Extended Practice Abstract Nº 3

GASCOGN'INNOV - Diagnosis of soil quality and evaluation of the impact of viticultural practices on soil biodiversity

Short description of the OG

Soil quality is seen as a lever to move towards more sustainable viticulture but is little considered in the implementation of viticultural practices. The Gascogn'Innov project aims to acquire technical knowledge about the impact of viticultural practices on soil biology in a dynamic way through a participative approach involving farmers, researchers and advisors. In the framework of the project, a methodology was implemented to integrate information provided by the soil bioindicators to manage farming systems.

Benefits

The main added ecological value for the farmer addressed by the OG: acquisition of knowledge so that farmers can perform soil quality diagnoses themselves; improved soil fertility; better understanding of the soil's overall functioning and the impact of their practices on it. Bio-indicators of soil quality should be included as part of sustainable crop management practices.

Stage of implementation

GASCOGN'INNOV has ended (2017–2022).

Key Data Box

Theme
Soil health – biodiversity – cover crop/green manure

Context
Geographical coverage: south of France, Gascony context (near Toulouse)
Soil specification: several test plots with different soil types

Duration
5 years (2017-2022), 3 stages:
2017: Initial soil diagnosis on 13 vineyard plots
2018: Redesign of viticultural system in collaboration with winegrowers and an interdisciplinary group of experts (agronomists, biologists)
2021: Final diagnosis on 23 plots (redesigned system vs control)

Partners involved:
Independent winegrowers, cooperatives, farmers associations, chamber of agriculture, technical institute, Interdisciplinary Expert Group

Budget:
416 970,00€

Main achieved or expected results

- **At the wine grower level:** detailed characterization of the biological functioning of the soil in each plot and its evolution over time. Linkage to the cropping system.
- **At the OG level:** creation of a **regional viticultural soil quality database** that allows positioning in relation to national reference systems.
- **Evaluation of the effect of practices on soil biology according to soil types, thanks to a set of indicators.**

A set of soil biological quality indicators has been evaluated: microorganisms (abundance and diversity of bacteria and fungi), fauna (abundance and diversity of nematodes and earthworms), physico-chemical characteristics, soil structure assessment and degradation rate of organic matter. Based on a network of 13 plots that were subject to an initial diagnosis in 2017, several

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agronomical practices to restore soil fertility were tested to redesign the cropping system (e.g., plant cover, organic matter inputs, reduction of herbicides, mineral fertilizers). System redesign was done in collaboration between winegrowers and an interdisciplinary group of experts (agronomists, biologists). Several indicators were measured on vine and soil at each vintage to assess vine health and productivity. One of the observed results: **decreasing the intensity of tillage and increasing the duration and diversity of grass coverage tends to increase the abundance of all the organisms studied.**

Figure 1. One of the indicators implemented to evaluate the population status of the soil: earthworm count

Figure 2. One of the indicators implemented to measure the organic matter degradation rate of the soil: litterbag

Related materials

Videos

Congress – 6e Assises des Vins du Sud-Ouest: https://www.youtube.com/watch?v=k8DWvdVZObA&t=9s (YouTube subtitles available)

OG presentation: https://www.youtube.com/watch?v=tjUNi5bhgpI&ab_channel=CLIMED-FRUIT

Web links

Symposium proceedings – 6e Assises des Vins du Sud-Ouest: https://www.vignevin-occitanie.com/wp-content/uploads/2022/05/gascogn-innov.pdf

Poster – TERCLIM International Terroir Congress: https://ives-openscience.eu/12910/

Contact information

Publisher:
IFV Sud-Ouest
1920 route de Lisle sur Tarn
81310 Peyrole
https://www.vignevin-occitanie.com/
Author(s): Gontier Laure
Contact: laure.gontier@vignevin.com

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Project website:
https://climed-fruit.eu/
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Extended Practice Abstract № 3

Green manure in mediterranean viticulture

Challenge

In Mediterranean vineyards, soils are often tilled to limit competition. However, there are various strategies that can be used to establish temporary vegetal cover or green manures to benefit from their associated agro-systemic services without having a negative impact on the vines.

Solution

Green manure is a plant cover crop that produces biomass and is returned to the soil to improve its fertility and structure, as long as hydro-nitrogen competition is kept under control, which is challenging but can be of real interest in the context of the poor soils of the Mediterranean basin. The date and type of destruction and the choice of species are important levers for the proper implementation of this practice. One possible method in a Mediterranean context: the use of a green manure in one row in two, installed and destroyed early, and then kept as mulch.

