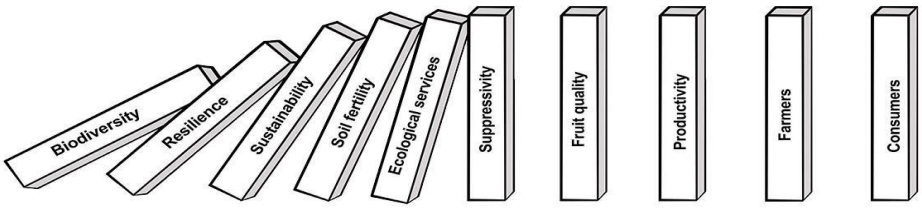
CORE organic

DOMINO



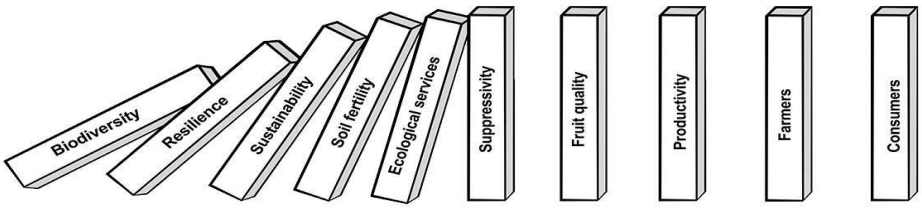
Newsletter n. 6

August 2021

The main results of DOMINO to improve organic orchard management

This is the last issue of the newsletter, as the project has ended on the 2nd of August 2021.
The aim of the project DOMINO was to reduce external inputs in intensive organic fruit orchards for pest control and fertilization and to improve the overall productivity and sustainability of this agroecosystem. Our aim was increasing orchard biodiversity, adaption of plant protection strategies to new demands and more adapted fertilisation strategies using efficient recycling of organic residues. In addition, these new management practices were expected to stabilize the cash flow of the farmers by the introduction of secondary cash crops. Finally, the project led to the design of mixed orchard systems more resilient to climatic and socio-economic challenges.
The objectives of DOMINO project included the development of innovative management strategies in intensive organic fruit orchards by the use of i) dynamic "living mulches" such as stoloniferous cash crops in the row and the sod with leguminous between the rows for weed control; ii) fertilization by recycled soil amendments and leguminous crops to increase resource use efficiency and improve ecosystem services and iii) net systems to support non chemical pest and diseases control.
We hope that the materials developed from the work carried out, all available on the project website and on the Organic Eprints repository can be useful to farmers, advisors and researchers, resulting in a positive "domino" effect on biodiversity, better fruit quality and overall sustainability of the organic fruits cropping systems. We believe that implementing diversified and stratified mixed cropping systems in highly intensive organic orchards can allow the exploitation of different layers, above and below ground, in contrast with the current partially conventionalized monoculture.

Davide Neri



Improving diversity in the cropping system

Living mulches, namely herbaceous plants with good attitude in covering the soil, were tested in organic orchards and vineyards to evaluate their capability for establishing and maintain a "good degree of biodiversity" and take advantage of all the environmental benefits associate to it.
Three main effects of living mulch on the agro-ecosystem were investigated: weed control, fertilisation and provision of additional income when the cover crop has also character of cash crop. A number of 44 different plant species were tested in field trials on apricot, apple and grapevine as living mulches.

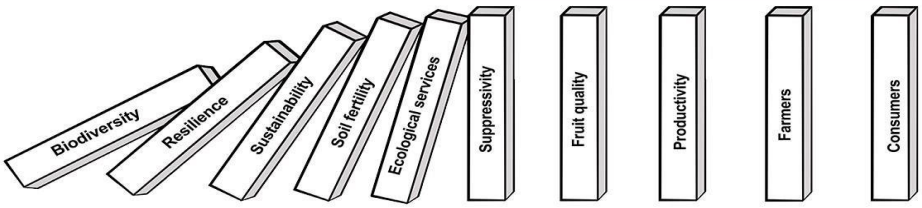
Main conclusions

- Species taken from local biodiversity provide significant advantages in terms of plant resilience and soil cover. For example, wild strawberry plants collected in the Sibillini Mountains gave excellent results in Central Italy, even with very low planting density, but they required the use of mechanical horizontal blade tillage and few manual interventions for improving the initial soil cover and to control the competition of aggressive weeds. Similarly, *Potentilla* transplanted from the orchard environment to the rows of FIBL's trial was capable to fully cover the strips within three months.

