation Techniques also appears with 17 practices, while 6.1 Reduced Pesticide Use is mentioned in 15 cases.

In contrast, 3.1 Decision Support Systems & Thresholds (10 entries), 1.5 Increase of natural regulation (11), and 1.6 Hygiene measures and biosecurity (4) are less frequently addressed. 8.1 Documentation and Reporting, 8.2 Impact Assessment, and 7.1 Pesticide Selection appear only marginally, with 3–4 entries each. Notably, 5.1 Pesticide Selection is not targeted at all.

This distribution reflects a strong orientation toward ecological intensification and non-chemical practices, while evaluation, digital decision tools, and chemical input optimization remain underexploited within the current dataset.

6.6. Year of practice implementation filter.

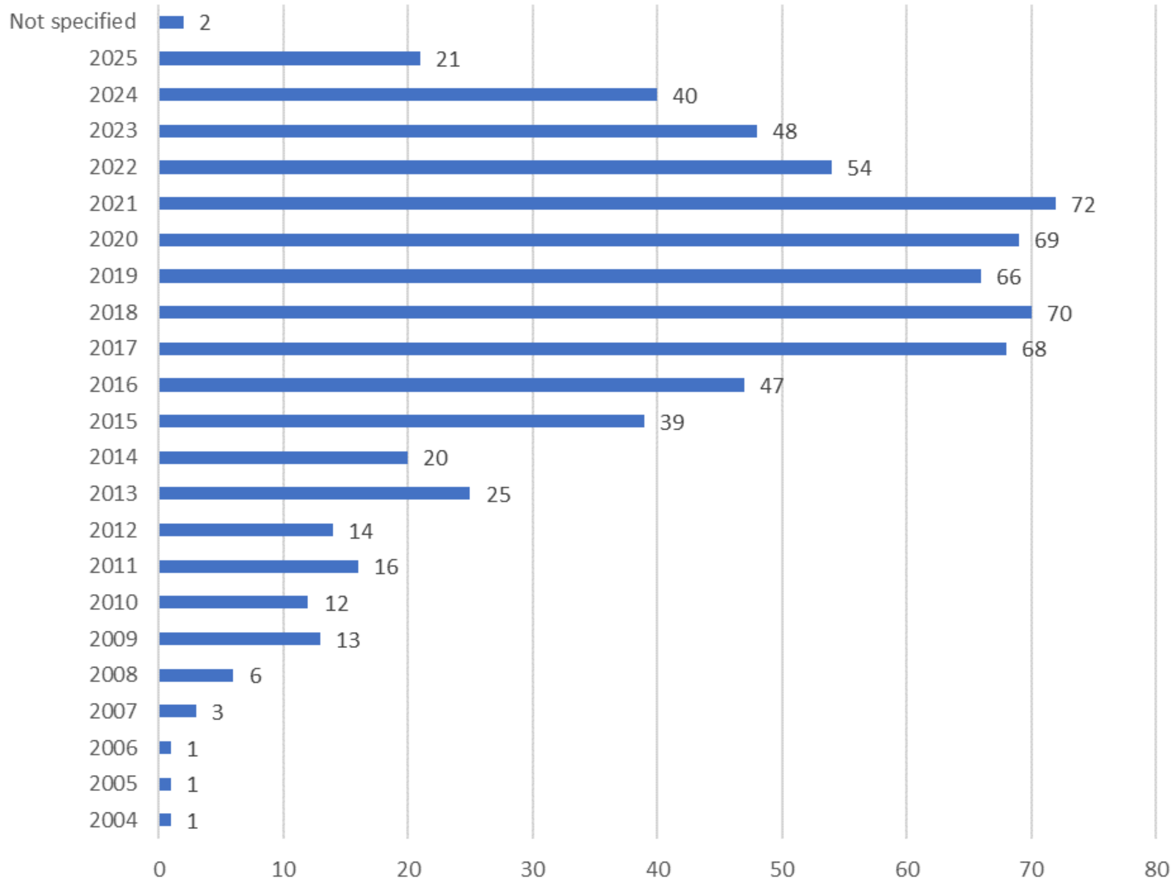

Figure 14. Distribution of practices by year of implementation

The distribution of practice implementation over time reveals a marked increase starting in 2015, with a sharp and sustained acceleration between 2017 and 2021. The peak is observed in 2021, with 72 practices recorded, followed closely by 2018 (70), 2020 (69), and 2017 (68). This surge likely reflects intensified research activity and stronger policy frameworks supporting sustainable agriculture and integrated pest management (IPM).

In contrast, the period before 2010 shows limited activity—fewer than 15 practices per year—suggesting that systematic documentation or implementation of IPM strategies was either rare or not yet a common priority. From 2022 onward, a moderate decline is observed, with 54 practices in 2022, 48 in 2023, and 40 in 2024, followed by 21 in 2025. However, these values remain relatively high compared to pre-2015 levels, indicating sustained engagement and interest in IPM.

This temporal distribution confirms the growing momentum of integrated pest management in recent years and supports the notion that IPM practices have evolved from a niche concern to a mainstream component of agricultural development and sustainability efforts.

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6.7. Quantitative analysis of the best practices on each IPM principle.

IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
1. Prevention And Suppression	1.1 Crop Selection	1.1.1 Cultivar And Rootstock Diversity	1.1.1.1 Use Resistant And/or Tolerant Cultivars	Cultivar mixtures	1
				Cultivar monoculture	17
		1.1.2 Crop Species Diversity	1.1.2.1 Crop Rotation	Crop sequences	6
				Relay cropping	2
				Service/cover crop (sequential)	4
				Fallow (pest suppression through fallow)	0
			1.1.2.2 Intercropping	Crop species mixtures	2
				Service/cover crop (spatial)	3
		1.1.3 Adaptation to Site Conditions	1.1.3.1 Crop selection based on Soil Conditions	Agrochemical	0
				Soil texture	1
				Soil structure	1
				Microbiology	0
			1.1.3.2 Crop selection based on Climatic Region, Conditions, or Factors	Climatic maps/tools/instruments	1
				Winter hardiness/early versus late cultivar	0
			1.1.3.3 Crop selection based on Infested Area	Phytosanitary risk	0
		1.1.4 Seed/Planting Materials	1.1.4.1 Use Of Certified Seed	Use of a certified standard	0
				Physiological value (quick emergence)	0
				Phytosanitary quality (absence of pathogens and weed seeds)	0
			1.1.4.2 Use Of Certified Planting Material	Use of a certified standard	0
			1.1.4.3 Seed Treatment	Microbial inoculants	1

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
				Steeping	0
				Thermic	1
				Botanicals	1
				Seed clusters	0
				Electron treatment	0
	1.2 Crop Establishment	1.2.1 Sowing	1.2.1.1 Sowing Time	Early/late sowing/delayed sowing	0
			1.2.1.2 Seeding Depth	Shallow or deep sowing	0
			1.2.1.3 Seed Density	Low density (disease prevention)	0
				High density (weed prevention)	0
			1.2.1.4 Sown plant spatial arrangement	Sowing in raised beds	0
				Sowing three densified rows	0
				Sowing positioned on the row and perpendicularity	0
		1.2.2 Planting (Cuttings/Seedlings)	1.2.2.1 Plant Spatial Arrangement	Row spacing	1
				Plant density	0
				Precision seeding/(patch cropping)	0
	1.3 Cultivation Techniques	1.3.1 Soil Cultivation	1.3.1.1 Reduced Tillage (Non-Inversion)	Cultivator (Tine or S-Tine Cultivator)	0
				Shallow Cultivator	1
			1.3.1.2 Direct Seed/ Direct Sowing	Drill Planters	0
				Seed Drills	0
				No-Till Seeders	0
				Air Seeders	0
			1.3.1.3 Plough (Inversion)	Moldboard Plough	0
				Chisel Plough	0
			1.3.1.4 Stale Seed Bed	Power Harrow	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
				Cultivator (Tine or S-Tine Cultivator)	0
		1.3.2 Crop management	1.3.2.1 Pruning	Appropriate time and weather condition	1
			1.3.2.2 Crop topping	Mechanical Topping	0
				Topping with Flail Mowers or Mulchers	0
		1.3.3 Harvest Management	1.3.3.1 Advanced Harvest Technology	Seed destruction	0
				Low impact harvest	0
			1.3.3.2 Optimal Harvest Timing	Early/late harvest	1
	1.4 Amendments	1.4.1.Suppressive Amendments	1.4.1.1 Mulching	Organic Mulch (e.g., straw, compost, wood chips)	2
				Inorganic Mulch (e.g., plastic film, gravel)	0
				Living Mulch (e.g., cover crops or ground cover)	4
				Temperature Regulation Mulch	0
			1.4.1.2 Organic Fertilisation	Compost (animal)	0
				Compost (plant)	2
				Green manure (cover crops)	1
				Vermicompost	0
				Animal Manure (Raw)	1
			1.4.1.3 Mineral Fertilisation	Optimised Nutrient Dosing	4
				Use of Slow-Release Fertilisers	0
				Split Applications	0
		1.4.2 pH Management	1.4.2.1 Liming	Type of Lime (Calcium Carbonate vs. Dolomitic Lime)	2

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
				Application Timing	0
				Lime Particle Size (Fineness)	0
				Lime Incorporation (Depth of Application)	0
				Interaction with Fertiliser Application	1
		1.4.3 Water Management	1.4.3.1 Irrigation	Drip irrigation	0
				Automated Irrigation Systems	0
				Sensor-Based Irrigation Management	0
			1.4.3.2 Drainage	-	0
	1.5 Increase of natural regulation	1.5.1 Management Of Ecological Infrastructure	1.5.1.1 Creation Or Restoration of Habitat For Beneficial Organisms Outside The Production Area	Hedges	0
				Beetle banks	0
				Field margins	0
				Semi-natural habitat (SNH)	0
				Buffer zones	2
				Introduction of man-made structures (e.g., bird poles, stone mounds, pollinator shelter)	0
			1.5.1.2 Creation Or Restoration Of Habitat For Beneficial Organisms Inside The Production Area	Flower strips	0
				Preserving grass clover between rows	0
				Provision of nesting sites (permanent herbaceous spots…)	0
				Provision of nesting sites (natural)	0
				Provision of nesting sites (artificial)	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
				Introduction of man-made structures (e.g., bird poles, stone mounds, pollinator shelter)	0
		1.5.2 Management of Resources To The Pest (landscape)	1.5.2.1 Removal of non-crop hosts around the parcel	-	0
	1.6 Hygiene measures and biosecurity	1.6.1 Cleaning Of Machinery And Equipment	1.6.1.1 Cleaning Of Machinery And Equipment	Frequency of Cleaning	0
				Cleaning Techniques	0
				Water and Detergent Use	0
				Legal and Biosecurity Requirements	0
		1.6.2 Management of Resources To The Pest (materials in the field)	1.6.2.1 Water/Soil Sanitation	-	0
			1.6.2.2 Removal Of Inoculum Sources	Removal of plant debris	0
				Removal of infested plant parts	0
				Plant debris management	0
				Mulching/cutting of debris	0
			1.6.2.3 Suppression Of Pest And Disease Reservoirs	Weed Hosts	0
				Crop Residue Management	1
				Alternate Hosts (Non-Crop Plants)	1
				Soil Reservoirs	0
				Water Sources	0
		1.6.3 Soil Disinfection	1.6.3.1 Removal Of Nematodes, Soil Pathogens	Sowing plant species with Soil disinfection/ disinfection effect	0
			1.6.3.2 Soil fumigation	-	0

Principle 1 – **Prevention and Suppression** – includes a total of 67 practices. The largest contribution comes from 1.1.1.1 Use Resistant And/or Tolerant Cultivars with 18 practices, 1.1.2.1 Crop Rotation with 12 practices and 1.4.1.Suppressive Amendments with 6 practices. The diversity of practices strongly emphasizes soil and crop management, particularly within crop selection and

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
field-level hygiene measures. On the other hand, certain subcategories such as seed density adjustment, precision sowing, or mechanical removal of inoculum sources showed low number or no practices recorded, indicating potential areas for development or underreporting.					
2. Monitoring	2.1 Monitoring	2.1.1 Monitoring	2.1.1.1 Drone-Based Crop And Pest Monitoring	Drone Type and Specifications	0
				Flight Planning and Scheduling	0
				Integration with Other Monitoring Systems	0
				Calibration and Maintenance	0
			2.1.1.2 Field Observations	Visual inspection of plants	2
				Soil survey	0
				Visual inspection of plant debris	0
			2.1.1.3 Remote Sensing	Remote Sensing Technology and Sensors	3
				Resolution and Scale	0
			2.1.1.4 Monitoring With Traps	Visual attractants	0
				Olfactory attractants (pheromones and feeding attractants)	4
				Smart traps	1
		2.1.2 Assessment	2.1.2.1 Monitoring Reports	Country level	0
			2.1.2.2 Advisory Service	Expertise and specialisation	1
				Customisation and recommendations	0
				Follow up and support	0
			2.1.2.3 Molecular detection tools	DNA-based analysis	6
				Enzyme-based analysis	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			2.1.2.4. Identification of pests and diseases	pest ID keys	1
			2.1.2.5 Geo-morphometric analysis for pest management	-	0
		2.1.3 Prognosis and forecast	2.1.3.1 Disease forecast models	weather conditions	1
			2.1.3.2 Disease prediction models	-	1

Principle 2 – **Monitoring** includes 20 founded practices, covering a broad spectrum of pest and crop monitoring tools. The most frequently reported categories include 2.1.2.3 Molecular detection tools with 6 practices, followed by 2.1.1.4 Monitoring With Traps with 5 practices and 2.1.1.3 Remote Sensing with 3 practices. This distribution indicates a growing integration of precision and molecular technologies in IPM monitoring, while also highlighting the need for expanded use of automated and sensor-based systems to improve early detection and decision-making.

IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
3. Decision making	3.1 Decision Support Systems & Thresholds	3.1.1 Prediction And Warning (Seasonal)	3.1.1.1 Use Of Pest And Disease Prediction Models	Thresholds	0
				Warning and Alert Systems	3
			3.1.1.2 Use Phenological Prediction Models	Growth stages prediction according to local climatic conditions	0
			3.1.1.3 Use Water Monitoring And Prediction Modelling	Real-time monitoring of field water capacity	0
		3.1.2 Predictive Farm Systems (Long Term/Systemic)	3.1.2.1 Modelling And Risk Assessment (Long Term)	Risk Factor Analysis (more detail required on which pest or risk it is)	1
		3.1.3 Thresholds	3.1.3.1 Thresholds	Thresholds for biological intervention	0
				Thresholds for chemical intervention	0

Principle 3 – **Decision making** includes a total of 4 practices that were identified, most of which relate to warning and alert systems (3) and risk factor analysis (1). No practices were reported for the use of thresholds (either biological or chemical), water or phenological modelling, or climatic stage prediction. This distribution indicates that while basic forecasting tools are in place,

