IOBC-WPRS IP Guidelines

Crop specific technical guidelines for integrated production of

Pome Fruits

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With the support of the IOBC-WPRS Working Groups, specifically the Working Group on "Integrated Protection of Fruit Crops", Sub-Group "Pome Fruit Arthropods".

Back

These guidelines are meant as inspiration for advanced Integrated Production (IP). Any organization that wants to design and operate an Integrated Production scheme can follow these guidelines. Guidelines drafted by national or regional organisations are referred to in the text as National or Regional IP guidelines.

This guideline consists of parts from the **IP General Technical Guidelines on Annual and Perennial Crops** and the **Crop Specific Technical Guidelines for Integrated Production** (text marked in green).

Two levels are distinguished:

- **Strict rules** are the minimum requirements that, according to the IOBC-WPRS, have to be met to ensure that the potential of the IP approach can be realized.
- **Recommendations** are preferred options for a higher level of IP application constituting extra care for the IP objectives. These approaches may increase the cost of production or the effort required.

–	Strict Rules	Recommendations
1. General Aspects	*In Integrated production good agricultural practices must be applied, products must be traceable to the producer and self-evaluation practice*	
1.1 Good Agricultural Practice (GAP), food safety management procedures and Integrated Production Standard	The IOBC General and crop specific Guidelines do not and cannot mention all published "must" rules of Good Agricultural Practice, but will present selected requirements that seem to be of special relevance to the IP concept. Any organisation that produces according to a certified IP standard will also have to comply with any national or international GAP/food safety standard as pertinent for their situation and markets.	
1.2 Traceability aspects out of general aspects	All participants of the food production chain are responsible for the quality of the final product and, if appropriate, for the quantification of (pollutant) residue levels. All farm products that are IP certified must be traceable to the registered farm and field where it has been grown.	
1.3 Self evaluation	Each farm participating in a certified IP production scheme has to complete once per year the inspection protocol (= check-list) of the specific IP scheme (as made available by the organisation that implements the IP guidelines).	IP guidelines should specify self-evaluation protocols and encourage their use. The result of this self-evaluation should be available at the farm inspection by the control-certifying organisation, and an appropriate correction plan implemented. IP guidelines should include annual training of farmers on specific IP aspects.

–	Strict Rules	Recommendations
2. Biodiversity and landscape	*Biodiversity is one of the major natural resources of the farm to minimise pesticide input. IP guidelines therefore must specify a strategy to actively optimise the biological diversity at all 3 levels (genetic, species, ecosystem).*	
2.1 Ecological infrastructure (ecological compensation areas)	The (non-cropped) ecological farm infrastructures must cover at least 5 % of the total farm surface (excluding forest). Existing ecological infrastructure on the farm must be	The surface of ecological infrastructure with low production intensity and without pesticide/fertilizer input should increase to 10%.

	preserved. Flowering field margins must be established as reservoirs of pest antagonists. Areas of linear elements (e.g. flowering border strips, hedges, ditches, stone walls), and non-linear elements (e.g. groups of trees, ponds etc.), being present or to be planned on the farm should be connected and combined in such a manner that spatial and temporal continuity is obtained. This continuity is a prerequisite for the enhancement of fauna diversity and for the maintenance of a diverse landscape. *Note: The 5% rule does not apply to individual farm in areas with predominantly small farms, with highly scattered properties In such cases the alternative way to comply with the requirement is to designate a surface of 5% or more of a comparable and homogeneous agro-climatic unit (e.g. same municipal district), set aside as ecological infrastructure by official and well documented regional programs. In this case, it has to be shown that the ecological infrastructure areas are well distributed in time and space in the municipal area, thus providing a guaranteed continuity.*	Development of a professionally formulated conservation assessment and plan for the farm and its implementation are recommended. Special attention should be given to enhance the functional biodiversity in and around fields: • Avoiding risks of increasing host pests. • Enhancing the functional biodiversity is possible after conducting specific studies focusing on the target organisms whose populations we wish to increase. IP guidelines should recommend appropriate species. • It is recommended to increase biodiversity within orchards providing ecosystem services such as pest regulation or improved nutrient uptake efficiency or weed seed predation. o e.g. by practicing an alternating mowing regime with a permanent supply of flowering plants as food sources for the orchard fauna). • Plants species that form the vegetation cover in the alleyways should be naturally occurring or be selected/planted due to its favourable characteristics. • Contamination by spray drift from neighbouring crops can be detrimental to beneficial and other fauna. It is advisable to protect the orchard by planting windbreaks as barriers. It is recommended to increase functional biodiversity within the orchard (e.g. by practicing an alternating mowing regime with a permanent supply of flowering plants as food sources for beneficials notably in early spring): • Plants species that form the vegetation cover should be native or be selected/planted due to its favourable characteristics for beneficials. • IP guidelines should provide a list of preferred plant species. This list should consider and possibly avoid known host plants of destructive new pests (e.g. *Halyomorpha halys*), as well as disease (e.g. fireblight); hawthorn should be as well avoided as a host of potential vector of the apple proliferation.
2.2 List of options	IP guidelines must provide a list of at least 5 ecological options for the active enhancement of biological diversity. At least 2 appropriate options have to be selected as "must" by the individual farmer. Examples of lists of options are given in the IOBC-WPRS Tool Box. Specific examples for pome fruits are: (i) Nesting boxes for smaller caterpillar feeding birds, such as insectivorous passerines, and/or perches for birds of prey (against voles), (ii) Refuges for predators. (including artificial ones), (iii) Host plants for beneficials (such as dedicated flower stripes or purpose planted hedgerow species), (iv) Resistant cultivars as pollinizer trees, (v) New wildlife habitats etc.	
2.3 Field size		The lateral dimension of an individual field should be considered as an important element in functional biodiversity, to provide ecological reservoirs and to secure connectivity with adjacent ecological infrastructures (see IOBC-WPRS Tool Box).
2.4 Buffer zones	Buffer zones between crop areas and sensitive off-crop areas, (such as surface waters, springs, important ecological infrastructures, heavily travelled roads, infested crops, hibernation areas of pests and diseases), must respect legal regulations. If no official regulation exists, buffer zones must be at least 3 m wide.	Buffer zones should preferably be wider than 3 meters.

