Water Solutions

Domaine Lafage

Domaine Bousquet
Naturally Organic Wines

Catena Institute of Wine

Two Hands Wines

The Fladgate Partnership

Taylor's Port

Symington Family Estates

Paul Clüver Family Wines

Paicines Ranch

Casa Relvas
Alentejo | Portugal

Herdade dos Grous

O'Neill
Vintners & Distillers

Familia González Byass
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Irrigation Technologies

RHST Industries

Salcheto
Toscana

Argos Analytics, LLC
The Climate Data You Need
www.argosanalytics.com
Designing Resilient Vineyards

The Vineyards at Dodon

Henry family estate of Pelham

Clos de Tres Cantos
Vitivinicultura Consciencia

Raimat
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SOLUTIONS SUMMARY

HERDADE DOS GROUS

HERDADE DOS GROUS

ALENTEJO, PORTUGAL

Solution | keyline design

Application | Vineyards

THE SOLUTION

Vineyard establishment and management following Keyline design principles 2023, first implemented at Herdade dos Grous in 2024.

The keyline design in our vineyard aims to optimise water distribution across the terrain, increase soil infiltration, and reduce runoff. This addresses the challenges of water scarcity and drought conditions typical of the Alentejo region, improving irrigation efficiency and crop resilience. This design enables one-time implementation, with continuous monitoring and maintenance.

The vineyard was designed and established following Keyline principles to optimise water distribution and enhance soil infiltration. Prior to planting, the soil was enriched with a winter cover crop mix of clovers, vetch, ryegrass, mustard, and forage radish, which protects the soil, improves fertility, and contributes organic matter. The cover crop is rolled after flowering using a roller-crop, leaving plant residues as mulch and incorporating seeds into the soil for the following season.

Portuguese grape varieties, well-suited to the Alentejo climate, were planted, and a drip irrigation system with auto-compensating emitters was installed to ensure efficient water use. Following vineyard establishment, holistic grazing with sheep is applied during the winter, enhancing soil structure, nutrient cycling, biodiversity, and cover crop regeneration. Each year, the cover crop is evaluated and adjusted as necessary, and the vineyard inter-rows are periodically managed with a Yeomans subsoiler to maintain underground furrows that maximize water distribution along the Keyline contours.

WATER-RELATED OUTCOMES

- Improved water infiltration and reduced runoff through Keyline design and the maintenance of subsoil furrows.
- Higher soil water-holding capacity as a result of permanent soil cover, increased organic matter, and improved soil structure.
- Increased irrigation efficiency using drip irrigation with auto-compensating emitters, ensuring uniform water application and minimizing losses.
- Enhanced drought resilience of the vineyard, particularly relevant under the semi-arid conditions of the Alentejo region.
- Reduced evaporation losses due to mulching from rolled cover crops and continuous soil cover.

Click here to read more about Herdade dos Grous' water solution.

PAICINES RANCH

CALIFONIA, USA

Solution | Holistic Regenerative Viticulture

Application | Vineyards

THE SOLUTION

The Holistic Regenerative Viticulture System, implemented in 2014, was developed to reduce reliance on poor-quality groundwater by improving the vineyard's ability to retain rainwater where it falls.

It is a continuous, observation-driven approach, guided by indicators such as soil cover, water infiltration, plant and insect diversity, and overall ecosystem health. The system combines practices including permanent soil cover, no tillage, adaptive grazing,

reduced tractor use, and vineyard design strategies like shading and north-facing exposure.
By actively enhancing soil health and biodiversity, the vineyard improves water retention and efficiency, strengthening resilience while reducing dependence on external water inputs.

WATER-RELATED OUTCOMES

- Soil carbon, as measured every 2-4 years, is on a continual increase (up 2% from baseline before planting).
- Overall irrigation use is generally declining in spite of vines getting bigger and several serious drought years.
- Water infiltration rates continue to improve (from close to 1 minute for 1 inch of rain to 4 seconds for the same amount

Click here to read more about Paicines Ranch water solution.

THE VINEYARDS AT DODON

MARYLAND, UNITED STATES

Solution | Healthy Soils

Application | Vineyard

THE SOLUTION

Dodon uses agroecological tools (cover crops, composting, livestock integration, and biodiversity) to regenerate living soils.
We begin by increasing plant diversity. Because we have a large seed bank and ample rainfall, we depend on naturally growing, native, and naturalized grasses and forbs.

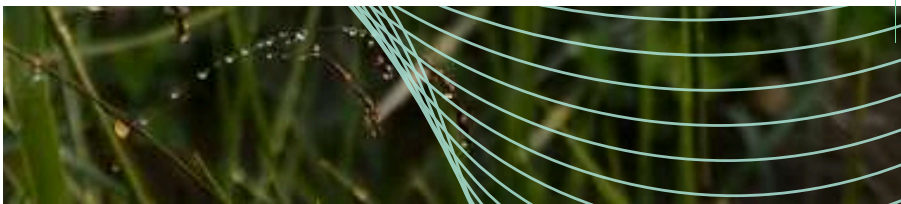
Starting at bloom, tall grasses over eight inches are terminated using a roller-crimper. This process creates a mulch layer between the rows, which cools the soil, boosts microbial activity, reduces pathogen pressure, and releases nutrients needed by the vines for fruit set.

Crimping enables diverse ground cover to thrive, resulting in cover crops with various root depths that create pathways for water infiltration during heavy rains.

WATER IMPACT & OUTCOMES

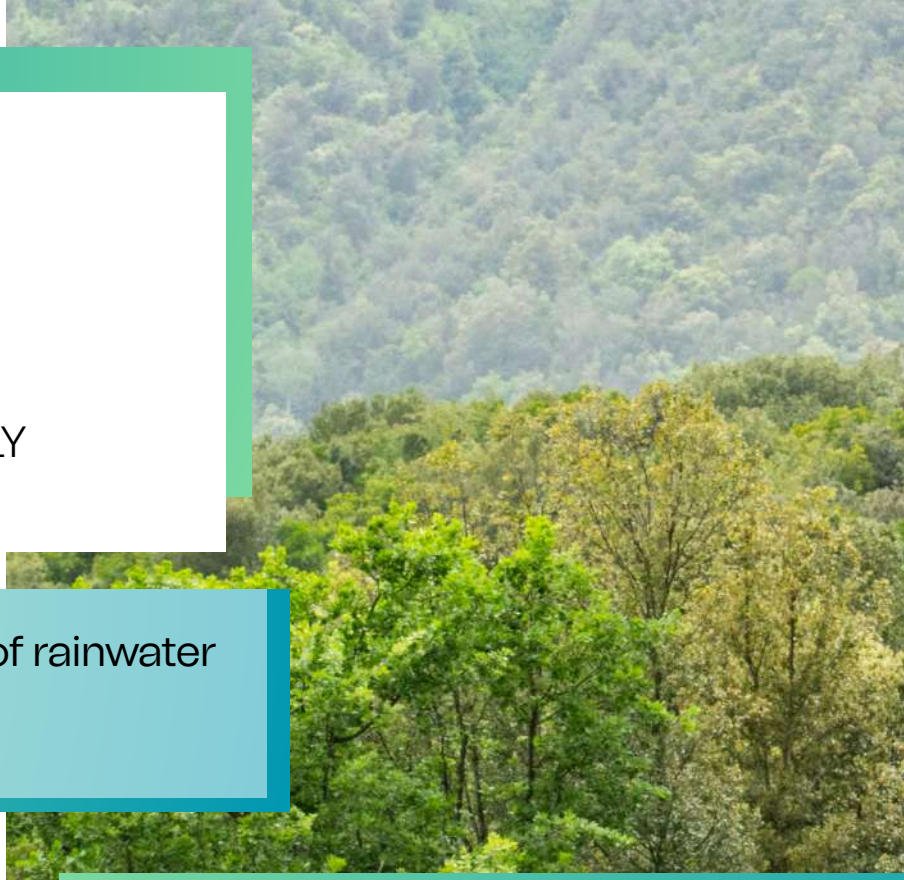
Taken together, the emphasis on plant diversity and soil health has resulted in a 30% increase in yield, a 40% reduction in fungicide use, eighteen fewer tractor passes per season, and better wine.

Click here to read more about The Vineyards at Dodon´s water solution.



SAN POLINO

BRUNELLO DI MONTALCINO, ITALY



Solution | Intentional guiding of rainwater

Application | Vineyard

THE SOLUTION

This solution involves cutting gently sloped channels around vineyard plots to improve how water is managed across the land.

These channels are designed to slow down the movement of rainwater, allowing it to be gradually absorbed into the soil rather than quickly running off.

As a result, areas that are prone to drought receive more consistent moisture, while during periods of heavy rainfall, the reduced water flow helps prevent soil erosion.

By encouraging water to infiltrate and spread evenly, the vines are able to access moisture from deeper in the soil, supporting their growth without the need for irrigation.

At the same time, this approach protects the structure and fertility of the soil, reducing long-term degradation.

WATER IIMPACT AND OUTCOMES

- We use satellite technology, with a two antennas in the vineyards, that measurs the amount of rainfall in our vineyards.
- This water is all absorbed by the soil as there is no run-off. We can retrieve these numbers but I do not have them available now.
- We work through observation and results rather than just data collection.

Click here to read more about San Polino´s water solution.

DOMAINE BOUSQUET

(MULTIPLE REGIONS), ARGENTINA,

Solution | Combination - Adapted Solution

Application | Winery and Vineyard

THE SOLUTION

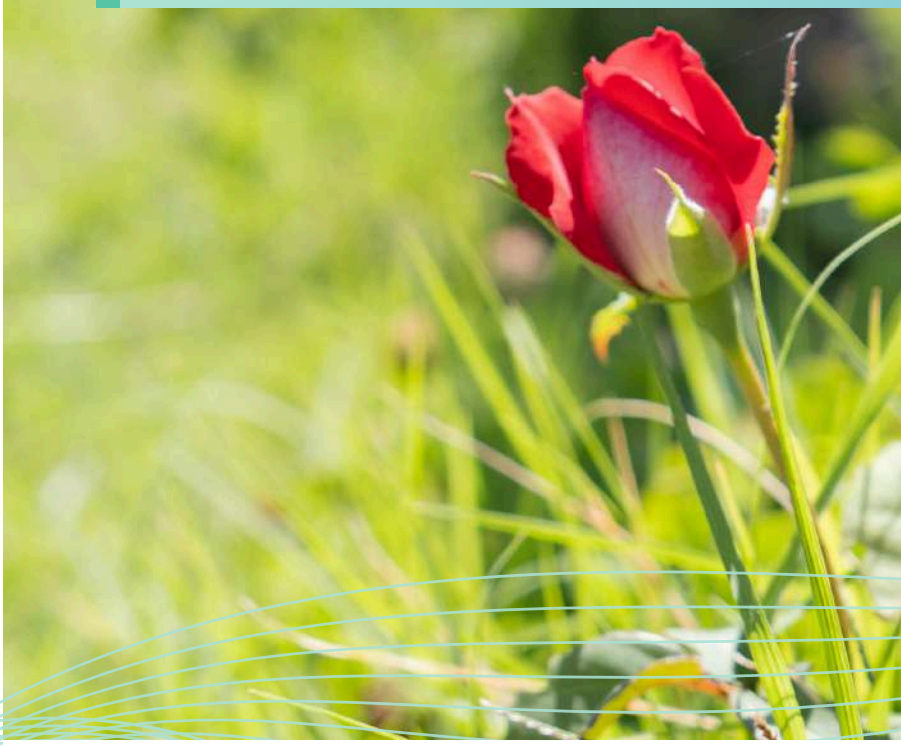
This solution improves irrigation efficiency by combining better planning, system upgrades, and monitoring. Irrigation scheduling was optimised using an Excel-based model that incorporates climate data and evapotranspiration, allowing water use to match plant needs more accurately.

Infrastructure improvements included installing hydrocyclones to prevent clogging and maintaining pumps, which restored about 15% of system efficiency. A new interconnection pipeline was added to fix uneven water distribution and reduce local shortages.

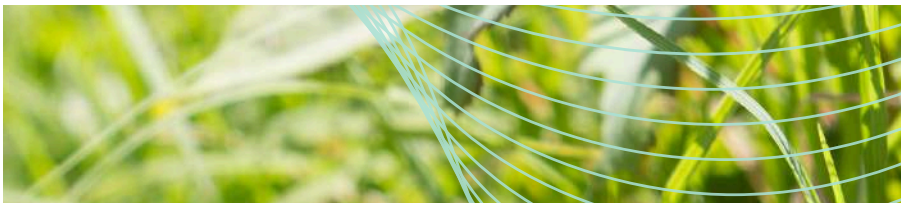
A seasonal deep soil saturation practice was introduced to build water reserves before bud break, supporting early plant growth. Additionally, a central dashboard and soil moisture sensors (implemented in 2025) enable real-time monitoring and more informed irrigation decisions.

RESULTS OBSERVED

- Reduced blue water use
- Cost savings



[Click here to read more about Domaine Bousquet´s water solution.]



SALCHETO

MONTEPULCIANO (SI) ITALIA

Solution | WF - Key Metric Track

Application | Water footprint

Key metric tracked:

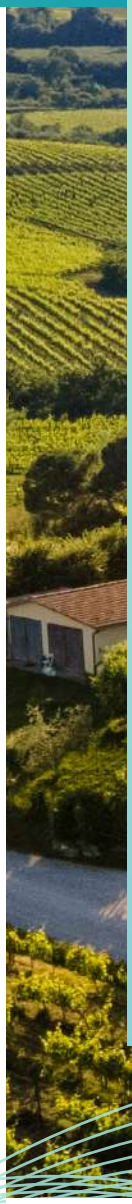
Water Scarcity Impact (m3eq)
Aquatic Acidification (kg SO2eq)
Aquatic Ecotoxicity (CTUe)
Human Toxicity (CTUh)
Aquatic Eutrophication (kg PO4eq)

The assement has been run following the ISO 14046 standard since 2016, in within the Equalitas Winery and Product Sustainbility certification. Since 2023 the calculations are made with the IT support of the Apra-Equalitas specific software.

For the Countryside Area, the reference unit was considered to be 1 q of grapes harvested and suitable for processing in the year under review.

For the Cellar Area, the reference unit was 1 liter of bulk wine produced and suitable for bottling.

Finally, for the Bottling Area, 0.75 liters of wine packaged and ready for sale were considered.



ACTIONS IMPLEMENTED

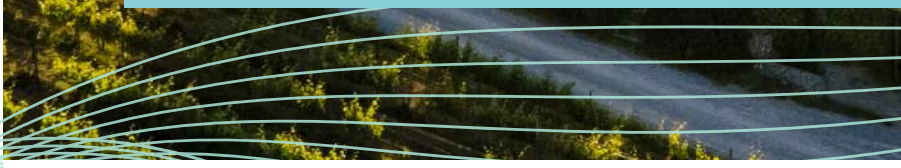
The calculation and monitoring of those indicators underlined the main direct and indirect impact of the winery entire value chain in regard of water based on an LCA approach.

The main direct impact regards water scarcity, where the use use of a lake to collect rain water together with the one depurated once out of the winery operations, has been the major improvement.

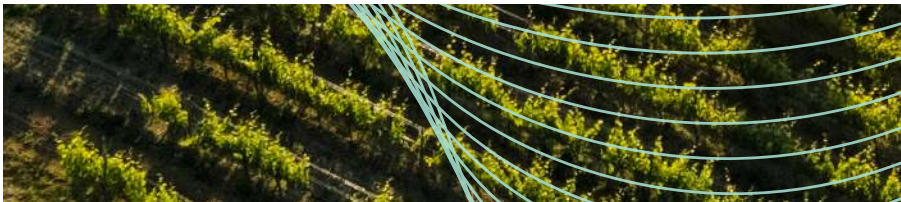
The main indirect impacts regarding the ecosytem acidification, eutrophication and ecotoxicity rise from the production of glass bottles, the use of energy and the consumption of fertilizers.

Fertilizers and diesel fuel are also the main impact sources regardin human toxicity.

The winery has since 2010 implemented several solutions such as light glasses (370gr for a 750ml) and alternative packagings (such as Bag in Boxes) but also through the reduction of energy, both in the cellar (which is energy independent) than in the vineyards (multi operations machineries and DSS and precision interventions), together with a significan reduction in the use of fertilizers (for example by autoproducing compost).



Click here to read more about Salcheto´s water solution.



PAUL CLÜVER FAMILY WINES

ELGIN, SOUTH AFRICA

Solution | Planting of undervine covercrop

Application | Vineyards

THE SOLUTION

This approach, implemented in 2025, addresses the challenge of lowering irrigation demand while reducing ground temperatures in the vineyard. Applied on a yearly basis, the solution consists of planting cover crops such as medics and clovers to protect the soil surface.

These plants help prevent excessive soil heating, reducing evaporation and improving moisture retention.

By moderating soil temperatures and maintaining a living cover, this practice creates a more balanced growing environment, supporting vine health while decreasing the need for irrigation.

WATER IMPACT & OUTCOMES

- Better soil water penetrability
- Lower irrigation needs.
- Less water stress.

100% Water saved

Click here to read more about Paul Cluver's water solution.

FATTORIA LA MALIOSA

TUSCANY, ITALY

Solution | Mulching

Application | Vineyards

THE SOLUTION

At Fattoria La Maliosa, vineyard water management is centred on a long-term, nature-led approach designed to address prolonged summer droughts and extreme temperatures exceeding 35°C.

Since 2013, the estate has implemented a mulching system applied either under the vine rows or across the entire parcel surface, depending on parcel size and planting method. The vineyards are managed without tillage, allowing wild grasses to establish naturally and increase biodiversity and soil complexity over time.

This practice helps maintain soft, permeable soils capable of absorbing rainfall effectively, even during heavy storms. As the vineyards are non-irrigated, long-term water conservation is achieved through annual mulching using organically produced hay made from the estate's own wild grasses.

Applied once a year between October and March, the hay is spread manually under the rows to a depth of 15–20 cm, fully covering the soil to retain moisture and protect against evaporation.

WATER IMPACT & OUTCOMES

100% Water saved

A study by the National Research Centre for Agriculture (CREA) examined soil organic matter and related soil properties in vineyard environments, and the findings have been published in scientific literature

Click here to read more about Fattoria la Maliosa's water solution.

Abacela

ABACELA WINES

UMPQUA VALLEY, USA

Solution | Drones to monitor irrigartion

Application | Vineyards

THE SOLUTION

Drone Use to Monitor Irrigation Leaks at Abacela Wines was first implemented in 2021 to address undetected breaks in irrigation lines caused by physical damage (such as cracked tubes or split heads) or biological factors (such as jack rabbits) across Abacela Wines' large vineyard.

By flying a drone weekly at approximately 50 meters above the vineyard, we can quickly identify abnormally green areas in what should be a dry, brown summer landscape.

These green patches signal potential irrigation leaks, allowing us to promptly send staff to inspect and repair the affected irrigation lines, reducing water loss and improving irrigation efficiency at Abacela Wines.

WATER IMPACT & OUTCOMES

- Helps quickly identify irrigation line breaks before they result in prolonged water loss
- Reduces unnecessary water drainage into the vineyard and surrounding areas
- Improves overall water-use efficiency by enabling faster repairs
- Minimizes wasted irrigation water during the dry summer season
- Supports more responsible and sustainable water management practices

Click here to read more about Abacela Wines' water solution.

RAIMAT
SUSTAINABLE WINEGROWING

RAIMAT WINES

COSTERS DEL SEGRE, SPAIN

Solution | Partial Root Drying (PRD)

Application | Vineyards

THE SOLUTION

Partial Root Drying (PRD), implemented since 2001 at Raimat, is an irrigation technique designed to improve grape quality while conserving water. Instead of using a single dripline, two driplines are installed along the vine's root zone—one irrigating the right side and the other the left.

Irrigation alternates every 15 to 21 days, with only one side receiving water while the other remains dry. The drying side triggers a hormonal response in the vine, causing stomata to close and reducing transpiration, while the irrigated side continues to receive sufficient water.

This controlled "stress signal" stimulates the vine's ripening processes, enhancing color, flavor, and seed maturation, ultimately improving the quality of the red wines produced at Raimat. PRD is applied from veraison to harvest, allowing consistent quality improvement and water savings.

WATER IMPACT & OUTCOMES

Up to 40% water savings and improved quality

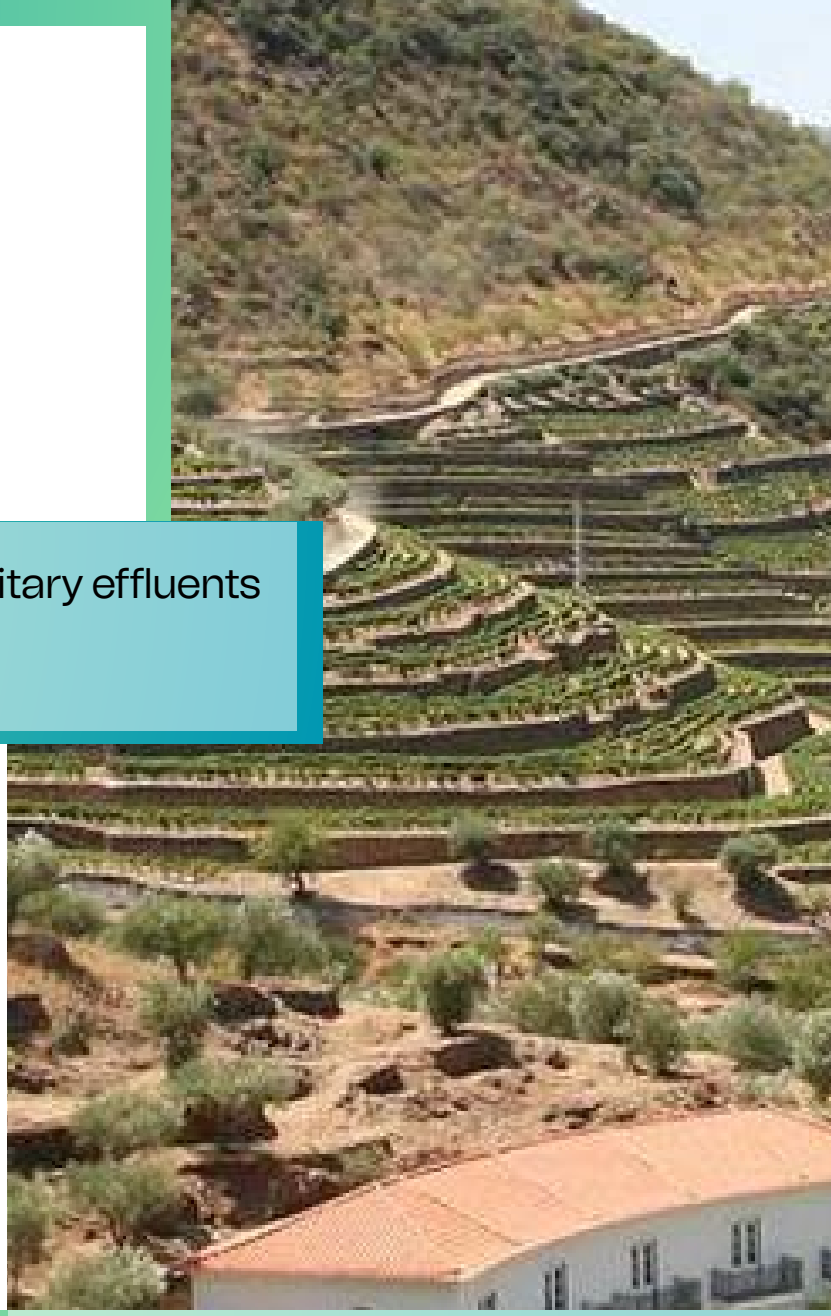
Click here to read more about Raimat Wines' water solution.

THE FLADGATE PARTNERSHIP

DOURO VALLEY, PORTUGAL

Solution | Treatment of phytosanitary effluents

Application | Vineyards



THE SOLUTION

Since 2020, the Fladgate Partnership has used dedicated on-site treatment systems to manage phytosanitary effluents from vineyard spraying operations.

Applied after each treatment cycle, these systems prevent contamination of soil and water resources by collecting residual spray mixtures and equipment wash water and treating them through controlled degradation and filtration processes. This ensures that treated water is safely managed, reducing the risk of pollution to surface water, groundwater, and soils—particularly important in steep, erosion-prone, and ecologically sensitive vineyard areas.

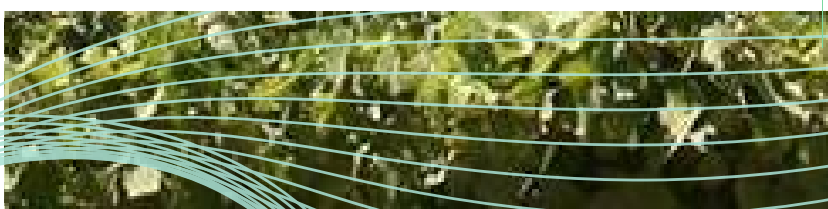
Instead of allowing residual spray mixtures and equipment wash water to be discharged into soil or watercourses, the system:

- Collects effluents generated during the cleaning of spraying equipment
- Treats contaminated water through controlled degradation and filtration processes
- Ensures that treated water is safely managed, preventing pollution of surface water, groundwater, and soils

WATER IMPACT & OUTCOMES

- Prevention of water contamination from phytosanitary residues
- Protection of surface and groundwater quality in vineyard ecosystems
- Reduced environmental risk linked to spraying operations

Click here to read more about The Fladgate Partnerships water solution.



Clos de Tres Cantos
Vitivinicultura Consciencia

CLOS DE TRES CANTOS

BAJA CALIFORNIA, MEXICO

Solution | Artificial Wetlands

Application | Vineyard

THE SOLUTION

The artificial wetland at Clos de Tres Cantos winery was developed through a collaborative effort between the winery, the Autonomous University of Baja California (UABC), and the Rio Arronte Foundation, combining practical, academic, and technical expertise. The design was led by a UABC master's student with support from researchers and implemented by a multidisciplinary team, including engineers and local artisans skilled in traditional materials.

The system is designed as a water reservoir integrated into natural or excavated land depressions, following contour lines to capture runoff, promote soil infiltration, and support aquifer recharge. Water flow is managed through structural elements such as containment walls with controlled outlets, which help regulate irrigation and prevent overflow.

Additionally, the wetland incorporates natural filtration through layers of sand, gravel, and pebbles, while selected vegetation stabilizes the structure, reduces evaporation, and enhances water purification, ensuring integration with the surrounding ecosystem.

WATER-RELATED OUTCOMES

- The water that is collected is completely filtered.
- Outcomes are reuse of water runoff and efficiency because the wetland is immediately before the well, so our water consumption in winter practically comes from the wetland.
- The cost is in maintenance; plants and stability of slops require some biannual maintenance.

Click here to read more about Clos de Tres Cantos water solution.

SYMINGTON FAMILY ESTATES, VINHOS SA

DOURO, PORTUGAL

Solution | Plant Aware Irrigation Deficit

Application | Vineyards

THE SOLUTION

Since 2014, irrigation management has been guided by a data-driven approach combining infrared drone and satellite imagery, soil analyses and moisture sensors, and plant-based measurements such as predawn leaf water potential.

These indicators are used weekly to adjust irrigation according to evapotranspiration demand and crop-specific coefficients.

This enables precise deficit irrigation, targeting only areas experiencing water stress and avoiding unnecessary water use.

The new approach was validated through field trials comparing the PAI methodology, a Standard Deficit Irrigation approach, and a Rainfed Control across replicated vineyard plots, including a Touriga Nacional block under defined site conditions.

WATER IMPACT & OUTCOMES

The new approach is based on three modules

- A plant-based sampling method to understand the response of the vines to the vintage.
- A continuous analysis to decipher the vintage and anticipate practices.
- Using the 360viti method to adapt water deficit practices to the needs of the plant, considering the objectives for different phenological stages.
- Reduce around 40% water use and optimising quality and yield

Click here to read more about Sygminton's water solution.

