# catalogue of **innovations**

in the field of the organic
olive oil production chain

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# CONTENTS




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"Catalogue on innovations in the field of the organic olive oil production chain".

# 1. Report Framework and Layout

## *General framework:*

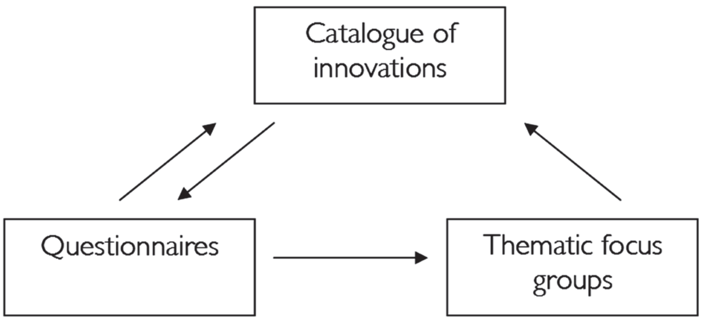
The catalogue focuses on innovations that have a direct or indirect effect on the environmental impact of the organic olive oil production chain.

The catalogue is based on:

1. census & study of research results in the field of the organic olive oil production chain
2. an analysis of the sector problems and innovation needs.

*The census is carried out by organizing a questionnaire-based survey* addressed to individuals directly related to the organic olive oil production chain. It involves the scientific institutions of four countries (Italy, Spain, Greece, Malta).

*Transnational thematic focus groups* analyzed the survey results, directly contributed information and identified research needs in compliance with the Technical Guidelines of the quality manuals (agronomic management; low impact processing; packaging).




*Schematic Information Flow Chart*

## *Specific Categories:*

Innovations cover all the aspects of the olive oil production chain and are presented as entries that may fall into the following six Categories:

### I. Cultivation

1a. Soil (management and cultivation techniques)
1b. Plant (varieties, rootstocks, grafting, pruning)
1c. Allelopathy
1d. Environmental management

## 2. Inputs

2a. Fertilization, Nutrients
2b. Plant protection

## 3. Production of olive oil

3a. Collection, transport and storage of olives (prior to extraction)
3b. Processing and extraction of olive-oil

## 4. Wastes and by-products of the organic olive oil production chain

4a Plant leaves and pruning material
4b Olive mill wastewaters
4c Olive mill pulps

## 5. Packaging, labeling and selling Olive Oil

5a. Packaging
5b. Labeling/certification
5c. Trade/promotion

## 6. Other

6a Innovations that do not fall into the above categories
6b Integrated approaches/applications that fall into more than one of the above categories

# *Layout*

Each innovation entry includes the following information (when applicable):

- *Short Description*
- *Target*
- *Cost*
- *Efficiency*
- *Reliability*
- *Application conditions/range*
- *Environmental Impact*
- *Remarks*

# 2. Framework of policies and CAP priorities

A thorough account of environment and sustainability oriented policies of the EU in the olive oil sector has been recently presented (Camasara et al., 2010). The organic olive oil production chain appears to have become "a peak of the iceberg", i.e. a pioneering paradigm, for the implementation and convergence of the majority of these policies under a common denominator.

Moreover, the majority of innovations pioneered within/for the organic olive oil production chain may, and are increasingly becoming, adopted by the conventional olive oil production chain, especially regarding cultivation, inputs related to plant/ecosystem protection and trade/promotion of specialized high quality products.

Questionnaire development and Thematic groups have focused to innovations directly related to this framework of policies.

Olive growing (either conventional or organic) has become more intensive over the last three decades. It is expanding to marginal land and is using an increasing amount of total agricultural land. Moreover, it is using more water (for irrigation) and, despite significant swift to two-phase centrifugation units, it is still using considerable quantities of water for olive processing.

Wastes from the olive oil production agro-industry pose a significant environmental issue. They include olive mill wastewaters produced by three-phase mills and olive waste sludge (alperujo) produced by two phase mills.

Contrary to the problems related to water consumption and waste production, (which show little divergence between conventional and organic production), the organic olive oil production chain has a lower impact as regards to soil erosion, desertification, pollution due chemicals and fertilizers (minimal), and effects on wildelife/vegetation biodiversity.

In the end of the last century, the CAP contributed directly to the expansion of the olive cultivation/production chain, (but also set a framework that led to the expansion of organic olive production). Subsidies directly coupled to the level of production were the main reason for this CAP effect.

In 2003 the reformed CAP led to the following replacement of payments to olive farmers by introducing:

- *The Single Farm Payment:* Olive producers receive a flat payment calculated on the basis of the average amount they received in production-related subsidies from 1999-2003.
- *The Olive Grove Payment:* A maximum 40% of the subsidy could remain linked to olive production but this intended to ensure that olive farming is done in a socially and environmentally sustainable way.

At the same time measures backed by Member States should focus on: Maintenance and restoration of terraces and stone walls, maintenance and restoration of wildlife habitats and landscape features, maintenance of permanent grass, reduction of soil vulnerability by increasing organic matter content, and creation of earthworks to reduce run-off on steep slopes. The aim of this approach was to ensure olive tree maintenance and avoid the degradation of land cover and landscape. Only Spain applied this measure from 2005 to 2010. The olive grove payment has been repealed as from 2010 as part of the "Health Check" CAP Reform in late 2008.

The CAP reform in 2003 also introduced the obligatory '*cross-compliance principle*'. Under this principle all CAP payments received by the farmer are linked to the meeting of certain minimum requirements and standards relating to the environment and animal welfare, as well as maintaining the land in good agricultural and environmental condition.

The EU's key biodiversity policy instruments are the Birds Directive (79/409/EEC) and the Habitats Directive (92/43/EEC). The Habitats Directive established the Natura 2000 network, which consists of the Special Protection Areas (SPAs) designated under the Birds Directive and the Special Areas of Conservation (SACs) designated under the Habitats Directive.

Member States are required to designate these areas, and local authorities responsible for the sites must set up environmental management plans and carry out restoration so that the sites achieve 'favourable conservation status'. In these areas, agriculture is allowed and considered complementary to environmental protection. **Agriculture and conservation must work side-by-side.** Since in these widespread areas low impact and environmentally- friendly farming practices and production systems are required, the organic olive oil production chain becomes favourable and advantageous.

Inevitably, there is a growing trend for organic plantations. Organic farming accounts for a relatively small but increasing share of EU cultivation. In Italy, already around

16% of olive-growing areas have been certified as being organic. In other countries, however, like Greece percentages are lower (4-5%) but expansion potential is huge. In all the Mediterranean countries of the EU olive farming consist by far the greater organic share of land under organic farming activity, often exceeding 50 %. The new organic farming regulation (834/2007 ) is expected to increase this tendency.

However, production costs, especially those related to plant protection, fertility management and marketing are high, subsidies are expected to decline and therefore innovations at both the farm/production level and the trade/marketing level are essential in order to make the organic olive oil production chain economically viable and even more compliable with the environmental/sustainability strategic priorities of the EU.

It should be mentioned that the IFOAM EU Group is still the only EU level network on organic farming policy but has a limited influence in general farming policy (Moschitz and Stolze, 2007). Environmental and consumer groups are not highly involved in organic farming policy, and general farmers' union, at the EU is not particularly active into supporting organic farming. Organic olive oil production is probably the largest organic production activity regarding farm size, number of farmers involved and single product economic value in the Mediterranean basin, however local olive farmer organizations are not integrated into networks influencing policy at the EU level.

