IOBC / WPRS
Commission “IP-Guidelines and Endorsement”

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INTEGRATED PEST MANAGEMENT

Design and application of feasible and effective strategies

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Colophon

This publication is based on the content of the IOBC crop specific IP (Integrated Production) guidelines.

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Preface

Integrated Pest Management (IPM) finally, after 50 years of development, will become the European standard in crop protection policy, according to the Sustainable Use of Pesticides (DIRECTIVE 2009/128/EC) to be implemented by 2014. This directive is aimed at establishing minimum rules for the pesticide use in the EU in order to reduce risks to human health and the environment from the use of pesticides.

IPM is a strategic approach towards crop protection aiming at effective and feasible approaches that safeguard the quality and quantity of the agricultural production whilst minimizing the impact of pesticide use on human health and the environment. IPM is part of a more comprehensive concept of Integrated Production that targets overall sustainability of the agricultural production on farms.

The International Organization of Biological Control (IOBC) started already in 1956 with the first meeting of European pioneers in biological control and evolved into an independent world-wide scientific organization (www.iobc-wprs.org). IOBC's expertise covers all aspects of sustainable crop protection and production in major annual and perennial crops. IOBC strongly advocates Integrated Production – a concept of sustainable agriculture developed since 1976 which has gained international recognition and application. The concept is based on the careful use of natural resources and regulating mechanisms to replace potentially polluting inputs. The agronomic preventive measures and biological/physical/chemical methods are carefully selected and balanced taking into account the protection of both, the health of farmers and consumers, and of the environment.

IOBC established over the last 20 years the general concept and crop specific guidelines for Integrated Production for the major crop in Europe. The current set of IP guidelines and related tools has proven helpful and inspirational for farmers' organizations looking for a feasible way to work with Integrated Production in the premium food segment. Further information and technical details can be found on the website (http://www.iobc-wprs.org/ip_ipm/) of the IOBC Commission on Integrated Production Guidelines and Endorsement.

In this booklet we bring together in a condensed form the expertise on IPM from the IOBC work as a helping hand for all those who are involved in establishing IPM in practice. We hope you find it inspirational and useful

Franz Bigler,
President of the IOBC – WPRS.

1. IPM Objectives, Principles and Strategy

1.1 IPM is part of IP

IP (Integrated Production) is a concept of sustainable agriculture based on the use of natural resources and regulating mechanisms to replace potentially polluting inputs. The agronomic preventive measures and biological/physical/chemical methods are carefully selected and balanced, taking into account the protection of health of both farmers and consumers and of the environment. Emphasis is placed on a holistic systems approach involving the entire farm as the basic unit, on the central role of agro-ecosystems, on balanced nutrient cycles, and on the welfare of all species in animal husbandry (Boller *et al*., 1998, 2004).

IPM (Integrated Pest Management) is the part of IP focusing on pest, disease and weed management. The **objective of IPM** as a strategic approach towards crop protection is to safeguard the quality and quantity of the production whilst minimizing the impact of pesticide use on human health and the environment. Integrated Pest Management (IPM) applies to noxious species of phytophagous animals, plant pathogens and weeds. Noxious species are those causing economic losses higher than their control costs.
Since almost all aspects of the management of a crop, or even a farm have a potential impact on the occurrence and development of pests, diseases and weeds, an integral approach towards crop protection starts with taking these interactions into account. Agro-ecosystems are the basis for planning, the approach can also be characterized as agro-ecology: working with natural processes and regulatory mechanisms rather than relying on interventions alone. IPM takes just as IP the whole farm as basic unit.

The basic IPM strategy focuses on minimizing the use and impact of pesticide. Therefore emphasis is given to preventive (indirect) measures which must be utilized to the fullest extent before direct control measures are applied. Direct measures may only to be taken if economically justified. All elements of the strategy should be carefully integrated in a coherent strategy, to be fully effective. Some additional explanations here:

- **Prevention**
  - Includes the management of all those aspects that interact with crop protection from the more basic farm layout aspects (field size and shape, ecological infrastructures) over crop rotations, soil management and fertilization to cultivar choice of crops, sowing date and density and other measures. (see next paragraph)
- **Justification of direct control**:
  - „Control" means management of the pest, disease or weed population to maintain it below the level that causes economic losses. Decisions about the necessity to apply control measures must rely on the most advanced tools available, such as prognostic methods, monitoring techniques, scientifically verified thresholds, and decision support systems.
- **Control**:
  - Direct plant protection may be used if otherwise economically unacceptable losses cannot be prevented by indirect means.
  - Preference is given to all forms of non-chemical control measures (biological, physical etc.).
  - Pesticides may be used and integrated in the IPM strategy; however they must be carefully selected based on their properties with respect to their impact on environment, ecology and human health. Detrimental effects on disease, pest and weed antagonists must be avoided. Use should be minimized by reduced doses, reduced application

frequency or partial applications, taking into account the risk for development of resistance in populations of harmful organisms.
    - Some control methods or pesticides may be banned for a specific IPM scheme.

Two aspects deserve special attention, the diversity of the farm ecosystem and the farmer himself.

- **Biological diversity**:
    - includes diversity at the genetic, species and ecosystem level. It is the backbone of ecosystem stability, natural regulation factors and landscape quality. Replacement of pesticides by factors of natural regulation cannot sufficiently be achieved without adequate biological diversity. Stable agro-ecosystems in which flora and fauna are diversified provide important ecological services to the farmer covered by the term "Functional Biodiversity".
- The **farmer**:
    - plays a key role in IP systems and in IPM. His/her insight, motivation and professional capability to fulfill the requirements of modern sustainable agriculture are intimately linked to his/her professional skills acquired and updated by regular training.

1.2 The principles of IPM, design of IPM strategies

When designing an IPM strategy for a specific region, farm or cropping system, the following principles should be followed (Table 1). The order of the principles follows the general IPM strategy. These principles have found their way into Annex III of the DIRECTIVE 2009/128/EC EU on "Sustainable use of pesticides".

Table 1: Principles of IPM. Strategic objectives and management.

Principle	Explanation	Strategic objectives	Management
1. Prevention and/or suppression of pests, diseases and weeds	The incidence and severity of most pest, disease and weed problems can be greatly lowered by applying agricultural measures that favor the competitive advantage of the crops against their harmful organisms	Prevent build-up of pest, disease and weed populations Escape periods of high pest, disease and weed pressure Optimize crop fitness against attacks Make use of resistance, tolerance and competitive ability Prevent spreading pest and diseases and weeds Keep your agro-ecosystem fit by supporting functional biodiversity Design of the complete agro-ecosystem	Crop rotation Timing of sensitive crop stages Fertilizing strategies, crop management, cultivar choice etc. Field hygiene and adapted agricultural practice Enhance & protect beneficial organisms Ecological infrastructure [1]
2. Monitoring of pest organisms and applying of economic damage thresholds	Assessing the necessity of intervention (control) based on knowledge about the real situation and the potential of losses leads to more targeted interventions	Know the pests, diseases and weeds: Know the beneficial organisms Monitor pest, disease and weed incidence: Define action threshold levels: Define early warning systems	Identify the *site-specific* key pests, diseases and weeds that require regular interventions Identify *site-specific* key beneficial organisms Use Monitoring traps and crop inspection Use Intervention thresholds, Forecasting models for pest and disease incidence, Decision support systems
3. Non-chemical control	Many interventions with pesticides can be replaced or supported	Optimize Interference with pest, disease and weed biology:	Mating disruption, Sterile insect technique. Use of bio-pesticides

methods	by non-chemical alternatives	Use Physical interference:	Crop covers such as nets, exclusion fences, mechanical weed control
4. Chemical control methods	Pesticides chosen with minimum side-effects and with minimal interference with preventive and non-chemical control methods	Select pesticides specifically targeted to harmful organisms and with minimal side effects, protect your allies (beneficial organisms) Optimize application technique and timing Optimize the dosage of pesticide Prevent development of resistance: Check efficacy	Classify pesticides according to toxicity, ecotox etc., special emphasis on protection of key beneficial organisms. Establish transparent criteria of preferred and less preferred pesticides Use well maintained and calibrated spraying equipment operated by trained persons. Use weather and efficacy forecasts when available to optimize timing and dosage Consider row or spot applications Anti-resistance strategies based on sequence or combinations of active ingredients and alternation with other IPM methods Adapt application rates and frequencies, Small untreated areas, (zero treatment or "spray windows"),
5. not permitted methods	Some interventions (mostly chemical) are prohibited because they interfere with the agro-ecosystem in a way that prevents sustainability	Chemical soil disinfection	

1: .Utilization of ecological infrastructures inside and outside production sites to enhance a supportive conservation biological control of key pests by antagonists.

2. Successful IPM strategies for the major perennial and annual crops

In this chapter we summarize IPM strategies for the major crops along the same lines of the basic principles and the order – prevention – justification of control – control. For each principle we distinguish the relevant information in general aspects and the specific points of interest for pests diseases and weeds. When no specific information is given these lines are omitted from the tables.

The tables are adaptations from the IP guidelines for these crops (groups of crops) as compiled and published by IOBC (on http://www.iobc-wprs.org/ip_ipm/). These guidelines are based on a long experience with developing and implementing IPM approaches.
We distinguish in the following tables measures that form the basics for any IPM scheme, or IPM approach and measures that will give additional value to IPM strategies, and can be considered suitable for a more advanced approach. The term guideline, as used in the following tables, refers to either guidelines used by regional or national authorities or to specific IP(M) schemes in certificated production.

Not all measures are described in great detail. The guidelines were established to fit for a wide range of growing conditions over Europe. For the use in specific growing areas, they should be sharpened to fit the local problems and possibilities. Specific points in the following tables can contradict in details. Thus, their use should be “or” rather than “and”. Use site-specific and regional conditions as an appropriate filter.

2.1 Perennial crops: fruit trees (pome fruit, stone fruit and citrus)

Table 2. Possible elements of the IPM strategy for fruit trees (pome fruit, stone fruit and citrus). Measures in bold are considered being basic for IPM (in guidelines must-sentences), the non-bold topics are considered additional possibilities for a more advanced level of IPM (in guidelines should-sentences) or specify in more detail the basic items in bold.