–	Strict Rules	Recommendations
3. Site selection	*Suitability of the site has to be assessed and taken into account.*	
3.1 Site selection	Only fields suitable for sustainable production of a particular crop can be used for IP production. If new sites are being brought into cultivation a proper	For new agricultural sites a plan needs to be developed, describing and scheduling the measures to minimise all identified (and controllable) risks for environment and crops.

	assessment must be done on the suitability of the site for IP production considering prior use of land, type of soil, erosion potential, soil health status, and prior use of persistent herbicides, quality and level of ground water, availability of sustainable water sources, and impact on and of the adjacent area. Non suitable sites must not be used for production. Sites with a favorable aspect and appropriate soils must be selected, avoiding the situations in which a continuous supply of inputs will be necessary. For instance, frost pockets, (areas with high risk for frost), poor drainage and shallow non-moisture retentive soils, must be avoided. Soil must be sampled and chemically analyzed prior to planting. For new orchards, the pH should be corrected before planting.	Where a new plantation follows the forest, the roots of forest trees should be checked for the presence of root rots (i.e. Armillaria, Rosellinia) and completely uprooted.

–	Strict Rules	Recommendations
4. Crop rotation / Sequence	*Crop rotation/sequence is a major method to improve soil quality and to prevent pests, diseases and weeds.*	
4.1 Annual crops: Frequency and sequence	Not applicable.	Not applicable.
4.2 Perennial crops: Crop sequence and inter/cover crops	When re-planting a perennial crop: • To avoid pathogen transmission and a less vital crop development in the first years after plantation replanting of same crop is only to be admitted in IP guidelines on a case by case analysis. Also agronomic characteristics and period of plantation should be chosen to reduce these risks. • Cover and catch crops have to be considered integrally in the design of the orchards. A minimum of one year break between two plantations.	The use of leguminous crops (Leguminosae/Fabaceae) as cover crops to improve soil structure, weed control and soil fertility is recommended; Leguminous crops fix N from the air and can contribute thus to the N supply. It is recommended to use a break crop (e.g. 1-year break: preferably grass, winter cereal or others; 2–3 years break: mixture of Fabaceae, Sinapis alba and others) before re-planting to homogenize the soil, and also to improve soil structure and fertility and possibly control specific pests, diseases and perennial weeds. Elimination of sources of disease inoculum (i.e. roots of old plants) is recommended before replanting.
4.3 (Inter) cover crops	Cover crops contribute to maintenance of soil physical property (erosion and compaction) (5.1) and soil fertility (7), enhancement of biodiversity (see 2), control of pest and diseases (see 9.1) and prevention of leaching of N. In perennial crops, cover crops must be used in the alleyways. Specific attention to possible host for *Halyomorpha halys*.	
4.4 Any further sub-chapter, e.g. for protected crops		

–	Strict Rules	Recommendations
5. Sustainable soil management	*Sustainable soil management aims at preserving and optimising soil quality (chemical, physical and biological) in order to sustain quality production on the long term.* *Sustainable soil management is an interplay between key farming methods such as crop rotation, fertilisation and soil tillage:* • *For crop rotation see 4.1 and 4.2 for respectively annual and perennial crops, see also 4.3/5.2 for cover crops* • *For soil fertility/nutrient management: see 7.* • *For soil tillage see 5.1 and for organic matter management 5.3*	
5.1 Soil tillage and compaction	Soil tillage methods and farm machinery use (type, intensity and traffic control: here called field traffic) are key factors to reduce erosion risk and sustain and improve soil fertility, Controlled traffic helps to improve aeration and water infiltration) appropriate soil tillage improves bio-physical soil properties, (e.g. aggregate size and stability) arranging for the least possible soil disturbance (to avoid compaction and erosion). Sound crop residue management helps to improve soil properties and fertility as well as increase water holding capacity Soil tillage methods and farm machinery for the management of soil must be used that are appropriate for soil type, cropping, topography, erosion risk and climate in order to sustain and improve soil fertility.	Minimum soil tillage or non- inversion tillage is recommended. However, if soil borne damaging organisms (weeds, pests, diseases) increase to a level that endangers crop production at all, occasional ploughing is appropriate. Timing of tillage can be used to optimise nitrogen management. Farm machinery and soil management should be chosen in order to minimise disturbance of soil stratification, to reduce soil compaction, to preserve organic matter, to improve the efficiency and effectiveness of mechanical weed control and agrochemical applications, and to reduce fuel consumption. GPS guided traffic (controlled traffic) is recommended where appropriate. It contributes to minimising the area that machinery drives on, thus reducing overall soil degradation.

5.2 Soil protectiona	Soils need to be protected for degradation and erosion by appropriate soil tillage and soil cover strategies maintaining the longest possible soil protection by crop or non-crop cover, without detriment to yield with minimum inputs of fertilisers and irrigation water. Soil protection should be sustainable under the local conditions and optimised locally. In regions with leaching and erosion risks, an appropriate soil cover, (with adequate N-uptake capacity), must be maintained. Where erosion damages are visible, a plan needs to be developed and implemented, describing and scheduling the measures to minimise erosion risks. For perennial crops: use of cover crops is required, see 4.2. Specific requirements for pome fruit orchards are: • Overall bare soil management of orchards throughout the year is not permitted. In arid areas bare soil management is permitted in spring and summer to avoid competition for water and nutrients. • Green cover can be used depending on local conditions. A vegetation cover in at least the alleyways is mandatory during the winter time. • Herbicides may only be used to supplement mechanical and physical weed control methods. • Herbicides must not be used to achieve overall bare soil. They can only be used locally during spring and summer when physical or mechanical control (preferred option) is not appropriate. • IP guidelines must specify a maximum width for the weed free strip and/or percentage of the soil surface which may be weed-free. The procedures for practical implementation must be defined in the regional guidelines according to climate, soil type, cultivars and precipitation.	Measures to avoid or to control soil erosion should be defined for each crop based on the erosion potential specific to the region and farm. In very sloping areas, soil protection can also be achieved with contour cultivation and/or terraces. Low intensity cultivation is preferred. Non inversion tillage can contribute to reduction of erosion. In areas with sufficient precipitation (e.g. >500 mm during the growth season) and suitable soil type the maintenance of a permanent or temporary green cover during the growth season is highly recommended to avoid soil compaction, promote water infiltration and increase biodiversity. It is recommended that in case of necessary control of weeds, herbicides should be replaced by mechanical cultivation, or by using a mulch soil cover with organic materials or by partial or total green cover. Mulch type and sanitary quality should be carefully selected since it could favour certain pest (e.g. voles). It is recommended that use of selective broad-leaf weed herbicides in the alleyways is avoided. The use of Leguminosae/Fabaceae plants as cover crops to improve soil structure, weed control and soil fertility is recommended. Take into consideration that some of these plants can be host plant of pest such as Halyomorpha halys. Alleyways should be sown with grass and/or herbs and have adequate width to easily accommodate the tractor wheels.
5.3 Organic matter	IP guidelines must specify a target range for optimal organic matter content. An organic matter balance must be calculated to determine the surplus or shortage of supply in reference to the defined optimal range Management must be targeted towards maintaining or reaching the targeted level of organic matter content for the specific soil type and location by appropriate measures (fertiliser choice, crop choice, cover crops and green manure etc.).	The use of bio-indicators, (earthworms, cellulose decomposing organisms, predatory mites etc.), for monitoring the diversity of fauna and flora is to be encouraged.
5.4 Soil disinfection	Chemical fumigation/disinfection is not allowed.	Solarisation is strongly recommended where effective. Consideration should be given to the incorporation of fresh biofumigant plant material (for ex. crucifers/mustards). Sowing or pre-planting biofumigant species is recommended.