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# 3. Rationale and applicability of innovations

## I. Criteria

General rating criteria include applicability under a wide range of socioeconomic and productive environments, short and long-term costs and investment, reliability, reproducibility of results, sensitivity to external factors (environmental conditions, market), dependence on local sources/ technology industry/labour availability. Specific emphasis is given to the environmental impact related to the introduction of innovations.

## 2. Development costs of innovations

"Blanket" applications are not the hallmark of organic production chains, and this applies well into the organic olive oil case. On the contrary, their characteristics include working hand-in-hand with ecological balances, adaptation to local conditions and diversification at all levels (agro-ecosystem, production-system, promotion and trade). Therefore the philosophy of centralized and uniform market chains and the production of inputs applicable under a wide variety of conditions is, with certain notable exceptions, not suitable to the organic olive oil production chains. This poses a difficulty regarding investment costs for developing and evaluating innovations for the agro technological and biotechnological industry. Such difficulties are less pronounced regarding marketing and trading since innovation costs are usually lower in these sectors (with the exception of investment costs in applying transportation, storage innovations).

## 3. Variability of Organic Olive Production Systems

According to general plantation characteristics and farming practices three broad types of conventional plantations are identified:

(1) *Traditional plantations* characterized by low chemical inputs high labour input, low tree density (usually not exceeding 200 trees/h) scattered old trees and use of terraces in sloppy areas.

(2) *Modernized traditional plantations* which blend traditional practices with higher inputs that may include agrochemicals, tillage, weed control, irrigation, higher plantation dencity and even mechanized harvesting.

(3) *High-input intensive modern plantations* of usually smaller tree varieties planted at high densities, characterized by the application of irrigation, and mechanized harvesting. Use of agrochemicals is high but often follows integrated management system practices. Plantation of small, bush-like pruned trees in dense rows that are mechanically cultivaterd and harvested is becoming increasingly common, however some controversy exists regarding long term sustainability.

Transition from conventional to organic is mainly carried out for the first two types i.e. *traditional* and *modernized traditional* plantations. Still, however, this is carried out under a wide variety of environmental, socioeconomic and production conditions.

## 4. Organic plantations as model systems for developing, applying and evaluating innovations

*It appears that organic olive tree plantations either in the form of monocultures or in the form of integrated farms including olive tree groves are increasingly becoming model systems for developing, applying and evaluating innovations that may have far more general applicability.*

*There are three main reasons that lead to this trend:*

(1) Organic olive-oil production is closer to the paradigm of sustainable low environmental impact agricultural/agroindustrial activity in the agrofood sector.Agricultural biotechnology and chemical industry are shifting R&D towards this paradigm

(2) Intensified, high agrochemical input plantations may be functional and advantageous for testing specific environmental problems related to high, localized or long term use of agrochemicals (as for example nitrate pollution, soil salinization, accelerated pesticide degradation). However, organic farms offer agricultural ecosystems that are diversified at multiple levels (plants, animals, microorganisms, insects, landscapes).These are functionally based on ecological balances and therefore more suitable for evaluating novel "subtle rather than harsh" technology that is taking advantage rather than disrupting such balances.

(3) Organic olive oil production is more compatible with the trend towards Internet based trade and promotion (including e-commerce), development of speciality products and the development of niche markets

# 4. Innovations showing applicability potential and/or compatibility with environmental protection

## 1. Spinosins

Spinosins are macrolide substances (polyketide-derived tetracyclic macrolides appended with two saccharides) isolated from the actinomycete *Saccharopolyspora spinosa*. A semisynthetic second-generation derivative, spinetoram has also been developed recently. "Spinosad" is the commercially available product is a defined combination of two principal non-synthetic fermentation factors, spinosyns A and D. It is used in olive tree cultivation, manly for the control of *Bactrocera oleae*.

Spinosad has a potentially wide application range including many commercially significant insects and a relatively good safety record (Racke, 2007). It must be ingested by the insect to induce a rapid excitation of the insect nervous system, therefore it has little effect on non-target predatory insects. This property makes it particularly appropriate for organic and integrated pest management programmes.

Dissipation is achieved by photolysis (mainly) and degradation.

Substantial work carried out on risk assessment and environmental fate shows good records (Racke, 2007). However, toxicity to aquatic fish and invertebrates has been reported.

Indications of resistance following long-term use, have been reported, especially in the USA; recent indications form Crete, Cyprus, calling for close monitoring have been reported (Kakani et al., 2010).

In the last years the use of spinosins is rising in Mediterranean organic olive farming, used as "spraying bait", but even by aerial application (Spain). Results are consistent and encouraging but cost is rather high.

## 2. *Psyttalia concolor*

*Psyttalia concolor* is a parsitooid of *Bactrocera oleae*. Several species of *Psyttalia* sp. from different countries have shown potential as control agents, but further research needed for selection/optimization (Daane and Johnson 2010). *P. concolor* use has been recently suggested as a potentially useful alternative to control costal populations of *B. oleae* in California, but droughts were expressed for its use for classical biological control (Yokoyama et al., 2008). It is easily mass-reared on the Mediterranean fruit fly (*Ceratitis capitata*). However, there is need for proper timing of parasitoid release depending on pest population dynamics and environmental factors. Application methodology standards have not been developed.

*P. concolor* is more efficient for small drupe varieties (it is a short ovipositor parasitoid of olive fruit fly). Therefore modified irrigation to minimize fruit size may increase efficiency, but could also affect plant growth/productivity.

Its use is limited at the moment and results are rather inconsistent. It is not working well in Spain, although trials for its introduction are carried out for over 20 years. It appears that *Psyttalia* is not surviving the low temperatures of winter, although some experts assume that there are other ecological factors that limit their acclimation. Results in the Zakynthos-Greece experimental trial were also inconclusive.

## 3. In-farm small scale olive mills

The respective technology is becoming increasingly improved and affordable and is of particular interest for organic olive oil production since: It may improve quality control, and conserve/ safeguard speciality characteristics. It presents a marketing/promotion advantage. It is compatible with agro-touristic activities

It minimizes olive drupe transportation and storage time. It shows great potential for in-farm processing and recycling of wastes.

However the technology is applicable by large scale farms or adjacent producer farms, since considerable capital investment is still needed and the technology may not be applied by small-hold farmers alone.

## 4. Kaolin

A kaolin (1:1 silicate clay) based particle film formulation is used to cover the plant leaf area and control *Bactrocera oleae*. Appears also effective for *Pray oleae*, *Saissetia oleae*, *Rhynchites cribripennis* and other common olive pests. Demands good application practice and favourable rain patterns. May cause slight maturation delay. Might reduce photosynthesis if non-properly applied. Does not affect fruit quality. Aesthetic issues may be raised in touristic regions.