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
comprehensive decision-support systems remain largely underdeveloped, with notable gaps in precision agriculture elements that could improve intervention timing and reduce unnecessary pesticide use.					
4. Biological, physical, and other nonchemical methods	4.1 Biological Control	4.1.1 Supplemental Release Of Live Beneficials	4.1.1.1 Release of Macrofauna (e.g., above-ground arthropod predators)	-	1
			4.1.1.2 Release of Microflora and Fauna (bacteria, fungi, nematoda)	entomopathogenic nematodes	1
	4.2 Biotechnical Control	4.2.1 Attractants and Repellents (natural)	4.2.1.1 Planting Of Repelling/Disturbing Plants	Strips	0
				Spots	0
				Push-pull strategies	1
				Trap crops	1
		4.2.2 Attractants And Repellents(other)	4.2.2.1 Use Of Pheromone Traps	Mass trapping	0
				Mating disruption	0
				Pheromone sticky traps (colourless)	0
			4.2.2.2 Other (Olfactory) Attractants/Repellents	Ultrasound	0
		4.2.3 Stimulation And Interference	4.2.3.1 Plant Resistance Activation	Induced resistance	2
				Use of Elicitors	1
			4.2.3.2 Ozon treatment (abiotic interference)	different exposure levels	1
			4.2.3.3 UV light (abiotic interference)	different exposure levels	1
		4.2.4 Engineering of biocontrol agents	4.2.4.1 Release of sterilised insect pest or organism	Mating interference	0
	4.3 Physical Control and Mechanical	4.3.1 Barriers	4.3.1.1 Barriers: Natural Materials	Straw barrier	0
				Chalk barrier	0
				Salt barrier	0
				Electric fences	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			4.3.1.2 Barriers: Other Physical	Nets	1
				Insect capture channels around fields to prevent walking insects from entering	0
		4.3.2 Thermal Control (Excluding Thermal Seed Treatment)	4.3.2.1 Heat Killing Of Pests And Diseases	Thermal weed control	2
				Soil sterilisation: steam	0
				Decontamination of amendments (of soil, planting materials, compost, etc)	0
			4.3.2.2 Temperature Management	Temperature control/ plasticulture	0
				Cold storage temperatures to kill pests in fruit storage	0
		4.3.3 Mechanical removal of pests	4.3.3.1 Mechanical Weeding	Hand or machine	3
				Physical removal, electrical, burning	0
				Burning between rows	0
			4.3.3.2 Robotic removal of pests and weeds	-	1
		4.3.4 Visual Attractant	4.3.4.1 Mass Trapping	Coloured traps	0
				Pan traps	0
				Light traps	0
				coloured sticky traps	0
	4.4 Natural Substances	4.4.1 Natural Substances	4.4.1.1 Essential Oils And Plant Extracts	Seed treatments	4
				Foliar/plant protection	7
			4.4.1.2 Bio-Pesticides/Botanical Pesticides	-	1
			4.4.1.3 Bio-Fertiliser/ Bio Products	-	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
Principle 4 – **Biological, physical, and other non-chemical methods** – 29 practices were identified, indicating a moderate diversity of non-chemical interventions in integrated pest management. The largest share was attributed to 4.4.1.1 Essential Oils and Plant Extracts and 4.3.3.1 Mechanical Weeding.					
5. Pesticide Selection	5.1 Pesticide Selection	5.1.1 Pesticide selection	5.1.1.1 Mixing Substances	-	0
			5.1.1.2 Single-Substance Choice	Choosing the least harmful pesticide	0
				Choosing the most specific pesticide	0
Principle 5 – **Pesticide selection** – no practices founded here. This reveal a need of research focusing on this principle					
6. Reduced pesticide use	6.1 Reduced Pesticide Use	6.1.1 Adapting spraying technology	6.1.1.1 Equipment/pesticide application techniques/machineries	Nozzle Selection and Calibration	0
				Spray Drift Control Technologies	0
				Automatic Section Control (ASC)	0
			6.1.1.2 Mode Of Application	Seed treatment/spraying	0
				Foliage application	1
			6.1.1.3 Precision Application	Band application	1
				Overall application	0
				Variable rate	0
				Spot spraying- green on brown selection of weeds	1
		6.1.2 Spray applications	6.1.2.1 Pesticide Dosage	Amount of spray liquid adapted to the crop	3
			6.1.2.2 Pesticide Timing	Weather conditions	1
				-	0
			6.1.2.3 Pesticide Frequency	Pest Population Dynamics	0
				Crop Growth Stage	1
				Environmental Conditions	0
			6.1.2.4 Pesticide And Adjuvants Placement	Pesticide is only sprayed on the outside of the orchard	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
Principle 6 – **Reduced pesticide use** – a total of 8 practices were identified under this principle. The largest share (5 practices) falls under 6.1.2 Spray applications topic and 3 on the 6.1.1 Adapting spraying technology topic.					
7. Anti-resistance strategies	7.1 Pesticide Selection	7.1.1 Choice Of Active Substance And Control Agent	7.1.1.1 Pesticide dosages (substance choice)	Appropriate dosages to kill a sufficient level of pests and pathogens to avoid resistance	1
7. Anti-resistance strategies	7.1 Pesticide Selection	7.1.1 Choice Of Active Substance And Control Agent	7.1.1.2 Timing of pesticide application	Targeting Early Pest Stages	0
7. Anti-resistance strategies	7.1 Pesticide Selection	7.1.1 Choice Of Active Substance And Control Agent	7.1.1.2 Timing of pesticide application	Timing Based on Pest Thresholds	1
7. Anti-resistance strategies	7.1 Pesticide Selection	7.1.1 Choice Of Active Substance And Control Agent	7.1.1.2 Timing of pesticide application	Avoiding Late Application	0
7. Anti-resistance strategies	7.1 Pesticide Selection	7.1.1 Choice Of Active Substance And Control Agent	7.1.1.3 Pesticide Replacement/Rotation	rotating different modes of action in active ingredients	0
7. Anti-resistance strategies	7.1 Pesticide Selection	7.1.1 Choice Of Active Substance And Control Agent	7.1.1.4 Pesticide Mixtures (Mixtures Of Moa)	Compatibility of Active Ingredients	1
7. Anti-resistance strategies	7.1 Pesticide Selection	7.1.1 Choice Of Active Substance And Control Agent	7.1.1.4 Pesticide Mixtures (Mixtures Of Moa)	Dosage adjustment	0
Principle 7 – **Anti-resistance strategies** – a total of 3 practices were identified under this principle, targeting the dosage, timing and mixture of pesticide application. No practices were reported for early targeting of pest stages, avoiding late applications, rotation of active ingredients, mixture compatibility, or dosage adjustment. This limited representation suggests that resistance management remains a significantly underdeveloped component in the current practice landscape and highlights the urgent need to expand strategies addressing the sustainability of pesticide efficacy within IPM frameworks.					
8. Evaluation	8.1 Documentation And Reporting	8.1.1 Record Keeping	8.1.1.1 Maintaining detailed activity logs	fertiliser applications documentation	0
8. Evaluation	8.1 Documentation And Reporting	8.1.1 Record Keeping	8.1.1.1 Maintaining detailed activity logs	fungicide application documentation	0
8. Evaluation	8.1 Documentation And Reporting	8.1.1 Record Keeping	8.1.1.1 Maintaining detailed activity logs	pesticide application documentation	0
8. Evaluation	8.1 Documentation And Reporting	8.1.1 Record Keeping	8.1.1.1 Maintaining detailed activity logs	IPM measure implementation	0
8. Evaluation	8.1 Documentation And Reporting	8.1.1 Record Keeping	8.1.1.2 Maintaining Pest Monitoring Records	On-farm monitoring records	0
8. Evaluation	8.1 Documentation And Reporting	8.1.2 Reporting Systems	8.1.2.1 Use of standardised reporting format	Standardised reporting across regions/countries	0
8. Evaluation	8.1 Documentation And Reporting	8.1.2 Reporting Systems	8.1.2.2 Use of digital reporting systems	Farm internal use	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			8.1.2.3 Risk assessment reports	-	0
			8.1.2.4 Data Sharing Platforms	-	1
	8.2 Impact Assessment	8.2.1 Efficacy Evaluation	8.2.1.1 Performance measurement	Pesticide efficacy	0
				Fungicide efficacy	0
				Herbicide efficacy	0
		8.2.2 Environmental Assessment	8.2.2.1 Assess Long-Term Environmental Sustainability	-	0
			8.2.2.2 Assess Impact on Biodiversity	Biodiversity assessment on the farm	0
			8.2.2.3 Assess Soil Health and Structure	Soil health and structure assessment on the farm	2
			8.2.2.4 Assess Ecosystem Services	Ecosystem service assessment on the farm	0
			8.2.2.5 Assess Water Quality	Water quality assessment on the farm	0
		8.2.3 Societal Assessment	8.2.3.1 Assess Equity and Access	Equity and Access assessment to IPM implementation across farms	0
			8.2.3.2 Assess Cultural and Social Values	Social assessment of IPM uptake	0
			8.2.3.3 Education and Awareness	Farmers round tables	0
			8.2.3.4 Education and Awareness	IPM workshops	0
		8.2.4 Economic Assessment	8.2.4.1 Assess Labour Costs and Expertise	-	0
			8.2.4.2 Availability of Subsidies and Support	Comprehensive list of subsidies	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			8.2.4.3 Environmental Impact and Regulation	-	0
			8.2.4.4 Assess Long-Term vs. Short-Term Costs (Investments)	On-farm IPM cost assessment	0
			8.2.4.5 Market Prices and Economic Conditions	-	0
			8.2.4.6 Crop Value and Yield	Market evaluation of crop and crop quality	0
			8.2.4.7 Cost of Control Measures	Effective on-farm IPM implementation cost	0

Principle 8 – **Evaluation** – a total of 3 practices were identified, primarily focusing on Data Sharing Platforms and Soil health and structure assessment on farm. No practices were reported for critical areas such as pesticide efficacy, biodiversity, water quality assessments, or societal aspects like equity and inclusion. Additionally, education and awareness activities, including farmer engagement, remain unaddressed. These gaps highlight the need to strengthen the social and environmental evaluation components of IPM practices to ensure more holistic impact assessments.

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6.8. Current level of development filter.

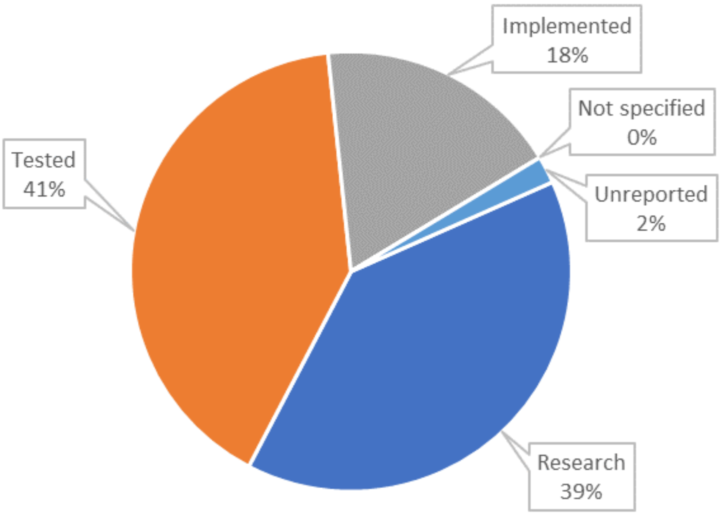

Figure 15. Classification of practices by development stage

The distribution of practices by their current level of development indicates that most have already been tested (61 cases, 41%), followed closely by those still in the research phase (59 cases, 39%). Only 27 practices (18%) have reached the full implementation stage, while none are marked as "Not specified". An additional 3 practices (2%) were Unreported, possibly due to missing information during documentation.

This distribution suggests that although many practices have progressed beyond conceptual development, the majority remain in experimental or pilot phases, reflecting ongoing optimization needs or limited transfer to real-world application. The data underscores the importance of bridging the gap between research, field validation, and large-scale adoption to fully realize the potential of integrated pest management strategies.

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6.9. Impact indicators filter.

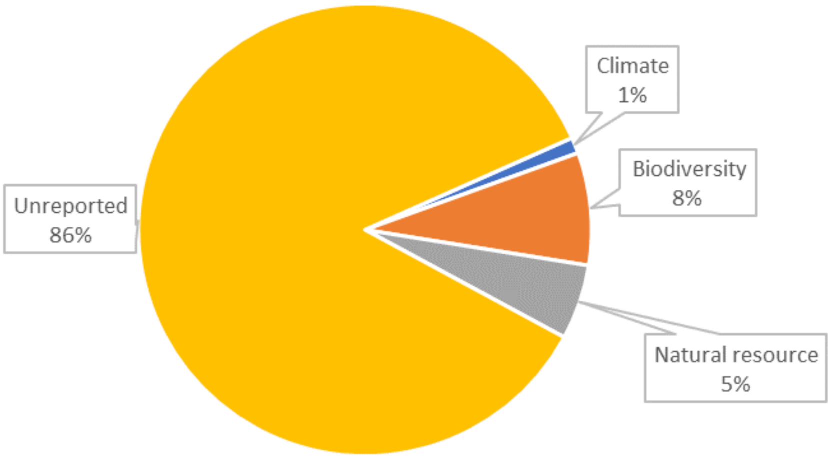

Figure 16. Classification of practices according to impact domains

The distribution of reported impact indicators shows a strong focus on Biodiversity (8%) and Natural resource protection (5%), while Climate impact has only 1%. This suggests that environmental considerations in IPM practices tend to prioritize biodiversity and natural resource conservation. 223 practices (86%) remain unreported in this category.

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7. Results of the BPD analyses based on the EIP-Agri projects

7.1. Crop category filter (share the best practices identified in each category).

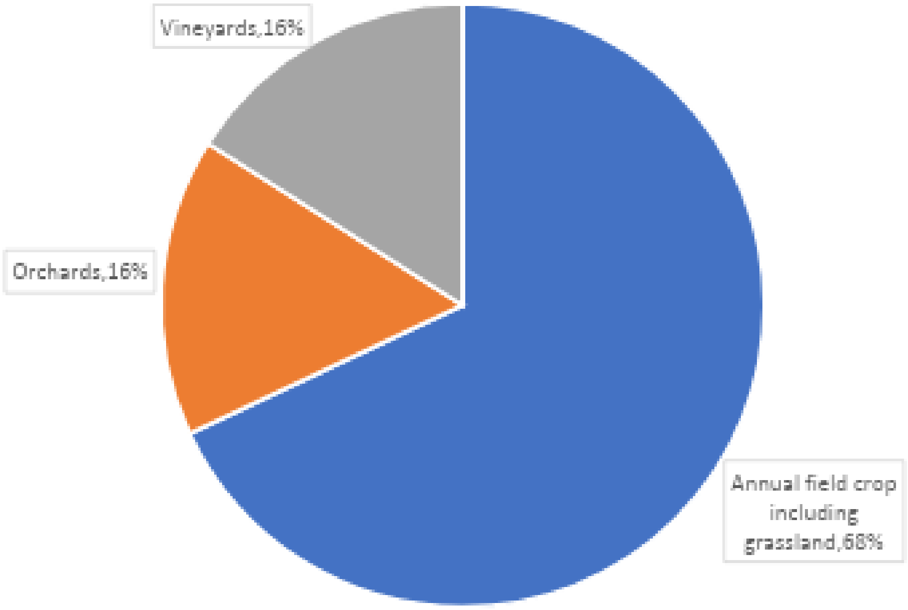

Figure 17. Crop category-wise distribution of practices

The distribution of analyzed practices by crop category reveals a clear predominance of annual field crops, including grassland, which account for 68% of all reported practices. This category significantly outweighs orchards (16%) and vineyards (16%), suggesting a stronger focus on research or implementation in extensive agricultural systems typical of annually cultivated land. No practice founded under "All" category, indicates lack of general applicability, independent of crop type. This distribution highlights the need to expand further and adapt integrated pest management practices in the fruit and wine sectors, where adoption still appears limited.

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7.2. Production system category filter (share the best practices identified in each category).

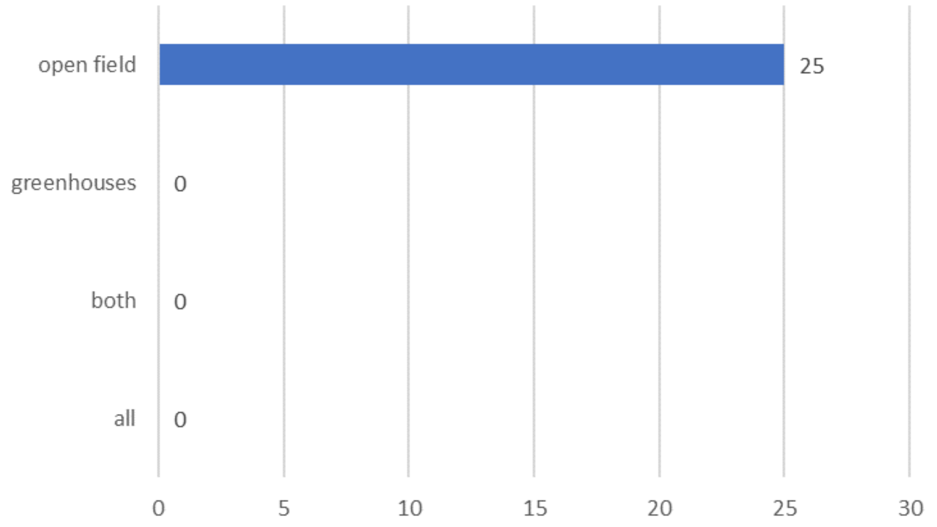

Figure 18. Practice distribution based on a production system

The distribution of practices by production system shows that all of them are associated with open-field conditions (25 practices). This distribution provides an overview of the contexts in which the analyzed practices have been applied, without implying preference or greater effectiveness of one system over another.

7.3. ESR scale filter

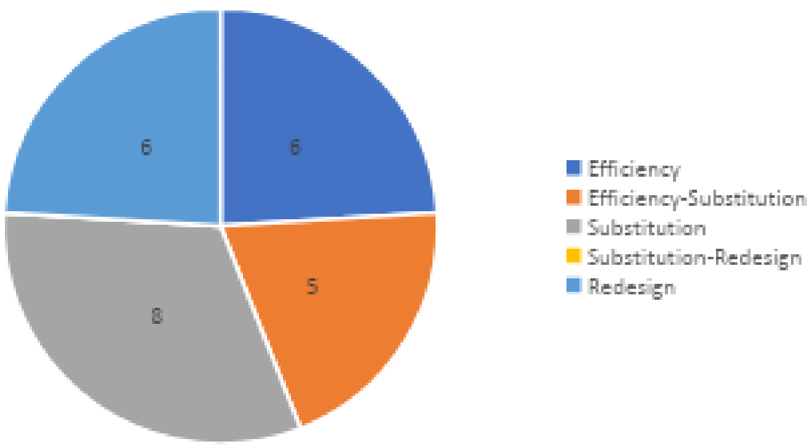

Figure 19. Distribution of practices by ESR scale

The chart shows the distribution of analyzed practices according to their level of intervention on the ESR scale. The highest share corresponds to practices categorized under Substitution, with 8 entries. These are followed by Redesign and Efficiency category, each with 6 practices and mixed-category Efficiency–Substitution with 5 practices. No practices founded under Substitution-Redesign category. This distribution reflects the diversity of strategic approaches, without implying any hierarchy or prioritization among the levels.

7.4. IPM principle filter

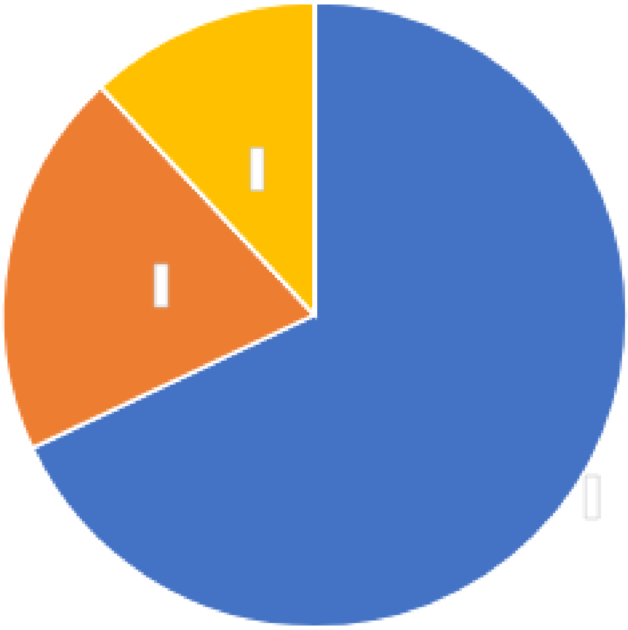

Figure 20. Practices grouped by IPM principles

The distribution of analyzed practices across the eight Integrated Pest Management (IPM) principles reveals a predominant focus on Principle 1 – Prevention and suppression, accounting for 68% of all entries. Principle 2 – Monitoring is the second most represented (20%) followed by Principle 4 – Biological with 12%. This distribution indicates a prevailing orientation of the measures towards prevention and alternative, non-chemical approaches, which align with the core objectives of IPM.