1. Prevention and/or suppression	
general	**Maintain a diverse ecosystem of plants and animals and enhance and protect ecological infrastructures**[1, 2] **Maintain vegetation, at least in alleyways**. **Guidelines must define a maximum width for the weed free strip and a maximum percentage of bare soil surfaces.** Protect headland attractants (flowering field margins) and (windbreak) hedges as reservoirs of pest antagonists. **Planting material must be pest and diseases free** and, if appropriate, certified virus-free or virus-tested. **The cultivation system, including planting pattern, training and pruning, has to respect the optimum physiological status of the crop plant.** **Citrus: when re-planting an orchard, the soil must be deep ploughed and the re-planting should not be done before a period of 8 months has elapsed, if the previous crop was citrus**.
pests	**Identify and protect key antagonists: e.g. predatory mites, aphid predators and parasitoids, other important parasitoids, *Anthocorid* bugs (in pear).** **Introduce phytoseiid predators if absent from orchards and when pest situation (e.g. spider mites) requires regular control measures.** ***Cydia molesta* and *Anarsia lineatella* in peaches and nectarines must be controlled as long as pest pressure is low**, by removal of infested shoots by pruning in summer. **Ensure adequate spatial separation of cultivars with successive ripening times to reduce the potential for fruit fly to complete its development** Stone fruit: infestations of *Capnodis tenebrionis* should be prevented by irrigation.
diseases	**Use cultural techniques to remove sources of overwintering of infestation or infections (e.g. wood scab, canker, brown rot).** Choice of cultivars: cultivars and rootstocks should be adapted to local conditions. Pome fruit: Varieties with low sensitivity to apple scab. Stone fruit and citrus: cultivars and rootstocks tolerant to fungal diseases and/or pests and resistant to viruses, phytoplasms bacteria and nematodes are preferred.
2. Monitoring of pest organisms and applying of economic damage thresholds	
general	**For each region, guidelines must specify which pests and diseases can and must be covered by forecasting and/or monitored, depending on availability of methods and crop loss potential. For monitored pests and diseases, intervention thresholds must be established and followed.**
pests	**Apricots: *Anarsia lineatella* populations must be monitored:** use pheromone traps. **Plums: *Cydia funebrana* must be monitored:** use pheromone traps**.** **Cherry: *Rhagoletis cerasi* must be monitored:** use yellow sticky traps**.**
3. Non-chemical control methods	
pests	**Alcohol-baited traps must be used for mass-trapping to control *Xyleborus dispar* where necessary.** **Interfering with biology:** pheromone mating disruption for codling moth and/or other tortricids, woodborers (*Sesiidae*). ***Bacillus thuringiensis* or insect-virus based products, such as: granulovirus for codling**

	moth, must be used for control of leaf roller and noctuid caterpillars where effective. **On citrus releases of *Cryptolaemus montrouzieri* and *Leptomastix dactylopii* must be used if available and effective.** Physical control: white sticky traps against sawflies, lure traps against bark beetles.
4. Chemical control	
general	**Establish anti-resistance strategies for pests, diseases and weeds according to recommendations of FRAC/IRAC /HRAC or EPPO.** **Use drift-minimizing spray equipment and nozzles**. The size and shape of the spray plume generated by the sprayer must be set to match the tree target. **Officially-recognized dose adjustment protocols (when available) must be followed** to adjust dose rates to suit the size and density of the target trees being sprayed. **Pesticide residues on fruits at harvest have to be further minimized** by maximizing safe-to-harvest intervals and by minimizing post-harvest chemical treatments.
pests	**Selective aphicides must be used where they are effective.** Peaches, nectarines, apricots: Scale insects should be controlled where necessary by application of mineral oil or poly-sulphurs in the dormant period. Cherry: a fast degradable insecticide should be applied for control where necessary.
diseases	**Restrictions**: Benzimidazole fungicides: pome fruit: storage rots and blossom wilt and localised application for canker control, only. Stone fruit: max. 2 appl./year. Dithiocarbamate fungicides (normally a maximum of 3 applications per season and not in succession so that predatory phytoseiid mites are not affected). On pear crops in regions where *Stemphylium versicarium* is a severe problem, the maximum number of applications is 4 per season). Similar restriction for other fungicide classes. Sulphur (use must be limited so that predatory phytoseiid mites are not affected).
weeds	**Guidelines must specify which herbicides can be used, persistent and leachable herbicides should be avoided.** Reduced dosage and split application strategies are preferred.
other	Growth regulation: (e.g. gibberellins, NAA) or a spray of etherel is permitted. On cherry trees, a spray of a naturally occurring (but chemically synthesized) crop setting agent (e.g. gibberellins NAA) is permitted.
5. Prohibited measures and strategies	
general	**Chemical soil disinfection**
pests	**Pyrethroids, all acaricides toxic to Phytoseiid mites**
others	**The use of non-naturally occurring, synthetic plant growth regulators as fruit finishing or ripening agents is not permitted.**

1: diverse ecosystem of plants and animals must be created and conserved. According to IOBC standards, at least 5% of the entire farm surface (excluding forests) must be identified and managed as ecological infrastructures with no input of pesticides or fertilisers, in order to enhance botanical and faunistic biodiversity and to enhance a supportive conservation biological control of key pests by antagonists

2: Stone fruit (plum , apricot): Species which are host plants of important fruit pathogens, particularly sharka and ESFY, must be avoided; Blackthorn and other Prunus sp. are hosts of Cacopsylla pruni which is the vector for ESFY; it is better to avoid them near plum and apricot orchards.

2.2 Perennial crops: grapevines

Table 3. Possible elements of the IPM strategy for grapevines. Measures in bold are considered to be basic for IPM (in guidelines must-sentences), the non-bold topics are considered additional possibilities for a more advanced level of IPM (in guidelines should-sentences) or specify in more detail the basic items in bold.

1. Prevention and/or suppression	
general	**Maintain a diverse ecosystem of plants and animals and enhance and protect ecological infrastructures[1].** Protect headland attractants (flowering field margins) and (windbreak) hedges as reservoirs of pest antagonists. **Guidelines have to provide a list of possible options for the active enhancement of biological diversity**. At least two of these ecological options have to be implemented in each vineyard. Establish a list of plants to be avoided in or adjacent to vineyards (e.g. sources to major grapevine diseases). **Maintain vegetation on alleyways to minimize herbicide use[2].** In regions with enough precipitation, establish botanically diverse permanent vegetation cover and continuing flower supply (food source for beneficial's), e.g. by alternating mowing of alleyways. **Prior to planting, eliminate sources of disease inoculums (i.e. roots of old vines) and perennial weeds.** **Planting material must be pest and diseases free** and, if appropriate, certified virus-free or virus-tested. **Plant training systems should not favor the development of pests and diseases** and should allow targeted pesticide application.
pests	**Identify and protect key antagonists: in particular predatory mites and parasitoids. Where phytoseiid predators are absent from vineyards, they must be introduced if the pest situation (e.g. spider mites, thrips) requires regular control measures.**
diseases	**Training, pruning and defoliation must ensure proper ventilation of the canopy and the grape zone** (e.g. as preventive measure against Botrytis). Use cultivars and clones with reduced susceptibility or resistance to Downy mildew (*Plasmopara viticola*) and, if available to other diseases.
2. Monitoring of pest organisms and applying of economic damage thresholds	
general	**For each region, guidelines must specify, which pests and diseases can and must be covered by forecasting and/or monitored, depending on availability of methods and crop loss potential. For monitored pests and diseases, intervention thresholds must be established and followed.**
diseases	**Where available, forecasting models and decision support systems must be used for Downy mildew (*P. viticola*).**
3. Non-chemical control methods	
pests	**Interfering with biology: pheromone mating disruption for grapevine moths and/or other tortricids.**
weeds	Mechanical weed control is preferred underneath plant rows.
4. Chemical control	
general	**Establish anti-resistance strategies for pests, diseases and weeds according to recommendations of FRAC/IRAC /HRAC or EPPO.**

	The official pre-harvest intervals must be followed and should be extended to minimize pesticide residues. **Use drift-minimizing spray equipment and nozzles**. **The size and shape of the spray plume generated by the sprayer must be set to match the canopy height.** Localized treatments on grape bunches are preferred (example in the case of *Botrytis*).
pests	**Restrictions: organophosphates and Carbamates only in exceptional situations**, if no other active ingredients approved (guidelines must specify exceptional conditions).
diseases	**Restriction** of dithiocarbamate fungicides to max. 3 applications per season (not in succession) so that predatory Phytsoeiid mites are not affected). Sulphur spray treatments only with concentrations that do not affect Phytsoeiid mites. **Restrict use of copper:** guidelines must define maximum input according to national or regional requirements. Guidelines must set an upper limit for the annual copper input.
weeds	**Guidelines specify maximum width of weed control area underneath grapevine rows and the allowed contact herbicides with low persistence.** Where available, apply reduced herbicide dosage strategies.
5. Prohibited measures and strategies	
general	**Pyrethroids and all acaricides classified toxic to phytoseiid mites** **Chemical soil sterilization**

1: see footnote 1 Table2.

2: exceptions possible for new plantations (first 3 years) and for regions with precipitation of less than 500 mm during growing season

2.3 Olives

Table 4. Possible elements of the IPM strategy for olives. Measures in bold are considered being basic for IPM (in guidelines must-sentences), the non-bold topics are considered additional possibilities for a more advanced level of IPM (in guidelines should-sentences) or specify in more detail the basic items in bold.

1. Prevention and/or suppression	
general	**Maintain a diverse ecosystem of plants and animals and enhance and protect ecological infrastructures[1].** Protect headland attractants (flowering field margins) and (windbreak) hedges as reservoirs of pest antagonists;. **Guidelines have to provide a list of possible options for the active enhancement of biological diversity**, at least two of these ecological options have to be implemented in each olive grove. **Maintain vegetation on alleyways to minimize herbicide use[2].** A green cover during winter is strongly advised at least in the alleyways, with an exception for arid areas where this green cover could create water deficiencies. In areas with high precipitation and adequate soil types the maintenance of a permanent or temporary green cover during the growth season is highly recommended. **Planting material** should be sound and certified as pathogen and pest-free, including substrates of growing media; **where this is not available the planting material of the highest health status available must be used.** **Planting and training system: olive trees must be regularly trained and pruned to achieve a balance between growth and regular yields and to allow good penetration of light and sprays;** severe pruning should be avoided except in cases of canopy renewal i.e. after intense cold periods, risk of disease damages or heavy infestation by scale insects. Cultivar choice: Cultivars resistant or tolerant to diseases, pests and adverse climatic conditions (i.e. frost) are recommended. **Irrigation must be applied according to need and with the best methods to avoid losses** (e.g. micro-irrigation). Excessive soil moisture may result in leaching of nutrients, competition with weeds, and risks of pest and disease (outbreaks).
pests	**Identify and protect key antagonists: in particular predatory mites and parasitoids:** usually the predator *Chrysoperla carnea*, important insect parasitoids (especially against scales or the olive fly) or another predator like *Anthocoris spp.* Where important natural enemies are absent from olive-groves where the pest situation requires regular control measures (e.g. parasitoids of scale insects), they should be introduced, if available and effective. **Olive fruit fly:** harvesting at the earliest possible time and stripping all the olive fruits from the tree. Infestation of *B. oleae* may be constrained in part by planting resistant cultivars. Avoid the interplanting of susceptible, large drupe varieties, with the more tolerant cultivars for oil production. Avoid the excess irrigation because the olive fly population is much favoured in irrigated olive groves.
diseases	**Eliminate sources of disease inoculum, especially of *Verticillium dahliae***; the absence of this fungus should be checked at planting; the plantation should be avoided in case of previous crops being host plants of *Verticillium*; intercropping with host plants of serious diseases (e.g. solanaceous plants and cotton) should be strictly avoided. Spontaneous weeds or cover crops that are known as non-host of *Verticillium* should be used at this purpose. Proper ventilation of the canopy is an important prophylactic measure against diseases especially *Fusicladium oleagineum* and *Colletotrichum spp*. After pruning cicatrisation of large cuts should be cured by mastics in order to avoid *Euzophera pinguis* or wood disease damages.

