# **REPORT ON SOIL HEALTH AND BIODIVERSITY**

Commissioned by the Nordic Alcohol Monopolies – a joint working group consisting of Alko, Vinmonopolet, Vinbuðin, Rúsdrekkasøla landsins and Systembolaget.



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# 1.BACKGROUND

### 1.BACKGROUND

### **1.1.** The origin of this report

The Nordic Alcohol Monopolies have chosen biodiversity and soil health as the focus topic for 2021. This report is the result of a project to further increase the knowledge on biodiversity and soil health in cereal and grape farming and to map the most common certifications, standards, and other sustainable farming methodologies. The expected usage of this report is to build internal knowledge of these topics so that the Nordic Alcohol Monopolies can guide suppliers and producers, as well as inform costumers about what the best practices are to promote soil health and biodiversity.

### **1.2.** Biodiversity and the beverage industry

Biodiversity and healthy soils are of vital importance for agriculture. Their benefits include sustained crop production, pollination, protection from crop pests and diseases, water regulation and purification, nutrient cycling, and carbon sequestration. The beverage industry is 100 % dependent on nature's delivery of ecosystem services, such as grapes and cereals. Biodiversity and healthy ecosystems are the best insurance for nature's long-term capacity to deliver those ecosystem services. Traditional smallscale agriculture and viticulture landscapes are also important habitats for many species, creating a symbiosis of sorts. However, the expansion and intensification of agriculture are among the biggest threats for both biodiversity and other soil properties globally, which in turn threatens the long-term productivity of agricultural soils. Such threats to biodiversity and soil degradation from agriculture globally include the destruction, degradation, and fragmentation of habitats, which results in species losses and increased vulnerability of remaining populations, and altered species interactions.

Within a human lifetime, the soil is considered a non-renewable resource, and the global extinction rate of species has reached alarming rates. Hence, agriculture urgently needs to transform into a more sustainable industry.

Globally, cereal agriculture covers around 730 million hectares of land, some of which is used for the production of alcoholic beverages, and land for viticulture covers around 7.5 million hectares. In this document, we have summarized information from the scientific literature that has identified important viticulture and cereal agriculture practices for sustaining biodiversity and soil health, and by that contributing to the agricultural systems' long-term stability and resilience to future disturbances and environmental change. Best practices for viticulture are presented in chapter 2, and best practices for cereal agriculture are presented in chapter 3.

#### **Biodiversity**

Biodiversity is defined as "The variability among living organisms from all sources, including, 'inter alia', terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems."

The definition used by the United Nations Convention on Biological Diversity

#### Soil health

There is not a single clear definition of soil health, but a commonly used definition is "the continued capacity of soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain biological productivity, promote the quality of air and water environments, and maintain plant, animal, and human health".

Soil health and soil quality are used interchangeably in the literature, but sometimes a distinction is made where either:

- soil quality refers to a snapshot in time of soil parameters, whereas soil health refers to the soil's continued long-term ability to function, or
- soil quality focuses on benefits for humans, whereas soil health refers to the soil as a vital living and functioning system

The focus on the soil as a living system highlights the importance of living organisms in the soil i.e., biodiversity in the soil.

#### **Ecosystem services**

Ecosystem services are the products and services that nature freely and of itself provides us with, and upon which we are dependent for our survival and wellbeing. Examples of ecosystem services include food production, water purification, protection against erosion, climate regulation, and recreation.

# **1.3.** Certifications as a means to promote sustainable production

Certifications are a great tool in the Nordic Alcohol Monopolies sustainability toolbox. Certifications are beneficial throughout the value chain as they enable traceability of the product's sustainable performance. The monopolies and their suppliers can set strategic goals for a certain percentage of certified beverages, the consumer can choose the certification that suits them, and the farmer has clear guidance through the processes of the certificates.

There is however an increasing number of certifications, farming standards, and methodologies. As the demand for, and interest in, sustainable production increases, it is necessary for the Nordic Alcohol Monopolies to increase the understanding of all these sustainable farming practices.

This report includes a review of the following sustainable farming concepts:

### Certifications

- Organic
- Biodynamic
- California Sustainable Wine
- Equalitas,
- Fair'N Green
- Vin Méthode Nature

In this report, the certifications, standards, and methodologies are presented separately based on their relevance to the wine or beer and spirits industry; those relevant to the wine industry in chapter 2, and those relevant to the beer and spirits industry in chapter 3.

#### Other standards or methodologies

- Agroforestry
- Carbon Farming
- Regenerative Agriculture
- Permaculture

## 2. FOR VINEYARDS, WINERIES, AND OTHER ACTORS IN THE WINE INDUSTRY

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### 2.1. Best practices in viticulture

The practices that have the highest scientific consensus with regards to what is important to improve the soil health and biodiversity in viticulture are:

#### • No or reduced use of agrochemicals

Pesticides and herbicides have a severe long-term impact on soil and aboveground biodiversity, which in turn have a long-term effect on productivity. Studies have shown that it can take 35 years before soil microbial activity is restored after intensive use of pesticides and mineral fertilizers has ceased, highlighting the urgency of reducing their use. Although pesticides can be effective in reducing pest species, they also have negative effects on their natural enemies, reducing nature's built-in cost-free pest protection. Mating disruption by using insect pheromones can be an effective alternative method of pest control.

#### Organic fertilizer

The effects of adding organic fertilizers depend on the type of soil and fertilizer, but it is overall better to use organic fertilizers than mineral fertilizers, which can have a long-term effect on soil biodiversity and microbial activity. Pruning wood can effectively be used as organic fertilizer in vineyards.

#### • No or reduced tillage

A reduced or ceased tillage is beneficial for soil and aboveground biodiversity, soil aggregate stability, soil respiration, and soil carbon sequestration.

#### • Soil cover

Mulch soil cover can be used to increase soil biodiversity, and the use of cover crops increases soil and aboveground biodiversity, natural enemies of pest species, soil organic carbon, water infiltration, and aggregate stability. Cover crops can also reduce soil erosion and the emission of green-

house gases. Using flowering cover crop species can be beneficial for wild bee species. Legume cover crops contribute to the natural binding of nitrogen from the air. When choosing and managing cover crop species composition, local conditions of water and nutrient availability should be considered. Another aspect to think about is that the natural pest enemies often stay in the cover crops, meaning that they don't reduce the pest pressure on the grapes as much as they could. Mowing the cover crops can assist in spreading the natural enemies from the cover crops to the vines.

- *Diversification of the agricultural landscape and green-blue corridors* A more diverse landscape increases soil and aboveground biodiversity, natural enemies of pest species, as well as reduces pest damage. The availability of water is of particular importance for biodiversity. There are multiple ways by which the agricultural landscape can be diversified. For example, by
  - setting aside parts of the land for semi-natural areas,
  - constructing ponds,
  - creating green-blue corridors (strips of semi-natural areas and ponds connecting the habitats), and,
  - management practices to increase plant diversity.

#### • Buffer zones around water bodies

A buffer zone of natural vegetation around water bodies reduces nutrient addition to the water from run-off. It also diversifies the agricultural landscape and generally enhances the in-water habitats.

While we have tried to order this list with the most important practices at the top of the list, the most important practices will depend on the local context and the properties of each specific farm.

# **2.2** Requirements of best practices in certifications, standards and methodologies

Mapping gives a good knowledge base of which certifications, standards and methodologies are most effective and how to work together with certifying bodies to develop the certifications to include other parts.