—	Strict Rules	Recommendations
6. Cultivars, rootstocks / cultivation systems	*Healthy and vital seeds, rootstock and/or plant material is important for a healthy and resilient crop. Using resistant and tolerant cultivars and varieties for the major pests and diseases is an essential element of the IP approach.*	
6.1 Choice of cultivars	Cultivars and rootstock must be adapted to local conditions. IP guidelines must supply the growers with a list of suitable cultivars. The list should be based also on existing official national lists of varieties. IP guidelines must specify the relevant traits of the cultivar that have to be taken into account when choosing a cultivar, such as disease and pest tolerance and resistance. The cultivar/rootstock chosen must offer good prospects for economic success with minimal use of agrochemicals. For example, Golden Delicious must not be planted on sites prone to russeting, nor Jonagold on sites unfavourable for fruit colouring and firmness. IP guidelines must provide a list of the relative susceptibilities of the commonly grown cultivars/rootstock of pome fruits to all important pests and diseases.	Disease resistant or tolerant varieties should be chosen if they are available and commercially acceptable. Appropriate cultivars can support IP approaches by reducing off farm agro chemical inputs such as fertilizers and pesticides. For instance through adequate resistance or tolerance to major diseases and pests. Alternation of cultivars (e.g. ripening period for flies) capable to disrupt pest cycle are recommended, where appropriate. Cultivars and rootstocks should be resistant or tolerant to pests, physiological disorders, fungal diseases, viruses, phytoplasmas are preferred.
6.2 Seed and plant quality	**Annual crops:**	**Annual crops:**

and health status	All seed and planting material for annual and herbaceous perennial crops that is purchased must be certified and accompanied by a plant health certificate. **Perennial crops:** If available, planting material for perennial crops must be sound and certified as virus tested, vector and disease free. Where this is not available, planting material of the highest health status available must be used.	Alternation and mixtures of cultivars are recommended, where appropriate. Seed and Planting material should be of the highest possible level of health status (virus/disease free). **Perennial crops:** All propagation material should be inspected by the grower to be free of pests and diseases. Infested material must not be used. It is strongly recommended that plant health quality control systems are implemented for private or inhouse (on farm) nursery propagation.
6.3 Cultivation/fruit management, planting and training system	The cultivation system, including planting pattern, training and pruning, has to respect the optimum physiological status of the crop plant. New plantations should adopt locally adapted cultivation systems that allow integrated plant protection principles and measures to enhance biodiversity to be integrated optimally. Planting systems must allow safer, more efficient spraying practices to be adopted. The use of non-naturally occurring synthetic plant growth regulators is generally not permitted. Their use can only be permitted when absolutely necessary in the following cases: • Where excessive numbers of flowers have pollinated and set during blossom and an excessive crop is likely to result, the young fruitlets must be thinned shortly after blossom to the optimum number to ensure adequate fruit size and quality. Chemical thinning agents are permitted on specific varieties that have excessive blooming (only economically feasible approach). • Conversely, where weather during blossom is unfavourable for pollination and set, sprays of naturally occurring (but chemically synthesized) crop setting agents (e.g. gibberellins, NAA) are permitted. The use of non-naturally occurring, synthetic plant growth regulators as fruit finishing, coloring or ripening agents is not permitted. Regional or national IP guidelines must set out which chemicals are permitted, clearly specifying the aim and the restrictions of their use.	To avoid excessive tree densities and to reduce the need of high chemical usage, single row planting systems are preferred. The planting system should allow for more efficient spraying practices as it is possible in orchards with small uniform trees with a lower canopy density. Planting distances should allow enough space for individual tree throughout its expected life span without the use of synthetic plant growth regulators or severe pruning. Excessive growth should be controlled by cultural measures such as reducing fertilizer input and irrigation supply, summer pruning and encouraging greater set of blossom. Mechanical or hand thinning is preferred and is often the most reliable. The use of nets (especially single row nets), for example in the case of fruit fly control or even rain or hail protection should be considered at the plantation.

–	Strict Rules	Recommendations
7. Plant nutrition	*Fertilisation should consider all aspect linked to soil management (see §5) and should be adapted to plant needs (types, dosages and timing) considering the farm context.*	

7.1 Nutrient management strategy macro nutrients P, K	IP guidelines must specify agronomically desirable and environmentally acceptable target ranges for soil fertility for at least P and K.
	