Results and experience on the effectiveness of kaolin formulations are rather inconsistent. For example certain promising results have been reported from Calabria, Italy (Perri et al., 2005) and Greece (Antonakou et al., 2005) but in Spain its use has not expanded since it's effectively against *Bactrocera oleae* is not high. In Greece its use is growing, especially for early control and mild infestations and when other insect pests are also present

## 5. *Sorghum bicolor* combined with corn gluten meal :

Both treatments may aid weed control (Duke et al., 2002) Allelopathic effects of *S. bicolor* grown as a cove crop is reported to aid weed control. Two application methods are proposed: (a) soil incorporation of stalks and residues of *S. bicolor* following cultivation, or (b) "pre-emergance/ emergence" spraying with water extract from dried and ground biomass.

There is limited experience of both application methods regarding effectiveness for weed control in olive orchards. However *S. bicolor* is among the most widely green manure crops grown between olive trees when legumes as *Vicia faba* are not selected.

Other effects and compatibility with olive tree cultivation include:

- Stalk incorporation is beneficial regarding C sequestration in soil. Serves as a green manure as well however, early incorporation or N source addition are needed to avoid soil-N immobilization in the olive tree vegetative period (early spring).
- Drought tolerance of *S.bicolor* complies with environmental conditions in many Mediterranean olive cultivation areas, however its use is still limited by water demand, in irrigated orchards only, and results appear often poor and inconsistent.
- *S. bicolor*may be combined with the application of *corn gluten meal*. This was developed 20 years ago in the USA as a pre-emergence treatment to aid control of dicot weeds. The weed seeds actually do germinate, but the corn gluten meal inhibits the expansion of the plants' roots and they quickly die of dehydration.

There is generally limited experience of this combined treatment in olive orchards. Although weed control is rarely a first priority problem in organic olive tree groves, the compatibility of the above measures with environmental protection, carbon sequestration, fertility and soil erosion management is appealing.

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# 5. Research hotspots for innovation development

A list of issues on which innovation development is of prime importance are presented below:

1. *Verticillium* wilt: Soil borne pathogen eventually leading to plant death. It is difficult to manage even in conventional systems. Affected areas are constantly expanding. Single control measures are mostly ineffective. An integrated disease management strategy that fits modern sustainable agriculture criteria must be implemented. Avoiding propagation *via* tools and plant material and maintenance of physical barriers may slow down the expansion of the disease. Direct effects of biofumigation with fresh biomass of supressive plants (Brasicaceae) and soil solarisation may also slow down disease expansion, but may not work at deep rhizosphere-soil layers and are rather costly. In cotton producing regions (eg. Thessaly Greece) the establishment of olive tree orchards in place of cotton fields affected by *Verticillium* should be prohibited. Techniques exercised in Organic farming like "balanced" plant nutrition, and activation/increase of soil life appear to promote both microbial competition in the rhizosphere and plant defence. Specific mycorrhizal inoculation appears also to be beneficial, but experimental results are yet inconclusive.

The use of chopped plant pruning material for soil mulching/incorporation, which is promoted in organic farming systems, should be viewed with caution in *Verticillium* wilt affected areas. Specific research is needed to asses the role of these techniques in spreading the disease as opposed to composting/co-composting or even removing of olive tree prunings.

2. Waste disposal: Regarding waste disposal three main points arise, depending on local production conditions:

(a) Technology for composting two phase olive mill centrifugation waste (alperujo) should be advanced. Co-composting with other materials to improve porosity during composting and final product quality should be evaluated and standardized. Blends of this material appear also to be promising substrate for the cultivation of oyster mushrooms (*Pleurotus* sp.) mushrooms. Valorization of alperujo derived from organic olive oil production for the production of the organic production of oyster mushrooms appears feasible.

(b) Innovations regarding uniform spreading of olive mill wastewaters derived from three phase olive mill centrifugation systems in the field are urgently needed. Systems may be mechanized or based on modified irrigation systems. Environmental imbalances caused by land spreading are rarely reported and only in extreme cases (as opposed to problems from application to water ecosystems). Scientific literature appears to from various Mediterranean countries appears to confirm safe land disposal as long as specific protocols are followed. Land spreading based on optimized protocols taking under account local soil and climatic conditions should be developed. GIS platforms appear suitable for their implementation. Aerobic pretreatment may be compatible with land spreading of olive mill wastewaters, but does not appear necessary in several soil/climate cases. Specific research is needed for the disposal of wastewater derived form secondary centrifugation of two phase waste (repasso) in similar ways.

(c) Innovations for temporarily stabilizing wastewaters under storage are also needed. Interesting results were shown, for example from the Working Group in Andalucía (CAPA), promoted by the Regional agriculture minister, or from applied research results of the Agricultural University of Athens, the Technical University of Athens and the University of Bari. These are shown to farmers in demonstration seminars and pilot plants. However, more dissemination is needed, combined with integrated measures that facilitate implementation (for example farmer access to respective machinery, but also strict application of legal frameworks regarding waste management). Questionnaire results confirm this approach.

3. Compatibility of relatively new cultivation techniques (including for example the super-high density system of planting olive trees developed in Spain or subsurface irrigation systems ) with organic farming should be evaluated under the specific needs and profile of the organic olive oil production chain (minimal environmental impact, compliance with ecological balances, protection and sustainability of agroecosystems).

4. Critical Ecosystem Biodiversity indexes: Indexes of biodiversity and Ecosystem health developed specifically for olive grove ecosystems would serve both as an assessment tool for certification agents and as a marketing tool promoting the "green" nature of organic olive oil production chain. Use of arthropods and certain insects (recent work on cocinelideae appears promising) could serve for the development of such indexes

5. Reliability of certification system. As organic olive oil gets a greater share in the market consumers are increasingly worried about the performance and reliability of the certification system. A demand was expressed for a less bureaucratic and more in-farm/post-harvest analyis based system (including in farm presence of certification agents and robust post harvest chemical/microbiological testing). The issue of a strict authorization and accountability framework for certification agents was also raised. Consumers also raised the issue of lack of information regarding previous history of the farm and surrounding activities.

6. Innovation regarding common marketing priorities, trade policies and infrastructure and joint promotion strategies will accelerate the expansion and "maturation" of the organic olive oil market. "Green" marketing policies should go beyond organoleptic properties of organic olive oil compared to conventional products. In parallel to the notion of "gourment" that addresses various senses and levels of appreciation, rural community structures, landscape/farming scenery and ecological balances should be directly linked to organic olive oil products.

# 6. Strategic targets for research and policies related to the development of innovations

## Sustainable use of pesticides policy should apply to biopesticides:

The Thematic Strategy on the sustainable use of pesticides was adopted in 2006 by the European Commission (COM (2006) 327), in order to complement existing EU pesticide rules. Two relevant legal acts were published in late 2009 by the EU Parliament and the EU Council [*], following their agreement in 2008.

The main elements of the legislation, are: a). a change in the way pesticide substances are evaluated; the creation of three EU mutual-recognition zones so that pesticides authorized by one country would be automatically considered authorized by other countries within the same zone (though individual countries would retain the right to impose national bans on particular substances); and b). introduction of rules on pesticide use, such as a general ban on aerial spraying and prohibition of pesticide use in certain places, such as near schools or in buffer zones along rivers and other water bodies.