**Table 1** below presents an overview of how the different certifications, standards and methodologies incorporate the best practices in their requirements. Each of the certifications, standards and methodologies is described more thoroughly in the following chapter.



		Certifications						Other standards and methodologies				
		Organic (EU)	Organic (USDA)	Biodynamic (Demeter)	ccsw	Equalitas	FairN Green	Vin méthode nature	Agroforestry	Carbon Farming	Permaculture	Regenerative Agriculture
rity	Reduced use of agrochemicals											
hest pric	Organic fertilizer											
Hig	No or reduced tillage											
High priority	Soil cover											
	Diversification of the agricultural landscape and green-blue corridors											
	Buffer zones around water bodies											

**2.3.** Introduction to common certifications, standards, and methodologies for sustainable viticulture

#### Certifications

#### **Organic (EU Organic and USDA Organic)**

Organic farming could be defined as "an integrated farming system that strives for sustainability, the enhancement of soil fertility and biological diversity while, with rare exceptions, prohibiting synthetic pesticides, antibiotics, synthetic fertilizers, genetically modified organisms, and growth hormones". For example antibiotics are only allowed for treatment of diseases but not for proactive use.

Organic is also a certification. In the EU, the certification for organic farming is the 'EU Organic' which is defined by EU legislation. The first EU legislation on organic was enforced in 1995. The current legislation was decided in 2010. There are many different certification programs within the EU, all following the same legislation.

The EU legislation has become the norm in the whole world, apart from The United States, where the organic requirements differ slightly. The differences between USDA Organic and EU Organic are note relevant for the effect viticulture has on soil health and biodiversity. The difference could however have an impact on soil health and biodiversity in general as EU Organic demands that the animal's feed should be produced on the same farm, or at least in the same region.

#### The key principles of EU Organic and USDA Organic are:

- The use of chemical pesticides and synthetic fertilizers is banned
- Antibiotics are severely restricted
- GMOs (genetically modified organisms) are not allowed

The International Federation of Organic Agricultural Movements (IFOAM) is a global umbrella organization that represents organic farming in European policymaking and advocates for sustainable farming. IFOAM represents almost 800 organizations in 117 countries.

#### USDA Organic versus 'Wine made with Organic Grapes'

United States Department of Agriculture legislates the rules for the certification 'USDA Organic'. It is however very rare to find the labeling USDA Organic on wines. The reason is that the certification strictly forbids any amount of sulfites, which is commonly used in the winemaking process. That is why the label "Wine made with organic grapes" is more common. This does require organic grapes but has no restriction on sulfites.

#### Potential damage through long term use of Copper

As chemical pesticides are strictly limited for organic practitioners, farms have to use other methods to manage pests. One practice is the use of Copper as a pesticide. There is still a debate about the use of copper and its effects on soil health and biodiversity. There are concerns that long-term use of Copper can damage soil health since the Copper accumulates in the soil. A recent meta-analysis shows that microbial activity decreased by 30% when a very high amount, 400 kg of Copper, was applied yearly per ha. The research did however conclude that applying copper at 4 kg/ha/ year, which is the level currently authorized by the EU Organic for viticulture, should not substantially modify soil biological quality and functions. However, since copper does accumulate in the soil, a 100-year continuous application in line with the EU Organic regulations would accumulate to 400 kg of copper, which in the research had severe effects on the soil health. Demeter limits the use of Copper to 3 kg/ha/year.

# The certification's relations with "best practice" found in the literature review

Organic has a strict limitation on agrochemicals. Due to this limitation, farmers have to use other practices to maintain fertile soil and protect against pests and mites. There are a lot of different possible practices but two of the most common ones are no or reduced tillage and cover crops.

Organic certifies on crop level, while all other certifications (described below) certify on farm level. Since organic focuses on crop-level, the certification doesn't have any requirements of buffer zones or diversification of the landscape.

#### **Biodynamic Farming (Demeter and Biodyvin)**

Biodynamic farming is a way of farming and gardening with a specific holistic and spiritual approach to growing food sustainably that originates from the philosophies of Rudolf Steiner. Biodynamic farming is not under government control which means that a farmer can call himself biodynamic even if he or she isn't certified. To become a certified biodynamic vineyard, the vineyard first needs to meet the requirements of EU Organic together with some additional requirements set by the certifying program. There are two dominant certification programs for Biodynamic farming, Demeter and Biodyvin.

#### Demeter

Demeter, the main certifying program for biodynamic farming, was established in Europe in 1928 and the US in 1985. There are approximately 700 wine producers worldwide certified through Demeter.

In addition to the requirements of EU Organic, the key practices and requirements for Demeter are:

- Animal husbandry is mandatory on all farms larger than 40 ha
- Inclusion of specific biodynamic preparations
- Biodiversity conservation area of at least 10% of farm area
- Demeter certifies on farm level, EU Organic on crop level
- Considerations are taken to distance to organic or conventional farms to reduce airborne residues of agrochemicals.

#### Biodyvin

Biodyvin is a French label and certification for biodynamic winemaking. It started in 1995 and currently has 175 estates in France, Germany, Italy, Portugal, Switzerland, and Spain.

Biodyvin has less detailed and specific requirements than Demeter. The idea is more to tend towards a reduction of the additives in wine. In a contrast to Demeter, which is managed by an anthroposophical company, Biodyvin is managed by a union of winegrowers. Biodyvin also includes a tasting of the wines which Demeter doesn't.

## The certification's relations with "best practice" found in the literature review

Biodynamic farming covers more of the best practices than organic farming. The inclusion of animal husbandry and the requirement of a conservation area have positive effects on biodiversity and soil health as they (i) help diversify the landscape, and (ii) enable the local production of organic/biodynamic fertilizer. The specific effects of the biodynamic preparations are not scientifically proven. Long-term field trials by FiBL (Forschungsinstitut für Biologischen Landbau) comparing biodynamic, organic, and conventional cropping systems does however suggests biodynamic practices as effective. FiBL: "In the biodynamic system, soil organic matter (humus) content remained stable for the first 21 years of the trial while it declined in all other systems".

#### Certified California Sustainable Wine (CCSW)

California Sustainable Wine Association (CSWA) was established in 2004 after a report on sustainable farming practices in the Californian region. The possibility to be certified as Certified California Sustainable Wine was launched in 2010. The certification is done after the 'Code of Sustainable Winegrowing' published by CSWA.

The Code of Sustainable Winegrowing has a strong focus on continuous improvement, which all certified vineyards and wineries must demonstrate. For each measure in the certification, there are four categories (see example in table 2), where a vineyard should aim to move from Category 1 (least consideration) to Category 4 (best rating). For a vineyard to become certified there are 60 required prerequisite practices and the vineyard needs to fulfill at least 85% of the requirements in Category 2.

8-4 Ecosystem Management – Riparian Habitat Vineyard & Winery								
Category 4	Category 3	Category 2	Category 1					
Banks of water courses have vegetated buffer strips adjacent to the waterway <i>And</i> Outside the buffer strip is a row of trees and shrubs that shade at least part of the water course.	Banks of watercourses have vegetated buffer strips adjacent to the waterway.	Vines are not planted up to the edge of the watercourse, but no vegetated buffer exists, or there are areas without buffer strips between the winery and waterways	The winery is located or the vineyard is planted up to the edge of the watercourse to maximize the land area used (in accordance with legal requirements). (Select N/A if there was no riparian habitat or waterway)					

Table 2. Example of the structure of The Code of Sustainable Winegrowing (CCSW, 2020)

The CCSW includes prerequisites covering a great width such as knowledge about ecosystems: e.g. "The vineyard or winery's role in a diverse and healthy ecosystem is understood, and there was an understanding of which practices promote ecosystem biodiversity". The handbook does not only include the best practice on which the farms are assessed, but it also includes educational material on many of the topics.

