


PromESSinG

Promoting EcoSystem Services in Grapes
Main outcomes of the PromESSinG project



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biodiversa

Biodiversity, ecosystem services and viticulture

Viticulture shapes the landscape setting in many European regions since centuries. In contrast to annual cropping systems the cultivated plants only occupy a small portion of the ground allowing non-crop vegetation to develop in inter-rows and under vines. Vineyards have therefore a high potential for providing habitats for a diverse range of organisms within the cultivated area. However, in the last decades, viticulture was intensified in many areas across Europe going along with an increased use of pesticides and intensive soil management. In addition, vineyard-surrounding semi-natural vegetation such as woodlands, hedgerows, fallows and grass strips were often removed turning vineyard landscapes into rather homogenous environments.

Accordingly, new approaches are needed to secure food production while creating sustainable agricultural systems requiring as few external inputs as possible. The interaction between biodiversity and ecosystem services (ESS) is recognized to play a key role in this context although large gaps in knowledge exist. In the framework of the project "Promoting ecosystem services in grapes" (PromESSinG) management options for promoting biodiversity linked ESS were identified in order to reduce external inputs in Central European vineyard ecosystems. The project thus intended to unravel biodiversity driven processes associated with the main ESS in viticultural systems taking different management factors into account.

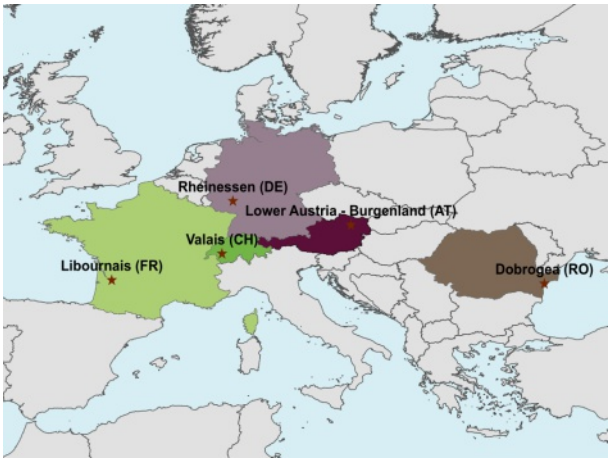
Vineyard landscapes included in the PromESSinG project - from left to right : Valais (Switzerland), Libournais (France), Rheinessen (Germany), Burgendland (Austria), Dobrogea (Romania)

This brochure summarizes the main results achieved in the project PromESSinG and gives management recommendations for winegrowers and other stakeholders in order to maximize ecosystem services in viticulture.

The PromESSinG project

Main Objective

Vineyard soils provide an important habitat for many species and soil management strategies are main drivers for optimizing yield and quality of grapes. The major objective in PromESSinG was therefore to ask how vineyard biodiversity of soil microorganisms (bacteria and fungi), soil meso- and macrofauna as well as plants support to vineyard ecosystem services and thus provide benefits to the vinegrower.