Biopesticides are considered "natural products" and there is an approach from the general public (but also from a part of the scientific community) that they should not necessarily pass through all evaluation stages. Moreover several "natural products" with pesticide properties are marketed as soil or plant growth/vigor improvers, but used by farmers for their pesticide properties. Cases of unofficial promotion of these properties were reported by farmers in the thematic/focus groups. Adaptation and application of the legislation for synthetic pesticides to biopesticides is a crucial innovation that should be implemented regarding the reduction of potential environmental impact of the "organic production chain". For example, the toxicity of rotenone does not justify its excessive use in the past, and recent data suggest than "natural" products may have a significant impact on soil microbial biodiversity. It appears that rules regarding recognition zones, placing biopesticides in the market, and on biopesticide use should be updated and not significantly differentiated from what applies to synthetic products.

## Precautions regarding introduction of biological agent innovations to novel ecosystems

"Innovations (and know-how") developed under specific needs and environmental constrains should not be applied in different cultivation areas without prior adaptation/experimentation. (Underlying question: Is the Mediterranean organic olive oil production chain uniform enough in terms of environmental conditions, ecosystems, availability of resources, tradition, enterprise management and marketing policies).

Microbial inocula of mycorhizal fungi, of nitrogen-fixing bacteria or of the vaguely specified "plant growth promoting bacteria" are now available in the market. It issue also applies to biopesticides based on insect/microbial agent release. These agents have been isolated from specific areas and environmental conditions. Should their application be promoted in other areas without prior experimentation testing their effectiveness and ecosystem impact under local conditions? Examples of competition with efficient local strains have been reported for arbuscular mycorrhizal fungi. Are there significant risks involved in the application of non-

* *Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides – Regulation (EC) No 11 07/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/11 7/EEC and 91/414/EEC.*

indigenous microbial soil inocula as far as disturbance of local microbial communities and competitiveness with local species are concerned? Is local microbial biodiversity at risk?

Pruning/cultivation techniques, tree varieties, fertilizers and harvest methods do not pose a direct threat to functional ecosystem balances but should be assessed in terms of their environmental impact before being introduced in new areas.

## Carbon sequestration and the South North: Ecosystem dissimilarity versus uniformity of policies

The majority of the Mediterranean areas in which organic olive growing is practiced are dominated by soils of mid-low fertility, particularly poor in organic matter (>2% and often >1%) often on sloppy terrain. They are consequently poor in organic nitrogen sources, with poor/fragile soil structure, and prone to erosion. Therefore the conservation and increase of organic inputs in these soils is of prime importance regarding their sustainability (apart of the associated need of using soils as a carbon sink for reducing atmospheric $CO_2$). However, the EU legislation is restricting application of manures and organic materials to European soils into minimal amounts per unit area, apparently based on the carbon and nutrient leaching problems indeed present for Northen European soils. Differentiated policies and legislation are needed for the environmental conditions and the soils of the South. Recycling of olive mill wastewaters, especially regarding agrochemical free organic production should be enhanced by relevant policies.

Nowadays, agro-industrial by-products, such as olive mill wastes and wastewaters are treated as industrial pollutants while they contain no xenobiotics and are derived by a simple physical process that separates vegetative oil from vegetative waters in the olive-mill decanter.

## Legislation regarding compost materials and soil improvers

Legislation regarding trade and use of non-locally produced composted materials and soil improvers appears not strict enough to minimize risks of introducing harmful materials into the environment. The raw materials and their origin should be described in detail in the packaging of these supplies (nutrient content is not particularly informative regarding environmental impact). The farmer has the right to know the area of origin and the raw materials of the agricultural supplies he is using in his farm The consumers also appear to appreciate this information.

A consensus at an EU level regarding characteristics of composted materials and soil improvers is also urgently needed and will ensure control and wide applicability of innovation development in the sector.

## Quality of organic olive oil, marketing issues

Should quality (and promotion) be related to olive varieties, cultivation area, cultivation practices or should it be based more in olive oil/product analysis (phenolics, chlorophyls, vitamins, analysis of oils and fats etc)?

Should blending of organic olive oil from different areas and varieties be allowed? Should it be obligatory to report such blending to consumers?

There is a trend to turn into just a couple of olive oil varieties in both conventional and organic cultivation. This may be suitable for conventional farming and may result in more uniform products and similar cultivation methods and disease/pest control systems. But does this comply with sustainability and particularly with biodiversity conservation issues endorsed by organic olive oil production systems?

## Trade/promotion

Is locality within the Mediterranean a sustainable promotion advantage for organically produced olive-oil or should organizations and institutions aim at promoting Mediterranean olive products altogether (to differentiate them from non-Mediterranean producers that are getting into the market).

# 7. General List of innovations

| *Short Description* | *Target* | *Cost* | *Efficiency* | *Reliability* | *Application conditions/range* | *Environmental Impact* | *Remarks* |
|---|---|---|---|---|---|---|---|
| **I. Cultivation**<br>1a. Soil (management and cultivation techniques) 1b. Plant (varieties, rootstocks, grafting, pruning) 1c. Allelopathy 1d. Environnemental management | | | | | | | |
| Tree borders usually using almond trees (dry regions) apple trees (more humid regions) or pomegranate shrubs (*Punica granatum*) or any other "rosácea" plant or crop (*Prunus sp, Mespilus, Malus, Pyrus*). | Multipurpose. Protection of natural wildlife contribution to pollination on natural vegetation and control of pests | Intermediate | Generally beneficial | Depending on correct choice of plants and spatial planting design | Wide application range | Maintains ecosystem functions | Tree type and orientation according to the specific agroecosystem |
| Niches (spots) of natural vegetation within and around the orchard area | Multipurpose. Protection of natural wildlife, shelter for the entomofauna, contribution to pollination on natural vegetation and control of pests | Low | Generally beneficial | Depending on correct choice of plants and spatial planting design | Wide application range | Maintains ecosystem functions | Spatial distribution should be planned according to the specific agroecosystem |
| Soil Solarization: Covering humid soil with plastic membranes during the hot period aiming to increase soil temperatures above tolerance levels for soil-borne pathogens | Potentially effective in reducing the incidence of verticillium wilt (*Verticillium albo-atrum* and *V. dahliae*) | Intermediate | Reduces spread of the disease but does not aid infected plants | Variable | Warm seasons and preferably flat land needed | Low | Could be used before establishing a new orchard. Performance potentially improved in combination with the fungal antagonist *Talaromyces flavus*. |
| Organic Mulching 1 (using chopped natural vegetation) and crushed olive tree pruning waste | Maintenance of soil humidity during summer<br>Protection from erosion in sloppy areas<br>Weed control (act by blocking light) | Low-Intermediate | Low-Intermediate | Low-Intermediate | Fertile soils and a wide rainy season to support natural vegetation are prerequisites that are rarely met in marginal lands | Soil and water conservation<br><br>In-farm recycling of plant biomass | Should evaluate local materials and conditions, to avoid spreading viable weed seeds and providing niches for pest and disease development |
| Organic Mulching 2 (using non-in-farm produced plant residues, pruning and composts) | Maintenance of soil humidity during summer<br>Protection from erosion in sloppy areas<br>Weed control (act by blocking light) | Intermediate-High | Intermediate-High | Intermediate-High | Farms should be geographically close to source.<br><br>The farm should be accessible by road | Soil and water conservation<br><br>Energy costs (Transportation, spreading) | Should evaluate materials and conditions to avoid introducing pests and disease inocula |
| Non-tillage with barley strips for sloped agricultural land in order to reduce erosion and pollution | Erosion and control of nutrient losses | Low-Intermediate | Intermediate-High | Intermediate-High | For sloped land and shallow light soils low in organic matter content | Beneficial | Apply barley strips perpendicular to soil slope |