	The frequent disinfecting of pruning equipment is recommended to avoid the spread of disease infections (e.g. *Pseudomonas spp.).* Mechanical destruction of healthy pruning materials is recommended.
weeds	**Prior to planting minimize population of perennial weeds.**
2. Monitoring of pest organisms and applying of economic damage thresholds	
general	**For each region, guidelines must specify, which pests and diseases can and must be covered by forecasting and/or monitored, depending on availability of methods and crop loss potential. For monitored pests and diseases, intervention thresholds must be established and followed.**
pests	**Monitor olive fruit fly:** by using traps established in late spring and baited with ammonium salts or protein hydrolysates, or using traps with food, sexual and/or visual attractants. The infestation level on the fruits has to be recorded. **Monitor *Prays oleae*:** by using sex pheromone traps and flower / fruit sampling**.** **Monitor *Saissetia oleae* and other scales (*Parlatoria oleae, Aspidiotus nerii* etc.):** to estimate the population density as well as the % of parasitism and the presence of honeydew or sooty mould. Other minor pest to be monitored where important.
3. Non-chemical control methods	
pests	**Olive fruit fly: several methods are available and have to be applied wherever effective:** mass trapping: food and sex attractant traps impregnated with insecticides (attract & kill technique); biological control: natural enemies such as larval and pupal parasitoids or epigeal predators and fungi may be active but generally they do not suppress the pest below economically significant levels. Suitable cover crops may support the regulatory effect of natural enemies. The Insect Sterile Technique can provide an alternative method, and should be evaluated. ***Prays oleae*: Sprayings against anthophagous larvae are only applied in cases of low percentage of olive flowering and high population density of the pest.** *Bacillus thuringiensis* can be used. Treatments with compatible selective insecticides should be applied to prevent the entry of hatched larvae in young fruit. *Saissetia oleae* and other scales (*Parlatoria oleae, Aspidiotus nerii* etc): can be efficiently controlled by beneficial fauna: cultural methods such as pruning and moderate use of nitrogen fertilisers are also important**.** *Zeuzera pyrina:* mass trapping or mating disruption can control this pest.
diseases	***Verticillium* wilt: is essential to avoid planting on infected soil and use pathogen-free propagation material or use resistant/tolerant cultivars**. Soil solarisation can contribute to the control of the disease.
weeds	Mechanical weed control is recommended option.
4. Chemical control	
general	Establish anti-resistance strategies for pests, diseases and weeds according to recommendations of FRAC/IRAC /HRAC or EPPO. **Use drift-minimizing spray equipment and nozzles**. The size and shape of the spray plume generated by the sprayer should be set to match the canopy height.
pests	**Olive fruit fly:** bait sprays: with this method, the quantity of sprayed insecticide is greatly reduced in comparison to cover sprays as well as the damage to beneficial and other fauna. Cover sprays can be applied based on economic thresholds depending on the variety and region, generally lower for table and higher for olive oil varieties. *Prays oleae*: Treatments with compatible selective insecticides should be applied to prevent the entry of hatched larvae in young fruit (see non-chemical).

	Zeuzera pyrina: direct application of pesticides in mines can be effective. **Restrictions:** broad-spectrum organo-phosphate and carbamate insecticides: precise indication and maximum number of applications are required.
diseases	**Restrictions: fungicides with high potential to develop resistance; copper (guidelines have to define the maximum amount in kg per ha and year)**
weeds	**The application of herbicides on the entire surface is not permitted.** Herbicides might be used under the canopy however they should be rapidly degradable, timing to be specified with specific attention to possible residues on fallen olive fruits. **Restrictions:** Post-emergence applications of herbicides are permitted in any case only after harvest. **Guidelines must specify which herbicides can be used, persistent and leachable herbicides should be avoided.** The timing and condition of use to be specified with respect to risks of residues on olives (dropped).
5. Prohibited measures and strategies	
general	**Chemical soil sterilisation is not permitted.**
pests	**Cover sprays with synthetic pyrethroid insecticides. The use of synthetic pyrethroid insecticides is permitted only in attractive traps or with the protein and/or pheromone bait system.**

1: see footnote 1 Table2. When an olive grove area is located adjacent to forests or area covered by typical plants of Mediterranean bush this is sufficient to cover the 5% rule.
2: see footnote 2 Table 3.

2.4 Soft fruits

Table 5. Possible elements of the IPM strategy for soft fruits (Strawberry, Raspberry, Blackberry, Currants, Gooseberry, Blueberry, Elder, etc.)[1]. Measures in bold are considered to be basic for IPM (in guidelines must-sentences), the non-bold topics are considered additional possibilities for a more advanced level of IPM (in guidelines should-sentences) or specify in more detail the basic items in bold.

1. Prevention and/or suppression	
general	**Maintain a diverse ecosystem of plants and animals and enhance and protect ecological infrastructures**[2] **Maintain vegetation, at least in alleyways.** Guidelines must define a maximum width for the weed free strip and a maximum percentage of bare soil surfaces. Mulching recommended. Protect headland attractants (flowering field margins) and (windbreak) hedges as reservoirs of pest antagonists. **Crop rotation must be targeted to minimize pest and disease pressure.** **Cultivar selection: preference for cultivars resistant or tolerant to fungal diseases, pests, viruses and/or phytoplasmas.** **Planting material must be pest and diseases free** and, if appropriate, certified virus-free or virus-tested. Planting system: planting distances should allow enough space for the plant throughout its expected life span without the use of growth regulators; a correct planting distance reduces humidity inside the row and therefore prevents cane diseases. **The cultivation system, including planting pattern, training and pruning, has to respect the optimum physiological status of the crop plant.**
pests	**Identify and protect key antagonists: e.g. predatory mites, aphid predators and parasitoids.** Planting material: care should be taken to avoid planting material contaminated with pesticide residues which may disrupt subsequent biological control programs. Site selection: Sites with significant infestations of soil insects (e.g. *Melolontha spp*.) should be excluded from production. Weeds and alleyways management: Partial mowing is preferred to avoid migration of phytophagous insects (e.g. leafhoppers and *Lygus*) to crops. **Strawberry: naturally-occurring phytoseiid predatory mites reduce populations of spider mites, tarsonemid mites and thrips and must be conserved.** Use of pesticides harmful to them must be avoided. **Predatory mite *Phytoseiulus persimilis* or another appropriate species must be introduced for biological control of two-spotted spider mite on protected crops (in tunnels etc.).** *Orius spp*. or suitable predatory mirids should be used to control western flower thrips on protected crops. Entomopathogenic nematodes, where available, should be used to control vine weevil and other soil-pests in protected crops. **Cane fruits: predatory mites must be conserved** in field crops and *P. persimilis*, or another suitable species, used for biological control in protected crops.
diseases	**Site selection:** Sites with significant infestations of plant-parasitic or virus-transmitting nematodes or specific soil-borne root rot fungus (*Armillaria* and *Phytophthora fragariae var. rubi*) should be excluded from production Protections (tunnels) allow to reduce the incidence of *Botrytis cinerea* but, on the other hand, can promote the development of other diseases such as powdery mildew on strawberries and currants.

	Crop rotation: A break of at least five years is generally recommended for the different crops, especially if root pathogens are present in the soil (*Phytophthora*, *Verticillium*, *Armillaria*, *Rosellinia*, etc.). However for strawberry crops with a life span of only one year, continuous cropping is permitted as long as soil-borne diseases do not occur at significant levels. Cane fruits: to prevent and control the development of cane diseases following cultural methods should be applied 1) early removal of infected and superfluous fruiting canes, 2) removal of fruiting canes immediately after harvest, 3) reduction of nitrogen fertiliser rates, 4) drip irrigation should be preferred to sprinkler and micro-sprinkler systems. Bush fruits: Currant branches infected with *Botrytis cinerea* and *Nectria cinnabarina* should be removed and the pruning wounds protected. Currant and gooseberry shoots infected with powdery mildew (*Sphaerotheca mors-uvae* and *Microsphaera grossulariae*) should be removed to reduce inoculum for the next growing season. Pay attention at the presence of *Armillaria* in the bark heaps before their use for mulching.
2. Monitoring of pest organisms and applying of economic damage thresholds	
general	**For each region, guidelines must specify, which pests and diseases can and must be covered by forecasting and/or monitored, depending on availability of methods and crop loss potential. For monitored pests and diseases, intervention thresholds must be established and followed.**
pests	**Cane fruits: *Byturus tomentosus* must be monitored regularly:** use white sticky traps**; raspberry clearwing moth, *Synanthedon hylaeiiformis*, must be monitored:** use pheromone traps. **Bush fruits: currant clearwing moth, *Synanthedon tipuliformis*, must be monitored:** use with pheromone traps**; infested shoots must be pruned and removed from the plantation.** **Black currant crops must be closely inspected for black currant gall mite galls** during the dormant period when they are easily visible and **all infested plant material must be removed from the plantation and destroyed.**
diseases	**Bush fruits: crops must also be inspected for symptoms of reversion disease immediately before flowering and all infected bushes must be grubbed and destroyed.**
3. Non-chemical control methods	
general	**The cultural practice of removal of sources of infestation or infection as far as practically possible is required.** Wherever an additional control measure is deemed necessary, a biological or biotechnical control method (e.g. *Bacillus thuringiensis* , pheromone mating disruption, entomopathogenic nematodes for vine weevil, *Trichoderma spp*. for root rots) should be used if available and effective. ***Bacillus thuringiensis* or insect-virus based products must be used where effective**.
4. Chemical control	
general	**Establish anti-resistance strategies for pests, diseases and weeds according to recommendations of FRAC/IRAC /HRAC or EPPO.** **Use drift-minimizing spray equipment and nozzles**. **Pesticide residues on fruits at harvest to be further minimized** by maximizing safe-to-harvest intervals and by minimizing post-harvest chemical treatments**.** **Officially-recognized dose adjustment protocols (when available) must be followed** to adjust dose rates to suit the size and density of the target trees being sprayed.
pests	**Restrictions:** acaricides for control of spider mite (maximum of 1 application per

	pesticide resistance group / year); pyrethroid insecticides (maximum of 1 application/year for control of *Anthonomus rubi* or aphids and thrips on strawberry; OP insecticides of short persistence and low toxicity to phytoseiid predatory mites (maximum of 2 applications/year)
diseases	**Restrictions:** benzimidazole fungicides (maximum of 1 application/year, except on raspberry a maximum of 2 applications per annum as directed sprays to control cane blight only); other fungicide groups with risk of resistance development (including EBIs, dicarboximides and QOLs) (maximum of 3 applications per group/year alternating different active ingredients)
weeds	**Guidelines must specify which herbicides can be used, persistent and leachable herbicides should be avoided. The timing and condition of use to be specified with respect to risks of residues on olives (dropped**) Reduced dosage and split application strategies.
other	**The use of plant growth regulators and of chemical agents for fruit management is not permitted.**
5. Prohibited measures and strategies	
general	**Chemical soil sterilization**
pests	**Persistent or phytoseiid mite toxic OP insecticides**

1: these elements are intended for soft fruit crops grown in the soil in the open or under non-heated protected cropping only. Although only the major soft fruit crops are covered specifically, the same principles can be extended to other closely related minor soft fruit crops

2: see footnote 1 Table 2.

2.5 Annual crops: arable crops

Table 6. Possible elements of the IPM strategy for cereals and oilseed rape (specified in table). Measures in bold are considered being basic for IPM (in guidelines must-sentences), the non-bold topics are considered additional possibilities for a more advanced level of IPM (in guidelines should-sentences) or specify in more detail the basic items in bold.