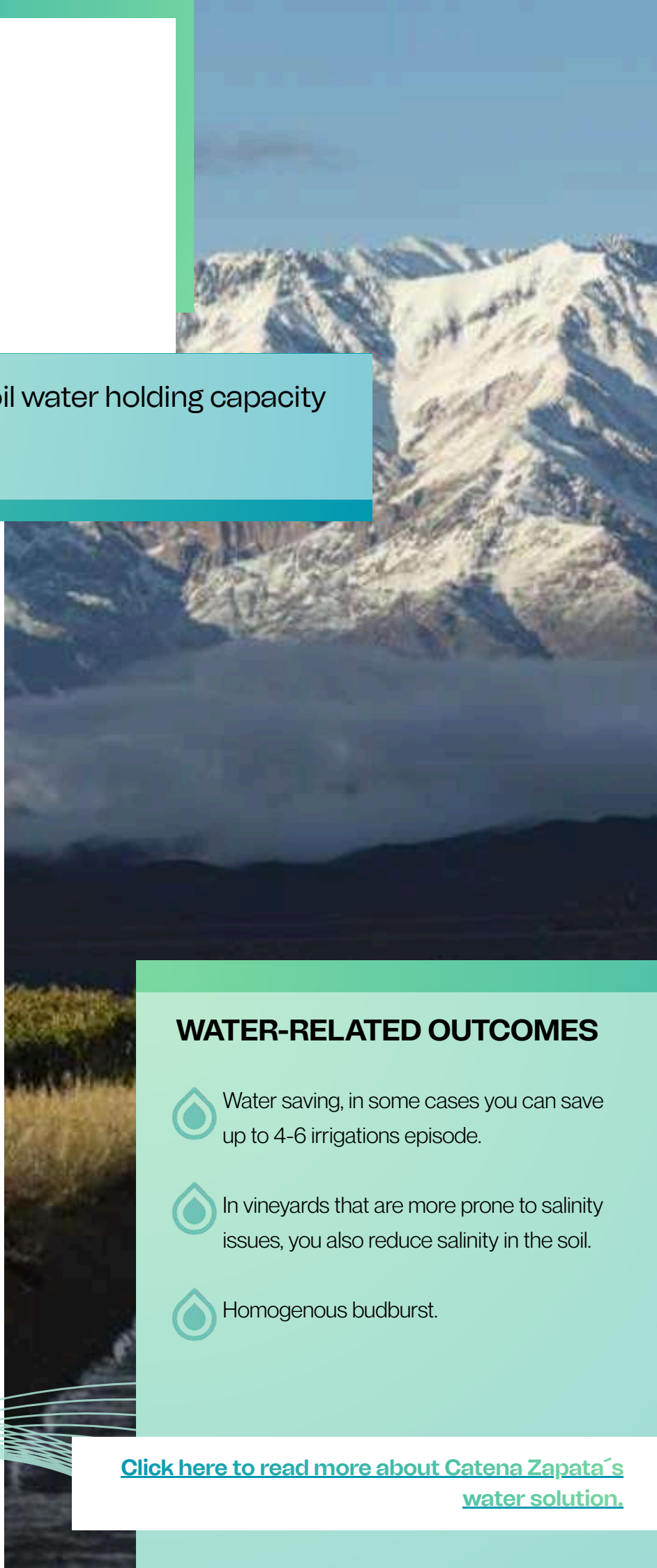
CATENA INSTITUTE of Wine

CATENA ZAPATA

MENDOZA, ARGENTINA

Solution | Irrigation up to soil water holding capacity

Application | Vineyard



THE SOLUTION

The solution involves managing irrigation to fully recharge the soil profile up to its soil water-holding capacity, particularly during the dry season from Winter to early Spring. This approach ensures that vines have sufficient water reserves stored in the soil, improving resilience during periods of limited rainfall.

In vineyards affected by salinity, irrigation practices are adjusted by relocating hoses to the inter-row areas. This helps promote salt leaching away from the root zone, reducing stress on the plants and improving soil conditions over time.

Seasonal factors are also considered in the strategy. During winter, water availability may be limited and low temperatures can pose a risk of freezing and damaging the irrigation system, requiring careful management and potential system shutdowns.

WATER-RELATED OUTCOMES

- Water saving, in some cases you can save up to 4-6 irrigations episode.
- In vineyards that are more prone to salinity issues, you also reduce salinity in the soil.
- Homogenous budburst.

Click here to read more about Catena Zapata´s water solution.

Courtesy NASA Visible Earth

Argos Analytics, LLC
Designing Resilient Vineyards
www.argosanalytics.com

ARGOS ANALYTICS, LLC

CALIFORNIA, UNIITED STATES

Solution | Water Demand Model (WDM)

Application | Vineyard

THE SOLUTION

The WDM (Water Deficit Model) is a daily soil water balance model that simulates how much water is available to plants based on weather and vineyard characteristics.

It uses inputs like precipitation, temperature, humidity, solar radiation, and wind, under different climate scenarios (wet, average, or dry years).

It models evapotranspiration and irrigation practices using parameters such as crop type, canopy configuration, row spacing, and root depth, to estimate daily soil water availability and potential, which indicate plant water stress.

Most parameters can be adjusted to test adaptation strategies, such as altering canopy management, changing irrigation frequency and volume, or redesigning vineyard layout (row direction, spacing) to improve water efficiency and resilience under changing conditions.

WATER IMPACT & OUTCOMES

- Reduced demand for irrigation water
- Ability to manage water stress and avoid severe stress even in dry years
- Optimal timing of irrigation (pre–bud break and growing season)
- Increased resilience of vineyards to drought
- Insight into future water demand under climate scenarios (wet, average, dry years)

Click here to read more about Argos Analytic's water solution.

RHST INDUSTRIES INC

QUEBEC, CANADA

Solution | RHST Water Pearls

Application | Vineyard

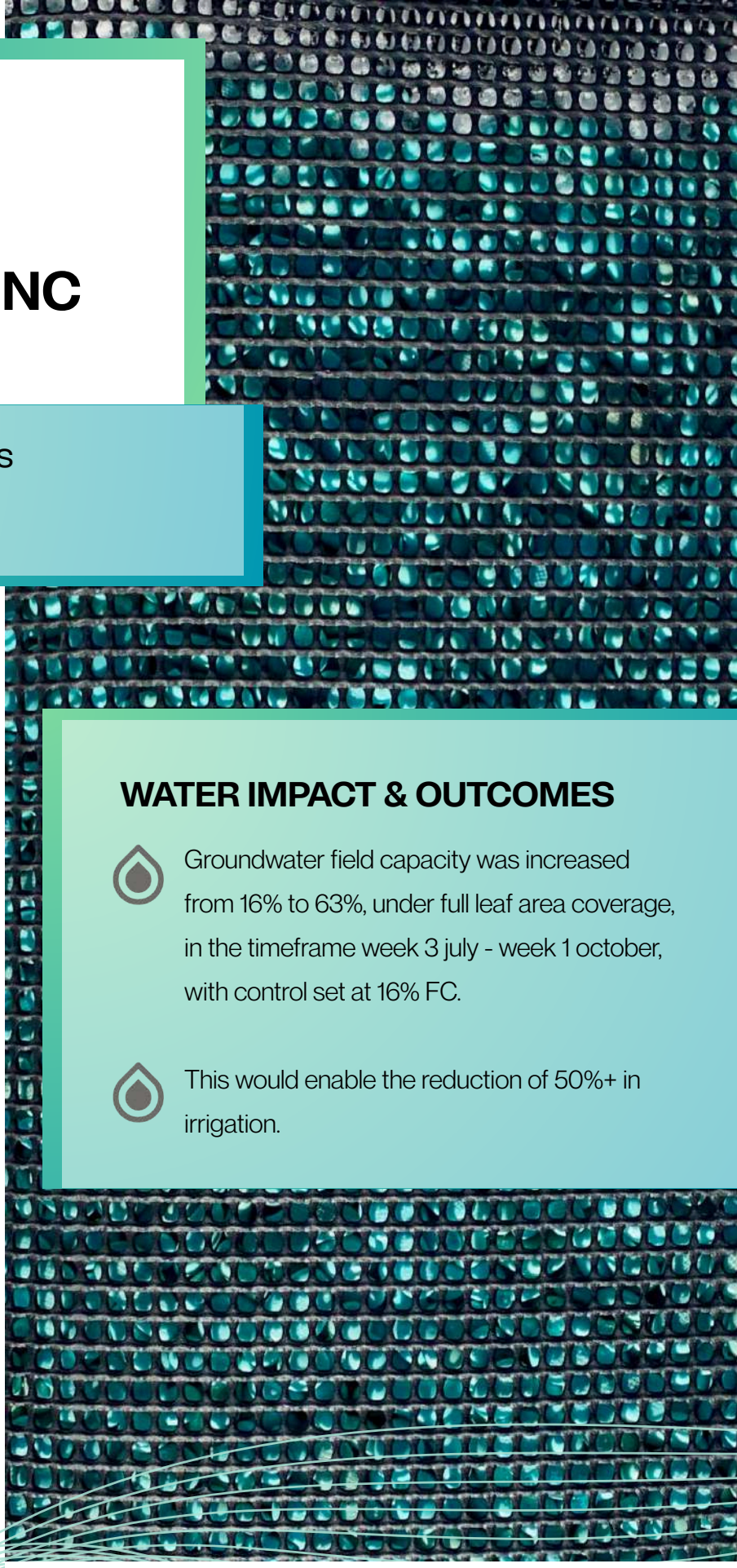
THE SOLUTION

The solution uses soil cover mats combined with WaterPearls to improve water efficiency and reduce maintenance.

The mats cover the soil around the roots, blocking weeds and reducing evaporation, while still allowing irrigation water to pass through.

WaterPearls, which are water-repellent biodegradable beads, help control how water moves and is retained in the soil.

Together, they improve water distribution, reduce water loss, and support plant growth, especially in dry conditions, while also lowering the need for herbicides.



WATER IMPACT & OUTCOMES

- Groundwater field capacity was increased from 16% to 63%, under full leaf area coverage, in the timeframe week 3 july - week 1 october, with control set at 16% FC.
- This would enable the reduction of 50%+ in irrigation.

Click here to read more about RHST INDUSTRIES INC´s water solution.

FAMILIA
GONZÁLEZ BYASS
VINOS Y SPIRITS · 1835

GONZALEZ BYASS

JEREZ, SPAIN

Solution | Arsepiado

Application | Vineyard

THE SOLUTION

In the Jerez DO, irrigation is not allowed, and rainfall is irregular and often runs off quickly on sloped vineyards, leading to water loss and soil erosion.

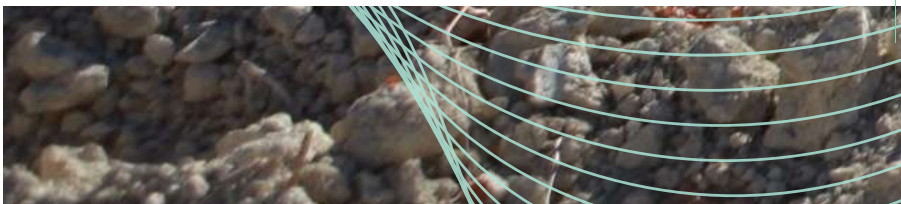
The solution is aserpiado: after harvest, growers reshape the soil along the rows into small basins or ridges. These structures slow down the flow of rainwater, allowing it to collect and gradually infiltrate the soil instead of running off.

This increases water retention in the soil, provides a more consistent moisture supply for the vines, and reduces erosion, helping maintain soil fertility and vineyard sustainability.

BENEFITS

- retain rainwater
- improve infiltration to increase water reserves in the soil
- reduce erosion of the slopes by helping to fix the soil

Click here to read more about Gonzalez Byass water solution.



HENRY family estate of PELHAM

HENRY OF PELHAM FAMILY ESTATE WINERY

NIAGARA PENINSULA, CANADA

Solution | Wetland Restoration & Bio Filters

Application | Vineyard

THE SOLUTION

This solution uses buried trenches filled with a mix of wood chips and stone to allow water to pass through while supporting the growth of microorganisms that help break down and filter pollutants.

The system connects to a shallow wetland retention area planted with native vegetation, where water is further naturally purified.

By designing the wetland with varying depths, it creates habitats for a wider range of species, increasing biodiversity.

Native plants are also added around the trench and pond to attract insects and wildlife, helping to build a balanced and self-sustaining ecosystem while improving water quality.

BENEFITS

- Healthy water courses and clean run-off
- Waste water 100% contained, no net water usage
- 100% permanent cover crop (0 tillage)

Click here to read more about Henry of Pelham Family Estate Winery water solution.

TWO HANDS WINES

TWO HAND WINES

BAROSSA VALLEY, AUSTRALIA

Solution | Sap Flow Management

Application | Vineyard

THE SOLUTION

This system combines vine-mounted sensors with continuous data analysis to optimise irrigation in vineyards. Sensors installed on selected vines measure evapotranspiration (water loss) 24/7.

These data are analyzed alongside seasonal observations to determine when vines are genuinely experiencing water stress. Instead of frequent irrigation, water is applied less often but in longer, targeted runs.

Over time, this approach intentionally conditions vines to become more drought-resistant, while complementary practices (like mid-row and under-vine management) support overall vineyard health.

WATER IMPACT & OUTCOMES

- Water reduction: Data-driven irrigation reduces water use by applying it only when needed (~50% less).
- Soil health: Targeted watering improves soil structure and nutrient retention.
- Vine health and resilience: Controlled stress promotes deeper roots and stronger drought resistance.

Click here to read more about Two Hand Wines´s water solution.

DOMAINE LAFAGE

ROUSSILLON, FRANCE

Solution | Conservation Irrigation

Application | Vineyard

THE SOLUTION

The proposed solution is a data-driven minimal irrigation strategy that can reduce water use by up to threefold while maintaining vine yield and grape quality.

Unlike fixed irrigation schedules, water is applied only when needed, based on soil moisture, vine water status, and berry development indicators. The approach calibrates the relationship between soil water content and vine water status for accurate irrigation decisions under drip systems, and it monitors berry growth and composition to prevent negative effects of water stress.

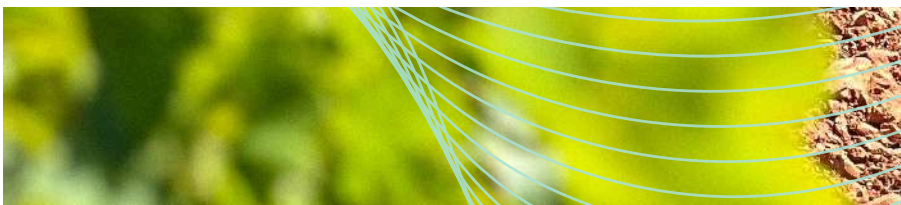
Irrigation is applied strategically during key growth stages, making it suitable for areas with low water availability, and it is implemented through a simple field protocol with threshold-based triggers.

Overall, this method allows growers to sustain productivity and wine quality while significantly reducing water consumption and can be adapted to different grape cultivars and terroirs.

WATER IMPACT & OUTCOMES

- Achieves up to 3× reduction in irrigation water use
- Improves water-use efficiency (more yield per unit of water)
- Reduces overall water footprint of vineyard operations

Click here to read more about Domaine Lafage´s water solution.



DOMAINE LAFAGE

ROUSSILLON, FRANCE

Solution | Biochar

Application | Vineyard

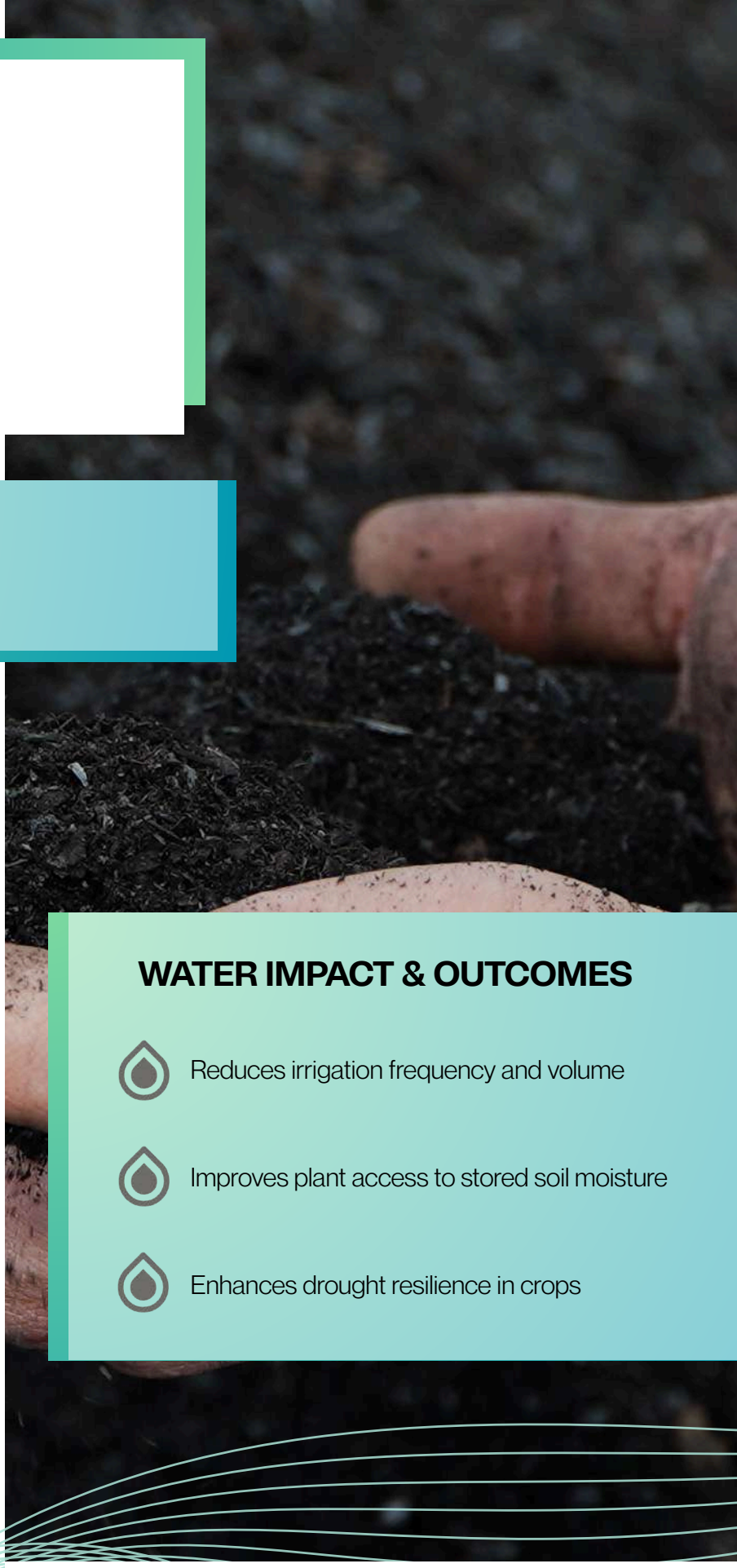
WATER SOLUTION

This solution addresses drought resilience by using biochar, a carbon-rich material produced from the thermal decomposition of organic biomass under limited oxygen.

When incorporated into soil, biochar improves its physical and chemical properties, particularly enhancing water retention, which is valuable in water-scarce regions. Its effectiveness depends on production characteristics, feedstock type, and the specific soil and crop conditions, requiring careful selection and site-specific application.

Biochar is typically applied to the topsoil, often mixed with compost or manure to enhance nutrient availability and prevent nutrient lock-up, with moderate, tailored application rates.

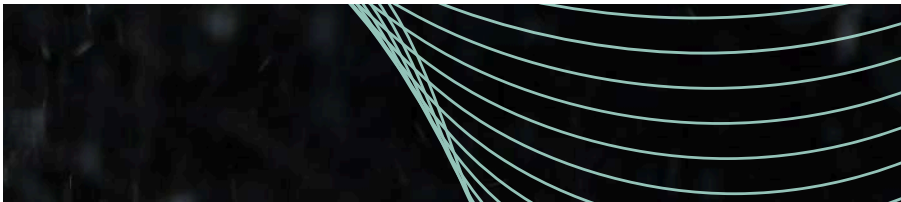
Once in the soil, biochar increases porosity, supports microbial activity, and improves water-use efficiency, helping crops reduce irrigation needs, though outcomes can vary and further research is needed to optimise its use.



WATER IMPACT & OUTCOMES

- Reduces irrigation frequency and volume
- Improves plant access to stored soil moisture
- Enhances drought resilience in crops

Click here to read more about Domaine Lafage´s water solution.



ESTATE WINES
ALPAMANTA

ALPAMANTA

MENDOZA, ARGENTINA

Solution | Drip Irrigation

Application | vineyard

WATER SOLUTION

We use a monitoring-based irrigation system to improve water efficiency across vineyard sections to help us measure rainfall, humidity, and soil conditions to determine the exact amount of water needed for each block of vines.

Because the vineyard has different soil types, irrigation is adjusted by zone to avoid over- or under-watering. This precision approach, similar to systems used in Mendoza, Argentina, helps optimise water use, reduce waste, and support healthy vine growth in each area.

WATER IMPACT & OUTCOMES

- Improved vine water balance and reduced plant stress
- Increased overall water-use efficiency at vineyard scale

Click here to read more about Alpamanta´s water solution.

Irrigation Technologies

CHARLES KRUG

NAPA VALLEY, UNITED STATES

Solution | Drip Irrigation-moisture monitoring

Application | Vineyard

WATER SOLUTION

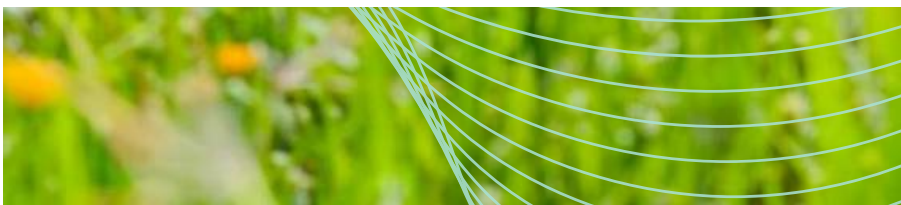
At Charles Krug Winery, irrigation decisions are based on continuous monitoring of soil moisture, temperature trends, weather forecasts, and overall vine health to maintain optimal vigor. This data-driven approach determines both the timing and duration of watering.

In addition to these practices, the winery uses DRI (Direct Root-zone Irrigation), a system that delivers water directly below the soil surface to the vine roots. Compared to traditional drip irrigation, DRI is much more efficient, significantly reducing water loss from evaporation and runoff. Their observations show that vines using DRI can achieve similar growth and productivity while using about **50% less water,** making it a more sustainable and precise irrigation method.

WATER IMPACT & OUTCOMES

- Reduce and conserve water in general
- Maintain healthy soil by leaching impurities from annual rainfal

[Click here to read more about Charles Krug water solution.]



LAWSON'S DRY HILLS
WINES OF MARLBOROUGH

LAWSON'S DRY HILLS WINES

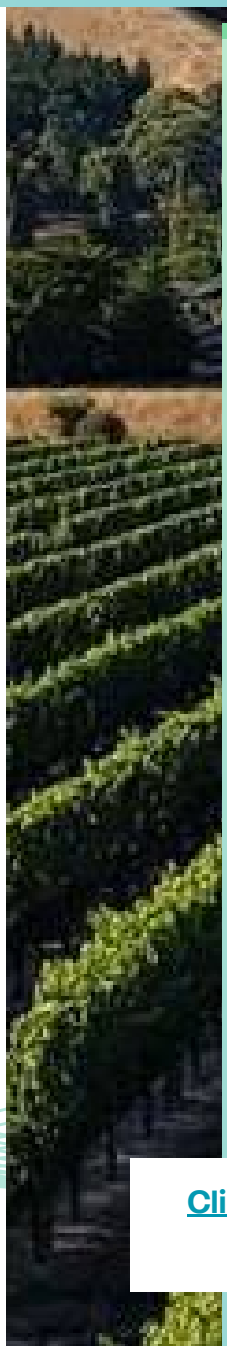
MARLBOROUGH, NEW ZEALAND

Solution | Rainwater Capture

Application | Winery

THE SOLUTION

Lawsons Dry Hills Wines implemented a Rainwater Capture solution in 2019 as an ongoing, permanent practice to address water scarcity. We had to increase the size of the downpipes to keep up with the flow and to direct it to a single, central downpipe. The water gores through a coarse-screen filtration before going into the tanks. We have 2 x 30,000 water tanks. From these storage tanks, the water is then pumped through two filtration units – one UV and one cartridge filter before being stored in a third tank, ready for winery use.. By capturing and using rainwater, the company reduces its reliance on a limited aquifer resource, helping to conserve groundwater and support long-term water sustainability and resilience.



WATER-RELATED OUTCOMES

We have consistently been very judicious with our water use, using approximately 1.6 litres of water per litre of wine produced, compared with the industry average of 3.1 litres for wineries of a similar size. This data is based on records from the last ten years (2015–2025, SWNZ/Agrilink).

Approximately 20% of our total water needs are now met through captured rainwater.

An additional benefit is that capturing rainwater prevents it from entering the wastewater system via gutters, concrete pads, and the wastewater sump.

Click here to read more about Lawsons Dry Hills Wines water solution.

CROFT PORT

(THE FLADGATE PARTNERSHIP)

DOURO VALLEY, PORTUGAL

Solution | Reducing diametre of must lines

Application | Winery

THE SOLUTION

Since 2020, Croft Port has used on-site treatment systems to manage winery effluent, preventing soil and water contamination.

While requiring investment, this proactive approach ensures a significant reduction in water use and reduces the load on the effluent plant.

Croft Port implemented a simple but highly effective operational change by reducing the diametre of the must lines, which go from the crushers to the fermentation tanks.

This adjustment allows staff to carry out the same cleaning tasks using less water per minute, without affecting hygiene standards or operational efficiency.

The solution required:

- Assessing existing piping diametres and flow rates
- Replacing oversized piping with appropriately sized alternatives
- Training staff to adapt cleaning practices accordingly

This low-tech intervention was rolled out quickly and integrated into daily operations with minimal disruption.

WATER IMPACT & OUTCOMES

- Immediate reduction in water consumption during cleaning operations
- Lower water use per cleaning task, driven by reduced diametres of piping.
- Decreased wastewater generation, easing pressure on treatment systems

Click here to read more about Croft Ports water solution.

O'NEILL VINTNERS AND DISTILLERS

CALIFORNIA, UNITED STATES

Solution | | Bio Filtro Vermifiltration

Application | Winery

THE SOLUTION

Effluent from the winery is collected into 250,000gal sumps, heavy solids are removed, then pH adjusted to 7.0 before spraying on top of the worm beds.

Within 2 hours, the water is percolated through the beds.

COD is reduced by 95% and nitrogen is reduced by up to 50% in the treated effluent.

The final effluent is collected into another 250,000 gallon sump, which is then applied to vineyards or field application.

Species is California red worm, and the beds are filled with wood chips, rocks, and substrate.

WATER IMPACT & OUTCOMES

- 80 million gallons of effluent can be treated annually.
- 500,000 pounds of used oak staves from the winery have been recycled into the beds since 2019.
- Over 5,000 tons per year of cover crop (alfalfa, sudan silage, and winter forage) are grown from the field application, which is harvested as cattle feed.

Click here to read more about O'Neill Vintners and Distillers water solution.

