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PURPOSE OF THIS DOCUMENT

This document is mainly directed at competent authorities in the Member States and aims to give guidance for establishing IPM principles with regard to the requirements within the new Thematic Strategy on the Sustainable use of Pesticides.

NOTE

As the new Thematic Strategy on the Sustainable use of Pesticides is still under development, this document has to be seen as a basis, which has to be updated according to the legislative developments.

Content

1 Introduction

Over the last decades, environmental policy evolved significantly within the European Union. It is still one of the policy areas which is closely linked with the concerns and expectations of citizens, relating to better protection of their environment, their health and the safety of their daily food requirements. The European Commission continuously works on appropriate legislation by introducing new legislation or revising existing Regulations and Directives.

The Framework Directive on the sustainable use of pesticides[1] is an important part of the package of legislation dealing with pesticide use and application. It aims at achieving a more sustainable use of pesticides by reducing the risks and impacts of pesticide use on human health and on the environment and promoting the use of IPM, and of alternative approaches such as non-chemical alternatives. Furthermore, it should fill the gap regarding the use-phase of pesticides.

This guidance document specifically focuses on how Integrated Pest Management is addressed in the Framework Directive and the consequences thereof for Member States and professional users.

There are two main sections in the Framework Directive focusing on the issue of IPM. Article xx addresses general requirements related to IPM, whereas in Annex III, general IPM principles are listed.

In order to go into more detail, Article 14 requires the following actions to be taken by Member States:

1. Member States shall **take all necessary measures to promote low pesticide-input pest management**, giving wherever possible priority to non-chemical methods, so that professional users of pesticides switch to practices and products with the lowest risk to human health and to the environment among those available for the same pest problem. **Low pesticide-input pest management includes Integrated Pest Management** as well as organic farming according to Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products.

2. Member States **shall establish or support the establishment of necessary conditions for the implementation of Integrated Pest Management**. In particular, they shall ensure that professional users have at their disposal information and tools for pest monitoring and decision-making, as well as advisory services on integrated pest management.

3. By 30 June 2013, Member States shall report to the Commission on the implementation of paragraphs 1 and 2 and, in particular, whether the necessary conditions for implementation of integrated pest management are in place.

4. Member States shall describe in their National Action Plan referred to in Article 4 how they intend to **ensure that the general principles of Integrated Pest Management as set out in Annex III[2] are implemented by all professional users by 1 January 2014**.

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

[1] COM(2006)373 final
[2] of the Framework Directive

5. Member States shall establish appropriate **incentives to encourage professional users to implement crop or sector specific guidelines for integrated pest management on a voluntary basis**. Public authorities and/or organisations representing particular professional users may draw up such guidelines. Member States shall refer to those guidelines that they consider pertinent and appropriate in their National Action Plans drawn up in accordance with Article 4.

As required under point 4, Member States have to show how they ensure that professional users implement general principles of IPM. Such general principles are already defined in Annex III. When looking at point 5, it becomes clear that differences exist between general IPM principles and crop specific and sector specific IPM guidelines because such IPM elements shall be voluntary whereas general IPM principles shall be mandatory.

This guidance document will help to identify the boundaries between general and crop specific IPM elements in order to assist Member States (MS) in considering this issue in their National Action Plans (NAP). It will also provide precise information on the actions MS have to take before IPM principles can be made mandatory and it will offer guidance for compliance monitoring. In the following chapters, the connections and the differences between IPM and Good Plant Protection Practise (GPPP) will also be explained and highlighted, and examples will be given whenever appropriate.

2 General IPM principles

2.1 What is IPM and what are the differences to GPPP?

While the term “Integrated Pest Management” (IPM) is a 50-year-old concept designed as a response to the increasing usage of chemical pesticides, the term “Good Plant Protection Practice” (GPPP) was first used in Europe in the 1980s.
GPPP demands strict compliance with legal regulations on pesticide use, but IPM is the “best practice” plant protection strategy with additional requirements.
Unfortunately, from the beginning, definitions and publications could not ensure unambiguous distinction between GPPP and IPM. This has resulted in varying definitions for both, but also in blurred boundaries between GPPP – as the technically accepted status quo – and IPM as the model or highest quality of practical plant protection. These problems remain up to the present time.
Because IPM was supposed to be a sophisticated strategy that was difficult to adopt, experts proposed a simpler basic strategy in former times, which is focused on the proper use of pesticides and should be adopted by all users, calling it Good Plant Protection Practice (GPPP). Unfortunately, there is no unified worldwide definition of GPPP even today.
The definition used in EU definition in the Regulation concerning the placing of plant protection products on the market (2009):

“Practice whereby the treatments with plant protection products applied to a given crop, in conformity with the conditions of their authorised uses, are selected, dosed and timed to ensure optimum efficacy with the minimum quantity necessary, taking due account of local conditions and of the possibilities for cultural and biological control.”

Following this definition GPP can be briefly defined as follows: *GPPP is the good professional practice in plant protection in compliance with the legal requirements.* Its focus is on the compliance regarding the use of authorised pesticides, the use of tested plant protection equipment and the qualification and training of users.

While GPPP focuses on the strict compliance with legal regulations on pesticide use and gives some additional recommendations, IPM is the advanced plant protection strategy with strong requirements specified in guidelines.

IPM is characterised by the following principles:

- Complex approach in harmony with the objectives of integrated plant production and particular emphasis on the sustainability of plant production,
- Embracement of ecological requirements and effects, in particular, the promotion of natural mechanisms of control
- Targeted and economical use of pesticides to reduce their dosage to the necessary minimum while utilising the full potentials of preventive and non-chemical measures.
- Knowledge-intensive system with wise decision-making,
- Openness to new ideas, scientific findings and technological advances.

There are more than one hundred definitions in official papers worldwide. The new EU definition in the Regulation concerning the placing of plant protection products on the market (2009) based on the new FAO definition contains the same basic idea as former definitions but is broader and more complex:

"*Careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep plant protection products and other interventions to levels that are economically justified and reduce or minimise risks to human health and the environment. IPM emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.*"

Based on the new legal requirements and in particular on the implementation of the 8 general principles (as specified in Annex III to the new Framework Directive), which will be further explained in the following chapters, IPM can be described as a holistic framework taking various aspects into account:

- Application of continuous, manifold general precautionary and supportive measures such as appropriate crop rotation, cultivation techniques, hygiene measures and enhancement of important beneficial organism by the utilisation of ecological infrastructures inside and outside the production sites.
- Using a well established continuous monitoring methodology/system, including a pest warning and forecast system, in order to follow the development of pests and diseases.
- Using an appropriate decision making system. Based on the monitoring results, this shall enable the professional user to decide whether and when to apply plant protection measures.
- Consider several rules in case a plant protection measure is necessary such as:
    - Non-chemical methods should be preferred whenever they provide satisfactory control
    - In cases where chemical methods have to be used, they shall be as specific as possible and shall have the least side effects
    - The doses applied shall be kept to a minimum possible level
- Using available anti-resistance strategies
- Using a record system that enables checking the success of the applied plant protection measures

When presenting these aspects in the form of a figure (see below) one can see how the various elements should work closely together in order to provide an integrated plant protection system.

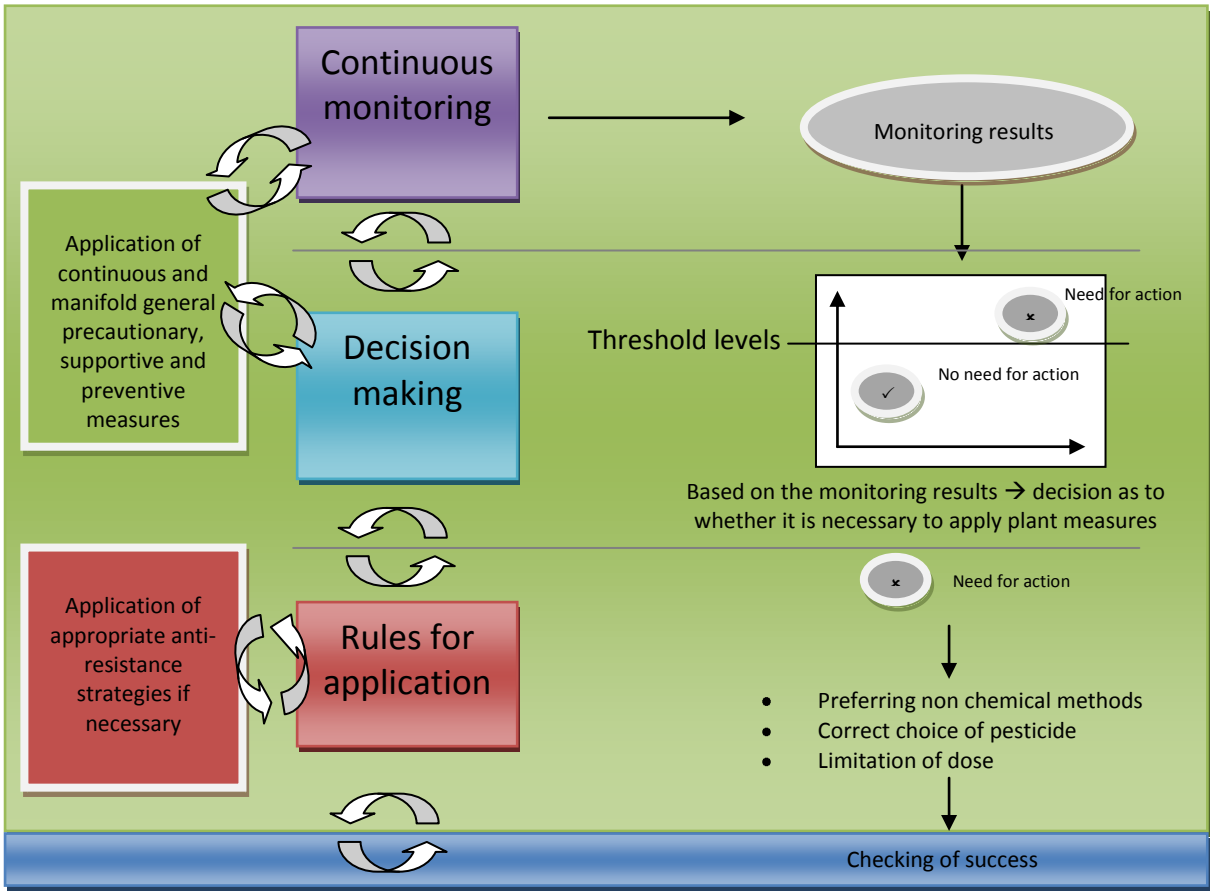


Figure 1 Framework for integrated pest management

When applying IPM, it is also essential to consider "what to do when" so that a well functioning management system can be established. In this regard, it seems appropriate to consider various periods throughout the year, which will differ for various crops, as well as differing between the MS due to climatic variations. In general, this would entail a splitting into post-harvest and pre-planting (off-season) as well as into different stages in the growing season – e.g. based on the different levels of development of a plant during the growing season – would seem appropriate.

From 2014, IPM has to be implemented and applied by the professional user of pesticides – the majority thereof will be farmers, however, Member States authorities have to establish several tools – mostly related to the provision of information – as a prerequisite in order to enable professional users to implement and apply IPM in a correct way.
For examples related to differentiation between GPPP and IPM please see Annex 1 – Examples.

2.2 What are the legal requirements related to IPM?

Apart from the general requirement that Member States shall take appropriate actions to promote low pesticide input pest management including IPM, Member States are obliged to work on several crucial aspects related to general IPM – the most important ones are the following:

- Member States shall establish or support the establishment of necessary conditions for the implementation of Integrated Pest Management. In particular, they shall ensure that professional users have at their disposal information and tools for pest monitoring and decision-making, as well as advisory services on integrated pest management.

  and

- Member States shall ensure that professional users implement general principles of Integrated Pest Management. The MS have to report to the Commission as to how this has been carried out within their NAPs.

In other words, this initially requires Member States to set up all tools necessary in order that professional users are able to apply the general principles. This could mean for example that necessary information is available for all professional users such as appropriate decision making systems. Having provided such a basis for the application of the principles, Member States are subsequently in a position to require from their professional users the use and application of the general principles. At the same time, Member States shall establish appropriate compliance monitoring systems in order to be able to obtain an overall picture of the acceptance and the implementation by professional users, and in order to monitor legislative obligations.
In the following, each of the eight general principles mentioned in Annex III of the Framework Directive will be discussed in detail. Apart from the precise description of the principle, detailed guidance will be given related to the tools, which have to be established before professional users can implement the principles. Furthermore, necessary communication elements will be highlighted and examples will be given in separate annexes. A separate chapter follows, which is related to compliance monitoring.