1. Prevention and/or suppression	
general	**Maintain a diverse ecosystem of plants and animals and enhance and protect ecological infrastructures [2].** **Cereals: may occupy not more than 67% in the rotation. Each cereal crop species counts as a different crop. Winter cereals, except oats, must follow at least one non-host break crop for key cereal pathogens.** Rotation as diverse as possible to restrict/limit pathogens and weed selection, and to balance nutrient uptake. Use within-farm diversification of cultivars and/or variety mixtures especially for animal feed. Sowing periods should be adjusted to local conditions in order to minimize pest, disease and weed pressure, and to make optimum use of water availability. **Oilseeds rape: Cruciferous crops[2] must not be grown more than 1 year in 4. Cruciferous cover-crops that are grown to reduce nematode populations are not considered to be part of the rotation. Oilseed rape must not follow sunflower of soybean.**
diseases	**Select cultivars with the highest resistance to key diseases while quality and yield requirements are met.** Cereals: Crop and cultivar diversity, resistant cultivars and rotations should reduce root and stem-based diseases sufficiently to avoid fungicide use. Oilseeds rape: Seed rate should be appropriate for location and sowing date to avoid a too dense canopy.
2. Monitoring of pest organisms and applying of economic damage thresholds	
pests	**For each region, guidelines must specify which pests and diseases can and must be covered by forecasting and/or monitored, depending on availability of methods and crop loss potential. For monitored pests and diseases, intervention thresholds must be established and followed.** Preferably for diseases also taking into account the resistance level of the cultivars.
weeds	Observe weed populations. Use decision support systems for weed control preferably taking into account low dose approaches.
3. Non-chemical control methods	
weeds	Cereals: use non-chemical weed control in the intercrop period (false seed bed), use late mechanical control against specific weeds (*Galium aparine, Vicia ssp*).
4. Chemical control	
general	**Establish anti-resistance strategies for pests, diseases and weeds according to recommendations of FRAC/IRAC /HRAC or EPPO.**
weeds	**Guidelines must specify which herbicides can be used, persistent and leachable herbicides should be avoided.** Where possible, limit herbicide use to key problem weeds and selected areas,
5. Prohibited measures and strategies	

1: see footnote 1 Table2.

2: Cruciferous cover-crops that are grown to reduce nematode populations are not considered to be part of the rotation.

Table 7. Possible elements of the IPM strategy for sugar beet and potatoes (specified in table). Measures in bold are considered to be basic for IPM (in guidelines must-sentences), the non-bold topics are considered additional possibilities for a more advanced level of IPM (in guidelines should-sentences) or specify in more detail the basic items in bold..

1. Prevention and/or suppression	
general	**Maintain a diverse ecosystem of plants and animals and enhance and protect ecological infrastructures [1].** **Sugarbeet: Select site specific cultivars with the highest resistance to key (soilborn) pests and diseases (including pathogen vectors)** like *Rhizoctonia*, *Cercospora*, *Rhizomania*, Beet cyst nematodes while quality and yield requirements are met**.** Rotation: maximum 1 every 4 years. Sugar beet or any alternative *Chenopodiacae* crops/weeds not to be grown more than 1 year in 4. Rotation as diverse as possible. Use nematode - resistant/neutral plants as catch crops. Avoid meadows or leys as a pre-crop. **Potatoes not to be grown more than 1 year in 4 to limit disease and nematode infestation.** Wider than 1 in 4 years is preferred. Winter cereals are suitable previous crops. Avoid alfalfa as previous crop (*Rhizoctonia* risk). **Potato dumps must be destroyed before emergence of the next potato crop.**
pests	**Potatoes: In nematode-infested fields, grow cultivars of high resistance to one or more of the nematode species or their dominating pathotypes must be grown..**
diseases	**Potatoes: select cultivars with a broad spectrum of resistance to major virus diseases and "field resistance" to late blight.** **Late Blight: Highly susceptible cultivars must not be grown**. the use of resistant/tolerant cultivars is the most appropriate preventive measure
weeds	Weed suppressing catch crops in autumn (Phacelia, clover, grass-clover mixtures)
2. Monitoring of pest organisms and applying of economic damage thresholds	
pests	**Sugar beet: use of available/validated thresholds for region specific pests** like flea beetles, lice/vectors of virus diseases. **Potatoes: control of Colorado potato beetle (*L. decemlineata*) where established) only according to threshold levels or national law.**
diseases	**Sugar beet: use of thresholds: f**ungal leaf diseases may only be treated according to (if available and validated) prediction models (DSS) or thresholds. **Potatoes: fungicide treatment must be based on forecasting models if available.** **For *Rhizoctonia*, seed treatment is permitted only if threshold levels for tubers with sclerotia of *R. Solani* are exceeded.**
weeds	Observe the weed species populations.
3. Non-chemical control methods	
weeds	A combination of mechanical (potatoes: harrowing and forming ridges, sugar beet: hoeing between rows) and chemical weed control should be used.
4. Chemical control	
general	**Establish anti-resistance strategies for pests, diseases and weeds according to recommendations of FRAC/IRAC /HRAC or EPPO.** **Use drift-minimizing spray equipment and nozzles**.
weeds	Guidelines must specify which herbicides can be used, persistent and leachable herbicides should be avoided.

	If available: Decision support systems for herbicides. Herbicides should be applied in reduced dosages. Sugar beet: Band spraying. Preferably, chemical weed control should be directed to the row area.
5. Prohibited measures and strategies	
general	**Nematicides are not allowed.**
diseases	**Copper use is not allowed**

1: see footnote 1 Table2.

Table 8. Possible elements of the IPM strategy for maize. Measures in bold are considered to be basic for IPM (in guidelines must-sentences), the non-bold topics are considered additional possibilities for a more advanced level of IPM (in guidelines should-sentences) or specify in more detail the basic items in bold.

1. Prevention and/or suppression	
general	**Maintain a diverse ecosystem of plants and animals and enhance and protect ecological infrastructures [1].** **Maize must not occupy more than 50% of the rotation** Maize should not occupy more than 33% of the rotation. **Select cultivars suited to the region and site with resistance/tolerance to soil-borne diseases or pathogen vectors** (like black rust and *Helmintosporium*). In areas prone to frit fly, select cultivars with rapid seedling emergence and development. Strips of flowering species (e.g. sunflowers) are recommended around corn fields as attractants for beneficial organisms.
pests	In areas with severe and frequent European Corn Borer or Mediterranean Corn Borer (*Sesamia nonagrioides*) attacks, crop residues should be minutely chopped and incorporated in the soil before pupae formation .
diseases	In areas with severe and frequent infestation of *Fusaria*, crop residue should be effectively incorporated in the soil.
2. Monitoring of pest organisms and applying of economic damage thresholds	
diseases	**Use of thresholds. Fungal leaf diseases may only be treated according to (if available and validated) prediction models (DSS) or thresholds.**
weeds	Observe the weed species populations.
3. Non-chemical control methods	
weeds	False seed bed preparation in spring A combination of mechanical and chemical weed control should be used Mechanical weed control recommended
4. Chemical control	
general	**Establish anti-resistance strategies for pests, diseases and weeds according to recommendations of FRAC/IRAC /HRAC or EPPO.** **Use drift-minimizing spray equipment and nozzles**.
pests	**Seed treatment against insects and soil born fungi if relevant in the region/on the site** **For the control of Corn Borers, only biological agents (e.g. *Trichogramma*), biotechnical methods (where available such as mating disruption) or insecticides without effect on beneficial organisms are allowed and must be used in accordance with threshold levels.**
weeds	Guidelines must specify which herbicides can be used, persistent and leachable herbicides should be avoided.

	If available use Decision Support Systems for herbicides. The adoption of a "period threshold" (effective weed control between 2nd -10th-leaf stage) is recommended, if applicable to the region. Herbicides to be applied in reduced dosages.
5. Prohibited measures and strategies	
general	Nematicides are not allowed.

1: see footnote 1 Table2.

Table 9. Possible elements of the IPM strategy for pulses (dry peas, faba beans, soybean). Measures in bold are considered being basic for IPM (in guidelines must-sentences), the non-bold topics are considered additional possibilities for a more advanced level of IPM (in guidelines should-sentences) or specify in more detail the basic items in bold.

1. Prevention and/or suppression	
general	**Maintain a diverse ecosystem of plants and animals and enhance and protect ecological infrastructures [1].** **Dry peas: Minimum interval between peas of 6 years in the rotation; minimum interval of 2 years between 2 different legumes. Faba beans: Minimum interval of 3 years in rotation; interval of 2 years between 2 different legumes.**
2. Monitoring of pest organisms and applying of economic damage thresholds	
pests	**Use of available/validated thresholds for region specific pests .**
diseases	**Use of thresholds. Fungal leaf diseases may only be treated according to (if available and validated) prediction models (DSS) or thresholds.**
weeds	Observe your weed species populations.
3. Non-chemical control methods	
weeds	**A combination of mechanical (at least harrowing) and chemical weed control must be used.** Use row distances that allow hoeing. Faba beans: Mechanical control to be preferred. Dry peas: Mechanical weed control recommended until occurrence of tendrils.
4. Chemical control	
general	**Establish anti-resistance strategies for pests, diseases and weeds according to recommendations of FRAC/IRAC /HRAC or EPPO.** **Use drift-minimizing spray equipment and nozzles**.
weeds	Guidelines must specify which herbicides can be used, persistent and leachable herbicides should be avoided. If available use Decision Support Systems for herbicides. Herbicides to be applied in reduced dosages.
5. Prohibited measures and strategies	
general	No nematicides are allowed.

1: see footnote 1 Table2.

2.6 Annual cops: field vegetables

Table 10. Possible elements of the IPM strategy for open field vegetables: Brassicas (Flowerhead Brassicas, cabbages, root and leaf Brassicas), carrots, fennel, celery and celeriac, leek and onion, lettuce and endive, spinach. Measures in bold are considered being basic for IPM (in guidelines must-sentences), the non-bold topics are considered additional possibilities for a more advanced level of IPM (in guidelines should-sentences) or specify in more detail the basic items in bold.

1. Prevention and/or suppression	
general	**Maintain a diverse ecosystem of plants and animals and enhance and protect ecological infrastructures[1]:** Protect headland attractants (flowering field margins) and (windbreak) hedges as reservoirs of pest antagonists, but avoid high structure infrastructures (hedges, trees etc.) in the vicinity of carrot fields (favouring populations of *Psila rosae*). Avoid salix near carrot fields (host of *Cavariella aegopodii*). **Crop rotation must be targeted to minimize pest and disease pressure**. **Brassicas: only 1 in 6 (soil pH<7), or 1 in 4 (soil pH >7) years**. Avoid plots with *Plasmodiophora* problems as long as inoculum is detectable (or 12 years). **Carrots: 1 in 4 to 6 years**, depending on the presence of *Meloidogyne spp*. nematodes (if present, include nematode suppressing crops) or soil-borne diseases, such as *Chalara* or Pythium. **Leek and onion: 1 in at least 3 years**, 1 in 4 years is recommended. *Fusarium* infested plots must be avoided. **Lettuce, Endive: 1 year (2 or 3 cycles) in 3 years or 1 crop cycle in 3 crop cycles.** **Spinach: 1 year (1 or 2 cycles) in 3 years or 1 crop cycle in 3 crop cycles.** (Admitted alternative only for processing produce: 1 crop cycle with 1 winter cereal as interval maximum 2 years). No other chenopodia in the interval. Good soil structure and drainage are important elements to prevent soilborn diseases (e.g. *Pythium* or *Sclerotinia*). **Dumps of infested vegetable crop residues in or near vegetable fields must be avoided** (inoculum risk). Incorporate infected or infested material or in field of origin, but do not recycle Brassicas infested with *Plasmodiophora* or carrots infested with Chalara. **Overlapping production cycles of summer and winter crops favouring a continuous infestation by diseases and pest must be avoided**, in particular in leek and onion (Downy mildew (*Peronospora destructor)* infestations).
pests	**Site selection:** Brassica crops: Avoid vicinity of winter oil seed rape or winter cultivations of cauliflower or Brussels sprouts (overwintering sites of important *Brassica* pests). Carrots: wind exposed fields against carrot fly.
diseases	**Use only seeds tested and certified free of diseases**: Onion: Planting material should be inspected for absence of infestation with *Sclerotium* spp. (White Rot) and *Fusarium* spp. **Use resistant/tolerant cultivars**: Carrots: *Alternaria*. Lettuce: *Bremia* and *Nasonovia*.
weeds	Stale seed beds should be used, where appropriate (e.g. before onion crops, spinach).
2. Monitoring of pest organisms and applying of economic damage thresholds	
general	**For each region, guidelines must specify, which pests and diseases can and must be covered by forecasting and/or monitored, depending on availability of methods and crop loss potential. For monitored pests and diseases, intervention thresholds must be established and followed.**
pests	Soil or plant analyses for the occurrence of nematodes should be carried out. **Use forecasting and monitoring systems, damage thresholds:** Monitor cutworms and wireworms (*Agriotes spp*.) with sex pheromone traps, Carrot/celery: monitor carrot fly with sticky traps and treat according to damage threshold, Leek/onion: monitor leek moth with pheromone traps.

