IOBC-WPRS IP Guidelines

Crop specific technical guidelines for integrated production of

Soft Fruits (Strawberry, Raspberry, Blackberry, Currants, Gooseberry, Blueberry, Elder, etc.)

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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 "Soft Fruits".

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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.
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 soft fruits are: (i) border areas and slopes of terraced plots rich in plant species, (ii) stone walls, (iii) provision of wildlife habitats; plant hosts of parasitoids and other natural enemies, (iv) headland attractants (flowering field margins) as reservoirs of pest antagonists, (v) correct management of field margins and surroundings to promote also native pollinators, availability of nesting sites, nectar and pollen sources, clean water, etc. IP guidelines must establish lists of plants to be avoided (e.g. sources of infestations of major diseases, viruses and pests and pernicious weeds).	Windbreaks are essential for the protection of raspberry, blackberry and blueberry plantations and should be planted on sites exposed to strong winds. Hedgerows should provide adequate screening to prevent pollution and contamination of fruit by exhaust fumes from busy roads. High diversity of their composition and structure should be the aim, using or encouraging native species where possible. IP guidelines should encourage the identification of species in the ecological infrastructures and stimulate the conservation of useful organisms.
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 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. For new soft fruit plantations, selection of site, cultivars, and planting system must be harmonised so that regular yields of quality fruit, and hence economic success, can be expected with	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. Neither strawberry nor cane fruit should be grown on sites infested with perennial weeds. If available, preliminary tests for soil-borne pathogens should be done. Sites contaminated with the soil-borne root rot pathogen *Verticillium dahliae* should be avoided for strawberry production. For blueberries and Rubus species, sites close to the forest

	the minimum use of agrochemicals and environmentally hazardous practices. For strawberry, and especially for raspberry production, a preference for sites where these crops have not been grown previously must be prioritised. Sites infested with the soil-borne root rot pathogen *Phytophthora* spp. must not be used.	should be excluded from production (or distance should be maximised) to avoid infection by *Armillaria* spp. and *Thielaviopsis basicola*.

—	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. Cane and bush fruit crops must not be replanted directly in the same field and an interval (e.g. 2 years) must be respected before replanting cane and bush fruits. The maximum life span of strawberry crops must not exceed three years to avoid poor fruit quality and pest or disease problems. Strawberry crops must be integrated into diverse crop rotations, preferably including cereals or peas or beans. Break crops that are host plants for *Verticillium* wilt, e.g. potatoes, tomatoes, eggplants or linseed, must be avoided. 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.	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. Sites with significant infestations of soil insects (e.g. *Melolontha*spp., *Otiorhynchus* spp.), plant-parasitic or virus-transmitting nematodes should be excluded from production. It is recommended that specific crops with nematode reducing potential such as *Tagetes* spp., Brassicaceae (*Raphanus sativus, Eruca sativa, Sinapis alba*) or *Sorghum* spp. are sown and/or incorporated to reduce nematode infestation prior to planting sensitive crops. It is recommended that specific crops with soil-borne insects reducing potential such as buckwheat (*Fagopyrum esculentum*) are grown as pre-planting crops and incorporated into the soil at bloom to reduce insect larvae infestation (e.g. *Melolontha* spp.) prior to planting sensitive crops. 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,* nematodes, etc). For strawberry, a crop rotation of two crops in three years followed by a three-year break is advised. In order to avoid the spread of pests and diseases, the spatial and temporal separation between successive soft fruit crops should be maximised.
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.	The application of green mulches can be used to reduce weeds, retain soil moisture, enhance soil biological processes and reduce soil compaction. Specific plants can be selected such as Alyssum to encourage and maintain populations of predatory insects such as Hoverflies and *Orius* spp. (taking into account the risk from thrips).
4.4 Any further sub-chapter, e.g. for protected crops		

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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	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