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| Corn gluten meal: A "pre-emergent" weed suppressant. It inhibits root growth as soon as the seed cracks open to sprout. | Weed control (not a high priority target in most organic olive tree groves) | Intermediate-High | Variable | Variable | Need of high doses to ensure effectiveness<br><br>Use as a "pre-emergant" only<br><br>Need of a short dry period after application (no rain or irrigation) | Low-transient | One of the few alternatives to synthetic herbicides (apart of cultivation techniques)<br><br>Corn gluten meal also acts as a fertilizer having a N-P-K ratio of 9-1-0 |
| *Sorghum bicolour:* Soil incorporation of stalks and residues following cultivation, or soil spraying with water extract from dried and ground biomass | Weed control (not a high priority target in most organic olive tree groves) | Low-Intermediate | Intermediate (depends on weeds) | Intermediate | By soil incorporation of plant stalks and residues or by "pre-emergance/ emergence " spraying of water extracts from ground plant materials | Insignificant-Low<br><br>Stalk incorporation is beneficial regarding C sequestration in soil, but addition of an organic source of N is needed for high stalk application loads | Good potential for certain weeds only<br><br>Drought tolerance complies with environmental conditions in many mediteranean olive cultivation areas |
| Phosphinothricin: Active ingredient of natural herbicide "bialaphos", derived from the actinomycetes *Streptomyces viridochromogenes* or *S. hygroscopicus* | Weed control (not a high priority target in most organic olive tree groves) | Intermediate-High | High | High | | Caution is warranted regarding (1) effects on beneficial microorganisms and (2) potential for acquired resistance and horizontal gene tranfer | The respective synthetic for of the active ingredient is glufosinate ammonium |
| Olive leaves: Heaps of leavesand twigs maintained between tree rows | Control of *Rhynchites (Coenorrhinus) cribripennis* | Low | Intermediate | Low | Areas affected by *R.. cribripennis* (a local problem in Southern Greece, Italy, France, but not in Spain) | Insignificant-potentially beneficial | Need for evaluation and potentially optimization<br>*R. cribripennis* rarely causes severe damage in olive trees |
| Formation of a ring zone around the olive tree trunk using syntheric insect trapping materials or even sticky substances | Control of insects moving on the trunk like *Otiorrhynchus cribricollis* and potentially scales | Low | Need for further evaluation | Need for further evaluation | Sticky substances rarely withstand weather conditions for along period | Insignificant | Lack of controlled trials<br>*O. cribricollis* rarely causes severe damage in olive trees |
| **2. Inputs**<br>2a. Fertilization, Nutrients 2b. Plant protection | | | | | | | |
| Mineral potassium and magnesium sulfate salts | K and Mg fertilization. Counterbalances excessive Ca availability | Intermediate | High | High | Slightly to highly alkaline calcareous soils | Low | Also improves fruit quality. Despite being natural minerals their use should be restricted in cases that a real need is detected |
| Matured or composted chicken manures | Good source of P, N and organic matter | Intermediate | High | Intermediate-High | Mainly P or P&N deficient soils | Care is needed regarding potential phosphate leaching<br><br>Lack of maturation stage leads to temporal biotoxicity | Difficulty to obtain raw materials form organic sources |

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| Sea-plant derived composts (Posidonia oceanica) | Plant nutrition, rich in boron | Low (if locally produced) | Intermediate | Good | Costal areas | Lack of efficient washing stage may lead to Na accumulation | Good source for boron |
| Sea-plant derived water extracts and composts teas (*Posidonia oceanica*) | Growth enhancement protection from diseases | Low-intermediate if locally produced) | Evaluation needed | Evaluation needed | Potentially wide | Low | Scarce data<br>High silica content may be related to its effects<br>May aid control of *Bactrocera oleae* |
| Sticky, coloured-surface traps | | Low | Poor | Poor | Effective for low insect populations | Insignificant-Low | Low specificity, small radius of attraction |
| Food attractant traps (ammonium salts and/or protein hydrolysates) | Control of *Bactrocera oleae* (olive fruit fly). Food attracts mainly females | Low | Intermediate | Intermediate | Effective for low insect populations | Insignificant-Low | Low specificity, small radius of attraction<br>Useful in May-June while males are immature. |
| Food attractant plus pyrethrine traps | Control of *Bactrocera oleae* | Low-Intermediate | Intermediate | Intermediate | Effective for low insect populations<br>Not particularly effective in the Autumn period | Insignificant-Low | Low specificity, small radius of attraction |
| Pheromone traps (sex pherormones) | Control of *Bactrocera oleae*<br>Pherormones mainly attract males | Intermediate | Intermediate-High | High | Large trapping areas needed | Low | High specificity, large radius of attraction |
| Food attractant plus pheromone traps | Control of *Bactrocera oleae* | Intermediate | Intermediate-High | High | Large trapping areas needed | Low | Intermediate specificity, large radius of attraction |
| Food attractant plus pheromone plus pyrethrine traps | Control of *Bactrocera oleae* | Intermediate | Intermediate-High | High | Large trapping areas needed | Low | Intermediate specificity, large radius of attraction |
| Alpha-cypermethrin (pyrethrinoid-based compound used for olive fly control by bait spray applications) eg Fastac (*) | Control of *Bactrocera oleae* | Intermediate | Intermediate-High | Intermediate-High | Potentially wide application range | Effective on non-target organisms<br><br>Toxicity to fish | (*) SYNTHETIC. No authorization for organic. Reported here for comparative reasons |
| Lamda-cyalothrin (pyrethrinoid-based compound used for olive fly control by bait spray applications) eg Karate (*) | Control of *Bactrocera oleae* | Intermediate | Intermediate-High | Intermediate-High | Potentially wide application range | Effective on non-target organisms<br><br>Toxicity to fish | (*) SYNTHETIC. No authorization for organic. Reported here for comparative reasons |
| Zeta cypermethrin (pyrethrinoid-based compound used for olive fly control by bait spray applications) eg Fury (*) | Control of *Bactrocera oleae* | Intermediate | Intermediate-High | Intermediate-High | Potentially wide application range | Effective on non-target organisms<br><br>Toxicity to fish | (*) SYNTHETIC. No authorization for organic. Reported here for comparative reasons |
| Spinosins: Macrolide substances isolated from the actinomycete Saccharopolyspora spinosa eg Success | Control of *Bactrocera oleae* | High | Intermediate-High | Intermediate-High | Potentially wide application range | Dissipation by photolysis and degradation.<br><br>Substantial work carried out on risk assessment and environmental fate shows good records.<br><br>Toxicity to aquatic fish and invertebrates | Low mammalian toxicity<br><br>Indications of resistance following long-term use |