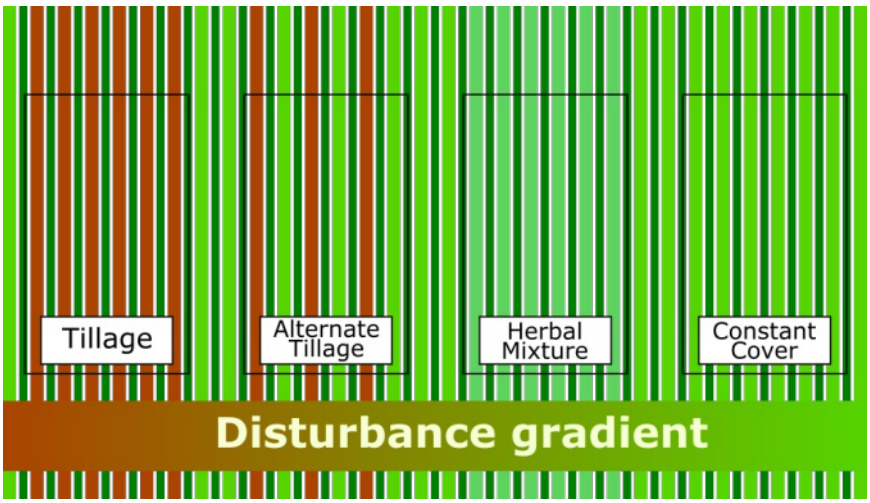


Location of PromESSinG study sites in Europe

Experimental setup

The PromESSinG project was set up in five Central European countries: Germany, France, Switzerland, Austria and Romania. Study areas represent important viticultural regions and cover a gradient from maritime to continental climates. In a common study with all regions involved we analysed the links between diversity of soil relevant species groups, main ecosystem services and management practices using a standardized study design that allowed to compare results across countries.

In addition, individual regional studies based on experimental sites in Germany, Switzerland and France focused on the effects of nitrogen fertilization, farming type (conventional, organic) as well as the amount of copper content in vineyard soils and therefore provided further insight in functioning of vineyard ecosystems. Here, further species groups such as solitary bees, spiders and fungi pathogenic to soil dwelling larvae were considered.



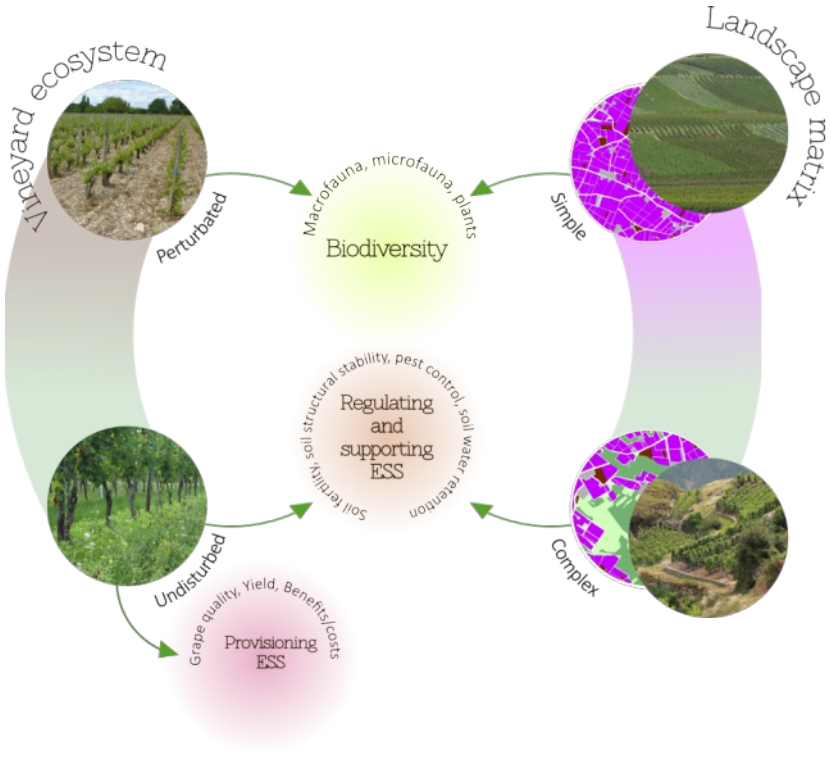
Scheme for experimental plots : example of modalities set-up in Germany

Vineyard soils and viticultural landscapes in focus

PromESSinG focused on effects of vineyard soil management strategies and vineyard surrounding landscape structure for promoting biodiversity and ecosystem services. Three different types of vineyard soil management were applied in experimental plots in all vineyards: bare ground, complete vegetation cover, and both types arranged in alternating alleys. Individual teams also focussed on green manure or species rich seed mixture as additional treatments.

Landscape scale was included in our study by selecting vineyards located in landscapes with different densities of hedges, woodlands, grasslands and other semi-natural habitats in order to analyse their effects on within-vineyard biodiversity.