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7.5. Level 1 filter

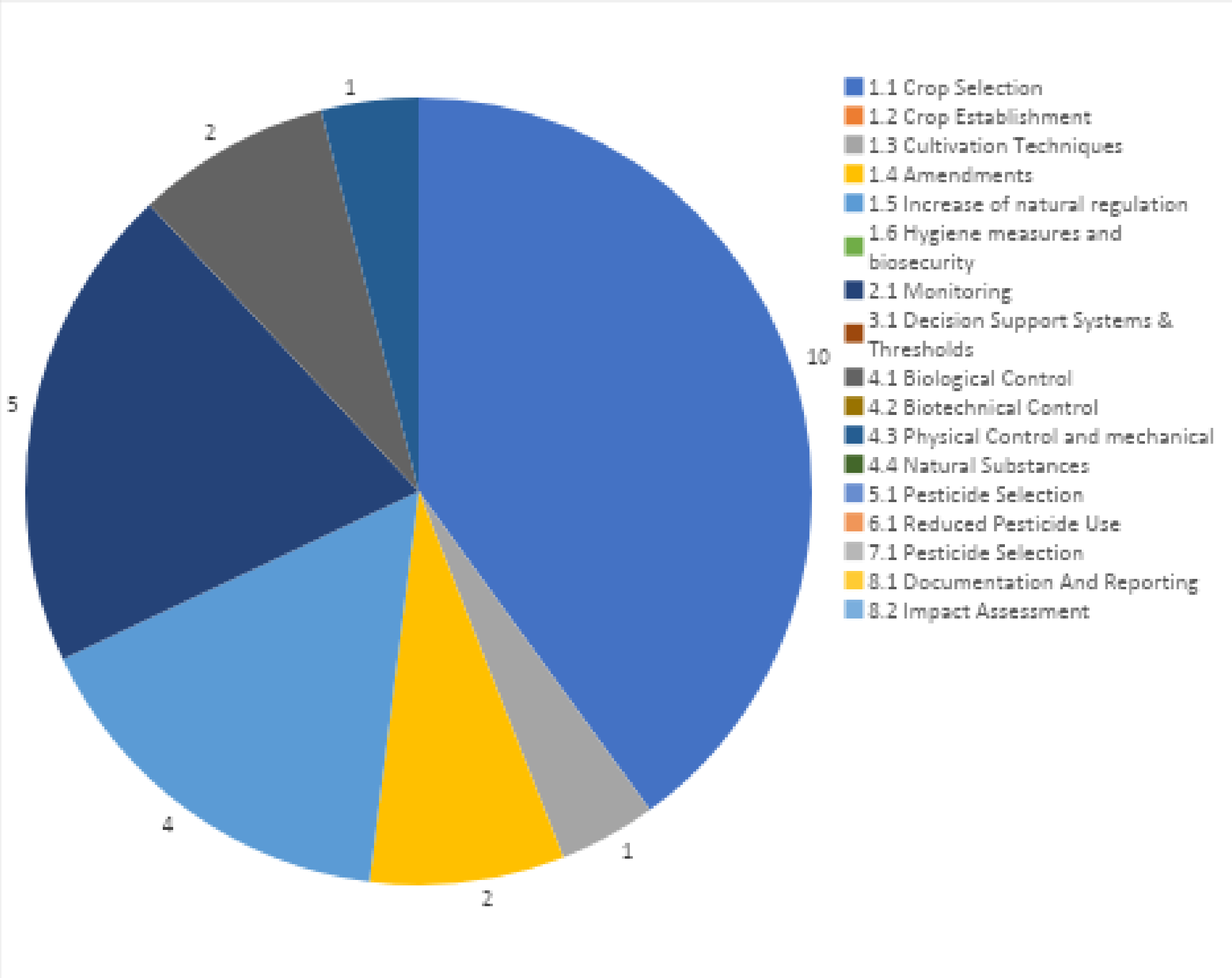

Figure 21. Categorical distribution of IPM practices (Level 1 classification)

Regarding the distribution of IPM practices across Level 1 categories, the dominant area is clearly 1.1 Crop selection, which includes no fewer than 10 practices, highlighting the central role of selecting crop material adapted to specific growing conditions. The second most frequent category is 2.1 Monitoring with 5 practices, followed by 1.5 Increase of natural regulation with 4 practices. 1.4 Amendments and 2.1 Monitoring count 2 practices each, and the last represented categories are 1.3 Cultivation Techniques and 4.3 Physical Control and mechanical with one practice each.

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7.6. Year of practice implementation filter

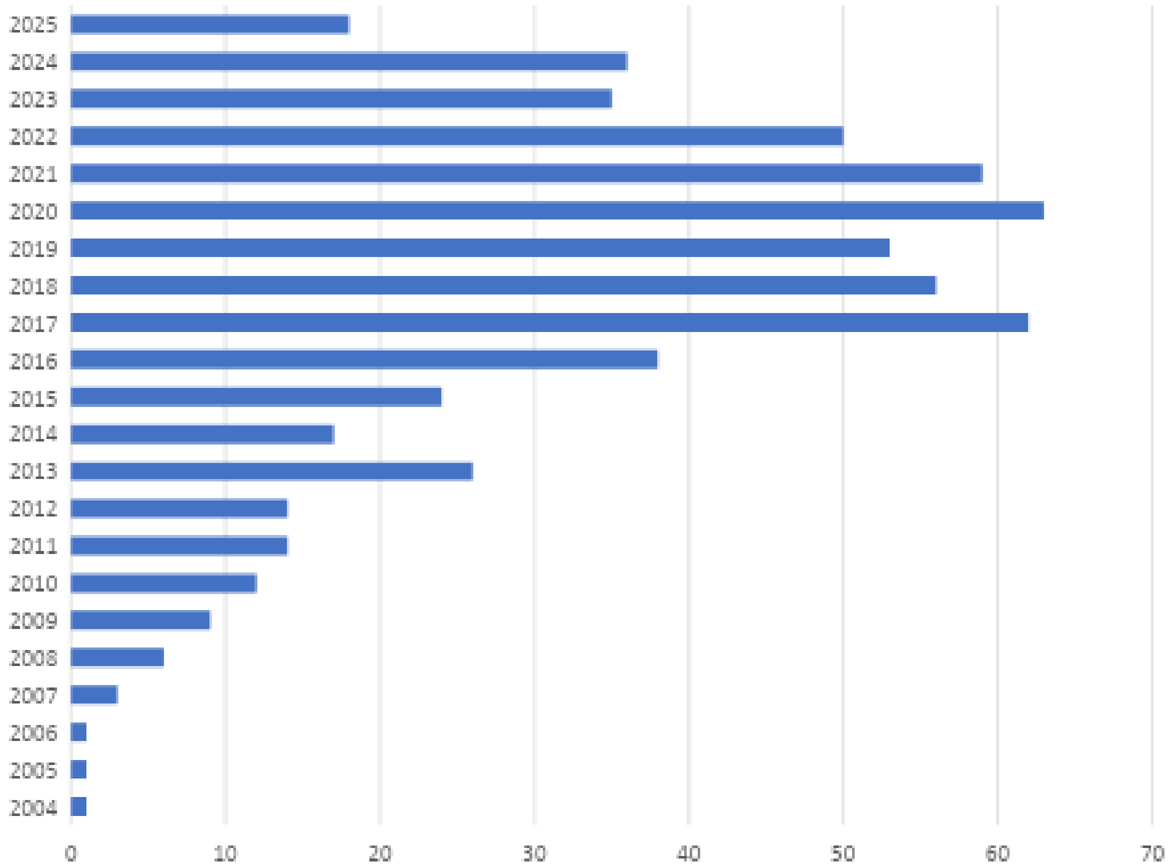

Figure 22. Distribution of practices by year of implementation

Regarding the year of practice implementation, the data shows a clear upward trend starting in 2013, reaching a peak in 2017-2021 period. Starting 2022 a moderate decline can be observed, although the number of implemented practices remains substantial, including those planned for 2025. Practices implemented before 2012 are relatively few, highlighting the recent and innovative nature of most documented approaches.

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7.7. Quantify best practice analysis on each IPM principle and level.

IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
1. Prevention And Suppression	1.1 Crop Selection	1.1.1 Cultivar and Rootstock Diversity	1.1.1.1 Use Resistant And/or Tolerant Cultivars	Cultivar mixtures	1
				Cultivar monoculture	0
		1.1.2 Crop Species Diversity	1.1.2.1 Crop Rotation	Crop sequences	8
				Relay cropping	0
				Service/cover crop (sequential)	0
				Fallow (pest suppression through fallow)	0
			1.1.2.2 Intercropping	Crop species mixtures	0
				Service/cover crop (spatial)	0
		1.1.3 Adaptation To Site Conditions	1.1.3.1 Crop selection based on Soil Conditions	Agrochemical	0
				Soil texture	0
				Soil structure	0
				Microbiology	0
			1.1.3.2 Crop selection based on Climatic Region, Conditions, or Factors	Climatic maps/tools/instruments	0
				Winter hardiness/early versus late cultivar	0
			1.1.3.3 Crop selection based on Infested Area	Phytosanitary risk	0
		1.1.4 Seed/Planting Materials	1.1.4.1 Use Of Certified Seed	Use of a certified standard	0
				Physiological value (quick emergence)	0
				Phytosanitary quality (absence of pathogens and weed seeds)	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			1.1.4.2 Use Of Certified Planting Material	Use of a certified standard	0
			1.1.4.3 Seed Treatment	Microbial inoculants	1
				Steeping	0
				Thermic	0
				Botanicals	0
				Seed clusters	0
				Electron treatment	0
	1.2 Crop Establishment	1.2.1 Sowing	1.2.1.1 Sowing Time	Early/late sowing/delayed sowing	0
			1.2.1.2 Seeding Depth	Shallow or deep sowing	0
			1.2.1.3 Seed Density	Low density (disease prevention)	0
				High density (weed prevention)	0
			1.2.1.4 Sown plant spatial arrangement	Sowing in raised beds	0
				Sowing three densified rows	0
				Sowing positioned on the row and perpendicularity	0
		1.2.2 Planting (Cuttings/Seedlings)	1.2.2.1 Plant Spatial Arrangement	Row spacing	0
				Plant density	0
				Precision seeding/(patch cropping)	0
	1.3 Cultivation Techniques	1.3.1 Soil Cultivation	1.3.1.1 Reduced Tillage (Non-Inversion)	Cultivator (Tine or S-Tine Cultivator)	0
				Shallow Cultivator	0
			1.3.1.2 Direct Seed/ Direct Sowing	Drill Planters	0
				Seed Drills	0
				No-Till Seeders	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
				Air Seeders	0
			1.3.1.3 Plough (Inversion)	Moldboard Plough	0
				Chisel Plough	0
			1.3.1.4 Stale Seed Bed	Power Harrow	0
				Cultivator (Tine or S-Tine Cultivator)	0
		1.3.2 Crop management	1.3.2.1 Pruning	Appropriate time and weather condition	1
			1.3.2.2 Crop topping	Mechanical Topping	0
				Topping with Flail Mowers or Mulchers	0
		1.3.3 Harvest Management	1.3.3.1 Advanced Harvest Technology	Seed destruction	0
				Low impact harvest	0
			1.3.3.2 Optimal Harvest Timing	Early/late harvest	0
	1.4 Amendments	1.4.1.Suppressive Amendments	1.4.1.1 Mulching	Organic Mulch (e.g., straw, compost, wood chips)	0
				Inorganic Mulch (e.g., plastic film, gravel)	0
				Living Mulch (e.g., cover crops or ground cover)	2
				Temperature Regulation Mulch	0
			1.4.1.2 Organic Fertilisation	Compost (animal)	0
				Compost (plant)	0
				Green manure (cover crops)	0
				Vermicompost	0
				Animal Manure (Raw)	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			1.4.1.3 Mineral Fertilisation	Optimised Nutrient Dosing	0
				Use of Slow-Release Fertilisers	0
				Split Applications	0
		1.4.2 pH Management	1.4.2.1 Liming	Type of Lime (Calcium Carbonate vs. Dolomitic Lime)	0
				Application Timing	0
				Lime Particle Size (Fineness)	0
				Lime Incorporation (Depth of Application)	0
				Interaction with Fertiliser Application	0
		1.4.3 Water Management	1.4.3.1 Irrigation	Drip irrigation	0
				Automated Irrigation Systems	0
				Sensor-Based Irrigation Management	0
			1.4.3.2 Drainage	-	0
	1.5 Increase of natural regulation	1.5.1 Management Of Ecological Infrastructure	1.5.1.1 Creation Or Restauration Of Habitat For Beneficial Organisms Outside The Production Area	Hedges	2
				Beetle banks	0
				Field margins	0
				Semi natural habitat (SNH)	0
				Buffer zones	0
				Introduction of man made structures (e.g. bird poles, stone mounds, polinator shelter)	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			1.5.1.2 Creation Or Restoration Of Habitat For Beneficial Organisms Inside The Production Area	Flower strips	2
				Preserving grass clover between row	0
				Provision of nesting sites (permanent herbaceous spots…)	0
				Provision of nesting sites (natural)	0
				Provision of nesting sites (artificial)	0
				Introduction of man made structures (e.g. bird poles, stone mounds, pollinator shelter)	0
		1.5.2 Management Of Resources To The Pest (landscape)	1.5.2.1 Removal of non-crop hosts around the parcel	-	0
	1.6 Hygiene measures and biosecurity	1.6.1 Cleaning Of Machinery And Equipment	1.6.1.1 Cleaning Of Machinery And Equipment	Frequency of Cleaning	0
				Cleaning Techniques	0
				Water and Detergent Use	0
				Legal and Biosecurity Requirements	0
		1.6.2 Management Of Resources To The Pest (materials in field)	1.6.2.1 Water/Soil Sanitation	-	0
			1.6.2.2 Removal Of Inoculum Sources	Removal of plant debris	0
				Removal of infested plant parts	0
				Plant debris management	0
				Mulching/cutting of debris	0
				Weed Hosts	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			1.6.2.3 Suppression Of Pest And Disease Reservoirs	Crop Residue Management	0
				Alternate Hosts (Non-Crop Plants)	0
				Soil Reservoirs	0
				Water Sources	0
		1.6.3 Soil Disinfection	1.6.3.1 Removal Of Nematodes, Soil Pathogens	Sowing plant species with Soil disinfection/ disinfection effect	0
			1.6.3.2 Soil fumigation	-	0
Principle 1 – **Prevention and Suppression** – includes a total of 23 practices, making it the most comprehensive IPM principle documented. The largest contribution comes from 1.1 Crop Selection, with 10 practices, highlighting widespread implementation of genetic and functional diversification strategies. Key examples include Crop sequences (8 cases), Microbial inoculants (1 case), and Cultivar mixtures (1 case). The remaining practices are 1.5 Increase of natural regulation (4 cases), 1.4 Amendments (2 cases) and 1.3 Cultivation Techniques (1 case). Overall, the distribution emphasizes crop selection as the main preventive measure, supported by targeted practices aimed at enhancing agroecosystem resilience.					
2. Monitoring	2.1 Monitoring	2.1.1 Monitoring	2.1.1.1 Drone-Based Crop And Pest Monitoring	Drone Type and Specifications	0
				Flight Planning and Scheduling	0
				Integration with Other Monitoring Systems	0
				Calibration and Maintenance	0
			2.1.1.2 Field Observations	Visual inspection of plants	0
				Soil survey	0
				Visual inspection of plant debris	0
			2.1.1.3 Remote Sensing	Remote Sensing Technology and Sensors	0
				Resolution and Scale	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			2.1.1.4 Monitoring With Traps	Visual attractants	0
				Olfactory attractants (pheromones and feeding attractants)	2
				Smart traps	0
		2.1.2 Assessment	2.1.2.1 Monitoring Reports	Country level	0
			2.1.2.2 Advisory Service	Expertise and specialisation	0
				Customisation and recommendations	0
				Follow up and support	0
			2.1.2.3 Molecular detection tools	DNA-based analysis	1
				Enzyme based analysis	0
			2.1.2.4. Identification of pests and diseases	pest ID keys	0
			2.1.2.5 Geo-morphometric analysis for pest management	-	0
		2.1.3 Prognosis and forecast	2.1.3.1 Disease forecast models	weather conditions	0
			2.1.3.2 Disease prediction models	-	2
Principle 2 – **Monitoring** includes 5 reported practices: 2 practices under 2.1.1.4 Monitoring With Traps category, 2 under 2.1.3.2 Disease prediction models category and one practice under 2.1.2.3 Molecular detection tools.					
3. Decision making	3.1 Decision Support Systems & Thresholds	3.1.1 Prediction And Warning (Seasonal)	3.1.1.1 Use Of Pest And Disease Prediction Models	Thresholds	0
				Warning and Alert Systems	0
			3.1.1.2 Use Phenological Prediction Models	Growth stages prediction according to local climatic conditions	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			3.1.1.3 Use Water Monitoring And Prediction Modelling	Real time monitoring of field water capacity	0
		3.1.2 Predictive Farm Systems (Long Term/Systemic)	3.1.2.1 Modelling And Risk Assessment (Long Term)	Risk Factor Analysis (more detail required to which pest or risk it is)	0
		3.1.3 Thresholds	3.1.3.1 Thresholds	Thresholds for biological intervention	0
				Thresholds for chemical intervention	0
Principle 3 – **Decision making** – no practices founded under this principle.					
4. Biological, physical and other non-chemical methods	4.1 Biological Control	4.1.1 Supplemental Release Of Live Beneficials	4.1.1.1 Release of Macrofauna (e.g. above ground arthropod predators)	-	0
			4.1.1.2 Release of Microflora and Fauna (bacteria, fungi, nematoda)	entomopathogenic nematodes	1
	4.2 Biotechnical Control	4.2.1 Attractants And Repellents (natural)	4.2.1.1 Planting Of Repelling/Disturbing Plants	Strips	0
				Spots	0
				Push-pull strategies	0
				Trap crops	0
		4.2.2 Attractants And Repellents(other)	4.2.2.1 Use Of Pheromone Traps	Mass trapping	0
				Mating disruption	0
				Pheromone sticky traps (colourless)	0
			4.2.2.2 Other (Olfactory) Attractants/Repellents	Ultrasound	0
				Induced resistance	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
		4.2.3 Stimulation And Interference	4.2.3.1 Plant Resistance Activation	Use of Elicitors	0
			4.2.3.2 Ozon treatment (abiotic interference)	different exposures levels	0
			4.2.3.3 UV light (abiotic interference)	different exposures levels	0
		4.2.4 Engeneering of biocontrol agents	4.2.4.1 Release of sterilised insect pest or organism	Mating interference	0
	4.3 Physical Control and mechanical	4.3.1 Barriers	4.3.1.1 Barriers: Natural Materials	Straw barrier	0
				Chalk barrier	0
				Salt barrier	0
			4.3.1.2 Barriers: Other Physical	Electric fences	0
				Nets	0
				Insect capture channels around fields to prevent walking insects from entering	0
		4.3.2 Thermal Control (Excluding Thermal Seed Treatment)	4.3.2.1 Heat Killing Of Pests And Diseases	Thermal weed control	0
				Soil sterilisation: steam	0
				Decontamination of amendments (of soil, planting materials, compost etc)	0
			4.3.2.2 Temperature Management	Temperature control/ plasticulture	0
				Cold storage temperatures to kill pests in fruit storage	0
				Hand or machine	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
		4.3.3 Mechanical removal of pests	4.3.3.1 Mechanical Weeding	Physical removal, electrical, burning Burning	0
				between rows	0
			4.3.3.2 Robotic removal of pests and weeds	-	0
		4.3.4 Visual Attractant	4.3.4.1 Mass Trapping	Coloured traps	0
				Pan traps	0
				Light traps	0
				Coloured sticky traps	0
	4.4 Natural Substances	4.4.1 Natural Substances	4.4.1.1 Essential Oils And Plant Extracts	Seed treatments	0
				Foliar/plant protection	0
			4.4.1.2 Bio-Pesticides/Botanical Pesticides	-	0
			4.4.1.3 Bio-Fertiliser/ Bio Products	-	0
Principle 4 – **Biological, physical and other non-chemical methods** – one practice founded here, under the 4.1.1.2 Release of Microflora and Fauna (bacteria, fungi, nematoda) category.					
5. Pesticide Selection	5.1 Pesticide Selection	5.1.1 Pesticide selection	5.1.1.1 Mixing Substances	-	0
			5.1.1.2 Single-Substance Choice	Choosing least harmful pesticide	0
				Choosing most specific pesticide	0
Principle 5 – **Pesticide selection** – no practices founded under this principle.					
6. Reduced pesticide use	6.1 Reduced Pesticide Use	6.1.1 Adapting spraying technology	6.1.1.1 Equipment/pesticide application techniques/machineries	Nozzle Selection and Calibration	0
				Spray Drift Control Technologies	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
				Automatic Section Control (ASC)	0
			6.1.1.2 Mode Of Application	Seed treatment/spraying	0
				Foliage application	0
			6.1.1.3 Precision Application	Band application	0
				Overall application	0
				Variable rate	0
				Spot spraying- green on brown selection of weeds	0
		6.1.2 Spray applications	6.1.2.1 Pesticide Dosage	Amount of spray liquid adapted to the crop	0
			6.1.2.2 Pesticide Timing	Weather conditions	0
				-	0
			6.1.2.3 Pesticide Frequency	Pest Population Dynamics	0
				Crop Growth Stage	0
				Environmental Conditions	0
			6.1.2.4 Pesticide And Adjuvants Placement	Pesticide only sprayed on the outside of orchard	0
Principle 6 – **Reduced pesticide use** – no practices founded under this principle.					
7. Anti-resistance strategies	7.1 Pesticide Selection	7.1.1 Choice Of Active Substance And Control Agent	7.1.1.1 Pesticide dosages (substance choice)	Appropriate dosages to kill sufficient level of pest and pathogens to avoid resistance	0
			7.1.1.2 Timing of pesticide application	Targeting Early Pest Stages	0
				Timing Based on Pest Thresholds	0
				Avoiding Late Application	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			7.1.1.3 Pesticide Replacement/Rotation	Rotating different mode of actions in active ingredients	0
			7.1.1.4 Pesticide Mixtures (Mixtures Of Moa)	Compatibility of Active Ingredients	0
				Dosage adjustment	0
Principle 7 – **Anti-resistance strategies** – no practices founded under this principle.					
8. Evaluation	8.1 Documentation and Reporting	8.1.1 Record Keeping	8.1.1.1 Maintaining detailed activity logs	Fertilizer applications documentation	0
				fungicide application documentation	0
				pesticide application documentation	0
				IPM measure implementation	0
			8.1.1.2 Maintaining Pest Monitoring Records	On farm monitoring records	0
		8.1.2 Reporting Systems	8.1.2.1 Use of standardised reporting format	Standardised reporting across regions/countries	0
			8.1.2.2 Use of digital reporting systems	Farm internal use	0
			8.1.2.3 Risk assessment reports	-	0
			8.1.2.4 Data Sharing Platforms	-	0
	8.2 Impact Assessment	8.2.1 Efficacy Evaluation	8.2.1.1 Performance measurement	Pesticide efficacy	0
				Fungicide efficacy	0
				Herbicide efficacy	0
		8.2.2 Environmental Assessment	8.2.2.1 Assess Long-Term Environmental Sustainability	-	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
			8.2.2.2 Assess Impact on Biodiversity	Biodiversity asessment on farm	0
			8.2.2.3 Assess soil Health and Structure	Soil health and structure asessment on farm	0
			8.2.2.4 Assess Ecosystem Services	Ecosystem service asessment on farm	0
			8.2.2.5 AssessWater Quality	Water quality asessment on farm	0
		8.2.3 Societal Assessment	8.2.3.1 Assess Equity and Access	Equity and Acess assessment to IPM implementation across farms	0
			8.2.3.2 Assess Cultural and Social Values	Soietal asessment of IPM uptake	0
			8.2.3.3 Education and Awareness	Farmers round tables	0
			8.2.3.4 Education and Awareness	IPM workshops	0
		8.2.4 Economic Assessment	8.2.4.1 Assess Labour Costs and Expertise	-	0
			8.2.4.2 Availability of Subsidies and Support	Comprehensive list of subsidies	0
			8.2.4.3 Environmental Impact and Regulation	-	0
			8.2.4.4 Assess Long-Term vs. Short-Term Costs (Investments)	On farm IPM cost asessment	0
			8.2.4.5 Market Prices and Economic Conditions	-	0
			8.2.4.6 Crop Value and Yield	Market evaluation of crop and crop quality	0
			8.2.4.7 Cost of Control Measures	Effectivve on farm IPM implementation cost	0

