Summary of the Online-Workshop: Making organic fruit growing more resilient – lessons learned from the Project DOMINO

On March 16th 2021, DOMINO organized a digital workshop to present the results of the project to a wider public. The workshop was hosted by the University of Hohenheim. A hundred participants from 12 European countries participated and discussed the project outcomes.

Sabine Zikeli (Center for Organic Farming, University of Hohenheim, Germany) presented the hosting University, the seminar and the organization of the program. She shared all the critical information, and introduced Julia Schneider, who was responsible for the virtual conference and for managing questions and logistics.
Davide Neri (Polytechnic University of Marche, Italy), coordinator of the project, opened the program by introducing the DOMINO project, the partnerships and the main objectives. The importance of escaping from the 'conventionalization' of management methods in intensive organic fruit production needs to be emphasized to face the reduction of biodiversity and the dependence on external inputs to maintain soil fertility and ensure plant protection. The research done in the DOMINO project aims to use recycled amendments, to increase biodiversity, to improve resilience and long-term sustainability, and to reduce the ecological footprint of organic fruit cultivation.

According to the project focus, the main workshop topics were 1) the integration of various new crops into the orchards, 2) new fertilization strategies to prevent nutrient imbalances and enhance internal nutrient use, and c) sheltered production to minimize the use of pesticides.

The workshop started with a stimulating keynote by Paolo Bàrberi (Institute of Life Sciences, Sant'Anna School of Advanced Studies, Pisa, Italy) on the "Challenges of enhancing biodiversity in permanent crops and solutions based on agroecology". He shared with the participants a four-step trait-based approach to foster biodiversity in agroecosystems, which benefits from a participatory approach to enhance acceptance among practitioners. The suitability of this approach for practical applications was demonstrated with an example of two organic vineyards applying different soil management practices and their impacts on biodiversity. The overall message from the presentation was that researchers and stakeholders need to come together in inter- and transdisciplinary action-research projects, and that researchers need to leave their comfort zone to boost the adoption of new agroecological practices.

Maria-Martha Fernandez (Centre Technique Interprofessionnel des Fruits et Légumes, France) then showed that DOMINO succeeded in testing many different species for the management of tree rows to increase biodiversity in the orchard. However, even though some living mulch species, like wild strawberry (*Fragaria vesca*), peppermint (*Mentha x piperita*) and *Potentilla reptans,* established well in vineyards and apple orchards, many others were not successful, did not establish and/or did not compete with weeds and thus were not able to control them. When comparing the potential of grain legumes (peas) and small seed legumes (dwarf alfalfa, micro clover and white clover) the impact of the local environment was striking: dwarf alfalfa and micro clover grew well and supplied sufficient

nitrogen in the South of France and Poland, respectively, while micro clover and white clover had problems germinating and faced high competition with grasses and weeds in the inter row in apple orchards in Switzerland and Germany. On the contrary, peas sown in the tree row developed well and provided a considerable amount of N to the trees in the Central European countries, although their performance was insufficient in Southern France.

As pest pressure is a key issue in organic fruit orchards, the impact of the innovative tree row management practices on both beneficial fauna and pests were assessed as well. Eligio Malusa (National Institute of Horticultural Research, Poland) showed that some living mulches reduced aphid infestations and increased the occurrence of predatory mites compared to the control. However, the effect depended on the apple variety assessed.

Patrizia Borsotto (CREA Research Centre for Agricultural Policies and Bioeconomy, Italy) introduced the participants to the approach used to assess the impact of the technical innovations introduced by DOMINO on ecosystem services. The assessment, based on the comparison of the stakeholders' perceptions between the current practices and the potential changes introduced by DOMINO, pointed out again the effect of local conditions. For example, while the impact of sheltered systems on biodiversity and aesthetics was assessed negatively everywhere, the impact of the row management on ecosystem services was perceived differently depending on the country. As a follow up, an economic assessment is planned, however, as not all ecosystem services have market prices, different methods to assess the impact of the practices applied in DOMINO on ecosystem services have to be applied.