Experimental plot showing perturbated (left) and undisturbed (right) modalities

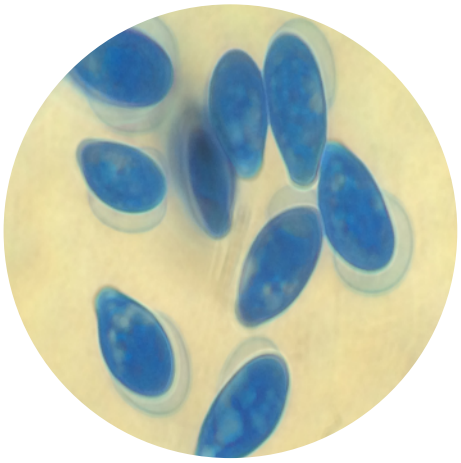


Parameters and their interactions studied in the PromESSinG project

Groups and traits in focus

Soil microoganisms

Soil microorganisms comprise a great diversity of different life forms and are the most abundant group of organisms in soils with thousands of different bacterial and fungal species in one gram of soil. Their activity is crucial for most fundamental soil functions such as decomposition, nutrient cycling, carbon cycling, soil stabilization.



Mesofauna

Several taxa of microarthropods are associated with soil functioning and soil organic matter decomposition. Springtails (Collembola belonging to the hexapods) and some taxa of the subclass of mites (Acari such as Oribatids) are the most studied and well-known arthropod detritivores. They can directly consume organic matter or indirectly stimulate its decomposition by consuming saprophytic fungi and bacteria. Disturbance by tillage in agricultural systems or variation of organic matter content due to management negatively impact their abundance and diversity.

Carabids

Carabids, also named ground beetles, provide important ecosystem services by consuming various insect pests and weed seeds. Several species are adapted to open habitats and intensively managed agricultural landscapes such as vineyards. Their abundance and diversity in perennial crops is likely to be influenced by the proportion of semi-natural habitats around fields and by soil management on a field scale. Their response to habitat complexity and diversity in the agricultural landscapes ranges from negative to positive effects of the proportion of semi-natural habitats in the surroundings.

Groups and traits in focus

Grape Quality

Grape production for wine making has a long lasting tradition across Europe, shaping the landscape and in many cases being the main income for farmers. Grape quality is therefore an important provisioning ecosystem service. Within PromESSinG the effects of soil management strategies on grape quality parameters were assessed. This was achieved by analyzing standard must parameters such as soluble solids, titratable acid and yeast assimilable nitrogen.

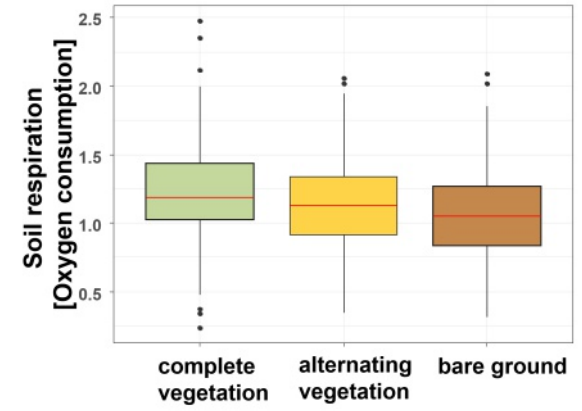
Solitary bees

Less known than their honey-producing relatives, solitary bees with around 20,000 species represent an important group of insect pollinators. They can colonize a variety of different habitats, while most of the species build their nests in soils. To persist, they need nesting and feeding resources. Even though vine is mainly self-pollinated, presence and diversity of solitary bees in vineyard landscapes can contribute to pollination of other crops. Solitary bee abundance and diversity was assessed in German organic and conventional vineyards located in viticultural landscapes with different complexity.

Entomopathogenic fungi

Entomopathogenic fungi (EPF) are important antagonists of soil-dwelling insect pests adapted to living in agricultural soils. They could be effective against soil-borne pests such as grapevine phylloxera. However, the high frequency of fungicide applications might reduce the effectiveness of EPF in vineyard soils. We compared effects of organic and conventional management, fungicide applications and soil parameters on natural occurrence of EPF in German vineyards.