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IPM principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)	No. of practices
Principle 8 – **Evaluation** – – no practices founded under this principle.					

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7.8. Current level of development category filter

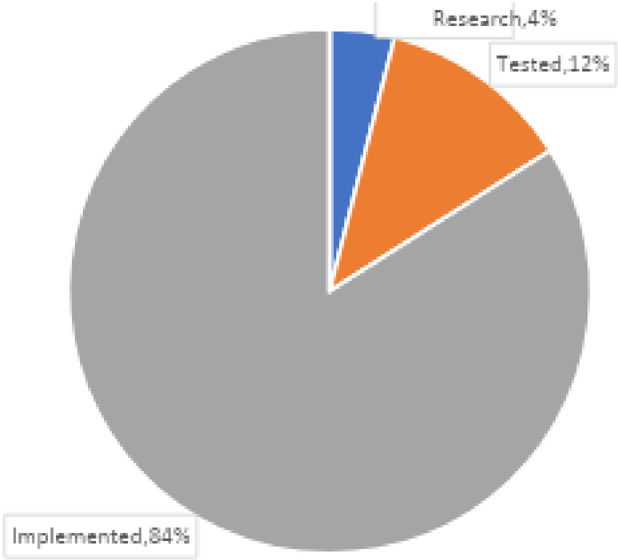

Figure 23. Classification of practices by development stage

Regarding the current level of development of the analyzed practices, the majority (84%) are Implemented, demonstrates a high degree of maturity and readiness for real-world application. 12% of the practices are under testing, indicating that they have already been validated under experimental or semi-practical conditions, and 4% are at the research level.

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7.9. Impact indicators category filter

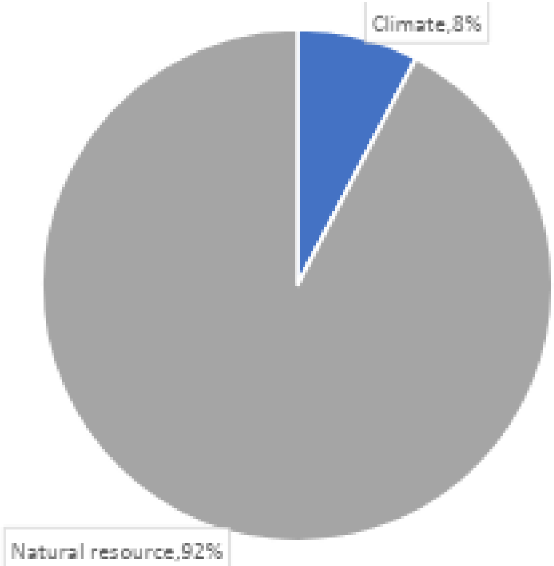

Figure 24. Classification of practices according to impact domains

Regarding the impact indicators, most of the analysed practices focus on preserving Natural resources (92%). The rest of the practices (8%) focus on climate, reflecting an overall commitment to environmental sustainability.

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Appendix 4 : New practices suggestions from EU and national projects

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Propositions of new IPM taxonomy layers from the analyzed projects

IPM-principle	Level 1 (target)	Level 2 (strategy)	Level 3 (practice)	Level 4 (conditions)
2. Monitoring	2.1 Monitoring	2.1.2 Assessment	2.1.2.4. Identification of pests and diseases	**New early detection methods**
4. Biological, physical and other non chemical methods	4.1 Biological Control	4.1.1 Supplemental Release Of Live Beneficials	4.1.1.2 Release of Microflora and Fauna (bacteria, fungi, nematoda)	**Microorganisms**
4. Biological, physical and other non chemical methods	4.1 Biological Control	4.1.1 Supplemental Release Of Live Beneficials	4.1.1.2 Release of Microflora and Fauna (bacteria, fungi, nematoda)	**Mix of plants extracts, microorganisms and resistance inducers**
4. Biological, physical and other non chemical methods	4.4 Natural Substances	4.4.1 Natural Substances	**4.4.1.4. Antimicrobial peptides**	**Replace traditional antibiotics**
1. Prevention And Suppression	1.4 Amendments	1.4.1.Suppressive Amendments	1.4.1.2 Organic Fertilisation	**Mixt organic based fertiliser: microbial+animal derived fertiliser**
4. Biological, physical and other non chemical methods	4.4 Natural Substances	**4.2.5 Targeted biological control**	**4.2.5.1. RNA interference**	**Suppression of a ecdysone receptor complex function by gene silencing**

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4. Biological, physical and other non chemical methods	4.2 Biotechnical Control	**4.2.6 Synthetic Substances**	**4.2.6.1 Synthetic insect growth regulators (S-IGRs)**	**Synthetic endocrine disruptors (neuropeptide disruptors)**
4. Biological, physical and other non chemical methods	4.1 Biological Control	4.1.1 Supplemental Release Of Live Beneficials	4.1.1.2 Release of Microflora and Fauna (bacteria, fungi, nematoda)	**Use of native atoxigenic strains**
6. Reduced pesticide use	6.1 Reduced Pesticide Use	6.1.2 Spray applications	**6.1.2.5 Pesticides mix**	**Combination of two or more active substances**
1. Prevention And Suppression	1.3 Cultivation Techniques	1.3.2 Crop management	**1.3.2.3. Mix of different management practices**	**Combination of different agronomic and biological practices**
5. Pesticide Selection	5.1 Pesticide Selection	5.1.1 Pesticide selection	5.1.1.1 Mixing Substances	**Choosing different MoA pesticides**
6. Reduced pesticide use	6.1 Reduced Pesticide Use	6.1.2 Spray applications	**6.1.2.5. Localised Spraying**	**Spot spraying**
4. Biological, physical and other non chemical methods	4.3 Physical Control and mechanical	4.3.3 Mechanical removal of pests	4.3.3.1 Mechanical Weeding	**Inter-row hoeing**
6. Reduced pesticide use	6.1 Reduced Pesticide Use	6.1.2 Spray applications	**6.1.2.5. Localised Spraying**	**Band spraying**
1. Prevention And Suppression	1.1 Crop Selection	1.1.2 Crop Species Diversity	**1.1.2.3 Diversified use of species diversity**	**Alternating different crop**

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4. Biological, physical and other non chemical methods	4.1 Biological Control	4.1.1 Supplemental Release Of Live Beneficials	4.1.1.2 Release of Microflora and Fauna (bacteria, fungi, nematoda)	**Entomopathogenic fungi**
4. Biological, physical and other non chemical methods	4.4 Natural Substances	4.4.1 Natural Substances	**4.4.1.1 Post-harvest products**	**Natural**

*New layers proposals from **European projects** (with **Bold and Red**)*

IPM-principle	**Level 1 (target)**	**Level 2 (strategy)**	**Level 3 (practice)**	**Level 4 (conditions)**
1. Prevention And Suppression	1.4 Amendments	1.4.1.Suppressive Amendments	1.4.1.3 Mineral Fertilisation	**Recycling fertiliser**
2. Monitoring	2.1 Monitoring	2.1.1 Monitoring	2.1.1.2 Field Observations	**Tapping method**
1. Prevention And Suppression	1.3 Cultivation Techniques	1.3.1 Soil Cultivation	1.3.1.1 Reduced Tillage (Non-Inversion)	**Strip-till**
1. Prevention And Suppression	1.3 Cultivation Techniques	1.3.1 Soil Cultivation	**1.3.1.5 Mulch sowing**	

*New layers proposals from **National projects** (with **Bold and Red**)*

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Appendix 5 : Codling moth case study

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Case study: Evaluation and classification of plant protection measures against *Cydia pomonella* L. (codling moth) by applying the comprehensive indicators developed within the Agrowise project

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1. Introduction

As a result of Task 2.3, standardized metrics were developed for the comparison of integrated pest management (IPM) practices and systems in the European Union. The proposed metric informs national authorities and can support farmers. It enables the monitoring of the effectiveness of pesticide reduction practices and systems and facilitates the follow-up of implemented measures. In this case study, we evaluated the available IPM practices that can be used against codling moth (CM) against the developed indicators.

2. Methodology

2.1 Evaluation parameters

To assess the value of a particular IPM practice, several factors are considered, including pesticide use reduction, pest control effectiveness, impact on biodiversity and other relevant parameters — in short, how valuable the practice is overall. To quantify this value, a specific metric was developed, which is described in detail in the deliverable of Task 2.3 and presented in Table 1. Based on the scores for each specific parameter, we evaluated the agronomic service provided (ASP) of each specific IPM practice, and then we evaluated the Improvement of Agronomic Service Provided (IASP) as another key parameter that assesses the progress of a new practice compared to existing practices (the „reference practice „for each country) for the same crop/pest combination. Each parameter was determined based on a comprehensive literature review and on expert opinion and experience. The ASP of each practice was assessed based on the evaluations and discussion with the experts. Figure 1 shows the interpretation of the ASP and IASP combinations.

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Table 1. List of parameters that were evaluated for each practice together with the definition and detailed description of ratings

PARAMETER	DEFINITION
Practice	Type of IPM practice evaluated
Effectiveness Against Target (%)	Measure how effective (%) a practice is against the target pest, rated from 1 (low) to 5 (high) based on field studies (literature review) or expert opinions.
Capacity to Reduce Pesticide Use /5	Assesses the potential to reduce pesticide use, rated from 1 (low reduction) to 5 (complete replacement).
Level of Pest Harmfulness /5	Rates the impact of a pest, with 1 for minor target pest and 5 for major target pests causing significant damage. This level is, wherever possible, based on field studies and literature review. When such studies or literature sources are unavailable, the level is assessed by an expert panel
Effect on Biodiversity	Evaluates the direct impact on biodiversity, rated from "--" (negative) to "++" (positive) (with the five levels being "--", "-", "0", "+", "++") where a highly positive effect allows for the restoration of certain biodiversity parameters. Note that this parameter reflects the direct effect of the practice on biodiversity. This impact is, wherever possible, based on field studies and literature review. When such studies or literature sources are unavailable, the impact is assessed by an expert panel.
Associated with Prophylaxis (Yes/No**)**	Indicates if the practice is preventive (Yes) or not (No).
Effect on Other Environmental Domains (-,0, +)	Assesses broader environmental impacts such as soil or water, rated as negative (-), neutral (0), or positive (+). This dimension aims to identify, when possible, in which environmental compartment the effect is observable and whether the effect is positive, negative, or neutral. These effects can vary widely and may include factors such as indirect effect on biodiversity (through the reduced pesticide use), nitrogen input or water resources preservation.
Territorial Scale	At what scale should the effects of the practice be evaluated: field (<4 ha), block of fields, or territory.
Temporal Scale	How long the effect of the practice lasts. What are the dynamics of the action? Is it a multi-year effect following the use of the practice, or is it a cumulative effect? The three modalities for this parameter will be: annual effect, multi-year effect, and cumulative effect. This parameter enables us to highlight the fact that a practice renders an additional service when it is renewed (cumulative effect), or a service when it is implemented and preserved over a long period of time (long-term effect). This information is decisive in adapting the mode of support for the implementation of the practice.
Anticipation /5	Anticipation is the time between the first use of the practice and the significant effects of this action:1 (day), 2 (week), 3 (month), 4 (year) and 5 (multi-year).