Principle 1

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

– crop rotation,
– use of adequate cultivation techniques (e.g. stale seedbed technique, sowing-dates and densities, under-sowing, conservation tillage, pruning and direct sowing),
– use, where appropriate, of resistant/tolerant cultivars and standard/certified seed and planting material,
– use of balanced fertilisation, liming and irrigation/drainage practices,
– preventing the spread of harmful organisms by hygiene measures (e.g. by regular cleansing of machinery and equipment),
– protection and enhancement of important beneficial organisms, e.g. by adequate plant protection measures or the utilisation of ecological infrastructures inside and outside production sites.

What does this principle mean?

In order to achieve an effective Integrated Pest Management system it is essential to combine various measures. All appropriate measures from various scientific disciplines should be combined into a systematic approach for optimised pest control. As a basic requirement for IPM, some precautionary or supportive measures have to be considered ensuring that an optimal exploitation of natural benefits is taken into consideration. In this regard, it seems very important to consider for example conservation of the natural biodiversity. Such measures can be regarded as indirect plant protection, covering – among other aspects – choice of appropriate resistant/tolerant cultivars, optimum crop rotation, adequate cultivation techniques, balanced fertilisation and irrigation practices, protection and enhancement of important natural enemies by adequate plant protection measures, utilisation of ecological infrastructures inside and outside production sites to enhance a supportive biological control.

It should be borne in mind that this list is not a closed and exhaustive list. The formulation used is "among other options," which means that the six points mentioned are the most important in this regard but one is free to add further necessary elements depending on one's national situation.

Which tools need to be set up by MS before a professional user can apply the principle?

In order to enable professional users to implement and apply this principle MS should define and provide clear guidance related to appropriate practise for the elements mentioned in this principle. For example, it is necessary to provide information related to appropriate crop rotation. Even if just the use of crop rotation is mentioned within principle 1, it should be an adequate scientifically accepted crop rotation scheme, which should be used by the professional user. The same is valid for the other elements addressed.

It is essential to provide guidance for all these elements – at least related to the main crops – in one's country and to give professional users information on appropriate practise.

The information should be easily accessible for all professional users; therefore, a web-based system might for instance be an appropriate solution. However, this depends on various parameters that

differ from country to country. While in some countries professional users are usually fully equipped with modern communication instruments, this might not be the case in other countries. Information offices or reference farms can also be useful tools providing information. The same is valid for newsletters or regular meetings. For minor crops, which are not very common in some countries, it might be worth appointing an external independent advisor.

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

What does this principle mean?

Pest/disease monitoring is one of the key elements of an IPM system. The purpose of monitoring is to collect information based on aspects from which a professional user can make appropriate decisions for managing harmful organism in the sense of IPM. Monitoring helps to determine if treatment is needed, and it helps to determine where, when, and what kind of treatments are needed and it allows authorities as well as users and tehri advisors to evaluate and adapt treatments. It seems obvious that such monitoring can be done in manifold ways, ranging from small efforts to highly sophisticated and time-consuming actions. In the Framework Directive, the expression “adequate” is used, followed by a concretisation that such tools shall include observation in the field as well as scientifically sound warning, forecasting and early diagnosis systems, where feasible, as well as the use of advice from professionally qualified advisors. Some Member States have well established systems of qualified advisors and should build on this. Others might have insufficient advisory systems available and shall therefore improve them and help professional users to implement a useful and appropriate monitoring methodology/system. In this regard, it is essential to think about the training of additional advisors in order to have sufficient personnel available for implementing IPM on a national level.

Which tools need to be set up by MS before a professional user can apply the principle?

For this principle, several aspects must be considered before establishing specific tools, which enable professional users to apply appropriate monitoring tools. Firstly, it seems that it could be left to the professional user to consider how they monitor harmful organisms, but remember that national authorities should be in a position to monitor the application of the principles and that the monitoring methodology/system has a significant impact on subsequent decision making. Authorities will hardly be in a position to evaluate the efficiency of an IPM system if it is based on an inappropriate monitoring methodology/system. Against this background, one should establish a framework for a monitoring methodology/system. In this regard, the production of logical guidelines has proven to be helpful. This should also include crop specific elements and should provide professional users with all information necessary to apply efficient monitoring in the sense of IPM. In particular, one should provide precise recommendations appropriate to one’s national situation relating to:

- Who should carry out the monitoring to ensure effectiveness? For example – qualification levels and independency should be considered. For further information and guidance, see Annex 1 – Examples.
- How shall the monitoring been carried out? For this aspect one should firstly identify an appropriate level – the system should include all necessary elements, but it should not burden professional users with useless efforts. It should be considered that different crops might require different monitoring methodology/systems. The need to identify pests and diseases correctly is one of the most crucial issues. For further information and guidance, see Annex 1 – Examples.
- Member States have to support professional users with monitoring activities in some cases, for example in the use of specific early warning instruments. Such monitoring activities will support the monitoring carried out at farm level and should be supervised by authorities. It is also possible to involve professional organisations or advisory services to provide such information. You should precisely define which monitoring activities will be carried out by authorities and which shall be under the responsibility of professional organisations, advisory services or professional users.

One last significant aspect – concerning all other IPM principles addressed in this document as well – is the research related to optimisation and further development of the tools provided. Such research should be supported to a large extent at national level and should be carried out by appropriate national experts in the relevant authorities or related institutes. Many aspects that change over time have to be considered when applying IPM. It is essential to keep track of such changes and to appropriately adapt all tools provided at MS level.

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

What does this principle mean?

Before describing principle 3, it should be highlighted that principles 2 and 3 in particular show how all aspects have to work together in an integrated way when applying IPM. They are closely linked and cannot be applied as a standalone principle. It is a prerequisite of IPM that monitoring and decision-making work together.

Apart from the key element of “monitoring” that has been addressed in principle 2, an appropriate decision making system is obligatory for all IPM systems. This means considering the outcome of the monitoring (e.g. a specific pest has been identified in a specific density) and based on robust and scientifically sound threshold values (e.g. above which pest density is intervention necessary?) the professional user has to decide if he or she shall apply plant protection measures and, in such case, which ones are suited. Only if the professional users are aware of the full set of up-to-date

information, will they be in a position to decide on the most appropriate plant protection measures and to ensure that plant protection will be done in an integrated way.

It is essential to consider all possible interactions and consequences of any intervention. The aim should be to apply a system that maximises the chance of economic management of pests with the lowest risk to the professional user, the environment and the public. It is essential to understand that any pest intervention will only be successful if results provide no economic disadvantage for the producer and the society.

Which tools need to be set up by MS before a professional user can apply the principle?

Generally speaking – a tool has to be set up which enables the professional user to make correct decisions in the sense of IPM. It is important to provide every professional user with access to necessary information and it should be provided in the form of threshold levels.

IPM is a decision-making process that requires a criterion on which to base a treatment decision – the threshold. There are four distinct types of thresholds commonly used: visual threshold, damage boundary, economic injury level and the action threshold. In the following, these thresholds are briefly explained. For additional information, see Annex 1 – Examples.

A visual threshold is regarded as the minimum density of a pest at which it can be observed while the damage boundary indicates the level at which damage can be observed. However, none of these levels automatically requires further action.

Economic injury level (EIL): this means the level at which a pest population is capable of producing an amount of damage that, if prevented, could offset the costs of treatment. In other words, this is the level at which treatment costs are balanced with the benefit resulting thereof. The establishment of EIL is an essential phase in the development of an IPM programme; it should also be considered that such levels need to be updated regularly. In order to establish the EIL, three issues should be considered: the costs of managing the pest, the monetary value of the crop yield and the amount of damage each pest can create.

Action threshold (AT): is the level just below the EIL at which one should apply a plant protection measure to keep an increasing pest population from reaching the EIL. Please be aware that establishing an action threshold is not a simple task and that this has to be done for all pests and for all crops separately. In order to provide efficient information to all professional users, the need for – and support of – research on this topic within a country should also be considered. In the following, the relation between the above-mentioned levels is shown schematically.

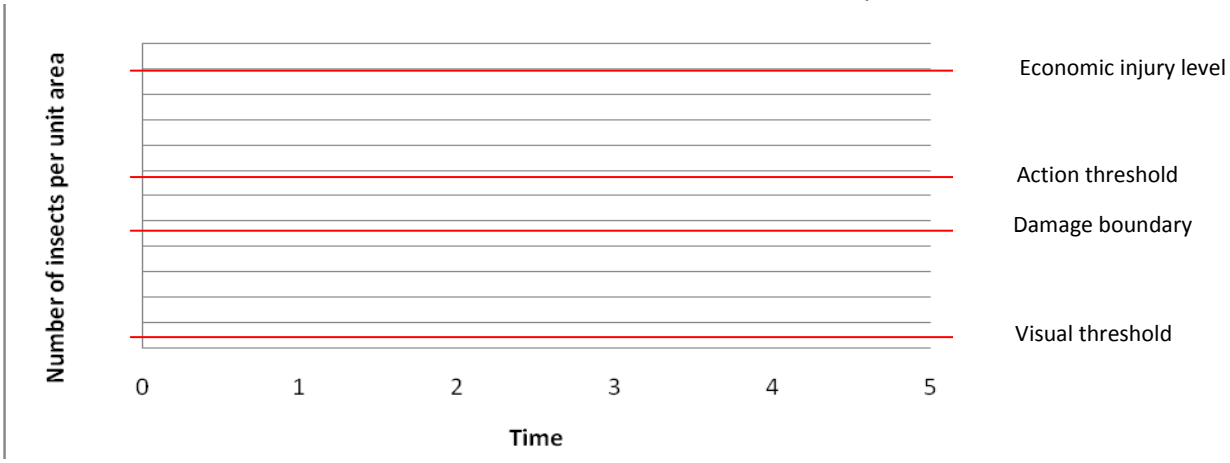


Figure 2 Correlation of different intervention levels

For further information and guidance please see Annex 1 – Examples.
In addition, it seems appropriate to consider the status of various pests:
Pest status: the ratio between crop losses and the cost of preventing this loss characterises the status of pests. Thus, pests can be allocated to three categories: (i) key or major pests persistent and occurring perennially which dominate management practise. In the absence of control, they cause severe economic damage; (ii) occasional pests whose status fluctuates and are under control in adequate biological and environmental conditions; (iii) minor pests that cause no significant damage under prevalent conditions but whose population might be directly stimulated by control procedures at controlling key or occasional pests. Please note that pests can change their classification from year to year, minor pests can become key pests in combination with other pests while key pests may also become occasional ones.
Different decision making systems for the three categories are needed to provide for example sufficient information related to key pests for general use by professional users but to leave decision making to an independent advisor in cases of occasional pests. Such decision-making systems need to be dynamic; they have to be adaptable according to naturally occurring changes. Various alternatives are available, and it is necessary to check therefore each national situation, taking into account key crops, climatic conditions, key pests, etc.
Many already elaborated decision making systems are available for purchase that are produced by private or international organisations. Such available systems which might already be in use by professional users provide a good basis on which to further build up a national decision making system or which might be suitable as an alternative.

Please also bear in mind that the information necessary for decision-making has to be specific for different crops and for each pest or disease, this means information has to be provided at a very precise level of detail.

Even if this aspect is not mentioned in the principle, an obligatory involvement of qualified independent advisory services or reference farms might provide additional tools to ensure proper decision-making.

One crucial point to be aware of is the aspect of controllability – in particular, the question of how to control professional users in their application of an adequate decision making system using the information one has provided.

Principle 4
Sustainable biological, physical and other non-chemical methods must be preferred to chemical methods if they provide satisfactory pest control.

What does this principle mean?

Whereas principles 2 and 3 more or less refer to the framework necessary for IPM – this means in particular an effective monitoring and – based thereon – a precise decision making system, principle 4 as well as the following principles go into more detail and provide clear guidance as to what should be considered in case plant protection measures are necessary. Principle 4 means in particular that preventative plant protection measures in order to suppress the occurrence of harmful organisms shall be considered as a first priority and should be applied to its fullest extent before intervention

with control (chemical) measures takes place. Biological, biotechnical, mechanical and physical methods shall be preferred to chemical methods if they can provide satisfactory control. This issue is especially important in horticulture, greenhouses, viticulture as well as fruit growing. This principle plays a lesser role for arable crops.

However, what is a satisfactory control? Releases of bio-control agents or the use of other non chemical methods commonly result in reduced pest populations; the often lower levels of efficacy from bio-control agents can be balanced in cases where various measures are combined, rather than to use one measure as a standalone tactic, to achieve satisfactory pest control.