## The certification's relations with "best practice" found in the literature review

CCSW does not have a strict ban on chemical fertilizers, pesticides, or herbicides. CCSW focuses on having a controlled usage of agrochemicals. CCSW is, based on the material reviewed, the certification with the lowest pressure on reduction of synthetic fertilizers. Only the highest category guides the farmer to set an economic threshold, i.e., an acceptable level of damage from insects and mites. The goal on this level is to maintain the level of pests and mites below this threshold with natural processes and cultural controls.

For herbicides, the requirements are low. In category 2, the level required for certification is formulated; *"The entire berm or vine row was treated with herbicides, and some weeds were tolerated."* 

CCSW has a low focus on reduced tillage. It is only a potential part of the requirement of a *"floor management strategy to reduce runoff"*. For categories 3 and 4, CCSW does however require some permanent nontiled vineyard row cover crop.

Of all the "best practices" CCSW has the highest requirements for Cover crops. One requirement being: "an annual resident cover crop (non-seeded) was managed between vine rows during winter".

With regards to enhancing biodiversity and soil health through the diversification of landscape, CCSW lacks requirements of a biodiversity conservation area or integration of forests.

#### Equalitas

Equalitas is an Italian certification for sustainable wine production. Equalitas certifies vineyards on three different levels:

- Organizational level: Sustainable Organisation module, SO
- Product level: Sustainable Wine module, SP
- Regional level: Designation of Origin for Sustainability module, DOS

The vineyard, wineries, and regions are all judged by the 'Equalitas Standard'. This standard is built upon three different levels of requirements:

- Major requirement (M)
- Minor requirements (m)
- Recommendation (R)

An organization qualifies for the certification if the farmer/winery complies with 100% of the major requirements, and that within 3 years also fulfills 30% of the minor requirements and 10% of the recommendations.

Equalitas requires the use of three indexes for biodiversity:

- *The soil biodiversity index* is an indicator of soil pollution. The index is derived from analyzing the population of microorganisms' life in soil samples.
- *The freshwater biodiversity index* is an indicator of the amount of pollution that is emitted to the surrounding waters. The index is derived from analyzing the population of microorganisms in water samples.
- *The lichen biodiversity index* is an indicator of the air quality of the farm. The index is calculated by inspecting both population sizes and different species of lichen within the farm.

#### Fair'N Green

Fair'N Green is a sustainable wine certification from Germany, with currently 67 wineries certified in six different countries: the Netherlands, Austria, Switzerland, France, Italy, and Israel. Fair'N Green standard, which is available online, is not as specific in its requirements compared to the other wine certifications. The certification process of Fair'N Green depends to a high degree on the third-party consultants that conduct the assessments on site. As an entry requirement, farms have to reach 50% of the points to be able to be certified and then improve annually by three percent.

The phrasing of Fair'N Green's is less directional than Equalitas or CCSW and hence the criterion for judgment is less transparent. As an example, "The grower takes measures to protect and promote the soil fauna of his cultivated areas" rather than having a requirement of certain measures. The reason for this is to take regards to the farm's specific conditions and climate.

Fair ´N Green is currently working with a group of experts on an update and review of the biodiversity section of their criteria catalog.

Apart from being a certification program, Fair'N Green is also involved in biodiversity research projects. Together with Geisenheim University of Applied Sciences, they are developing a *Biodiversity toolkit for viticulture*. Initially, 30 model wine estates from all wine-growing regions in Germany will be selected and a "biodiversity plan" with concrete objectives will be established for each farm. The farms will be intensively advised and supported in the implementation of biodiversity measures. The implementation of measures will be accompanied by floristic and faunistic monitoring.

## The certification's relations with "best practice" found in the literature review.

Even if Fair'N Green is partly vague and non-directional in its requirements, the ambition level of the requirements are high and a farm that is certified Fair'N Green will have implemented measures to protect and enhance biodiversity. We believe that of the certifications analyzed in this report, Fair'N Gren generates the highest biodiversity and soil health.

Fair'N Green is the wine-specific certification with the strongest requirements for the reduction of agrochemicals. Synthetic-conventional herbicides and conventional insecticides are not allowed (unless there are local requirements by regulatory authorities to the contrary).

With regards to fertilizers, the farmer "usually doesn't" use synthetic nitrogen fertilizers. Fair'N Green states that "the nutrient supply should be ensured through sowing or comparable measures" and requires that the farmer produces his own organic fertilizer if possible. Self-produced organic fertilization is beneficial both for soil and biodiversity locally as it requires the inclusion of animal husbandry. But it is also beneficial for reduced carbon emissions as the carbon cycle is closed on the farm. This makes Fair'N Green's agrochemical requirements some of the most beneficial to soil health and biodiversity of all the certifications, standards, and methodologies.

Diversification of the landscape is strongly addressed through several requirements. Soil cover is primarily addressed through the requirement of the grower to return the harvest residues to the agricultural land.

#### Vin Méthode Nature

Vin Méthode Nature is a new French certification from 2019. The certification intends to protect and promote natural wine. Natural wine does not have any official global definition. The Vin Méthode Nature is an effort to create one.

The requirements of Vin Méthode Nature with the highest materiality for biodiversity is that the grapes have to be certified Organic or Demeter and that the grapes need to be picked manually. The other requirements are on the production phase, which aims to be as natural as possible. Vin Méthode Nature comes with two different versions of the certification. One allows a small number of sulfites before bottling while the other does not.

Vin Méthode Nature has now been approved by the French authority DGCCRF (the French bureau or department for competition and consumer protection). The certified organizations are thereby allowed to put the certification text and logo on the label. However, this does not mean that the DGCCRF has initiated or supported the definition or that the authorities see it as a first step towards an official definition.

## The certification's relations with "best practice" found in the literature review

Vin Méthode Natural has the same effect on soil health and biodiversity as organic or Demeter, dependent on the origin of the grapes.

Due to the requirement that the grapes need to be harvested manually, this could have an additional positive effect on soil health and biodiversity as it reduces compactification and to a greater degree enables interrow sowing and grassing, and a more flexible vineyard design.

#### Other standards and methodologies

#### Agroforestry

Agroforestry is a collective name for the use of woody perennials (trees, shrubs, palms, bamboos, etc.) on the same land as crops and/or animals, in some form of spatial arrangement or temporal sequence. There is no unified definition, certification program, or global agroforestry organization. Agroforestry can be seen both as a tool that is included in the other certifications or methodologies, but also as a methodology in itself. One way to reach diversification of the agricultural landscape, which is shown by science to improve biodiversity, is to engage in agroforestry.

The three main types of agroforestry systems are *agrisilvicultural systems*<sup>1</sup>, *silvopastoral systems*<sup>2</sup>, and *agrosylvocopastoral systems*<sup>3</sup>.

Agroforestry can be beneficial in all types of farming but the primary arguments for agroforestry are in the tropics and the subtropics. This is due to agroforestry, apart from having possible positive environmental effects, in these areas also contribute with social values such as extra income and food for local societies.