	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.	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. The additional aims of soil protection are to maintain plant species diversity in cane and bush fruit plantations, to minimise the use of herbicides without detriment to yield with minimum inputs of fertilisers and irrigation water. Overall, bare soil management of fruit plantations 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. Herbicides may only be used to supplement mechanical and physical weed control methods. They must not be used to achieve overall bare soil. 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 IP 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. To avoid a detrimental competition for moisture and nutrients, a weed free strip should be maintained in the rows of cane and bush fruit crops by mulching the soil surface or by mechanical cultivation. In strawberry crops, mulching the soil with straw and/or plastic is recommended to reduce fruit contamination, weed competition and infection by fungal diseases. Mulch type and its sanitary quality should be carefully selected since it could favour certain pest. Also humidity should be considered as it can benefit the presence of soil predators, acting against thrips, by maintaining an adequate microclimate or, alternatively, an excess could favour the activity of *Drosophila suzukii*). For elderberry production, it is recommended that, where possible, ground cover is allowed to develop in the weed free strip at times of year (e.g. the winter) when soil moisture is adequate. Alleyways should be of grass and/or herbs and of adequate width to easily accommodate tractor wheels and allowing easy access to collect fruits on the ground to avoid *D. suzukii*. Non-competitive grass/herb mixtures (including leguminous e.g. miniclover) are recommended. Graminaceous species supply pollen to phytoseiid mites and some aphid species providing "banker" aphids such as Rhopalosiphum spp. to attract and maintain natural enemies. 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 soil N. The use of selective broad-leaf weed herbicides in the alleyways should be avoided. Where possible, buffer zones immediately adjacent to soft fruit plantations should be partially mowed to avoid migration of phytophagous insects (e.g. thrips, leafhoppers and *Lygus*) to crops.
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. Solarisation (especially for southern Europe) or cover crops against nematodes, *Verticillium*, *Phytophthora* and others is recommended. However, it is important to consider that, in the long term, the disinfection of soil is not a sustainable approach for soil-borne disease management. There should be a preference to improve soil biodiversity instead of creating a sterile soil. The latter leaves soil vulnerable to pathogens and is not sustainable. Consideration should be given to the incorporation of fresh biofumigant plant material. Sowing or pre-planting biofumigant species is recommended. ASD (Anaerobic soil disinfestation) is recommended for protected crops. Pre-planting, disinfection with steam is an option that can be

considered particularly for protected crops, but not encouraged because of the amount of energy required.

–	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 chosen must offer good prospects for economic success with minimal use of agrochemicals. IP guidelines must set out a list of the relative susceptibilities of the commonly grown cultivars of soft fruits to all important pests and diseases when available. IP guidelines must state a list of cultivars with the following properties: i) Strawberry cultivars with resistance to *Verticillium* wilt and/or powdery mildew, ii) Raspberry cultivars less susceptible to *Phytophthora* spp. and/or virus-transmitting aphids, iii) Blackcurrant cultivars resistant to blackcurrant gall mite and/or reversion disease, iv) Blackcurrant and gooseberry cultivars resistant to powdery mildew.	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. A preference for cultivars resistant or tolerant to fungi, pests, viruses and/or phytoplasmas should be incorporated.
6.2 Seed and plant quality and health status	**Annual crops:** 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. Healthy planting material strongly contributes to prevention of, for instance, problems with *Phytophthora* spp., *Verticillium, Xanthomonas, Colletotrichum,* virus diseases, tarsonemid mites, aphids or free-living nematodes. If growers propagate their own planting material, they must test the health status of the material in accordance with regulation (growing and propagation material has to be separated).	**Annual crops:** 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. Additional testing of the health status of planting material must be recommended. If possible, start biocontrol at propagation level, at least for soil borne diseases. The treatments/products used during the nursery stage could affect the initial settlement of biological control agents during the production stage and effect pesticide resistance development.
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 find a balance between growth and yield (penetration of radiation). The use of plant growth regulators is not permitted. Planting systems must allow safer, more efficient spraying practices to be adopted (even distribution of pesticide on and in the canopy), that minimise spray drift. Planting distances must 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 diseases.	Adapt a cropping system that minimises the need for pesticide input, for example the plant density, cultivation system to the cultivar, soil and climate. Excessive growth should be controlled by cultural measures, incorporating precision fertiliser and irrigation supply, pruning and encouraging an optimal fruit set. Pruning can also be a preventive method against pests and diseases. The flowers of soft fruits are usually self-fertile. However, entomophilous pollination increases fruit set, fruit quality and production. Where native pollinators are insufficient, local honeybees and/or native bumble bees should be introduced to ensure adequate pollination. Ridge cultivation lowers the risk of infection with root rots and should be preferred in strawberries as well as in raspberries, especially on heavy soils. Soft fruit plantations protected under polythene clad tunnels mitigate some pest and disease problems.