As a keynote for the second part of the workshop dealing with the improvement of fertilization strategies in organic fruit growing, Else Bünemann-König (FIBL, Switzerland) gave a presentation entitled "Fertilization in Organic Farming – Challenges and Potentials". She presented results from the RELACS project on the assessment of nutrient inputs and nutrient balances in organic farming in Europe. From RELACS it became clear that an increased reliance on biological nitrogen fixation of the farms tends to result in nutrient mining for phosphorus and potassium. Accentuated by increasing area under organic management, there is a need for external nutrient sources, and the organic sector has to discuss the conditions for acceptance of recycled fertilizers made from human wastes.

Thomas Holtz (Organic Farming Group, Laimburg Research Center, Italy) and Sabine Zikeli (Center for Organic Farming, University of Hohenheim, Germany) took up the topic and presented the results of the fertilizer assessments done in DOMINO in incubator, pot and field trials in Italy, Poland and Germany. The tested fertilizers - biogas digestates, clover-grass based products (i.e. silage and pellets), and peas sown in the tree row and mulched - were found to be feasible substitutes to currently used fertilizers (e.g. horn grit, poultry manure or silage), as differences in yield and product quality were mostly not significant in comparison with the traditionally used fertilizers. The results from mineralization studies from incubator and pot trials revealed different timings in nitrogen release by the different organic amendments and thus created a basis for improving synchronization between amendment application and crops' seasonal needs. However, the use of clover-grass silage and peas has to be adapted to local conditions in order to minimize N immobilization and untimely N release. To overcome the risk of nutrient imbalances (surplus of N and P, deficit

of K) soil and leaf nutrient contents need to be monitored, and nutrient balances need to be calculated in order to alternate the kind of fertilizers used and to adapt the nutrient supply to soil and plant needs.

In the last part the of the workshop, Clémence Boutry (FIBL, Research Institute of Organic Agriculture, Switzerland) and Thomas Holtz presented the results of a temporary coverage system for sheltered apple production that was tested in Switzerland and Italy. The coverage system reduced the occurrence of pests and fungal diseases considerably, also during storage. However, it was not possible to eliminate diseases completely. Due to the changed microclimate, diseases such as powdery mildew gained importance. Furthermore, pests overwintering on the trees can become a problem. Despite the positive effects, in particular the great reduction in plant protection and scab control, one has to consider the workload for the management of the nets and that the training of trees needs to be adapted to the nets.

During the final discussion, Davide Neri (Polytechnic University of Marche, Italy), coordinator of the project, and Markus Kelderer (Group Organic Farming, Laimburg Research Center, Italy) summarized the outcomes from the workshop on the three main areas of DOMINO research, pointing out the following:

1) First steps have been made to increase biodiversity in organic orchards and vineyards by introduction living mulches in the tree row, but open questions remain on how to maintain the living mulches in the long-term due to competition with weeds and trees and how to select appropriate species for the different locations. In addition, it should be addressed whether farmers will accept this new cropping system, as there might be no additional direct financial return, though higher costs for seeds and plantlets of the living mulches exist. However, the positive effects of the living mulches on ecosystem services are a reality that could be considered when developing policies supporting agroecological practices.

2) The alternative fertilizers tested in DOMINO are valid options to the currently used contentious inputs that can enhance internal nutrient cycling. However, the application of clover-grass based fertilizers and peas as living mulches need to be adapted to local conditions. None of the alternative fertilizers alone can solve the problem of imbalanced nutrient flows in orchards; this can only be achieved by alternating different fertilizers according to site-specific conditions. The mineralization studies using incubator and pot trails were found to be very helpful for improving synchronization between amendment N release and crops' seasonal needs.

3) Sheltered production systems efficiently reduce pesticide application, but costs are high and pests can be more aggressive under the physical cover, e.g. wooly aphids. In addition, negative perceptions of local citizens might prevent their use. It should be emphasized that in an overall assessment of protection techniques, in addition to agronomic and economic factors, environmental aspects are also of primary importance, in particular the emissions of greenhouse gases correlated with a specific technique. From an analysis of the carbon footprint (CF) of different types of physical protection with a life cycle assessment (LCA) methodology, protection generally requires high quantities of plastic and metal components that inevitably generate a high carbon footprint. The installation of anti-water and anti-

insect covers can generate a footprint of up to roughly 1,500 kg CO_2 equivalent per hectare per year, while a traditional anti-hail net generates values equal to about half.