Extended Practice Abstract Nº 15

Sowing subterranean clover, a self-reseeding cover crop, in the under-row area of the vineyard

Challenge

In Tuscany, Italy, vineyard soil and weed management is based on mechanical treatments between rows and herbicide application under the row, with a negative impact on soil fertility, soil conservation and biodiversity. Intensive tillage systems and harsh climate events due to climate change increase erosion phenomena.

Solution

The innovative approach involved introducing an annual self-reseeding legume cover crop under the rows, complemented by a perennial grass-legume mixture sown in the inter-rows. Specifically, a subterranean clover (*Trifolium subterraneum* spp. *brachycalicinum* L.) was sown under the rows once in late summer/early autumn and lasted for 3 to 4 years thanks to its self-reseeding capacity.

Benefits

The clover biomass serves as living mulch in autumn, winter and spring, transitioning to dead mulch in summer, thus minimising competition with grapevines for water and nutrients and reducing drought stress thanks to the soil coverage during the summer. At the end of summer, the spontaneous germination of clover seeds initiates a new biological cycle under the rows, offering benefits such as suppressing weed emergence and improving soil fertility.

Applicability box

Theme
Biodiversity, carbon sequestration, climate change adaptation, cover crops, erosion control

Context
Vineyard management in the Tuscan hills is shifting towards more sustainable practices.

Application time
All year

Required implementation time
The practice requires the time needed for crop establishment after sowing, around 1–2 months.

Period of impact
3–4 years

Equipment
Manually we obtained the best results, but it is important to improve the mechanization of this practice for a wider scalability

Practical recommendation

- The subspecies *brachycalicinum* has evolved to tolerate dry soils and is better suited to sub-alkaline, silty clay loam soils.
- Sowing subterranean clover requires careful (but not deep) soil preparation in the under-row area during the first year. The soil should be adequately prepared to ensure germination and support the plant's development during the initial, more delicate growth stages.
- If weather conditions allow, sowing should preferably be carried out after the grape harvest (early autumn). This way, the plants can germinate and grow before winter, providing good ground cover at the onset of the vine growing season.
- Even when sowing is delayed to early spring in challenging years, favourable weather conditions can still ensure the successful establishment of subterranean clover.

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Figure 1. *An overview of the experimental plots where subterranean clover was sown at the Monterosola farm, which is the subject of this abstract and one of the farms involved in the OG Ioconciv.*

Further information

Videos

https://www.ioconciv.it/video/

Web links

https://www.ioconciv.it/documentazione/

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This extended practice abstract was elaborated in the CLIMED-FRUIT project.
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Extended Practice Abstract Nº 15

Simplified cost/benefit analysis

Sowing subterranean clover in the under-row area in the vineyard

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

Mechanical weed control between rows and herbicide application under the vine rows negatively impact soil fertility and conservation, reducing agroecosystem biodiversity. Moreover, vineyards in Tuscany are mostly located in hilly soils, where erosion is exacerbated by intensive tillage systems and extreme climate events due to climate change, such as heavy rainfall and prolonged drought periods.

The use of cover crops in viticulture is considered an agroecological strategy to cope with climate change, improving the sustainability of conventional and organic viticulture. In fact, cover crops can deliver important agroecosystem services, e.g., improving soil fertility, reducing soil erosion and weed presence, increasing carbon and nitrogen input and biodiversity.

The ex-ante situation analysed here is based on an organic farm that performs weed control through repeated mechanical weeding under the rows, while the proposed innovation consists of sowing self-reseeding subterranean clover under the rows, which can re-seed itself for up to 4 years. The clover biomass will cover the soil in autumn, winter and spring as a living mulch, and in summer, when it completes its cycle, it will act as a dead mulch, avoiding competition with vines for water and nutrients. This practice offers benefits in terms of weed suppression, soil fertility improvement, reduced greenhouse gas emissions, decreased soil erosion and lower costs for the farmer.

Economical costs and benefits

The analysis covers a period of four years (2019–2023) and considers 1.25 ha on an organic farm involved in our Operational Group (OG). Although the proposed innovation proved highly advantageous (considering the work needs to be done once every 4 years), it was carried out manually, as the seeder designed to simultaneously sow both the inter-row and under-row areas and built for the project was not efficient. Therefore, the next step, particularly for farmers managing large areas, is to achieve the mechanisation of this practice.