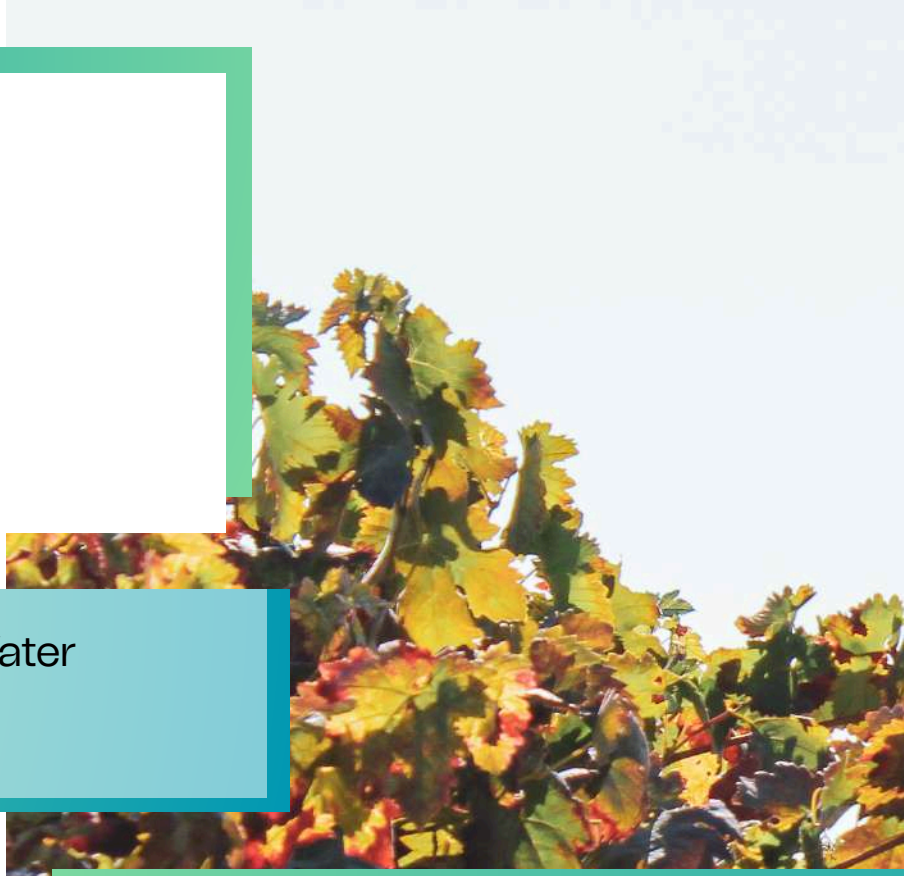
CASA RELVAS
ALENTEJO | PORTUGAL

CASA RELVAS

ALENTEJO, PORTUGAL

Solution | Reuse of Wasted Water

Application | Winery



THE SOLUTION

The solution involves a biological treatment process at the Casa Relvas WWTP, including effluent elevation, pH adjustment, equalization, primary and secondary decantation, a biological reactor, and sludge thickening.

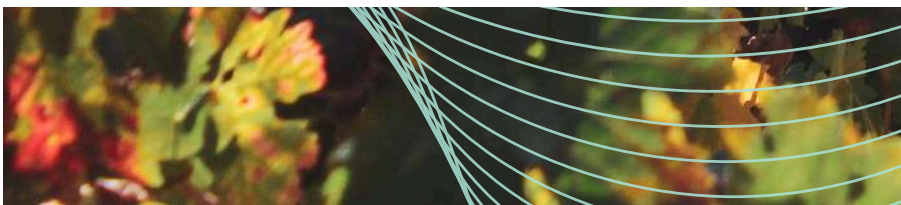
This process homogenizes the effluent and creates optimal conditions for microorganisms to decompose organic matter, transforming industrial wastewater into effluent comparable to domestic wastewater.

The treated effluent is then conveyed to a municipal line leading to the São Miguel WWTP for final treatment before discharge, with part of the water redirected to nearby reserves for vineyard irrigation.

WATER IMPACT & OUTCOMES

- Water availability for reuse , the proximity to water reserves allows part of the treated water to be reused for vineyard irrigation, reducing demand on freshwater sources.
- Safe environmental discharge.
- Treated water is reused in irrigation, promoting circular water use and reducing overall freshwater consumption.

Click here to read more about Casa Relvas´s water solution.



DOMAINE LAFAGE

ROUSSILLON, FRANCE

Solution | REUSE - Vermifiltration

Application | Winery

WATER SOLUTION

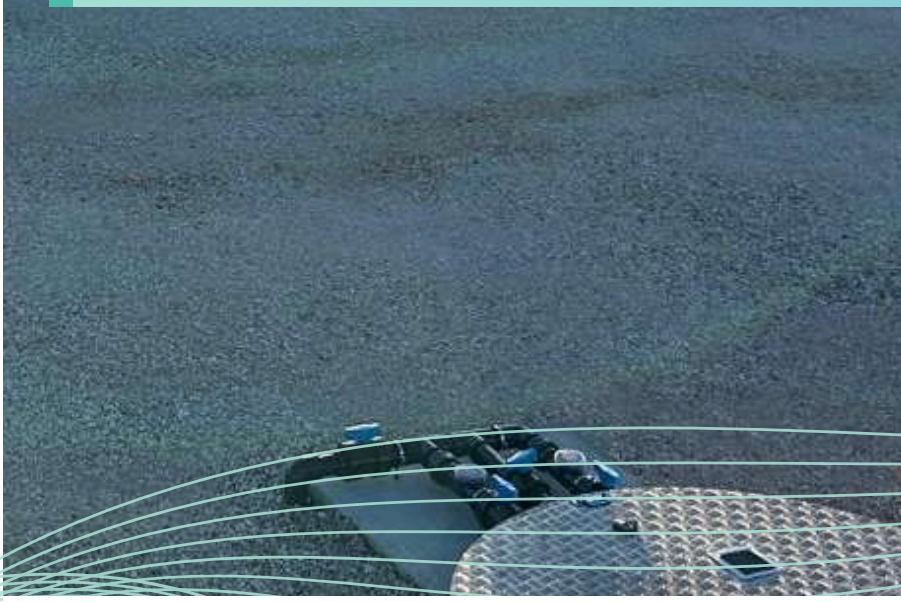
This solution uses a vermifiltration system to treat wastewater so it can be safely reused for irrigation.

Wastewater passes through a filter bed of wood chips inhabited by earthworms, which maintain porosity and create a biologically active environment, while microorganisms form a biofilm that breaks down pollutants and reduces pathogens.

The treated water becomes suitable for irrigation without chemical additives. Implemented on-site using water from a borehole in an aquifer unsuitable for human consumption, the system is low-energy, low-maintenance, and sustainable, providing a continuous irrigation source while reducing reliance on freshwater.

WATER IMPACT & OUTCOMES

- Reuse the totality of the water pumped from the borehole.
- Nutrient-rich water supports crop growth



Click here to read more about Domaine Lafage´s water solution.

DETAILED SOLUTIONS

HERDADE DOS GROUS

ALENTEJO, PORTUGAL

Solution | Keyline Design Principles

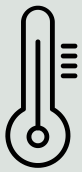
Application

In the Vineyard

Average Annual Precipitation

250 mm (10 inches)

Average Temperatures in growing season



19ºC and above
(Hot climate) 66.2ºF

Vineyard Size

50 ha - 100 ha
(123 acres - 247 acres)

Type of Soil

Schist & Slate

Water Supply

Private dam and from the state-managed Alqueva system

THE SOLUTION

Year of implementation: First implemented at Herdade dos Grous in 2024.

Specific water-related challenge: The Keyline design in our vineyard aims to optimise water distribution across the terrain, increase soil infiltration, and reduce runoff. This addresses the challenges of water scarcity and drought conditions typical of the Alentejo region, improving irrigation efficiency and crop resilience. This design enables one-time implementation, with continuous monitoring and maintenance.

Frequency: One-time implementation, with continuous monitoring and maintenance

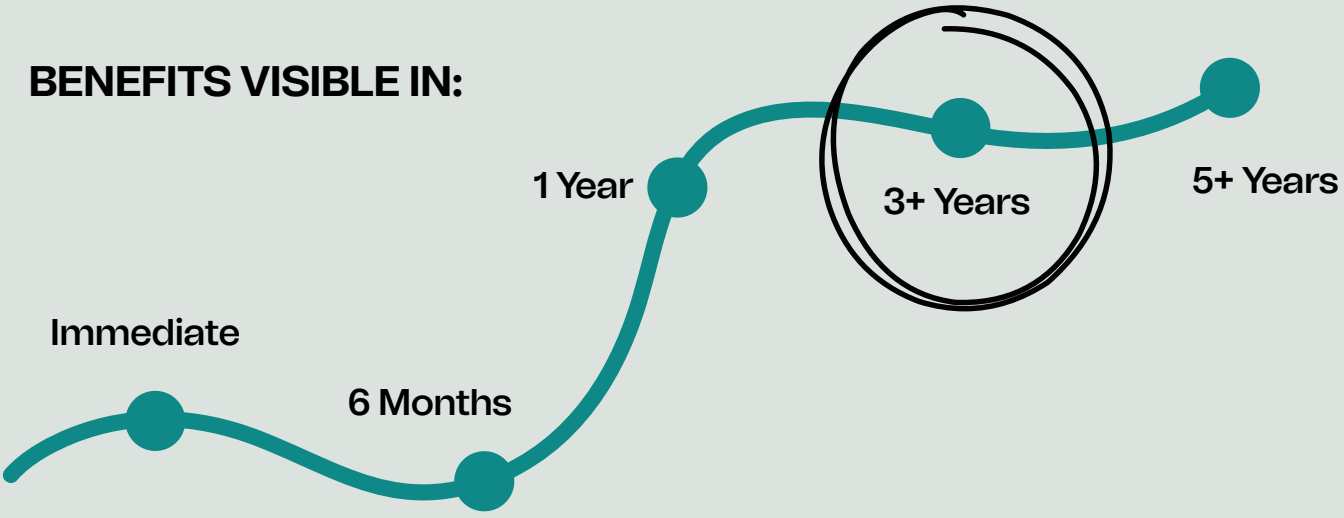
Solution Description:

The vineyard was designed and established following Keyline principles to optimise water distribution and enhance soil infiltration. Prior to planting, the soil was enriched with a winter cover crop mix of clovers, vetch, ryegrass, mustard, and forage radish, which protects the soil, improves fertility, and contributes organic matter. The cover crop is rolled after flowering using a roller-crop, leaving plant residues as mulch and incorporating seeds into the soil for the following season. Portuguese grape varieties, well-suited to the Alentejo climate, were planted, and a drip irrigation system with auto-compensating emitters was installed to ensure efficient water use. Following vineyard establishment, holistic grazing with sheep is applied during the winter, enhancing soil structure, nutrient cycling, biodiversity, and cover crop regeneration. Each year, the cover crop is evaluated and adjusted as necessary, and the vineyard inter-rows are periodically managed with a Yeomans subsoiler to maintain underground furrows that maximize water distribution along the Keyline contours.

WATER IMPACT & OUTCOMES

- Improved water infiltration and reduced runoff through Keyline design and the maintenance of subsoil furrows, allowing rainfall and irrigation water to be distributed more evenly across the vineyard.
- Higher soil water-holding capacity as a result of permanent soil cover, increased organic matter, and improved soil structure.
- Increased irrigation efficiency using drip irrigation with auto-compensating emitters, ensuring uniform water application and minimizing losses.
- Enhanced drought resilience of the vineyard, particularly relevant under the semi-arid conditions of the Alentejo region.
- Reduced evaporation losses due to mulching from rolled cover crops and continuous soil cover.

BENEFITS VISIBLE IN:



BENEFITS

- Improved soil organic matter and biological activity due to cover crops and winter holistic sheep grazing.
- Reduced soil erosion during intense rainfall events.
- Improved nutrient cycling, reducing dependency on external inputs.
- Increased biodiversity and alignment with regenerative agriculture practices.

Quantitative indicators are currently being monitored, and further data will be collected as the system matures.

LIMITATIONS & CHALLENGES

The main challenges of implementing this solution are related to climatic variability, technical complexity, operational constraints, and initial investment. The Keyline design required manual vineyard planting, as the layout does not allow for standard mechanical planting, resulting in higher establishment costs.

Additionally, the vineyard design limits certain mechanised operations, such as mechanical harvesting, increasing long-term reliance on manual labor. In semi-arid regions such as Alentejo, prolonged drought periods may reduce the short-term effectiveness of soil-based water retention strategies. Furthermore, regenerative practices such as cover crop management, holistic grazing, and subsoil maintenance require precise timing, skilled management, and continuous monitoring to ensure the system performs as intended.

EFFORT & RECOMMENDATION

Implementation complexity

1 2 3 **4** 5

Recommendation to a peer

1 2 3 4 **5**

Human effort

(time and difficulty)

1 2 3 **4** 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

500-2000€/USD

Annual Cost

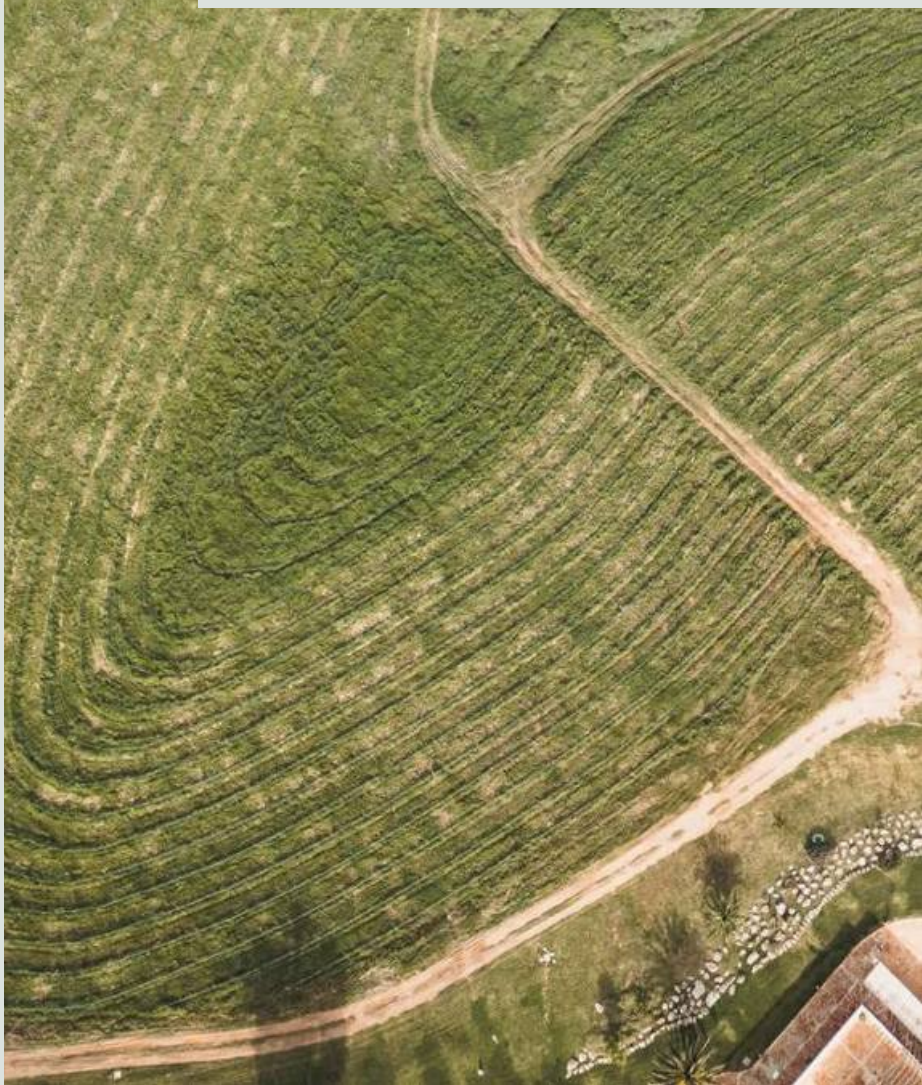
(per hectare or winery operation)

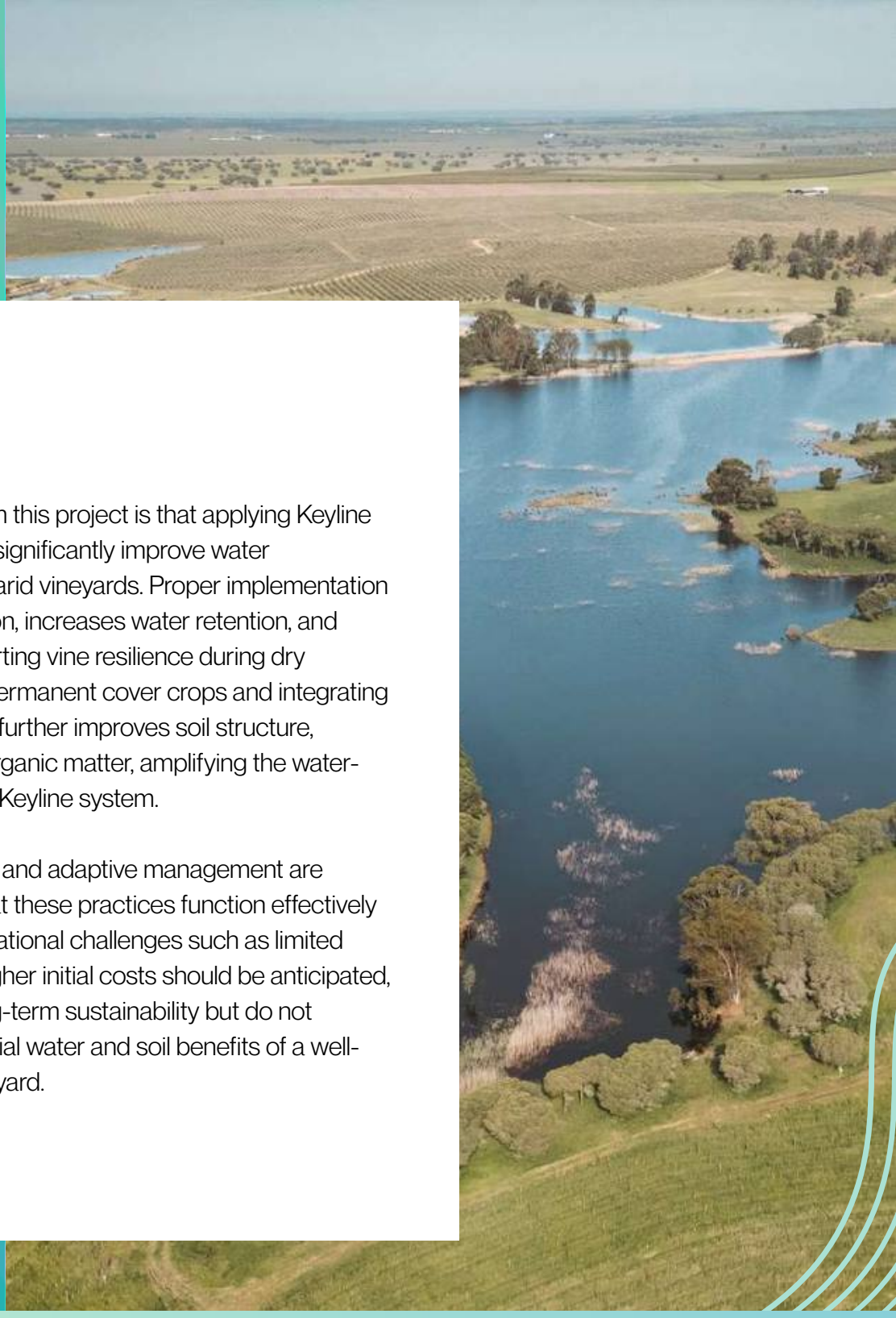
100-500€/USD

Savings Per Year

(estimated economic benefits)

500-2000€/USD





LEARNINGS

The main learning from this project is that applying Keyline design principles can significantly improve water management in semi-arid vineyards. Proper implementation enhances soil infiltration, increases water retention, and reduces runoff, supporting vine resilience during dry periods. Maintaining permanent cover crops and integrating holistic sheep grazing further improves soil structure, nutrient cycling, and organic matter, amplifying the water-related benefits of the Keyline system.

Consistent monitoring and adaptive management are essential to ensure that these practices function effectively over time. Finally, operational challenges such as limited mechanisation and higher initial costs should be anticipated, as they can affect long-term sustainability but do not outweigh the substantial water and soil benefits of a well-managed Keyline vineyard.

This Keyline vineyard project demonstrates how landscape design, cover crops, and holistic grazing can work together to significantly improve water efficiency, soil health, and drought resilience in semi-arid viticulture regions. The practices implemented are adaptable and provide a replicable model for other vineyards facing water scarcity challenges.

LAWSON'S DRY HILLS WINES

MARLBOROUGH, NEW ZEALAND

LAWSON'S DRY HILLS
WINES OF MARLBOROUGH

Solution | Rainwater Capture

Application

In the Winery

Bottling system

In-house

Liters of wine / Year

500,000 Lt -
2,000,000 Lt

Water Supply

Aquifer

Water Final destination

Irrigated to
the vineyard

THE SOLUTION

First year of implementation: 2019

Specific water-related challenge: Water scarcity. The aquifer is a limited resource that needs to be conserved and our reliance on it lessened. By capturing and using rainwater, the company reduces its reliance on a limited aquifer resource, helping to conserve groundwater and support long-term water sustainability and resilience.

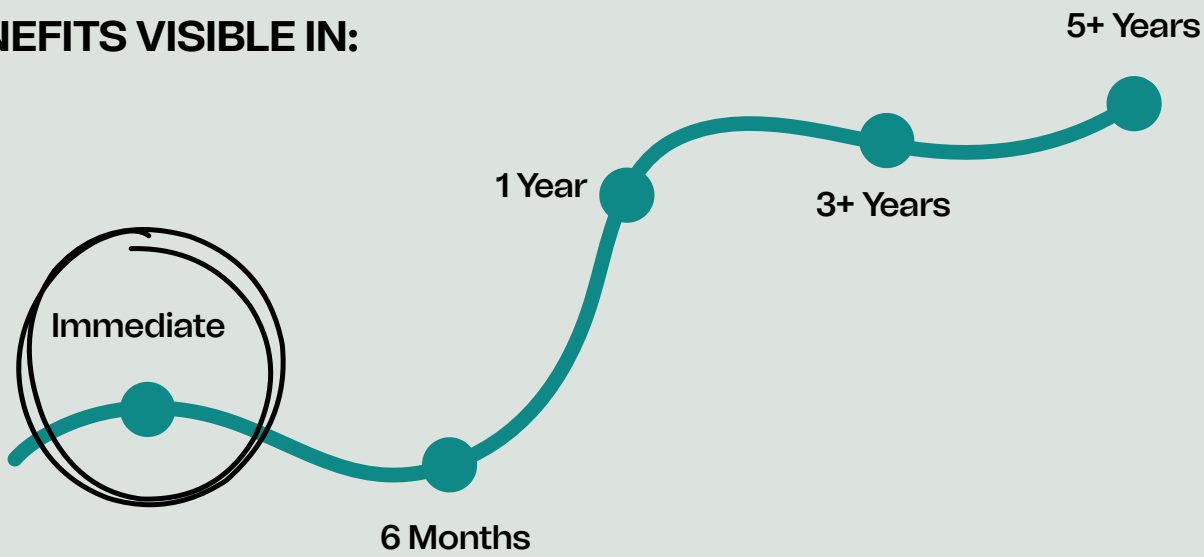
Frequency: Ongoing - permanent

Solution description: Rainwater Capture. Lawsons Dry Hills Wines implemented a Rainwater Capture solution in 2019 as an ongoing, permanent practice to address water scarcity. We had to increase the size of the downpipes to keep up with the flow and to direct it to a single, central downpipe. The water gores through a coarse-screen filtration before going into the tanks. We have 2 x 30,000 water tanks. From these storage tanks, the water is then pumped through two filtration units – one UV and one cartridge filter before being stored in a third tank, ready for winery use.

WATER IMPACT & OUTCOMES

- We have always been very judicious with our water use - so much so that we only use about half of the amount of water (1.6l per litre of wine produced) than the average of other wineries our size (3.1l). (Data from the last ten years, 2015 - 2025 SWNZ/Agrilink)
- The main outcome from this solution is that approximately 20% of our water needs now come from captured rainwater.
- A second outcome is that it has prevented rainwater entering into our wastewater system (via gutters, onto the concrete pad, then into the wastewater sump).

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 3 4 5

Recommendation to a peer

1 2 3 4 5

Human effort

(time and difficulty)

1 2 3 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

>5000€/USD

Annual Cost

(per hectare or winery operation)

100-500€/USD

Savings Per Year

(estimated economic benefits)

<100€/USD

LIMITATIONS & CHALLENGES

Initial set-up costs were in the region of $50,000 NZD, but no further limitations or challenges.

This may be a barrier as there is no financial gain. We did it as it is part of our ISO14001 Environmental Management System to which we are fully committed (and certified).

LEARNINGS

A very positive outcome.

CROFT PORT
(THE FLADGATE PARTNERSHIP)

DOURO VALLEY, PORTUGAL

Solution | Reduction of Must Lines Diametre

Application

In the Winery

In-house bottling system

750ml bottles of wine produced annually

4,000,000 bottles (winey-level estimate)

Water Supply

On-site sources

Used Water

On-site wastewater treatment and regulated discharge

THE SOLUTION

First year of implementation: 2021

Specific water-related challenge you are addressing: Excessive water consumption during routine winery cleaning operations caused by oversized piping.

Frequency: Daily, applied during cleaning and sanitation operations, at the end of each crush.

Detailed Solution Description:

Since 2004, Croft Port uses on-site treatment systems to manage winery effluents, preventing soil and water contamination. While requiring investment, this proactive approach ensures safe and effective water management

Croft Port implemented a simple but highly effective operational change by reducing the diametre of the must lines in the winery.

By switching to smaller-diametre must lines, the winery significantly reduced water usage while maintaining effective cleaning.

This adjustment allows staff to carry out the same cleaning tasks using less water per minute, without affecting hygiene standards or operational efficiency.

The solution required:

- Assessing existing piping diametres and flow rates
- Replacing oversized piping with appropriately sized alternatives
- Training staff to adapt cleaning practices accordingly

This low-tech intervention was rolled out quickly and integrated into daily operations with minimal disruption.