	A nutrient allocation plan for P and K for each crop on a plot/field level must be established, taking into consideration:
	
	• The actual field status of soil fertility in relation to agronomically desirable and environmentally acceptable levels (P, K evt Mg).
	• The balance approach: Off-farm fertilizer input must only compensate the real exportation and unavoidable technical losses resulting:
	  • for annual crops in an balance of inputs and exports at a rotational level (including the technical unavoidable losses),
	  • for perennial crops in an annual balance of inputs and exports.
	• Additional inputs can be justified to maintain the desired soil fertility level, Inputs exceeding this plan are unacceptable: for instance small quantities of phosphate are sufficient to cause over-enrichment of surface waters. Phosphate from agricultural land is mostly translocated by erosion of small soil particles.
	• The distribution of macro nutrients over the years might be different to the export with crops, as long as the rotational balances are maintained.	

7.2 Assessing P, K and other nutrient requirements	Organic matter and nutrient analysis (minimal for P and K) of the soil is the basis for assessing nutrient requirement (except N): see 6.1. Soil analyses for the major elements, P, K, Mg, must be carried out at defined intervals (i.e. 3-10 years, depending on the crop). IP guidelines must specify the analysis techniques and desired ranges of soil fertility. See also 6.1. Uptake and demand criteria for major nutrients are an additional source for fertilization plans, however the soil balance approach on a rotational level must be maintained.	Foliar analysis can be applied as complementary test method. The application of nutrients in variable-dosages based on vigour maps or soil or plant samples is recommended.
7.3 Nitrogen supply and timing	N supply and timing must be matched with the crop demand. The use of nitrogen needs particular care because nitrogen leaching and evaporation have significant environmental consequences. A N fertilization plan must be established that specifies for every crop and plot the N sources and available amounts and shows how the crop demand is met. Taking into account: Hidden nutrient sources such as importation through polluted air (N). The soil mineral N status before cropping season. Mineral N and N mineralisation from organic sources. IP guidelines have to define for each crop the maximum nitrogen input, (expressed in kg N/ha/year or crop rotation component), and specify eventually the time-window of adequate N application. The chemical content of at least NPK in all inorganic and organic fertilizers must be known and documented. Where possible and appropriate N fertilization systems must be used that enable split applications based on N status of soils and or plants.	N - requirements should be covered by Leguminosae, (biological N-fixation), to the largest possible extent while preventing any danger of leaching and taking into account possible effect on augmenting soil borne damaging organisms. The total amount of available nitrogen in organic fertilisers should be accounted for a period of 3 years. The use of slow release fertilizers can contribute to minimize nutrient losses and increasing nutrient availability during the period that they are most needed. IP growers should be encouraged to reduce the amount of nitrogen whenever possible. Splitting of N (after harvest, beginning of spring and eventually end of spring) is recommended (amount to be based on soil sample analysis).
7.4 Supply of other major or micro nutrients	Inputs have to be justified on the basis of a fertilization plan. See 6.1 nutrient allocation plan. The chemical content of at least NPK in all inorganic and organic fertilizers must be known and documented. Where foliar symptoms or plant analyses indicate a deficiency of micronutrients the application of these elements is justified. These elements should be, in general, administered via the root system. Foliar fertilization is only permitted when soil application is not possible or when the soil characteristics limit the efficiency of soil application (for instance Calcium through the leaf).	The replacement of mineral P-input through enhancement of the activity of soil organisms (e.g. mycorrhiza) should be encouraged.
7.5 Organic manures	Organic manures or compost can help to improve soil fertility by increasing organic matter content, improving nutrient and water retention, and reducing erosion. Organic manures must contain only the lowest possible load of heavy metals and other toxicants and meet the legal regulations. Any use of treated human sewage sludge on land destined for agricultural use must be in accordance with updated versions and internationally applied “Codes of Practice for the agricultural use of Sewage Sludge”. Existing “Codes of Practice for the Control of Microbial Hazards” give further guidance. Untreated human sewage sludge must not be applied to farmland.	The use of organic fertilisers, including high quality compost, should be promoted. More severe limitations for heavy metal and other toxicants exceeding minimum legal requirements are to be encouraged.
7.6 Safe and efficient application of fertilisers and manures	Application machinery must be kept in good condition. Regular servicing and annually verifying calibration, (quantity per time and per area), must be carried out by the qualified farmer or a specialised company. IP guidelines must contain lists of measures to reduce technically unavoidable nutrient losses by leaching, erosion and evaporation, (e.g. ground cover or timing of soil cultivation). Manures and fertilizers must not be applied to logged water, frozen soil, or steep ground where there is a risk of run-off.	Slurry should not be applied within 10 m of a watercourse or 50 m from a well, spring or borehole that supplies water for human consumption or for use in farm dairies. Injection or low emission methods of application of manures and slurry should be applied to reduce ammonia and GHG emissions. If only mineral fertilizers are used, fertigation is preferred.
7.7 Storage of fertilisers	Storage conditions and safety precautions for fertilizers must fulfil the basic requirements of Good Agricultural Practice (GAP). Solid fertilisers, manures and plant nutrients must be stored in a clean, dry location where there is no risk of water	

	contamination. Inorganic and organic fertilisers must not be stored with fresh produce and plant propagation material.	

—	Strict Rules	Recommendations
8. Irrigation	*Irrigation has to be based on crop requirement and the irrigation method has to be adapted to the crop and farming context.* *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). Excessive use of irrigation water is wasteful.*	
8.1 Water requirement of the crops	All measures must be taken to minimise water loss and to optimise product quality.Irrigation is only justified if the available water does not satisfy the crop's requirements taking into account also soil types, climatic conditions and the relation between the amount applied and quality/quantity of the crop. The calculated water amount must not exceed field capacity (water holding capacity) also to avoid nitrate leaching.	Irrigation scheduling systems should be used where available. Advanced systems like deficit irrigation should be used. Systems used should: • Utilise, whenever possible, local data on reference evaporation rates calculated by means of local meteorological stations. • The amount of applied water should be recorded in the farm records.
8.2 Irrigation methods	A water management plan must be available at the farm that specifies water sources, the decision support tools, the irrigation methods, etc. The irrigation plan needs to be established individually for each plot. This will help to optimise water usage and reduce waste, e.g. irrigating at night, maintenance to reduce leakage, collection of rainwater from roofs, etc.	The most efficient and commercially practical water delivery system should always be used to ensure best utilisation of water resources. Whenever possible, a combination of irrigation with fertilisation (fertigation) should be considered. Take into account that irrigation might influence the nutrient dynamics. The use of drip irrigation is preferred. For frost protection, overhead irrigation could be recommended.
8.3 Water quality and supply	Irrigation water has to be shown to be of adequate quality (conductivity, Cl-content, salinity and content of polluting agents), not exceeding the official tolerance levels, and pathogens relevant to the crop. The use of untreated sewage water for irrigation/fertigation is prohibited. Where treated sewage water is used, water quality must comply with the WHO-Guidelines on "Safe Use of Wastewater and Excreta in Agriculture and Aquaculture".	Irrigation water should be obtained from sustainable sources, (i.e. sources that supply enough water under normal conditions). The regular analysis of the water quality with respect to heavy metals, N, and Na/Cl content etc., is recommended. The installation of measuring devices in every plot for registering the amount of water applied is to be encouraged.