Benefits

- As soil cover: protects from erosion, improves the physical properties of the soil (water retention capacity, structural stability...)
- Enhances microbiological soil life and contributes to intra-parcel biodiversity
- Reduces rainwater runoff
- By modifying both the stock of mineral nitrogen during its growth phase and the quantities of nitrogen mineralized after its destruction, green manure can influence the supply of nitrogen to the vine, and thus limit the use of external inputs
-

Applicability box

Theme
Soil health – biodiversity – cover crop/green manure

Context
In Mediterranean conditions: particular attention must be paid to adaptation to the farm context for species selection and crop management practices because of water competition

Application time
September–April

Required implementation time
Soil preparation + seeding + rolling/ shredding + burying = approximately 7h/ha

Period of impact
October-May

Equipment
Seeds, seeder, roller, chipper, tines/discs tools

Practical recommendation

Soil preparation and seeding: the soil must be sufficiently crumbled to ensure good seed germination. Seeding can be carried out by broadcasting with a spreader or by using a ploughshare for more precise sowing or sowing under cover. In the Mediterranean context, sowing as early as possible (late August-early September) will ensure that the seedlings are well developed during heavy rainfall in autumn to reduce erosion, and also prevents vine leaves from flying away (which is an additional source of nutrition for the

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soil). Over-dosing seedlings (for all species) is also advisable in Mediterranean conditions, as well as choosing a well-diversified mix (legumes, grasses, brassicas) to ensure the sustainability of the cover with rotation of the dominant species. **Green manure destruction:** the choice of destruction method depends on the objectives being pursued. Grinding or mowing in spring destroys the aerial parts and allows them to dry out. Mowing or rolling can be useful to mulch and maintain the soil without chemical weeding or tillage. Mulch can have a favourable impact on soil moisture, so it is of interest in conditions of low rainfall. In a Mediterranean context, it is advisable to destroy the cover crop in early spring to avoid too much water competition, which would also have an impact on the mineralisation of the cover crop once it has been destroyed.

Figure 3: Example of green manure in a Mediterranean context (Spain, Rioja)

Related materials

Web links

Guide: Winegrowing practices & adaptation to climate change in the POCTEFA area (VITISAD project):
https://www.vignevin-occitanie.com/wp-content/uploads/2023/01/guide-vitisad-fr-FINAL.pdf
https://www.vignevin-occitanie.com/wp-content/uploads/2023/12/guide-vitisad-es-FINAL.pdf
Green manure in viticulture (IFV): https://www.vignevin-occitanie.com/fiches-pratiques/les-engrais-verts-en-viticulture-2/
Seeding mechanization of green manure (IFV): https://www.vignevin-occitanie.com/fiches-pratiques/mecanisation-du-semis-des-engrais-verts/
Green manure destruction (IFV): https://www.vignevin-occitanie.com/fiches-pratiques/destruction-des-engrais-verts/
Green manure (IFV): species https://www.vignevin-occitanie.com/wp-content/uploads/2019/02/Fiches-engrais-verts.pdf
https://www.vignevin-occitanie.com/fiches-pratiques/les-engrais-verts-en-viticulture-2/
Guide (Chambre d'Agriculture de l'Hérault): Green manure in viticulture

Contact information

Publisher:
IFV Sud-Ouest
1920 route de Lisle sur Tarn
81310 Peyrole, https://www.vignevin-occitanie.com/
Author(s): Laure Gontier, Clara Gérardin
Contact: laure.gontier@vignevin.com,

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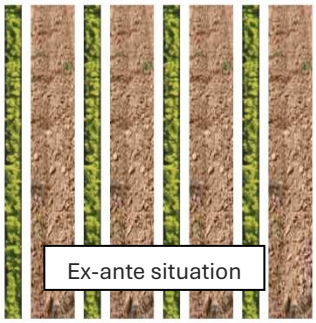
Simplified cost/benefit analysis

Green manure in mediterranean viticulture

Introduction – presentation of ex-ante and ex-post situation

For the purposes of this analysis, we have taken the case of a 15 ha Mediterranean vineyard with a density of 4,500 vines/ha located in the South of France. The ex-ante situation considered is based on inter-rows with 100% tillage. The ex-post situation considers one inter-row out of two tilled and one inter-row out of two with the implementation of a green manure sown at the end of the summer, then rolled at the beginning of spring to be used as mulch during the season. In the ex-post situation, we could also consider mowing the inter-row with the mulch before the harvest in the event of a major resurgence of weeds. Note that this ex-post strategy can be alternated every year (the tilled row becomes the sown row). In both situations, we consider natural weed cover in winter and mechanical work under the row during the season.