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| *Psyttalia* sp. *(concolor, ponerophaga)*: parsitooids of *Bactrocera oleae* | Control of *Bactrocera oleae* | Intermediate-High (could be significantly reduced by large scale production) | Intermediate | Low | Further research needed for optimization | Apparently low | More efficient for small drupe varieties (short ovipositor parasitoid of olive fruit fly) Need for proper timing of parasitoid release & modified irrigation to minimize fruit size. |
| *Beauveria bassiana*: Parsitic fungus for arthropods and insects eg Naturalis-SC | Control of *Bactrocera oleae* | Intermediate-High | Variable | Variable | Further research needed for optimization | Low | Need for further evaluation |
| Kaolin (a kaolin based particle film formulation) eg Surround-WP | Control of *Bactrocera oleae*<br><br>Appears effective for *Pray oleae*, *Saissetia oleae* and other common olive pests | Intermediate | Intermediate | Variable | Demands good application practice and favourable rain patterns Not particularly effective in the Autumn period | Insignificant (might reduce photosynthesis if non-properly applied) | Does not affect fruit quality<br><br>Aesthetic issues may be raised in touristic regions |
| *Bacillus thuringiensis:* Well established insect control agent acting through a gut toxin produced by the bacterium | Control of Lepidoptera *(Prays oleae)* | Intermediate | High | High | Application in May to control the floral bud generation (floralbudsat the "york" stage) | General toxicity to Lepidoptera<br><br>Potential for resistance development | Reports on resistance development by Lepidoptera to the toxin are increasingly published |
| Rotenone: Botanical insecticide derived from the roots of several tropical plants (*Derris* spp., *Lonchocarpus* spp., *Tephrosia* spp.) | *Bactrocera oleae* | Intermediate-High | Intermediate | Intermediate | Wide application range | High toxicity to fish<br><br>Toxicity Category III but raised to Category I by EPA when formulated as an emulsifiable concentrate.<br><br>Rotenone has been substitued by Spinosins | High toxicity to non-target organisms.<br><br>Serious doubts regarding safety of oils extracted from drupes treated with rotenone.<br><br>Currently under reappraisal |
| Azadirachtins: Natural tetranortrterpenoids derived from seed of the Neem-tree (*Azadricactra indica*) | Potentially effective for a wide range of olive cultivation pests | Intermediate | Low-Intermediate<br><br>No systematic assessment studies on olive ecosystems | Low-Intermediate<br><br>No systematic assessment studies on olive ecosystems | No systematic assessment studies. Potentially wide | No environmental / ecosystem risk data on olive plantations available)<br><br>Fungistatic properties affect mycorrhizal fungi<br><br>Potentially toxic to aquatic fish and invertebrates | Potentially effective. More research is warranted<br><br>Not authorized in all Mediterranean countires for use in organic olive oil production |
| Release of parasitoids for the control of scales | Control of scales | Intermediate | Intermediate | Intermediate | Areas significantly affected by scales A balanced agrosystem is sufficient in the most of cases | Low | Only when enemies are not naturally introduced in the ecosystems |

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| Copper compounds: Disease control (copper sulphate is probably the oldest means for the control of bacterial & fungal pathogens) | Effective against many fungal and bacterial diseases including: Peacok Spot (*Spilocaea oleagina*) Olive knot (*Pseudomonas savastanoi* pv. *Savastanoi*) Fumagine *Capnodium oleae* Anthracose (*Gloeosporium olivarum*) | Low-Intermediate | Intermediate-High | Intermediate-High | Good application practice needed | Wide range toxicity<br><br>Cu is a plant nutrient bit a toxic heavy metal pollutant at high doses | Allowed under special condition only, in the lack of alternatives |
| Sulphur dust and ash | Appear to act as repellents for minor pests as *Rhynchites Coenorrhinus) cribripennis* | Low-Intermediate | Low | Variable | application in May-June | May interfere with physiological processes like photosynthesis R. cibripennis is a local problem in Southern Greece, Italy, France, but not in Spain) | Aesthetic issues may be raised in touristic regions |
| Inocula of arbuscular mycorrhizal fungi | Target is improved drought stress rather than improved P nutrition | Low-Intermediate | Depends on inoculum and soil ecological conditions | Variable | Drought affected soils and low in Phosphorous | Efficiency of local strains should be checked | Experimentation mainly performed in seedlings |
| Biodynamic/ Homeodynamic Y01 combined with B23 (fruttopiu) Activation of tissue repair mechanism following fruit tissue punctires by *Bactrocera oleae* ovipositor. | Control of *Bactrocera oleae* | Low | Supposed to work well in a biodynamic framework | High in Biodynamic farms | Biodynamic cultivation | Negligible | B23 also used for oil concentration increase in olive fruits |
| **3. Production of olive oil**<br>3a. Collection, transport and storage of olives (prior to extraction) 3b. Processing and extraction of olive-oil | | | | | | | |
| In-farm small scale mills | Quality control<br><br>marketing/promotion advantage<br><br>compatibility with agro-tourism | Depends on machinery | Depends on investment | High | Large scale farms or adjacent producer farms | Minimal olive drupe transportation<br><br>Great potential for in-farm processing and recycling of wastes | Technology is becoming increasingly improved and affordable |
| Addition of herbs, antioxidants or natural flavours in bottling or even storage tanks | Speciality products only, niche markets | Production costs are rather low<br><br>Promotion costs are high | No technical difficulty | Long term effects (interactions of ingredients) should be investigated | Wide application range | Evaluation of biochemical, chemical effects of final consumable product should be carried out | Products hard to categorize commercially<br><br>Potentially high promotion costs<br><br>Fears that such products may eventually lead to marketing damage of the pure oil image if not properly promoted |

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| **4. Wastes and by-products of the organic olive oil production chain**<br>4a. Plant leaves and pruning material 4b. Olive mill wastewaters 4c. Olive mill pulps | | | | | | | |
| Organic Mulching 3 (from olive tree pruning) | Maintenance of soil humidity during summer<br>Protection from erosion in sloppy areas<br>Weed control (act by blocking light) | Intermediate | Intermediate | Intermediate-High | Wide application range | Soil and water conservation<br><br>In-farm recycling of plant biomass | Should pre-evaluate materials to avoid introducing pests and disease inocula |
| Organic Composting (tree prunnings, leaves, alperujo, olive mill wastewaters) | Recycling olive tree biomass | Variable depending on method / plant size | Intermediate-High | Intermediate-High | Wide application range | Improves recycling and C sequestration using soil as a C sink<br><br>Improves soil fertility, and long term sustainability, decreases erosion, and water use efficiency of OMW are used for watering the compost piles | Tree prunings serve as good bulking agent<br><br>Long maturation period necessary especially if olive leaves and OMW are used |
| Extraction of organic antioxidants and compounds used in cosmetics from olive mill wastes. | Added value products | High | Variable | NA | Nutraceticals / cosmetics | Potentially covers waste processing costs | Further research and optimization needed<br><br>Much experience in Italy |
| **5. Packaging, labeling and selling Olive Oil**<br>5a. Packaging 5b. Labeling/certification 5c. Trade/promotion | | | | | | | |
| E-Commerce | Trade directly to consumers | Low | Improving | Improving | Direct contact with consumers / versatility | Potentially reduces transportation points | Increasing share of the market<br>No appropriate alternative for big organic olive oil producers (eg Andalucia case) |
| Certification institutions that are specialized to organic olive oil production chain | Specialized service to the organic olive oil production chain | Similar to broad range certification institutions | High | High | National/ International level | Could potentially deal more efficiently with specific issues related to the organic olive oil production chain | Potentially antagonistic to broad range certification institutions<br><br>To be more discussed. Not a clear solution |
| **6. Other** | | | | | | | |
| Biodynamic/ Homeodynamic B23 (fruttopiu).<br>Oil concentration increase in olive fruits | Oil pruduction | Low | Supposed to work well in a biodynamic framework | High in Biodynamic farms | Biodynamic cultivation | Negligible | Also used for Activation of tissue repair mechanism following fruit tissue punctires by *Bactrocera oleae* ovipositor. |

# 8. Results of the inquiry on innovations in organic olive oil production chains in Greece

## Profile of subjects

A total of 200 surveys were submited, each containing 40 questions.