Legend

Estimated indicator

Measured indicator

	Ex-ante	Ex-post
Variable costs		
Input		
Installation *(material + labour)*		€712.50
Labour (excluding installation)	€435.47	€112.50
Machine costs (fuel + depreciation)	€6629.84	
TOTAL	**€7065.31**	**€825.00**
COMPARISON	Global reduction of 90% of the cost: 	

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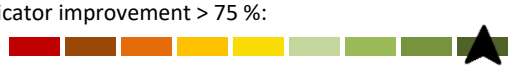
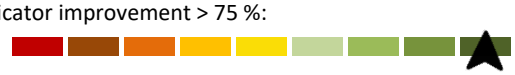
Environmental costs and benefits

Energy	Indicator improvement > 75 %: 
Considering that in terms of time, the manual preparation of the seedbed takes around 4–6 hrs/ha, and the clover lasts for 4 years, the fuel savings per ha are very significant.	
Water	Not measured but a positive impact can be considered: 
As reported by authors who worked in a similar pedoclimatic context, in Tuscany, the cover crops showed a higher water conservation capacity from the early vegetative growth stage in spring to post-harvest in autumn. The cover crop mulching, especially during the summer, played a conservative role, which means that it kept more water in the soil and built a reservoir that increased water availability for the vine row. Consequently, the cover increased the soil water availability for the vine row, while it modified the microclimate conditions of the vine row by lowering its sensible heat[1] [2].	
Soil	Indicator improvement of 20%: 
The presence of clover in the under-row area for 4 consecutive years seems to have induced some slight modifications in the soil characteristics. In particular, it appears to have increased the total nitrogen content of the soil in that area, demonstrating it to be a practice that also made it possible to keep the soil organic matter at the initial levels (unlike the farm's standard technique). To estimate this indicator, we took our results into account and referenced the bibliography from studies conducted in similar conditions, in Tuscany [3].	
Air	Indicator improvement > 75 %: 
Avoiding mechanical weed control for 4 years, we saved 184 kg CO_2 per year.	
Biodiversity	Indicator improvement of above- and below-ground diversity of 20%: 
Implementing cover crops in vineyards increases plant biodiversity. As reported in the literature[4], extensive vegetation management generally enhances both above- and below-ground biodiversity compared to intensive management. Organic management, along with practices that avoid herbicides, has a stronger positive effect on ecosystem services and biodiversity than soil tillage.	

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(2) Warren Raffa, D.; Antichi, D.; Carlesi, S.; Frasconi, C.; Marini, S.; Priori, S.; Bàrberi, P. (2021). Groundcover Mulching in Mediterranean Vineyards Improves Soil Chemical, Physical and Biological Health Already in the Short Term. Agronomy, 11, 787. https://doi.org/ 10.3390/agronomy11040787

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Extended Practice Abstract Nº 15

Go-ioconciv: a sustainable approach to reduce tillage and herbicide use in vineyards

Short description of the OG/project

The project focused on weed control in vineyards, aiming to reduce herbicide application and soil disturbance, enhancing soil fertility through the promotion and evaluation of alternative and sustainable methods for managing inter- and intra-row spaces. Cover crops were explored as an agroecological solution to improve the sustainability of both conventional and organic viticulture. Implemented from 2019 to 2023 on four farms in Tuscany, Italy, the innovative approach involved introducing an annual self-reseeding legume cover crop under the rows, specifically a subterranean clover, complemented by a perennial grass-legume mixture sown in the inter-rows.

Benefits

Providing agroecosystem services such as enhanced soil fertility, reduced soil erosion and weed presence; increased carbon storage, nitrogen inputs and biodiversity

Stage of implementation

The project has finished; its completion date was in May 2023.

Key data box

Theme
Biodiversity, carbon sequestration, climate change adaptation, cover crops, erosion control

Context
Vineyard management in the Tuscan hills is shifting towards more sustainable practices.

Duration
4 years

Partners involved
CAICT Formazione srl, CIRAA (UniPi), Ri.Nova, Podere Spazzavento farm Bellesi Alberto farm, La vite farm, Tenuta Monte Rosola farm, CfGC (UniFi)

Budget
€355,175.76

Particularity
Self-reseeding legume cover crop sown under the row in vineyards

Main achieved or expected results

The subclover was proven to be competitive against weeds in a long-term context; in fact, it reseeded itself for four years, reducing grape yield only slightly, at most less than 9% in the wettest year, and having no influence on the berry nitrogen content, compared to the farm standard strategy, namely herbicides or mechanical weeding. Moreover, we observed a reduction in tillage and herbicide spray costs, and we should have had a reduction in greenhouse gases, increase in carbon sequestration, reduction in soil erosion and herbicide leaching, although further studies are needed to investigate these aspects in depth. A future challenge involves improving clover establishment in the first year. To address this, the project team developed a prototype mechanical drilling machine capable of sowing different cover crops in intra- and inter-row spaces. However, the seeder machine presented limitations in seed distribution, and to obtain a good result, some farmers decided to carry out sowing manually. Therefore, further collaboration with farmers and the machinery industry is essential to adapt and improve the machine, as well as exploring locally adapted clover cultivars or other similar species to increase its widespread application.

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a)

b)

c)

Figure 2. *Pictures (a) and (b) show the subclover at its maximum vegetative stage, while (c) shows the subclover after it has died, continuing to cover the soil as dead mulch.*

Existing materials

Videos

https://www.ioconciv.it/video/

https://www.youtube.com/watch?v=VHEc0I_WJEM&list=PLqU_4ysqg2QmO7plsRi5r5C_M4mMFuVwW&index=6&ab_channel=CLIMED-FRUIT

Web links

https://www.ioconciv.it/documentazione/

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