Key results



Microbial activity (measured as the consumption of oxygen per gram of dry soi) is higher in vineyards covered with complete vegetation than in vineyards with bare ground

Soil sampling in field

Soil microorganisms

To assess the effect of soil disturbance we used genetic methods to look at bacterial and fungal diversity and the compositions of their communities. Additionally we measured the activity of the soil microbes by looking at the consumption of oxygen of the microbes in a soil sample and we measured the decomposition rates of organic material.

On average we found about 2000 different bacterial species and ~290 fungal species in ¼ Gram of vineyard soil. We could show that across all participating countries soil disturbance did not primarily affect the diversity of microorganisms but mainly the composition of microbial communities. An even stronger pattern was found for microbial activity which was clearly lower in vineyards with a high level of disturbance (bare ground). Decomposition rates of organic material was only weakly affected showing a slightly higher decomposition rate in more disturbed plots.

What about soil copper contamination ?

Copper sulfite is regularly applied in vineyards as a pest control agent to prevent fungal infestations on grapes. We have measured the soil copper contamination in the vineyards and observed that copper content had a strong non-target influence on the soil microbial community compositions of bacteria, fungi and protozoa.

Key results

Mesofauna

Abundance of soil microarthropods was quite high in our samples, with about xxx individuals per m^2 in the top-soil layers (10 cm depth). Both Acari or Collembola abundances decrease in more disturbed treatments (tillage) compared to complete cover plots.

Microarthropods are strongly involved in ecological interactions and functioning of soil and recycling of nutrients. Their abundance but also their diversity is negatively impacted by tillage in vineyards, the herbaceous diversity and cover in inter-rows enhancing their living conditions.

Extraction of meso-fauna

Ground beetles

Carabids were sampled in 69 vineyards across Europe between 2015 and 2017. Their abundances are quite similar to those of other agricultural studies. Tillage and intermediate disturbance treatments (like green manure or alternating covers between vine-rows) led to significantly higher species richness and activity-density (a proxy for abundance) of carabids in our European vineyards.

By their diversity and abundance, carabids are potentially contributing to several ecological functions in vineyards like weed or pest control. However, we could show that landscape structure is more important for this species group than soil management.