Gender: 70.5% male and 29.5% female.

Age distribution: 6% between 25 and 34 years old, 47% between 35 and 50 years old and 47% between 51 and 80 years old.

Geographic distribution: 40% of the subjects were from the islands (16% Ionian Sea, 16% Aegean Sea, 8% Crete), 35,5% were from South Continental Greece (Pelloponisos), 17.5% from Central Continental Greece (Thessaly and Sterea Ellada) and 7% from Thrace (Evros, Rodopi).

Main activity: 67% "Farmers", 25% "No agricultural profile", 7.5% "Company" and 0.5% "Processing agro-industry".

Group activity: The majority of the subjects stated they belonged to some type of union or cooperative. 48.5% were members of an agricultural cooperative, 20.5% were members in a Producers' Union/ Organization, 4% stated they were members in both and f27% did not belong to any of the two.

## Farm profile

Multi-cropping: 69% of the farms grow olives as a single crop.

Farms size: 2% of farms are less than 1 ha, 40% are between 1-5 ha, 23.5% are between 5-10 ha, 23% between 10-25 ha and only 11.5% above 25 ha.

Olive varieties cultivated: "Koroneiki", 37%, "Kalamon" 18%, "Amfissis" 10%, "Manaki' 6%, "Ladolia" 5%, "Piliou" 4%, "Throumpa" 4%, "Patrinia" 4%, "Kolovi" 3% "Megaritiki" 3% and "Chalkidikis" 2%. In addition to the above there are at least 6 more varieties reported with each of them being cultivated in less that 1% of the farms adding up to approximately 4% of the cultivation varieties.

Number of olive trees per farmer: 0.5% of the subjects cultivate more than 5000 trees, 7.5% cultivate between 2000 – 5000 trees, 19% cultivate 1000 – 2000 trees, 31.5% cultivate 500 – 1000 trees and the large majority (41.5%) of the inquired subjects cultivate less than 500 trees.

Irrigation: 34% of the inquired subjects apply irrigation.

Main machinery used: Tractor 64.5%, lawnmower 64.5%, rotator 55.5%, Spraying pump 48%, cultivator 42%, ripper 30.5%, platform 29.5% and pruning hook machine (23%. Finally, much fewer subjects reported they were using a digger 3.5%, a fertilizer distributor 1.5%. or other machinery 9.5%.

## Expertise and information/education sources

General educational level: 20.5%, primary school education, 49.5%, secondary school education, 29% higher (post-secondary or tertiary) education and 1% post-graduate education.

Education relevant to specific training in agriculture: 33% attended seminars for young farmers, 24% attended training seminars on agricultural issues, 24% attended seminars on organic agriculture, 5% had graduated from an agricultural college and 15% of had no specific training on agriculture related issues.

*Experience in organic farming*: 28% had more than 10 years of experience in organic farming, 42% had between 6 and 10 years of experience, 29% had between 2 and 5 years of experience and only ca 1% had less than 2 years of experience.

*Acquiring information, training and knowledge on organic farming:* Self-training and general info (73%), books, journal and periodicals (55%), other organic farmers (55%) and *via* training seminars (24%). The majority of the subjects (70%) have a consultant for the production and trade of their organic products who is usually an agronomist/plant scientist (in 93% of the cases).

*Relative Productivity size*: 67% of the inquired subjects believed that their production size is medium, 15% consider it low and ca 18% consider it high.

## Cultivation and environmental management

*Rainfall patterns*: The highest rainfall in the examined regions occurs in the period between November to February. Considerable rainfall also occurs in October and March. During the rest of the year, (April till September) rainfall is dramatically reduced (practically zero in the summer months). Heavier rains in the Fall period (October-December) in areas of Western Greece cause difficulties in the control of olive fruit fly (*Bactocera oleae*) and occasionally of Peacok Spot (*Spilocaea oleagina*).

*Multi-culture*: Half of the inquired subjects believe that an organic farm/field can be cultivated with only one type of crop, ca 32% believe that it can be cultivated with more than one types of crops, and 18% answer that they do not know what is preferable. 77% of the farmers report the presence of natural hedges and wild vegetation points in their farms. In addition, 68% of the subjects report that they have observed some populations of birds and/or animals in relation to adjacent conventional agricultural farms.

*Soil tillage:* Soil tillage is carried out in Spring in the majority of cases (81%), but rarely in early summer (9%), autumn (8%) or late winter (3%). The most usual cultivation methods are performed by: milling (35%), brush and lawn cutter (23%), cultivator (21%) and tractor with plow (39%). The depth of tillage is reported to be between 15-20 cm in most cases (55%), between 25-30 cm and 10-15 cm in fewer cases (25% and 18% respectively) and much less often superficial (2% of all cases).

*Soil characteristcs*: Most subjects characterize their soil as moderately fertile (57%), followed by those who characterize it fertile (41%) and those who believe it is infertile (only 4% of the cases). The majority of the subjects report their soil structure as medium (74%) a few report it as heavy (20%) and less report it as light (6%).

*Inputs:* 76% of the inquired subjects use fertilizer and other inputs derived from the market: plant protection (78%), manure (74%), organic products and seeding (54%), compost (33%) and seeds (11%).

*Soil fertility management*: Soil fertility is improved with one or more of the following ways: manure (53%), mulching (33%), green manure (25%), compost (21%), organic fertilizers (13%), lawn greens (13%), crop rotation (11%), residues incorporation (8%), co-cultivation (6%) and finally long term plan for the selection (2%).

*Management of plant biomass:* incorporation (59%), mulching (30%), animal grazing (mostly sheep and occasionaly goats) (20%). Farmers who sow green manure, apply it in the whole olive grove floor (77%) and in strips between the tree rows (23%).

## Regulation and Control of pests and diseases

*Disease identification*: Diseases are identified mainly empirically (61% of cases) and less so after the advise of a specialist (24%). 15% of the inquired subjects report that they use both their experience and the agronomist's opinion.

*Measures*: 45% of the inquired subjects follow a preventive strategy in order to avoid disease and the rest 55% generally act after the disease has occurred, judging from its expansion.

*Tolerance of cultivated varieties to environmental stress and diseases*: The subjects consider that such tolerance exists towards drought (53% of the cases), temperature (42%) and pathogens (30% of the cases). The specific varieties that are reported to present tolerance to either of the above factors are mostly "Koroneiki", "Throumpa" and "Amfissis" (in order of reporting frequency).

*Specific problems:* Approximately 15% of the inquired subjects report no particular pest/disease problems. The rest report the following pests and diseases: *Bactrocera oleae* (91%), *Spilocaea oleagina* (29%), *Prays oleae* (22%), *Pseudomonas savastanoi* (9%), *Coenorrhinus cribripennis* (5%), *Euphyllura olivina* (5%), *Calocoris trivialis* (4%), and *Leveillula taurica* (4%).