# The method's relations with "best practice" found in the literature review

Agroforestry contributes to is the diversification of landscape, but does not contribute to any of the other best practices. The environmental benefits are dependent on what type of agroforestry is practiced. Due to the lack of a clear definition, the implementation of agroforestry can vary. In general, agroforestry is positive for both carbon sequestration and biodiversity if it is incorporated in a monocultural farming landscape. However, if a natural habitat is converted to agricultural land where trees are incorporated, agroforestry has a direct negative impact on biodiversity.

<sup>&</sup>lt;sup>1</sup> A combination of crops and trees.

<sup>&</sup>lt;sup>2</sup> Combine forestry and grazing of domesticated animals on pastures, rangelands or on-farm.

<sup>&</sup>lt;sup>3</sup> Often illustrated by homegardens involving animals as well as scattered trees on croplands used for grazing after harvests.

#### Permaculture

Permaculture is a design principle. The UK Permaculture explains it as:

- 1. Permaculture is an innovative framework for creating sustainable ways of living.
- 2. It is a practical method of developing ecologically harmonious, efficient, and productive systems that can be used by anyone, anywhere.

There is no official definition or certification program for permaculture. Globally there are many groups involved in the practices of permaculture. Permaculture originates from 1978 as an opposition to western industrialized farming methods.

The definitions of permaculture are intentionally vague and nondirectional. Permaculture is a knowledge intense practice where the farming is based on permaculture principles applied to the farm's (or garden, house, communities, and businesses) unique prerequisites, rather than a set of requisites for everyone. There is therefore no official list of which farming practices are included in permaculture, but common practices include agroforestry, vermicomposting (using earthworms to break down compost), harvesting rainwater, building with natural materials, sheet mulching, domesticated animals, and designing the farm so that gravity disperses water.

One way to understand the concept of 'design' is through the permaculture concept of 'zones'. Zones is about designing a farm-based frequency of human use and plant or animal needs. Frequently manipulated or harvested elements of the design are located close to the house in zones 1 and 2. Manipulated elements located in zones with higher numbers are used less frequently. *The method's relations with "best practice" found in the literature review.* Permaculture can contribute to all of the best practices found in the literature review. There are however no required practices, which makes it hard to value the level of soil health and biodiversity solely on the farm claiming the inclusion of permaculture. That is why we recommend Permaculture to be of lower priority

#### **Carbon Farming**

Carbon Farming is an emerging concept which involves the sequestering of carbon through specific agricultural measures. There is no official definition, certification program, or global organization for carbon farming.

There are however structured, and business-oriented, organizations for Carbon farming. One of these is the USDA Natural Resource Conservation Service (NRCS) which has compiled research on what practices are most effective in sequestrating carbon. The list of practices enhances "soil health and sequester carbon, while producing important co-benefits: increased water retention, hydrological function, biodiversity, and resilience." Another organization is Carbon Cycle Institute which calculates the carbon sequestered and connects the farmers with businesses who can buy carbon credits from the farmers as compensation for their emission. A carbon farming farm can thereby brand its products as 'carbon sequestering products' or 'carbon positive products'.

### The practices with the absolute highest carbon sequestration according to NRCS were:

- Conservation Cover<sup>4</sup>
- Residue and Tillage Management, No-Till/Strip-Till/Direct Seed
- Multi-Story Cropping<sup>5</sup>
- Silvopasture Establishment<sup>6</sup>
- Forage and Biomass Planting<sup>7</sup>
- Nutrient Management<sup>8</sup>
- Tree/Shrub Establishment<sup>9</sup>
- Forest Stand Improvement<sup>10</sup>

These practices often also contribute to improved biodiversity and this list can be added to the best practice list compiled in this report.

## The method's relations with "best practice" found in the literature review

If Carbon farming became a certification, and this certification would include the 15 practices which were listed to have the highest carbonsequestering effect, it would be the certification with most of the best practices covered for viticulture. This would imply that it would have the biggest benefit to soil health and biodiversity.

The certification would be "dark green" (strongly supports) on 'organic fertilizer', 'no or reduced tillage' and 'soil cover'.

Carbon farming would be ranked "medium green" (supports) on 'diversification of landscape' since it only encourages the establishment of trees or shrubs, and on "buffer zones around water bodies" as the requirement on this was only in the category of second-best carbon sequestrating effect. The certification would also entail limitations of agrochemical use.

If a farm works together with one of the Carbon farming organizations mentioned above, the 15 practices with the highest carbon sequestration is of high probability to be implemented.

 Table 3. How Carbon Farming as a certification based on NRCS would match the best practices for viticulture.
 Reduced use of agrochemicals

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<sup>4</sup> Establishing perennial vegetation on land retired from agriculture production increases soil carbon and increases biomass carbon stocks.

<sup>5</sup> Establishing trees and shrubs that are managed as an overstory to crops increases net carbon storage in woody biomass and soils. Harvested biomass can serve as a renewable fuel and feedstock.

<sup>6</sup> Establishment of trees, shrubs, and compatible forages on the same acreage increases biomass carbon stocks and enhances soil carbon.

<sup>7</sup> Deep-rooted perennial biomass sequesters carbon and may have slight soil carbon benefits. Harvested biomass can serve as a renewable fuel and feedstock.

<sup>8</sup> Precisely managing the amount, source, timing, placement, and form of nutrient and soil amendments to ensure ample nitrogen availability and avoid excess nitrogen application reduces N2O emissions to the atmosphere.

<sup>9</sup> Establishing trees and shrubs on a site where trees/shrubs were not previously established increases biomass carbon and increases soil carbon. Mature biomass can serve as a renewable fuel and feedstock.

<sup>10</sup>Proper forest stand management (density, size class, understory species, etc.) improves forest health and increases carbon sequestration potential of the forest stand. Managed forests sequester carbon above and below ground. Harvested biomass can serve as a renewable fuel and feedstock.

Carbon Farming

#### **Regenerative Agriculture**

Regenerative Agriculture is, much like Carbon Farming, a concept that has no clear definition or certification program. There is no umbrella organization responsible for structuring information or practice. The name does however contain the purpose of the concept: agriculture that regenerates the land.

Different organizations are promoting regenerative agriculture. One of the more prominent is Terra Genesis International which explains regenerative agriculture as being guided by four principles:

- 1. Progressively improve whole agroecosystems (soil, water, and biodiversity)
- 2. Create context-specific design and make holistic divisions that express the essence of each farm
- 3. Ensure and develop just and reciprocal relationships amongst all stakeholders
- 4. Continually grow and evolve individuals, farms, and communities to express their innate potential

Terra Genesis International also lists the ten Regenerative Agricultural Practices that can progressively improve the whole agroecosystems. These are:

- 1. No-till farming & pasture cropping
- 2. Organic annual cropping
- 3. Compost & compost tea
- 4. Biochar & terra preta
- 5. Holistically managed grazing
- 7. Ecological aquaculture
   8. Perennial crops

6. Animal integration

- 9. Silvopasture
- 10.Agroforestry

Terra Genesis International is currently inviting stakeholders to discuss the need for, and interest in, a regenerative agriculture certification.

Another organization within Regenerative Agriculture is the Noble Research Institute, which highlights that the focus is on the outcome of "actual improvements to soil health and the overall quality and health of the land (the soil, water, plants, animals and humans)" rather than the practices.