A pitfall trap, used to sample carabids

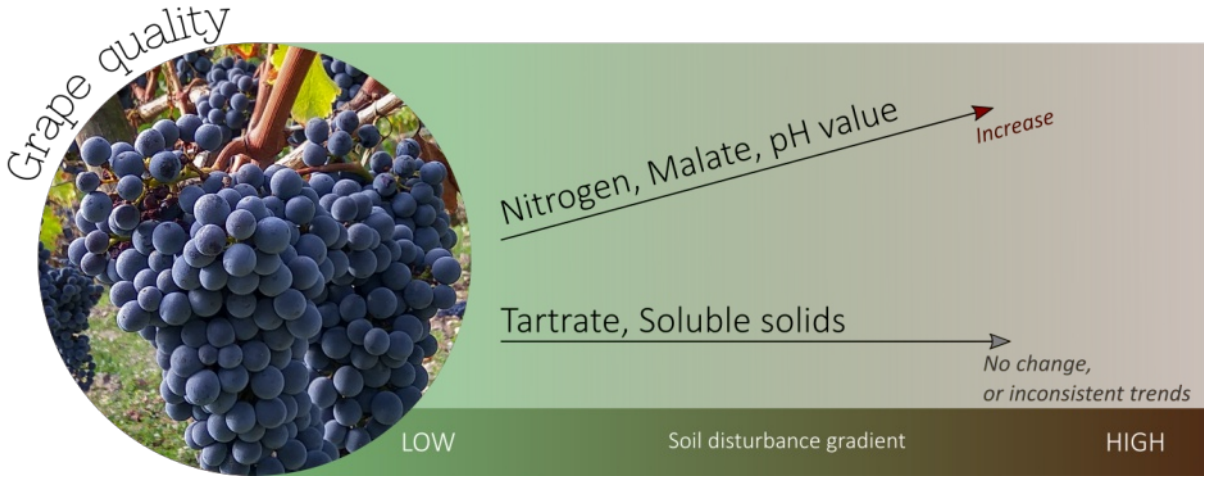
Key results

Collecting berries for quality analysis

Grape Quality

The process of wine making can be both, highly technical or very natural, depending on the winemaker's philosophy and the type of wine produced. But in both cases high quality and healthy grapes are necessary. Successful fermentation needs available sugars and nitrogen to feed the yeast and to minimize the amount of undesirable by-products like off odors. Especially the available nitrogen in grape must depends on many factors as grape variety, rootstock, soil and viticultural practices. Across Europe we determined a wide range of available nitrogen in must, from 20 up to 500 mg L-1 (recommendations range from 150 – 400 mg L-1).

Available nitrogen was differing to quite an extent between vineyards in the same country as well as between countries. Must obtained from some vineyards in France and Romania showed quite low values, whereas higher values were observed in Austria and Switzerland, the values obtained in Germany were in between. Although the absolute values were different the effects of the different cover crop managements was the same in all countries: repeated tillage to ensure bare ground gives higher mobilization of N and higher contents in grapes. This can be beneficial for vineyards which are low in nitrogen, but on the other hand could lead to higher N availability and increased vegetative growth, more compact berries prone to *Botrytis* infections and high must N content leading e.g. to undesirable amines. A balanced nutrition is important and permanent vegetation cover ensure higher diversity and other ESS. Winegrowers need to stabilize their nutrition of vines by establishing an equilibrium which is maybe not possible for any soil and climatic conditions, but could help to combine positive ecological effects with sustainability of grape production.

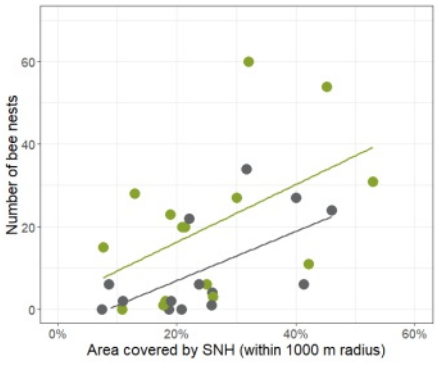


Evolution of quality parameters according to soil disturbance gradient

Key results

Solitary bees

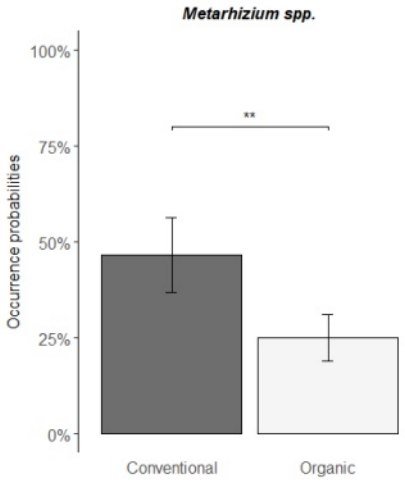
We analysed impacts of organic and conventional management as well as landscape structure on abundance and diversity of solitary bees in artificial trap nests installed in 15 organic and 15 conventional vineyards in Rhinehessen, Germany.
We found 918 solitary bee nests in our trap nests in total, comprising 15 bee species. 3 of these bee species are red listed. Bee abundance and diversity was higher in vineyards surrounded by large amounts of semi-natural habitats. In addition, organic farming supported higher bee abundances. We could show that this important pollinator group can nest in vine growing systems and can be promoted by preserving, maintaining and establishing semi-natural habitats in viticultural landscapes - maybe in cooperation with local conservation groups. On a local scale, organic management can additionally promote solitary bee abundance.