One should be aware of the fact that preference of non-chemical methods might lead to higher economic expenditure for professional users.

Which tools need to be set up by MS before a professional user can apply the principle?

As also explained for most of the other principles, provision of information is a crucial prerequisite to enable professional users to apply this principle correctly. There are two main elements of information, which appear necessary for principle 4. On the one hand, it is necessary to give guidance related to possible biological, physical and other non-chemical methods. Such information must be specific for crops as well as for pests and diseases. One should ensure that all professional users have easy access to information and that the information is updated continuously. On the other hand, the principle states that non-chemical methods are preferred where they provide satisfactory pest control. It should be made clear to professional users what is meant by “satisfactory pest control”. In particular, this is correlated with a reduction but not necessarily with a complete eradication of the pest/disease/weed. To define “satisfactory” one should consider decreasing rates and periods as well as sustainability of a measure. It has proven to be a good concept to carry out demonstration experiments or to use demonstration farms for specific methods in order to show how such non-chemical methods can be applied efficiently. It is essential to support research and practical testing in this field at national levels.

As written in the Framework Directive, it seems that this principle only refers to the fact of decreasing pest populations or disease rates, but one should be aware of the economic efforts related to non-chemical measures, which have to be compensated by the professional user. As for all other principles, the information provided shall be as precise as possible to enable control of a professional user in the adequate application of the principle.

Principle 5

The pesticides applied shall be as specific as possible for the target and shall have the least side effects on human health, non-target organisms and the environment.

What does this principle mean?

Similar to principle 4, principle 5 also provides a rule in case plant protection measures have to be applied. In such a case, it addresses chemical plant protection methods, including plant and tree extracts and mineral pesticides. Where pesticides have to be applied, priority shall be given to measures which have the minimum impact on human health, non-target organisms and the

environment. The product applied must be appropriate for the target as indicated on the product label, or for officially approved off-label uses.

For this principle, it should be considered that the aim is not the complete elimination of a pest, but the reduction to a level below the economic threshold.

Which tools need to be set up by MS before a professional user can apply the principle?

Similar to other principles, the provision of information is also for principle 5 a prerequisite in order to enable professional users to apply the principle. It is important to provide specific information for all relevant crops and relevant pests, indicating which pesticide shall be used and taking into account the target specificity as well as hazardous properties and classifications. It is necessary to provide professional users with precise information (including toxicology and ecotoxicology) on which pesticide can be used for each combination of pest/crop.

One should ensure that all professional users have easy access to information and that the information is updated continuously. The involvement of advisory services is recommended.

As for all other principles, the information provided shall be as precise as possible to be able to control whether a professional user has applied the principle adequately.

Principle 6

The professional user should keep the use of pesticides and other forms of intervention to levels that are necessary, e.g. by reduced doses, reduced application frequency or partial applications, considering that the level of risk in vegetation is acceptable and they do not increase the risk for development of resistance in populations of harmful organisms.

What does this principle mean?

In accordance with the demand for “as much as necessary but as little as possible” it is a stated aim of IPM to limit the use of pesticides to the necessary minimum in order to avoid the unnecessary use of chemical pesticides and to increase the use of non-chemical plant protection methods. The necessary minimum normally corresponds to the registered dose, which is determined after years of laboratory and field trials.

Relating to the use of chemical pesticides on farms and holdings, the necessary minimum is the term used to describe the minimum amount needed to ensure that crops are successful, not least in terms of their economic viability. This implies that all other practicable options to prevent and deter harmful organisms must have been exhausted and that consumer, environment and user protection provisions have been adequately taken into account.

If adequate decision support is employed, the occurrence of harmful organisms and optimal dates for control can be determined and, consequently, the pesticide application frequency or dosage reduced accordingly. However, reducing dosages is related to the risk of development of resistance in populations of harmful organism, which can result from further dosage reduction as well as from long-term pesticide use. This is more unlikely to happen in cases of compliance with label instructions. Therefore, it should be very carefully determined if dosage reductions lower than those recommended are appropriate and useful. Advisory services should be involved in this regard.

It should be highlighted that IPM is a framework, which allows the use of pesticides on specific occasions, but it is not a general rule to avoid pesticides in all plant protection measures. Depending on the monitoring and decision making systems, the use of pesticides is sometimes unavoidable. In such cases, careful and scientifically accepted handling and use is appropriate.

Which tools need to be set up by MS before a professional user can apply the principle?

It is the duty of authorities at MS level to ensure that every professional user of chemical pesticides complies with the requirements of this principle. However, before professional users can comply with it, specific tools must be set up, which enable them to obtain information on the issue "what is a necessary level?" Access to sufficient information in this regard is a fundamental prerequisite. A crucial point to be aware of is the aspect of controllability – in particular, the question of how to control professional users in applying only the necessary level.

In IPM, the use of pesticides on farms and holdings must be kept to the necessary minimum, for example by using reduced dosages and application frequencies, or by partial applications. Compliance with the necessary minimum can only be achieved if all general IPM principles are accurately implemented. Compliance with the necessary minimum as well as the deviation from a rate of unnecessary applications depend on farmers' knowledge, professional training, experience, attitude to risk and the quality of the advice and other specialist information they act upon. Economic conditions also affect the behaviour of users.

Tools necessary to be implemented can be manifold in this regard but have to provide guidance to professional users for the issue "what is the necessary level?" However, to some extent this would disregard any unforeseen differences, for example due to weather conditions. Another possibility would be to strengthen the position of independent advisors.

One further possibility – already realised in several countries – is the establishment of a network of reference farms (random sample of typical farms) and some demonstration farms (to demonstrate the necessary minimum). This is recommended in order to collect necessary minimum data in main crops, which vary from region to region and year to year. With this approach it is ensured that all influences (seasonal, local, etc.) are taken into consideration on an up-to-date basis. In addition, the approach of the treatment frequency index (TFI) could be used as the indicator for pesticide use intensity. It describes the number of pesticide applications on a field, crop, or farm, taking any pesticide dose reductions or partial field applications into account. Pesticides applied in tank mixes are listed separately. The necessary minimum can be determined as a defined interval around the average of the treatment. For further explanation, please see Annex 1 – Examples. It should be stressed that the paragraph above comprises possibilities, for example the use of the TFI and not strict obligations.

Finally, one should consider some mechanism to review and update the tools provided to professional users. In particular, checking whether professional users comply with the tools provided, one must make sure that the tools are appropriate and up-to-date and therefore effective. Where this is not guaranteed, professional users will be in a position to either follow the tools they are provided with – in a worst-case scenario this result in an ineffective pest management with its various consequences, or to adapt the tools according to their current needs, resulting in an effective pest management, however, this might not be in line with the national legal requirements."

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

What does this principle mean?

Resistance is a double-edged sword: pests become resistant to pesticides, and plants can develop resistance to pests. Principle 7 refers to the first meaning – that pests become resistant to pesticides. According to the IRAC (Insecticide Resistance Action Committee), resistance may be defined as 'a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species'. The resistance problematic is supported by various factors, it depends on the pest as well as on the pesticide used, and remains a problem even after relevant pesticides are no longer being applied. Resistance problems increase over time when pesticides are always used which have a similar mode of action. There are two main groups of resistances – the metabolic resistance and the target site resistance. While in the first case the reason for resistances is that pests and pathogens may overcome the toxic effect of a pesticide by metabolising the active ingredient into less toxic compounds, pests change their genetic code (change in the target site), reducing the absorption of the chemical or by avoiding exposure to the compound for the target site resistance.
One further phenomenon related to pesticide resistances that should also be considered carefully is the problem of cross-resistances: Pests automatically develop resistance against other pesticides that might have similar chemical groups or similar metabolic degradation pathways.
One should also consider that survivors breed and pass on their resistance trait to their offspring. With each passing generation, the pest population becomes more difficult to control with the same pesticides as compared with earlier generations.
Diversifying the methods of plant protection (e.g. physical, biological, chemical) and alternating among classes of pesticides with different modes of action can help to lessen the possibility of pest resistance. Managing pest resistance is very important in helping to prolong the effective life of essential pesticides.

Which tools need to be set up by MS before a professional user can apply the principle?

Firstly, one should consider that using IPM itself helps to keep resistance problems low. The increasing use of pesticides is one of the key factors that encourage resistance problems. However, even if an IPM system is used, application of pesticides might still be necessary. In such a case, it should be assured that resistance problems do not arise, or that they are limited.

One should be aware of the fact that by the time a pesticide begins to fail, it is already too late to do much about it, other than to switch to a new pesticide with a different mode of action (if one is available).

This should be made very clear to professional users in order to make them aware of necessary measures.

The tool to be established before professional users can apply principle 7 is once again a tool to provide information. Such information should cover several aspects in particular:

- Information on known risk of resistance development for specific plants and pests
- How to apply chemicals in a way that resistance problems are kept to a low level?
- Recommendations for anti-resistance strategies ensuring alternatives to relevant pesticides with a different mode of action

In this regard, one should also consider the authorisation of pesticides and research related to new pesticides having different modes of action than the current ones.

Further information is provided in Annex 1 – Examples.

It should be ensured that all professional users have access to this information. Similar to the other principles, it is necessary to continuously update this information.

If the involvement of an external independent advisor has already been considered, for instance, in principles 2, 3 or 6, it might also be advantageous to involve the advisor in this principle as well.

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

What does this principle mean?

In order to check the success of applied plant protection measures, documented evidence is required on the mode of application according to label instructions, to ensure that the application has been accurately calculated, prepared and recorded. It is required by the professional user to reflect on the used plant protection measure in case the action threshold was exceeded and the plant protection measure was required. This is necessary to finalise the process of an intervention – this means making sure that the intervention was sufficient – but it is also helpful to obtain information on the effectiveness and benefit of the used plant protection measure. This approach is important for learning from experiences and is helpful for all following interventions. It is important to note that this principle addresses all plant protection measures even if the principle starts with a link to the use of pesticides.

Which tools need to be set up by MS before a professional user can apply the principle?

Several different aspects are to be considered before setting up tools necessary for professional users in order to implement the principle. For example, proper documentation of the success by the professional user provides an excellent basis for reviewing if the established tools are helpful and leads to sufficient results regarding the application of integrated pest management. It might be of benefit to obtain information on the successes, or maybe it is desired that the professional user checks the successes for his or her own documentation. In any case, clear guidance must be provided to the professional user as to how success should be checked and which data should be used for this. In this regard, monitoring results before, during and after the intervention, decision-making processes and applied plant protection measures as well as levels of plant development, threshold

limits used etc. are of interest. Only with the full set of available information, is it possible to evaluate success.

A further important point that needs to be precisely defined is “what does success mean”? It should be made very clear that success is not related to a complete elimination of a pest, but that the decrease below specific thresholds is important. In order to be able to compare measures in a very rough way it seems appropriate to categorise results of the success check into (e.g.) ‘measure failed,’ ‘measure provided adequate results’ or ‘measure provided excellent results.’ For each category, a definition is necessary, taking into account the monitored pest decrease and the necessary period for the plant protecting measure. The effect – benefit ratios should be considered as well. It is important that such definitions have to be established for each plant protection measure group separately. A non-chemical method might lead to the same success but might take some more time.

Since it is necessary to control compliance with this principle, the use of standard documentation sheets should be considered, which are already available in several countries via the plant protection services. An example can be found in Annex 1 – Examples.

3 Compliance monitoring

The role of the Members States here is:

1. to encourage and promote compliance;
2. to inspect for compliance; and
3. to respond to situations of non-compliance.

Point 1 is very important in order to make professional users aware of the regulation, the benefits and related support. It is expected that once the framework is provided to implement IPM, the majority of professional users will aim to comply with the principles. However, for a minority, deterrence is necessary. The effectiveness of a deterrence approach depends upon:

- the perception by the potential violators that they are likely to be detected;
- a quick response when non-compliance is detected; and
- penalties that encourage violators to change their behaviour.

These are some very general points, and since the Framework Directive leaves some leeway as to how to monitor professional users applying the general principles, it is essential to find a proper method of compliance monitoring in order to take into account national considerations. Aspects such as control form, control frequency, evaluation of key aspects, control techniques, control documentation, as well as consequences and penalties in case of non-compliance of professional users with national legislation should be taken into account.
Another element, which appears to be important, is to check if any similar monitoring systems already exist and if they can be used for this purpose as well.