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Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Evaluates the likelihood of resistance development if the practice is widely adopted (rare, possible, likely).
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	The impact of introducing the practice on the overall resistance risk of the strategy including effects on treatments that the method does not directly target (reduction, maintenance, or increase in risk).
ASP (Agronomic service provided)	Measures how well a practice maintains crop yield and income while protecting crops. The assessment of the ASP is evaluated based on the above parameters, rated as: Major ASP (ASP III); Moderate (ASP II) or Low (ASP I) and Insufficient ASP (ASP 0).

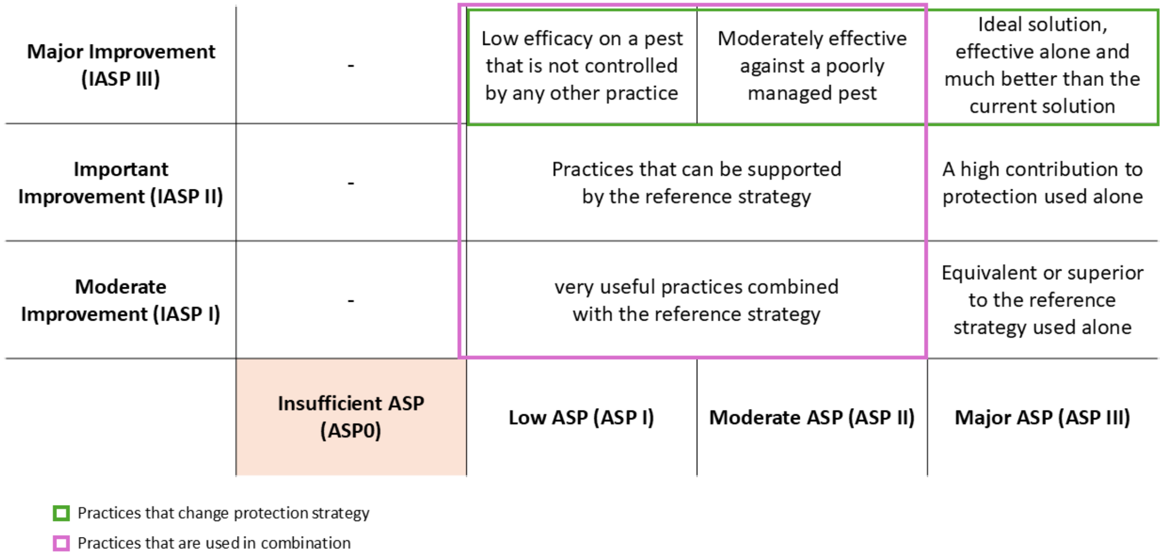

Figure 1. Interpretation of ASP and IASP combinations

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2.2 IPM practices that could be used for Codling moth control

Based on the intensive discussion among experts in the Agrowise project we defined the list of available IPM practices that can be used for codling moth control (Table 2). The practices are systematized according to the taxonomy produced as part of Work package 2 of the Agrowise project.

Table 2. List of the IPM practices that are available for codling moth control in apple orchards

IPM principle	Practice
1. Prevention and suppression	1.5.1 Management of ecological infrastructure (Promote the impact of naturally occurring beneficial insects such as earwigs and Anthocorids)
	1.6.2.2 Removal of infested plant parts - Collecting infested apple fruits (removing / destroying dropped fruit as a reservoir)
	1.6.2.3 Suppression of Pest and Disease Reservoirs (Proximity of potential pest reservoirs (Apple, Pear, crab apple, neighboring orchards, ornamental planting) that can support pests
2. Monitoring	2.1.1.2 Field observations – oviposition marks on fruits from May on (depending on region)
	2.1.1.4 Monitoring with traps / Smart traps
	2.1.2.2 Advisory service
3. Decision making	3.1.1.1 Use of pest and disease prediction models
	3.1.3. Thresholds
4. Non-chemical solutions	4.1.1 Supplemental Release of Live Beneficials - Cydia pomonella Granulovirus - CpGV
	4.1.1 Supplemental Release of Live Beneficials- *Steinernema carpocapse*, *Steinernema feltiae*
	4.1.1. Supplemental release of live beneficials – *Trichogramma* species
	4.2.2.1 Use of Pheromone Traps - Mating disruption (Pheromone dispensers for insect confusion)
	4.2.2.1 Use of Pheromone traps – Mass trapping
	4.2.4.1 Sterilized insect pest or organism – SIT

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	4.3.1.2 Barriers: Other Physical – Nets - Insect proof nets mesh size (2.4 x 4.8 mm) used to protect orchards from hail
	4.3.1.2 Barriers - cardboard banning (belts) - Cardboard banding applied to the trunks of host trees, works as a trap for codling moth larvae
	4.4.1.2 Biopesticides/Botanical pesticides
6. Reduced pesticide use	6.1.1.1 Equipment/pesticide application techniques/machineries – nozzle selection and calibration/ spray drift control technologies - recycling sprayer
7. Resistance management	7.1.1.3 Pesticide replacement/rotation – alternation of active ingredients

2.3 Evaluation

The evaluation process was carried out in three phases. In the first phase, the available literature on each IPM practice was collected. After careful reading of the literature, the expert panels from Croatia and France organized a workshop where they discussed the literature sources and agreed on their opinion and assessment of each specific parameter and ASP for chosen IPM practices. The Croatian expert panel identified the reference practice for Croatia and estimated the IASP for IPM practices by comparing the ASP with the reference practice.

Each partner of the Agrowise project was asked to identify and describe the reference practice for their country (Table 3), give their opinion on the identified ASP of IPM practices and provide evidence for a possible correction of the estimated ASP, and estimate the IASP of each IPM practice for their country.

All participating team members organized a joint workshop where the correction of the ASP of each practice was discussed and the IASP of each practice was reassessed based on possible corrections.

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Table 3. Description of the reference practices in Croatia, France, Germany, Ireland and Italy

Country	Reference practice	Detailed description
Croatia	5-7 insecticide treatments /season	The insecticide treatment decision should be based on the capture of the moths on pheromone traps (3-5 moths/trap) or on the fruit inspection (2% of infested fruits for the first generation and 1% of infested fruit for the second generation). Allowed and applied insecticides are: deltamethrin (2 treatments/season), esfenvalerate (3 treatments/season), acetamiprid (1 treatment/season), emmamectin benzoate (3 treatments/season), tebufenozide (2 treatments7season), pyriproxyfen (2 treatements/ season), abamectin + chlorantraniliprole (1 treatment/season), chlorantraniliprole (1 treatment/season).
France	6-12 insecticide treatments/season or 2 insecticide treatments + mating disruption (1-3)	The use of mating disruption alone can reduce the number of conventional insecticide treatments to **2** on healthy orchards, positioned to complement the peak of codling moth flight. The diffusers are placed in the upper third of the trees, and the edges of the plot are reinforced (10 to 20% more). 1 to 3 applications per season, depending on the target and the type of diffuser, are recommended. The number of diffusers per hectare depends on the supplier (500-1000/ha). They must be applied before the start of the first flight. This practice requires regular observations (every 10 to 15 days) on the upper part of the trees and on the fruit, with particular attention paid to the edges of the “confused” zone to ensure that the method is effective, and to intervene quickly if confusion alone is insufficient. Also, the effectiveness of this method is highly dependent on surface area. The minimum surface area varies from 1 to 3 ha, depending on the type of diffuser, target, pest pressure and tree shape. The larger the surface area, the more effective the confusion. This often requires consultation between farmers in the same area. To optimize chemical control of codling moths in orchards, it is important to monitor the evolution of codling moth populations. Allowed insecticides: Cydia pomonella granulovirus (CpGV) and CpGV-V15 (max 10 treatments/season), CpGV-V22 (max 9 treatments/season), deltamethrine and lambda-cyalothrine (max 3 treatments/season), spinosad (max 2 treatments/season), *Baccilus thuringiensis* subsp kurstaki (Souche SA-11) (max 6 treatments/season), chlorantraniliprole and

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		cypermethrine (max 1 treatment/season), emamectine benzoate and tebufenozide (max 3 treatments/season).
Germany	mating disruption + 2-3 insecticide treatments /season	Installation of pheromone dispensers (RAK 3) for mating disruption before flight activity. Regular infestation control and fruit inspection are important (pheromone traps, 500-1000 fruits). Insecticide treatment based on thresholds: > 0.5% infestation end june, > 0.5-1% infestation at harvest. Insecticides: acetamipride (1 treatment/year), granulovirus (10 treatments/season), chlorantraniliprole (2 treatments/seaon), Bt kurstaki strain ABTS-351 (3 treatments/season), pyriproxyfen (2 treatments/season), tebufenozide (3 treatments/year).
Ireland	2-4 insecticide treatments / season	The insecticide treatment decision should be based on the capture of the moths on pheromone traps (3–5 moths/trap) and degree-day models. Using the RIMpro Cydia model, treatment timing is guided by the predicted egg development and larval hatch risk. Ovicides should be applied just before the egg hatch starts. Larvicides should be applied at the beginning of larval hatch, when the risk curve starts to rise and about 10–30% of eggs are predicted to hatch. A second treatment may be needed if the hatch period is prolonged. The following insecticides and biological agents are permitted in Irish orchards: Spinosad – up to 4 treatments/season (1 pre-blossom at 150 mL/ha and 3 post-blossom at 250 mL/ha), deltamethrin (3 treatments/season), chlorantraniliprole (2 treatments/season), acetamiprid (2 treatment/season), Bt kurstaki (e.g., 2348 strain) (3 treatments/season), CpGV (3 treatments/season) and pyriproxyfen (2 treatments/season).
Italy	Average 6 insecticide treatments/ season	Monitor at least 500 fruits per hectare for initial penetration holes and apply treatments if infestation levels exceed 0.3% in June, 0.5% in July, and 0.8% in August. Insecticides: tebufenozide, etofenprox, emamectin benzoate, chlorantraniliprole (2 treatments/season), spinosad (3 treatments/season), spinetoram (1 treatment/season), acetamiprid (no restriction in the number of treatments/seasons). Apart from sexual confusion, farmers can use: CpGV and entomopathogens.

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3. Results

Table 4. Evaluation process of Management of ecological infrastructure as IPM practice

1.5.1 Management of ecological infrastructure (Promote the impact of naturally occurring beneficial insects such as earwigs and Anthocorids)		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	10-15%	Cahenzli et al., 2019 Maalouly et al., 2013 Mátray and Herz 2022 Pajač Živković and Barić 2012 Ricci et al., 2011 Sigsgaard 2014
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	++	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	4 – year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**I – Low**	

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Table 5. Evaluation process of Removal of infested plant parts as IPM practice

1.6.2.2 Removal of infested plant parts - Collecting infested apple fruits (removing / destroying dropped fruit as a reservoir)		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	10-15%	Buehrer and Grieshop 2014 IRAC 2019 Judd et al., 1997 Steenwyk et al., 2015
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	3 – month	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**I – Low**	

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Table 6. Evaluation process of Suppression of Pest and Disease Reservoirs as IPM practice

1.6.2.3 Suppression of Pest and Disease Reservoirs (Proximity of potential pest reservoirs (Apple, Pear, crab apple, neighboring orchards, ornamental planting) that can support pests		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	<5%	Rici et al., 2009
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	-	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Territory	
Temporal Scale	Muti-year effect	
Anticipation /5	4 – year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Increase	
ASP (Agronomic service provided)	**0 - Insufficient**	

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Table 7. Evaluation process of Field observations – oviposition marks on fruits as IPM practice

2.1.1.2 Field observations – oviposition marks on fruits from May on (depending on region)		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	0	Bloomefield et al., 2017 Wood 1964
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 – year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**II - Moderate**	

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Table 8. Evaluation process of Monitoring with Smart traps as IPM practice

2.1.1.4 Monitoring with traps / Smart traps		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	0	Čirjak et al., 2022 Čirjak et al., 2023 Pajač Živković et al., 2020 Preti et al., 2021a Preti et al., 2021b Suto 2022
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	-	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 – year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**II - Moderate**	

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Table 9. Evaluation process of Advisory service as IPM practice

2.1.2.2 Advisory service		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	0	Pedersen et al., 2019 Toepfer et al., 2020
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 – year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II - Moderate**	

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Table 10. Evaluation process of Use of pest and disease prediction models as IPM practice

3.1.1.1 Use of pest and disease prediction models		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	0	Barros-Parada et al., 2015 Jiang Dong et al., 2018 Jones et al., 2013
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Block of fields	
Temporal Scale	Annual effect	
Anticipation /5	4 – year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**II - Moderate**	

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Table 11. Evaluation process of Thresholds as IPM practice

3.1.3. Thresholds		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	0	Knight and Light 2005 Wildbolz 1962
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Longterm effect	
Anticipation /5	4 – year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**II - Moderate**	

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Table 12. Evaluation process of Supplemental Release of Live Beneficials - Cydia pomonella Granulovirus – CpGV as IPM practice

4.1.1 Supplemental Release of Live Beneficials - Cydia pomonella Granulovirus - CpGV		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	75 - 95%	Fan et al., 2022 Huber and Dickler 1977 Lacey et al., 2004 Lacey et al., 2008 Stará and Kocourek 2003
Capacity to Reduce Pesticide Use /5	4	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	3 – month	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Very likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II - Moderate**	

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Table 13. Evaluation process of Supplemental Release of Live **Beneficials**- *Steinernema carpocapse, Steinernema feltiae* as IPM practice

4.1.1 Supplemental Release of Live Beneficials- *Steinernema carpocapse, Steinernema feltiae*		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	50%	Barić and Pajač Živković 2020 Grubišić et al., 2010 Lacey and Unruh 2005 Lacey et al., 2006
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 – year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II - Moderate**	

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Table 14. Evaluation process of Supplemental release of live beneficials – *Trichogramma* species as IPM practice

4.1.1. Supplemental release of live beneficials – *Trichogramma* species		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	70%	Cossentine and Jensen 2000 Damianov et al., 2014 Kienzle et al., 2012 Nagy 1973 Sauer 2017 Sigsgaard et al., 2017
Capacity to Reduce Pesticide Use /5	4	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	+	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Territory	
Temporal Scale	Multi-year effect	
Anticipation /5	2 – week	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II - Moderate**	

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Table 15. Evaluation process of Mating disruption as IPM practice

4.2.2.1 Use of Pheromone Traps - Mating disruption (Pheromone dispensers for insect confusion)		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	75%	Płuciennik 2013 Stelinski et al. 2008 Knight et al. 1995 Witzgall et al. 2008 Barić and Pajač Živković 2017
Capacity to Reduce Pesticide Use /5	5	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Block of fields	
Temporal Scale	Cumulative effect	
Anticipation /5	2 to 3	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction of resistance risk	
ASP (Agronomic service provided)	**III - Major**	

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Table 16. Evaluation process of Mass trapping as IPM practice

4.2.2.1 Use of Pheromone traps – Mass trapping		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	60%	Jaffe et al., 2018 Lösel et al., 2000 Proverbs et al., 1975
Capacity to Reduce Pesticide Use /5	4	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Block of fields	
Temporal Scale	Cumulative effect	
Anticipation /5	3 – month	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II - Moderate**	

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Table 17. Evaluation process of Sterilized insect pest or organism – SIT as IPM practice

4.2.4.1 Sterilized insect pest or organism – SIT		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	90%	Botto and Glaz 2010 Proverbs et al., 1982 Proverbs 1964 Thistlewood and Judd 2019 Vreysen et al., 2010
Capacity to Reduce Pesticide Use /5	5	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Territory	
Temporal Scale	Cumulative effect	
Anticipation /5	4 – year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**III - Major**	

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Table 18. Evaluation process of Nets - Insect proof nets as IPM practice

4.3.1.2 Barriers: Other Physical – Nets - Insect proof nets mesh size (2.4 x 4.8 mm) used to protect orchards from hail		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	80-90%	Alaphilippe et al., 2016 Baiamonte et al., 2016 Marshall and Beers 2022 Marshall and Beers 2023 Pajač Živković et al., 2016 Sauphanor et al., 2012 Tasin et al., 2008
Capacity to Reduce Pesticide Use /5	5	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	-/0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	-/0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 – year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**III - Major**	

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Table 19. Evaluation process of Cardboard banning (belts) as IPM practice

4.3.1.2 Barriers - cardboard banning (belts) - Cardboard banding applied to the trunks of host trees, works as a trap for codling moth larvae		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	78-86% (1. generation)	Judd et al., 1997 Kienzle et al., 2003
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	-	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 – year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II - Moderate**	

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Table 20. Evaluation process of Biopesticides/Botanical pesticides as IPM practice

4.4.1.2 Biopesticides/Botanical pesticides		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	40%	Creed et al., 2015 Gökçe et al., 2018 Pszczolkowski et al., 2011 Pszczolkowski 2023 Suomi et al., 1986
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	-	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	3 – month	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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Table 21. Evaluation process of nozzle selection and calibration/ spray drift control technologies - recycling sprayer as IPM practice

6.1.1.1 Equipment/pesticide application techniques/machineries – nozzle selection and calibration/ spray drift control technologies - recycling sprayer		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	80%	Ade et al., 2007 Doruchowski et al., 2017 Fornasiero et al., 2017 Jamar et al., 2010 Lešnik et al., 2005
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	--	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	2 – week	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Low	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**II - Moderate**	

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Table 22. Evaluation process of alternation of active ingredients as IPM practice

7.1.1.3 Pesticide replacement/rotation – alternation of active ingredients		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	90%	Bassi et al., 2009 Pajač Živković and Barić 2017
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	-	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	-	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 – year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**I - Low**	

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Table 23. ASP and IASP level assigned to each IPM practice – per country (dark green - major improvement, light green - important improvement, yellow - moderate improvement, red - no improvement)

Practice	ASP (Agronomic service provided)	IASP (Improvement of agronomic service provided)				
		Croatia	France	Germany	Ireland	Italy
1.5.1 Management of ecological infrastructure	**I** - Low	I	I	I	I	I
1.6.2.2 Removal of infested plant parts - Collecting infested apple fruits	**I** - Low	I	I	I/II	I	I
1.6.2.3 Suppression of Pest and Disease Reservoirs	**0** -Insufficient	0	0	0	0	I
2.1.1.2 Field observations - oviposition marks on fruits	**II** - Moderate	I	I	I/II	II	0
2.1.1.4 Monitoring with traps / Smart traps	**II** - Moderate	I	I	I	II	0
2.1.2.2 Advisory service	**II** - Moderate	II	II	I	II	I
3.1.1.1 Use of pest and disease prediction models	**II** - Moderate	I	I	I	I	0
3.1.3. Thresholds	**II** - Moderate	II	II	0	II	II
4.1.1 Supplemental Release of Live Beneficials - Cydia pomonella Granulovirus - CpGV	**II** - Moderate	II	II	0	II	III
4.1.1 Supplemental Release of Live Beneficials- *Steinernema carpocapse*, *S. feltiae*	**II** - Moderate	II	II	II	II	I
4.1.1. Supplemental release of live beneficials - *Trichogramma* species	**II** - Moderate	III	II	I	II	I
4.2.2.1 Use of Pheromone Traps - Mating disruption (Pheromone dispensers for insect confusion)	**III** - Major	III	I	0	III	0
4.2.2.1 Use of Pheromone traps - Mass trapping	**II** - Moderate	I	I	I	I	II
4.2.4.1 Sterilized insect pest or organism - SIT	**III** - Major	III	III	II	II	III
4.3.1.2 Barriers: Other Physical - Nets - Insect proof nets mesh size (2.4 x 4.8 mm) used to protect orchards from hail	**III** - Major	III	III	II	I	I
4.3.1.2 Barriers - cardboard banning (belts)	**II** - Moderate	I	II	I	I	I
4.4.1.2 Biopesticides/Botanical pesticides	**II** – Moderate	I	I	I	I	I
6.1.1.1 Equipment/pesticide application techniques/machineries - nozzle selection and calibration/ spray drift control technologies - recycling sprayer	**II** -Moderate	I	I	I	II	0
7.1.1.3 Pesticide replacement/rotation - alternation of active ingredients	**I** – Low	I	I	I	I	0

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4. References

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Appendix 6 : Powdery mildew case study

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Case study: Evaluation and classification of plant protection measures against powdery mildew in vineyards by applying the comprehensive indicators developed within the Agrowise project

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1. Introduction

As a result of Task 2.3, standardized metrics were developed for the comparison of integrated pest management (IPM) practices and systems in the European Union. The proposed metric informs national authorities and can support farmers. It enables the monitoring of the effectiveness of pesticide reduction practices and systems and facilitates the follow-up of implemented measures. In this case study, we evaluated the available IPM practices that can be used against powdery mildew in vineyards using the developed indicators.