—	Strict Rules	Recommendations
9. Integrated plant protection (IPM)	*The Principles of Integrated Plant Protection have to be applied. Preventive (indirect) measures and observations in the field on pest, disease and weed status must have been considered before intervention with direct plant protection measures takes place*	

9.1 Prevention (= indirect plant protection)	The prevention and/or suppression of key pests, diseases and weeds can be achieved or supported among other options especially by the:
	• Choice of appropriate resistant/tolerant cultivars.
	• Use of an optimal replanting interval or similar strategy to prevent diseases and weakness.
	• Use of adequate cultivation techniques, (e.g. green cover, pruning, removal of infected prunings, alternate mowing); pruning not only removes dead tissues but also allows proper ventilation and more effective spray coverage.
	• Use of balanced fertilisation (especially low nitrogen input) and irrigation practices.
	• Protection and enhancement of important natural enemies by adequate plant protection measures.
	• Utilisation of ecological infrastructures inside and outside production sites to enhance a supportive conservation biological control of key pests by antagonists.
	
	IP guidelines must (see 8.1.3.c) describe a basic selection of preventive measures that have to be implemented.
	
	The prevention and/or suppression of key pests and diseases
		The prevention and/or suppression of key pests and diseases should be supported among other options especially by:
		• Hygiene, proper disinfection or cleaning of buildings, clothes, hands, tools, booms, tanks, sprayers and machines is recommended.
		• Preventing the carryover of organisms which transmit a phytohygenic damage potential, when spread. Examples: Weeds like *Cyperus esculentus* or *Rorippa palustris*, nematodes like *Globodera rostochiensis*, fungi like *Plasmodiophora brassicae* with machines.
		
		The prevention and/or suppression of key pests and diseases should be supported among other options especially by:
		• Choice of appropriate resistant/tolerant cultivars,
		• Removal or destruction of overwintering sources of infestation or infection (e.g. wood scab, canker, brown rot, leaves against apple scab) as far as practically possible is required. For instance:
		  • Cardboard trapping of overwintering larvae of *Cydia pomonella*,
		  • Placement of refugia, e.g. for spiders or earwigs, in fruit trees,
		  • Removal of sources of infestation during the

	The prevention and/or suppression of key pests and diseases must be supported among other options especially by: • The protection and enhancement of beneficial organisms (e.g. predatory mites, arthropod predators, parasitoids, pollinators), • Use of adequate cultivation techniques (e.g. green cover, alternate mowing, etc.), • Use of optimum fertilization (especially low nitrogen input) and irrigation practices, • Ecological infrastructures inside and outside production sites to enhance a supportive conservation biological and to control of key pests by antagonists (e.g. field margins, selection of native plants in hedgerows), • Removal of infected organ/plants in case of uncurable diseases (e.g. apple proliferation, fireblight).	season such as powdery mildew.
9.2 Risk assessment and monitoring	Interventions to control pests, diseases and weeds must be based on adequate monitoring methods and tools to determine whether and when to apply direct control measures. Robust and scientifically sound warning, forecasting and early detection/diagnosis systems (decision support systems) as well as sound threshold values are essential components for decision making. The official forecasts of pest and/or disease risks, or officially established threshold levels defined for the region must be taken into account before treatments. Diseases • For apple scab forecasting models such as RIMpro, A-SCAB or CIMMET. • For Fire blight forecasting models such as RIMpro or Mary Blight to verify risk of infections during blossoming. Insect and mites • Degree-days and phenology models (e.g. RIMpro, MRV, etc.) to adjust the mating disruption installation time and the need of reinforcement in key phenology times or the timing of other treatments; combined with other methods suitable for important pests. • Monitoring of predators and parasitoids (e.g. visual assessment, beating) to assess beneficial-pest ratio. • Visual assessment (e.g. aphid and mite in spring and summer; overwintering pests on branches, egg and mobile form counting of tetranychids). • Traps baited with food based attractants (e.g. Fruitfly, Tortricidae in orchards with mating disruption). • Use of pheromone or kairomone traps if available (e.g. *Cydia pomonella* and other pests). Others • Beating (e.g. *Anthonomus* spp., *Rhynchites* spp.). • Colored sticky traps (e.g. *Hoplocampa* spp.). • *Halyomorpha halys* - Brown marmorated stink bug (BMSB) • Early detection by using traps such as dark green pyramid traps or transparent sticky panel traps. Some lures are also available.	Empirical threshold values should be replaced by more scientifically sound approaches, like DSS, and expert systems. Existing and validated forecasting models for diseases should be used and the use of adequate monitoring devices by groups of growers is recommended. Sampling of fruits or other plant tissues is recommended to determine/assess the infestation level of phytophagous insects. Sampling and assessment of stored fruits post-harvest can highlight potential problems in specific orchards the following year. Sampling secondary pests with pheromone/kairomone traps if available is recommended (e.g. mealybugs, scales, trips).
9.3 Direct plant protection method	Where indirect plant protection measures are not sufficient to prevent a problem and forecasts and threshold values indicate a need to intervene with direct plant protection measures, priority must be given to: • Those measures which have the minimum impact on human health, non-target organisms and the environment. • Biological, biotechnical* and physical methods must be preferred above chemical methods if they provide satisfactory control. **: Biotechnical control methods are defined in applied entomology as highly specific procedures that influence the behavior or development of pests without direct biocidal activity, such as mating disruption, deterrents, sterile insect*	Weed management should be achieved, as far as possible, by non-chemical methods. Botanical pesticides for pests and diseases. Diseases • Using alternatives to chemical fungicides (avoiding sulphur). Insect and mites • Use of entomopathogenic nematods and fungi (supported by irrigation or with favourable weather conditions). • Use of exclusion nets as physical barrier to keep out the orchards *Cydia pomonella* (this system can decrease the presence of *Halyomorpha halys*, mainly adults, and