Based on this background, there are various possibilities which can be considered for compliance monitoring. As agricultural structures and common attitudes towards plant protection in general in the MS are differently developed, there might also be varying approaches to promote implementation of IPM. On the one hand side MS might emphasise the significance of advisory services and on the other hand relay upon the already responsible handling of the issue by the farmers. In other words some MS might need to be more restrictive than others to be in compliance with IPM.

– One possibility would be to strengthen the involvement of certified advisors. It might be a tool to expect compliance if a professional user is supported by such an advisor.
  From a MS point of view, it seems important to provide some criteria for such advisory services, including for example a certification scheme.
  Depending on the national situation – for example, the advisory service is a public organisation, or if various private organisations are involved, it would be important to consider who could bring in the knowledge necessary to implement IPM. It is common practise that advisory services provide initial warnings and that farmers react with monitoring activities in this regard. Where a MS decides to involve various private organisations and to expect compliance of professional users that work with these advisory services, it seems necessary to provide a standard set of information (for example guideline considering pests and diseases in the

proceeding of the year, threshold levels, etc.) to be used. This ensures that all advisory services work on a similar level and guarantees fair treatment of professional users. It is also necessary to highlight the importance of monitoring activities. Where insufficient numbers of advisors are available, professional users have to ensure regular monitoring activities of their fields by themselves.

→ If a MS chooses to follow such an approach, the following performance indicators seem appropriate:
- evidence provided by the professional user showing the appointment of an appropriate advisory service (including implementation of e.g. warning service subscription)
- evidence provided by the professional user showing regular contacts with the advisory service (regular monitoring and consultations have to be ensured)
- evidence provided by the professional user and issued by the advisory service showing that the farmer is in line with IPM requirements

In many countries, advisory services are well established and can be used in an adapted way for implementing IPM. However, MS have to ensure that the work carried out by the advisors is in line with the general requirements in the Framework Directive via certification for example.
It should be mentioned that the involvement of qualified advisory services is important regarding implementation of IPM. Even if a MS does not to expect compliance by professional users where they are supported by such an advisory service, the involvement is necessary in order to assist the farmer in compliance with the requirements.

– Another possibility would be to place more responsibility for compliance on the farmers themselves. This does not exclude the involvement of advisors; however, the professional user is more actively involved in ensuring compliance. Choosing this approach means for MS that sufficient and updated information has to be available for the professional users upon which they can base their work. It is necessary in this regard to provide information on how monitoring should be conducted, which threshold levels should be used and – in the case of a necessary plant protection measure – how to choose the right measure considering resistance problems as well as the effectiveness of a measure. As soon as such an information framework is provided, a set of inspections to assess or verify compliance by professional users can be carried out. The types of inspections include the following:
  - inspections; these are inspection actions whereby professional users must provide evidence that they practise IPM according to the requirements. This can for example be achieved by control of their documentation and some questions related to their working practise. Therefore, a specific control sheet seems suitable which could be similar to the crop specific control sheets used by IOBC.
  - surveillance inspections; these are actions that take place continuously and on a broader range. Such activities could for example be linked to advisory services, which report to MS authorities on their observations. In addition, this could mean that a representative number of farmers are asked to report plant protection measures via e.g. an internet tool.

- Control inspections; these are actions that take place in cases where professional users have been identified within an inspection as being non compliant and determines whether behaviour has changed.

→ If a MS chooses to follow such an approach, the following performance indicators seem appropriate:
  - evidence provided by the professional user showing that a monitoring and decision making system is in place (documentation of monitoring results, knowledge of and compliance with threshold values, correct choice and application of chemical/non-chemical measures, knowledge and application of supportive measures)

Both approaches must allow for action to be taken in case of non-compliance. Such actions might comprise the following and might change over the years, since it seems appropriate to have a transition period in which consequences aim at encouraging professional users rather than penalising them:

- provision of further advice (warning) and/or penalty: this can for example mean an educational letter informing professional users of how they can improve their behaviour, or which obliges them to attend a training seminar; control inspections are recommended
- sanctions and penalties; such penalties can range from small to higher fines or they might lead to a stop or shut down of any activity related to non compliance;

It is important to consider that professional users cannot be expected to perfectly implement the provided guidance from the beginning on. A reasonable transition period is necessary between establishment of guidance and first control/sanctions, in order to allow users to learn how to implement the guidance.

It is also important to consider each national situation and to find a proper way of encouraging professional users to comply with IPM. It should be highlighted that there is no quantifiable specific parameters for example for pesticide residues that can be used to evaluate compliance; there are various parameters that may change between the various professional users depending on the local conditions. It is therefore necessary to allow some flexibility regarding how a professional user aims to comply with the eight general principles. This is especially necessary for principle 1 which in fact covers a list of actions and indicates that these actions should be taken “amongst other options”.

In this regard, it is also important to highlight the fact that not all principles can strictly be followed in one approach. This becomes evident for example when looking at “target specificity and minimization of side effects” (principle 5) versus “application of anti-resistance strategies” (principle 7). The latter clearly depends on the availability of different active ingredients (different crop protection products) with different properties/modes of action/target cells or target processes and hence potentially different effects upon non-target species. Some other ‘tools’ or ‘methods’ (forecasting, diagnosis) might simply not be available to all farmers for all pests.

One last aspect before a number of elements for control are considered is the fact that it seems obvious that inspections will take place at farm level. That is, at a level of application in the field. At

this point, a farmer should work according to crop specific guidelines, which are not expected to be obligatory. Therefore, it is necessary to bear in mind that the aim is to control whether the general principles are being respected. This will be the case if professional users act in an adequate and appropriate way regarding their crops and taking into account expressions such as “balanced measures”, “if feasible” and “appropriate”, etc. It must be determined whether the framework for IPM is in place at farm level and whether the professional user is aware of the requirements relating to IPM. However, there might be different ways to comply with IPM requirements.

The following table lists those elements which can be controlled for the various principles.

Table 1 Elements to be used for compliance monitoring

No.	Principle	Elements that can be used as performance indicators
(1)	Measures for prevention and/or suppression of harmful organisms	Is the professional user aware of possibilities related to preventive and supportive measures and has he applied them appropriately? In particular:
	1.1 Crop rotation	Has the professional user checked the latest information related to crop rotation? Has a crop rotation scheme been applied, which is scientifically accepted and recommended by the MS for the region?
	1.2 Cultivation techniques	Has the professional user checked the latest information relating to current practicable cultivation techniques? Has a cultivation technique been applied, which is scientifically accepted and recommended by the MS for the region?
	1.3 Resistant varieties	Has the professional user checked the latest information relating to varieties known to be resistant to specific pests as well as information on tolerant varieties? Where provided by the MS – has the professional user considered information about the different levels of susceptibility of approved varieties and their suitability for different regional conditions? Has an available resistant variety been applied, which is scientifically accepted and recommended by the MS for the region?
	1.4 Fertilisation/irrigation	Has the professional user checked the latest information on fertilisation and irrigation measures and techniques appropriate for the regional conditions? Has an appropriate fertilisation /irrigation been applied, which is scientifically accepted and recommended by MS for the region?
	1.5 Hygiene measures	Has the professional user checked the latest information related to hygiene measures? Have hygiene measures been applied, which are scientifically accepted and recommended by the MS for the region?
	1.6 Enhancement of beneficial organisms	Has the professional user checked the latest information relating to enhancement of beneficial organisms? Have measures relating to protection and enhancement of beneficial organisms been applied, which are scientifically accepted and recommended by MS for the region?
(2)	Tools for monitoring	Is the professional user aware of any early warning or forecasting system used at MS or regional level? Has any information been considered relating thereto? Has the professional user implemented a monitoring system appropriate for the region? Has he carried out monitoring activities at regular intervals? This can be check

		by checking the documentation.
(3)	Threshold values as basis for decision-making	Has the professional user checked any threshold levels to be considered together with monitoring results? Have threshold levels been applied, which are scientifically accepted and recommended by the MS for the region?
(4)	Non-chemical methods to be preferred	Where plant protection measures are necessary – has the professional user checked the availability of non chemical methods? Have non-chemical methods been applied, which are scientifically accepted and recommended by the MS for the region in cases where they are expected to provide satisfactory pest control?
(5)	Target-specificity and minimization of side effects	Where various pesticides are authorised for a specific purpose – has the professional user selected the one with the highest target specificity and the least side effects? In cases of any deviation from this rule – has the deviation occurred due to scientifically accepted reasons e.g. anti resistance strategies?
(6)	Reduction of use to necessary levels	Where plant protection measures are necessary – has the professional user checked the possibility of keeping the intervention to a necessary level? Have any reduction measures been applied which are scientifically accepted and recommended by the MS for the region?
(7)	Application of anti-resistance strategies	Where plant protection measures are necessary – has the professional user checked the information on risks for resistance development and available anti resistance strategies? Where necessary, has the professional user applied a strategy which is scientifically accepted and recommended by the MS for the region?
(8)	Records, monitoring, documentation and checking of success	Has the professional user carried out a proper documentation of the monitoring and the applied plant protection measures? Has he checked the success immediately after a plant protection measure?

By performing compliance-monitoring activities, a great deal of information can be gathered.

In this regard, it should be considered that MS are obliged to report in future to the European Commission on how IPM principles are implemented and how it will be ensured that they are applied by all professional users. A simple but effective instrument therefore is the collection of various data for statistical use. Compliance monitoring might be an appropriate way of obtaining such data.

A further aspect to be considered relating to all aspects of IPM is that it is necessary to check and to continuously reassess the information provided to professional users. It is critical that the information is efficient and useful as well as in line with the latest scientific knowledge. If this is not the case, such information should be revised immediately.

4 Communication to professional users

In order to achieve an effective implementation of IPM in one's country it is important to communicate to professional users, to make them aware of the framework of IPM and the related obligations. It should be part of compliance monitoring activities – at least for the implementation period to support and to encourage professional users to comply with IPM and to assist them in doing so.

In this regard, special training activities, winter schools or specific field meetings, seminars or logical guidance have proven to be an excellent instrument in communicating to professional users, to exchange information and give advice via personal contacts and to train them appropriately. In order to benefit as many professional users as possible and to increase attendance at such training activities, distances to meetings should be appropriate.

It might also be helpful – in order to ensure adequate provision of current information – to encourage the professional user to adopt modern media and communication systems. Such existing or established systems must be fed with data to ensure users receive comprehensive, timely and current information on plant protection practices. It is of key importance that every user has free access to sufficient information, or at low cost. In Annex 2 – Communication to professional users – further information is provided.

With regard to principle 1, it is important to inform professional users on the importance of various precautionary and supportive elements in connection with IPM. Further information is necessary on appropriate practise regarding elements in principle 1.

In principle 2, the importance of monitoring should be stressed, demonstrating to professional users that an appropriate monitoring method/system alone can lead to an efficient decision making system and thus to the achievement of a more sustainable use of pesticides. Furthermore, it is important to provide information on how monitoring is to be carried out.

In parallel with and relating to principle 3, it is crucial to inform professional users on the importance of decision making, showing them that an efficient decision making system alone can lead to an effective IPM system. Professional users should be told where they can obtain information and how this information should be used. It is important also to inform professional users immediately and continuously about newly obtained threshold levels.

It is important to inform professional users on several issues relating to an essential plant protection measure in connection with principles 4 to 7. In particular, professional users should be told where to find relevant information and how to use it, and the involvement of plant protection services is strongly recommended in order to assist them.

5 Crop specific IPM principles

As already mentioned in the introduction, it is important to be very clear about the boundaries between general IPM principles and crop specific ones. As stated in the Framework Directive, only the eight general IPM principles discussed in chapter 2 shall be made mandatory while crop specific IPM principles shall be voluntary. In this regard, “crop-specific” in particular means aspects that differ from crop to crop and that have to be considered for specific crops alone.

At first sight, this differentiation seems clear, but some of the general IPM principles are applied differently when they are concretised for each crop. Therefore, it is necessary to think about two different crop specific IPM principles – on the one hand, crop specific concretisation of the general principles, and additional and independent principles on the other, which are not yet addressed within the general principles but are necessary for specific crops. Such latter examples are most often included in a general integrated production scheme of which IPM is one part, such as specific treatments related to the harvest.

Such a concretisation of the general principles is necessary in all cases in order to assure effectiveness. This means for example that a specific crop rotation scheme has to be used for specific crops or that specific non-chemical methods have to be used for specific pests and crops. Such an appropriate concretisation is a pre-requisite for the success of the IPM system. The text of the common position of the European Council considers this issue by using expressions like “adequate techniques” or “as specific as possible” or “suitable”. In addition, it becomes clear that not just the application of a principle shall be mandatory but that the adequate – this means the scientifically accepted – application of it is requested to be mandatory. It should also be considered that such concretisations could change over time. In this regard, it is essential to provide professional users with guidance as explained in chapter 2.2 in order to enable them to apply the correct measures.