2. Methodology

2.1 Evaluation parameters

To assess the value of a particular IPM practice, several factors are considered, including pesticide use reduction, pest control effectiveness, impact on biodiversity and other relevant parameters — in short, how valuable the practice is overall. To quantify this value, a specific metric was developed, which is described in detail in the deliverable of Task 2.3 and presented in Table 1. Based on the scores for each specific parameter, we evaluated the agronomic service provided (ASP) of each specific IPM practice, and then we evaluated the Improvement of Agronomic Service Provided (IASP) as another key parameter that assesses the progress of a new practice compared to existing practices (the „reference practice „for each country) for the same crop/pest combination. Each parameter was determined based on a comprehensive literature review and on expert opinion and experience. The ASP of each practice was assessed based on the evaluations and discussion with the experts. Figure 1 shows the interpretation of the ASP and IASP combinations.

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Table 1. List of parameters that were evaluated for each practice together with the definition and detailed description of ratings

PARAMETER	DEFINITION
Practice	Type of IPM practice evaluated
Effectiveness Against Target (%)	Measure how effective (%) a practice is against the target pest, rated from 1 (low) to 5 (high) based on field studies (literature review) or expert opinions.
Capacity to Reduce Pesticide Use /5	Assesses the potential to reduce pesticide use, rated from 1 (low reduction) to 5 (complete replacement).
Level of Pest Harmfulness /5	Rates the impact of a pest, with 1 for minor target pest and 5 for major target pests causing significant damage. This level is, wherever possible, based on field studies and literature review. When such studies or literature sources are unavailable, the level is assessed by an expert panel
Effect on Biodiversity	Evaluates the direct impact on biodiversity, rated from "--" (negative) to "++" (positive) (with the five levels being "--", "-", "0", "+", "++") where a highly positive effect allows for the restoration of certain biodiversity parameters. Note that this parameter reflects the direct effect of the practice on biodiversity. This impact is, wherever possible, based on field studies and literature review. When such studies or literature sources are unavailable, the impact is assessed by an expert panel.
Associated with Prophylaxis (Yes/No)	Indicates if the practice is preventive (Yes) or not (No).
Effect on Other Environmental Domains (-,0, +)	Assesses broader environmental impacts such as soil or water, rated as negative (-), neutral (0), or positive (+). This dimension aims to identify, when possible, in which environmental compartment the effect is observable and whether the effect is positive, negative, or neutral. These effects can vary widely and may include factors such as indirect effect on biodiversity (through the reduced pesticide use), nitrogen input or water resources preservation.
Territorial Scale	At what scale should the effects of the practice be evaluated: field (<4 ha), block of fields, or territory.
Temporal Scale	What are the dynamics of the action? Is it a multi-year effect following the use of the practice, or is it a cumulative effect? The three modalities for this parameter will be: annual effect, multi-year effect, and cumulative effect. This parameter enables us to highlight the fact that a practice renders an additional service when it is renewed (cumulative effect), or a service when it is implemented and preserved over a long period of time (long-term effect). This information is decisive in adapting the mode of support for the implementation of the practice.
Anticipation /5	Anticipation is the time between the first use of the practice and the significant effects of this action. This anticipation is based on continuous use of the practice over time (if the rotation is interrupted, the effects will not be realized): 1 (day), 2 (week), 3 (month), 4 (year) and 5 (multi-year).
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Evaluates the likelihood of resistance development if the practice is widely adopted (rare, possible, likely).
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	The impact of introducing the practice on the overall resistance risk of the strategy including effects on treatments that the method does not directly target (reduction, maintenance, or increase in risk).
ASP (Agronomic service provided)	Measures how well a practice maintains crop yield and income while protecting crops. The assessment of the ASP is evaluated based on the above parameters, rated as: Major ASP (ASP III); Moderate (ASP II) or Low (ASP I) and Insufficient ASP (ASP 0).

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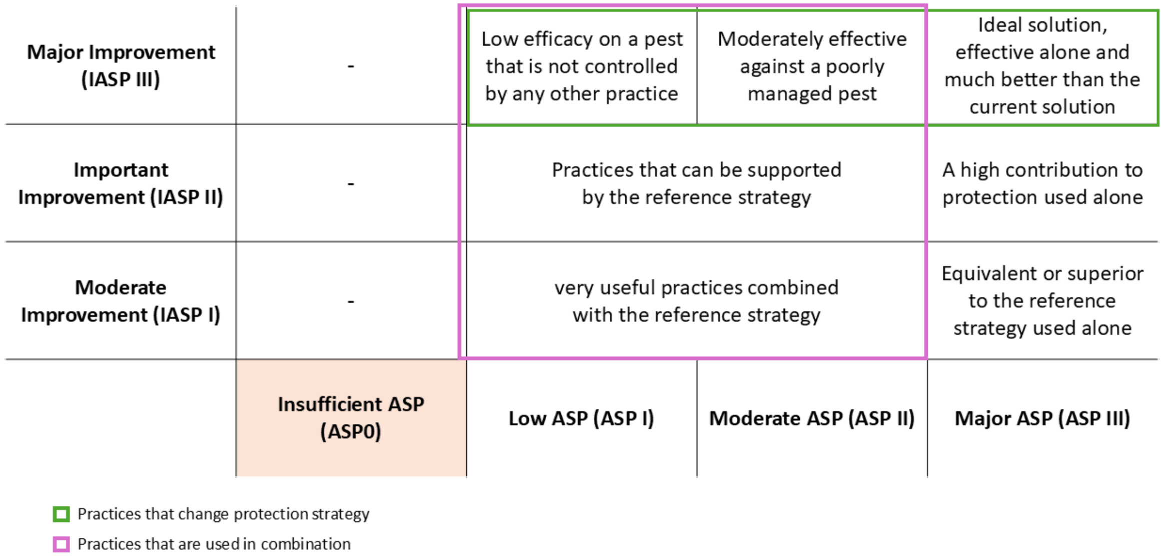

Figure 1. Interpretation of ASP and IASP combinations

2.2 IPM practices that could be used for powdery mildew control in vineyards

Based on the intensive discussion among experts in Agrowise project we defined the list of available IPM practices that can be used for powdery mildew control (Table 2). The practices are systematized according to the taxonomy produced as part of Work package 2 of the Agrowise project.

Table 2. List of the IPM practices that are available for powdery mildew control in vineyards

IPM principle	Practice
1. Prevention and suppression	1.1.1.1. Use Resistant varieties
	1.3.2.1. Pruning - Improve air circulation in the canopy to reduce humidity

	1.3.2.1. Pruning - reduce shading in the canopy
	1.3.2.1. Pruning - Removing flag shoots early in the season
	1.3.2.1 Pruning - Partial defoliation of the grape zone for better deposition of fungicides
	1.1.3 Crop Selection -> Adaptation to Site Conditions - Slope of the terrain recommended
2. Monitoring	2.1.2.2 Assessment -> Advisory Service
	2.1.1 Monitoring -> Monitoring - First monitoring of the underside of the leaf
	2.1.1 Monitoring -> Monitoring - Early monitoring with lab analysis for powdery mildew presence
3. Decision making	3.1.1.1. Use of disease prediction models - Decision support system e.g. Vitimeteo Oidium (DE)
4. Non-chemical solutions	4.4.1.1 Essential Oils and Plant Extracts - Sweet orange
	4.4.1.1. Essential Oils and Plant Extracts
	4.4.1.2. Natural substances: Biopesticides: Fungal extracts of Penicillium chrysogenum and Saccharomyces
	4.4.1.2. Natural substances: Bio-Pesticides/Botanical Pesticides - Bicarbonate
	4.4.1.2. Natural substances: Bio-Pesticides/Botanical Pesticides - Chitosan
	4.4.1.2. Natural substances: Bio-Pesticides/Botanical Pesticides - Sulfur
5. Pesticide selection	5.1.1. Pesticide selection
6. Reduced pesticide use	6.1.2.1 Pesticide dosage – reduced application in resistant varieties
	6.1.2.2 Pesticide timing – application start in critical situations from the 3-leaf stage, otherwise from the 5-leaf stage
	6.1.2.3 Pesticide Frequency - application intervals adapted to crop growth and weather conditions
	6.1.2.4. Spray application: Pesticide and adjuvants placement: Improving spray application efficiency and spray distribution in the canopy
7. Resistance management	7.1.1.2. Timing of pesticide application: A treatment of liquid lime sulfur before rainfall in winter

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2.3 Evaluation

Each partner of the Agrowise project involved in WP2 was asked to identify and describe the reference practice for their country (Table 3), give their opinion on the identified ASP of IPM practices and provide evidence for a possible correction of the estimated ASP, and estimate the IASP of each IPM practice for their country.

Table 3. Description of the reference practices in Croatia, France and Italy for powdery mildew in vineyards

Country	Reference practice	Detailed description
Croatia	Sulphur in the growing phase shortly before bud break, and tree to nine leaves. 1-2 treatments before flowering, followed by several fungicide treatments until the berries reach full size.	The number of fungicide treatments vary among years, regions and vineyards. In some areas the pressure is very high, all commercial cultivars are moderately or very susceptible. Organic vineyards still rely heavily on Sulphur, but some other substances are starting to be used more widely, e.g. CA hydrogen carbonate, certain bacillus-based bio fungicides, *Ampelomyces*-based bio fungicides, etc. Fungicides: more than 100 registered products
France	Continuous treatments from spring onwards. 6 to 7 PPP passes. The first (and sometimes the second) are sulfur-based The number of PPP treatments may vary (between 1 and 3).	Boscalides, Fluopyram, Fluxapyroxad, difenoconazole, penconazole, tebuconazole, tetraconazole, metrafenone, pyriofenone - Maximum 1 application per active substance to maintain mutational diversity. Do not use boscalide if already used as an antibotrytis agent. Spiroxamine, Flutianile – maximum 2 applications / season Proquinazide, Cyflufenamide - 1 application + 1 additional application if the duration of the protection period so requires. Orange essential oil - 6 applications max per crop (Product: Orocide). 7 applications max per crop (Product: Prev-gold). Therefore: product specific. Bacillus amyloliquefasciens – 10 applications - maximum
Italy	Sulphur in the phases between vegetative awakening and flowering. Two precautionary treatments before flowering and the end of product persistence used. EACH TIME: Alternate active	For table grapes, infected berries are not tolerated due to the depreciation of the product. Chemical interventions: in cases where it is necessary to carry out treatments in the phases between vegetative awakening and flowering, intervene with Sulphur - carry out 2 precautionary treatments mixed with anti-downy mildew products in the following phenological phases: immediately before flowering, at the end of flowering at the end of the persistence period of the product used

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	substances with different mechanisms of action	- in the phases between post-fruit setting and veraison, alternate the active substances with different mechanisms of action, adopting shorter intervals (max 10 days) in correspondence to the phases of greater growth of the grapes. - take care of the distribution of the s.a. using 800-1000 l/ha of water in the canopy vineyards. Low-risk substances can also be used in the case in which they are not explicitly stated in the crop sheets. It is, however, decided to explicitly state the s.a. in the sheet, where the adversity and the crop are present Products registered for powdery mildew: Eugenol, Geraniol, Timol, Laminarina, Zolfo, Ampelomyces Quisqualis, Bacillus amyloliquefaciens, Bacillus pumilus, Cerevisane, COS-OGA, Orange essential oil, Proquinazid, Pyriofenone, Bupirimate, Trifloxystrobin, Azoxystrobin, Pyraclostrobin, Ciflufenamid, Penconazol, Tetraconazol, Difenoconazol, Tebuconazol, Mefentrifluconazol, Spiroxamina, Boscalid, Fluxapyroxad, Metrafenone, Meptildinocap

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3. Results

1.1.1.1 Cultivar and Rootstock Diversity -> Use Resistant And/or Tolerant Cultivars		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	90%	
Capacity to Reduce Pesticide Use /5	5	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Territory	
Temporal Scale	Multi-year effect	
Anticipation /5	4-year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Major ASP – III**	

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1.1.3 Crop Selection -> Adaptation to Site Conditions - Slope of the terrain recommended		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)		
Capacity to Reduce Pesticide Use /5		
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Territory	
Temporal Scale	Multi-year effect	
Anticipation /5	5-multiyear	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**Moderate ASP – II**	

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1.3.2.1. Crop management -> Pruning - Improve air circulation in the canopy to reduce humidity		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)		CEPP Action sheet – 2023-123
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4-year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Low ASP – I**	

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1.3.2.1. Crop management -> Pruning - Reduce shading in the canopy		
PARAMETER	VALUE	SOURCE
Effectiveness Against Target (%)		
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4-year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Low ASP – I**	

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1.3.2.1. Crop management -> Pruning - Removing flag shoots early in the season		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)		
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4-year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Low ASP – I**	

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1.3.2.1. Crop management -> Pruning - Partial defoliation of the grape zone for better deposition of fungicides		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)		
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4-year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Low ASP – I**	

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2.1.1 Monitoring -> Monitoring - First monitoring of the underside of the leaf		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	25%	
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Block of fields	
Temporal Scale	Annual	
Anticipation /5	3 – month	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Moderate ASP - II**	

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2.1.1 Monitoring -> Monitoring - Early monitoring with lab analysis for powdery mildew presence		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)		CEPP Action sheet – 2021-094
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Block of fields	
Temporal Scale	Annual	
Anticipation /5	3 – month	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Moderate ASP - II**	

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2.1.2.2 Assessment -> Advisory Service		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)		CEPP Action sheets - 2019-055,2017-016
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Territory	
Temporal Scale	Annual	
Anticipation /5	3 – month	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Moderate ASP - II**	

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3.1.1.1 Prediction and Warning (Seasonal) -> Use of Pest and Disease Prediction Models - Decision support systems (Ex: Vitimeteo oidium DE)		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)		CEPP Action sheet – 2019-055
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Block of fields	
Temporal Scale	Annual effect	
Anticipation /5	3 – month	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Moderate ASP - II**	

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4.4.1.2 Natural Substances -> Bio-Pesticides/Botanical Pesticides - "Fungal extracts of Penicillum chrysogenum, saccharomyces		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)		CEPP Action sheet – 2025-028
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	2-week	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Moderate ASP - II**	

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4.4.1.1 Natural Substances -> Essential Oils And Plant Extracts		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	80%	
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	-	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	-	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	2-week	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Moderate ASP - II**	

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4.4.1.1 Natural Substances -> Essential Oils And Plant Extracts - Sweet orange		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	40%	CEPP Action sheet – 2024-044
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	-	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	-	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	2-week	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Moderate ASP - II**	

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4.4.1.2 Natural Substances -> Bio-Pesticides/Botanical Pesticides - Bicarbonate		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)		CEPP Action sheet – 2021-105
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	2-week	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Moderate ASP - II**	

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4.4.1.2 Natural Substances -> Bio-Pesticides/Botanical Pesticides - Chitosan		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)		CEPP Action sheet – 2023-104
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	2-week	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Moderate ASP - II**	

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4.4.1.2 Natural Substances -> Bio-Pesticides/Botanical Pesticides - Sulfur		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	75%	CEPP Action sheet – 2021-008
Capacity to Reduce Pesticide Use /5	4	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	2-week	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Major ASP - III**	

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5.1.1 Pesticide Selection -> Pesticide Selection		
PARAMETER	VALUE	SOURCE
Effectiveness Against Target (%)		
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	1-day	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Low ASP - I**	

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6.1.2.1 Spray Application -> Pesticide Dosage - Reduced application in resistant varieties		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)		CEPP Action sheet – 2022-108,2017-019
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	1-day	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Moderate ASP - II**	

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6.1.2.2 Spray Application -> Pesticide Timing - Application start in critical situation from the 3 leaf stage, otherwise from the 5 leaf stage		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)		CEPP Action sheet – 2021-101
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	1-day	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Low ASP - I**	