	technique. Control method to be used if available and effective. Insect and mites Lepidoptera • Mating disruption must be used as the basic method for control of *Cydia pomonella* and other *Lepidoptera*, wherever possible. Where an additional or alternative control measure is required, priority should be given to use of selective compounds. • Granulovirus against codling moth and *Adoxophyes orana*. • *Bacillus thuringiensis* against caterpillars and some leafrollers.	presence of *Halyomorpha halys*, mainly adults, and reduce damages on apple and pear). Diptera • Mass trapping or attract and kill could be used as the basic method for control of *Ceratitis capitata*, *Synanthedon myopaeformis*, etc. wherever possible. Others • Oils and kaolin clay for aphids, Psyllidae and overwintering pests. • *Halyomorpha halys*: use of nets to avoid the entry of the pest and damages on fruits. • Soft body insects (e.g.Aphididae) and Tetranychidae: a products with the mechanical mode of action should be used for control it.
9.3.1 Restrictive use of pesticides	IP guidelines must (see 8.1.3.d) classify pesticides (to be used for the key pests, diseases and weeds) in three categories: 'permitted' (green list), 'permitted with restrictions' (yellow list) and 'not permitted' (red list) based upon± • Their toxicity to man • Their toxicity to key natural enemies • Their toxicity to other non-target organisms • Their pollution potential for the environment (soil, water, air) • Their ability to stimulate pests and diseases • Their selectivity • Their persistence • Their potential to develop resistance in target • Incomplete or missing information • The necessity of use. Regularly updated data on the eco-toxicological profiles of pesticides are compiled by IOBC cf. toolbox). All agrochemicals used must fulfil the basic requirements of GAP. • The plant protection product applied must be officially approved for the target, as indicated on the product label, or for officially approved off-label uses. • In countries that have no official registration schemes yet, reference is made to the FAO Code of Conduct on the Distribution and Use of Pesticides. • All pesticide applications must comply with the statutory conditions regarding the specific crop, maximum permitted total dose, maximum number of treatments, spray intervals and pre-harvest interval, as indicated on the product label or authorised off-label uses. • Since label doses are maximum doses approved by the registration authorities, reduced dosages are possible, (especially in herbicides). Chemical soil disinfection is not allowed. Based on the general criteria, the following categorization of pesticides and pesticide groups is established. It may require up-dating with the development of new products. Not Permitted* • Organochlorine insecticides and acaricides, • All acaricides toxic to Phytoseiid mites, • Antibiotics, • Non-naturally occurring plant growth regulators, • Persistent herbicides. Permitted with Restrictions • Copper-based products: (maximum of 4 kg/ha of copper ion /year). • Benzimidazole fungicides (storage rots and blossom wilt and, as a paint for canker control, only). • 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	The use of reduced dosages is recommended wherever possible in accordance with national documentation, experience and legislation. In Europe EPPO standards are also used as references.

	severe problem, normally a maximum number of 4 applications per season). • Neonicotinoids permitted only as an exception (when no other methods available): max two applications/year (acetamiprid & thiacloprid are permitted). • Pyrethroids: The use of a single/two spray application(s) of a non-acaricidal synthetic pyrethroid per season for control of Mediterranean fruit fly shortly before harvest is permitted, as well as for Halyomorpha halys. This is a temporary exception where no alternative control method is available, used as a reinforcement of other methods. Where such use is permitted by IP guidelines, a research program to find effective non-pesticide alternative treatments must be rigorously pursued. • Persistent herbicides with DT90<1 vegetation period: the situations of their exceptional use must be clearly specified (e.g. in the first three years after planting, maximum of one dose-equivalent per annum). **The list of "non-permitted" and "Permitted with restrictions" still contains group of active ingredients no longer allowed in Europe; if these groups are still allowed outside Europe, than these rules must be followed:*	
9.3.2 Resistance management	Where the risk of resistance against a plant protection measure is known and where the level of pests, diseases or weeds requires repeated application of plant protection products in the crops, IP guidelines and IRAC / HRAC/ FRAC** have to provide clear recommendations or mandatory requests for an anti-resistance strategy to maintain the effectiveness of the products. ***:* • *IRAC = Insecticide resistance action committee* • *HRAC = Herbicide resistance action committee* • *FRAC = fungicide resistance action committee*	
9.4 Lists to be compiled as part of IP guidelines	IP guidelines must establish for each crop: 1. A restrictive list of key pests, diseases and weeds that are economically important and require regular control measures in the region / crop concerned. 2. A list of the most important known site-specific natural antagonist(s), with information on their importance in each crop. The protection and augmentation of at least 2 antagonists must be mentioned in advanced as a desirable objective sustainable production systems. 3. A list of preventive and highly selective direct control measures to be used in the IP program ("green list"). See explanations and examples in the IOBC-WPRS Tool Box. 4. A list of pesticides to be used with restrictions ("yellow list"): A selected group of plant protection products that do not qualify for the "green list" but should be available to the grower despite certain negative aspects, (especially for reasons of resistance management or earmarked for exceptionally difficult cases). These listed products are permitted only for precisely identified uses with clearly defined restrictions.	
9.5 Application and recording of pesticides	All pesticide applications must be registered with name, date, crop-pest / crop- disease combination, dosage and field identification where applied. Buffer zones of adequate size between treated crop areas and sensitive off-crop areas, (surface water, springs, ecological infrastructures), must be observed, (see point 2.6). The official pre-harvest intervals to minimise pesticide residues must be followed and should, if possible, be extended. They must be recorded for all applications of crop protection product and evidence should be provided that they have been observed. In situations with continuous harvesting, systems must be in place in the field to ensure that safety rules are sufficiently followed (e.g. warning signals). Spraying during windy weather conditions when wind velocity is exceeding 5m/sec, is not allowed.	It is strongly recommended that the application of pesticides is limited to the smallest possible area (e.g. band spraying, spot treatments, field and site specific localized treatment). The use of best application techniques available to minimize drift and loss is highly recommended. Small untreated areas, (zero treatment or "spray windows"), should be maintained in each crop and in each major plot/field except for arthropod pests, diseases and weeds declared as "highly dangerous/ contagious" by national authorities or in cases with high infectious pests or diseases. Perennial crops: The use of methods to calculate the right dose of pesticides and spray volume to be applied as a function of the plant growth stage and canopy architecture - such as for instance the TRV (Tree Row Volume) or the LWA (Leaf Wall Area) methods – is highly recommended. Always explore this keeping in mind the specific properties of each pesticide-active ingredient. Reduced dosages (rates) are possible (especially in herbicides) if