		Protecting soft fruit crops with tunnels can create a microclimate suitable to other pests and diseases (e.g. *Tetranychus urticae, Botrytis cinerea*, powdery mildew).

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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.
		The use of biofertilisers (microbial-based, such as mycorrhizal fungi and plant growth promoting rhizobacteria - PGPR) are recommended. Consortia (mixtures) of microorganisms are
		
		preferred instead of single species/categories due to higher rate of colonization and efficacy. Application rates of mineral fertilizers should be reduced to 50-70% of normal doses when applying biofertilisers.

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 (i.e. beginning of spring, end of spring, beginning of summer) is recommended (amount to be based on soil sample analysis). Use of organic liquid fertilizers (e.g. coal, plant or animal derived products) is encouraged to further reduce the soil application of N.
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.	The replacement of mineral P-input through enhancement of the activity of soil organisms (e.g. mycorrhiza) should be encouraged.

	Where foliar symptoms or plant analysis indicate a deficiency of micronutrients the application of these elements is justified. These elements must be administered via the root system or leaf according to the nutrient (for instance calcium through the leaf).	
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. 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 or trickle irrigation (and fertigation) is preferred.
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. Irrigation (system type and water quantity) should be well adapted to the needs of the plant, since water stress (both excess and deficiency) could increase infections of some diseases such as *Armillaria* root rot if excessive or enhance the

development of *Tetranychus* spp. if the environment is too dry.

—	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. *Drosophila suzukii* (spotted-wing drosophila): Sanitation practices (in particular unmarketable and waste fruit removal and destruction during and post-harvest) are necessary to reduce the use of insecticides.	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. • Choice of appropriate resistant/tolerant cultivars; • Removal of sources of infestation or infection (such as leaves, canes, dead plants, weeds, fruits) should be applied as far as practically possible. • Achieving early installation of predatory mites and insects by using supplementary feed such as pollen, *Ephestia* spp. eggs, etc. • Manage the humidity to avoid the effects of dry climate, which can exacerbate spider mite attacks. • *Drosophila suzukii* (spotted-wing drosophila): In order to minimize damage, preferably select cultivars that ripen before population buildup. Early harvest and/or increasing the harvest frequency reduce the exposure of fruits to the pest. Avoid water stagnation in and around the fields, keep the grass mowed under the plants, black plastic mulch can create a hot/dry microclimate, unsuitable for *D. suzukii*development. Use pruning and canopy management in order to limit humid shaded areas in the foliage and facilitate the exposure of most of the fruits to sunlight. • The use of insect-proof nets around the perimeter of crops could be considered, with an awareness of the effects on immigration natural enemies and pollinators.
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. Regionally adapted Decision Support Systems (DSS) for pests, diseases and weeds help to justify control and to optimize the timing. Monitoring by observation or pheromone trapping (follow individual recommendations per trap type).	Empirical threshold values should be replaced by more scientifically sound approaches, like DSS, and expert systems. In berries, most of pests and diseases have a rapid lifecycle (spider mites, thrips, aphids), hence frequent monitoring of the crop is very important. This consists of, at least weekly, checking of the crop for possible pest and diseases on plants, on colored traps with or without pheromones, lure trapping, and training of crop workers to identify and report problems. Recording these data helps, over time, to define economic thresholds. In addition to monitoring traps it is very important to check the fruits regularly as they begin to ripen. Monitoring should continue right up until harvest and beyond. Monitoring of natural enemies should be done alongside pests to enable informed decisions on control measures needed.
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. In protected crops, insect-proof nets against pests are recommended, especially when the pressure is high (e.g. *Drosophila suzukii*). In open field crops, predators (e.g. *Chrysoperla*) and parasitoids against aphids are recommended although efficacy could vary. The application of predators and parasites should focus on all life stages of pests, for example thrips can be targeted on leaves and in the soil. Consider the use of *Trichopria* in the margins of crops for *Drosophila suzukii* control, early season.