## The method's relations with "best practice" found in the literature review

If regenerative agriculture would become a certification based on the list stated by Terra Genesis International, it would be the certification that covers the second most of the best practices This would suggest that it would be strongly beneficial to biodiversity and soil health in viticulture.

The certification would get dark green (strongly supports) on 'the reduction of agrochemicals' based on the organic annual cropping and that regenerative agriculture draws upon organic farming principles.

Silvopasture, agroforestry, animal husbandry, and holistically managed grazing would together with the grapevines create a 'diversification of the agricultural landscape'.

Regenerative Agriculture does however have a focus on holistically managed grazing, which could be challenging to integrate into viticulture. Since there are no certifications, the effects of regenerative agricultural practices on soil health and biodiversity are currently unclear.

Table 4. How RegenerativeAgriculture as a certificationbased on Terra GenesisInternational would matchthe best practices for viticulture.

Requirements strongly support Requirements supports No requirement but is included Not included



3. FOR CEREAL FARMERS, BREWERIES, DISTILLERIES, AND OTHER ACTORS IN THE BEER AND SPIRITS INDUSTRY

### 3. FOR CEREAL FARMERS, BREWERIES, DISTILLERIES, AND OTHER ACTORS IN THE BEER AND SPIRITS INDUSTRY

### 3.1. Best practices in cereal agriculture

The practices that have the highest scientific consensus with regards to what is important to improve the soil health and biodiversity in cereal farming are:

#### • No or reduced use of agrochemicals

Pesticides and herbicides have a severe long-term impact on soil and aboveground biodiversity, which in turn have a long-term effect on productivity. Studies have shown that it can take 35 years before soil microbial activity is restored after intensive use of pesticides and mineral fertilizers has ceased, highlighting the urgency of reducing their use. Although pesticides can be effective in reducing pest species, they also have negative effects on their natural enemies, reducing nature's built-in cost-free pest protection. Mating disruption by using insect pheromones can be an effective alternative method of pest control.

#### • Organic fertilizer

The effects of adding organic fertilizers depend on the type of soil and fertilizer, but it is overall better to use organic fertilizers than mineral fertilizers, which can have a long-term effect on soil biodiversity and microbial activity.

#### Crop rotation

The rotation of crops in the agricultural field increases biodiversity, soil health, soil organic matter, soil aggregate stability, and crop yield, and reduces disease outbreaks, pest pressure, and soil erosion. A longer rotation cycle is generally more beneficial and should include three or more crops, preferably a mix of different plant functional groups.

#### • Intercropping

Intercropping can increase biodiversity, soil health, soil organic matter, soil aggregate stability, and crop yield, and reduce disease outbreaks, pest pressure, and soil erosion. The selection of species is important for the intercropping system to have the desired effect.

#### • No or reduced tillage

A reduced or ceased tillage is beneficial for soil and aboveground biodiversity, soil aggregate stability, soil respiration, and soil carbon sequestration.

#### • Diversification of the agricultural landscape

A more diverse landscape can have a positive effect on biodiversity and the presence of natural enemies of pest species, reduce soil erosion, improve soil nutrient cycling, and reduce run-off. The agricultural landscape can be diversified by for example using smaller field sizes, setting aside parts of the land for semi-natural habitats, or using strips of land for native vegetation, such as prairie strips.

#### • Soil Cover

Soil cover can be used to increase soil biodiversity, and the use of cover crops increases soil and aboveground biodiversity, natural enemies of pest species, soil organic carbon, water infiltration, and aggregate stability. Cover crops can also reduce soil erosion and greenhouse gas emission. Using flowering cover crop can be beneficial for wild bee species. Legume cover crops bind nitrogen from the air. When choosing and managing cover crop species composition, local conditions of water and nutrient availability should be considered. Another aspect to think about is that the natural pest enemies often stay in the cover crops, meaning that they don't reduce the pest pressure on the grapes as much as they could. Mowing the cover crops can assist in spreading the natural enemies from the cover crops to the vines.

#### • Buffer zones around water bodies

A buffer zone of natural vegetation around water bodies reduces nutrient addition to the water from run-off. It also diversifies the agricultural landscape and generally enhances the in-water habitats.

While we have tried to order this list with the most important practices at the top of the list, which of the most important practices will depend on the local context and the properties of each specific farm.

# **3.2.** Requirements of best practices in certifications, standards and methodologies

Mapping gives a good knowledge base of which certifications, standards and methodologies are most effective and how to work together with certifying bodies to develop the certifications to include other parts

Table 5 below presents an overview of how the different certifications, standards and methodologies incorporate the best practices in their requirements. Each of the certifications, standards and methodologies is described more thoroughly in the following chapter.

 Table 5. How the most common certifications, standards

 and methodologies link to the best practices for higher

 biodiversity and soil health in cereal farming.

Requirements strongly support Requirements supports No requirement but is included Not included

			Certifications		Other standards and methodologies				
		Organic (EU)	Organic (USDA)	Biodynamic (Demeter)	Agroforestry	Carbon Farming	Permaculture	Regenerative Agriculture	
	Reduced use of agrochemicals								
rity	No or reduced tillage								
hest prio	Crop rotation								
Hig	Diversification of the agricultural landscape and green-blue corridors								
	Intercropping								
ity	Organic fertilizer								
igh prior	Soil cover								
Ξ	Buffer zones around water bodies								

**3.3.** Introduction to common certifications, standards, and methodologies for sustainable cereal farming

#### Certifications

#### **Organic (EU organic and USDA Organic)**

Organic farming could be defined as "an integrated farming system that strives for sustainability, the enhancement of soil fertility and biological diversity while, with rare exceptions, prohibiting synthetic pesticides, antibiotics, synthetic fertilizers, genetically modified organisms, and growth hormones". For example antibiotics are only allowed for treatment of diseases but not for proactive use.

Organic is also a certification. In the EU, the certification for organic farming is the 'EU Organic' which is defined by EU legislation. The first EU legislation on organic was enforced in 1995. The current legislation was decided in 2010. There are many different certification programs within the EU, all following the same legislation.

The EU guidelines have become the norm in the whole world, apart from The United States, where the organic requirements differ slightly. The differences between USDA Organic and EU Organic are not relevant for viticulture. It could however have an impact on soil health and biodiversity in general as EU Organic demands that the animal's feed should be produced on the same farm, or at least in the same region.

#### The key principles of EU Organic and USDA Organic are:

- The use of chemical pesticides and synthetic fertilizers is banned
- Antibiotics are severely restricted
- GMOs (genetically modified organisms) are not allowed
- Crops are rotated

The International Federation of Organic Agricultural Movements (IFOAM) is a global umbrella organization that represents organic farming in

European policymaking and advocates for sustainable farming. IFOAM represents almost 800 organizations in 117 countries.

## The certification's relations with "best practice" found in the literature review

Organic has a strict limitation on agrochemicals. Due to this limitation, farmers have to use other practices to maintain fertile soil and protect against pests and mites. There are a lot of different possible practices but two of the most common are no or reduced tillage and cover crops.

Organic certifies on crop level, while all other certifications (described below) certify on farm level. Since organic focuses on crop-level, the certification doesn't have any requirements of buffer zones or diversification of the landscape.