diseases	Where available, use forecasting systems in onion/leek (*Peronospora destructor*, *Alternaria*).
weeds	Observe the weed species populations.
3. Non-chemical control methods	
pests	**Use physical crop covers (nets**) in Brassica crops, carrot: against cabbage root fly, flea beetles and carrot fly. If approved, use *Bacillus thuringiensis* -products against lepidopteran pests. Where available, use sterile male technique (SIT) against onion fly.
weeds	Weed management should be achieved, as far as possible, by non-chemical methods.
4. Chemical control	
general	**Establish anti-resistance strategies for pests, diseases and weeds according to recommendations of FRAC/IRAC /HRAC or EPPO.** **Pesticide residues on fruits at harvest to be further minimized by maximizing safe-to-harvest intervals and by minimizing post-harvest chemical treatments.** **Use drift-minimizing spray equipment and nozzles**.
pests	Brassicas, lettuce, endive: only aphicides non-toxic to aphid antagonists. Spinach: Treatments against leaf miners and *Pegomyia spp*. only for early larval stages. **Presence of antagonists must be surveyed and taken into account.** Restrictions: Slugs: treatments with baits restricted to the field margin areas.
weeds	**Guidelines must specify which herbicides can be used, persistent and leachable herbicides should be avoided.** Herbicides to be applied in reduced dosages.
5. Prohibited measures and strategies	
general	Chemical soil disinfection. Exceptions can be considered for sanitation in severe cases of area-wide importance, if recommended by the respective national or regional authorities.

1: see footnote 1 Table 2.

Table 11. Possible elements of the IPM strategy for open field vegetables: tomato (fresh and processing), pepper, eggplant, zucchini, cucumber, melons and water melons, and beans/peas (fresh and processing). Measures in bold are considered being basic for IPM (in guidelines must-sentences), the non-bold topics are considered additional possibilities for a more advanced level of IPM (in guidelines should-sentences) or specify in more detail the basic items in bold.

1. Prevention and/or suppression	
general	**Maintain a diverse ecosystem of plants and animals and enhance and protect ecological infrastructures[1]:** Protect headland attractants (flowering field margins) and (windbreak) hedges as reservoirs of pest antagonists. **Crop rotation must be targeted to minimize pest and disease pressure**. **Tomato: 2 crops in 4 years without replanting , 2 in 5 years with replanting**, 1 in 2 years, if grafted material is used. **Cucurbit crops: 1 in at least 3 years.** **Beans/peas: 1 year (1 or 2 cycles) in 3 years or 1 crop cycle in 3 crop cycles**. (Admitted alternative only for green beans for processing: 1 crop cycle with 1 winter cereal as interval maximum 2 years). No leguminosae in the interval. **All propagation material must be inspected by the grower to be free of pests and diseases.** Infested material must not be used. Purchased material should be accompanied by a plant health or quality certificate. Good soil structure and drainage are important elements to prevent soilborn diseases

	(e.g. *Pythium* or *Sclerotinia*). **Dumps of infested vegetable crop residues in or near vegetable fields must be avoided** (inoculum risk). Destroy infected material or incorporate in field of origin.
diseases	**Use only seeds tested and certified free of diseases**: tomato seeds and transplants must be free of bacterial and virus diseases. For cucurbit crops, certified bacteria-free seeds for *Pseudomonas spp*. and *Erwinia spp*. are mandatory. **Use resistant/tolerant cultivars:** tolerance/resistance against nematodes, viruses, fungal pathogens. For beans/Peas, preference use cultivars with resistance/tolerance against Anthracnose (for *peas Peronospora viciae f. sp. pisi*) **Drip irrigation must be used, where possible**.
2. Monitoring of pest organisms and applying of economic damage thresholds	
general	**For each region, guidelines must specify, which pests and diseases can and must be covered by forecasting and/or monitored, depending on availability of methods and crop loss potential. For monitored pests and diseases, intervention thresholds must be established and followed.**
pests	Soil or plant analyses for the occurrence of nematodes should be carried out. **Use forecasting and monitoring systems, damage thresholds**: monitor lepidopteran pests with sex pheromone traps.
weeds	Observe the weed species populations.
3. Non-chemical control methods	
pests	If approved, use *Bacillus thuringiensis* products against lepidopteran pests and Colorado potato beetle (*L. decemlineata*). **Guidelines must specify for which particular crops and pests, priority must be given to Bt.** **Biological control must be established** against aphids, white flies (*B. tabaci*), spider mites and leaf miners, e.g. with antagonists, (banker plant strategy against aphids)
weeds	Weed management should be achieved, as far as possible, by non-chemical methods. Establish anti-resistance strategies according to recommendations of HRAC
4. Chemical control	
general	**Establish anti-resistance strategies for pests, diseases and weeds according to recommendations of FRAC/IRAC /HRAC or EPPO.** **Pesticide residues on fruits at harvest to be further minimized by maximizing safe-to-harvest intervals and by minimizing post-harvest chemical treatments.** **Use drift-minimizing spray equipment and nozzles**.
pests	**Tomato: chemical treatments against thrips are permitted only if viroses cause problems in the region.**
weeds	**Guidelines must specify which herbicides can be used, persistent and leachable herbicides should be avoided.** Herbicides to be applied in band spraying and reduced dosages.
5. Prohibited measures and strategies	
general	Chemical soil disinfection. Exceptions can be considered for sanitation in severe cases of area-wide importance, if recommended by the respective national or regional authorities.

1: see footnote 1 Table 2.

3. IPM implementation: approaches and tools

3.1 Tools to design and successfully implement IPM

For a successful design and implementation of IPM, the principles described in chapter 1 have to be applied on the specific pests, diseases and weeds for any given region or copping system. The design starts with the identification of the key pest, diseases and weeds to be addressed by an IPM strategy, followed by the identification of feasible and effective measures in the different categories prevention, justification of control and control options. The IPM options in chapter 2 can serve as source of inspiration.

In this chapter we describe some tools and approaches that might be helpful when implementing IP/IM schemes.

- Identity Card: The design of an IPM strategy for a specific crop/region combination (see also 3.2 Identity Card), might be visualized in a flow chart as described in paragraph 3.3.
- Pesticide database: For any IPM strategy the careful choice of pesticides to reduce impact of its use and to prevent unwanted interactions with the ecological resources, is of great importance. The IOBC has compiled a database of pesticides with all the side effects (see 3.4) that might be helpful.
- Feedback cycle: A well designed IPM scheme that is implemented in practice and followed by self-control or more formal audits or certification, can provide a solid base for a continuous improvement and innovation cycle to strengthen the IPM approaches and to reduce even further the impact of chemical crop protection (see 3.5).
- SESAME: In paragraph 3.6 we describe the SESAME tool that was designed by the IOBC commission to help organizations that want to implement IP/IPM guidelines. It constitutes out of a checklist and a representational tool to display the performance of farms.

The IOBC commission has been involved in the endorsement of IOBC guidelines for a limited number of organizations (see textbox endorsement). The cooperation of the commission with these organizations was inspirational and provided an incentive to develop and improve the above mentioned practical tools for IP/IPM implementation. In this chapter we use the example of LIVE Oregon (certifying IP vineyards, see textbox) to illustrate the tools and their use. LIVE is one of the organizations that is endorsed by the IOBC.

> **IOBC endorsement**: The IOBC commission on IP guidelines initiates and coordinates the compilation of guidelines for all major crops in Europe. These guidelines bring together the knowledge and experience from the different working groups of the IOBC. The IP commission created the opportunity for growers organizations to be endorsed when their guidelines matches the standards of the IOBC. Main purpose was to gain experience with the application and certification of the IP guidelines in practice.
> Four organizations were endorsed over the years: Tyflo, a wine producers' organisation in France, LIVE(vineyards) in Oregon, United States, Trecoop, a cooperative producing pome fruits in Cataluña, Spain and Apofruit, a cooperative producing stone fruits in Emilia-Romagna, Italy.

3.2 Identity card

The ID card is a crop- and site- or region-specific description of the key pests and diseases and the climatic and agro-ecological conditions favoring or preventing problems with these harmful

organisms. Important part of the ID card is a list of the key beneficial organisms that must be favored and protected. See example in chapter 3.1. The ID card is helpful in maintaining the focus on the key issues. Table 12 gives an example for the LIVE Oregon region vineyards

Table 12. ID card LIVE - Oregon region – vineyards. See text paragraph 3.2.

Weather	Cool Weather, Maritime Viticultural Areas

Key pests *to be controlled*	
Diseases	Powdery Mildew (*Uncinula necator*) | *Botrytis cinerea*
Mites	Localized *Eriophyidae* mites (Rust mite, Blister mite)
Weeds	In vineyard rows, various tall annual and perennial species
Voles	Mouse like rodents similar to pocket gophers

Key Beneficial's *to be protected*	
Typhlodromus pyri	The most important predatory mite on blackberries in western Oregon and Washington.
Parasitoid/Predatory Complex:	An insect whose immature stages develop on or inside a single host eventually killing that host

Low Input Viticulture and Enology, Inc. (LIVE)

LIVE is a non-profit organization based in Salem, Oregon, USA that provides education and independent third-party certification of vineyards and wineries using international standards of sustainable viticulture and enology practices in wine-grape and wine production. LIVE seeks cooperation with organizations working on standards for sustainable viticulture. LIVE is endorsed by the IOBC and follows the IP guidelines for Integrated grape production. LIVE works also together with Salmon-Safe to address watershed impacts from not only the vineyards and wineries of our members, but also the other areas on their farms. Salmon-Safe certification is included in the LIVE certification membership.

LIVE has been certifying growers in Oregon since 1999 and in Washington since 2006. LIVE recently expanded its geographical boundary to include all of the Pacific Northwest, including British Columbia and Idaho. LIVE has currently 225 certified vineyard members (and 272 enrolled: 47 on the way to certification) amounting to some 24.000 acres (9700 ha). About 40% of Oregon vineyard acres and 5% of Washington vineyard acres farm according to LIVE practices, and over thirty wineries have already been certified. We anticipate LIVE's continued expansion throughout the Pacific Northwest as growers and winemakers continue to perceive the value in third-party certification.

LIVE works actively with university extension services to improve its standards, reach out to growers, and incorporate the latest research into the technical discussions.