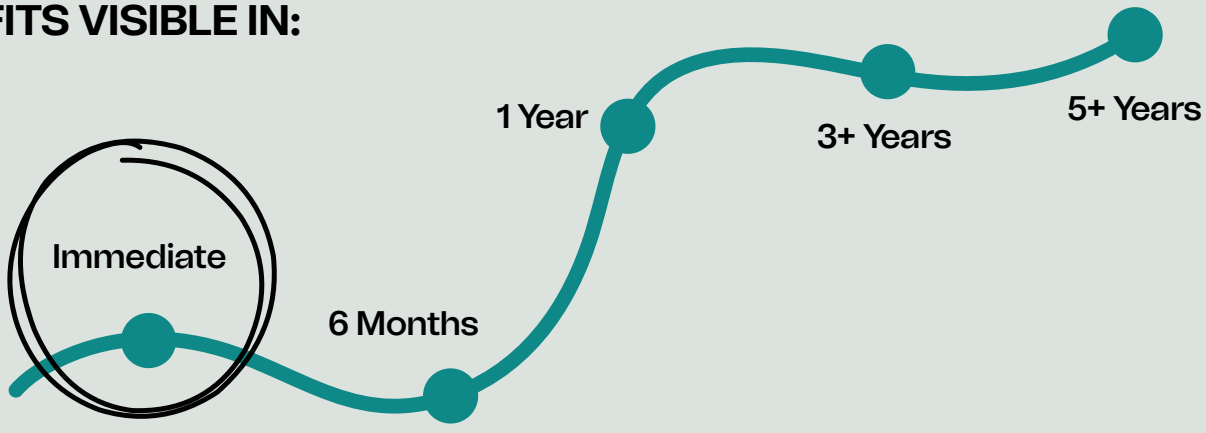
BENEFITS

- Reduced energy use linked to pumping
- No impact on cleaning effectiveness or hygiene standards
- High staff acceptance due to ease of use

WATER IMPACT & OUTCOMES

- Immediate reduction in water consumption during cleaning operations
- Lower water use per cleaning task, driven by reduced volumes
- Decreased wastewater generation, easing pressure on treatment systems

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 **3** 4 5

Recommendation to a peer

1 2 3 4 **5**

Human effort

(time and difficulty)

1 **2** 3 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

HIGH, DEPENDENT ON SIZE AND COMPLEXITY

Annual Cost

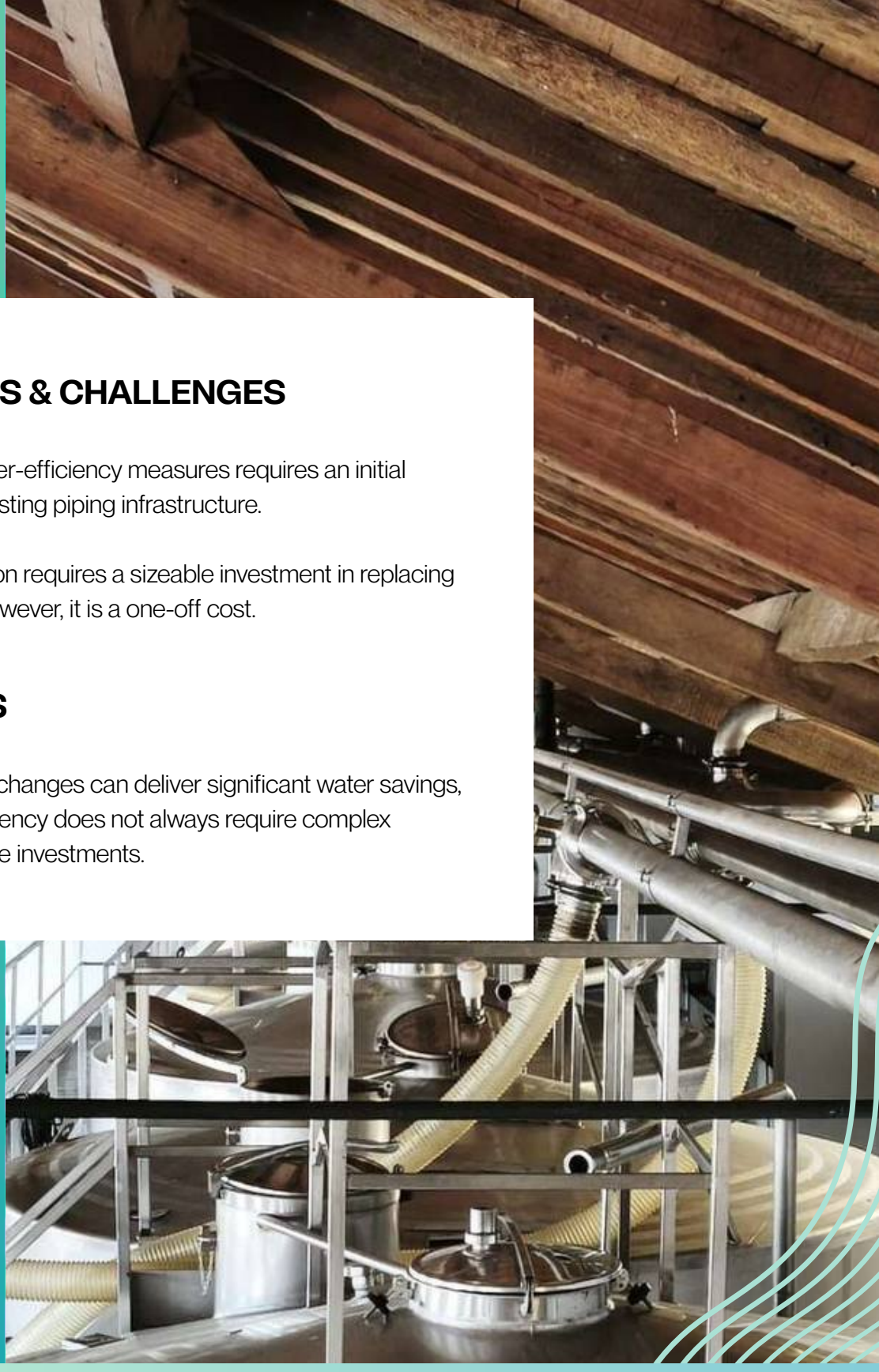
(per hectare or winery operation)

ONE TIME INVESTEMENT

Savings Per Year

(estimated economic benefits)

<100€/USD



LIMITATIONS & CHALLENGES

Implementing water-efficiency measures requires an initial assessment of existing piping infrastructure.

The implementation requires a sizeable investment in replacing existing piping. However, it is a one-off cost.

LEARNINGS

Small operational changes can deliver significant water savings, showing that efficiency does not always require complex technology or large investments.

This solution demonstrates how simple, low-tech adjustments can deliver immediate water savings and should be considered a baseline action for wineries seeking to reduce their water footprint.

FATTORIA LA MALIOSA

TUSCANY, ITALY

Solution | Mulching Under Row

Application

In the Vineyard

Average Annual Precipitation

980 mm

Average Temperatures in growing season

19ºC and above (Hot climate) 66.2ºF

Vineyard Size

<10 hectares (24,7 acres)

Type of Soil

Clay and Volcanic

Water Supply

Rain

THE SOLUTION

Year of implementation: 2013

Specific water-related challenge : prolonged summer droughts combined with extreme temperatures (>35°)

Frequency : 1 time/year between october and march

Solution Description:

In our vineyards we don't till and allow wild grasses to grow and increase biodiversity and complexity over time.

This promotes an environment where soil remains soft and available to absorb water during rainfalls, even in the event of heavy storms.

Our vineyards are not irrigated and our solution for water conservation over long periods is mulching with the farm's own produced organic hay, made up of the above wild grasses.

We spread the hay manually with rakes underrow once a year, it has to be at least 15/20 cm of depth completely covering the ground (please look at our instagram for videos of the procedure).

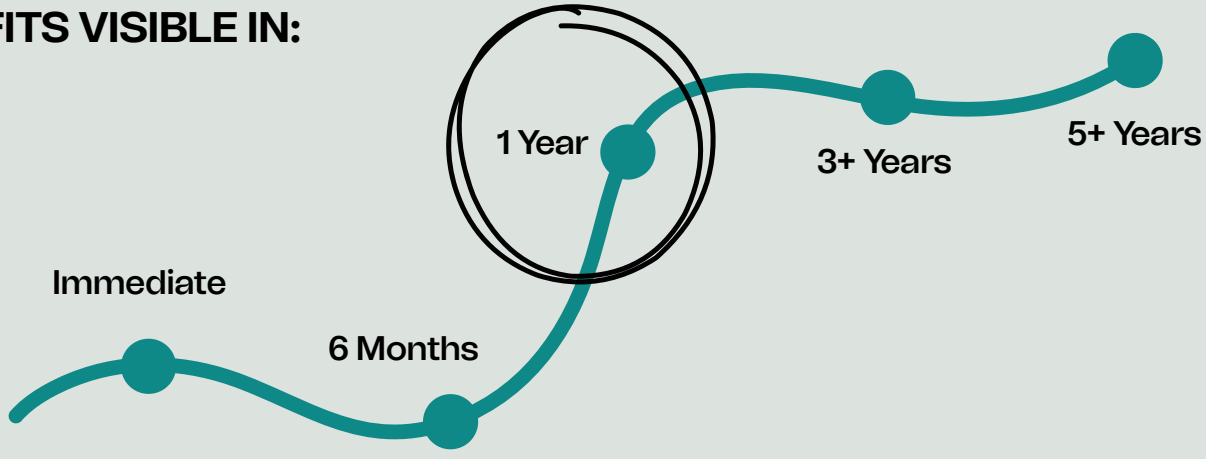
BENEFITS

- Every single drop of water is retained exactly where it falls, no runoffs, no erosion
- Humidity stays on the ground permanently thus promoting slow degradation into organic substance in the long term
- In the event of summer rains the humidity stays on the ground for about 2 weeks
- Cooling effect on the soil over the summer months preserving soil life no matter the temperatures
- Increase in wild grass complexity thus balancing over time soil ecosystems
- Ultimately improved climate resilience and aging of vineyards
- Promoting grape skin thickenss and quality at harvest time due to no artificial irrigation
- Optimal water footprint for vineyards that survive and thrive without anything but rainwater. A completely natural cycle

WATER IMPACT & OUTCOMES

- 100% Water saved
  A study by the National Research Centre for Agriculture (CREA) examined soil organic matter and related soil properties in vineyard environments, and the findings have been published in scientific literature

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 **2** 3 4 5

Recommendation to a peer

1 2 3 4 **5**

Human effort

(time and difficulty)

1 2 3 **4** 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

100-500€/USD

Annual Cost

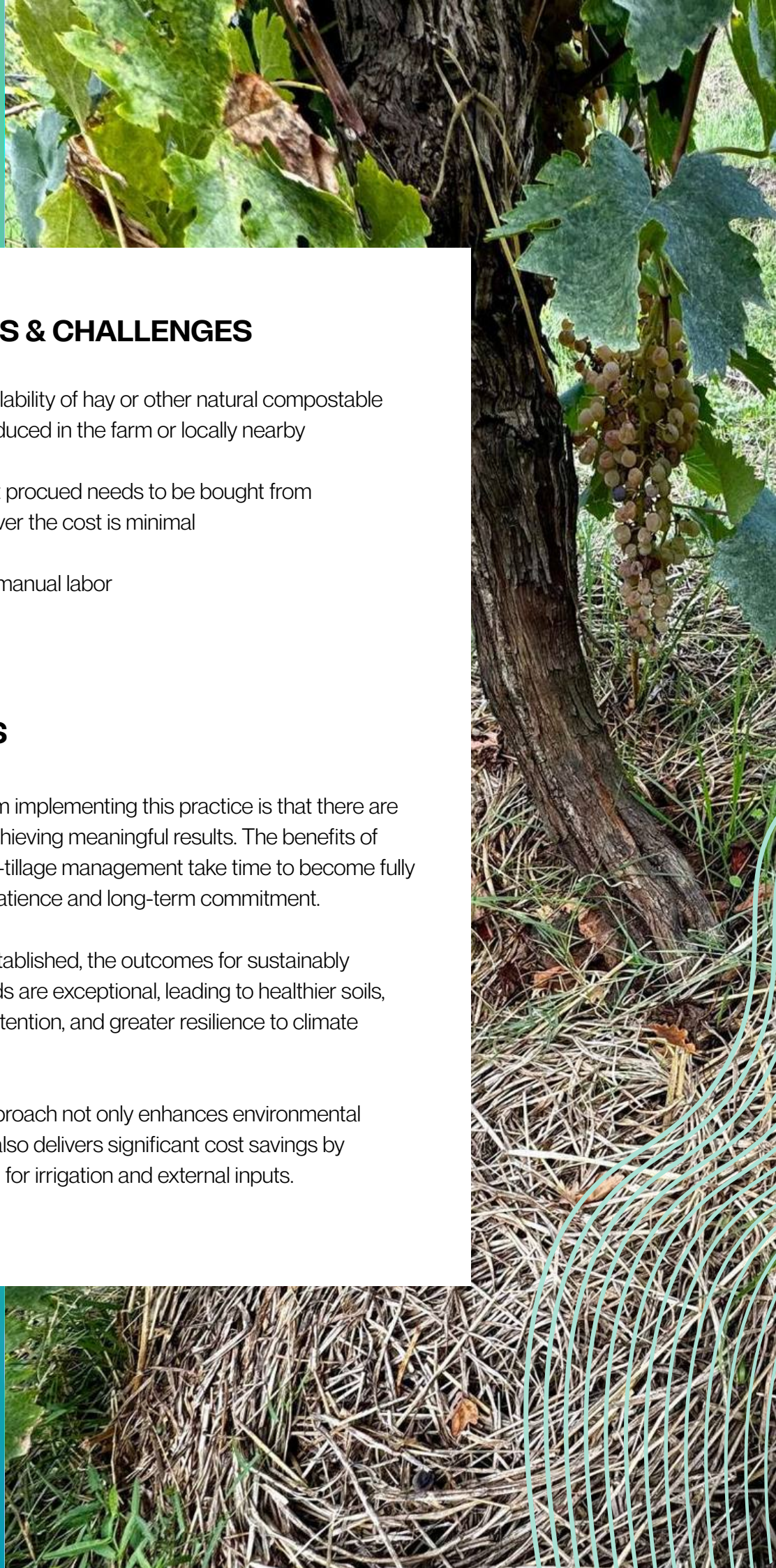
(per hectare or winery operation)

100-500€/USD

Savings Per Year

(estimated economic benefits)

500-2000€/USD



LIMITATIONS & CHALLENGES

TECHNICAL availability of hay or other natural compostable material to be produced in the farm or locally nearby

FINANCIAL if not procued needs to be bought from neighbours, however the cost is minimal

OPERATIONAL manual labor

LEARNINGS

A key learning from implementing this practice is that there are no shortcuts to achieving meaningful results. The benefits of mulching and non-tillage management take time to become fully visible, requiring patience and long-term commitment.

However, once established, the outcomes for sustainably managed vineyards are exceptional, leading to healthier soils, improved water retention, and greater resilience to climate stress.

Over time, this approach not only enhances environmental sustainability but also delivers significant cost savings by reducing the need for irrigation and external inputs.

Abacela

ABACELA WINES

UMPQUA VALLEY, USA

Solution | Drone Use to Monitor Irrigation Leaks

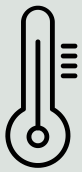
Application

In the Vineyard

Average Annual Precipitation

1168 mm (50 inches), wet winter, very dry summer (10% of annual)

Average Temperatures in growing season



17-18°C, intermediate to warm

Vineyard Size

10 ha - 50 ha (24,7 - 123 acres)

Type of Soil

Loam

THE SOLUTION

Year of implementation: 2021

Specific water-related challenge :
Breaks in irrigation lines can happen from physical issues (tubes cracking, heads splitting, etc.) or biological issues (jack rabbits) can go undetected in a large vineyard, using a drone weekly we can spot green areas quickly.

Frequency : Weekly

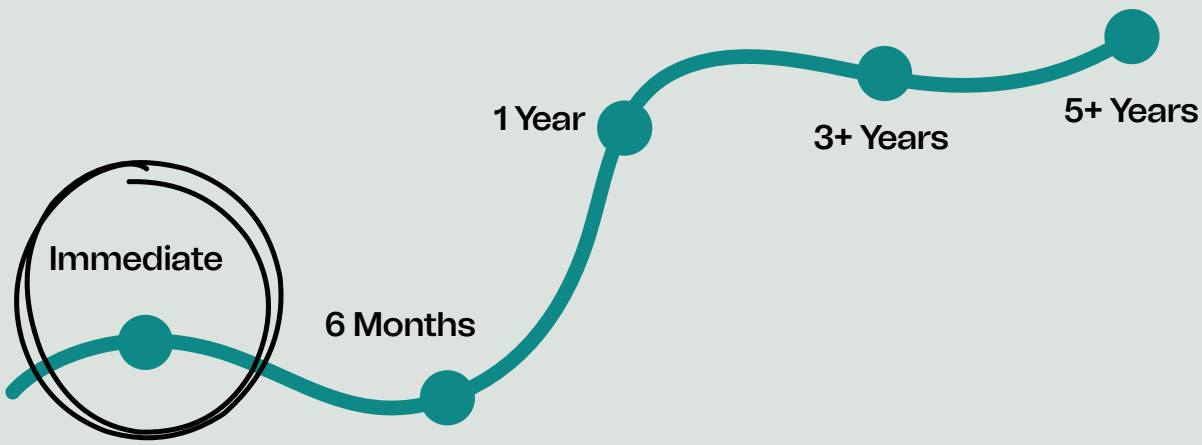
Solution Description:
Drone Use to Monitor Irrigation Leaks at Abacela Wines, by flying a drone over the entire vineyard, at approximately 50 meters above the surface, so it can quickly identify abnormally green areas in what should be a dry, brown summer landscape.

These green patches signal potential irrigation leaks, allowing us to promptly send staff to inspect and repair the affected irrigation lines, reducing water loss and improving irrigation efficiency at Abacela Wines.

WATER IMPACT & OUTCOMES

- Helps quickly identify irrigation line breaks before they result in prolonged water loss
- Reduces unnecessary water drainage into the vineyard and surrounding areas
- Improves overall water-use efficiency by enabling faster repairs
- Minimizes wasted irrigation water during the dry summer season
- Supports more responsible and sustainable water management practices

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 3 4 5

Recommendation to a peer

1 2 3 4 5

Human effort

(time and difficulty)

1 2 3 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

100-500€/USD

Annual Cost

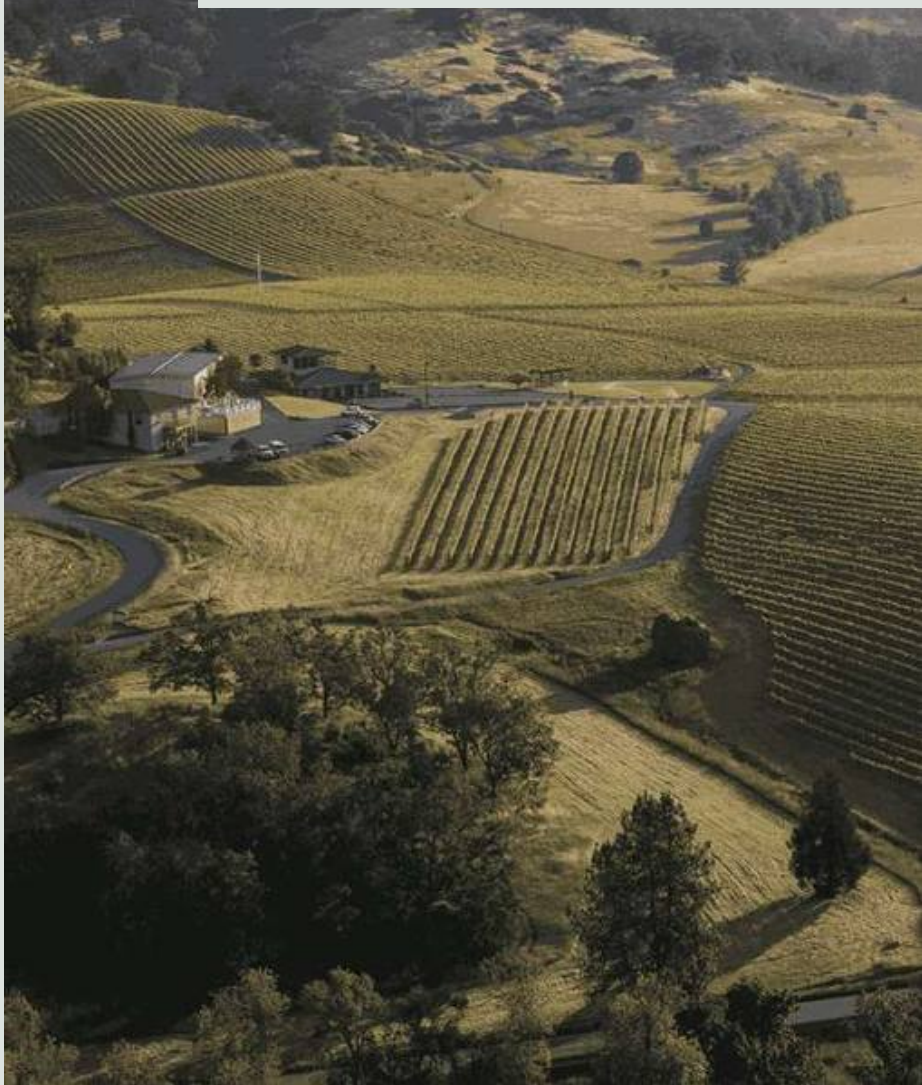
(per hectare or winery operation)

100-500€/USD

Savings Per Year

(estimated economic benefits)

100-500€/USD



LIMITATIONS & CHALLENGES

The main limitations of this approach relate to technical capacity and operational resources. It requires access to a drone equipped with a high-quality camera, as well as a team member with the skills and availability to operate it regularly.

To be effective, flights need to be carried out approximately once a week, which means the task must be built into routine operational duties.

LEARNINGS

A key learning has been the importance of flight altitude.

Flying the drone at a lower altitude significantly improves visibility, making it easier to identify areas of increased vegetation growth as well as pinpoint leaks, which can often be seen spraying across the landscape.

Lower flights therefore lead to more accurate detection and faster response.

RAIMAT

COSTERS DEL SEGRE, SPAIN

Solution | Partial Root Drying

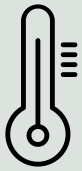
Application

In the Vineyard

Average Annual Precipitation

250 mm (10 inches) - 500 mm (20 inches)

Average Temperatures in growing season



19ºC and above (Hot climate) 66.2ºF

Vineyard Size

> 250ha (617 acres)

Type of Soil

Loam

Water Source

Melting snow through river and reservoir, fully irrrigated

THE SOLUTION

Year of implementation: 2001

Specific water-related challenge : Improve quality and save water

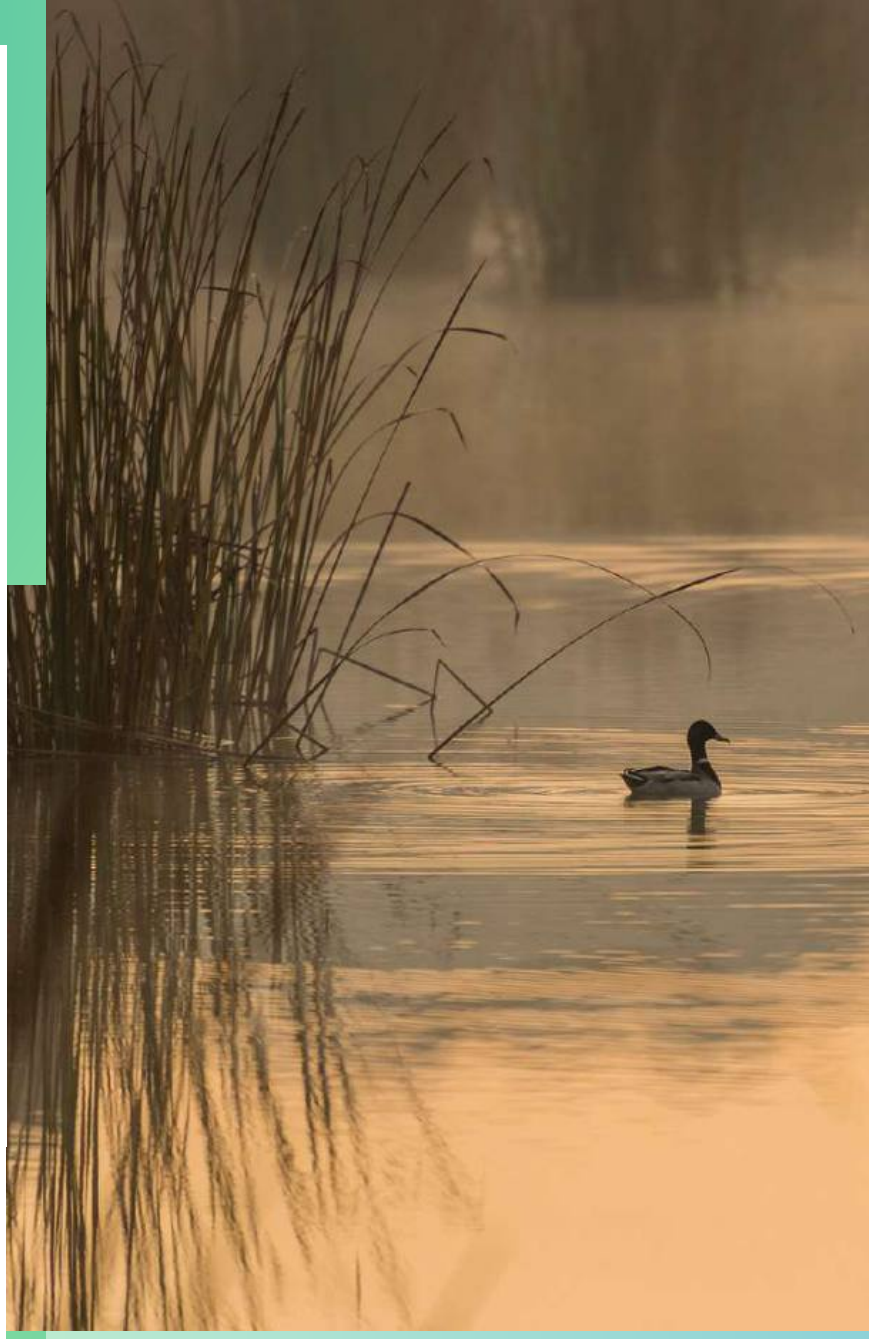
Frequency : From veraison to harvest

Solution Description:

Partial Root Drying (PRD), implemented at Raimat, is an irrigation technique designed to improve grape quality while conserving water. Instead of using a single dripline, two driplines are installed along the vine's root zone—one irrigating the right side and the other the left.

Irrigation alternates every 15 to 21 days, with only one side receiving water while the other remains dry. The drying side triggers a hormonal response in the vine, causing stomata to close and reducing transpiration, while the irrigated side continues to receive sufficient water.

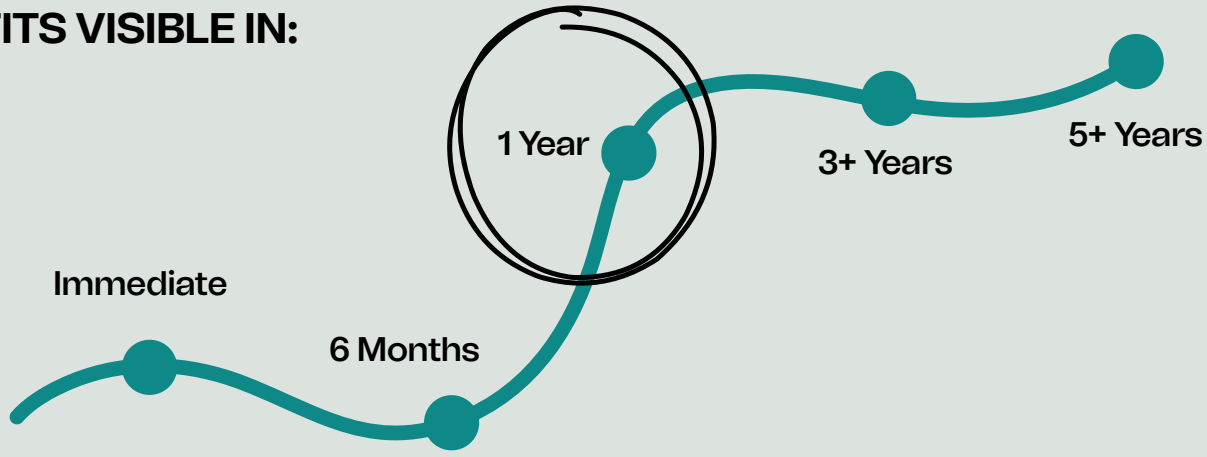
This controlled "stress signal" stimulates the vine's ripening processes, enhancing color, flavor, and seed maturation, ultimately improving the quality of the red wines produced at Raimat. PRD, allowing consistent quality improvement and water savings.