Against this background, the question is still not answered as to which principles shall be mandatory and which shall be voluntary. It is clear that the general principles are mandatory and that therefore professional users are obliged to take them into account following the information provided by MS authorities. However, the ways in which the general principles are implemented in practise differ from MS to MS, depend on various parameters and even change over time. More or less crop specific elements add additional requirements to the general principles. In some cases there might be several possibilities for such additional requirements to consider a general principle in practise, for example if several target specific pesticides might be available, all having similar hazardous properties. In such a case, it is not mandatory to apply one specific pesticide but the professional user has to comply with the general principle “use the most target specific and less hazardous pesticide”. If he/she uses a pesticide from a recommended list he/she will comply with the general principle and is therefore compliant with the requirements in the Framework Directive. As mentioned, such requirements can change over time. As this aspect is crop specific this would mean that the recommendations have to be changed, but not the legislation itself. In such a way it can be assured that updated scientific knowledge on how IPM is applied in practise can be used immediately by professional users, without facing the necessity to change any legislation.

The following figure shows this approach schematically:
The eight general principles are the basis and are mandatory. For each of the eight principles addition requirements will come up when they are translated into practise, and this means crop specific specifications will be necessary. Some of these additional requirements are closely linked to the fulfilment of the eight general principles, however, there might be several possibilities available or there will even be changes over time in order to comply with the general principles. Therefore, these additional requirements are necessary but not mandatory.

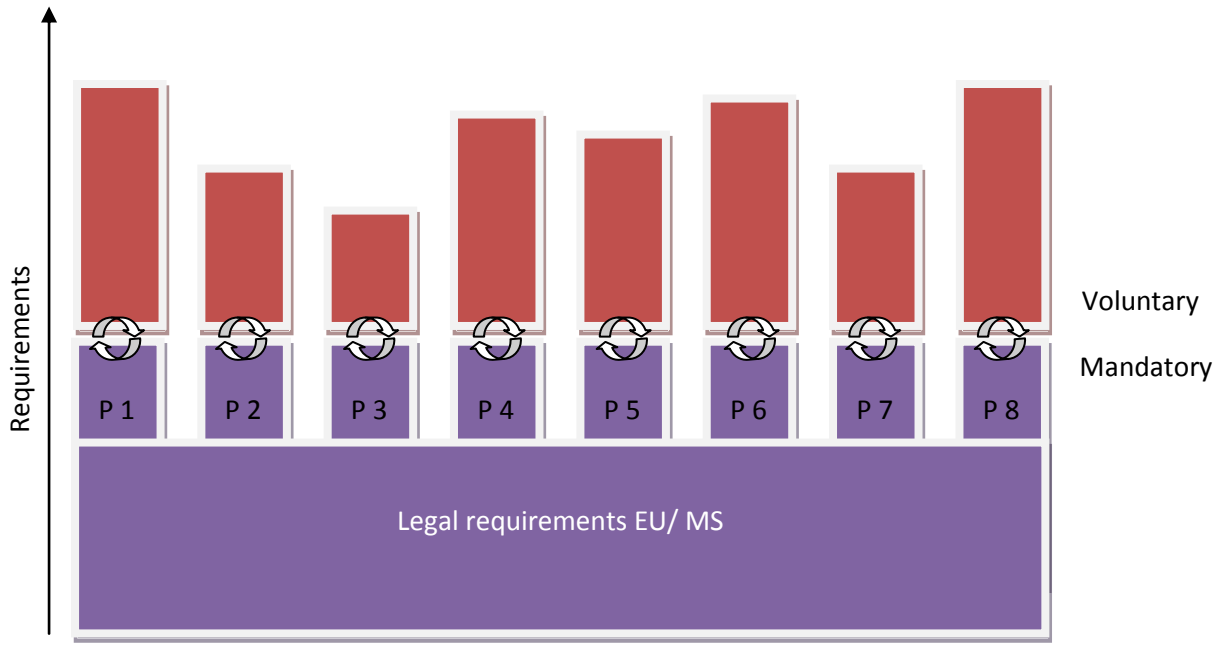


Figure 3 Relation between general and crop specific IPM principles (P= principle)

As regards additional crop specific elements, there seem to be no additional elements that should be considered for all crops. However, there are specific elements related for example to fruit growing such as treatment of the fruit or – related to harvesting – post-harvest handling, storage and fruit quality. It must be determined at each national level as to which crops require crop specific IPM guidelines. Depending on this decision for each of the crops. It must be determined if such additional requirements are necessary.

In most countries, crop specific guidelines are already available under the framework of "integrated production (IP)". It should be highlighted that IPM is a part of IP and that such crop specific IP guidelines can be used as a basis for further elaboration. However, it must be ensured that the requirements related to the general IPM principles are covered. A possible structure for such crop specific guidelines is given in Annex 3 – Recommendation for crop specific guidelines.

A precise example showing what a MS has to do in relation to the general principles and what is necessary on a crop specific level is also provided in Annex 3 – Recommendation for crop specific guidelines.

6 Annex 1 – Examples

Similarities and differences between GPPP and IPM

The following table shows how various elements are addressed in GPPP and in IPM. This will help to distinguish between the two systems clearly.

Table 2 Similarities and differences between GPPP and IPM

	Good Plant Protection Practice	Integrated Pest Management
Compliance with legal regulations	Strict compliance with legal regulations with respect to additional recommendations	Strict compliance with legal regulations and additional requirements in terms of a more sustainable farming and superior quality
Prevention and Suppression of harmful organisms		Requirements, e. g. 3-field rotation in arable cropping
- **Crop rotation**	Recommendations	
- **Cultivation techniques**	Common practise	Appropriate practise has to be used
- **Resistant varieties**	Use of site-related appropriate varieties	Use of resistant varieties when feasible
- **Fertilisation, irrigation**	Common practice	Best practice has to be used
- **Hygiene measures**	Common practice	Best practice has to be used
- **Enhancement, beneficial organisms**	No particular measures of natural pest control	Consideration and use of natural control. Beneficial organisms are included in action thresholds, use of selective pesticides, enhancement of natural pest control by field margins and other structural elements
Monitoring	Observation of fields for infestation	Pest monitoring according to information of advisory services or monitoring plan, use of available forecasting tools
Threshold values	Use of threshold values are not required, decision-making after simple evaluation of infestation, including experience and, if possible, advisory service information	Decision-making after field monitoring using action thresholds and all available forecasting and decision making systems
Non-chemical methods	No demands for using non-chemical methods	Use of non-chemical methods if feasible
Target specificity and side-effects	Prompt use of authorised and appropriate pesticides according to legal requirements	Prompt use of authorised pesticides most appropriate for IPM and with least side-effects
Necessary minimum	Users should endeavour to use pesticide on necessary minimum basis	Users have to keep pesticide use to levels that are necessary (as much as needed and as low as possible) by reduced doses, reduced application frequency and partial applications
Documentation	Documentation of field-related pesticide use	Documentation of field-related infestation situations and pesticide use

Example: implementation of general IPM principles controlling Colorado potato beetle (Leptinotarsa decemlineata), CPB in potato plants

It is presumed that the farmer is informed about the pest's life cycle, the conditions under which the damage is caused, action thresholds and available control measures. Larvae and adult beetles feed on the foliage of the host plants, but it is the larvae that can cause extensive damage if populations are high. If left uncontrolled, it can completely defoliate a potato crop and consequently will have a pronounced effect on yield. Feeding of adult beetles occurs from April and of larvae from May.

General principle	Action
(1) Measures for prevention and/or suppression of harmful organisms	
1.1 Crop rotation	It is presumed that the farmers have knowledge of the benefits arising from crop rotation and already puts it into practice. However, current practicable measures and new scientific findings regarding CPB suppressing crop rotation shall be provided to them. Thus farmers should know that planting potatoes in the same field year after year is unfavourable. The infestation level caused by CPB considerably increases when the distances between rotated fields and locations where potatoes were planted the previous season are near. In other words, the farther this season's potato field is from last season's potato field, the fewer the pest problems. The farmer should know that crop rotation can delay CPB population build up, but will not prevent an infestation unless fields are fairly well isolated. Non-host crop rotation is to be preferred. In general, avoid solanaceous crops as rotation choices. Although longer non-host crop rotations are ideal, they are often not economically feasible. A rotation of less duration is still beneficial, but to a lesser degree. Based upon the information given and after taking economic considerations into account, a crop rotation suppressing CPB infestation, organized on three fields and appropriate to control nematodes as well, could be: potato, winter wheat, winter rye.
1.2 Cultivation techniques	It is a prerequisite for the farmer to be provided with information about the current practicable cultivation techniques that help to optimise the crop growing resulting in plants having a high tolerance to CPB feeding.
1.3 Resistant varieties	Since no varieties are known to be resistant to CPB in Europe, the farmer should be provided with information on tolerant varieties by MS authorities. Furthermore, MS authorities should provide information about the different levels of susceptibility of approved potato varieties and their suitability for different regional conditions. Since many pests can be transmitted in infected seed tubers, including bacterial ring rot, blackleg, common scab, late blight, potato viruses, powdery scab, Rhizoctonia, root knot nematodes, silver scurf, and wilt diseases, certified seed tubers should be used. Despite the fact that certified seed tubers are not guaranteed to be disease free, they show low percentages of pest and disorder symptoms. Specialised advisors on varieties should be consulted in this matter in order to enable the farmer to choose a variety that is appropriate for the regional growing conditions, possibly one being more tolerant to CPB and warrants sales.
1.4 Fertilisation, irrigation	The farmer is to be provided with special information on fertilisation and irrigation measures and techniques appropriate for the regional conditions by MS authorities. Fertilisation and irrigation on tribute to healthy crops, consequently becoming more tolerant to CPB infestation.

1.5 Hygiene measures	Hygiene measures are of less importance in CPB control, but measures of equipment disinfection have to be considered when soil is infested by yellow and white potato cyst nematodes (***Globodera rostochiensis* and** *Globodera pallida)* or virus diseases.
1.6 Enhancement of beneficial organisms	The farmer is to be provided with special information on the potential of beneficial organisms in reducing the infestation level. Thus, the farmer should know that generalist predators such as ladybird beetles, lacewings, predatory bugs, spiders, etc. provide some control. There are also a number of CPB parasites. *Doryphorophaga doryphorae* and *D. coberrans* are two species of fly that parasitize CPB larvae; a wasp, *Edovum puttleri*, parasitizes eggs. In the first half of the season, soil predators, mostly ground beetles, climb potato plants to feed on second- and third-instar larvae of the CPB. In the second half of the season, ladybird beetles and green lacewings are the predominant predators, feeding on eggs and on first and second instars. Mulched plots support greater numbers of predators compared to non-mulched plots, resulting in significantly less defoliation by CPB. Tuber yields increase by a third. MS authorities should support the maintenance and building of field margins by providing information and raising attention to regional environmental programmes including financial promotions if available.

(2) Tools for monitoring

The farmer shall implement all monitoring measures appropriate to the given conditions. Therefore information is to be provided on recent appropriate tools for monitoring CPB by MS authorities, e.g. estimation of foliage loss in % and checks of 5 plants at 5 sampling points in a visualized line. To assist in the detection of insects, a small, white drop cloth can be positioned at the base of the plant; then gently tap the plant to dislodge any insects that may be present. Note: a batch of CPB eggs can easily be mistaken for ladybirds eggs. Furthermore, in Germany, the implementation of computer based forecasting systems e.g. SIMLEP 1-3 (Simulation Leptinotarsa= Colorado potato beetle) can be used in order to obtain the precise date for chemical control measure by the plant protection advisory service and farmers. Authorities of all MS should promote the adoption or development of such computer based forecasting models.

(3) Threshold values as basis for decision-making

Threshold values are to be defined by MS authorities and made available to the farmers. It is crucial to the farmer to know the action threshold values for CPB prior to a pesticide application. Action threshold values for CPB control are reached e.g. at 20% foliage loss or 20% of examined plants showing a high infestation which is 1 adult or 1 batch of eggs or 10 larvae.