3.3 Flow Chart IPM-strategy: Green/Yellow chart

The Green/Yellow Chart as developed by IOBC, summarizes the IPM-Strategy for the key pests, diseases and weeds identified in the ID card, visualizing the sequence of interventions from

preventive measures to eventual chemical interventions. This is the same sequence as the principles described in paragraph 1.2. The identified prevention and monitoring options are listed in the green part of the chart. Feasible and effective control options have to be identified. The preferred options can be listed in the green part of the chart. The options that are less preferred (based on their potential impact on human health, environment or ecosystem) and should only be used in restricted cases or with restrictions, are in the yellow part of the chart.

This approach is very helpful when defining or distinguishing the more preferred options for crop protection and possible secondary options to be used when first options are not fully applicable (also for economic reasons) or effective.

Simplified principle of a green-yellow flow chart

	Green list, preferred options			Yellow options with restrictions	
	1	2	3	4	5
	Prevention	Monitoring	Direct Control	Direct Control	Restrictions
General aspects					
Pest Problem 1					
Pest Problem 2					
Pest Problem 3					
Disease Problem 1					
Disease Problem 2					
Weed Problem 1					

Figure 1. Format of a flow chart IPM-strategy: green & yellow chart.

In Figure 2, the green and yellow chart is presented of The LIVE-Oregon region vineyards (see ID card in table 12). The most important aspects of prevention are mentioned here as instructions, there are lists of options behind those instructions.

Figure 2. LIVE Oregon vineyards: Green and Yellow List (Easy Referral Chart for Vine Protection).

	Control Methods *to be used prior to chemical control methods or to make them more effective*			**Chemical Control Methods**	
	Green list, preferred options			**Yellow list, options with restrictions**	
DISEASE/PEST/ WEEDS	**1** Prevention	**2** Monitoring and decision making	**3** Non chemical control	**4** Chemical Control	**5** Chemical Control with Restrictions Prohibited Practices
General Aspects	✓ Green cover, alternating mowing, hedges to enhance beneficial's, low nitrogen input and open canopies	✓ Monitor vineyard for unusual symptoms			
Powdery Mildew	✓ Prevent excess vigour ✓ Practice timely sucker and open canopy	✓ Use of appropriate temperature models when available	✓ Open Canopy	✓ Fungicides with restrictions ✓ Fungicides E-G, I (Preventative) ✓ Fungicides H (Curative)	✓ To avoid the development of resistance, do not spray the same chemical families consecutively ✓ No more than 3 DMI applications allowed per season ✓ Sulphur treatments restricted to 5 lbs. per treatment and total of 35 lbs. of actual sulphur per season
Botrytis	✓ Prevent excess vigour ✓ Maintain open canopy and remove east side leaves after shatter		✓ Open Canopy	✓ Fungicide A-D application post bloom and/or pre berry touch and/or at verasion	✓ Comply strictly with restrictions imposed by resistance management (limited number of treatments, avoidance of products of same resistance group). ✓ More than 3 applications of botrytiscides from the same chemical family is prohibited
Weed Problem	✓ Planting cover crop		✓ Mechanical, hand hoeing	✓ Herbicides	✓ Diquat, Paraquat and all residual herbicides are prohibited ✓ The use of chemical herbicides on more than 50% of vineyard floor is prohibited

Rust Mites					✓ Max 5lbs of sulphur at woolly bud, 5lbs 10 days later ✓ Lime sulphur limit 1 application at 2.5lbs/acre. Must have confirmed presence of rust mite either previous year or current year dormant sample

- Column 4: the letter behind the fungicide, the group code used by LIVE refers to different resistance groups, as described in the pesticide database of the LIVE organization (example in figure 3).
- DMI refers to dimethylation inhibitors, a certain category of fungicides.

3.4 Pesticide side-effects database

The IOBC has compiled from the work of the Working group on "Pesticides and Beneficial Organisms" a database on the side effects of pesticides. The database can be found at the IOBC website. The document to a large extent is based on results of comparative field trials analyzed by IOBC experts and, therefore, reflects their judgment. Where no IOBC data were available, the database reflects the expert judgment of sources outside IOBC. It intends to provide help when selecting pesticides and does not replace official governmental documents.

Since pesticide selection is an important and integral part of the design and application of IPM strategies, a directory of approved pesticides should be available for each region/country that must also include the compiled information of side effects on the individual groups of beneficial's (e.g. parasitoides, predatory mites). Such a directory provides basic information for the selection of more preferred pesticides within an IPM-strategy, as finally displayed in a "Green /Yellow Chart" (see 3.3). The IOBC pesticide database might be helpful in this respect.

Figure 3 gives a part of the database as the LIVE organization has compiled it for its members. The list is much longer and provides information on pesticide class, resistance development risk, persistence and leachability, and toxicity.

2012 LIVE Yellow List of Approved Pesticides for Region I (Cool Weather, Maritime Viticultural Regions)

Important | This list is to be used in conjunction with the LIVE Passport for Region I. Restrictions on certain chemistries are annotated in red directly to the right of the Active Ingredient(s).

Fungicides

Target Pest	Active Ingredient	! Restrictions !	Common Trade Name(s)**	LIVE Group code	FRAC Code*	Resistance Risk	Maximum Number of Applications	Formulation	Chemical Family	Soil Half Life (Days)	Leaching Potential	REI (Hours)	PHI (Days)	Toxicity Class	Signal Word	Toxicity Information: Bees	Toxicity Information: Fish	Toxicity Information: Predatory Mites	Toxicity Information: Earth Worms
Botrytis cinerea																			
	Fenhexamid		Elevate	A	17	L to M	3	WDG	Hydroxyanilide	1	L	4	0	III, IV	CAUTION	M	N	N	
	Cyprodinil		Vangard	C	9	M	3	WG	Anilinopyrimidine	126	L	12	7	III, IV	CAUTION	M	N	N	
	Pyrimethanil		Scala	C	9	M	3	SC	Anilinopyrimidine	22	L	12	7	III, IV	CAUTION	M	N	N	
	Bacillus subtilis		Serenade	D	-	Unknown	3	WDG	Biological			4	0	IV	CAUTION				N
	Reynoutria spp		Regalia	Q	P5	L	See Label		Plant Host Inducers			4	0		CAUTION				
	Azoxystrobin!	!For these three materials, the intended use must be clarified on the LIVE Pesticide Reporting Form (whether for botrytis or mildew) and must have matching rate.	Abound	F	11	H	3	FL	Strobilurines	14	L	12	14	III	CAUTION	T	N	N	
	Trifloxystrobin!		Flint	F	11	H	3	WG	Strobilurines	1	L	12	14	III, IV	CAUTION	T	N	N	
	Boscalid!		Endura / Pristine	F	7	M to H	3	WG	Strobilurines	14	H	12	14	III	CAUTION	T	N	N	
	Copper Formulations *below* | Limit 3lbs/acre per year of ACTIVE INGREDIENT. Copper has extreme persistence in soil. If used as a pesticide, grower must document *in writing* a clear need for the application, that no less harmful alternative exists, and that there is negligible risk of contaminating nearby waterways.																		
	Copper Hydroxide	*See important restriction above*	NuCop; Champ	I	M (Multi-site)	L		WG	Inorganic			24	0	III	DANGER	T	T		
	Copper Oxide		Nordox	I	M (Multi-site)	L		WG	Inorganic			24	0	III	CAUTION	T	T		
	Copper Octanoate (soap)		Liqui-Cop; Cueva	I	M (Multi-site)	L		LC	Inorganic			4	0	III	CAUTION				
	Copper Sulfate		Bordeaux Mix	I	M (Multi-site)	L			Inorganic			SL	SL	III	CAUTION	T	T		

2012

Figure 3. Part of the pesticide database, for the fungicides against *Botrytis cinerea*, the yellow /red list of pesticides as provided by the LIVE organization to its members.

- Notice the LIVE group code in red, that also was used in the green and yellow chart.

3.5 Checklists and inspections facilitate improvement

IPM strategies are often part of Integrated Production schemes. The experience from organizations that work with certified (and IOBC endorsed) IP guidelines show that working with guidelines offers the possibility to continuously improve the performance of the production systems. Figure 4 schematizes this improvement cycle.

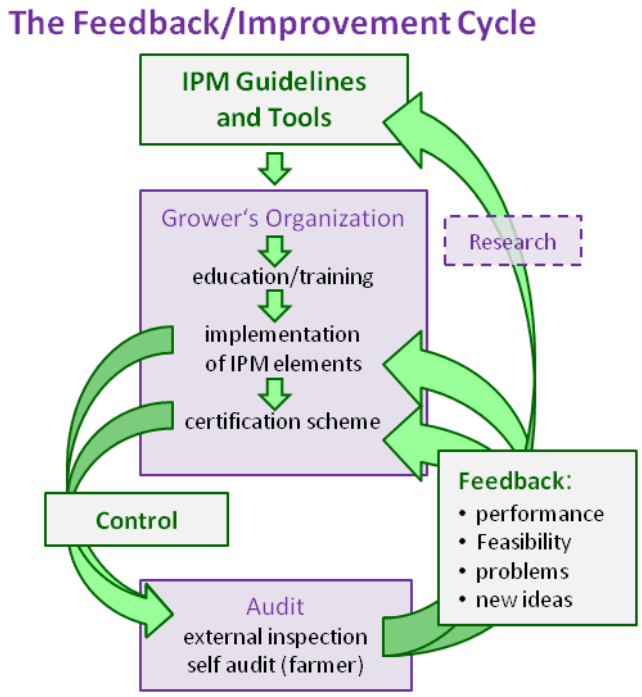


Figure 4. The feedback Improvement cycle.

The cycle consist out of the following elements:

- IPM guidelines are implemented by, as example a grower's organization, and supported/facilitated by offering appropriate training for farmers and technicians.
- The application of the IP guidelines is in this example certified.
- The certification scheme offers the critical control points of the IP guidelines. These control points can be used to offer farmers the possibility for self-control.
- The self-control followed by the external audit can offer a detailed and realistic, rich picture of the implementation challenges and occurring problems. How much insight can be gained depends on the instruction of the inspectors.
- The feedback provides information on the performance of the farms, on the feasibility of the approaches, on the occurring or emerging problems and or inclarities in the guidelines. Eventual the feedback can lead to new research questions.

The experience from LIVE shows that more evaluative reporting by the inspectors, proves to be very helpful to identify areas that need further clarification or more precise interpretation of guidelines or areas where additional research is needed or where more training is welcome. New approaches coming from research organizations on IPM can find their way into the guidelines.

3.6 Sesame – checklist – radar of performance

The IP guideline commission of the IOBC, has developed since 2005 in close collaboration with farmers' organizations, a tool named SESAME in order to apply IP standards at the organizations' farm inspection level. SESAME consists basically of a simplified checklist (derived from the IP guidelines of these organizations) for the self-audit of the farmer (ca. 50 check points), of a more detailed data base for the inspection body, and a visual display ("radar") of the farm performance in major control areas. See also IOBC website (http://www.iobc-wprs.org/ip_ipm/).

Figure 5 a and b give the example of the checklist for the LIVE organization.