	technique. Control method to be used if available, permitted and effective, e.g. • Biopesticides (e.g. *Bacillus thuringiensis, Beauvaria bassiana*). • Semiochemicals (e.g. Pheromone mating disruption) • Botanicals (e.g. plant extract) • Entomopathogenic nematodes (e.g. *Steinernema* spp., *Heterorhabditis* spp.) and fungi (e.g. *Beauveria* spp., *Metarhizium anisopliae*) for soil-borne pests (e.g. vine weevil, slugs, *Melolontha* spp. and others) • Antagonistic / mycoparasitic fungi such as entomopathogenic fungi (*Metarhizium anisopliae*) for some typical pests of protected crops (e.g. *Tetranychus urticae, Trialeurodes vaporariorum* and thrips), • *Trichoderma* spp. for root rots or *Gliocladium catenulatum*for *Botrytis* spp. Control. • Predatory mites against phytophagous mites, e.g. Phytoseiidae. • Predatory mites and predatory insects such as *Orius* spp., against thrips. • Predators (*Chrysoperla, Aphidoletes*, hoverflies) and parasitoids against aphids for protected crops. • Coleopterans, such as *Atheta coriaria* (efficient in protected crop), for insects' stages in the soil.	
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 certain pesticides and pesticide groups is established and may require updating with the development of new products. **Not Permitted*** • Plant growth regulators. • Organochlorine pesticides. • Persistent (DT50 > three months), toxic or ground-water polluting residual herbicides including triazines. • Diquat, Paraquat	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. • The occurrence of pesticide residues on fruits at harvest should be further minimised by maximising safe-to-harvest intervals. • Spray applications should be localised to parts of plantations where damaging infestation is present. • Adoption of anti-resistance strategies for the at-risk pesticides is strongly recommended. **Additional requirements for integrated plant protection on strawberry** • Entomopathogenic nematodes and fungi, where available, should be used to control vine weevil and other soil pests on protected crops. • *Botrytis cinerea* infections on strawberry and other soft fruits can be prevented with an early covering of tunnels and /or the regular use of the antagonistic fungus *Gliocladium*. • *Orius* spp. or suitable predatory mirids should be used to control western flower thrips on protected crops. • *Drosophila suzukii* (spotted-wing drosophila) selective insecticides must be used where necessary. Note: At the time of the definition of the present guideline, *D. suzukii* is a new pest in Europe and integrated control strategies (such as insect-proof net or biological control, high temperatures at the end of the crop under tunnels as a sanitation measure) are still to be defined. For these reasons, a specific exception is admitted for non-selective insecticide use (see 9.3.1). **Additional requirements for integrated plant protection on cane fruits** • To prevent and control the development of cane diseases the following cultural methods should be applied i) early removal of infected and superfluous fruiting canes, ii) removal of fruiting canes immediately after harvest, iii) reduction of nitrogen fertilisers rates, iv) drip irrigation should be used in preference to sprinkler and micro-sprinkler systems. • Injurious mirids including *Lygus rugulipennis* and *Lygocoris pabulinus* should also be monitored using pheromone traps.