#### **Biodynamic Farming (Demeter)**

Biodynamic farming is a way of farming and gardening with a specific holistic and spiritual approach to growing food sustainably that originates from the philosophies of Rudolf Steiner. Biodynamic farming is not under government control which means that a farmer can call himself biodynamic even if he or she isn't certified. To become a certified biodynamic vineyard, the vineyard first needs to meet the requirements of EU Organic together with some additional requirements set by the certification program.

Demeter, the main certification program for biodynamic farming, was established in Europe in 1928 and the US in 1985. In addition to the requirements of EU Organic, the key practices and requirements for Demeter are:

- Animal husbandry is mandatory on all farms larger than 40 ha
- Inclusion of specific biodynamic preparations
- Biodiversity conservation area of at least 10% of farm area
- Demeter certifies on farm level, EU Organic on crop level
- Considerations are taken to distance to organic or conventional farms to reduce airborne residues of agrochemicals.

Demeter is not a common certification for beers. In Sweden, there is currently no Demeter-certified beer.

### The certification's relations with "best practice" found in the literature review

Biodynamic farming covers more of the best practices than organic farming. The inclusion of animal husbandry and the requirement of a conservation area have positive effects on biodiversity and soil health as it (i) helps diversifies the landscape, and (ii) enables the local production of organic/biodynamic fertilizer. There is a need for more studies on the effects of biodynamic preparations on soil health and biodiversity. Longterm field trials by FiBL (Forschungsinstitut für Biologischen Landbau) comparing biodynamic, organic, and conventional cropping systems does however suggests biodynamic practices as effective. FiBL: "In the biodynamic system, soil organic matter (humus) content remained stable for the first 21 years of the trial while it declined in all other systems".

#### Other standards or methodologies

#### Agroforestry

Agroforestry is a collective name for the use of woody perennials (trees, shrubs, palms, bamboos, etc.) on the same land as crops and/or animals, in some form of spatial arrangement or temporal sequence. There is no unified definition, certification program, or global agroforestry organization. Agroforestry can be seen both as a tool that is included in the other certifications or methodologies, but also as a methodology in itself.

One way to reach diversification of the agricultural landscape, which is shown by science to improve biodiversity, is to engage in agroforestry. The three main types of agroforestry systems are *agrisilvicultural systems*<sup>11</sup>, *silvopastoral systems*<sup>12</sup>, and *agrosylvocopastoral systems*<sup>13</sup>.

Agroforestry can be beneficial in all types of farming but the primary arguments for agroforestry are in the tropics and the subtropics. This is due to agroforestry, apart from having possible positive environmental effects, in these areas also contribute with social values such as extra income and food for local societies.

The environmental benefits are dependent on what form of agroforestry is practiced. Due to the lack of a clear definition, the implementation of agroforestry can vary. In general, agroforestry is positive for both carbon sequestration and biodiversity if it is incorporated in a monocultural farming landscape. However, if a natural habitat is converted to agricultural land where trees are incorporated, agroforestry has a direct negative impact on biodiversity.

## The method's relations with "best practice" found in the literature review

Agroforestry contributes to is the diversification of landscape, but does not contribute to any of the other best practices. The environmental benefits are dependent on what type of agroforestry is practiced. Due to the lack of a clear definition, the implementation of agroforestry can vary. In general, agroforestry is positive for both carbon sequestration and biodiversity if it is incorporated in a monocultural farming landscape. However, if a natural habitat is converted to agricultural land where trees are incorporated, agroforestry has a direct negative impact on biodiversity.

<sup>&</sup>lt;sup>11</sup> A combination of crops and trees

<sup>&</sup>lt;sup>12</sup> Combine forestry and grazing of domesticated animals on pastures, rangelands or on-farm.

<sup>&</sup>lt;sup>13</sup> Often illustrated by homegardens involving animals as well as scattered trees on croplands used for grazing after harvests.

#### Permaculture

Permaculture is a design principle. The UK Permaculture explains it as:

- 1. Permaculture is an innovative framework for creating sustainable ways of living.
- 2. It is a practical method of developing ecologically harmonious, efficient, and productive systems that can be used by anyone, anywhere.

There is no official definition or certification program for permaculture. Globally there are many groups involved in the practices of permaculture. Permaculture originates from 1978 as an opposition to western industrialized farming methods.

The definitions of permaculture are intentionally vague and nondirectional. Permaculture is a knowledge intense practice where the farming is based on permaculture principles applied to the farm's (or garden, house, communities, and businesses) unique prerequisites, rather than a set of requisites for everyone. There is therefore no official list of which farming practices are included in permaculture, but common practices include agroforestry, vermicomposting (using earthworms to break down compost), harvesting rainwater, building with natural materials, sheet mulching, domesticated animals, and designing the farm so that gravity disperses water.

One way to understand the concept of 'design' is through the permaculture concept of 'zones'. Zones is about designing a farm-based frequency of human use and plant or animal needs. Frequently manipulated or harvested elements of the design are located close to the house in zones 1 and 2. Manipulated elements located in zones with higher numbers are used less frequently.

#### The method's relations with "best practice" found in the literature review

Permaculture can contribute to all of the best practices found in the literature review. There are however no required practices, which makes it hard to value the level of soil health and biodiversity solely on the farm claiming the inclusion of permaculture. That is why we recommend Permaculture to be of lower priority

#### **Carbon Farming**

Carbon Farming is an emerging concept which involves the sequestering of carbon through specific agricultural measures. There is no official definition, certification program, or global organization for carbon farming.

There are however structured, and business-oriented, organizations for Carbon farming. One of these is the USDA Natural Resource Conservation Service (NRCS) which has compiled research on what practices are most effective in sequestrating carbon. The list of practices enhances "soil health and sequester carbon, while producing important co-benefits: increased water retention, hydrological function, biodiversity, and resilience." Another organization is Carbon Cycle Institute which calculates the carbon sequestered and connects the farmers with businesses who can buy carbon credits from the farmers as compensation for their emission. A carbon farming farm can thereby brand its products as 'carbon sequestering products' or 'carbon positive products'.

### The practices with the absolute highest carbon sequestration were:

- Conservation Cover<sup>14</sup>
- Residue and Tillage Management, No-Till/Strip-Till/Direct Seed
- Multi-Story Cropping<sup>15</sup>
- Silvopasture Establishment<sup>16</sup>
- Forage and Biomass Planting<sup>17</sup>
- Nutrient Management<sup>18</sup>
- Tree/Shrub Establishment<sup>19</sup>
- Forest Stand Improvement<sup>20</sup>

These practices often also contribute to improved biodiversity and this list can be added to the best practice list compiled in this report.

# The method's relations with "best practice" found in the literature review

If Carbon farming became a certification, and this certification would include the 15 practices which were listed to have the highest carbonsequestering effect, it would be the certification with the most best practices covered for cereal farming. This would imply that it would have the biggest benefit to soil health and biodiversity.

The certification would be "dark green" (strongly supports) on 'organic fertilizer', 'no or reduced tillage' and 'soil cover'.

Carbon farming would be ranked "medium green" (supports) on 'diversification of landscape' since it only encourages the establishment of trees or shrubs, and on "buffer zones around water bodies" as the requirement on this was only in the category of second-best carbon sequestrating effect. The certification would also entail limitations of agrochemical use. If a farm works together with one of the Carbon farming organizations mentioned above, the15 practices with the highest carbon sequestration is of high probability to be implemented.

Table 6. How Carbon Farming as acertification based on NRCS wouldmatch the best practices forcereal farming.