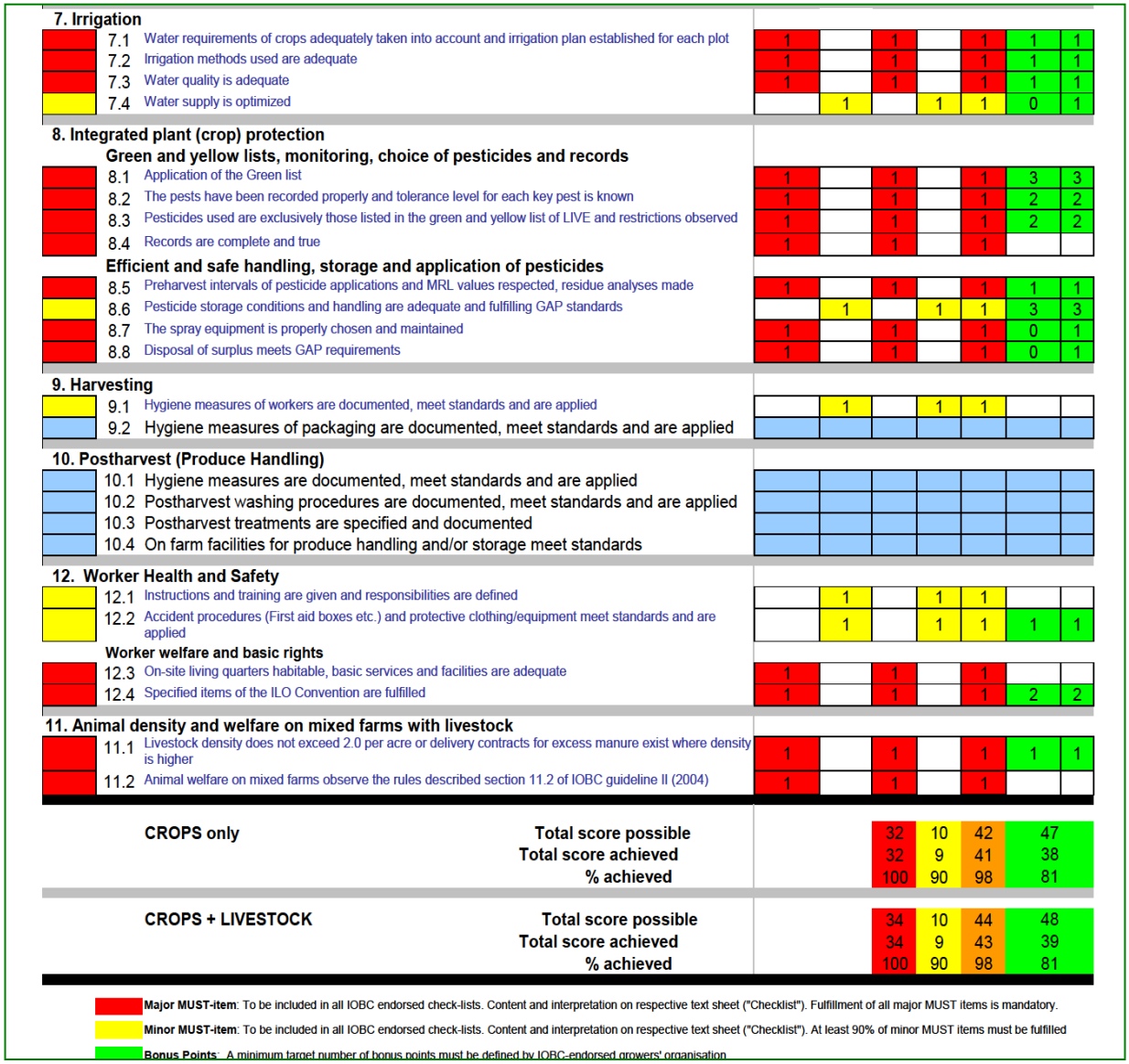
2008 LIVE Inspection Summary (Farm inspection protocol)

IOBC Standard for Integrated Production

Control points to be verified by inspection body

			Must					Bonus	
			1 (achieved), 0 (not achieved)	Check if achieved (where applicable)	max possible score major must	max possible score minor must	max possible total score	accumulated sum of bonus achieved	max possible
1. Farm records, self-inspection, training and traceability									
	1.1	Records complete, available at inspection and kept for 3 years	1		1		1	1	1
	1.2	Self-evaluation (internal audit) made, documented and available at inspection	1		1		1		
	1.3	Corrective action taken based on results of inspection		1		1	1		
	1.4	Participation in annual training courses approved by LIVE	1		1		1	1	1
	1.5	Traceability for fruit at farm level	1		1		1		
2. Biodiversity, ecological infrastructures									
	2.1	At least 5% of farm surface identified and managed as ecological infrastructures	1		1		1	3	3
	2.2	At least 2 ecological options for active enhancement of biodiversity fulfilled	1		1		1	3	3
	2.3	Buffer zones between crop areas and sensitive off-crop areas established (Min. 30-50 feet)	1		1		1	1	1
3. Site selection									
	3.1	Every field suitable for sustainable production and clearly identifiable	1		1		1		
	3.2	In new cultivation sites an adequate risk assessment made, documented and corrective plan established		1		1	1	0	1
4. Site management									
	4.1	Annual crops: Crop rotation requirements fulfilled							
	4.2	Perennial crops: Alleyway/intertree strip management fulfills specified requirements	1		1		1	2	3
	4.3	Soil fertility and protection by adequate measures	1		1		1	3	3
	4.4	Chemical fumigation/disinfection and residual herbicides not allowed	1		1		1		
5. Varieties, rootstock, sowing/planting aspects									
	5.1	Adequate choice of cultivars		1		1	1	0	2
	5.2	Adequate quality and health status		0		1	1		
	5.3	Use of GMOs according to guidelines	1		1		1		
	5.4	A soil test prior to planting is required	1		1		1	3	3
6. Plant nutrition and fertilizer use									
	6.1	Soil and petiole analyses data adequate, not older than prescribed interval	1		1		1	0	1
	6.2	Fertilization plan based on rules established for each crop	1		1		1	2	3
	6.3	Measures to reduce nutrient loss are followed	1		1		1	1	1
	6.4	Nitrogen supply and timing applied according to fertilization plan	1		1		1		
	6.5	Other major nutrients (especially P and K) applied according to fertilization plan	1		1		1		
	6.6	Storage conditions and handling of fertilizers fulfill basic requirements of GAP		1		1	1	1	1
	6.7	Restrictions of using human sewage sludge strictly observed	1		1		1		
	6.8	Organic materials with only technically lowest possible load of heavy metals	1		1		1		

Figure 5a. Sesame-farm inspection protocol –list of control points for the LIVE members. Example for an individual farm. Part a. see also figure 5b.
In the columns on the left the major areas of control are listed, detailed in control points, on the right the compliance can be scored. In this example the control points are divided in major musts (red columns, to be fulfilled for 100%) and minor musts (yellow, to be fulfilled for, for instance, 90%), an approach that is often followed in these type of schemes. Bonus points can be gathered in this approach, offering the possibility to score practices that are advocated, thus attracting attention to new and additional possibilities to work in line with the IPM objectives. The actual score is compared to the potential score.



7. Irrigation								
	7.1	Water requirements of crops adequately taken into account and irrigation plan established for each plot	1		1		1	1	1
	7.2	Irrigation methods used are adequate	1		1		1	1	1
	7.3	Water quality is adequate	1		1		1	1	1
	7.4	Water supply is optimized		1		1	1	0	1
8. Integrated plant (crop) protection									
		Green and yellow lists, monitoring, choice of pesticides and records							
	8.1	Application of the Green list	1		1		1	3	3
	8.2	The pests have been recorded properly and tolerance level for each key pest is known	1		1		1	2	2
	8.3	Pesticides used are exclusively those listed in the green and yellow list of LIVE and restrictions observed	1		1		1	2	2
	8.4	Records are complete and true	1		1		1		
		Efficient and safe handling, storage and application of pesticides							
	8.5	Preharvest intervals of pesticide applications and MRL values respected, residue analyses made	1		1		1	1	1
	8.6	Pesticide storage conditions and handling are adequate and fulfilling GAP standards		1		1	1	3	3
	8.7	The spray equipment is properly chosen and maintained	1		1		1	0	1
	8.8	Disposal of surplus meets GAP requirements	1		1		1	0	1
9. Harvesting									
	9.1	Hygiene measures of workers are documented, meet standards and are applied		1		1	1		
	9.2	Hygiene measures of packaging are documented, meet standards and are applied							
10. Postharvest (Produce Handling)									
	10.1	Hygiene measures are documented, meet standards and are applied							
	10.2	Postharvest washing procedures are documented, meet standards and are applied							
	10.3	Postharvest treatments are specified and documented							
	10.4	On farm facilities for produce handling and/or storage meet standards							
12. Worker Health and Safety									
	12.1	Instructions and training are given and responsibilities are defined		1		1	1		
	12.2	Accident procedures (First aid boxes etc.) and protective clothing/equipment meet standards and are applied		1		1	1	1	1
		Worker welfare and basic rights							
	12.3	On-site living quarters habitable, basic services and facilities are adequate	1		1		1		
	12.4	Specified items of the ILO Convention are fulfilled	1		1		1	2	2
11. Animal density and welfare on mixed farms with livestock									
	11.1	Livestock density does not exceed 2.0 per acre or delivery contracts for excess manure exist where density is higher	1		1		1	1	1
	11.2	Animal welfare on mixed farms observe the rules described section 11.2 of IOBC guideline II (2004)	1		1		1		

CROPS only	**Total score possible**	32	10	42	47
	Total score achieved	32	9	41	38
	% achieved	100	90	98	81
CROPS + LIVESTOCK	**Total score possible**	34	10	44	48
	Total score achieved	34	9	43	39
	% achieved	100	90	98	81

Major MUST-item: To be included in all IOBC endorsed check-lists. Content and interpretation on respective text sheet ("Checklist"). Fulfillment of all major MUST items is mandatory.

Minor MUST-item: To be included in all IOBC endorsed check-lists. Content and interpretation on respective text sheet ("Checklist"). At least 90% of minor MUST items must be fulfilled

Bonus Points: A minimum target number of bonus points must be defined by IOBC-endorsed growers' organisation

Figure 5b. Sesame-farm inspection protocol –list of control points for the LIVE members. Example for an individual farm. Part b. At the bottom the scores are summarized.

The LIVE organization established the control lists on internet as an application the members can use and fill in on line. Every control point is explained in detail so as to make sure that the interpretation is clear and robust. See screenprint of website for an impression (figure 6).

The results of the self-inspection or also of the formal inspection can be visualized as the extent to which the farmers population complies with the basic rules/demands and how they perform when it comes to acquiring bonus points from the list of opportunities provided by the regional organization. See for instance figure 7 as example of the performance of the LIVE organization.

In principle, when the baseline of an agricultural system is defined, the IOBC Sesame checklist could be used also to evaluate both the absolute or relative level of IP or IPM guideline standard taking into account of absolute must and of bonus requirements. The relative level could be evaluated by calibrating the scoring system compared to the baseline (=initial conditions) of the different standard to compare.