(4) Non-chemical methods to be preferred

The farmer shall implement non-chemical methods for pest control whenever feasible. MS authorities shall especially support the implementation of this particular principle by providing information on recent research findings, field demonstrations, training programmes and seminars. Existing non-chemical methods to control the CPB are:

- NOVODOR FC (*B. thuringiensis* ssp. *tenebrionis)*, a form of Bt that is not genetically engineered and can be used
- NEEMAZAL-T/S (Neem seed-extracts)
- SPRUZIT NEU (pyrethrum/rape oil)
- Combined application of NEEMAZAL-T/S and, 2 days later, NOVODOR FC treatment is the best strategy for controlling defoliation through CPB
- Parasitic nematodes; commercial formulations of *Heterorhabditis* species are available and have been shown to be more pathogenic, to the CPB than *Steinernema* species of nematodes, which are also commercially available
- Bt is effective only if ingested by the pest, and then only in the larval stage. Furthermore, Bt sprays are generally effective only against newly hatched CPB larvae. Applications should be made within one to two days.

Essential for a successful control of CPB by using the listed bio-pesticides is the ideal timing of the treatment at the maximum occurrence of larvae (L3/L4).

(5) Target-specificity and minimization of side effects

To enable the farmer to comply with the requirements, MS authorities shall provide extensive information on recent research findings regarding side effects on non-target organisms as well as on new developments in drift minimizing spraying equipment.
Notice, the authorisation of pesticides to control CPB varies between MS.
To allow the farmer to select a pesticide or pesticide combination as target-specific as possible, a balanced decision-making, pest control effect, side effects on non-target organisms and resistance avoidance is to be aspired to. In other words, the selection of a pesticide shall be as protective for the environment as possible and meet economic requirements of the farmer as well. Drift of pesticide into other adjacent fields, public or private grounds or survey water while applied, is to be minimised as well. The farmer should know and respect buffer zones close to his acres and leave border strips to field margins untreated. He should use certified and most precise spraying equipment.

(6) Reduction of use to necessary levels

The farmer is to be provided with information by MS authorities to enable him to avoid unnecessary treatments in CPB control. When implementing this particular principle it is crucial to consider that all general principles significantly contribute to a reduced use of chemical pesticides to a necessary level.
If the population distribution of CPB permits, the farmer should consider the option of partial or border strip- applications to reduce insect numbers. Furthermore, he should know about timely intervention at larval state, L1-L2, will enhance insecticide effectiveness and provide better pest suppression. Late season pesticide applications to reduce overwintering adults are not cost effective and contribute greatly to increasing insecticide resistance.

(7) Application of anti-resistance strategies

The farmer is to be provided with all useful information on threatening pesticide resistance of CPB in his region and strategies to prevent further resistance development by MS authorities. Additionally, MS authorities shall acquire further information on this subject from the pesticide producing industry and evaluate the obtained results.
The CPB has been steadily gaining resistance to the insecticides commonly employed to control this insect. To prevent further resistance development, alternation between different classes of insecticides for the first and second larvae generation is strongly recommended. A proper control strategy is based upon the different modes of action of the active substances included. The reduction of application rate should not be permitted. The major classes of available active substances are: Pyrethroids, Neonicotinoids and Spymericines.

(8) Records, monitoring, documentation and checks of success

The farmer shall document all surveyed data on infestation level, occurrence of beneficial organisms, conduced treatments as well as results of pest control measures.
Therefore, the farmer is to be provided by the responsible MS authority with a template (digital or print version) to enable him to easily write down all collected data. To check the success of pesticide application, the farmer should monitor the infestation level promptly after the treatment. This is particularly necessary in the case of threatening CPB resistance towards certain active substances or when biological control measures are applied, which often allow only a moderate control.

Principle 1

Crop rotations

Crop rotations significantly contribute to suppressing harmful organisms. In order to achieve this aim, the following crop rotations are not accepted at all:

- wheat in monoculture (extreme enhancement of weeds and fungal diseases)
- potato in monoculture (enhances accumulation of nematodes and fungal diseases)
- sugar beet in monoculture (enhances accumulation of nematodes and fungal diseases)
- oil seed rape in monoculture (enhancement of fungal diseases)
- maize in monoculture (adverse ecological effects)

Crop rotations that are assessed as critical and therefore are usually not accepted:

- wheat, wheat, sugar beet (enhancement of weeds, grass weeds and fungal diseases)
- wheat, wheat, oil seed rape (enhancement of weeds, grass weeds and fungal diseases)
- wheat, wheat, potato (enhancement of weeds, grass weeds and fungal diseases)

Crop rotations including three different crops are suitable, e.g.:

- wheat, barley, oil seed rape
- sugar beet, wheat, barley

Crop rotations including five different crops are best, in particular rotations with 60% cereals:

- sugar beet, winter wheat, winter barley, pea, winter wheat
- winter oil seed rape, winter wheat, maize, winter wheat, winter barley
- potato, winter wheat, maize, winter wheat, winter rye

or

Crop rotations including up to 67% cereals:

- maize, winter wheat, winter rye, potato, winter wheat, winter rye
- winter oil seed rape, winter wheat, winter rye, pea, winter wheat, winter barley
- sugar beet, winter wheat, triticale, pea, winter wheat, winter barley

Principle 2

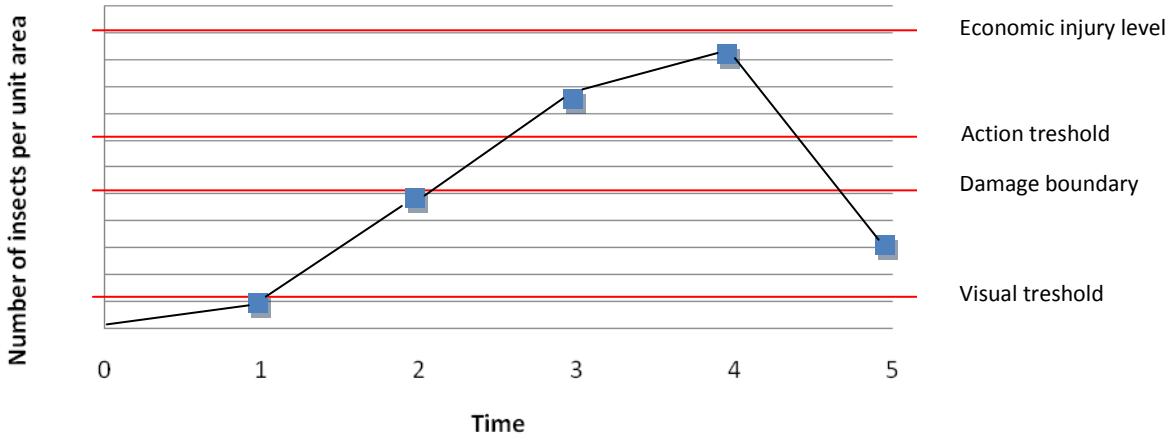
Example for the determination of infestation in arable crops.[3]
The infestation of harmful organisms is to be assessed field dependent.
Monitoring shall be conducted starting from the middle of one side of the acre and continued linearly (along a visualised line) to find five control points. The distance between the control points shall be 20m. When fields are larger than 10 hectares the monitoring shall be conducted at two field sides using 10 control points in the way as mentioned before. For assessment of weed infestation, 10 to 20 equally distributed control points along a transverse crossing through the acre shall be monitored. For subsequent analysis the mean of the data of every single control point is to be generated.

[3] Based on: "Recommendations for the integrated plant protection in arable farming" Burth, U., et al. (2001) Nachrichtenb. Deut. Pflanzenschutzd. 53 (12), S. 324- 329

Who has to conduct the monitoring? – The farmer himself or a private advisor on behalf of the client.
When is the monitoring to be carried out? – According to the state warning service, considering action thresholds and the growing stages of the crop.
How frequently is the monitoring to be conducted? – According to the forecasting system, warning service and decision making tools.

Principle 3

Within the description of principle 3, a figure has been provided showing the relationship of the different treshold levels. In the following an example is shown explaining what is expected by a professional user.



shows results of the monitoring activities.

Point in time 1: the result of the monitoring shows that a minimum of pests can be recognised; no damage can be observed and there is no need for action indicated

Point of time 2: the result of monitoring shows that the damage boundary is reached. This means a lot more pests could be observed but only initial damages are recognisable. There is still no need for action indicated.

Point of time 3: the results of monitoring show that the defined action threshold is exceeded. This means the pest population has reached a critical mass and without any intervention, the professional user would risk economic damage. Therefore, there is a need for action indicated at this point in time. The professional user has to decide which plant protection measure he/she will apply.

Point of time 4: even if the professional user has already applied a plant protection measure the pest population still increases slowly, however, the economic injury level is still not reached, this means the economic value of the crop is still higher than the value of the plant protection measure. The professional user is still in the position to make a profit from the plants.

Point of time 5: the results of monitoring show that the pest population has decreased far below the action level and even below the damage level. The plant protection measure was sucessful.

For example, the action threshold value for aphid infestation in winter barley, validated by the state advisory service, is 15% of all examined barley plants.
For foliage disease on winter wheat or winter barley, validation by the state advisory service is relevant:

- Powdery mildew: 60% (of all examined plants)
- Net blotch disease: 20% (of all examined plants)
- Rhynchosporium: 50% (of top three leaves of all examined plants) or 10% (of top two leaves of all examined plants)
- Dwarf leaf rust of barley: 30% (of all examined plants)

Principle 4

Application of *Trichogramma brassicae* in maize
The egg parasitoid wasp *T. brassicae*, released against the European Corn Borer *Ostrinia nubilalis*, is a common biological control method in maize (arable crops).
Trichogramma is usually distributed and released as parasitized eggs attached to a card or other surface. Out in the field, hatched adult wasps lay their eggs into their hosts' eggs wherein the developing wasp larvae destroy the pest eggs.
To achieve sufficient results, the frequency of release is twice during the period of oviposition of *O. nubiliaris*, first at the beginning of the pests' flight period and again eight to ten days later. *More generally, when determining the frequency of release for biocontrol agents, further factors must be considered e.g. the density of the planting, its location and environment, the pest and abundance of it.*
The timing of the release takes place according to light-trap catches, which indicate the beginning of the flight. *In general, release is also affected by weather, crop, host, predation, pesticides, and dispersal.* The rate of release in maize is 200,000 wasps per hectare. No technical facility is needed for dispersal on smaller areas, but on large scale farming sites special equipment is to be implemented.

Principle 5

Pirimicarb against aphids having minimal impact against Coccinellidae (ladybirds).
Active substance: **Pirimicarb**
Trade name: "Pirimor granules"
Target organism: aphids, aphids as virus vector has **minimum impact against Coccinellidae** (ladybirds)
Resulting from the intensive flight of aphids in the previous autumn, the farmer decides to spray the winter barley in early spring (April) in order to prevent the distribution of virus-infested aphids as vectors. The farmer expects more infestation by aphids during the growing season and acknowledges the beneficial effects of Coccinellidae (ladybirds). Thus, he decides to apply "Pirimor" because this pesticide has minimum impact against Coccinellidae.

Principle 6

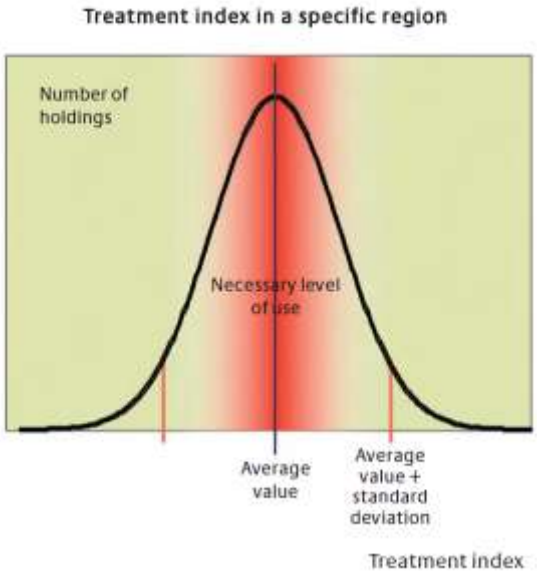
In general, the application rate varies between 50 to 100% within the necessary level.