WATER IMPACT & OUTCOMES

Up to 40% water savings and improved quality

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 3 4 5

Recommendation to a peer

1 2 3 4 5

Human effort

(time and difficulty)

1 2 3 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

>5000€/USD

Annual Cost

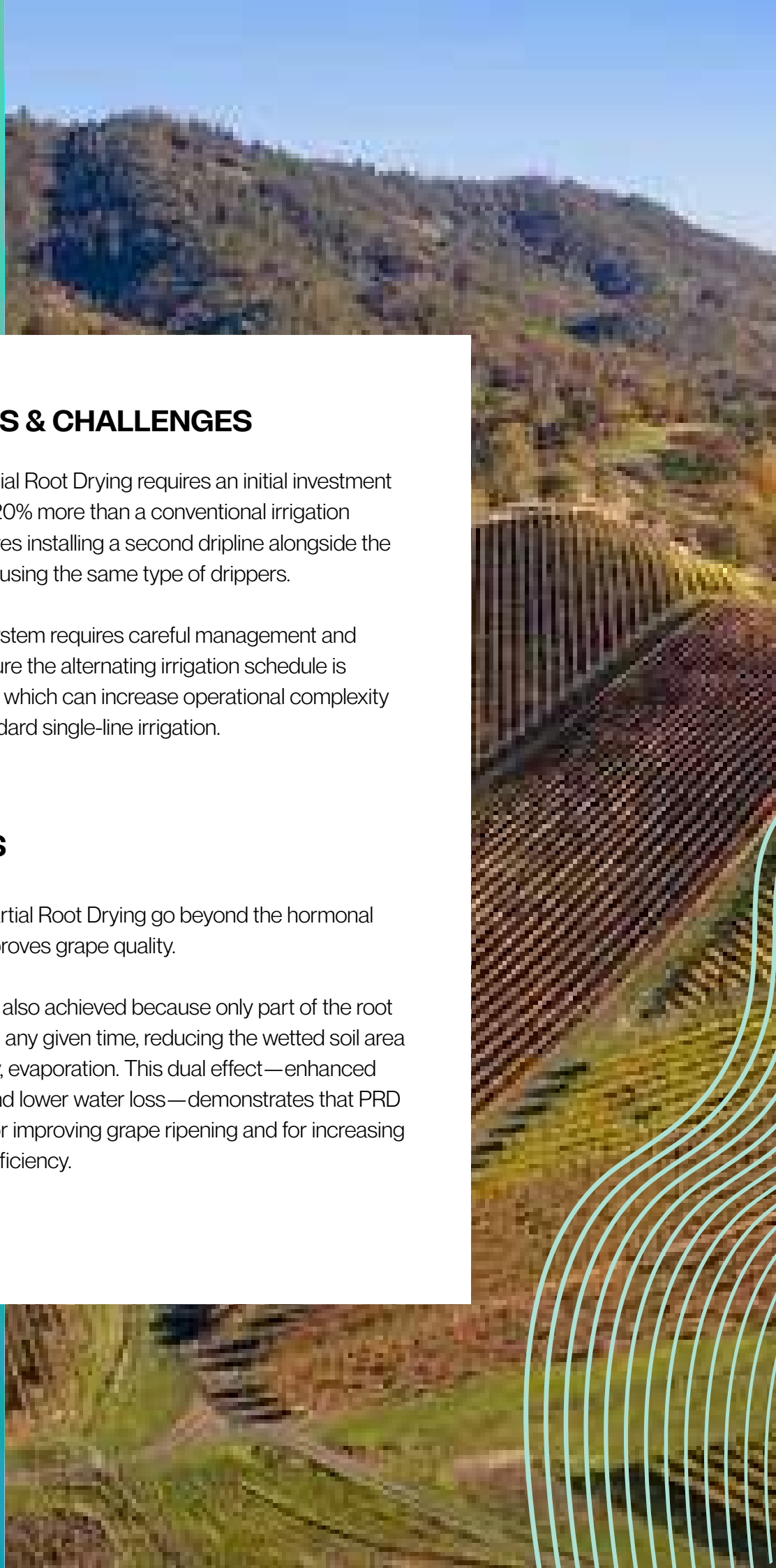
(per hectare or winery operation)

<100€/USD

Savings Per Year

(estimated economic benefits)

100-500€/USD



LIMITATIONS & CHALLENGES

Implementing Partial Root Drying requires an initial investment of approximately 20% more than a conventional irrigation system, as it involves installing a second dripline alongside the existing one while using the same type of drippers.

Additionally, the system requires careful management and monitoring to ensure the alternating irrigation schedule is correctly followed, which can increase operational complexity compared to standard single-line irrigation.

LEARNINGS

The benefits of Partial Root Drying go beyond the hormonal activation that improves grape quality.

Water savings are also achieved because only part of the root zone is irrigated at any given time, reducing the wetted soil area and, consequently, evaporation. This dual effect—enhanced vine physiology and lower water loss—demonstrates that PRD is effective both for improving grape ripening and for increasing overall irrigation efficiency.

THE FLADGATE PARTNERSHIP

DOURO VALLEY, PORTUGAL

Solution | On-Site Systems for Phytosanitary Effluent Treatment

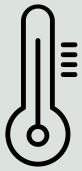
Application

In the Vineyard

Average Annual Precipitation

Low (high interannual variability; Mediterranean climate)

Average Temperatures in growing season



Warm to hot

Vineyard Size

400 hectares (group-level estimate)

Type of Soil

Schist

Water Source

Rainwater and surface runoff

THE SOLUTION

Year of implementation: 2010

Specific water-related challenge:
Preventing contamination of soil and water resources from phytosanitary effluents generated during vineyard spraying operations.

Frequency: Applied after each phytosanitary treatment cycle

Solution Description:
The Fladgate Partnership implemented a dedicated system for the collection and treatment of phytosanitary effluents generated during vineyard spraying activities.

Instead of allowing residual spray mixtures and equipment wash water to be discharged into soil or watercourses, the system:

- Collects effluents generated during the cleaning of spraying equipment
- Treats contaminated water through controlled collection and disposal processes
- Ensures that treatment residues are safely managed, preventing pollution of surface water, groundwater, and soils

This approach significantly reduces the risk of diffuse pollution in a region characterised by steep slopes, erosion risk, and high ecological sensitivity.

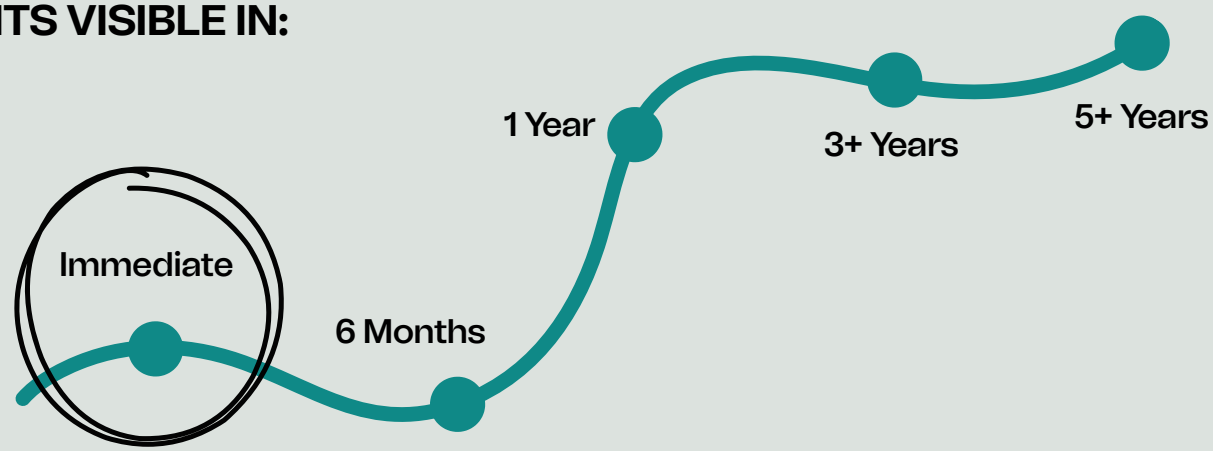
WATER IMPACT & OUTCOMES

- Prevention of water contamination from phytosanitary residues
- Protection of surface and groundwater quality in vineyard ecosystems
- Reduced environmental risk linked to spraying operations

BENEFITS

- Improved compliance with environmental regulations
- Reduced long-term soil degradation
- Enhanced ecosystem protection in sensitive catchment areas

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 **3** 4 5

Recommendation to a peer

1 2 3 4 **5**

Human effort

(time and difficulty)

1 2 **3** 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

15,000–25,000 € /$ est.

Annual Cost

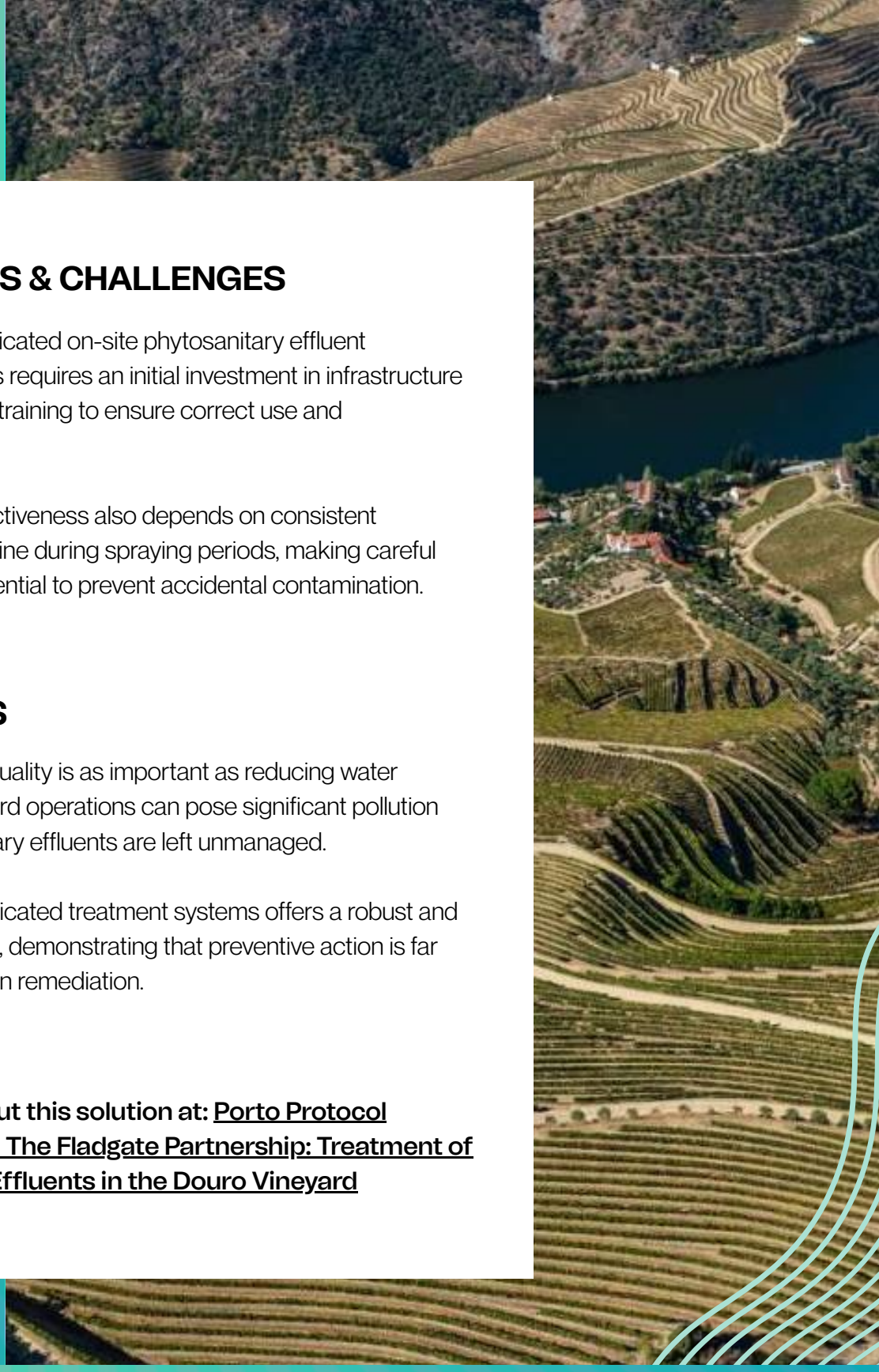
(per hectare or winery operation)

300 € / USD

Savings Per Year

(estimated economic benefits)

Indirect — avoided remediation costs, compliance risks, and environmental damage



LIMITATIONS & CHALLENGES

Implementing dedicated on-site phytosanitary effluent treatment systems requires an initial investment in infrastructure and ongoing staff training to ensure correct use and maintenance.

The system's effectiveness also depends on consistent operational discipline during spraying periods, making careful management essential to prevent accidental contamination.

LEARNINGS

Managing water quality is as important as reducing water quantity, as vineyard operations can pose significant pollution risks if phytosanitary effluents are left unmanaged.

Implementing dedicated treatment systems offers a robust and replicable solution, demonstrating that preventive action is far more effective than remediation.

Read more about this solution at: Porto Protocol Solutions Hub – The Fladgate Partnership: Treatment of Phytosanitary Effluents in the Douro Vineyard

This solution addresses a critical but often overlooked water issue in viticulture: pollution prevention. It is particularly relevant for vineyards located in steep, erosion-prone or environmentally sensitive regions.

CLOS DE TRES CANTOS

BAJA CALIFORNIA, MEXICO

Clos de Tres Cantos
Vitivinicultura Consciencia

Solution | Artificial Wetlands

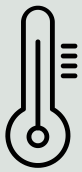
Application

In the Vineyard

Average Annual Precipitation

<250 mm (10 inches)

Average Temperatures in growing season



17ºC - 19ºC
(Warm climate)
62.5ºF - 66.2ºF

Vineyard Size

<10 hectares (24,7 acres)

Type of Soil

Granite
(Sandy)

Water Supply

Well

THE SOLUTION

First year of implementation: 2022

Specific water-related challenge: Was designed to improve infiltration of the little rain that falls and runoff in winter.

Frequency : 1 time. Needs maintenance each year or two

Detailed Solution Description:
The artificial wetland at Clos de Tres Cantos winery was developed through a collaboration between the winery, the Autonomous University of Baja California (UABC), and the Rio Arronte Foundation. The winery provided on-site support, while academic and technical expertise shaped the design.

A UABC master's student led the wetland design, supported by input from MIT researchers. The construction brought together a diverse group, including environmental engineers, a Kumiai indigenous weaver specialized in handling local reeds from San José de la Zorra, and a craftsman experienced in adobe, used to seal parts of the structure.

The system functions as a water reservoir, built within a natural depression or an excavated cavity at the base of hillsides, stream beds, or springs. Its design follows contour lines to capture runoff and encourage water infiltration into the soil, contributing to aquifer recharge.

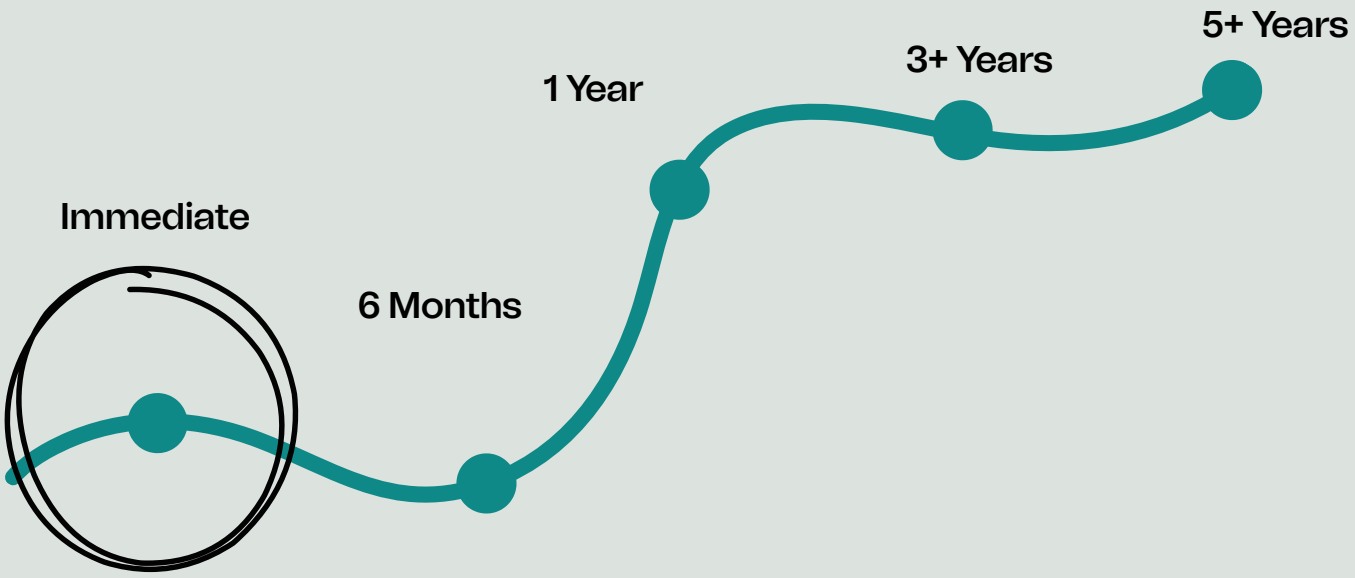
To regulate water flow, the wetland may include a containment wall (or "curtain") with controlled outlets. These help manage irrigation and prevent overflow damage. In some cases, the base is lined, while surrounding vegetation stabilizes slopes and provides shade, reducing evaporation.

The wetland also incorporates natural filtration systems using layers of sand, gravel, and pebbles. Carefully selected plant species support water purification and integrate the system into the local ecosystem.

WATER IMPACT & OUTCOMES

The water that is collected is completely filtered. Outcomes are reuse of water runoff and efficiency because the wetland is immediately before the well, so our water consumption in winter practically comes from the wetland. The cost is in maintenance; plants and stability of slops require some biannual maintenance.

BENEFITS VISIBLE IN:



BENEFITS

Improves water retention and infiltration
Enhances soil moisture and contributes to aquifer recharge by slowing and storing runoff

Reduces water loss and erosion
Captures runoff and stabilizes slopes, minimizing soil degradation

Supports natural water purification
Filtration through substrates and plants improves water quality

Enhances biodiversity
Creates habitats for aquatic and semi-aquatic species, supporting local ecosystems

Reduces evaporation
Vegetation cover provides shade and helps maintain water levels

Acts as a carbon sink
Vegetation and wetland systems contribute to carbon absorption

Improves climate resilience
Helps buffer the effects of climate variability by regulating water availability

Integrates local knowledge and materials
Combines scientific research with traditional practices, strengthening long-term sustainability

EFFORT & RECOMMENDATION

Implementation complexity

1 2 3 **4** 5

Recommendation to a peer

1 2 3 4 **5**

Human effort

(time and difficulty)

1 2 **3** 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

5000€/USD

Annual Cost

(per hectare or winery operation)

2000-5000€/USD

Savings Per Year

(estimated economic benefits)

500-2000€/USD

LIMITATIONS & CHALLENGES

If the rain is scarce, the wetland does not capture enough water. And requires periodically financial investment on maintenance.

LEARNINGS

My personal opinion is that although there are some expenses that have to be afforded in order to leave the wetland functional, it's worth it and much better than the reservoirs in which 60-70% of the water evaporates at high temperatures.

Besides this, I think Clos de Tres Cantos wetland is a good experimental model to raise awareness among winemakers and together work as a community to improve the Guadalupe basin.

In this regard, we actually give conferences and workshops to increase awareness among winemakers in the valley.

"We plan each development of our land with an awareness of being in harmony with the landscape"

CATENA ZAPATA

MENDOZA, ARGENTINA

CATENA INSTITUTE of Wine

Solution | Irrigation up to soil water holding capacity

Application

In the Vineyard

Average Annual Precipitation

250 mm (10 inches)

Average Temperatures in growing season

17ºC - 19ºC
(Warm climate)
62.5ºF - 66.2ºF

Vineyard Size

50 ha - 100 ha
(123 acres - 247 acres)

Type of Soil

Sandy Soils

Water Supply

Well
Drip Irrigation

THE SOLUTION

Year of implementation: Since always

Specific water-related challenge: Drought resilience

Frequency: Once a year

Solution Description:

From Winter to early Spring, we irrigate to fill the soil profile based on its soil water holding capacity. In vineyards with salinity problems, we move the hoses to the interrow for salinity leaching.

Soil's water holding capacity being: the amount of water (mm) that a soil can store after natural drainage. It may vary depending on: effective rooting depth, % coarse fragments (stones), and texture.

SOIL'S WATER HOLDING CAPACITY CALCULATION:

1. Record irrigation valve, operation, and plot.
2. Sample the soil profile down to a physical limiting layer. Subdivide into different samples if contrasting textures are present.
3. Record the depth (cm) of each layer and of the total profile.
4. Estimate the percentage of coarse fragments (gravel/stone content) of the soil profile.
5. Place the sample in a weighing container (filter pan), seal the lid with insulating tape to prevent moisture loss.
6. Determine soil texture.
7. Measure wet weight.
8. Oven-dry the sample at 65 °C for 48 hours or until constant weight is reached.
9. Once constant weight is achieved, record the value.
   Dry weight = current W (g/g).
10. Calculate gravimetric water content (%):

$$\left(\frac{wet\ weight - dry\ weight}{dry\ weight}\right) x\ 100$$

11. Based on texture, obtain from tables:
- Bulk density (BD; g/cm^3)
- Water content at field capacity (Wc; g/g)

12. Calculate soil water deficit (g/g):

$$Deficit = W_c - W_{actual}$$

13. Convert to water depth per unit soil depth (mm/cm):

$$mm\ water\ per\ cm\ soil = \frac{Deficit\ \left(\frac{g}{g}\right) x\ BD\ \left(\frac{g}{cm^3}\right)}{10}$$

14. Total irrigation depth to apply (mm):

Total depth = (mm/cm) x soil depth (cm) x (1 - fraction of stones)

15. Obtain or calculate the irrigation application rate (mm/h)
16. Irrigation time required to reach field capacity (hours):

$$Time = \frac{Total\ depth\ (mm)}{Application\ rate\ \left(\frac{mm}{h}\right)}$$

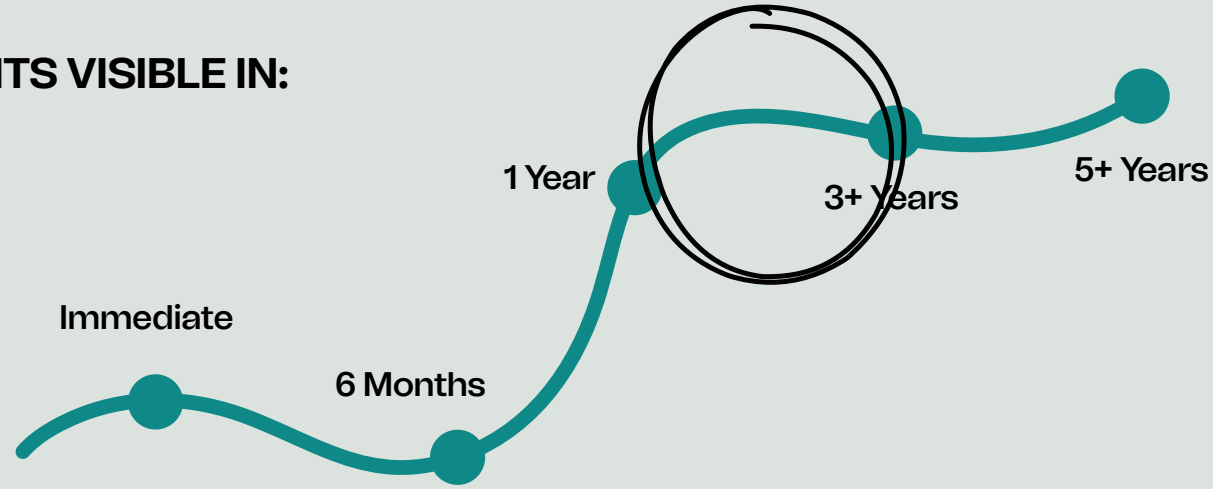
BENEFITS

- Avoid over-irrigation
- Prevent losses due to deep percolation
- Assess the available water reserve within the soil profile

WATER IMPACT & OUTCOMES

- Water saving, in some cases you can save up to 4-6 irrigations episode.
- In vineyards that are more prone to salinity issues, you also reduce salinity in the soil.
- Homogenous budburst.

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 3 4 5

Recommendation to a peer

1 2 3 4 5

Human effort

(time and difficulty)

1 2 3 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

<100/USD

Annual Cost

(per hectare or winery operation)

500-2000€/USD

Savings Per Year

(estimated economic benefits)

500-2000€/USD

LIMITATIONS & CHALLENGES

Water availability sometimes decreases during winter, temperatures below 0° Celcius can freeze the irrigation system.

LEARNINGS

Knowing your soil´s water holding capacity is the starting point to build on further decisions during the growing season. You can then add other measurements such as shoot growth, stem water potential, soil samples, among others.

PAUL CLÜVER FAMILY WINES

ELGIN, SOUTH AFRICA

Solution | Planting of undervine covercrop

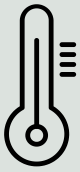
Application

In the Vineyard

Average Annual Precipitation

500 mm (20 inches) - 750 mm (30 inches)

Average Temperatures in growing season



15°C - 17°C (Moderate climate) 69°F-62.5°F

Vineyard Size

50 ha - 100 ha (123 acres - 247 acres)

Type of Soil

Clay

Water Supply

Dams
Fully Irrigated

THE SOLUTION

Year of implementation: 2025

Specific water-related challenge: Lowering Irrigation demand and lowering ground temperatures

Frequency : Yearly

Solution Description:

In our vineyards, medics and clovers are planted between vine rows as annual legume cover crops. They are sown each year after harvest to maintain a healthy, self-regenerating population.

These species act as nitrogen fixers and help improve soil structure, while their low-growing, dense nature creates consistent ground cover between the vines.

This cover also plays a role in regulating soil conditions, including temperature and moisture, while protecting the soil during winter and supporting water movement into the vine root zone during the growing season.

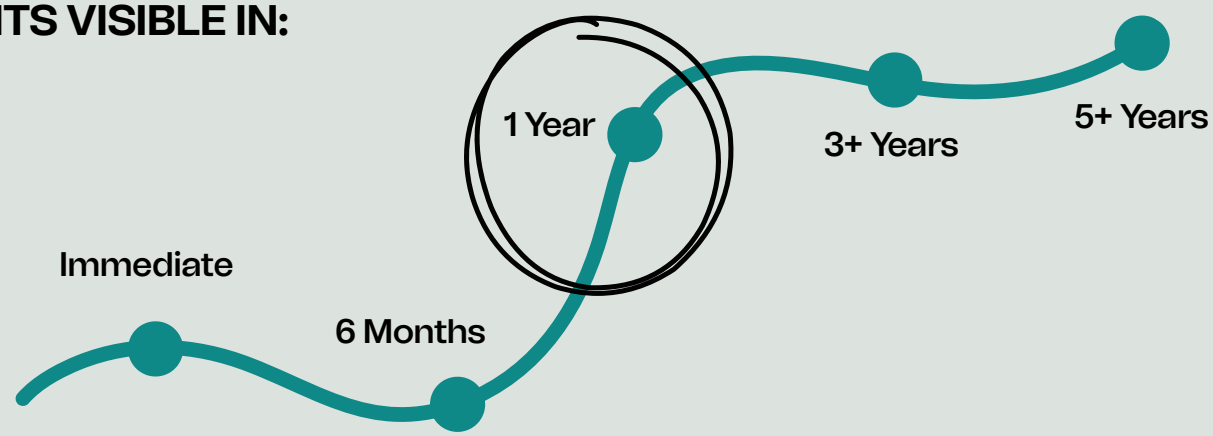
BENEFITS

- Fixes nitrogen, improving soil fertility
- Enhances soil structure
- Suppresses weed growth naturally
- Keeps soil cooler and prevents high soil temperatures
- Reduces risk of water erosion in winter
- Creates a more balanced and stable growing environment
- Supports overall vine health and resilience

WATER IMPACT & OUTCOMES

- Reduces evapotranspiration from soil
- Decreases water evaporation by lowering soil temperature
- Improves water infiltration into the vine root zone
- Enhances soil moisture retention
- Supports more efficient use of available water
- Helps maintain more stable soil moisture levels throughout the season

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 **3** 4 5

Recommendation to a peer

1 2 3 **4** 5

Human effort

(time and difficulty)

1 2 **3** 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

100-500€/USD

Annual Cost

(per hectare or winery operation)

100-500€/USD

Savings Per Year

(estimated economic benefits)

100-500€/USD

Index

LIMITATIONS & CHALLENGES

Hard to maintain a good cover crop with the competition from other weeds that in not beneficial.

LEARNINGS

Plant your cover early rather than later to make sure it has good soil temperatures to germinate.

SYMINGTON FAMILY ESTATES, VINHOS SA

DOURO, PORTUGAL

Solution | Plant Aware Irrigation (PAI) Deficit Irrigation

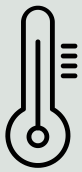
Application

In the Vineyard

Average Annual Precipitation

500 mm (20 inches) - 750 mm (30 inches)

Average Temperatures in growing season



19ºC and above (Hot climate) 66.2ºF

Vineyard Size

<10 hectares (24,7 acres)

Type of Soil

Loam

Water Supply

River

THE SOLUTION

Year of implementation : 2023

Specific water-related challenge: In the face of global warming and climate change, the aim of this project is to reduce water usage for irrigation and promote drought resilience.

Frequency: Three to five times a year during the growing season, depending on the annual climate conditions.

Solutions Description:
Since 2014, we have been using infrared drones and satellite data to identify the areas of our vineyards that are most susceptible to water stress. We then manage the irrigation of these areas accordingly.

We use capacitive probes to monitor soil humidity levels and a Scholander pressure chamber to measure predawn leaf water potential after berry set until harvest. We take weekly measurements to adjust the irrigation, taking into account evapotranspiration demand and a specific crop coefficient.