		applied on the user's own risk (declined liability of companies) and if resistance management criteria (especially fungicides) do not impose the full dosage. The applied dose rate and water volume should be adapted to the area where the treatment is needed and its structure. In case of vertical crops such as pome fruit, the crop canopy area has to be considered, since it is recognized that the concentration dose expression - e.g. dose per hL or % - is no longer sufficient. To allow the three-dimensional nature of the crop to be considered, the dose rate (on the label) should to expressed in e.g. kg or L per ha of Leaf Wall Area (LWA) or in kg or L per m3 of Tree Row Volume (TRV). The grower should have sufficient technical knowledge or external technical support to calculate/determine the LWA or TRV of the orchard(s) he/she wants to spray. The used water volume should also be adapted to the canopy area (for a full cover spray a runoff water volume is recommended). The exact concentration of the product (l or kg per l water used for spraying) is of secondary importance, as long as the required product per unit leaf wall area is deposited by the water over the full canopy. In exceptional cases the concentration (product dose rate/water volume) can be of primary importance, e.g. for treatment of a product with physical action (which depends on the concentration) or a spot application in an "Attract & Kill" strategy.
9.6 Efficient and safe storage and handling of pesticides	The basic requirements of Good Agricultural Practice (GAP) with respect to storage (9.6.1), safe handling application and training (9.6.2) and disposal of surplus mix, obsolete pesticides and empty containers (9.6.3), must be fulfilled and outlined in IP guidelines.	
9.6.1 Storage	Pesticides must be stored in accordance to legal regulations, in a locked room and separated from other materials. Keys and access to the pesticide store must be limited to workers with formal training in the handling of pesticides. Pesticides must only be stored in their original package.	
9.6.2 Safe handling, application and training	There must be adequate facilities for measuring, mixing and filling the products. Adequate emergency facilities, such as running water, eyewash facilities, first aid box and emergency procedures, must be provided to deal with potential operator contamination. Operators must have appropriate protective clothing and equipment for all operations involving chemicals. All sprayer operators must have appropriate training and hold, where relevant, the appropriate certificate of competence.	
9.6.3 Disposal of surplus mix, obsolete pesticides and empty containers	Surplus mix or tank washings must either be sprayed onto a designated untreated part of the crop or disposed of by a registered waste contractor or applied in a biodegradation unit. The safe disposal of spare pesticides must be planned and recorded. They must only be disposed of through an approved chemical waste contractor. Empty pesticide containers must be rinsed with water three times and the rinse water returned to the spray tank. Empty containers must not be re-used but should be crushed or perforated to prevent re-use	Under normal circumstances surplus spray mix should not occur. However, if surplus should occur, disposal must comply with local regulations. Applications onto designated fallow land should demonstrate that this is legal practice and that there is no risk of surface water contamin
9.7 Spraying equipment (pesticides) and technique	The basic requirements of Good Agricultural Practice (GAP) with respect to the operation and maintenance of spray equipment must be fulfilled and outlined in IP guidelines. The equipment must be kept in a good state of repair. Adequate functioning of the equipment must be verified before each treatment. A thorough technical service of the equipment, (especially manometers and nozzles), should follow the national rules and obligations. Equipment must be verified every 4 year (3 years from 2021) or according to the national guidelines by a competent organisation for correct operation and calibration. The use of aircraft and helicopters is forbidden, except for situations where access to the plot is impossible because of exceptional weather conditions, or if plot topography allows no other way of spraying. Radial flow air assisted sprayers traditionally used for tree and bush fruit spraying are often inefficient and generate high levels of spray drift. Wherever possible spraying equipment and spraying conditions minimising the health risk of the operator and drift must be preferred and tractors must be fitted with a	The use of drift reduction techniques with the least drift and pesticide loss should be encouraged whilst maintaining efficacy. When new sprayers are purchased, transverse flow design, tunnel sprayers or sprayers allowing treatment of each side of the row should where possible be selected. Atomizers must be equipped with stop drop system on the nozzles. Spraying equipment and spraying conditions minimising the health risk of the operator and drift should be preferred.

	cab. The spray impact on the environment can be minimised by the proper calculation of the amount of product needed per ha.	
9.8 Pesticide residues	Legal requirements of pesticide residues must be fulfilled.	

—	Strict Rules	Recommendations
10. Harvest	*Harvest practices must fulfil the general requirements for product quality, food safety and traceability established by national or international standards. Selected must items see below.*	
10.1 Product quality	Fruit must be harvested at the correct time according to the cultivar and for the purpose intended. Only fruit of sound internal and external quality may be certified and labelled as meeting Integrated Fruit Production standards. Standards for internal quality based on sound scientific evidence must be defined in regional or national guidelines wherever possible. Where such quality standards are established, regional guidelines and standards must set out measures for checking the quality of fruit (including taste, firmness and internal condition if possible). A representative sample of fruit of each major variety (or cultivar group), from each orchard and from each store must be assessed for fruit quality before marketing.	The necessary measures to obtain optimum product quality at harvest should be defined for each crop taking into account actual national and international standards for external and internal quality.
10.2 Hygiene	All staff must be aware of the need to harvest, transport, store and pack produce with the utmost care having received basic training in personal hygiene requirements for handling of fresh produce. A documented and up-dated risk assessment e.g. HCCP covering hygiene aspects of the harvest process and of produce handling operations must be made and hygiene procedures implemented. With regard to other labour conditions ILO (international labour organisation) charts give guidance.	