For the application of the herbicide “Fenikan” (active substances are Diflufenican and Isoproturon) the application rate varies between 1.5 to 2.5 l/ha because the preparation has a considerable reserve of effect. Decision making as to what extent the dosage shall be reduced, depends on further influential factors:

- developmental stage of weeds
- composition of weed flora
- controllability of weeds (easy or difficult to control)
- infestation level
- parameters of tank mixture, e.g. formulation additives
- potential of preparation
- weather conditions
- intraspecific competition
- reserve of effect

Treatment frequency index[4]

The treatment index lists the number of times a plant protection product is used on a given piece of land, crop or farm, taking account of any reductions in the amounts used and whether only partial areas of land are treated. Plant protection products applied in mixed tanks are listed separately. When calculating the treatment index, the use of a plant protection product in the maximum amount allowed per application (target organism on the crop) receives a score of 1.0. If the amount used is reduced by – for instance – half, the treatment index score drops to 0.5. If the plant protection product is applied to just part of the crop area in question, perhaps to only 50 percent, the treatment index score also falls to 0.5. The scores are then added in accordance with the number of plant protection product applications for each growing year. If the indices are averaged for a selected unit (e.g. Germany, survey region, farm), a representative index can be calculated given a large enough number of random samples. Treatment indices are particularly suited to documentation of the various intensities in the use of plant protection products on crops, fields, farms and in given regions and years. Multiyear data can be used to identify trends.



4 Source: German National Action Plan on sustainable use of plant production products, Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz.

Existing surveys and other studies conducted on farms have shown that in the use of plant protection products on a specific crop, there is large variance in the treatment index between farms that work under similar locational conditions (survey regions). For each survey region where sample numbers are representative, statistical measures such as means and standard deviations can be calculated in order to plot this variance, and statistical tests can be carried out to identify significant temporal trends in the treatment index. It is also possible to rank the active substances used according to plant protection product (herbicide, fungicide and insecticide) and crop type.

Principle 7

There are several different options that can be used in an anti-resistance strategy. Such options comprise amongst others:

- Minimise the use of pesticides – this should in any case be the aim of IPM.
- Avoid any persistent chemicals – such chemicals will continue to be present in the environment and therefore pests are exposed to it for a long time. This supports the development of resistances.
- Rotation of pesticides – do not use the same pesticide or pesticides with similar modes of action time after time. The more often pests are treated with the same chemical the higher the risk that they adapt to this situation by developing resistance.
- Create pesticide-free windows – such areas allow susceptible pests to escape a pesticide's toxic effects. These pests will reproduce and preserve susceptible genetic profiles in the pest population, ensuring that resistant pests will not take over.
- Be careful with using mixtures – only if permitted by label instructions and manufacturers' recommendations, use a tank mix of two or more materials with different modes of action. Avoid using a mixture of substances with the same mode of action. In specific situations, the simultaneous application of two different pesticides may be necessary, but even in such cases tank mixes should be avoided. Example, insect growth regulators (IGRs) only control the immature stages of insects. If the adult stage must also be controlled, it will be necessary to apply another insecticide. It is recommended in such a case to use different types of application. For instance, if the IGR is applied as a spray, it would be preferable for example to use for the adult stage an aerosol with rapid elimination of the adults but little residual. This will inhibit the surviving immature insects from becoming resistant to the substance applied for the adult.
- Spot spraying – similar to the idea of pesticide free windows, the spraying of “hot spots” is recommended where pest numbers are above the action threshold. Large areas are left unsprayed for susceptible pests to survive. If necessary, these areas can be treated later, if thresholds are reached.

Pyrethroid resistance of rape blossom beetle (*Meligethes aeneus*)
Strategies for controlling in 2008

Pyrethroid resistant rape blossom beetles (*Meligethes aeneus*) are widely distributed in Germany and other European countries. The beetles' sensitivity towards pyrethroids varies. Other insect pests on oilseed rape are also exposed to pyrethroids which are often applied more than once per season. Therefore, control of the rape blossom beetle (*M. aeneus*) focuses on utilisation of pesticides with different active substances to hinder a further selection of pyrethroid resistance.
At present, there are only two control possibilities excluding pyrethroids, namely BISCAYA (2 treatments maximum) and organophosphorous compounds (Reldan 22, Pyrinex), used at a high infestation level.
Other harmful insects in the crop are the rape stem weevil (*Ceutorhynchus napi*) and the cabbage seedstalk curculio (*Ceutorhynchus quadridens*). In this case the preferred control measure is the application of class I (or II instead) pyrethroids, when the rape blossom beetle is coincidently present (monitoring by means of yellow colour trap). If the rape blossom beetle is present in a high abundance pyrethroid (class I or II) plus organophosphorous compound (Reldan 22, Pyrinex) shall be used. With a coincidental presence of rape blossom beetles (including larvae), BISCAYA (two treatments maximum) is to be used for the control of pod pests. If BISCAYA is not possible, a class I pyrethroid is to be used. When the rape blossom beetle is not present, any authorised pesticides may be used.

Authorised pesticides for rape blossom beetle control in oil seed rape, 27/02/2008:

Pyrethroids class I:	Talstar, Trebon (B1, use before blossom only), (Mavrik authorisation § 15a, possible authorisation in season 2008)
Pyrethroide class II:	Bulldock, Decis liquid, Fastac SC Super, Fury, Karate Zeon,
Sumicidin	alpha EC, Trafo WG
Neonicotinoids:	BISCAYA
Organophosphorous compound:	Reldan 22 and Pyrinex (authorised § 11, both B1, use before blossom only)

Table 3 Example for anti-resistance strategy

Indication (sufficiently abundant for control)	Occurrence of rape blossom beetle (*M. aeneus*) [RBB]	Strategy/recommended pesticide
Rape stem weevil (*Ceutorhynchus napi*) and cabbage seedstalk curculio (*Ceutorhynchus quadridens*)	No RBB	any pyrethroid
	RBB present	Class I pyrethroids
Rape stem weevil (*C. napi*), Cabbage seedstalk curculio (*C. quadridens*) and RBB	Danger of high infestation by RBB	Pyrethroid plus Reldan or Pyrinex
RBB before blossom	RBB below action threshold	No control measures

Indication (sufficiently abundant for control)	Occurrence of rape blossom beetle (*M. aeneus*) [RBB]	Strategy/recommended pesticide
	RBB above action threshold	BISCAYA
	High infestation by RBB	Reldan or Pyrinex
RBB in blossom with larvae	RBB low infestation	No control measures
	RBB high infestation	BISCAYA (in case of 2 applications BISCAYA, class I Pyrethroid)
Pod pests	RBB low infestation	Any Pyrethroid or BISCAYA
	RBB infestation significantly present	BISCAYA (in case of 2 applications BISCAYA, class I Pyrethroid)

According to experiences from the fields in 2008 and new trial data as well as possibly changing pesticide authorisation, the given strategy may require modification.

Principle 8

The following table shows an example of a field record system. Therein plant protection measures can be documented and the success can be checked.

Table 4 Documentation sheet

No. of region (arable cropping)							federal state:		
registration no. of farm/holding:		crop:		farms/holdings expanse per crop (ha):			year of harvest:		
field no.:	to be filled in by authority	field name:		field expanse (ha):			soil parameters:		
sowing date:									
variety:									
previous crop:									
cultivation measures:									
measures done by farmer									evaluation by federal authority
No.	harmful organism	BBCH	date	plant protection measure	Application rate	l/ha, kg/ha	treated area (ha)	basis for decision making*	
* e.g. monitoring, warning service, forecasting system (e.g. proPlant, ISIP)									

Annex 2 – Communication to professional users

In this Annex, templates are provided that can be used for the communication to professional users. Please note that a careful check relating to compliance with national legislation and the national framework has to be carried out and that the templates provided below will have to be adapted accordingly.

Principle 1

Supporting measures:
IPM should be a system in which various parameters and disciplines interact together. One necessary aspect is that naturally occurring benefits are used to the best extent. For example, the conservation of biodiversity is a fundamental measure in IPM. In addition, the use of appropriate crop rotation schemes or the use of a balanced fertilisation, etc. avoid any unnecessary environmental stresses and thereby promote a well-functioning natural biological system. ..... (*legislation in your country*) foresees application of various elements. All elements should be used in your daily work and should be treated as prerequisite for the success of IPM.

Appropriate practise to be applied:
In order to assist professional users in the implementation of ..... (*legislation in your country*) ..... (*name of authority/organisation in your country*) has established precise guidance on appropriate practise relating to several supporting measures one should use in general for all your plants. This information comprises xxx *(describe what the information covers)* and is available on ..... *(website or request information).*

Principle 2

Reason for monitoring:
It is essential that you establish an effective monitoring method/system for all crops, which are under your control in order to collect precise data on pests and diseases on a continuous basis. It is essential that you are always aware of the current status of your plants and that you are aware of any developments relating to pests infestations or any diseases. Only if you are aware of the actual situation and the dimension of a problem can you decide properly if and when plant protection measures are necessary.

Monitoring methodology/system to be applied:
In order to assist professional users in the implementation of ..... (*legislation in your country*) ..... (*name of authority/organisation in your country*) has established precise guidance on how to carry out proper monitoring. This information comprises xxx *(describe what the information covers)* and is available on ..... *(website or request information).*

Principle 3

Decision making:
Based on the results of your monitoring activities, it is necessary to decide whether a plant protection measure is needed or not. ..... (*name of authority/organisation in your country*) has established threshold levels, which shall be used as an indication as to whether further actions are necessary. In particular, the defined action thresholds show you exactly at which pest infestation

stage you should react with a plant protection measure. Precise guidance on the use of such levels is available on ..... *(website or request information).*

Principle 4

Reason for preferring non-chemical methods:
One of the major aims of applying IPM is reducing the use of pesticides to only unavoidable cases. By applying an integrated way of monitoring and consequent decision-making, you should always consider non-chemical plant protection measures before applying pesticides. It is not forbidden to use pesticides at all but it is forbidden to use them in cases where non-chemical alternatives would also have provided satisfactory pest control.

Non-chemical methods to be preferred:
In order to assist professional users in the implementation of ..... (*legislation in your country*) ..... (*name of authority/organisation in your country*) has established precise guidance on which non-chemical plant protection measures should be considered under which conditions. This information comprises xxx *(describe what the information covers)* and is available on ..... *(website or request information).*

Principle 5

Reason for preferring target specific pesticides:
In cases where the use of pesticides is unavoidable, it should be made clear that the "best" pesticide is used. "Best" in this sense does not mean that it is effective regardless of its effects on humans or other beneficial organisms. It means that if several pesticides are available for a pest problem you always have to use the one which has the highest target specificity (in the best case it would only kill the pest) and which has the least side effects for humans, non-target organisms and the environment (in the best case it would have no effects at all on all organisms – other than the pest – as well as on the environment).

Target specificity and effects on non-target organism and the environment:
In order to assist professional users in the implementation of ..... (*legislation in your country*) ..... (*name of authority/organisation in your country*) has published information relating to the specificity and effects of pesticides, which should be considered before carrying out a chemical plant protection measure. This information is available on ..... *(website or request information).*

Principle 6

Reason for restriction to necessary levels:
Where intervention is necessary, it should be ensured that only as little as necessary is carried out. This means you should for example reduce doses and application frequency to a minimal necessary level. Please note also that it might be counter-productive if too little is carried out. This can lead very rapidly to the development of resistances.

Necessary minimum:
In order to assist professional users in the implementation of ..... (*legislation in your country*) ..... (*name of authority/organisation in your country*) has published information related

to the necessary application minimums of pesticides and other plant protection measures, which should be considered before any intervention. This information is available on ..... *(website or request information).*

Principle 7

Need for anti-resistance strategies:
When pesticides are applied, you always have to consider the problem of pests and pathogens becoming resistant to the pesticide. This problem becomes more and more severe as pests and pathogens pass such resistance on to their offspring. There are currently many resistance problems known, as well as appropriate strategies to overcome them. Before you apply a pesticide, please check if resistance problems are known and how you should overcome them. In order to assist you, ... (*name of authority/organisation in your country*) has published information relating to resistance problems and related anti-resistance strategies, which should be considered before any intervention. This information is available on ..... *(website or request information).*

Principle 8

Need for checking of success:
IPM is an integrated system with continuous monitoring and which takes appropriate decisions in cases of pest infestation. Since it is essential not to use an intervention strategy which is most powerful and kills everything in the field immediately, it is also essential to see if the selected intervention strategy leads to sufficient results as well. The selected intervention strategy should indeed also be effective, but in a more controlled and targeted way with preference for the less harmful option. In order to assist you, ... (*name of authority/organisation in your country*) has published information relating to the data needed for checking the success, which should be considered by professional users. This information is available on ..... *(website or request information).*

Annex 3 – Recommendation for crop specific guidelines

As previously mentioned, crop specific guidelines are most often published within the framework of integrated production guidelines. Such guidelines should cover the following elements:

1. Integrated and holistic approach and ensuring availability of necessary information

Within this aspect, the following points should also be considered:

- Explanation on the obligations related to production according to a certified IPM guideline for professional users
- The guideline must enable situational decisions in terms of IPM
- National/regional institutions provide IPM-specific information, annual training programmes and on-site advice; the professional user must be aware of how to access the information
- The professional user is obliged to procure required information on IPM and to participate in continuous training activities

2. Support and use of natural control mechanisms (general principle 1)

Individual aspects should be considered, such as:

- Measures for protection and support of beneficial organisms have to be considered
- Use of protecting strips to avoid contamination of other bordering environments
- Increase of biodiversity

3. Measures which prevent pest infestation (general principle 1)

The following should be addressed here:

- Use of appropriate crop rotations systems
- Use of appropriate cultivation techniques
- Use of balanced fertilisation, liming, irrigation/drainage
- Use of appropriate planting material

4. Identification of infestation and application of decision making systems (general principle 2-3)

Within this aspect, the following points should be considered:

- Use of appropriate monitoring systems
- Warning and forecasting system
- Application of threshold values

5. Application of non-chemical and chemical pest prevention measures (general principle 4-7)

Individual aspects should be considered, such as:

- Preference of non-chemical methods
- Application only of necessary doses
- Use of adequate pesticides, considering hazardous properties

- Use of appropriate application techniques

6. Control of success and documentation (general principle 8)

The following should be addressed here:

- Check of success
- Documentation of monitoring results

The following table shows what a MS has to do in relation to the general principles and what is necessary on a crop specific level. It becomes obvious that a lot of very specific information needs to be available when the general principles are applied in practise. This is in line with the above-mentioned additional requirements necessary for a crop specific application of the general requirements. The example focuses on controlling Colorado potato beetle (Leptinotarsa decemlineata), CPB in potatoes.