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6.1.2.3 Spray Application -> Pesticide Frequency - Application intervals adapted to growth and weather conditions		
PARAMETER	VALUE	SOURCE
Effectiveness Against Target (%)		
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	1-day	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**Low ASP - I**	

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6.1.2.4 Spray Application -> Pesticide and Adjuvants Placement - Improving spray application efficiency and spray distribution in the canopy		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)		
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	1-day	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**Low ASP - I**	

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7.1.1.2 Choice of Active Substance and Control Agent -> Timing of pesticide application - A treatment of liquid lime sulfur before rainfall in winter		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)		
Capacity to Reduce Pesticide Use /5		
Level of Pest Harmfulness /5	4	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	1-day	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**Low ASP - I**	

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Table 23. ASP and IASP level assigned to each IPM practice – per country (dark green - major improvement, light green - important improvement, yellow - moderate improvement, red - no improvement)

Practice	ASP (Agronomic service provided)	IASP (Improvement of agronomic service provided)		
		Croatia	France	Italy
1.1.1.1. Use Resistant varieties	**III - Major**	III	III	III
1.3.2.1. Pruning - Improve air circulation in the canopy to reduce humidity	**I - Low**	0	I	0
1.3.2.1. Pruning - reduce shading in the canopy	**I - Low**	0	I	0
1.3.2.1. Pruning - Removing flag shoots early in the season	**I - Low**	I	I	I
1.3.2.1 Pruning - Partial defoliation of the grape zone for better deposition of fungicides	**I - Low**	I	I	I
1.1.3. Crop Selection - Adaptation to Site Conditions	**II - Moderate**	I	I	II
2.1.1.2 Field observations – first monitoring of the underside of the leaf	**II - Moderate**	I	I	I
2.1.1 Monitoring -> Monitoring - First monitoring of the underside of the leaf	**II - Moderate**	0	I	0
2.1.1 Monitoring -> Monitoring - Early monitoring with lab analysis for powdery mildew presence	**II - Moderate**	0	I	0
3.1.1.1. Use of disease prediction models - Decision support system e.g. Vitimeteo Oidium (DE)	**II - Moderate**	II	I	II
4.4.1.2. Natural substances: Biopesticides: Fungal extracts of Penicillium chrysogenum and Saccharomyces	**II - Moderate**	II	I	II
4.4.1.1. Natural Substances -> Essential Oils and Plant Extracts	**II - Moderate**	I	I	II
4.4.1.1. Natural Substances -> Essential Oils and Plant Extracts – Sweet orange	**II - Moderate**	I	II	II
4.4.1.2. Natural substances: Biopesticides / Botanical pesticides - Bicarbonate	**II - Moderate**	II	I	I
4.4.1.2. Natural substances: Biopesticides / Botanical pesticides – Chitosan	**II - Moderate**	II	I	III
4.4.1.2. Natural substances: Biopesticides / Botanical pesticides – Sulfur	**III - Major**	0	I	0

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5.1.1. Pesticide selection	**I - Low**	**0**	**I**	**0**
6.1.2.1 Pesticide dosage – reduced application in resistant varieties	**II - Moderate**	**I**	**I**	**III**
6.1.2.2 Pesticide timing – application start in critical situations from the 3-leaf stage, otherwise from the 5-leaf stage	**I - Low**	**0**	**I**	**0**
6.1.2.3 Pesticide Frequency - application intervals adapted to crop growth and weather conditions	**I - Low**	**I**	**I**	**I**
6.1.2.4. Spray application: Pesticide and adjuvants placement: Improving spray application efficiency and spray distribution in the canopy	**I - Low**	**I**	**I**	**I**
7.1.1.2. Timing of pesticide application: A treatment of liquid lime sulfur before rainfall in winter	**I - Low**	**0**	**I**	**0**

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4. References

1. CEPP - https://commission-cepp.ecophyto.inrae.fr/fiches-action-cepp

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Appendix 7 : Weeds in arable crops case study

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Case study: Evaluation and classification of plant protection measures against weeds in arable crops by applying the comprehensive indicators developed within the Agrowise project

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1. Introduction

As a result of Task 2.3, standardized metrics were developed for the comparison of integrated pest management (IPM) practices and systems in the European Union. The proposed metric informs national authorities and can support farmers. It enables the monitoring of the effectiveness of pesticide reduction practices and systems and facilitates the follow-up of implemented measures. In this case study, we evaluated the available IPM practices that can be used against weeds in arable crops using the developed indicators.

2. Methodology

2.1 Evaluation parameters

To assess the value of a particular IPM practice, several factors are considered, including pesticide use reduction, pest control effectiveness, impact on biodiversity and other relevant parameters — in short, how valuable the practice is overall. To quantify this value, a specific metric was developed, which is described in detail in the deliverable of Task 2.3 and presented in Table 1. Based on the scores for each specific parameter, we evaluated the agronomic service provided (ASP) of each specific IPM practice, and then we evaluated the Improvement of Agronomic Service Provided (IASP) as another key parameter that assesses the progress of a new practice compared to existing practices (the „reference practice „for each country) for the same crop/pest combination. Each parameter was determined based on a comprehensive literature review and on expert opinion and experience. The ASP of each practice was assessed based on the evaluations and discussion with the experts. Figure 1 shows the interpretation of the ASP and IASP combinations.

In the literature review, the practices were almost exclusively system based. As a result, the first column – effectiveness, was hard or unable to estimate. To classify 'major', moderate' or 'low' ASP in this case, the following key was used:

- Major ASP - for practices that are in all (or almost all) the systems tested. These practices seem to be useful in almost all situations. Practices for which a significant effect and a measurable reduction in use can be established. These are practices that are therefore used as the first building block in a system redesign. These practices may be prophylactic or curative, and are often multi-purpose, even if the level of effect measured changes depending on the conditions.
- Moderate ASP - for practices that are often used in combination. Those practices that can, in certain specific cases, be used as the first building block in redesigning a system, but their own level of effect is more complicated to measure, and they are systematically

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associated with other practices (either major or minor) to be recognized as providing a service. They do not demonstrate a reduction in use without being associated with other practices, but they are nonetheless essential in the design of innovative systems.

- Low ASP – for practices that are rarely combined or used in very specific conditions. Those practices that are contextually associated with the previous ones to achieve greater services in combination. However, they are only of interest in a limited number of cases where they address targeted issues (one weed species, which is not harmful in most systems but can still be harmful in certain cases).

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Table 1. List of parameters that were evaluated for each practice together with the definition and detailed description of ratings

PARAMETER	DEFINITION
Practice	Type of IPM practice evaluated
Effectiveness Against Target (%)	Measure how effective (%) a practice is against the target pest, rated from 1 (low) to 5 (high) based on field studies (literature review) or expert opinions.
Capacity to Reduce Pesticide Use /5	Assesses the potential to reduce pesticide use, rated from 1 (low reduction) to 5 (complete replacement).
Level of Pest Harmfulness /5	Rates the impact of a pest, with 1 for minor target pest and 5 for major target pests causing significant damage. This level is, wherever possible, based on field studies and literature review. When such studies or literature sources are unavailable, the level is assessed by an expert panel
Effect on Biodiversity	Evaluates the direct impact on biodiversity, rated from "--" (negative) to "++" (positive) (with the five levels being "--", "-", "0", "+", "++") where a highly positive effect allows for the restoration of certain biodiversity parameters. Note that this parameter reflects the direct effect of the practice on biodiversity. This impact is, wherever possible, based on field studies and literature review. When such studies or literature sources are unavailable, the impact is assessed by an expert panel.
Associated with Prophylaxis (Yes/No)	Indicates if the practice is preventive (Yes) or not (No).
Effect on Other Environmental Domains (-,0, +)	Assesses broader environmental impacts such as soil or water, rated as negative (-), neutral (0), or positive (+). This dimension aims to identify, when possible, in which environmental compartment the effect is observable and whether the effect is positive, negative, or neutral. These effects can vary widely and may include factors such as indirect effect on biodiversity (through the reduced pesticide use), nitrogen input or water resources preservation.
Territorial Scale	At what scale should the effects of the practice be evaluated: field (<4 ha), block of fields, or territory.
Temporal Scale	What are the dynamics of the action? Is it a multi-year effect following the use of the practice, or is it a cumulative effect? The three modalities for this parameter will be: annual effect, multi-year effect, and cumulative effect. This parameter enables us to highlight the fact that a practice renders an additional service when it is renewed (cumulative effect), or a service when it is implemented and preserved over a long period of time (long-term effect). This information is decisive in adapting the mode of support for the implementation of the practice.
Anticipation /5	Anticipation is the time between the first use of the practice and the significant effects of this action. This anticipation is based on continuous use of the practice over time (if the rotation is interrupted, the effects will not be realized): 1 (day), 2 (week), 3 (month), 4 (year) and 5 (multi-year).
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Evaluates the likelihood of resistance development if the practice is widely adopted (rare, possible, likely).
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	The impact of introducing the practice on the overall resistance risk of the strategy including effects on treatments that the method does not directly target (reduction, maintenance, or increase in risk).
ASP (Agronomic service provided)	Measures how well a practice maintains crop yield and income while protecting crops. The assessment of the ASP is evaluated based on the above parameters, rated as: Major ASP (ASP III); Moderate (ASP II) or Low (ASP I) and Insufficient ASP (ASP 0).

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Major Improvement (IASP III)	-	Low efficacy on a pest that is not controlled by any other practice	Moderately effective against a poorly managed pest	Ideal solution, effective alone and much better than the current solution
Important Improvement (IASP II)	-	Practices that can be supported by the reference strategy		A high contribution to protection used alone
Moderate Improvement (IASP I)	-	very useful practices combined with the reference strategy		Equivalent or superior to the reference strategy used alone
	Insufficient ASP (ASP0)	**Low ASP (ASP I)**	**Moderate ASP (ASP II)**	**Major ASP (ASP III)**

Practices that change protection strategy

Practices that are used in combination

Figure 1. Interpretation of ASP and IASP combinations

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2.2 IPM practices that could be used for weed control in arable crops

Based on the intensive discussion among experts in Agrowise project, the list of available IPM practices that can be used for weed control was identified (Table 2). The practices are systematized according to the taxonomy produced as part of Work package 2 of the Agrowise project.

Table 2. List of the IPM practices that are available for weed control in arable crops

IPM principle	Practice
1. Prevention and suppression	1.1.1.1.2 Use Resistant And/or Tolerant Cultivars -> Cultivar monoculture / cultivar mixtures
	1.1.2.1.1 Crop Rotation -> Crop sequences
	1.1.2.1.3 Crop Rotation -> Service/cover crop (sequential)
	1.1.2.1.2 Crop Rotation -> Relay cropping
	1.1.2.1.4 Crop Rotation -> Fallow (pest suppression through fallow)
	1.1.2.2.1 Intercropping -> Crop species mixtures
	1.1.2.2.2 Intercropping -> Service/cover crop (spatial)
	1.1.3 Crop Selection -> Adaptation to Site Conditions
	1.1.4.1.2 Use of Certified Seed -> Physiological value (quick emergence)
	1.1.4.1.3 Use of Certified Seed -> Phytosanitary quality (absence of pathogens and weed seeds)
	1.1.4.3.1 Seed Treatment -> Microbial inoculants
	1.1.4.3.2 Seed Treatment -> Steeping / Seed clusters
	1.2.1.1 Sowing -> Sowing Time
	1.2.1.2 Sowing -> Seeding Depth
	1.2.1.3.2 Seed Density -> High density (weed prevention)
	1.2.1.4.2 Sown plant spatial arrangement -> Sowing three densified rows
	1.2.1.4.3 Sown plant spatial arrangement -> Sowing positioned on the row and perpendicularity
	1.3.1.1 Soil Cultivation -> Reduced Tillage (Non-Inversion)
	1.3.1.2 Soil Cultivation -> Direct Seed/ Direct Sowing
	1.3.1.3 Soil Cultivation -> Plough (Inversion)
	1.3.1.4 Soil Cultivation -> Stale Seed Bed
	1.3.2.2.1 Crop topping -> Mechanical Topping

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	1.3.2.2.2 Crop topping -> Topping with Flail Mowers or Mulchers
	1.3.3.1.1 Advanced Harvest Technology -> Seed destruction
	1.4.1.1.3 Mulching -> Living Mulch (e.g., cover crops or ground cover)
	1.4.2.1.1 Organic Fertilisation -> Compost (animal and plant)
	1.4.2.2 Balanced fertilisation -> Balanced Mineral Fertilisation
	1.4.4 Amendments -> Water Management
	1.5.1.1.3 Creation or Restauration of Habitat for Beneficial Organisms Outside the Production Area -> Field margins
	1.6.2.2.1 Removal of Inoculum Sources -> Removal of plant debris
	1.6.3 Hygiene measures and biosecurity -> Soil Disinfection
2. Monitoring	2.1.1.1.1 Monitoring -> Drone-Based Crop and Pest Monitoring
	2.1.1.2 Monitoring -> Field Observations
3. Decision making	3.1 Decision making -> Decision Support Systems & Thresholds
4. Non-chemical solutions	4.3.3.1 Mechanical removal of pests -> Mechanical Weeding
	4.4.1.1 Natural Substances -> Essential Oils and Plant Extracts
5. Pesticide selection	5.1.1 Pesticide Selection -> Pesticide Selection
6. Reduced pesticide use	6.1.2.4 Spray Application -> Pesticide and Adjuvants Placement
	6.1.1.1 Adapting Spraying Technology -> Equipment/pesticide application techniques/machineries
	6.1.1.2 Adapting Spraying Technology -> Mode of Application / Precision Application
	6.1.2.2 Spray Application -> Pesticide Timing
	6.1.2.1 Spray Application -> Pesticide Dosage
7. Resistance management	7.1.1.3 Choice of Active Substance and Control Agent -> Pesticide Replacement/Rotation

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2.3 Evaluation

Each partner of the task was asked to identify and describe the reference practice for their country (Table 3), give their opinion on the identified ASP of IPM practices and provide evidence for a possible correction of the estimated ASP, and estimate the IASP of each IPM practice for their country.

Table 3. Description of the reference practices in Croatia, France and Italy for weeds in arable crops

Country	Reference practice	Detailed description
Croatia	1 treatment / season + no tillage	1 treatment per season with combinations of active ingredients, combining with no tillage (around 10-20% area in Croatia is using no tillage). Active ingredients: fluroxypyr 200g/l, clopyralid 600g/l, 2-4D 600g/l, prosulfocarb 800g/l, amidosulfuron 750g/kg, tribenuron 750g/kg, combinationfor ex. - florasulam (6 g/l) + 2,4-D (450 g/l) . All active ingredients and combinations: https://fis.mps.hr/fis/javna-trazilica-szb/
France	3 treatments/ season + no tillage	The most frequent cropping system in France (based on the most recent study of protection practices, 2017) - 3 phytosanitary treatments (total number of doses: 1.8) and no systematic tillage, as 60% of wheat acreage undergoes no soil intervention.
Italy	2 treatments/ season + tillage	The most frequent cropping system for arable crops include the tillage of the soil and 2 treatments per crop season. The active substances and their limitation of use are listed in the Guidelines on regional level (https://www.reterurale.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/24285). In the case of wheat grown with no tillage, glyphosate is allowed in pre-sowing phase (once every two years). In the pre- or post-emergency phase, some substances, such as triallate, pendimetalin, flufenacet, bifenox, diflufenican, beflubutamine, chlorotoluron, can be applied to control the monocotyledons and the dicotyledons weeds. In the post-harvest phase, in case of no-tillage cultivation, pelargonic acid and glyphosate could be used for weeds management (glyphosate can be applied only if not used in the pre-sowing phase). EACH TIME: Alternate the active substances with different mechanisms of action.