Living mulch of wild strawberry in vineyards

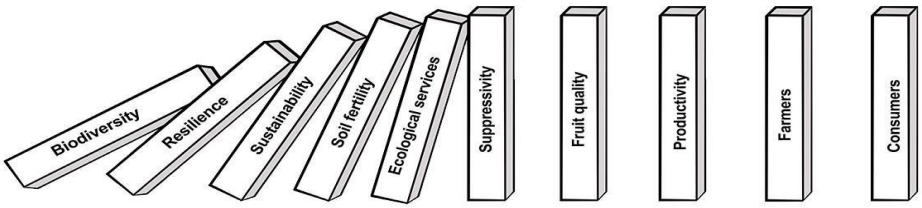
- The use of complementary weed control measures during the establishment of the living mulches can greatly help them to compete with weeds and thus to properly settle down. But, either through manual or mechanical preliminary weeding, these additional measures can be costly and the work done by the project did not demonstrate whether the transition phase would be really limited to 1 or 2 years.

- Mint was tested in Poland, Germany and France. This species proved to be rather ubiquitous. It gave excellent (or, at least, quite good) results in terms of soil covering capacity, weed control, and biomass production.



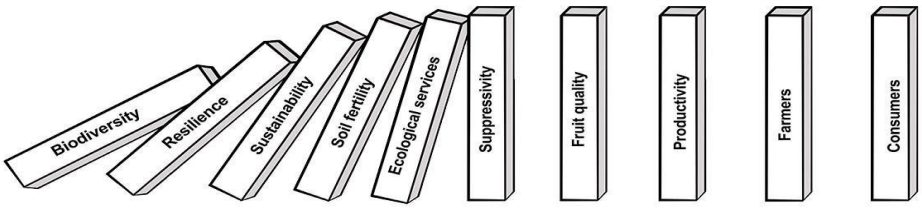
Living mulch od peppermint ready for harvesting leaves

- Other species yielded good results during the trials, such as dwarf white clover, *Achillea millefolium*, *Gallium album*, *Hieracium aurantiacum*, *Hieracium lactucella*, *Tropaeolum sp.*, *Alchemilla vulgaris*, *Cucurbita pepo*, *Fragaria sp.* (with specific climatic and pedological requirements) and *Potentilla sp.* (when transplanted from the surrounding environment). However, some species failed in determined agro-ecosystems. The experiments highlighted that species are highly site-specific hence their adaptation to local conditions must be carefully checked in advance, through testing the potential species in small areas to verify *in situ* their growth.



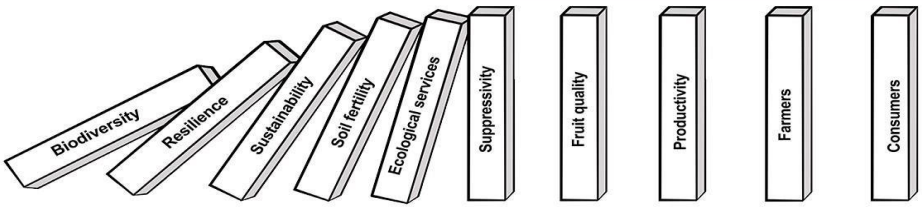
Examples of living mulches with a) Alchemilla vulgaris, b) Gallium album, c) nasturtium and d) potentilla

- Macro- and micro-nutrients in the fruit crop were not affected by living mulches at the end of the trials. Roots of some cover crops (peppermint and Alchemilla vulgaris) and of the apple trees were found to differently explore the soil layers in this system, showing that the association of the living mulch with the trees is an interesting example of mutualism. Moreover, some allelopathic species showed interesting action on tree root development, with potential beneficial impact on nutrients uptake. However, reduced soil nitrogen availability was observed in some cases, especially when the living mulch was not well established and overgrown by weeds. In addition, in some cases cover crops attracted the wild fauna, with damages to the trees.
- Officinal plants, strawberries, and pumpkin also showed good potential as cash crops in specific orchards and vineyards.