Economical impact

Sources of economic data: IFV Viticout calculator and "Les engrais verts en viticulture", Chambre d'Agriculture de l'Hérault

Legend
Estimated indicator
Measured indicator

	Ex-ante:	Ex-post:
Costs (including fuel, labour, inputs, depreciation)		
Tillage	200 €/ha *Tillage every row (4 passes/year, 50 €/ha/pass)*	100 €/ha *Tillage one row in two (4 passes/year, 25 €/ha/pass)*
Green manure seeds	0 €/ha	130 €/ha
Green manure operations	0 €/ha	Seedling one row in two (1 pass/year): 48 €/ha
		Rolling (1 pass/year): 14 €/ha
		Mowing (1 pass/year): 19 €/ha
TOTAL	200 €/ha	311 €/ha
COMPARISON	Global increase of 50% of the cost:	

Economical benefits: In the ex-post situation, less time is needed for tillage between the rows, and all the operations linked to the green manure are spread over time, which means that the daily workload can be spread out. Depending on the itinerary chosen, planting green manures can also help reduce inputs (less chemical N fertilizer). Note: under-row and inter-row tillage can be combined in the ex-ante situation, which is not necessarily the case in the ex-post situation. Also, the itinerary described in the ex-post situation should not have an impact on yield, which is why it is not taken into account in this analysis.

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Environmental impact

Energy	Indicator improvement of 25%: 

Fuel consumption is higher in the ex-ante situation. If we take the case of a diesel tractor, average fuel consumption linked to inter-row management decrease from around 52 L/ha/year for the ex-ante situation to 40 L/ha/year for the ex-post situation (*source: GES&VIT, IFV tool for carbon footprint calculation*). Indicator for fuel consumption improve from 25%. On the other hand, the use of green manure in the ex-post situation enables between 10 and 20 units of nitrogen /ha/year [5] to be returned, depending on the legumes composition of the green manure. This saves on external nitrogen inputs and the associated energy costs.

Fuel Consumption	**Ex-ante**	**Ex-post**
Rotary arrow (soil labour)	13L/ha/pass all rows: total 52L	6 L/ha/pass one row in two: total 25L
Seeding	-	5L/ha
Mulching	-	6,5 L/ha
Mowing	-	3L/ha
Total	52L	40L

Water	Indicator approximate improvement between 1 to 24%: 

By reduction of nitrate leaching by direct uptake of the residual N of the soil and by decreasing runoff [4], green manures allow mitigation of water pollution.

Soil	Indicator approximate improvement from 50% and up: 

Impact of green manure on soil:

- Protect soil from erosion[0] and prevent soil crusting and sealing[6]
- Maintain favourable soil structure and porosity: improve water infiltration and reserve refilling[7]. Particularly interesting in areas where precipitations occur during winter over a short period of time in a series of heavy rainfall events (case of “Cévenol episodes” in some French mediterranean vineyards)
- Improve soil fertility: nitrogen supply [8] (amount of N available for associated crop depends on C/N ratio of the green manure[9]), leaching reduction
- More biomass returned compared to spontaneous soil cover, increased organic matter content in the medium to long term

Air	12% increase in emissions but offset by carbon storage: 

The carbon footprint of the ex-ante and ex-post situations was calculated using the GES&VIT tool developed by IFV. In the ex-ante situation, the impact of the management of the inter-rows with 100% tillage implies a carbon footprint of 170 kg CO2eq/ha/year (including 4 passes/year). In comparison, inter-row management in the ex-post situation has a footprint of 190 kg CO2eq/ha/year (taking into account 4 passes of tillage every other row, green manure sowing, mulching and mowing every other row). Although emissions increase very slightly (+12%), the establishment of a green manure and its return to the soil increase storage, which explains why the net carbon footprint of the ex-ante situation is lower than the ex-post situation.

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Biodiversity	Indicator approximate improvement between 25 to 49%: 

Impact of green manure on biodiversity:

- Green manure and reduced soil perturbation provide resources that maintain higher trophic levels in soils
- Positive impact on earthworm abundance and activity (1)
- Positive impact on microbial biomass and soil biological activity (1, 2)
- Mulching could favor arthropod and micro-arthropod abundance compared with a plant cover without impacting microbial biomass (1)
- In some cases, service crops can favour inorganic N immobilization because of microorganism demand (3)

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