Table 5 General and related crop specific requirements

(1) Measures for prevention and/or suppression of harmful organisms			
General IPM -obligatory-		**Actions necessary to bridge the gap between general and crop specific**	**Crop specific IPM -voluntary-**
1.1 Crop rotation	MS obliges the professional user to consider appropriate crop rotation schemes for all his crops	- MS have to elaborate information on appropriate crop rotation based on scientific knowledge or have to involve advisory services - MS have to inform the professional user on where to obtain information on appropriate crop rotation for main crops	- planting potatoes in the same field year after year is unfavourable. - the infestation level caused by CPB considerably increases when the distances between rotated fields and locations where potatoes were planted the previous season are near. - crop rotation can delay CPB population build-up, but will not prevent an infestation unless fields are fairly well isolated. - Non-host crop rotation is to be preferred. - avoid solanaceous crops as rotation choices. - Non-host crop rotations are ideal, a rotation of less duration is still beneficial, but to a lesser degree. - possible example for crop rotation: potato, winter wheat, winter rye.
1.2 Cultivation techniques	MS obliges professional user to consider appropriate cultivation techniques for all his crops	- MS have to elaborate information on appropriate cultivation techniques based on scientific knowledge or have to involve advisory services - MS have to inform professional users on where to obtain information on appropriate cultivation techniques	- information about the current practicable cultivation techniques that helps to optimise the crop growing resulting in plants holding a high tolerance to CPB feeding

General IPM -obligatory-		Actions necessary to bridge the gap between general and crop specific	Crop specific IPM -voluntary-
1.3 Resistant varieties	MS obliges professional user to consider appropriate resistance varieties for all his crops	- MS have to elaborate information on appropriate resistant varieties based on scientific knowledge or have to involve advisory services - MS have to inform professional users on where to obtain information on appropriate resistant varieties	- no varieties known in Europe to be resistant to CPB - information on tolerant varieties by MS authorities. - information about the different levels of susceptibility of approved potato varieties and their suitability for different regional conditions. - since many pests can be transmitted in infected seed tubers, including bacterial ring rot, blackleg, common scab, late blight, potato viruses, powdery scab, Rhizoctonia, root knot nematodes, silver scurf, and wilt diseases, certified seed tubers should be used. - specialised advisors on varieties should be consulted in this matter in order to help the farmer to choose a variety that is appropriate for the regional growing conditions and possibly being more tolerant to CPB
1.4 Fertilisation irrigation	MS obliges professional user to consider appropriate fertilisation and irrigation for all his crops	- MS have to elaborate information on appropriate fertilisation and irrigation based on scientific knowledge or have to involve advisory services - MS have to inform professional user on where to obtain information on appropriate fertilisation and irrigation	- special information on fertilisation and irrigation measures and techniques appropriate for the regional conditions - fertilisation, irrigation shall contribute to healthy crops, consequently being more tolerant to CPB infestation
1.5 Hygiene measures	MS obliges professional user to consider appropriate hygiene measures in his daily work (e.g. disinfection of equipment)	- MS have to elaborate information on appropriate hygiene measures based on scientific knowledge or have to involve advisory services - MS have to inform professional users on where to obtain information on appropriate hygiene measures	- Hygiene measures are of less importance in CPB control - measures of equipment disinfection have to be considered when soil is infested by yellow and white potato cyst nematode (Globodera rostochiensis and Globodera pallida) or virus diseases

General IPM -obligatory-		Actions necessary to bridge the gap between general and crop specific	Crop specific IPM -voluntary-
1.6 Enhancement of beneficial organisms	MS obliges professional user to consider appropriate measures to enhance beneficial organism	- MS have to elaborate information on appropriate measures to enhance beneficial organism based on scientific knowledge or have to involve advisory services - MS have to inform professional users on where to obtain information on appropriate measures to enhance beneficial organism	- information on the potential of beneficial organisms in reducing the infestation level - general predators such as ladybirds beetles, lacewings, predatory bugs, spiders, etc. provide some control. - there are also a number of CPB parasites: Doryphorophaga doryphorae and D. coberrans are two species of fly that parasitize CPB larvae; a wasp, Edovum puttleri, parasitizes eggs - in the first half of the season, soil predators, mostly ground beetles, climb potato plants to feed on second and third instar larvae of the CPB - in the second half of the season, ladybirds, beetles and green lacewings are the predominant predators, feeding on eggs and on first and second instars. - mulched plots support greater numbers of predators compared to non-mulched plots, resulting in significantly less defoliation by CPB. - tuber yields were increased by a third. - support the maintenance and building of field margins by providing information and raising attention to regional environmental programmes including financial promotions if available.

(2) Tools for monitoring			
General IPM -obligatory-		**Actions necessary to bridge the gap between general and crop specific**	**Crop specific IPM -voluntary-**
MS obliges professional user to apply an appropriate monitoring system **MS obliges professional user to consider information obtained via installed forecasting systems**		- MS have to elaborate information on appropriate monitoring systems based on scientific knowledge or have to involve advisory services - MS can implement forecasting systems (e.g. computer based models) - MS have to set up monitoring activities on MS level (early warning) - MS have to inform professional users on where to obtain information on appropriate monitoring systems and any information related to forecasting and early warning	- information on recent appropriate tools for monitoring CPB e.g. estimation of foliage loss in % and check of 5 plants at 5 sampling points in a visualized line - to assist in the detection of insects, a small, white drop-cloth can be positioned at the base of the plant; then gently tap the plant to dislodge any insects that may be present. - information explaining that a batch of CPB's eggs are easily mistaken as ladybirds' eggs - if appropriate, implementation of computer-based forecasting systems can be used in order to obtain the precise date for chemical control measures by plant protection advisory service and farmers

(3) Threshold values as basis for decision-making		
General IPM -obligatory-	**Actions necessary to bridge the gap between general and crop specific**	**Crop specific IPM -voluntary-**
MS obliges professional user to apply crop and pest specific threshold values before a plant protection measure can be considered	- MS have to elaborate information threshold values based on scientific knowledge or have to involve advisory services - MS have to inform professional user on where to obtain information on threshold levels	- action threshold values for CPB prior to a pesticide application - action threshold values for CPB control are reached e.g. at 20% foliage loss or 20% of examined plants showing a high infestation what is 1 adult or 1 batch of eggs or 10 larvae
(4) Non-chemical methods to be preferred		
General IPM -obligatory-	**Actions necessary to bridge the gap between general and crop specific**	**Crop specific IPM -voluntary-**
MS obliges professional users to prefer non chemical methods in cases where they provide satisfactory pest control	- MS have to elaborate information on appropriate non chemical measures based on scientific knowledge or have to involve advisory services - MS have to inform professional users on what satisfactory pest control means exactly - MS have to inform professional users on where to obtain information on non chemical methods	- information on recent research findings, field demonstrations, training activities and seminars - existing non-chemical methods to control the CPB are: • NOVODOR FC (B. thuringiensis ssp. tenebrionis), a form of Bt that is not genetically engineered and can be used • NEEMAZAL-T/S (Neem seed-extracts) • SPRUZIT NEU (pyrethrum/rape oil) • Combined application of NEEMAZAL-T/S and 2 days later NOVODOR FC treatment is the best strategy for controlling defoliation through CPB parasitic nematodes; commercial formulations of Heterorhabditis species are available and have been shown to be more pathogenic, to the CPB than Steinernema species of nematodes, which are also commercially available • Bt is effective only if ingested by the pest, and then only in the larval stage. Furthermore, Bt sprays are generally effective only against newly hatched CPB larvae. Applications should be made within one to two days. - essential for a successful control of CPB by using the listed bio- pesticides is the ideal timing of the treatment at the maximum occurrence of larvae (L3/L4).

(5) Target-specificity and minimization of side effects		
General IPM -obligatory-	**Actions necessary to bridge the gap between general and crop specific**	**Crop specific IPM -voluntary-**
MS obliges professional users to use the pesticide with the highest target specificity and the least side effects on human health and the environment	- MS have to elaborate information on target specificity and side effects of pesticides based on scientific knowledge or have to involve advisory services - MS have to inform professional users on where to obtain information on target specificity and side effects	- in-depth information on recent research findings regarding side effects on non-target organisms as well as on new developments in drift minimizing spraying equipment - guidance on the selection of a pesticide which shall be as protective for the environment as possible and also meet economic requirements of the farmer - drift of pesticide into other adjacent fields, public or private grounds or survey water while being applied, is to be minimised - buffer zones close to the farmer's acres and border strips to untreated field margins should be considered - certified and most precise spraying equipment should be used
(6) Reduction of use to necessary levels		
General IPM -obligatory-	**Actions necessary to bridge the gap between general and crop specific**	**Crop specific IPM -voluntary-**
MS obliges professional users to use the pesticide with the highest target specificity and the least side effects on human health and the environment	- MS have to elaborate information on target specificity and side effects of pesticides based on scientific knowledge or have to involve advisory services - MS have to inform professional users on where to obtain information on target specificity and side effects	- if the population distribution of CPB permits, the farmer should consider the option of partial or border strip-applications to reduce insect numbers - information on timely intervention at larval state L1-L2 which will enhance insecticide effectiveness and provide better pest suppression. Late season pesticide applications to reduce overwintering adults are not cost effective and contribute greatly to increasing insecticide resistance
(7) Application of anti-resistance strategies		
General IPM -obligatory-	**Actions necessary to bridge the gap between general and crop specific**	**Crop specific IPM -voluntary-**
MS obliges professional users to consider anti resistance strategies	- MS have to elaborate information on anti-resistance strategies based on scientific knowledge or have to involve advisory services - information on this subject should be obtained from the pesticide producing industry and evaluated independently	- information on threatening pesticide resistance of CPB in region and strategies to prevent further resistance development - the CPB has been steadily gaining resistance to the insecticides commonly employed to control this insect. To prevent further resistance,

	- MS have to inform professional user on where to obtain information on anti resistance strategies	development of alternation between different classes of insecticides for the first and second larvae generation is strongly recommended. - a proper control strategy is based upon the different modes of action of the active substances included. - the reduction of application rate should not be permitted. - the major classes of available active substances are: pyrethroids, neonicotinoids and spymericines.
(8) Records, monitoring, documentation and check of success		
General IPM -obligatory-	**Actions necessary to bridge the gap between general and crop specific**	**Crop specific IPM -voluntary-**
MS obliges professional users to document monitoring results and use of plant protection measures **MS obliges professional users to check the success of a plant protection measure**	- MS have to elaborate documentation templates to be used - MS have to elaborate information on how to check the success of a plant protection measure based on scientific knowledge or have to involve advisory services - MS have to inform professional users on where to obtain information on documentation and checking of the success	- documentation of all surveyed data on infestation level, occurrence of beneficial organisms, conduced treatments as well as results of pest control measures - template (digital or print version) to enable the professional user to easily write down all collected data - to check the success of pesticide application, the farmer should monitor the infestation level promptly after treatment - this is particularly necessary in the case of threatening CPB resistance towards certain active substances or when biological control measures are applied, which often allow only moderate control