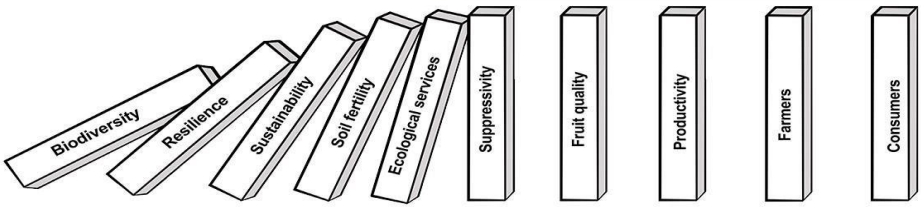


Pumpkins and fruits of wild strawberry as additional crop from living mulches

- Winter pea grown on the row of apple trees yielded very good results either in the German and the Swiss experiments, with high nitrogen releases after mowing, just in time to satisfy at least partly the needs of the trees. However, the efficacy of legume crops, grown in the row and/or in the interrow as an internal source of nitrogen supply, can be reduced by the timing of mineralisation of the green manure which may not match the actual need of the fruit tree crop. Further constraints are represented by the soil tillage/crop protection operations, periodically carried out in the orchard and implying the use of tractors and machinery, which may undermine the cover crop. It was also observed that in some cases rodents may negatively affect the proper development of the legumes.



Different leguminous species to manage row and interrow: a) mixture of clover and sheep's fescue, b) mixture of several leguminous species, c) microclover in the interrow



Fertilization management

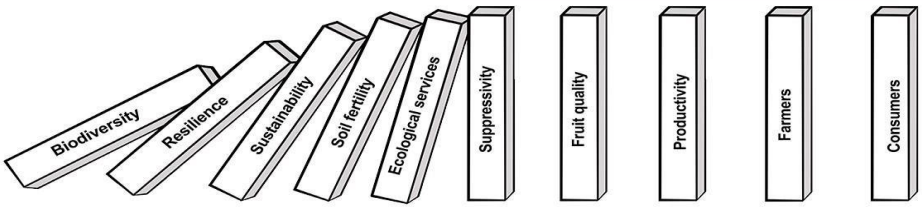
Different alternative fertilisers and fertilisation strategies, namely recycled organic matters and nutrients, clover grass-based materials, leguminous intercrops and non-contentious commercial fertilizers were tested. Their applicability in organic fruit production was verified.

Main conclusions

- All fertilisers tested can be used as nutrient source in intensive organic apple orchards with specific adaptation to the cultivation conditions.
- Nitrogen availability from peas and clover-grass based fertilisers depended strongly on application dates and times of incorporation, which can result in insufficient N availability during the period of intensive plant demand. As clover pellets are easy to apply, vegan and of non-contentious origin, they represent a valid option for organic farmers

Peas grown for green manuring and pellets from leguminous plants

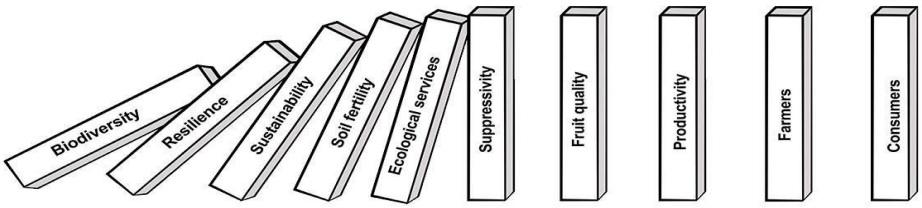
- The liquid fertilizers biogas digestates, Lumbreco (a vermi-compost produced in Bulgaria) and stillage showed very good fits to the N demand of the trees in spring due to a quick N release after application. All three products are rich in NH_4^+ which determines the fast N release even at low temperatures.
- Digestates from biogas plants may be however challenging for farmers since C/N ratios and overall nutrient composition may differ according to the source of production and the quality of the digested organic raw materials.
- Stillage from conventional sugar production is currently widely used in organic farming, but contamination with pesticides from conventional production might occur.



A biodigestate and liquid stillage

- Using fertilisers based on legumes (clover grass silage, clover biomass from the inter row or peas mulching on the row) reduces soil contamination risks in comparison to biogas digestates, stillages, and composts). It also enhances farm internal N cycles leading to an overall higher N efficiency in organic fruit growing systems.
- Legume-based fertilisers are largely location-dependent and more knowledge intensive than the current use of contentious inputs as mineralisation of plant-based material has to be synchronized with tree crop needs by adopting different application times and incorporation methods.
- Application costs may be however high in some contexts and some of the tested fertilisers are currently still too expensive for the use in commercial organic fruit production.
- Various trade-offs in terms of sustainability exist (e.g. concerning biodiversity and realisation of nutrient cycling), which have to be appraised by each farmer according to his real or perceived conditions.