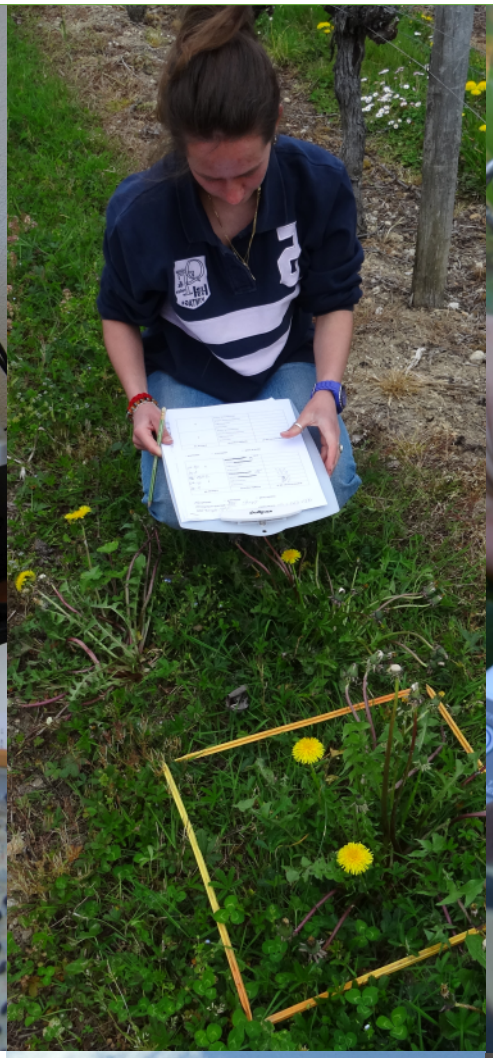
Abundance of solitary bees in vineyards is positively influenced by the area covered with semi natural habitats in viticultural regions

Entomopathogenic fungi

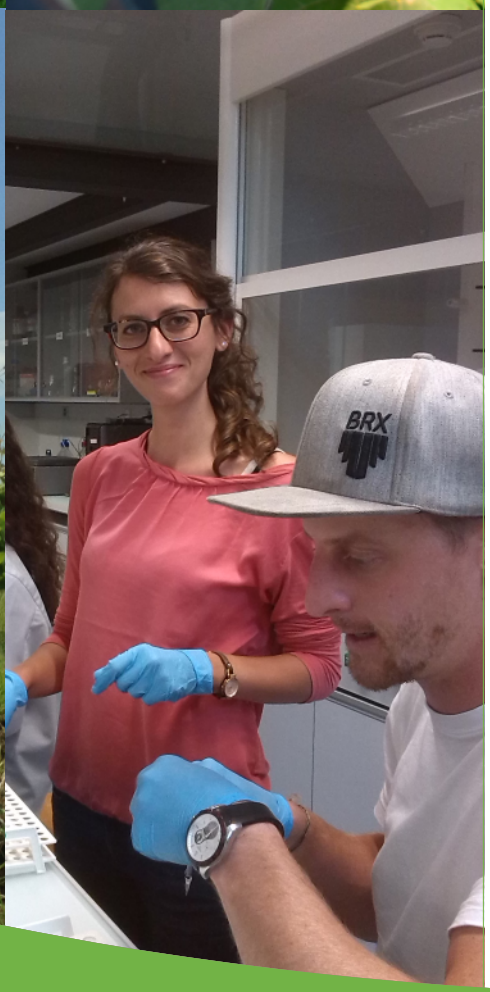
Presence of entomopathogenic fungi in our studied organic and conventional systems was mainly driven by soil nutrient conditions, with a high C:N-ratio being the main predictor for their occurrence. We could show that in spite of the intensive fungicide applications, soil-borne EPF and especially the genus *Metarhizium* can have high frequencies in vineyard soils.



Fungi of the genus *Metarhizium* occur significantly more often in conventional than in organic vineyard soils

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More information ...

Partners

If you would like to know more you can obtain more information under www.promessing.eu, or contact the PromESSinG team!

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