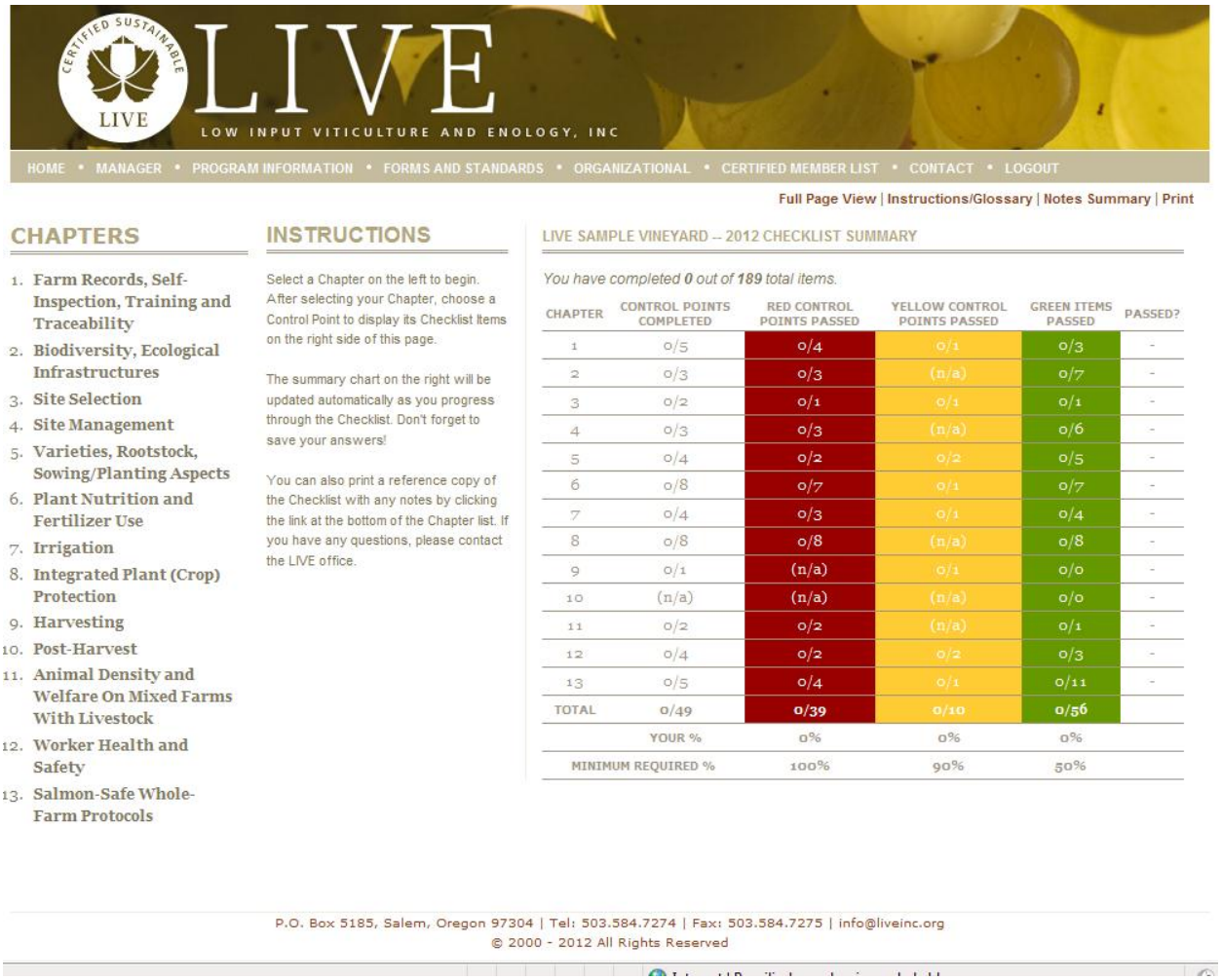


Figure 6. Screen print of the website of LIVE, Self control list, structured in chapters.

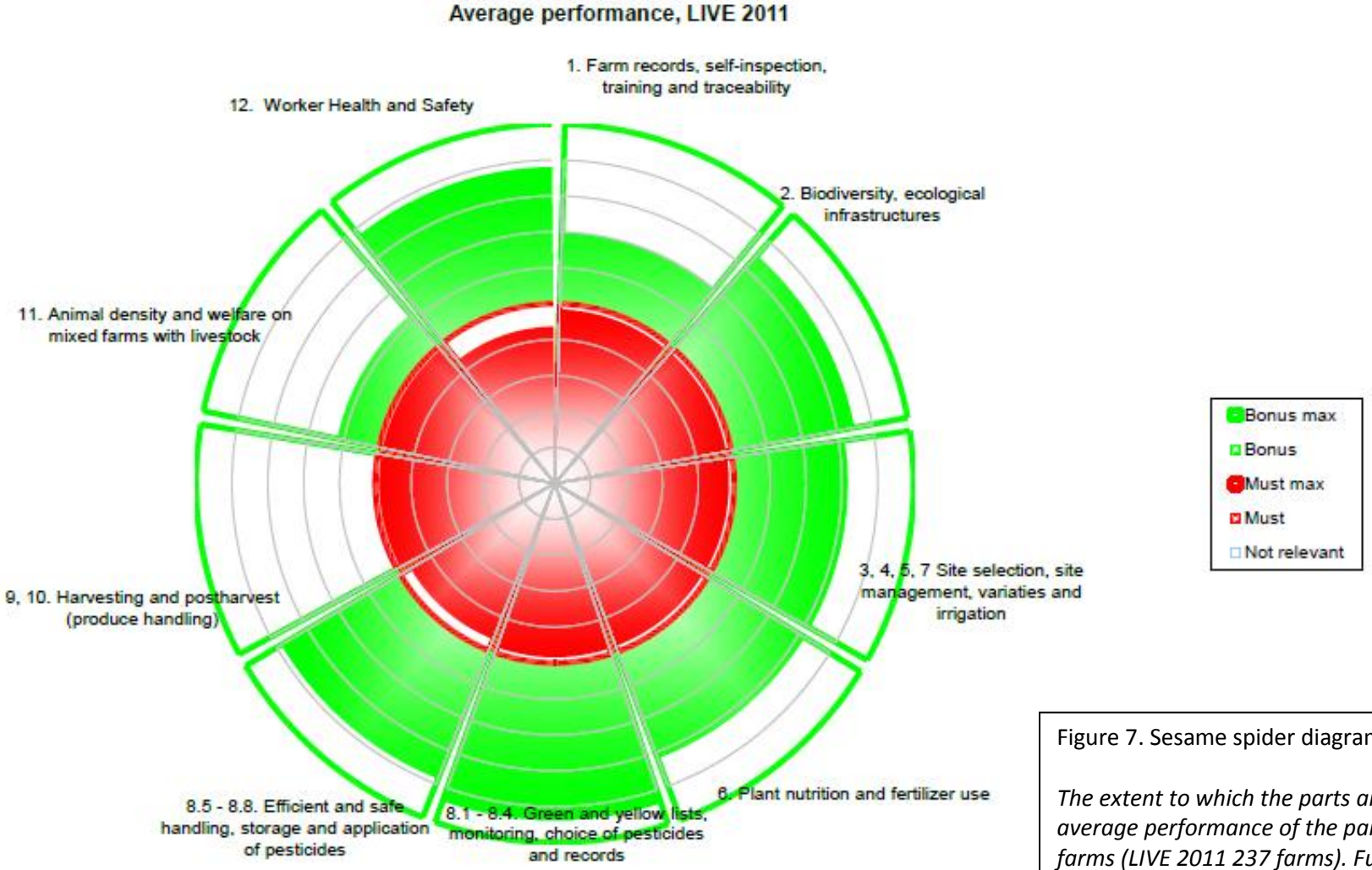


Figure 7. Sesame spider diagram. LIVE 2011.

The extent to which the parts are filled reflects the average performance of the participating/controlled farms (LIVE 2011 237 farms). Full would be all farms fulfill all control points or acquired all possible bonus points.

4. Conclusions

IPM is the international widely recognized and acknowledged concept for an approach towards crop protection that focusses on the integration of cultural, biological, and physical methods and means into the crop protection approaches in order to reduce dependency, use and impact of pesticides and to increase resource use efficiency. Integrated Crop Protection would be a more appropriate name since it deals with the whole range of pests, diseases and weeds.

IPM, by its very nature links crop protection to all other aspects of the farming. IPM embeds crop protection in the agro-ecological interactions and identity of the total farm. A clever use of those interactions can provide for a strong preventive and controlling effect on the occurrence and development of pest, diseases and weeds. By optimizing interactions between crop rotation, soil cultivation, fertilization, ecological infrastructure management and crop management like cultivar choice, sowing techniques, row distances, crop density etc., IPM is an integral building block of more sustainable farming approaches.

IPM methods, means and tools have been in development for almost 5 decades now. Many effective and feasible approaches have been elaborated for all major crops all over the world. This effort not only rationalized pesticide input, it also substituted pesticide inputs by other means. Many examples show proof that integrated approaches provide more sustainable and robust control of pest, diseases and weeds, as compared to solutions relying one-sidedly on chemical control.
IOBC as organization, as independent platform for scientists from all over Europe and beyond, is dedicated to the task of developing integrated and biological solutions for present and future crop protection challenges. IOBC was and is instrumental in the development, exchange and diffusion of new IPM knowledge and approaches.

Yet, more research and verification efforts are needed to find solutions for the crop protection challenges that we are facing. Moreover, innovations have to become available for farmers in practice. New approaches, including a more active involvement of all stakeholders, are needed to facilitate and support the introduction and adoption of IPM in practice. The challenge is ever so large to safeguard the production quality and quantity whilst reducing further the use and impact of pesticide inputs. IOBC remains an excellent platform to integrate these activities from the basic research to implementation schemes.

IPM adoption and implementation in practice is an ongoing challenge, as clearly formulated in the Directive on sustainable use of pesticides (SUD, 2009/128/EC) of the European Union. This directive targets a level of IPM that can and should be applied by all farmers. However, for every crop more advanced levels of IPM are possible. They can be identified and addressed as specific possibilities tailored to the specific situations characteristic to each geographical region. Within the EU, single measures can be also connected to other instruments, like the basic agricultural subsidies (pillar I) or the agri-environmental schemes (pillar II).

In this booklet the crop protection part of Integrated Production guidelines (IP), compiled by IOBC, is summarized. It gives an overview of IPM approaches/methods and means for a wide range of different crops. Two levels are distinguished: a basic level that seems suitable as requirement for all famers, and a more advanced level that constitutes the preferred level, always to be applied as specific approaches for specific regions/cropping conditions. We hope that this will give inspiration for professionals in the agri-business and policy makers in their efforts to increase the adoption of IPM in practice.

The IOBC expertise is wide and extensive. The IPM options, presented in this booklet were formulated to suit a wide range of conditions. For the inevitable adaptation of general guidelines and

recommendations to the specific requirements of the individual regions, IOBC can provide the knowledge and insight in the practical possibilities of IPM implementation.

5. References

- Boller, E.F: Avilla, J.; Gendrier, J.P.; Jörg E.; Malavolta C. 1998. Integrated Production in Europe: 20 years after the declaration of Ovrannaz. IOBC/WPRS Bulletin 21(1).
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- IOBC guidelines: http://www.iobc-wprs.org/ip_ipm/download_documents.html

Annexes

Annex III SUD: General principles of integrated pest management

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 fertilization, liming and irrigation/drainage practices,
— preventing the spreading of harmful organisms by hygiene measures (e.g. by regular cleansing of machinery and equipment),
— protection and enhancement of important beneficial organisms, e.g. by adequate plant protection measures or the utilization of ecological infrastructures inside and outside production sites.
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.
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.
4. Sustainable biological, physical and other non-chemical methods must be preferred to chemical methods if they provide satisfactory pest control.
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.
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.
7. Where the risk of resistance against a plant protection measure is known and where the level of harmful organisms requires repeated application of pesticides to the crops, available anti-resistance strategies should be applied to maintain the effectiveness of the products. This may include the use of multiple pesticides with different modes of action.
8. Based on the records on the use of pesticides and on the monitoring of harmful organisms the professional user should check the success of the applied plant protection measures.