Requirements strongly support Requirements supports No requirement but is included Not included



<sup>14</sup>Establishing perennial vegetation on land retired from agriculture production increases soil carbon and increases biomass carbon stocks.

<sup>15</sup>Establishing trees and shrubs that are managed as an overstory to crops increases net carbon storage in woody biomass and soils. Harvested biomass can serve as a renewable fuel and feedstock.

<sup>16</sup>Establishment of trees, shrubs, and compatible forages on the same acreage increases biomass carbon stocks and enhances soil carbon.

<sup>17</sup> Deep-rooted perennial biomass sequesters carbon and may have slight soil carbon benefits. Harvested biomass can serve as a renewable fuel and feedstock.

<sup>18</sup> Precisely managing the amount, source, timing, placement, and form of nutrient and soil amendments to ensure ample nitrogen availability and avoid excess nitrogen application reduces N2O emissions to the atmosphere.
<sup>19</sup> Establishing trees and shrubs on a site where trees/shrubs were not previously established increases biomass carbon and increases soil carbon. Mature biomass can serve as a renewable fuel and feedstock.

<sup>20</sup>Proper forest stand management (density, size class, understory species, etc.) improves forest health and increases carbon sequestration potential of the forest stand. Managed forests sequester carbon above and below ground. Harvested biomass can serve as a renewable fuel and feedstock.

#### **Regenerative Agriculture**

Regenerative Agriculture is, much like Carbon Farming, a concept that has no clear definition or certification program. There is no umbrella organization responsible for structuring information or practice. The name does however contain the purpose of the concept: agriculture that regenerates the land.

Different organizations are promoting regenerative agriculture. One of the more prominent is Terra Genesis International which explains regenerative agriculture as being guided by four principles:

- 1. Progressively improve whole agroecosystems (soil, water, and biodiversity)
- 2. Create context-specific design and make holistic divisions that express the essence of each farm
- 3. Ensure and develop just and reciprocal relationships amongst all stakeholders
- 4. Continually grow and evolve individuals, farms, and communities to express their innate potential

Terra Genesis International also lists the ten Regenerative Agricultural Practices that can progressively improve the whole agroecosystems. These are:

- 1. No-till farming & pasture cropping
- 2. Organic annual cropping
- 3. Compost & compost tea
- 4. Biochar & terra preta
- 5. Holistically managed grazing
- 6. Animal integration
- 7. Ecological aquaculture
   8. Perennial crops
- 9. Silvopasture
- 10.Agroforestry

Terra Genesis International is currently inviting stakeholders to discuss the need for, and interest in, a regenerative agriculture certification.

Another organization within Regenerative Agriculture is the Noble Research Institute which highlights that the focus is on the outcome of "actual improvements to soil health and the overall quality and health of the land (the soil, water, plants, animals and humans)" rather than the practices.

## The method's relations with "best practice" found in the literature review

If regenerative agriculture would become a certification based on the list stated by Terra Genesis International, it would be the certification that covers all but one of the best practices. This would suggest that it would be strongly beneficial to biodiversity and soil health in cereal farming.

The certification would get dark green (strongly supports) on 'the reduction of agrochemicals' based on the organic annual cropping and that regenerative agriculture draws upon organic farming principles.

Silvopasture, agroforestry, animal husbandry, and holistically managed grazing would together with the cereals create a 'diversification of the agricultural landscape'. It would get 'light green' (included but not a requirement) on 'intercropping' as agroforestry is included but alley cropping is not specified.

Regenerative Agriculture does however have a focus on holistically managed grazing, which could be challenging to integrate into cereal farming. Since there are no certifications, the effects of regenerative agricultural practices on soil health and biodiversity are currently unclear.

Table 7. How RegenerativeAgriculture as a certificationbased on Terra Genesis Internationalwould match the best practices forcereal farming.





# 4. GENERAL FINDINGS AND REFLECTIONS

### 4. GENERAL FINDINGS AND REFLECTIONS

# **4.1.** General findings on organic vs conventional agriculture's impact on biodiversity

Although there is some variation among the results of different studies, there is generally higher biodiversity connected to organic and biodynamic agriculture, compared to conventional. This is true for both soil and aboveground biodiversity. One explanation of the variation in results could be the legacy effects of intensive use of agrochemicals before the conversion to organic practices. It could take over three decades after conversion before soil microbial activity is restored.

However, since organic agriculture is sometimes connected to lower yield, the environmental impact per unit of product could still be severe. Several studies recommend integrated agriculture, which uses the best practices from both organic and conventional farming, that works best in the specific region. This way, the environmental impact can be reduced with almost no reduction in yield.

There are several other farming systems than organic, biodynamic, and conventional, but because of lack of data, these are the ones most compared in the literature (and of these, mainly organic and conventional).

# **4.2.** Reflections from reviewing the sustainable farming certifications, standards, and methodologies

#### The best certification for soil health and biodiversity in viticulture

Fair'N Green seems to have the highest requirements currently with regards to the best practices. This would suggest that Fair'N Green farms have the best conditions for soil health and biodiversity.

This is based on what was viewed as the lowest requirements to receive the certification. It could be that Fair'N Green stands out due to the structure of

their certification protocol making us include all their requirements as the lowest requirements.

Even if CCSW didn't cover as many best practices in their Category 2 practices, we believe that CCSW is a good program for gradual improvement of soil health and biodiversity on the farm. The Code of Sustainable Winegrowing is a very pedagogical and instructional tool that the other certifications can learn from.

We recommend that you encourage CCSW and Equalitas to further increase the limitations on agrochemicals.

#### The best certification for soil health and biodiversity in cereal farming

Biodynamic farming is the practice that covers most of the best practices. This would suggest that Demeter farms have better soil health and biodiversity than EU or USDA Organic.

We recommend that you specifically encourage the development of a carbon farming certification for cereal production.

#### Agrochemicals

Conventional use of agrochemicals harms biodiversity and soil health. It is beneficial for biodiversity and soil health to strive towards no synthetic fertilizers, chemical pesticides, and herbicides. The strictness of organic does however seem to be hindering wine farmers as we see the winespecific certifications being more liberal in banning agrochemicals and instead focuses on limiting the use.

#### **Carbon Farming the next frontier?**

We advise you to follow and promote the development of carbon farming due to (i) its potent market solution of selling carbon credit, (ii) the high focus on the climate issue, and (iii) the farming practices that increase the carbon in the soil are beneficial to biodiversity and soil health.

## Differences between specific wine certifications and general certifications

The specific wine certifications (specifically Equalitas and CCSW) are more pragmatic when it comes to agrochemicals and organic fertilizers than Organic or Demeter. Rather than banning agrochemicals, these certifications encourage a monitored and controlled use of agrichemicals, to reduce excessive use over time.

This approach could have the benefits of attracting more farmers to sustainable farming practices. Instead of having a strict ban, the barrier to join might be lower if there is gradual progress along which you could evolve.

Fair'N Green is currently reviewing a new version of its biodiversity framework. This new biodiversity framework is moving towards a less restrictive phrasing regarding synthetic fertilizers.

Among all the reviewed certifications, CCSW has the lowest encouragement of a reduction of agrochemicals. This could be due to regional cultural norms or the regional climate making a low agrochemical intervention farming harder.

Wine-specific certifications are more holistic: The wine certifications help decrease impacts of the whole vineyard or winery operation. They act as a sustainability management program that helps the organization in a gradual manner decrease other indirect negative impacts on the global and local biodiversity, e.g., requirements of renewable energy.