—	Strict Rules	Recommendations
11. Post harvest management and storage	*Post-harvest handling and storage practices should fulfil the general requirements for product quality, food safety and traceability established by national or international standards.*	
11.1 Hygiene	See 10.2.	
11.2 Post-harvest washing	The water used for washing final produce must have potable quality and recycled water must be filtered. At adequate intervals a water analysis must been carried out by an accredited laboratory at the point of entry into the washing machinery. The levels of the parameters analysed must be within accepted WHO thresholds or must be accepted as safe for the food industry by the competent authorities.	
11.3 Post-harvest treatments	Treatments with pesticides and other chemical substances must, in general, not be applied to fresh produce for immediate consumption. If there is no alternative to ensure maintenance of good quality of produce destined for longer storage, a selected list of permitted treatments must be established and those eliminated that are in contradiction to the requirements of human health, sustainable production practices and consumers' expectations on natural and healthy food. The record of each treatment must include the justification for the application. Where effective non-chemical post-harvest treatments (e.g. physical treatments or approved biological control agents) are available, they must be used for the control of diseases and/or disorders. For scald the use of 1-MCP is permitted when justified by specific conditions and as long as there's no non-chemical or physical alternative.	

	IPM strategies should try to avoid pre harvest fungicides. If unavoidable, the alternative could be a postharvest fungicide treatment of fruit, in many cases more effective, taking into consideration the following aspects: • Fruit treated with fungicides for storage diseases control in pre-harvest may not be treated in post- harvest. • Postharvest fungicide treatment is only permitted on cultivars with a moderate to high susceptibility to storage diseases. • Only lots with a significant risk of storage diseases but which are otherwise suitable and intended for long-term storage (aver 2-3 months) may be treated with fungicide post-harvest. • Cultural methods to minimize the risk of postharvest diseases, including where appropriate mulching of the soil surface to minimize soil splash, removal of sources of inoculum from orchards, should be used. • Avoid harvest during or immediately after rain. • Avoid producing wounds during harvest and handling, ensure bins are clean and storage conditions are high quality on monitored. • The risk of storage diseases, based on diseases history, orchard factors and weather, must be determined and recorded for each orchard before harvest using scientifically sound and published methods. • The dose (or concentration) of fungicide must be adjusted so that adequate control is achieved with minimum fungicide residues on fruits. • A safe and legally acceptable method for disposal of excess fungicide solution must be used.	
11.4 Storage and/or further processing	Storage methods must be such as to maintain high internal and external fruit quality. Stores, controlled atmosphere and refrigeration equipment must be maintained to ensure maximum efficiency and must be regularly monitored to ensure correct operating conditions. Accurate records must be kept and made available for inspection. Product in store should be regularly monitored for external and internal condition and firmness.	

–	Strict Rules	Recommendations
12. Energy use, GHG emissions and waste management	*GHG emissions from agriculture need to be reduced, specifically Methane (CH4), Nitrous oxide (N2O). Emissions from agriculture constitute more than 50% of the EU emission of these gasses. Also the Carbon dioxide (CO2) emission needs to be lowered. Agriculture has also a unique opportunity to sequester Carbon in soils. All amounting to a lower carbon footprint of the farm and the produce. Methods to reduce the carbon footprint and to sequester carbon in soils (see chapter on soil cultivation etc.) and long term biomass like woods (> 50 years) should be included in IP methods.* *The evaluation of such emission should be based on LCA methods to calculate emissions from cradle to farmgate in terms of CO2 equivalent (farm or produce).*	
12.1 Energy use and renewable energy	IP guidelines have to specify efforts to reduce energy use.	Apply the techniques that reduce the direct energy consumption and indirect consumption through purchase of inputs and use wherever possible renewable energy (biodigestion, solar and wind energy, etc.) to substitute non-renewable sources of energy.
12.2 GHG emission reduction	IP guidelines have to specify efforts.	Effective and efficient mitigation methods to reduce GHG emission should be applied that do not reduce productivity (both in terms of quality and quantity). Specifically the following strategies should be evaluated and eventually adapted (see also the other chapters of these guidelines): • Agrochemical input reduction (pesticides and notably mineral fertilizers). • Soil management (directed on improving soil structure) minimal tillage. • Organic matter management, (crop residues, green manures, soil cultivation techniques, crop choice and rotation). • Best practice of organic manure processing (e.g. biodigestion) and management/distribution (e.g. very fast incorporation or injection in soil).

		• Mechanisation, reduce number of operations, fuel use, low energy consuming irrigation, etc. • Energy use in storage and processing.
12.3 Carbon sequestration	IP guidelines have to specify efforts.	Optimize organic matter input (including crop residue) and soil management in order to result in a positive organic matter balance and thus in sequestration of CO2. Possibilities are dependent on the actual organic matter status of the soil. Healthy crop residue (such as residue from pruning and foliage) should be left within the orchard or taken up in the farm nutrient cycle.
12.4 Waste management	IP guidelines have to specify efforts.	Each farm should keep a waste register and develop and implement its sorting and recycling (farm recycling) find alternatives for non degradable materials.

–	Strict Rules	Recommendations
13. Plant production on mixed farms	*Animal and crop production are interrelated components of mixed farms.*	
13.1 Agronomic aspects	For the production of annual and perennial fodder crops: see specifically the general rules of chapters on fertilization and crop protection. Animal density: A maximum livestock density of 2.0 Livestock Units (LU) /ha must be observed in order to avoid excessive amounts of manure that would offset balanced nutrient cycles (especially of P). Mandatory laws on stock density have to be followed.	
13.2 Animal welfare	Holding conditions for farm animals must satisfy at least national legal regulation. However, farms operating at higher quality levels need to consider ethical aspects, especially the welfare of the farm animals. All veterinary treatments should be recorded.	

–	Strict Rules	Recommendations
14. Worker's health, safety and welfare	Any organization that seeks endorsement of IOBC for their guidelines should be able to demonstrate that they follow basic international standards on workers safety, health and welfare. Appropriate standards are those outlined in the Declaration of the International Labour Organisation (www.ilo.org), an organisation of the United Nations.	