Compost and a product from biodigestate



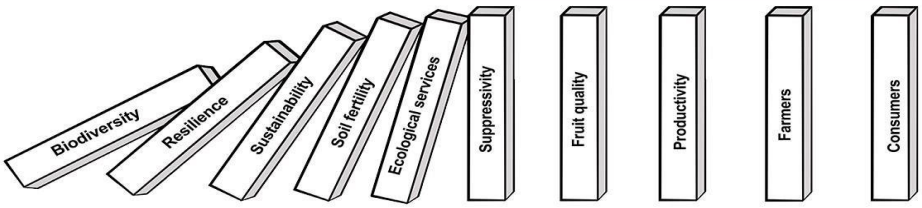
New orchard protection systems

The orchard functioning under partly closed covering systems was quantified in order to validate the reduction of external inputs use. The treatment based on spraying organic chemicals was compared with the exclusive use of covered systems. Trials were carried on apple and under different environmental and managing systems. Plastic covering on the top and lateral netting systems were applied to reduce foliage wetting and to prevent insect attacks.

Main conclusions

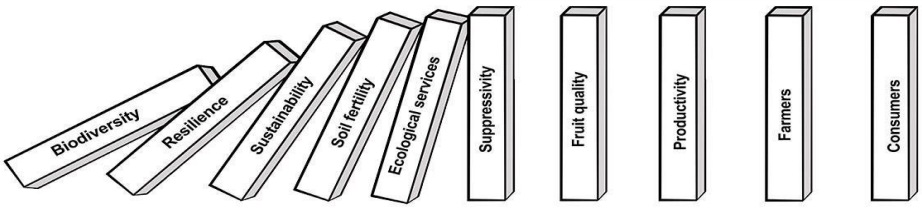
- The tested partly closed covering systems allowed reduce losses, or at least produced the same results of the organic sprayed plots, in terms of both infected fruits and infection intensity. The systems induced reduction on number of fruits damaged by the codling moth, and more generally the feeding damages were markedly lower in the covered treatment, while no significant difference was found for 'other feeding' damages, mainly caused by grubs and caterpillars.
- The rain-proof roof allowed to reduce the wetting of the fruits mainly in the top part of the trees limiting post-storage losses caused by post-storage scab. Covered fruits resulted significantly less damaged than the sprayed ones in both years. No differences were observed for *Monilia* spp., cracked apples and bitter pit.

The temporary net unfolded over apple trees



- For what concerns the shelf life of the fruits, no differences were found for *C. acutatum*, *Phytophthora cactorum*, bitter pit, post-storage scab and *Neofabraea alba* in 2020, between the covered and the organic treatments.
- In general, the rain-proof roof allowed to reduce the post-storage losses caused by post-storage scab.
- Aphids where present in both treatments, but mostly in the covered one (woolly apple aphid).
- Not clear the effect of covered systems on beneficial insects, whether they are free to move across the canopies or not. Further observations are needed.

Other examples of temporary nets

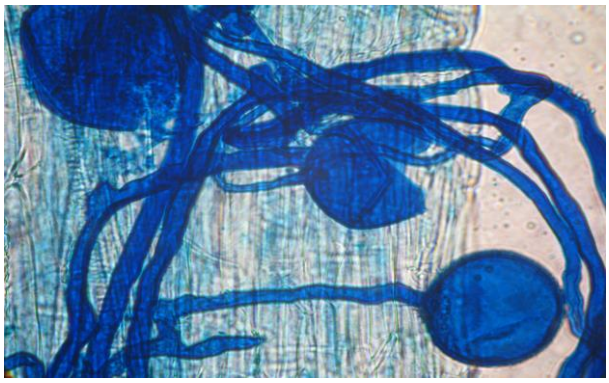


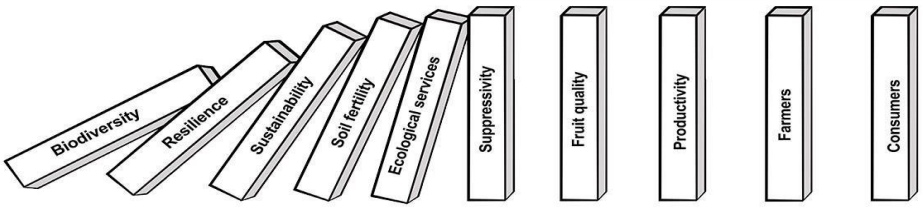
Environmental and economic effects

The added value of the different strategies tested by the project was appraised in terms of generation of eco-services and biodiversity improvement, considering soil microbiota, mesofauna, entomofauna and flora diversity.