#### No cereal or beer/spirits specific sustainability certification

Intensive conventional cereal farming does harm biodiversity and soil health. There does not seem to be any prominent beer or cereal-specific certification for sustainable beer or cereal farming. The beer and cereal industry will probably have to focus on moving towards organic since the value chain (i) contains more than one ingredient, and (ii) contains ingredients that are available at greater commodity markets, (iii) beer often isn't brewed by the farm growing the crops. The craft beer community could give rise to further requirements and standards. Together with the general interest and need for sustainable solutions, the farming practices of the cereals production might become more relevant for the consumer in the coming years.

#### **Regenerative agriculture**

We advise this to be of medium priority. A regenerative agriculture certification would be a beneficial complement to organic to further improve the conditions for soil health and biodiversity. We do however believe that Carbon Farming will have a bigger expansion if such a certification is developed. If you want to learn more about regenerative agriculture, contact Terra Genesis as they are currently looking for partners interested in a regenerative agriculture certification.

#### Permaculture & Agroforestry

We advise this to be a low priority. Even if both methods are beneficial for biodiversity, they are vague and lack certification. It is of course beneficial to be able to inform customers that there aren't any permaculture wines per se, but that organic and biodynamic farms can use the principles of permaculture. Permaculture and agroforestry are rather ways to implement the requirements of the other certifications.

#### **Carbon farming + organic**

The combined practice of organic, Demeter, or any of the wine-specific certifications, together with the principles of carbon farming would be a beneficial combination for soil health and biodiversity based on the literature review and the compilation of certifications.

# 5. METHODOLOGY

### **5. METHODOLOGY**

### 5.1. Literature study of best practices

Google Scholar has been used as a search engine using the following search terms:

vineyard biodiversity vineyard biodiversity review vineyard soil health review grain agriculture biodiversity review cereal agriculture biodiversity review grain soil health review grain soil health biodiversity review cereal soil health biodiversity review

Because of the timeframe and budget of this project, we have focused on reading literature studies and meta-studies since these already are compilations of knowledge from many different studies.

### 5.2. Valuation of certifications

The grading of certifications in the matrix is based on the assumption that all of the measures, on that certification's lowest level (if there are several), have been implemented.

Since the certifications Equalitas, CCSW, and Fair'N Green are based on the farm getting a certain percentage of criteria or scoring, none of the measures are technically mandatory. For Equalitas only "M" has been viewed as requirements. At Fair'N Green all of the statements have been viewed as mandatory. At CCSW all category 2 has been viewed as mandatory. If there has been very strong wording in the "m" or "R" of Equalitas or categories 3 or 4 of CCSW, this has been included in the valuation.

It has to be taken into consideration that the valuation of the different methods is based on widely different materials. The certifications have different grading systems and the information of how these grades are set are disclosed to a varying degree. For Fair'N Green certification the vineyard needs 50% of the points to become certified. But as the requirements listed in the certification handbook don't have any gradations as the CCSW system, everything stated a practice was treated as a requirement. But since the farmer only has to receive 50% of the points, it is not clear how many of, or how well, the listed practices need to be fulfilled. The vineyards are of course also able to do far more than their selected certification program requires them to do.

It could therefore be the case that an Equalitas farm has more biodiversity and soil healthy farming practice than a Fair'N Green certified farm, even if the certification matrix will tell you otherwise.

# 6. FURTHER READING

### **6. FURTHER READING**

### 6.1. Certifications

Organic EU Organic https://ec.europa.eu/info/food-farming-fisheries/farming/organic-farming/organics-glance\_sv

IFOAM https://www.ifoam.bio

USDA Organic https://www.usda.gov/topics/organic

Biodynamic

**Demeter** https://www.demeter.net/certification/standards

Biodyvin http://www.biodyvin.com

Vin Méthode Nature https://vinmethodenature.org

**Equalitas** https://www.equalitas.it/en/

**Certified California Sustainable Wine Growing** https://www.sustainablewinegrowing.org

Fair'N Green https://www.fairandgreen.de/en/english-home-page-2/

# **6.2.** Standards and methodologies for sustainable farming

#### Agroforestry

United Nations Food and Agriculture Organisation about agroforestry: http://www.fao.org/forestry/agroforestry/90048/en/

World Agroforestry – a research center focusing on the benefits of trees to people and the environment: https://www.worldagroforestry.org/about/agroforestry

**Permaculture** https://www.permaculturenews.org

**Carbon Farming** USDA Natural Resource Conservation Service: Practice Standards for Greenhouse Gas Emission Reduction and Carbon Sequestration https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/air/quality/?cid=stelprdb1044982

Carbon Cycle Institute https://www.carboncycle.org/carbon-farming/

Svensk Kolinlagring (Swedish Carbon Sequestrating) https://kolinlagring.se

**Regenerative agriculture** 

**Terra Genesis International site about regenerative agriculture** *http://www.regenerativeagriculturedefinition.com* 

Noble Research Institute about the difference between organic and regenerative agriculture. https://www.noble.org/regenerative-agriculture/organic-vs-regenerative-agriculture/

### 6.3. Scientific literature

#### Coppers effect on soil health

Karimi, B., Masson, V., Guilland, C. et al. Ecotoxicity of copper input and accumulation for soil biodiversity in vineyards. Environ Chem Lett (2021). *https://doi.org/10.1007/s10311-020-01155-x* 

#### Compilation of science on biodiversity and soil health in viticulture

Abad, J., Hermoso de Mendoza, I., Marín, D., Orcaray, L., & Santesteban, L. G. (2021a). Cover crops in viticulture. A systematic review (1): Implications on soil characteristics and biodiversity in vineyard. OENO One, 55(1), 295–312.

https://doi.org/10.20870/oeno-one.2021.55.1.3599

Abad, J., Hermoso de Mendoza, I., Marín, D., Orcaray, L., & Santesteban, L. G. (2021b). Cover crops in viticulture. A systematic review (2): Implications on vineyard agronomic performance. OENO One, (2), 1–27.

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Karimi, B., Cahurel, J. Y., Gontier, L., Charlier, L., Chovelon, M., Mahé, H., & Ranjard, L. (2020). A meta-analysis of the ecotoxicological impact of viticultural practices on soil biodiversity. Environmental Chemistry Letters, 18(6), 1947–1966.

https://doi.org/10.1007/s10311-020-01050-5

Katayama, N., Bouam, I., Koshida, C., & Baba, Y. G. (2019). Biodiversity and yield under different land-use types in orchard/vineyard landscapes: A meta-analysis. Biological Conservation, 229(June 2018), 125–133.

https://doi.org/10.1016/j.biocon.2018.11.020

Petrescu Bakış, A. L., Macovei, I., Barros, P., Gomes, C., Carvalho, D., Cabral, J. A., ... Santos, M. (2021). Is biodiversity linked with farm management options in vineyard landscapes?

A case study combining ecological indicators within a hybrid modeling framework. Ecological Indicators, 121(September 2020).

https://doi.org/10.1016/j.ecolind.2020.107012

Thiéry, D., Louâpre, P., Muneret, L., Rusch, A., Sentenac, G., Vogelweith, F., ... Moreau, J. (2018). Biological protection against grape berry moths. A review. Agronomy for Sustainable Development, 38(2).

https://doi.org/10.1007/s13593-018-0493-7

#### Compilation of science on biodiversity and soil health in cereal agriculture

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