- Diquat, Paraquat.
- Persistent or phytoseiid mite toxic OP insecticides.
- Pyrethroid insecticides and pyrethroid acaricides. (1)

Permitted with Restrictions

- Non-persistent (DT50 < three months), non-toxic, non-ground water polluting residual herbicides (maximum of one dose-equivalent/annum).
- Benzimidazole fungicides (maximum of one application/year, except on raspberry a maximum of two 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 three applications per group/year alternating different active ingredients.
- Acaricides for control of spider mite (maximum of 1 application per pesticide resistance group /year).
- OP insecticides of short persistence and low toxicity to phytoseiid predatory mites (maximum of 2 applications/year).

*The list of "Not permitted" and "permitted with restrictions" still contains groups of active ingredients no longer allowed in European union; if these groups are still allowed outside Europe than these rules must be followed.

Note (1) as a short-term measure, whilst research is undertaken to identify more selective control methods synthetic pyrethroid insecticides may be used in the following circumstances:

- Maximum of one application/year in emergencies, if no alternatives are available. In case of demonstrated damages provoked by Drosophila suzukii, and under same conditions as above, a maximum of two applications/year is permitted as a specific short-term measure.
- IP programmes, which permit the use of pyrethroids, must have an active research effort to identify alternatives that are more favourable.

Additional requirements for integrated plant protection on 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.
- Where application of a harmful pesticide cannot be avoided, effects may be alleviated by downward-directed spraying to reduce deposits on the undersides of leaves where the predatory mites occur mainly and/or making additional releases after the application has been deemed non-toxic.
- The 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.).

Additional requirements for integrated plant protection on cane fruits

- Predatory mites must be conserved in field crops and *Phytoseiulus persimilis*, or another suitable species, used for biological control in protected crops.
- *Byturus tomentosus* must be monitored regularly by using white sticky traps or with non-sticky bucket traps enhanced with attractant lures including eventual use for mass trapping.
- The raspberry clearwing moth, *Pennisetia hylaeiformis* and in blackberry, *Synanthedon vespiformis* must be monitored with pheromone traps. Infested shoots must be pruned and removed from the plantation.

Additional requirements for integrated plant protection of bush fruits

- The currant clearwing moth, *Synanthedon tipuliformis*, must be monitored with pheromone traps. Infested shoots must be pruned and removed from the plantation.
- Blackcurrant crops must be closely inspected for blackcurrant gall mite galls during the dormant period when they are easily visible and all infested plant material

Additional requirements for integrated plant protection of bush fruits

- Branches and stems infected with canker and wood diseases should also be removed and the pruning wounds protected protected with an appropriate product.
- 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.
- In blueberry production, organic mulch with bark, wood chips or sawdust is commonly used. Take into account that it can be a dangerous inoculum source of root rot pathogens, *Armillaria* spp. in particular.

	When they are easily visible and all infected plant material must be removed from the plantation and destroyed. Crops must also be inspected for symptoms of reversion disease immediately before flowering and all infected bushes must be grubbed and destroyed.	
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. Application of pesticides toxic to pollinators is prohibited during the flowering period to avoid sublethal effects and mortality of pollinators.	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.
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	

	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 cab. The spray impact on the environment can be minimised by the proper calculation of the amount of product needed per ha.	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 designs or tunnel sprayers should be selected where possible. Sprayers should be properly and regularly calibrated with and hold the relevant certification. Spray efficacy and deposit should be monitored and nozzle direction adjusted to avoid spray drift.
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.	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. For strawberries and cane fruits, picking should be done early in the day while fruit is cool. Fruit should be transferred promptly to cold stores. Pre-refrigeration could reduce post-harvest diseases.
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.	
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. Post-harvest chemical treatments of fruit are not permitted.	

—	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. Crop residues (such as residue from pruning and foliage) should be used and taken up in the farm nutrient cycle: such residues should be properly decomposed/managed before use to prevent pest and pathogen propagation.
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.	