Main conclusions

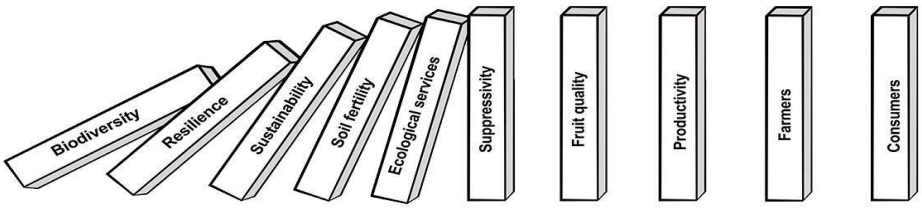
- In case of organic fertilizers, those with a higher rate of mineralisation (and mostly likely those in liquid form) appear to positively stimulate different "layers" of the soil biodiversity.
- The organic fertilisers with longer mineralisation rate can have a different path in the impact of soil biodiversity, which could positively affect also different ecosystem services related to climate change mitigation such as C sequestration. However, a full assessment of the whole production process would be needed to fully appraise the carbon footprint of any organic fertilizer.
- In case of living mulches, the positive impact is immediately evident considering that an additional layer of plants is added to the orchard, particularly if the soil is tilled.
- The selection of the living mulch or cover crop can provide several additional ecosystem services, most of them related to an overall increased biodiversity (i.e. below and above ground).





Soil biodiversity is important to maintain fertility: all organisms are linked in the life web. Spores of mycorrhizal fungi (a) can be utilized as feed for beneficial nematodes (b), which become the feed of earthworms (c).

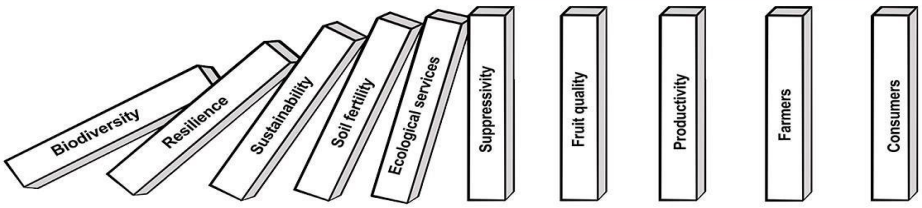
- In case of the temporary net systems of the orchard, the impact on biodiversity could be positive if the pest control is concerned, even though a possible negative impact could be generated on the long term within the pest/predator equilibrium, which could affect some pests' population development.
- The good biomass production of some living mulch species used in the project trials point also to their use as a secondary income source, since their leaves and flowers have a commercial use for making valuable medicinal/functional food products.
- In case of few species, such as mint, the utility of using the essential oil for diseases control could be exploited with a direct application of the oil extracted from the living mulch in the orchard, implementing a circular economy approach.
- Same approach is applied through the exploitation of locally produced organic fertilisers hence assuring the recycling of nutrients and providing externalities valuable for the processes related to management of wastes and safe water supply.
- Direct economic benefits (savings in operational costs) as well as additional ecosystem services (N supply, C sequestration) can be expected also from classical cover crop or living mulch species such as the leguminous.
- Both organic fertilisers and living mulches can represent a sustainable solution for management of organic orchards as long as they are adapted to the specific orchard conditions.



Pollinators (a) and soil life (b) are supported by living mulches.

Read more at the CORE Organic website:
http://www.coreorganic.org/
find publications from the project at:
http://www.domino-coreorganic.eu/

CORE organic DOMINO



The DOMINO consortium

Coordinator:

Davide Neri

Department of Agricultural, Food and Environmental Sciences

Università Politecnica delle Marche

Italy

e-mail: d.neri@univpm.it

Partners:

Hristina Kutinkova, Fruit Growing Institute,

BulgariaMarkus Kelderer, Laimburg Research

Centre, Italy

Eligio Malusa, Research Institute of Horticulture, Poland

Maria-Martha Fernandez, Centre Technique Interprofessionnel Fruits Légumes,

FranceMichael Friedli, Research Institute of Organic Agriculture – FiBL, Switzerland

Sabine Zikeli, Hohenheim University, Germany

Stakeholders involved:

Werner Castiglione – BioSudtirol,

Italy Christian Gamper - Vi.P Bio

Vinschgau, ItalyReinhard Verdorfer

- Bioland Südtirol,Italy Ulrich Kiem

SBR organic, Italy

Vincenzo Vizioli – AIAB Associazione Italiana Agricoltura Biologica. Italy

Christoph Höfflin - Fördergemeinschaft Ökologischer Obstbau e.V.,

GermanyStowarzyszenie Polski EkoOwoc - Poland