This provides us with the data needed to create an accurate deficit irrigation plan, ensuring that water is only provided to areas where it is needed due to excessive drought conditions. Although our irrigation strategy is already based on the principle of deficit irrigation, we believed that it could be optimised further.

Although good results with Standard Deficit Irrigation solution, the new PAI Deficit Irrigation* solution was developed using a demonstrator comprising two selected vineyard plots: one using the PAI methodology and the other using the standard approach.

Simultaneously, a medium-scale trial was set up with the two irrigation management methodologies and a rainfed control in randomised blocks with three replicates.

For the case study, a Touriga Nacional plot grafted in 196-17 and planted in 2009 (2x1m) with landscape systematisation on terraces facing south at 140 m elevation was used.

WATER IMPACT & OUTCOMES

Although the standard strategy only replenishes a percentage of the water lost, with the PAI system (using the The 360viti approach's goal, developed by Fruition Sciences) it is possible to optimise irrigation, leading to greater water and energy savings.

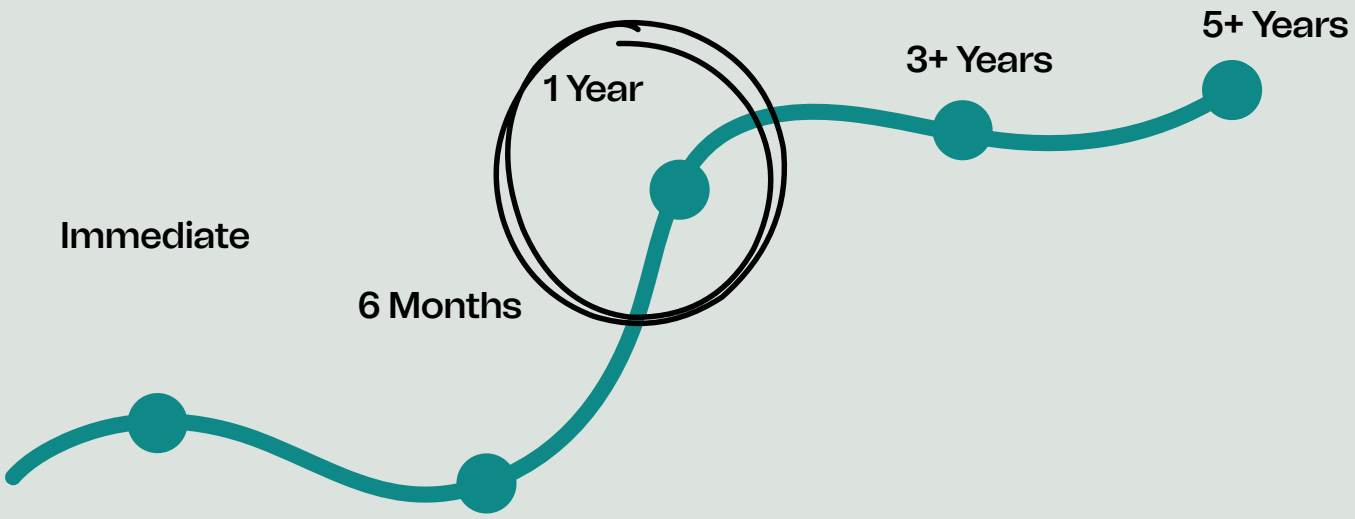
The approach is based on three modules:

i) **a plant-based sampling method to understand the response of the vines to the vintage.** It includes weather data, shoot elongation and sugar loading measurements, as well as a measurement of sap flow, which is a continuous, non-destructive, real-time measurement.

ii) **a continuous analysis to decipher the vintage and anticipate practices for the coming weeks.** This is based on the five-period method, an original approach developed by Fruition Sciences.

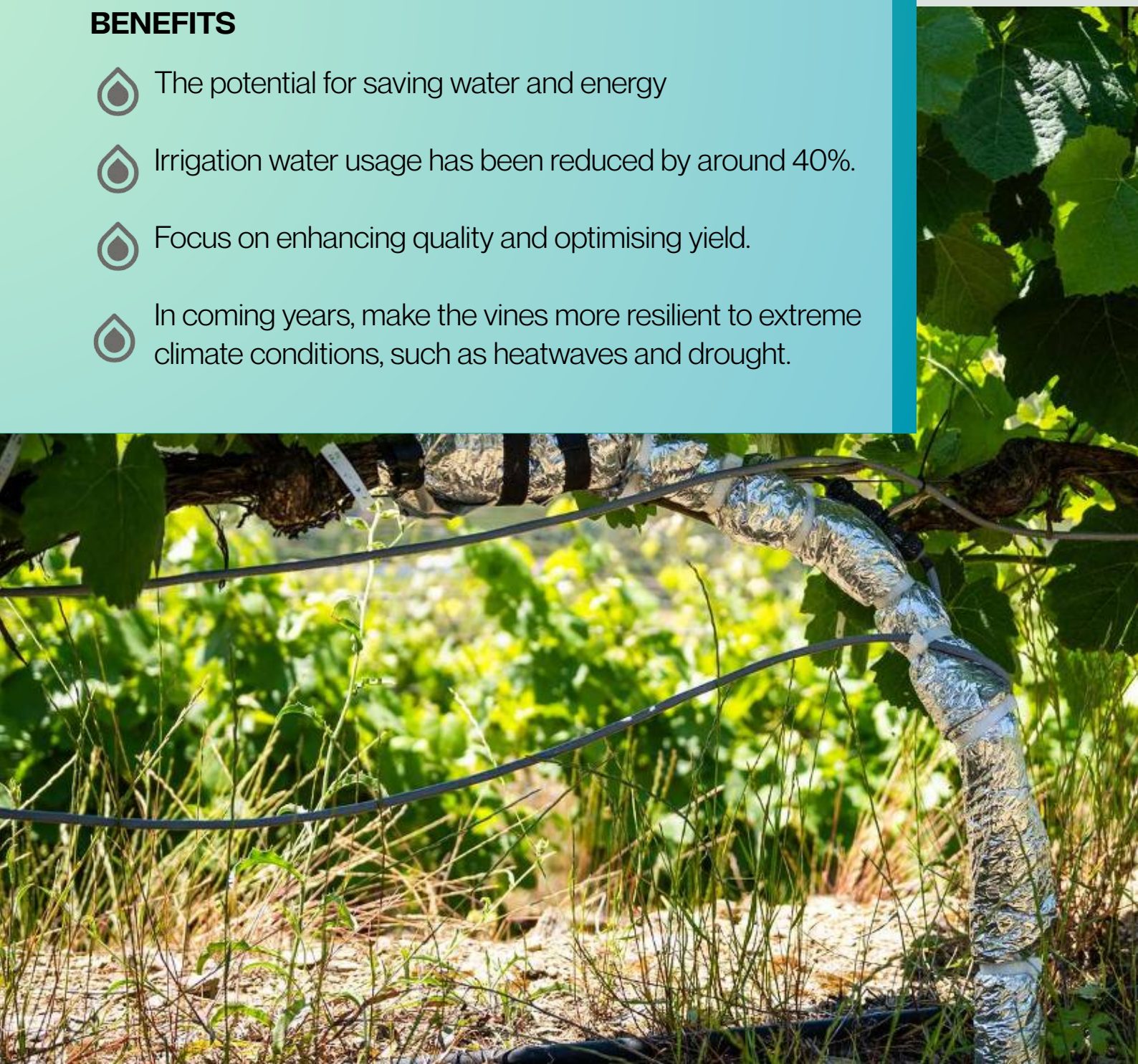
iii) **the 360VITI method** is used to adapt water deficit practices to the needs of the grape, taking into account the vintage and objectives for the different phenological stages.

BENEFITS VISIBLE IN:



BENEFITS

- The potential for saving water and energy
- Irrigation water usage has been reduced by around 40%.
- Focus on enhancing quality and optimising yield.
- In coming years, make the vines more resilient to extreme climate conditions, such as heatwaves and drought.



LIMITATIONS & CHALLENGES

- Site selection for the PAI demonstrator
- Cost of equipment
- Technical knowledge required
- The need for equipment maintenance during the season.

LEARNINGS

Invest in processes and methodologies to support the selection of representative plots and blocks in the vineyard, as well as complementary monitoring methods. These could include classic methods such as monitoring with Predawn Leaf Water Potential and soil moisture.

Invest in training the team that monitors the Demonstrator, as this will help to ensure the smooth running of the project.

The cumulative effect in subsequent seasons should be tracked to highlight the gain in drought resilience.

To know more read our Sustainability Report.

*Vine&Wine Portugal Project, co-financed by the RRP – Recovery and Resilience Plan and the European NextGeneration EU Funds, within the scope of the Mobilizing Agendas for Reindustrialization, under reference C644866286-00000011

EFFORT & RECOMMENDATION

Implementation complexity

1 2 3 **4** 5

Recommendation to a peer

1 2 3 **4** 5

Human effort

(time and difficulty)

1 2 3 4 **5**

COSTS & SAVINGS

Initial Cost
(per hectare or winery operation)
2000-5000€/USD

Annual Cost
(per hectare or winery operation)
<100€/USD

Savings Per Year
(estimated economic benefits)
500-2000€/USD

CASA RELVAS

ALENTEJO, PORTUGAL

Solution | Reuse of Wasted Water

Application

In the Vineyard

Average Annual Precipitation

500 mm (20 inches) - 750 mm (30 inches)

Average Temperatures in growing season

19ºC and above (Hot climate) | 66.2ºF

Vineyard Size

> 250ha (617 acres)

Type of Soil

Schist & Slate

Water Supply

Company-owned dams; Public dams and reused wasted water

THE SOLUTION

Year of implementation: 2022

Specific water-related challenge: Wastewater reuse at vineyards irrigation, and that water came from a municipality facility that receive also the whater that we use at our winery

Frequency: Every year

Solution Description:
To do the initial treatment in our WWTP, and before sending the effluent to the municipal outfall that will take it to the São Miguel WWTP, we have the following processes:

- Elevation of the effluent;
- Refine the pH;
- Equalization;
- Primary decanters;
- Biological reactor;
- Secondary decanter;
- Sludge thickener

Basically, this Water Waste Treatment Plant has a biological treatment process. There are several phases of treatment in order to homogenize the effluent and create constant and favorable conditions of nutrition, pH and organic matter for the microorganisms responsible for decomposing and treating the effluent.

Casa Relvas WWTP receives between 30 to 60 cubic metres of effluent, performs a first treatment that allows transforming the industrial effluent into domestic effluent. Afterwards, it is rejected in a municipal branch line that gathers both the effluent from our WWTP and the one from Aldeia de São Miguel de Machede.

This effluent is channeled to the municipal WWTP operated by Águas de Portugal, which treats it so that it can be discharged into the hydric environment.

Given the proximity of the Herdade da Pimenta water reserves and the WWTP, we decided to receive the water in the water reserve first and then use it for irrigation of the vineyards.

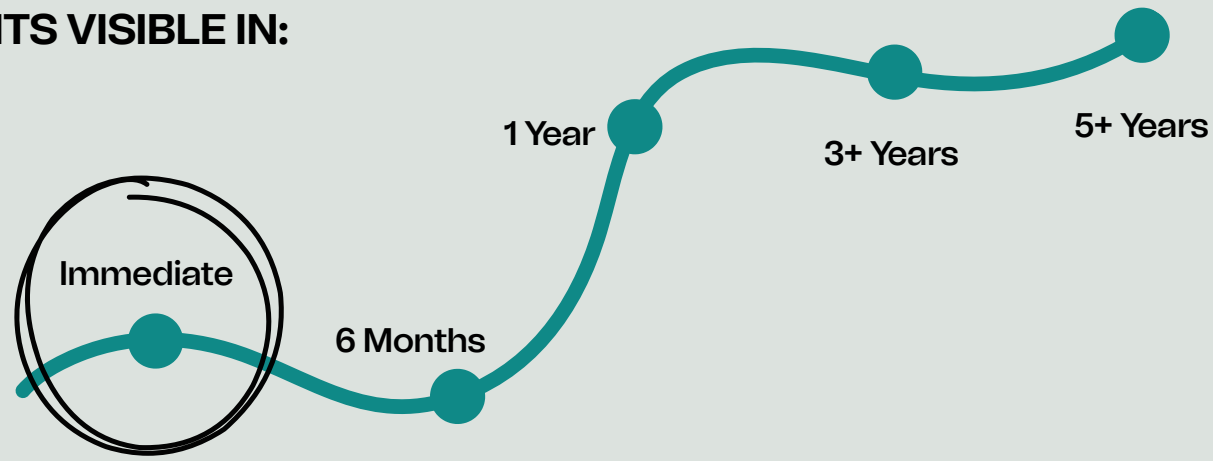
LIMITATIONS

- The primary limitation is that the available water volume is insufficient to meet our requirements

LESSONS

- Expansion of the equalization tank.
- We could have implemented this earlier.

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 3 4 5

Recommendation to a peer

1 2 3 4 5

Human effort

(time and difficulty)

1 2 3 4 5

COSTS & SAVINGS

Initial Cost
(per hectare or winery operation)

Annual Cost
(per hectare or winery operation)

Savings Per Year
(estimated economic benefits)

HENRY OF PELHAM FAMILY ESTATE WINERY

NIAGARA PENINSULA, CANADA

HENRY family estate of PELHAM

Solution | Wetland Restoration & Bio Filters

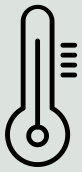
Application

In the Vineyard

Average Annual Precipitation

750 - (30 inches) - 1000 mm (40 inches)

Average Temperatures in growing season



15ºC - 17ºC (Moderate climate) 69ºF-62.5ºF

Vineyard Size

100 ha - 250 ha (247 -617 acres)

Type of Soil

Clay

Water Supply

Rain
Partially Irrigated

THE SOLUTION

Year of implementation : 2000

Specific water-related challenge: Pond restoration/cleaning run-off water

Frequency : Ongoing

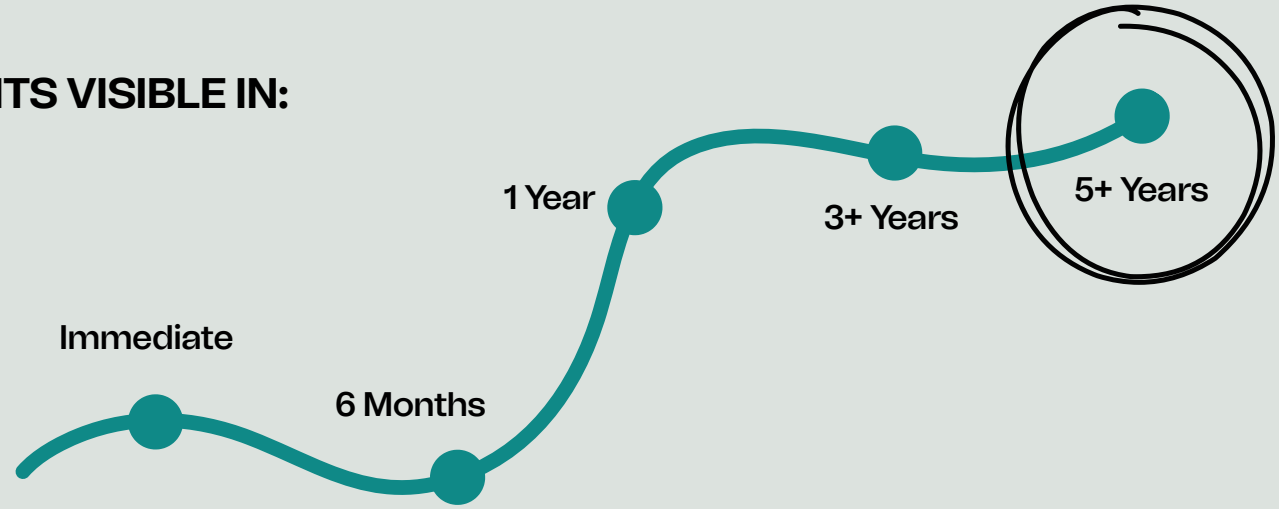
Solution Description:

Buried trenches with a mixture of wood chips and clear stone that allows water to go through it. Micro organisms build up and there's a shallow wetland retention area planted with cat tails and other native species that further filter the water. 3 different depths allows for a diversity of species. On top of the trench and around the pond we planted native species for their collaborative characteristics to attract insects and animals that build up the eco-system.

BENEFITS

- Healthy water courses and clean run-off
- Waste water 100% contained, no net water usage
- 100% permanent cover crop (0 tillage)

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 3 4 5

Recommendation to a peer

1 2 3 4 5

Human effort

(time and difficulty)

1 2 3 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

5000€/USD

Annual Cost

(per hectare or winery operation)

2000-5000€/USD

Savings Per Year

(estimated economic benefits)

500-2000€/USD

LIMITATIONS & CHALLENGES

The Niagara Peninsula Conservation Authority (NPCA) presented the idea and helped support it including partial funding.

A local contractor executed the project with little challenges.

LEARNINGS

Recommend working with a local resource like the NPCA

"It is negligibly more expensive to invest in these projects than not to do them, yet these initiatives have a huge impact on reducing our water and carbon footprint."

SAN POLINO

BRUNELLO DI MONTALCINO, ITALY

Solution | Intentional guiding of rainwater via channels around vineyards

Application

In the Vineyard

Average Annual Precipitation

500 mm (20 inches) - 750 mm (30 inches)

Average Temperatures in growing season

19ºC and above (Hot climate) | 66.2ºF

Vineyard Size

<10 hectares (24,7 acres)

Type of Soil

Clay

Water Supply

Rainwater
No irrigation

THE SOLUTION

Year of implementation: 1994

Specific water-related challenge: Erosion avoidance and drought resilience

Frequency: With every rainfall

Solution Description: Our first solution involves cutting gently sloped channels around vineyard plots to improve how water is managed across the land. These channels are designed to slow down the movement of rainwater, allowing it to be gradually absorbed into the soil rather than quickly running off. As a result, areas that are prone to drought receive more consistent moisture, while during periods of heavy rainfall, the reduced water flow helps prevent soil erosion.

By encouraging water to infiltrate and spread evenly, the vines are able to access moisture from deeper in the soil, supporting their growth without the need for irrigation. At the same time, this approach protects the structure and fertility of the soil, reducing long-term degradation.

As a second and important solution we allow spontaneous growth of native plant species as cover crops in and around the vineyards, finding that they do not act in competition to the vines' access to water.

The same seems to be true for our third solution whereby we plant maples and fruit trees in and around the vineyard.

These trees draw water up from the lower soil, potentially assisting the vines during the arid summer months, and providing shade which enables water retention in the soil.

Obviously water management is a challenge for us in a mediterranean climate but we are working step by step to understand how we can manage this issue to the best of our knowledge, and we are always ready to learn from other people.

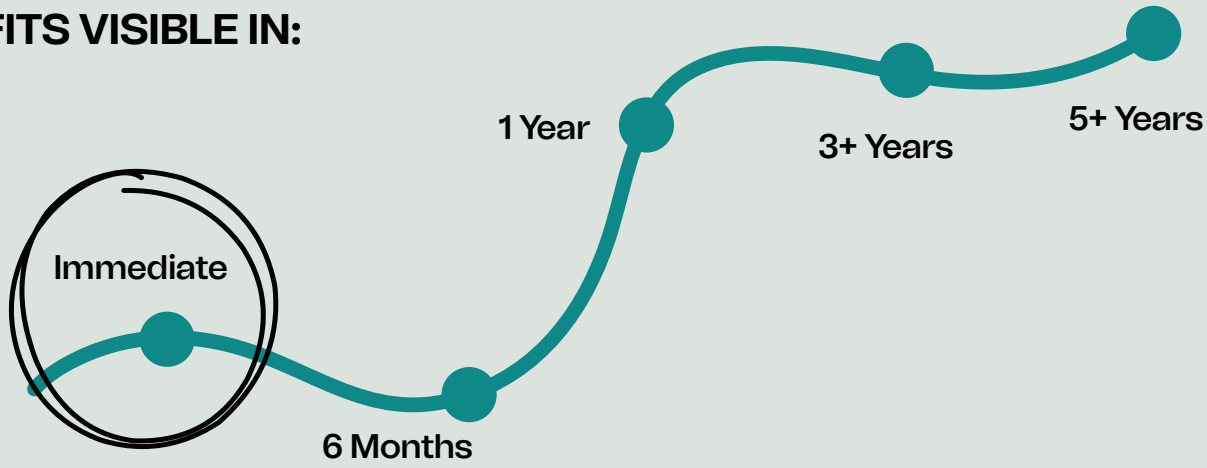
WATER IMPACT & OUTCOMES

- Through the use of two separately placed antennas in the vineyards we use satellite technology to measure the amount of rainfall in our vineyards.
- Rainwater is mostly all absorbed by the soil and any run-off flows down through erosion-management channels, dug carefully along the contours of the vineyards.
- We work through observation and have honed our agricultural practices to enable rapid response through action in these times of chaotic and unpredictable weather non-patterns

BENEFITS

- Better compliance with environmental regulations
- Reduced long-term soil degradation
- Enhanced ecosystem protection in sensitive catchment areas

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 **3** 4 5

Recommendation to a peer

1 2 3 4 **5**

Human effort

(time and difficulty)

1 2 **3** 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

5000€/USD

Annual Cost

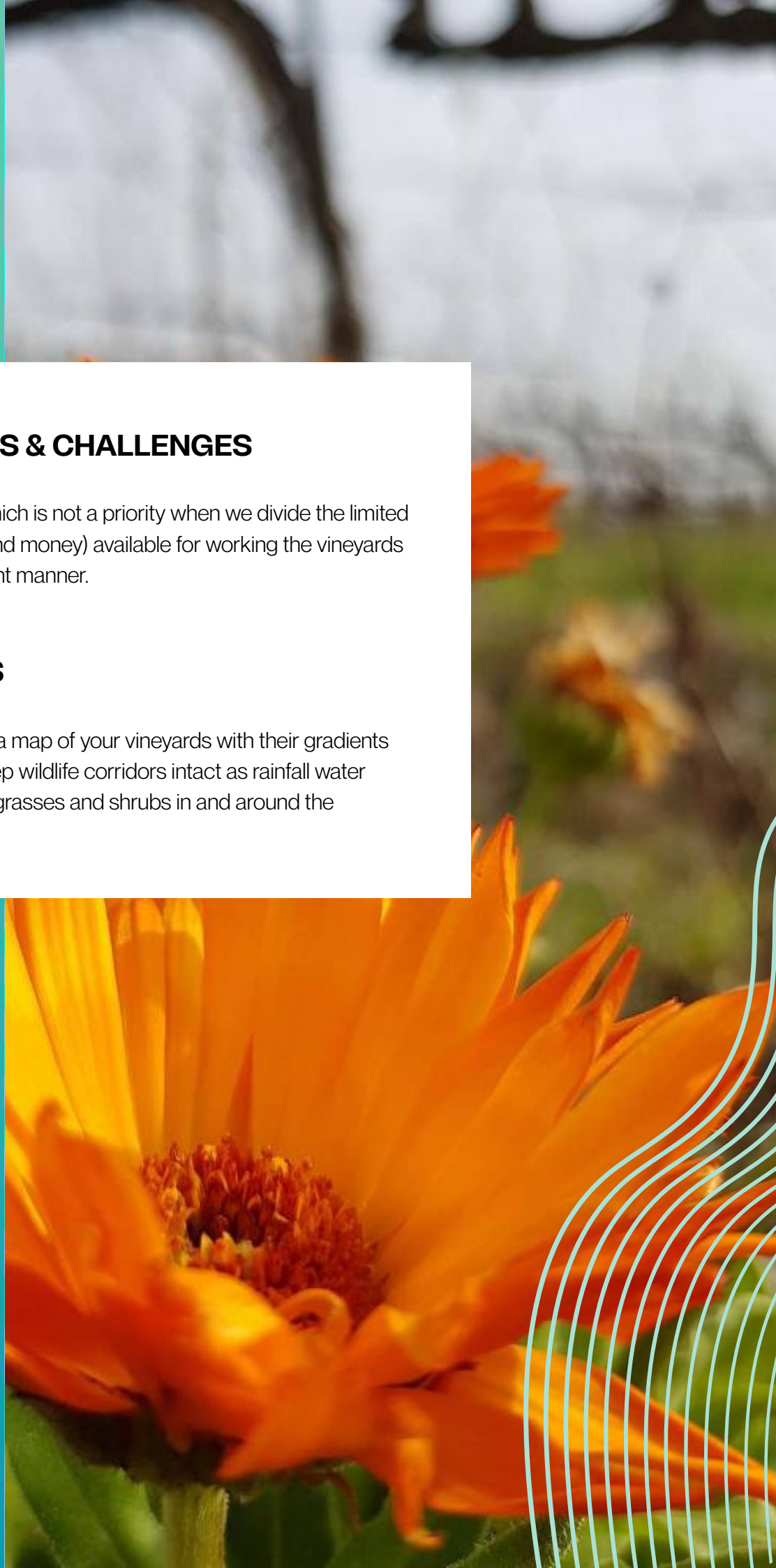
(per hectare or winery operation)

500-2000€/USD

Savings Per Year

(estimated economic benefits)

2000-5000€/USD



LIMITATIONS & CHALLENGES

Data collection which is not a priority when we divide the limited resources (time and money) available for working the vineyards in the most efficient manner.

LEARNINGS

You should make a map of your vineyards with their gradients and soil types, keep wildlife corridors intact as rainfall water buffers and plant grasses and shrubs in and around the vineyards.

GONZALEZ BYASS

JEREZ, SPAIN

FAMILIA GONZÁLEZ BYASS
VINOS Y SPIRITS 1835

Solution | Aserpiado

Application

In the Vineyard

Average Annual Precipitation

640 mm (25 inches)

Average Temperatures in growing season

19ºC and above (Hot climate) | 66.2ºF

Vineyard Size

500 mm (20 inches) - 750 mm (30 inches)

Type of Soil

Albariza

Water Supply

Rainwater

THE SOLUTION

Year of implementation: old practice in the region

Specific water-related challenge : the DO Jerez doesnt allow to irrigate the vineyards it is important to findways to feed the plant throughout the year. Rain in the region is normally located in autumn and spring and it rains heavily during few days. The vineyard in Jerez is formed by slopes so water runs down freely.

Frequency : once a year

Solution Description:

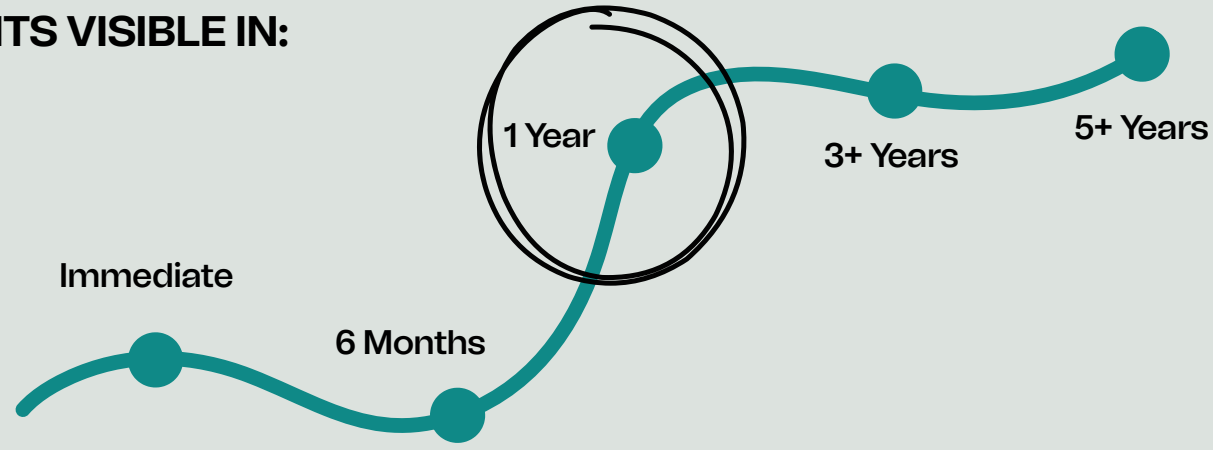
A characteristic agricultural practice in the Jerez area is called “aserpiado.” It is carried out in September–October (right after the harvest) and consists of creating small pools or undulations along the vineyard rows in plots with significant slopes.