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3. Results

1.1.1.2. Use Resistant And/or Tolerant Cultivars (cultivar monocultures and cultivar mixtures)		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	0%	Andrew et al. 2015 Wu et al. 2025
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	++	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**I – Low**	

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1.1.2.1.1. Crop Rotation -> Crop sequences		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	Nichols et al. 2015
Capacity to Reduce Pesticide Use /5	5	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	++	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Territory	
Temporal Scale	Cumulative effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**III – Major**	

*The evaluated practices are almost exclusively system based. As a result, the parameter - Effectiveness Against Target, was unable to estimate

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1.1.2.1.3. Crop Rotation -> Service/cover crop (sequential)		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	50%	Weisberger et al. 2019
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	++	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Block of fields	
Temporal Scale	Cumulative effect	
Anticipation /5	5 - multiyear	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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1.1.2.1.2. Crop Rotation -> Relay cropping		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	++	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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1.1.2.1.4. Crop Rotation -> Fallow (pest suppression through fallow)		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	Nichols et al. 2015
Capacity to Reduce Pesticide Use /5	4	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	++	
Associated with Prophylaxis (Yes/No**)**	Yes, no	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Multiyear effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**III – Major**	

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1.1.2.2.1 Intercropping -> Crop species mixtures		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	4	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	++	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**III – Major**	

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1.1.2.2.2 Intercropping -> Service/cover crop (spatial)		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	++	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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1.1.3 Crop Selection -> Adaptation To Site Conditions		
PARAMETER	VALUE	SOURCE
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	++	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**I – Low**	

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1.1.4.1.2 Use of Certified Seed -> Physiological value (quick emergence)		
PARAMETER	VALUE	SOURCE
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	++	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**I – Low**	

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1.1.4.1.3 Use of Certified Seed -> Phytosanitary quality (absence of pathogens and weed seeds)		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	+	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**0 – Insufficient**	

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1.1.4.3.1 Seed Treatment -> Microbial inoculants		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**I – Low**	

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1.1.4.3. Seed Treatment -> Steeping / Seed clusters		
PARAMETER	VALUE	SOURCE
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**I – Low**	

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1.2.1.1 Sowing -> Sowing Time		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	35 %	Andert et al. 2024
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**III – Major**	

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1.2.1.2 Sowing -> Seeding Depth		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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1.2.1.3.2 Seed Density -> High density (weed prevention)		
PARAMETER	VALUE	SOURCE
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	+	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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1.2.1.4.2 Sowing three densified rows		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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1.2.1.4.3 Sown plant spatial arrangement -> Sowing positioned on the row and perpendicularity		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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1.3.1.1 Soil Cultivation -> Reduced Tillage (Non-Inversion)		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	Tataridas et al. 2022 Sanaullah et al. 2020 Mpanga et al. 2020 Nichols et al. 2015
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	+	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	5 - multiyear	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**III – Major**	

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1.3.1.2 Soil Cultivation -> Direct Seed/ Direct Sowing		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	Murphy et al. 2006 Nichols et al. 2015
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	++	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	5 - multiyear	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**I – Low**	

1.3.1.3 Soil Cultivation -> Plough (Inversion)		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	--	
Associated with Prophylaxis (Yes/No**)**	Yes, No	
Effect on Other Environmental Domains (-,0, +)	-	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	4 – year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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1.3.1.4 Soil Cultivation -> Stale Seed Bed		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	4 – year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**III – Major**	

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1.3.2.2.1 Crop topping -> Mechanical Topping		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	5 - multiyear	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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1.3.2.2.2 Crop topping -> Topping with Flail Mowers or Mulchers		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	+	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	5 - multiyear	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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1.3.3.1.1 Advanced Harvest Technology -> Seed destruction		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	-	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	-	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	5 - multiyear	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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1.4.1.1.3 Mulching -> Living Mulch (e.g., cover crops or ground cover)		
PARAMETER	VALUE	SOURCE
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	4	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	++	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	5 - multiyear	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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1.4.2.1 Organic Fertilisation -> Compost (animal and plant)		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	+	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	5 - multiyear	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**I – Low**	

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1.4.2.2 Balanced Fertilisation -> Balanced Mineral Fertilisation		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	4	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	++	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	5 - multiyear	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**III – Major**	

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1.4.4 Amendments -> Water Management		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	5 - multiyear	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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1.5.1.1.3 Creation or Restauration of Habitat for Beneficial Organisms Outside the Production Area -> Field margins		
PARAMETER	VALUE	SOURCE
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	++	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	+	
Territorial Scale	Field	
Temporal Scale	Multiyear effect	
Anticipation /5	5 - multiyear	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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1.6.2.2.1 Removal of Inoculum Sources -> Removal of plant debris		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	5 - multiyear	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**II – Moderate**	

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1.6.3 Hygiene measures and biosecurity -> Soil Disinfection		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	4	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	--	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	-	
Territorial Scale	Field	
Temporal Scale	Multiyear effect	
Anticipation /5	3 - month	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**I – Low**	

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2.1.1.1 Monitoring -> Drone-Based Crop and Pest Monitoring		
PARAMETER	VALUE	SOURCE
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	-	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**II – Moderate**	

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2.1.1.2 Monitoring -> Field Observations		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	3	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**III – Major**	

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3.1. Decision making -> Decision Support Systems & Thresholds		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	Yes	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	4 - year	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	No	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**II – Moderate**	

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4.3.3.1 Mechanical removal of pests -> Mechanical Weeding		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	5	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	-	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	-	
Territorial Scale	Field	
Temporal Scale	Cumulative effect	
Anticipation /5	2-week	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Unlikely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**III – Major**	

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4.4.1.1 Natural Substances -> Essential Oils and Plant Extracts		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	50%	Tataridas et al. 2022 Travlos et al. 2020
Capacity to Reduce Pesticide Use /5	2	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	2 - week	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**I – Low**	

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5.1.1 Pesticide Selection -> Pesticide Selection		
PARAMETER	VALUE	SOURCE
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	1 - day	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**I – Low**	

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6.1.1.1 Adapting Spraying Technology -> Equipment/pesticide application techniques/machineries		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	60%	Vasileiadis et al. 2015 Loghavi et Mackvandi 2008 Dammer et Wartenberg 2007 Gerhards and Oebel 2006
Capacity to Reduce Pesticide Use /5	4	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	1 - day	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**II – Moderate**	

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6.1.1 Adapting Spraying Technology -> Mode of Application / Precision Application		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	Loddo et al. 2020
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	1 - day	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**II – Moderate**	

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6.1.2.1 Spray Application -> Pesticide Dosage		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	1 - day	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**I – Low**	

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6.1.2.2 Spray Application -> Pesticide Timing		
PARAMETER	VALUE	SOURCE
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	2 - week	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**I – Low**	

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6.1.2.4 Spray Application -> Pesticide and Adjuvants Placement		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	-	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	-	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	2 - week	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Maintenance	
ASP (Agronomic service provided)	**I – Low**	

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7.1.1.3 Choice of Active Substance and Control Agent -> Pesticide Replacement/Rotation		
PARAMETER	**VALUE**	**SOURCE**
Effectiveness Against Target (%)	*	
Capacity to Reduce Pesticide Use /5	1	
Level of Pest Harmfulness /5	5	
Effect on Biodiversity (--, -,0, +, ++)	0	
Associated with Prophylaxis (Yes/No**)**	No	
Effect on Other Environmental Domains (-,0, +)	0	
Territorial Scale	Field	
Temporal Scale	Annual effect	
Anticipation /5	3 - month	
Capacity of the Method to Withstand Resistance Risks- Resistance Risk Against the Practice	Likely	
Capacity of the Method to Withstand Resistance Risks- Modulation of Resistance Risk	Reduction	
ASP (Agronomic service provided)	**I – Low**	

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Table 23. ASP and IASP level assigned to each IPM practice – per country (dark green - major improvement, light green - important improvement, yellow - moderate improvement, red - no improvement)

Practice	ASP (Agronomic service provided)	IASP (Improvement of agronomic service provided)		
		Croatia	France	Italy
1.1.1.1.2 Use Resistant And/or Tolerant Cultivars -> Cultivar monoculture / cultivar mixtures	**I - Low**	I	I	I
1.1.2.1.1 Crop Rotation -> Crop sequences	**III - Major**	II	II/III	II
1.1.2.1.3 Crop Rotation -> Service/cover crop (sequential)	**II - Moderate**	II	II	II
1.1.2.1.2 Crop Rotation -> Relay cropping	**II - Moderate**	II	II	II
1.1.2.1.4 Crop Rotation -> Fallow (pest suppression through fallow)	**III - Major**	I	II	I
1.1.2.2.1 Intercropping -> Crop species mixtures	**III - Major**	II	II/III	II
1.1.2.2.2 Intercropping -> Service/cover crop (spatial)	**II - Moderate**	II	II	II
1.1.3 Crop Selection -> Adaptation Site Conditions	**I - Low**	I	I	II
1.1.4.1.2 Use of Certified Seed -> to Physiological value (quick emergence)	**I - Low**	II	I	0
1.1.4.1.3 Use of Certified Seed -> Phytosanitary quality (absence of pathogens and weed seeds)	**0 - Insufficient**	0	0	0
1.1.4.3.1 Seed Treatment -> Microbial inoculants	**I – Low**	I	I	I
1.1.4.3.2 Seed Treatment -> Steeping / Seed clusters	**I – Low**	I	I	I
1.2.1.1 Sowing -> Sowing Time	**III - Major**	II	II/III	I
1.2.1.2 Sowing -> Seeding Depth	**II - Moderate**	I	I	I
1.2.1.3.2 Seed Density -> High density (weed prevention)	**II - Moderate**	II	II/III	I
1.2.1.4.2 Sown plant spatial arrangement -> Sowing three densified rows	**II – Moderate**	II	II	II
1.2.1.4.3 Sown plant spatial arrangement -> Sowing positioned on the row and perpendicularity	**II - Moderate**	II	II	II
1.3.1.1 Soil Cultivation -> Reduced Tillage (Non-Inversion)	**III - Major**	I	II	II
1.3.1.2 Soil Cultivation -> Direct Seed/ Direct Sowing	**I – Low**	I	II	I
1.3.1.3 Soil Cultivation -> Plough (Inversion)	**II - Moderate**	I	I	I
1.3.1.4 Soil Cultivation -> Stale Seed Bed	**III - Major**	II	II	I
1.3.2.2.1 Crop topping -> Mechanical Topping	**II - Moderate**	II	II	0
1.3.2.2.2 Crop topping -> Topping with Flail Mowers or Mulchers	**II - Moderate**	II	II	0

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1.3.3.1.1 Advanced Harvest Technology -> Seed destruction	**II - Moderate**	**III**	**II/III**	**I**
1.4.1.1.3 Mulching -> Living Mulch (e.g., cover crops or ground cover)	**II - Moderate**	**II**	**II**	**0**
1.4.2.1.1 Organic Fertilization -> Compost (animal and plant)	**I – Low**	**I**	**I**	**III**
1.4.2.2 Balanced Fertilisation -> Balanced Mineral Fertilisation	**III - Major**	**I**	**II**	**III**
1.4.4 Amendments -> Water Management	**II - Moderate**	**I**	**I**	**II**
1.5.1.1.3 Creation or Restauration of Habitat for Beneficial Organisms Outside the Production Area -> Field margins	**II - Moderate**	**II**	**II**	**III**
1.6.2.2.1 Removal of Inoculum Sources -> Removal of plant debris	**II - Moderate**	**II**	**II**	**II**
1.6.3 Hygiene measures and biosecurity -> Soil Disinfection	**I – Low**	**I**	**I**	**I**
2.1.1.1.1 Monitoring -> Drone-Based Crop and Pest Monitoring	**II - Moderate**	**II**	**I**	**III**
2.1.1.2 Monitoring -> Field Observations	**III - Major**	**II**	**I/II**	**III**
3.1 Decision making -> Decision Support Systems & Thresholds	**II - Moderate**	**II**	**II**	**III**
4.3.3.1 Mechanical removal of pests -> Mechanical Weeding	**III - Major**	**III**	**II/III**	**II**
4.4.1.1 Natural Substances -> Essential Oils and Plant Extracts	**I – Low**	**II**	**II**	**II**
5.1.1 Pesticide Selection -> Pesticide Selection	**I – Low**	**II**	**I**	**I**
6.1.2.4 Spray Application -> Pesticide and Adjuvants Placement	**I – Low**	**I**	**I**	**II**
6.1.1.1 Adapting Spraying Technology -> Equipment/pesticide application techniques/machineries	**II - Moderate**	**II**	**I**	**I**
6.1.1.2 Adapting Spraying Technology -> Mode of Application / Precision Application	**II - Moderate**	**II**	**I**	**I**
6.1.2.2 Spray Application -> Pesticide Timing	**I – Low**	**I**	**I**	**I**
6.1.2.1 Spray Application -> Pesticide Dosage	**I – Low**	**II**	**I**	**I**
7.1.1.3 Choice of Active Substance and Control Agent -> Pesticide Replacement/Rotation	**I – Low**	**I**	**I**	**I**

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Appendix 8 : IPM practices sorted by their time of anticipation (left) / by their ESR classification (right)

NB : The complete table of gradings can be found here https://doi.org/10.57745/CTRK1E, or visualised on each layer of the taxonomy on the taxonomy's website attached to https://doi.org/10.57745/CA3AVE.

Practices by Anticipation time	Practices by ESR classification
Within 1 day to 1 week	***Efficiency***
Equipment/pesticide application techniques/machineries	Mixing Substances
Barriers: Natural Materials	Equipment/pesticide application techniques/machineries
Mechanical Weeding	Pesticide Dosage
Bio-Pesticides/Botanical Pesticides	Pesticide Frequency
Barriers: Other Physical	Precision Application
Precision Application	Pesticide Timing
Pesticide Dosage	Pesticide dosages (substance choice)
Pesticide Timing	Timing of pesticide application
Crop topping	Pesticide Replacement/Rotation
Field Observations	Pesticide Mixtures (Mixtures Of Moa)
Other olfactory Attractants/Repellents	Mode Of Application
Ozon treatment (abiotic interference)	Identification of pest and diseases
Robotic removal of pests and weeds	Single-Substance Choice
Mass Trapping	Performance measurement
Mixing Substances	***Improvement***
Mode Of Application	Geo-morphometric analysis for pest management
Pesticide dosages (substance choice)	Pesticide And Adjuvants Placement
Within 1 to 3 months	Monitoring Reports
Cleaning Of Machinery And Equipment	Field Observations
Soil fumigation	Disease forecast models
Monitoring With Traps	Thresholds
Identification of pest and diseases	Disease prediction models
Essential Oils And Plant Extracts	Use Of Pest And Disease Prediction Models
Pesticide Mixtures (Mixtures Of Moa)	Monitoring With Traps
Irrigation Management	Molecular detection tools
Remote Sensing	Water/Soil Sanitation
Molecular detection tools	Use Phenological Prediction Models
Use Water Monitoring And Prediction Modelling	Maintaining detailed activity logs
UV light (abiotic interference)	***Substitution***
Temperature Management	Drone-Based Crop And Pest Monitoring
Single-Substance Choice	Advisory Service
Advanced Harvest Technology	Soil fumigation
Optimal Harvest Timing	Remote Sensing
Disease forecast models	Use of digital reporting systems
Heat Killing Of Pests And Diseases	Modelling And Risk Assessment (Long Term)
Timing of pesticide application	Mass Trapping
Water/Soil Sanitation	Bio-Fertiliser/ Bio Products
Drone-Based Crop And Pest Monitoring	Use Water Monitoring And Prediction Modelling
Seed Treatment	Essential Oils And Plant Extracts
Removal Of Inoculum Sources	Use standardised reporting format
Bio-Fertiliser/ Bio Products	Bio-Pesticides/Botanical Pesticides
Pesticide Frequency	Risk assessment reports
Use Of Pest And Disease Prediction Models	Release of Microflora and Fauna (bacteria, fungi, nematoda)
Release of Microflora and Fauna (bacteria, fungi, nematoda)	Barriers: Natural Materials
Pesticide And Adjuvants Placement	Crop Value and Yield
Direct Seed/ Direct Sowing	Cost of Control Measures

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Stale Seed Bed	Cleaning Of Machinery And Equipment
Pruning	Other olfactory Attractants/Repellents
Use Of Pheromone Traps	Barriers: Other Physical
Release of sterilised insect pest or organism	Maintaining Pest Monitoring Records
Performance measurement	Data Sharing Platforms
Use Of Certified Seed	Seed Treatment
Reduced Tillage (Non-Inversion)	Release of Macrofauna (e.g. above ground arthropod predators)
Thresholds	Plant Resistance Activation
Seeding Depth	Ozon treatment (abiotic interference)
Plough (Inversion)	UV light (abiotic interference)
Mulching	Robotic removal of pests and weeds
Balanced Mineral Fertilisation	Environmental Impact and Regulation
Disease prediction models	Use Of Certified Seed
Pesticide Replacement/Rotation	Use Of Certified Planting Material
Sown plant spatial arrangement	Drainage
Removal of non-crop hosts around the parcel	Heat Killing Of Pests And Diseases
Geo-morphometric analysis for pest management	Mechanical Weeding
Release of Macrofauna (e.g. above ground arthropod predators)	Market Prices and Economic Conditions
Within 1 year	Seed Density
Liming	Balanced Mineral Fertilisation
Advisory Service	Liming
Use Phenological Prediction Models	Irrigation Management
Use Of Certified Planting Material	Suppression Of Pest And Disease Reservoirs
Seed Density	Removal Of Nematodes, Soil Pathogens
Plant Spatial Arrangement	Use Of Pheromone Traps
Drainage	Release of sterilised insect pest or organism
Use of digital reporting systems	Assess Labour Costs and Expertise
Crop selection based on Climatic Region, Conditions Or Factors	Availability of Subsidies and Support
Crop selection based on Infested Area	***Redesign***
Sowing Time	Crop selection based on Soil Conditions
Suppression Of Pest And Disease Reservoirs	Pruning
Monitoring Reports	Removal of non-crop hosts around the parcel
Crop selection based on Soil Conditions	Temperature Management
Removal Of Nematodes, Soil Pathogens	Assess Long-Term Environmental Sustainability
Planting Of Repelling/Disturbing Plants	Cultural and Social Values
Organic Fertilisation	Assess Long-Term vs. Short-Term Costs
Risk assessment reports	Plough (Inversion)
Plant Resistance Activation	Stale Seed Bed
Modelling And Risk Assessment (Long Term)	Crop topping
Use standardised reporting format	Advanced Harvest Technology
Market Prices and Economic Conditions	Organic Fertilisation
Crop Value and Yield	Removal Of Inoculum Sources
Cost of Control Measures	Crop selection based on Infested Area
Data Sharing Platforms	Seeding Depth
Education and Awareness (e.g. farmers round tables	Optimal Harvest Timing
Assess Labour Costs and Expertise	Assess Impact on Biodiversity
Use Resistant And/or Tolerant Cultivars	Assess soil Health and Structure
Availability of Subsidies and Support	Assess Ecosystem Services
Maintaining detailed activity logs	Assess Water Quality
Maintaining Pest Monitoring Records	Equity and Access
Within 5 years	Education and Awareness (e.g. farmers round tables
Cultural and Social Values	Use Resistant And/or Tolerant Cultivars
Crop Rotation	Crop selection based on Climatic Region, Conditions Or Factors
Intercropping	Sowing Time
Equity and Access	Plant Spatial Arrangement
Creation Or Restoration Of Habitat For Beneficial Organisms Inside The Production Area	Reduced Tillage (Non-Inversion)
Creation Or Restoration Of Habitat For Beneficial Organisms	Direct Seed/ Direct Sowing

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Outside The Production Area	
Assess Water Quality	Sown plant spatial arrangement
Environmental Impact and Regulation	Mulching
Assess Long-Term vs. Short-Term Costs	Planting Of Repelling/Disturbing Plants
Assess Long-Term Environmental Sustainability	Intercropping
Assess Impact on Biodiversity	Crop Rotation
Assess soil Health and Structure	***System Redesign***
Assess Ecosystem Services	Creation Or Restoration Of Habitat For Beneficial Organisms Outside The Production Area
Over >5 years	Creation Or Restoration Of Habitat For Beneficial Organisms Inside The Production Area

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