*Specific means for pest and disease control*: Insect traps (72%), biological control (55%), cultivation practices (27%) and rarely pheromones (9%).

*Contamination risks*: Only ca. 41% of the inquired subjects recognize that there exists some risk of contamination of their organic cultivations. The vast majority (76%) considers the neighboring conventional farms as the main possible risk. Other possible reported risks are synergistic effects from pest control measures (mainly for *Bactrocera oleae*) (12%), high speed roads (10%) and inappropriate irrigation water (2%).

## Harvesting, transportation, oil processing and packaging

*Harvest:* The olives are harvested by hand in the majority of cases (64%). 22% of the subjects report mechanical harvesting and 14% report harvesting by both ways.

*Olive transportation*: Mainly by owned vehicle (78%) and less so by the vehicle of the purchaser/mill owner (17% of the cases) or rented vehicle (5% of the cases). 92% of the inquired subjects report that they take special care in cleaning the transportation vehicles in order to avoid cross-contamination.

*Olive processing*:56% of the inquired subjects report that they do not follow any specific olive processing variant whereas the rest 44% report that they do follow a specific processing variant (referring mainly to cold crushing).

*Packaging:* Only 17% of the inquired subjects package their own products (using mostly glass containers). However, 72% believe that packaging is necessary for the following reasons: Commercially recognizable products (75%), Quality (74%), Safety (63%), Trade competitiveness (58%), Facilitated of distribution (50%).

## Quality, marketing and labeling

*Quality:* The majority of producers report the production of high quality olive-oil: 21% - Excellent, 42% - High, 33% - Medium, 4% - Low.

*Other Products*: The majority of the subjects produce olive oil (86%) with the next most common product being table olives (37%). Few farmers produce olive pâté (6%), soap (2.5%), Cosmetics/Pharmaceuticals (1%) or other products (3%).

*Labeling:* Only 12% of the inquired subjects use some kind of label or trade-mark. only 17% of them report it is their own label.

*Certification:* 47% of the inquired subjects are certified according to extra quality standards at national or international level. The certification logos include: Organic farming (95%), Bio Suisse (39%), PGI (29%), NOP (10%), PDO (8%) and other (1%, ISO22000).

*Promotion and trading*: The inquired subjects promote and trade their organic products with the following ways: Selling to wholesaler who processes and trades (54%), directly in open public markets (11%), to visiting stakeholders and consumers in the farm (10%), to supermarkets (7%), in organic stores (6%), on their own (including processing and packaging) (7%), and in other ways (31%). Finally, 31% of the inquired subjects report that they are using some kind of new technology in their business (mostly e-mail, internet).

# 9. Summary points

- The organic olive oil production chain appears to have become "a peak of the iceberg", i.e. a pioneering paradigm, for the implementation and convergence of the majority of these policies under a common denominator.
- The majority of innovations pioneered within/for the organic olive oil production chain may, and are increasingly becoming, adopted by the conventional olive oil production chain, especially regarding cultivation, inputs related to plant/ecosystem protection and trade/promotion of specialized high quality products.
- Regarding problems related to water consumption and waste production, there is little divergence between conventional and organic production, but the organic olive oil production chain has a lower impact as regards to soil erosion, desertification, pollution due chemicals and fertilizers (minimal), and effects on wildelife/vegetation biodiversity.
- According to the EU's key biodiversity policy instruments Member States are required to designate these areas, and local authorities responsible for the sites must set up environmental management plans and carry out restoration so that the sites achieve 'favourable conservation status'. In these areas, agriculture is allowed and considered complementary to environmental protection. Since in these widespread areas low impact and environmentally- friendly farming practices and production systems are required, the organic olive oil production chain becomes favourable and advantageous.
- Production costs, especially those related to plant protection, fertility management and marketing are high, specific subsidies for converting to organic are expected to decline and therefore innovations at both the farm/production level and the trade/marketing level are essential in order to make the organic olive oil production chain economically viable and even more compliable with the environmental/sustainability strategic priorities of the EU.
- Despite the turn of the industry to "green", diversification of means and measures rather than application of "blanket" products is the hallmark of organic production chains, and this applies well into the organic olive oil case. This poses a difficulty regarding investment costs for developing and evaluating innovations for the agro technological and biotechnological industry that aims to broad spectrum applications.
- It appears that organic olive tree plantations either in the form of monocultures or in the form of integrated farms including olive tree groves are increasingly becoming model systems for developing, applying and evaluating innovations that may have far more general applicability for Mediterranean agriculture.
- A list of innovation and their basic characteristics and applicability range/constraints are presented in sections 6 and 7.
- Indexes of biodiversity and ecosystem health developed specifically for olive grove ecosystems would serve both as an assessment tool for certification agents and as a marketing tool promoting the "green" nature of organic olive oil production chain.
- Innovation regarding common marketing priorities, trade policies and infrastructure and joint promotion strategies will accelerate the expansion and "maturation" of the organic olive oil market. "Green" marketing policies should go beyond organoleptic properties of organic olive oil compared to conventional products.
- Sustainable use of pesticides policy should apply to biopesticides: Biopesticides are considered "natural products" and there is an approach from the general public (but also from a part of the scientific community) that they should not necessarily pass through all evaluation stages. Moreover several "natural products" with pesticide properties are marketed as soil or plant growth/vigor improvers, but used by farmers for their pesticide

properties. Adaptation and application of the legislation for synthetic pesticides to biopesticides should be implemented regarding the reduction of potential environmental impact of the "organic production chain".

- There may be significant risks involved in the application of non-indigenous microbial soil inocula as far as disturbance of local microbial communities and competitiveness with local species are concerned Local microbial diversity may be at risk
- The EU legislation is restricting application of manures and organic materials to European soils into minimal amounts per unit area, apparently based on the carbon and nutrient leaching problems indeed present for Northen European soils. Differentiated policies and legislation are needed for the environmental conditions and problems related to the management of the majority of the Mediterranean soils.
- A consensus at an EU level regarding characteristics of composted materials and soil improvers is urgently needed and will ensure control and wide applicability of innovation development in the sector
- There is a trend to turn into just a couple of olive oil varieties in both conventional and organic cultivation. This may be suitable for conventional farming and may result in more uniform products and similar cultivation methods and disease/pest control systems. But does this comply with the profile of organic olive oil production systems?
- *Bactrocera oleae* is the most common pest problem (91% of farmers reported it in questionnaires in Greece), but effective means of control are available. On the contrary, *Verticillium* wilt is constantly expanding and, although not still amajor problem it is difficult to manage. Single control measures are mostly ineffective. Currently, an integrated disease management strategy that fits modern sustainable agriculture criteria must be developed
- Certain figures derived from the questionnaires (Greece) are not ideal for an "organic" profile or may pose constraints in olive oil organic farming development: 69% of the farms grow olives as a single crop (monoculture). 41.5% of the inquired subjects cultivate less than 500 trees. Tillage is carried out in Spring in the majority of cases (81%) whereas no-tillage proactiices are rare. 76% of the inquired subjects use fertilizer and other inputs derived from the market. Only 17% of the inquired subjects package their own products