It has two main purposes: one is to **prevent runoff** that causes soil to be dragged from the upper parts of the hillside down into the valley, and the second is to **retain water** in these small “pools” to promote its infiltration into the soil. The task is performed using a tool called an **aserpiadora**.

BENEFITS

- retain rainwater
- improve infiltration to increase water reserves in the soil
- reduce erosion of the slopes by helping to fix the soil.

BENEFITS VISIBLE IN:



"The economic benefit depends on how much rain falls and infiltrates, and on the value of the of grapes"

EFFORT & RECOMMENDATION

Implementation complexity

1 **2** 3 4 5

Recommendation to a peer

1 2 3 4 **5**

Human effort

(time and difficulty)

1 **2** 3 4 5

COSTS & SAVINGS

Initial Cost
(per hectare or winery operation)

Annual Cost
(per hectare or winery operation)
100-500€/USD

Savings Per Year
(estimated economic benefits)
100-500€/USD

LIMITATIONS & CHALLENGES

- In the past the aserpia was done by hand or with the help of animal traction, which involved an important effort and high cost, nowadays it is realized mechanically with a specific machine.

- Difficult to combine with green covers (asepiado is in place between autumn and spring)

- If first rains are very heavy, they can break the aserpiado

LEARNINGS

- Important to do it right after haverst, before first rains, as with the softer soils after summer it is easier to implement.

- If it's a plot with a lot of slope, it's better to ridge up all the rows that collect the water from October–November–December, and before pruning, leave one row worked and the next one not.

PAICINES RANCH VINEYARD

CALIFORNIA PAICINES AVA, UNITED STATES

Solution | Holistic Regenerative Viticulture System

Application

In the Vineyard

Average Annual Precipitation

< 250 mm (10 inches)

Average Temperatures in growing season

17ºC - 19ºC (Warm climate) 62.5ºF - 66.2ºF

Vineyard Size

10 ha - 50 ha (24,7 - 123 acres)

Type of Soil

Clay

Water Supply

Well
Fully Irrigated

THE SOLUTION

Year of implementation: 2014

Specific water-related challenge: Reducing reliance on groundwater - which is poor quality, holding rainwater where it falls by creating high water holding capacity

Frequency: This is a continuous process

Solution Description:

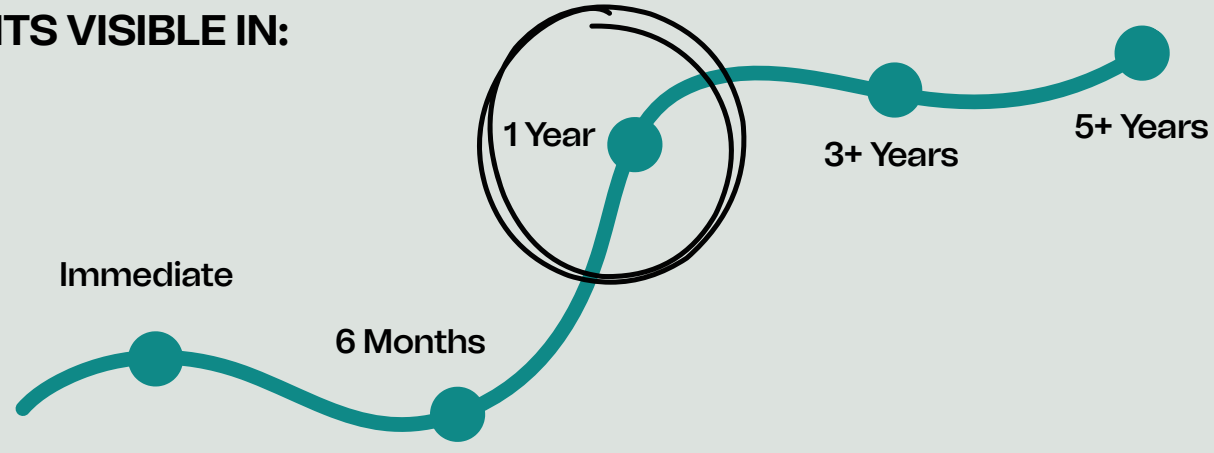
This is an ongoing process and involves consistently paying attention to indicators of ecosystem health like: plant diversity, water infiltration rate, soil cover, vine vigor, insect diversity, earthworm populations, etc.

We take a comprehensive (holistic) approach to all of our vineyard management and so practice the following: 1) keep soil covered throughout the year, 2) never use tillage of any type, 3) only mow during the summer when vines are young (first 1-2 years), 4) graze when appropriate (allowing adequate rest/recovery) generally multiple times each year), 5) minimize tractor passes, 6) Use a partial overhead trellis system which shades most of the vineyard during the hottest part of each day, 7) selected s site that primarily faces North to maintain less intense sun exposure and drying, 8) actively managing for high below and above ground biodiversity and soil health to better retain all of the rain and irrigation water used in the vineyard.

WATER IMPACT & OUTCOMES

- Soil carbon as measured every 2-4 years is on a continual increase (up 2% from baseline before planting).
- Overall irrigation use is generally declining in spite of vines getting bigger and several serious drought years.
- Water infiltration rates continue to improve (from close to 1 minute for 1 inch of rain to 4 seconds for the same amount

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 **3** 4 5

Recommendation to a peer

1 2 3 4 **5**

Human effort

(time and difficulty)

1 2 **3** 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

2000-5000€/USD

Annual Cost

(per hectare or winery operation)

100-500€/USD

Savings Per Year

(estimated economic benefits)

500-2000€/USD

LIMITATIONS & CHALLENGES

- We farm in a warm/hot climate and very rarely do we achieve the historic average for rainfall.

LEARNINGS

- We started managing holistically on this site several years before planting in order to build soil health and fertility before installing the trellis and vines. It is easier to design and install a vineyard designed to be resilient with high biodiversity and low input costs before planting rather than modifying an existing vineyard - if you have that option.

ARGOS ANALYTICS, LLC

CALIFORNIA, UNIITED STATES

Courtesy NASA Visible Earth

Argos Analytics, LLC
Designing Resilient Vineyards
www.argosanalytics.com

Solution | Water Demand Model (WDM)

Application

In the Vineyard

Average Annual Precipitation

750 - (30 inches) - 1000 mm (40 inches)

Average Temperatures in growing season

15ºC and below (Cool climate) | 69ºF

Vineyard Size

10 ha - 50 ha (24,7 - 123 acres)

Type of Soil

Loam

Water Supply

Rainfall, purchased water, partially irrigated

THE SOLUTION

Year of implementation: 2022

Specific water-related challenge: The WDM is a tool for projecting future demand for irrigation water and evaluating drought resilience. It also has the ability to evaluate potential adaptation measures.

Frequency: Once to establish a baseline for the vineyard and as needed to simulate the effectiveness of potential adaptation measures.

Solution Description:
The WDM is a daily water balance model reflecting soil water holding capacity and driven by precipitation, temperature, humidity, solar radiation and wind scenarios, e.g. wet, average and dry years. These can be derived from climate projections, historical data or simply constructed. Irrigation is modeled based on current or possible future practices.

Evapotranspiration is modeled based on the daily weather in the scenarios and parameters including crop coefficients, row direction and row and vine spacing, canopy configuration, water spreading pattern from drip emitters and root depth. The outputs are daily available soil water and soil water potential and shows the degree of water stress.

Most of the parameters can be modified to reflect potential adaptation measures in order to simulate them and evaluate their effectiveness.

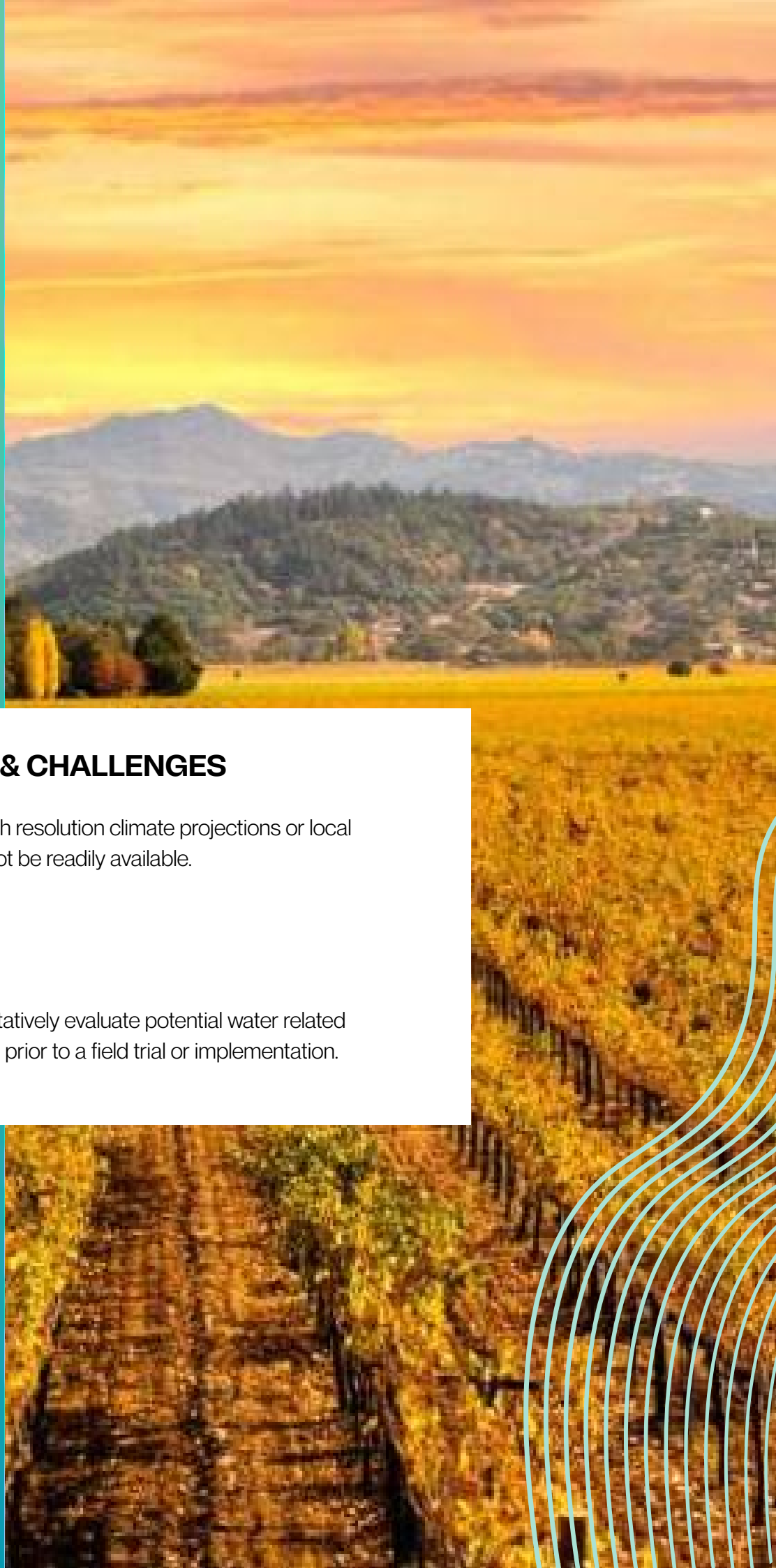
Examples include modifying canopy configuration through changes in canopy management practices, increasing root depth by irrigating less frequently with larger amounts of water and, when redeveloping a vineyard, changing row direction and row and vine spacing.

WATER IMPACT & OUTCOMES

- Reduced demand for irrigation water
- More efficient water use by optimizing irrigation practices
- Ability to manage water stress and avoid severe stress even in dry years
- Optimal timing of irrigation (pre–bud break and growing season)
- Increased resilience of vineyards to drought
- Insight into future water demand under climate scenarios (wet, average, dry years)

BENEFITS

- Provides a clear picture of water use, soil water and water stress with current practices and vineyard design
- Identifies opportunities for improvement
- Allows potential changes to be evaluated using simulation
- Optimises crop yield and quality, especially when water is scarce
- Reduces water and energy costs from excessive irrigation
- Improves vineyard sustainability and resource conservation
- Enhances long-term planning for climate change impacts



LIMITATIONS & CHALLENGES

In some locations high resolution climate projections or local historical data may not be readily available.

LEARNINGS

It's possible to quantitatively evaluate potential water related adaptation measures prior to a field trial or implementation.

O'NEILL VINTNERS AND DISTILLERS

CALIFORNIA, UNITED STATES

Solution | Bio Filtro Vermifiltration

Application

In the Winery

In-house bottling system

750ml bottles of wine produced annually

> 2 000 000 Lt

Water Supply

Municipal supply

Used Water

Bio Filtro Worm Farm

THE SOLUTION

First year of implementation: 2019

Specific water-related challenge:

Wastewater treatment was the top priority, to recycle clean water back into our aquifer and for vineyard irrigation.

Frequency: Daily

Solution Description:

Effluent from the winery is collected into 250,000gal sumps, heavy solids are removed, then pH adjusted to 7.0 before spraying on top of the worm beds.

Within 2 hours, the water is percolated through the beds.

COD is reduced by 95% and nitrogen is reduced by up to 50% in the treated effluent.

The final effluent is collected into another 250,000 gallon sump, which is then applied to vineyards or field application.

Species is California red worm, and the beds are filled with wood chips, rocks, and substrate.

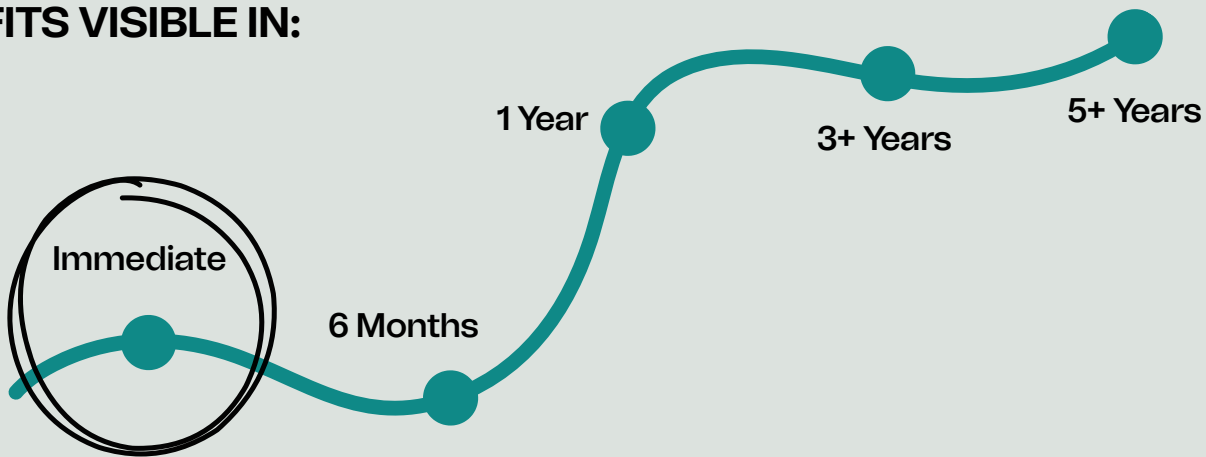
WATER IMPACT & OUTCOMES

- 80 million gallons of effluent can be treated annually.
- A total of 350 million gallons has been processed through the system since 2019, achieving the aforementioned results of COD and nitrogen reduction in treated effluent.
- Every 3 years, the bed substrate is removed and replenished with new wood chips and new worms, generating 28,000+ cubic yards of compost + worm castings.
- 500,000 pounds of used oak staves from the winery have been recycled into the beds since 2019.
- Over 5,000 tons per year of cover crop (alfalfa, sudan silage, and winter forage) are grown from the field application, which is harvested as cattle feed.

BENEFITS

- This is a very simple system to operate and has very little impact and has low CO2 footprint
- Requires low energy,
- Produces little waste, and
- All waste is recyclable

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 3 4 5

Recommendation to a peer

1 2 3 4 5

Human effort

(time and difficulty)

1 2 3 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

$200,000 USD

Annual Cost

(per hectare or winery operation)

$4,500 USD

Savings Per Year

(estimated economic benefits)

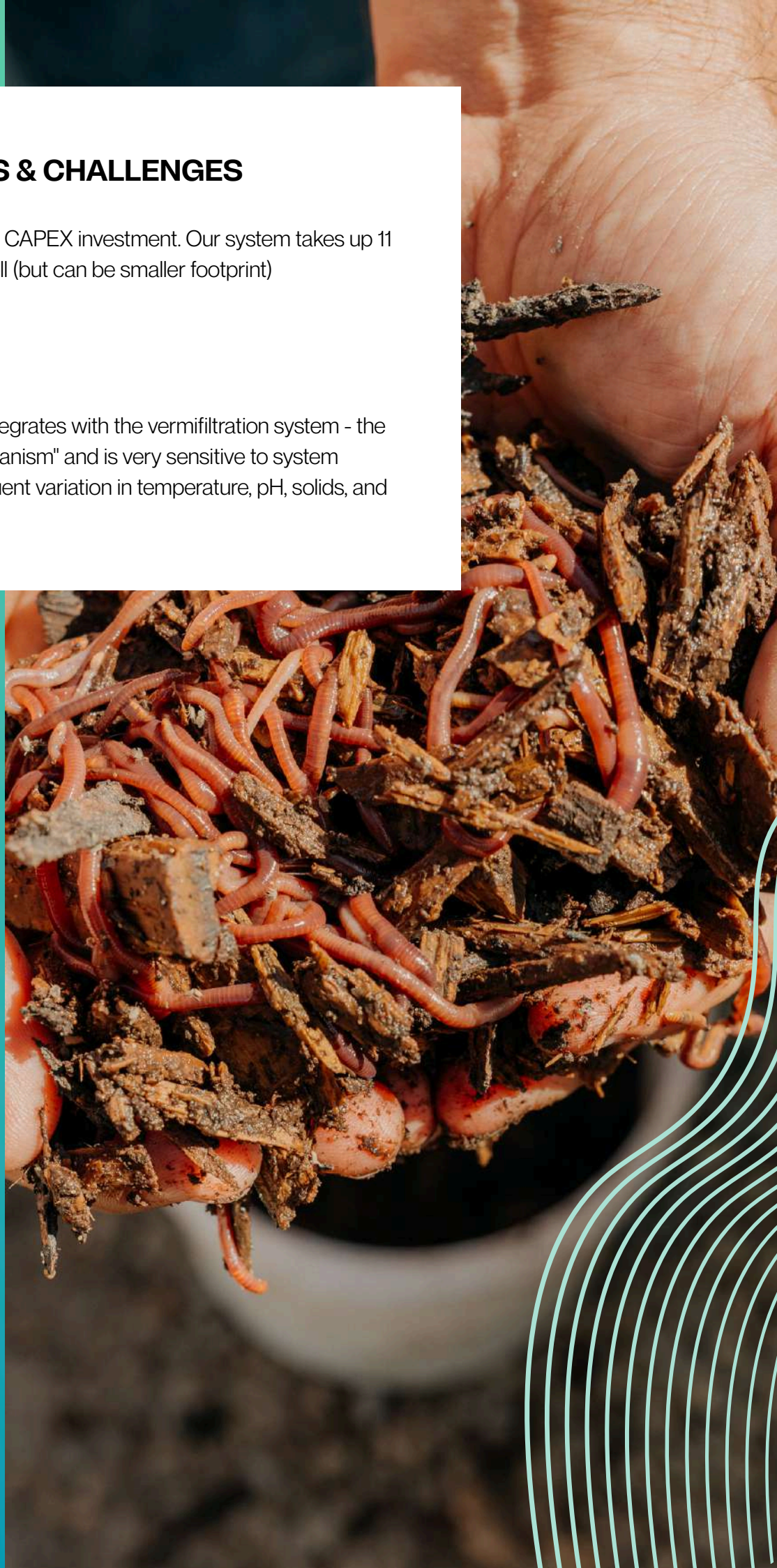
<100 USD

LIMITATIONS & CHALLENGES

Significant financial CAPEX investment. Our system takes up 11 acres of land as well (but can be smaller footprint)

LEARNINGS

How the effluent integrates with the vermifiltration system - the system is a "live organism" and is very sensitive to system impacts due to effluent variation in temperature, pH, solids, and sulfates.



RHST INDUSTRIES INC

QUEBEC, CANADA

Solution | RHST Water Pearls

Application

In the Vineyard

Average Annual Precipitation

1345 mm (53 inches)

Average Temperatures in growing season

19°C and above (Hot climate) | 66.2°F

Vineyard Size

<10 hectares (24,7 acres)

Type of Soil

Sandy Soils

Water Supply

Well
Fully Irrigated

THE SOLUTION

First year of implementation: 2022

Specific water-related challenge: drought resilience, water footprint, sustainable watershed extraction, water offsets and radiative forcing displacement

Frequency: Applied every 50 years

Solution Description:

Soil cover mats laid over the root zone, with irrigation lines laid over. no herbicide is required as weeds do not grow through the mats.

Water Pearls are the result of 25 years of research aimed at boosting crop productivity and water efficiency through sustainable means. These small, grape-sized beads are made from organic compound, mainly simple sugar, and feature a patented, inert diblock-polymer structure.

Their unique shape and microscopic surface bumps make them superhydrophobic, extremely water-repellent, and long-lasting. Fully UV-biodegradable, WaterPearls are designed for use throughout the cultivation process, offering a natural, efficient, and eco-friendly solution for modern agriculture.

The solution is adaptable for all fruit and nut trees. It has been trialed in university research facilities in arid zones. As an above ground soil permeable soil cover, wih high albedo, it will benefit the grower, on multiple aspects.

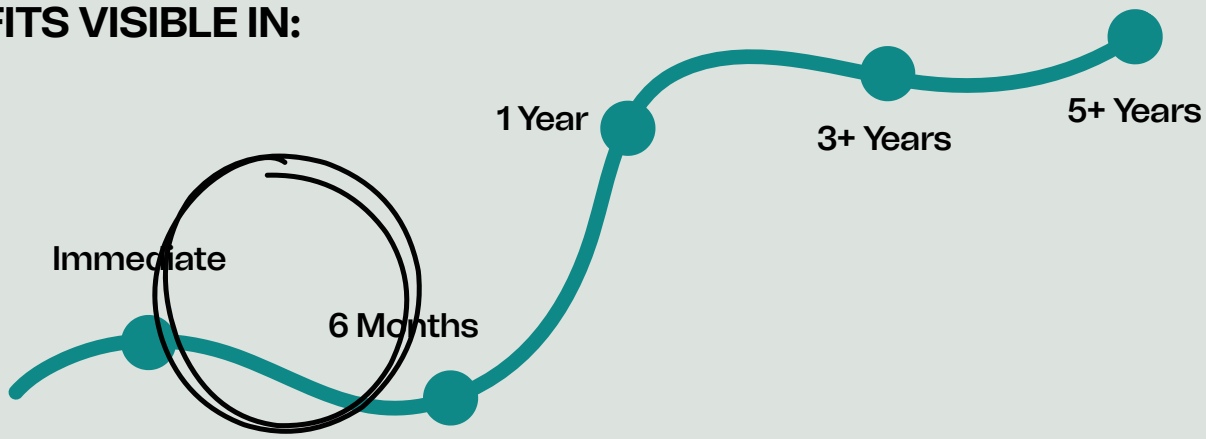
WATER IMPACT & OUTCOMES

- Groundwater field capacity was increased from 16% to 63%, under full leaf area coverage, in the timeframe week 3 july - week 1 october, with control set at 16% FC.
- This would enable the reduction of 50%+ in irrigation.

BENEFITS

- 40–60% reduction in non-productive evaporation
- Improved soil moisture persistence
- Reduced plant water stress
- Yield stability and uplift under deficit irrigation
- Increase agricultural productivity of rainfed farmland closer to that of irrigated farmland.
- Deferrable or tradable water rights
- Reduced thermal volatility
- Lower surface salinity migration
- Suppressed weed germination (via dry surface layer)

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 3 4 5

Recommendation to a peer

1 2 3 4 5

Human effort

(time and difficulty)

1 2 3 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

>5000€/USD

Annual Cost

(per hectare or winery operation)

<100€/USD

Savings Per Year

(estimated economic benefits)

>5000€/USD

LIMITATIONS & CHALLENGES

If traffic above ground (equipment) or organic farming with grazing animals, is anticipated, the mats can be covered with 5-10 cm of topsoil. This will extend lifespan of mats to >100 years

LEARNINGS

Applied irrigation water can be reduced by 50%+, nutrient application can be reduced by 15%+, closely follow the VPD and weather data to adjust irrigation schedule, ensure good date acquisition of control and test zones, compare yields and quality of harvested crop.

TWO HAND WINES

BAROSSA VALLEY, AUSTRALIA

TWO HANDS WINES

Solution | Sap Flow management

Application

In the Vineyard

Average Annual Precipitation

250 mm (10 inches) - 500 mm (20 inches)

Average Temperatures in growing season

19ºC and above (Hot climate) | 66.2ºF

Vineyard Size

<10 hectares (24,7 acres)

Type of Soil

Clay

Water Supply

Rainwater, private water supply
Fully Irrigated

THE SOLUTION

First year of implementation: 2019

Specific water-related challenge:
the method aims at building up a drought resistant and a resilient vineyard

Frequency: All year long

Solution Description:
The system is a combination of hardware and data analysis. We install on a few vines across different part of the vineyard sensors that wrap around the vines.

The sensors measure 24/7 the evapotranspiration of the vines. The analysis of those data combines with other measurement during the season allow us to understand when the vine is actually struggling from our dry weather and we then apply a longer irrigation run.

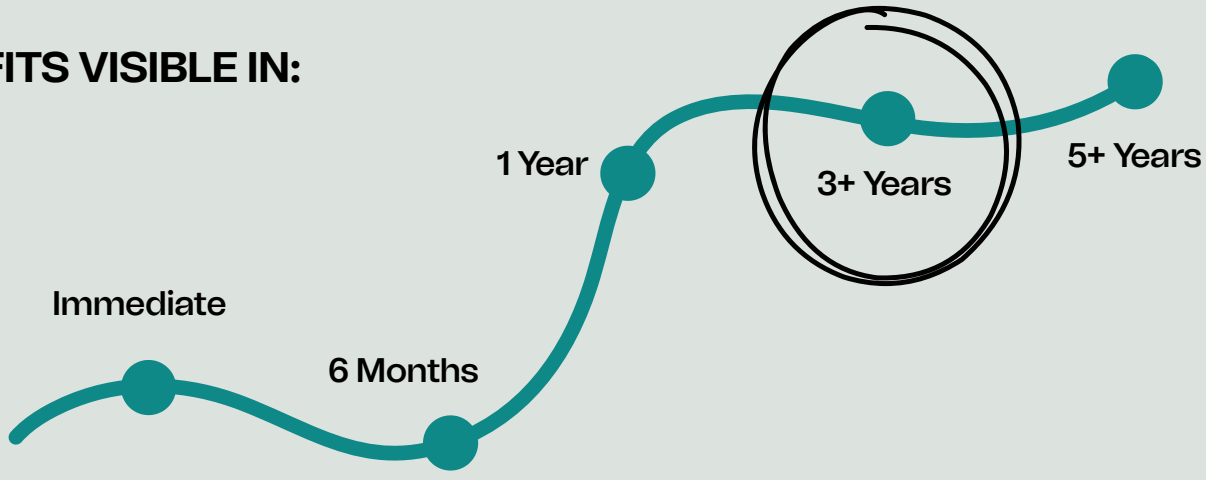
By doing so, we are pushing the vines year on year to increase their resistance to drought, and we space out our irrigation and reduce them over time. Since its induction in 2019, we believe we have saved around 50% of the water we were using. We are also encouraging the root system to go deeper as we limit and reduce irrigation, creating a more resilient vineyards.

This techology is used in conjonction with over practices such a mid-row and undervine management.

WATER IMPACT & OUTCOMES

- Water reduction: Data-driven irrigation cuts water use by delivering it only when vines truly need it, reducing overall consumption by around 50%.
- Soil health: Less frequent, targeted watering improves soil structure, supports microbial life, and reduces nutrient loss.
- Vine health and resilience: Controlled water stress encourages deeper roots and strengthens vines' ability to withstand drought over time.

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 3 **4** 5

Recommendation to a peer

1 2 3 4 **5**

Human effort

(time and difficulty)

1 2 3 **4** 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

500-2000€/USD

Annual Cost

(per hectare or winery operation)

500-2000€/USD

Savings Per Year

(estimated economic benefits)

2000-5000€/USD

LIMITATIONS & CHALLENGES

Depending on the level of details you want to get, technology can be expensive (500 to 700 Euro per hectare per year) and time consuming with data collection.

LEARNINGS

At times, the challenge is to trust the technology and try not to follow historical vineyard practices even if recommendation could be confronting.

In saying that, like any technology, Sap Flow Management is a tool and it gives you information.

Use those as a guide and shift gradually to use the data as your main assistance in decision making.

THE VINEYARDS AT DODON

MARYLAND, UNITED STATES

Solution | Healthy Soils

Application

In the Vineyard

Average Annual Precipitation

750 - (30 inches) - 1000 mm (40 inches)

Average Temperatures in growing season

19ºC and above (Hot climate) | 66.2ºF

Vineyard Size

<10 hectares (24,7 acres)

Type of Soil

Sandy loam

Water Supply

Rain

THE SOLUTION

First year of implementation: 2016

Specific water-related challenge:"Hydroclimate whiplash," moving from extreme drought to extraordinary downpours

F**requency:** continuous

Solution Description:

Dodon uses agroecological tools (cover crops, composting, livestock integration, and biodiversity) to regenerate living soils.

We begin by increasing plant diversity. Because we have a large seed bank and ample rainfall, we depend on naturally growing, native, and naturalized grasses and forbs.

Starting at bloom, tall grasses over eight inches are terminated using a roller-crimper. This process creates a mulch layer between the rows, which cools the soil, boosts microbial activity, reduces pathogen pressure, and releases nutrients needed by the vines for fruit set.

Crimping enables diverse ground cover to thrive, resulting in cover crops with various root depths that create pathways for water infiltration during heavy rains.

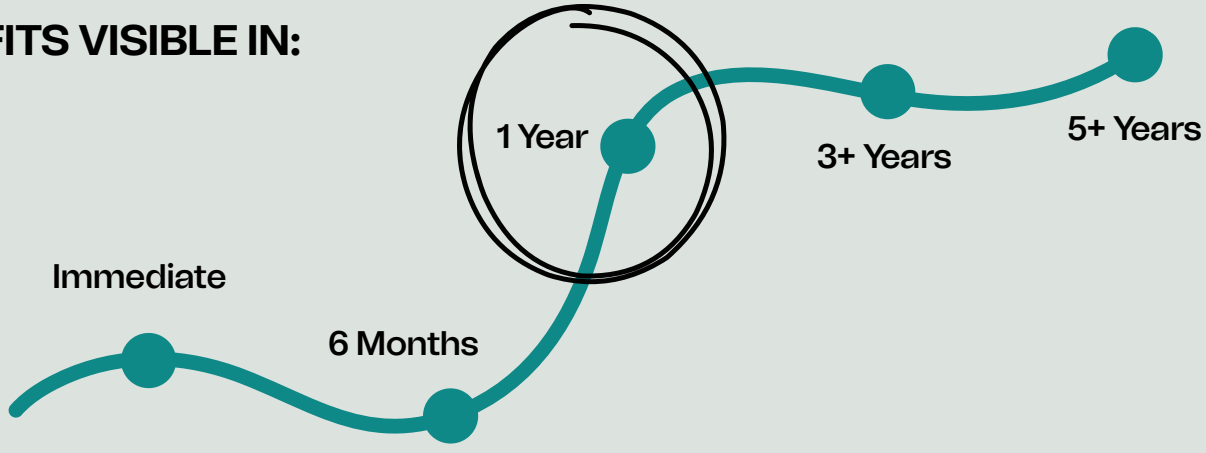
BENEFITS

- Soil organic matter has increased twelve-fold over a decade, resulting in excellent aggregate structure and decreased compaction.
- Rainfall quickly infiltrates into the soil, reducing standing water in the vineyard.
- Rainfall is retained in the living soil and becomes accessible to the vines during more frequent droughts.
- Cooler soil leads to decreased evapotranspiration.
- The diverse cover crops also increase pollinator and natural predator activity, promoting a functional and resilient ecosystem.

WATER IMPACT & OUTCOMES

- Taken together, the emphasis on plant diversity and soil health has resulted in a 30% increase in yield, a 40% reduction in fungicide use, eighteen fewer tractor passes per season, and better wine.

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 3 4 5

Recommendation to a peer

1 2 3 4 5

Human effort

(time and difficulty)

1 2 3 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

$100–500€/USD

Annual Cost

(per hectare or winery operation)

0 €/USD

Savings Per Year

(estimated economic benefits)

>10,000€/USD

LIMITATIONS & CHALLENGES

The chief limitation is learning how to apply the tools at our site. Participating in organizations like the Porto Protocol has helped us learn.

LEARNINGS

·Natural processes are highly effective at solving vineyard challenges, including the hydrological whiplash that occurs when significant drought alternates with extreme downpours.
·Healthy, living soil provides important benefits throughout the vineyard, such as water management, disease reduction, and supporting vine nutrition and health.

"Evolution is cleverer than you are."

DOMAINE LAFAGE
ROUSSILLON, FRANCE

Solution | Conservation Irrigation

Application

In the Vineyard

Average Annual Precipitation

250 mm (10 inches) - 500 mm (20 inches)

Average Temperatures in growing season

19°C and above (Hot climate) | 66.2°F

Vineyard Size

> 250ha (617 acres)

Type of Soil

Limestone & Chalk (Calcareous)

Water Supply

Borehole, well and reused water
Partially Irrigated

THE SOLUTION

First year of implementation: 2021

Specific water-related challenge:
Irrigation demand

Frequency: Every Year

Solution Description:

The proposed solution is a data-driven minimal irrigation approach that reduces water use (up to threefold) while maintaining vine yield and grape quality. Instead of fixed irrigation schedules, water is applied only when needed based on soil, plant, and berry indicators.

The method relies on calibrating the relationship between soil water content and vine water status (predawn leaf water potential), which differs between irrigated and rainfed systems. This ensures accurate irrigation decisions under drip irrigation.

It also integrates monitoring of berry development (sugar, organic acids, and berry size) to assess the impact of water stress on growth and ripening, allowing timely intervention before negative effects occur.

Designed for low water availability conditions (<500 m^3/ha/year), irrigation is applied strategically at key growth stages. The approach is implemented through a simple field protocol combining measurements and threshold-based irrigation triggers.

Overall, this solution enables growers to maintain productivity and wine quality while significantly reducing water consumption, and can be adapted to different cultivars and terroirs.

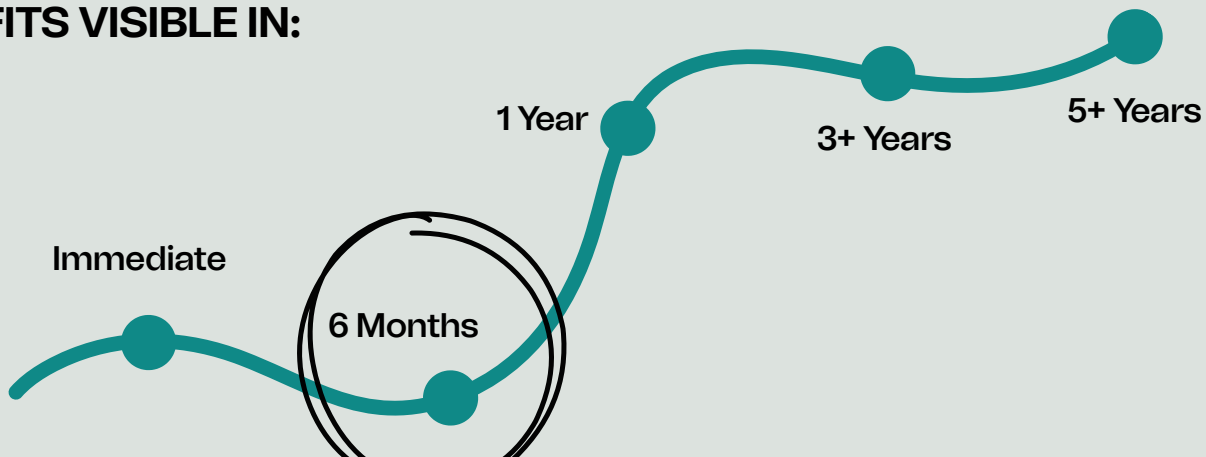
WATER IMPACT & OUTCOMES

- Saving 1000m^3 of water per hectare
- Achieves up to 3× reduction in irrigation water use
- Improves water-use efficiency (more yield per unit of water)
- Supports sustainable production in water-limited (<500 m^3/ha/year) conditions
- Reduces overall water footprint of vineyard operations

BENEFITS

- Maintains consistent yield and grape quality under reduced irrigation
- Prevents vine stress and impaired berry development
- Enables data-driven decision-making through simple field measurements

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 3 4 5

Recommendation to a peer

1 2 3 4 5

Human effort

(time and difficulty)

1 2 3 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

<100€/USD

Annual Cost

(per hectare or winery operation)

<100€/USD

Savings Per Year

(estimated economic benefits)

<100€/USD

Index

LIMITATIONS & CHALLENGES

To be very precised on the timing of irrigation, the amount, the reason, the phenological stage...

DOMAINE LAFAGE
ROUSSILLON, FRANCE

Solution | Biochar

Application

In the Vineyard

Average Annual Precipitation

250 mm (10 inches) - 500 mm (20 inches)

Average Temperatures in growing season

19ºC and above (Hot climate) | 66.2ºF

Vineyard Size

> 250ha (617 acres)

Type of Soil

Limestone & Chalk (Calcareous)

Water Supply

Borehole, well and reused water
Partially Irrigated

THE SOLUTION

First year of implementation: 2021

Specific water-related challenge:
Drought resilience

Frequency: Once a year

Solution Description:

Biochar is a carbon-rich material obtained through the thermal decomposition of organic biomass under limited oxygen conditions. When applied to soil, it functions as an amendment that enhances the soil's physical and chemical properties, particularly its capacity to retain water.

This makes it a relevant solution for agricultural systems in regions facing water scarcity.

The effectiveness of biochar depends on its production characteristics and the context in which it is applied. Different feedstocks, such as wood, crop residues, or manure, produce biochars with varying levels of porosity, nutrient content, and stability.

However, selecting the appropriate type requires consideration of soil texture, climate conditions, and crop requirements.

Implementation involves integrating biochar into the soil, typically within the topsoil layer, where it can influence root-zone moisture.

Prior to application, biochar is often combined with organic materials such as compost or manure.This step improves nutrient availability and avoids temporary nutrient lock-up. Application rates depend on soil conditions, but moderate, site-specific amounts are recommended.

Once added to soil, biochar increases porosity and improves water retention, while supporting microbial activity and long-term fertility. These effects help crops use water more efficiently, reducing irrigation needs. However, its effectiveness varies by context, and further research is needed to optimise its use.

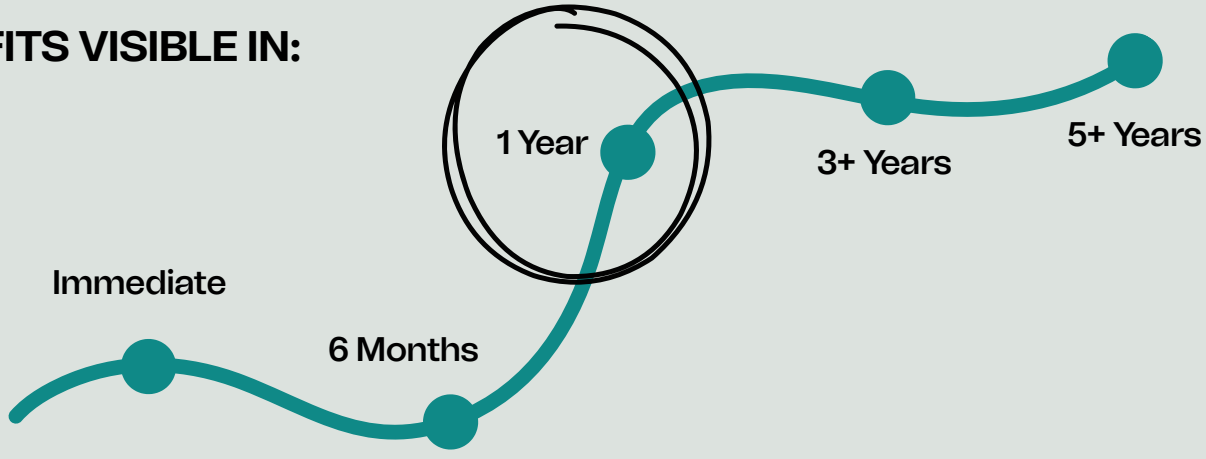
WATER IMPACT & OUTCOMES

- Reduction of irrigation needs in areas experiencing water scarcity
- Increases soil water retention capacity
- Reduces irrigation frequency and volume
- Improves plant access to stored soil moisture
- Enhances drought resilience in crops

BENEFITS

- Improves soil structure and fertility
- Reduces nutrient leaching
- Supports beneficial microbial activity
- Utilizes agricultural waste, contributing to sustainability
- +50% production (3 years after plantation)

BENEFITS VISIBLE IN:



EFFORT & RECOMMENDATION

Implementation complexity

1 2 3 4 5

Recommendation to a peer

1 2 3 4 5

Human effort

(time and difficulty)

1 2 3 4 5

COSTS & SAVINGS

Initial Cost

(per hectare or winery operation)

>5000€/USD

Annual Cost

(per hectare or winery operation)

TO BE CALCULATED

Savings Per Year

(estimated economic benefits)

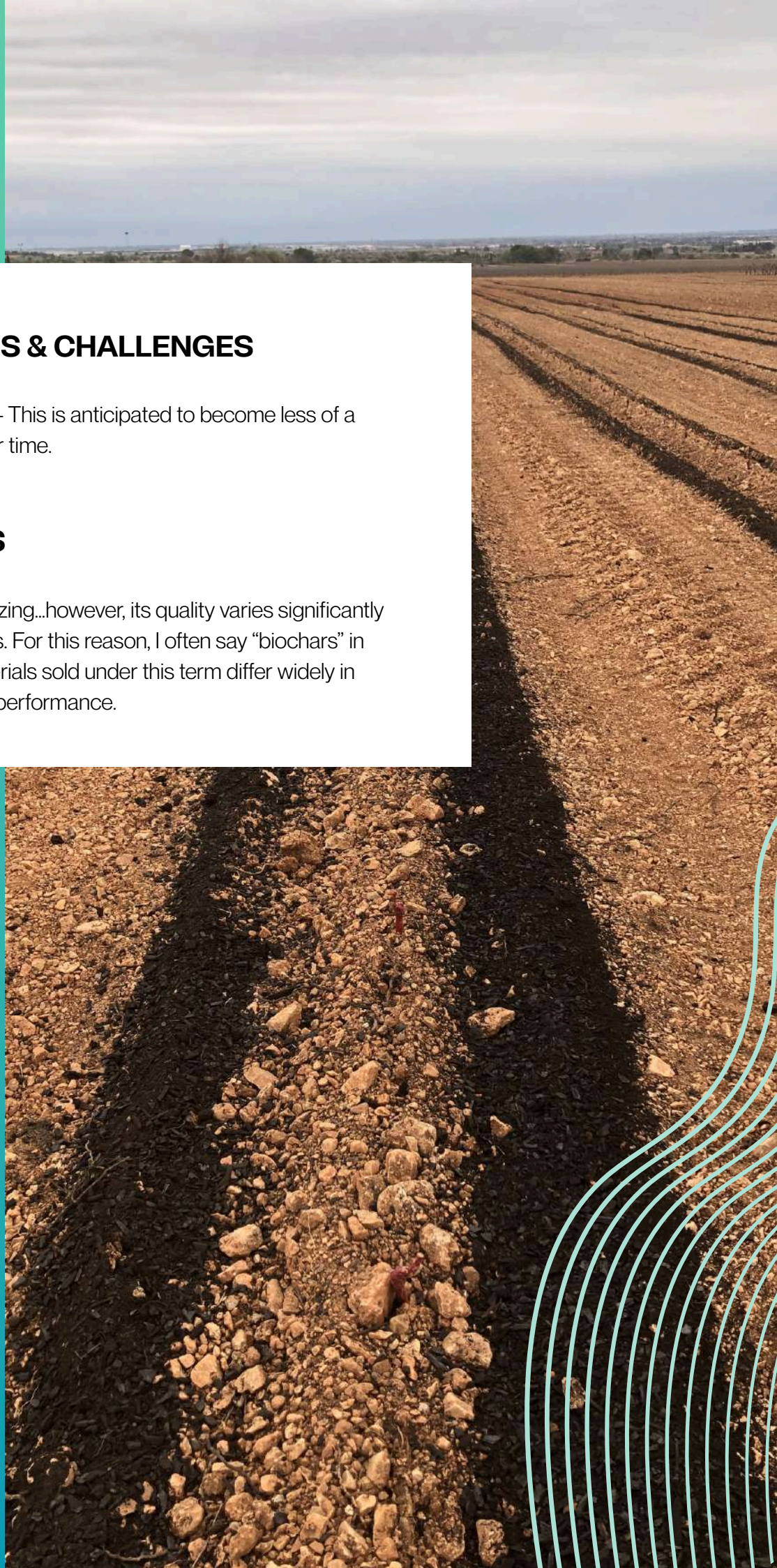
500-2000€/USD

LIMITATIONS & CHALLENGES

Cost of biochars – This is anticipated to become less of a limiting factor over time.

LEARNINGS

Biochars are amazing...however, its quality varies significantly between suppliers. For this reason, I often say “biochars” in the plural, as materials sold under this term differ widely in composition and performance.



DOMAINE LAFAGE
ROUSSILLON, FRANCE

Solution | REUSE - Vermifiltration

Application

In the Winery

In-house bottling system

750ml bottles of wine produced annually

> 2 000 000 Lt

Water Supply

Borehole

Used Water

Reused

THE SOLUTION

First year of implementation: 2026

Specific water-related challenge:
REUSE for irrigation

Frequency: All year long

Solution Description:

Using a vermifiltration system to treat wastewater so it can be safely reused for irrigation. Wastewater passes through a filter bed of wood chips populated with earthworms.

The worms maintain a porous structure and create a biologically active environment, while microorganisms form a biofilm that breaks down pollutants and reduces pathogen levels. This process produces water suitable for irrigation without the need for chemical treatment.

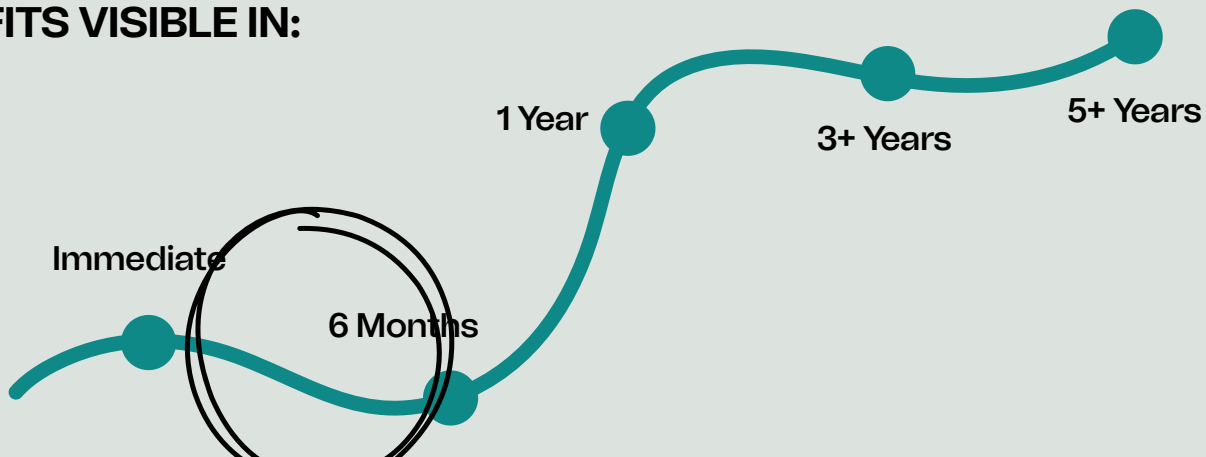
In practice, all water pumped from the borehole, located in an aquifer unsuitable for human consumption, is treated and reused on-site.

The system is low-energy, low-maintenance, and sustainable, providing a continuous source of irrigation water while minimizing freshwater use.

WATER IMPACT & OUTCOMES

- We reuse the totality of the water we are pumping from the borehole.
- Reduced reliance on freshwater
- Nutrient-rich water supports crop growth

BENEFITS VISIBLE IN:



COSTS & SAVINGS

Implementation complexity

1 2 3 4 5

Recommendation to a peer

1 2 3 4 5

Human effort

(time and difficulty)

1 2 3 4 5

COSTS & SAVINGS

Initial Cost
(per hectare or winery operation)

TO BE CALCULATED

Annual Cost
(per hectare or winery operation)

TO BE CALCULATED

Savings Per Year
(estimated economic benefits)

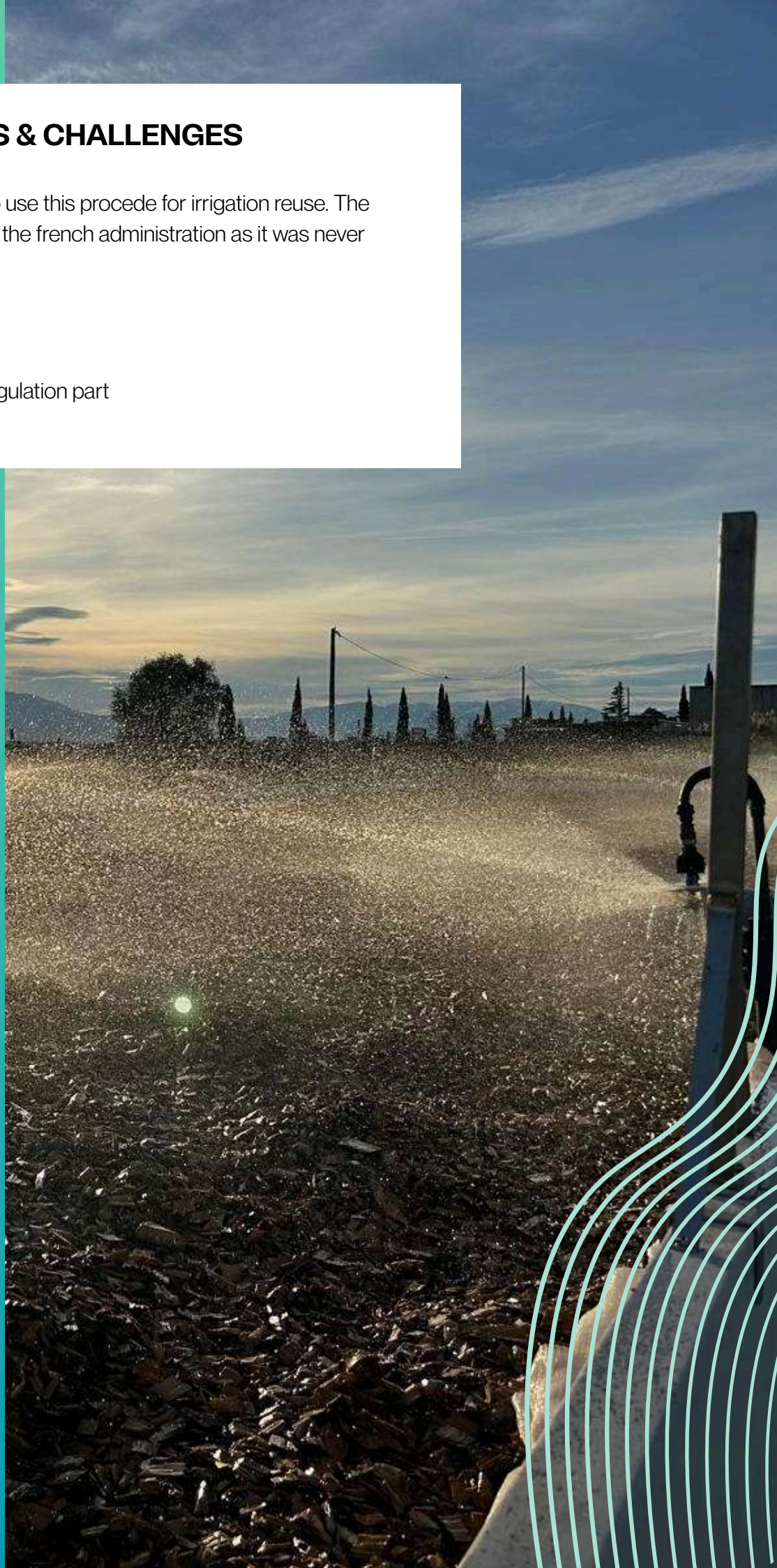
TO BE CALCULATED

LIMITATIONS & CHALLENGES

We were the first to use this procede for irrigation reuse. The challenge was with the french administration as it was never done before.

LEARNINGS

To anticipate the regulation part



DOMAINE BOUSQUET

ARGENTINA (MULTIPLE REGIONS)

Solution | Combination/ adapted method

Application

In the Vineyard and Winery

Average Annual Precipitation

250 mm (10 inches) - 500 mm (20 inches)

Average Temperatures in growing season

19ºC and above (Hot climate) | 66.2ºF

Vineyard Size

100ha - 250ha (247- 617 acres)

Water Types Included

Water Supply

Well
Fully Irrigated

THE SOLUTION

Key metric tracked:
L(water), L(wine) (for industrial) - m3/ha, m3/kg (agriculture)

Main water hotspots identifies:
Vineyard irrigation

What surprised you most?

-improved irrigation scheduling: Transitioned to an excel-based model integrating climatic data, and evapotranspiration rates/

-infrastructure & filtration upgrades: installed hydrocyclones to prevent emitter dogging and restored 15% system efficiency through pump maintenance.

Distribution Optimization: Constructed an interconnection pipeline to resolve localized water shortages.

Deep Soil Saturation Protocol: Established a seasonal practice to replensih deep water reserves before bud break.

Advanced Monitoring: Implementation of a central consumption dashboard and the integration of soil moisture sensors (as of 2025)

RESULTS OBSERVED

- Reduced blue water use
- Cost savings

LESSONS FOR OTHER WINE PRODUCERS

True water efficiency requires a dual approach: optimizing physical infrastructure while simultaneously adopting rigorous, data driven secheduling.

We learned that advanced modeling *using evotranspiration data) is most effective only when the delivery system is flawless.

By combining basic maintenence like cleaning pump suctions and upgrading filtration.

Water is the most precious resource in agriculture and by extention, the foundation of life itself. At our estate, we treat every drop as a vital asset, ensuring that our production practices honor its scarcity and importance.

SALCHETO

MONTEPULCIANO (SI) ITALIA

Approach used | ISO 14046 / LCA-based

Application

In the Vineyard, Winery and Indirect Activities

Average Annual Precipitation

500 mm (20 inches) - 750 mm (30 inches

Average Temperatures in growing season

17ºC - 19ºC (Warm climate)
62.5ºF - 66.2º

Vineyard Size

50 ha - 100 ha (123 acres - 247 acres)

Water Types Included

Water Supply

Municipal water and pond
No irrigation

THE SOLUTION

Key metric tracked:
Water Scarcity Impact (m3eq)
Aquatic Acidification (kg SO2eq)
Aquatic Ecotoxicity (CTUe)
Human Toxicity (CTUh)
Aquatic Eutrophication (kg PO4eq)

The assement has been run following the ISO 14046 standard since 2016, in within the Equalitas Winery and Product Sustainbility certification. Since 2023 the calculations are made with the IT support of the Apra-Equalitas specific software.

For the Countryside Area, the reference unit was considered to be 1 q of grapes harvested and suitable for processing in the year under review.

For the Cellar Area, the reference unit was 1 liter of bulk wine produced and suitable for
bottling.

Finally, for the Bottling Area, 0.75 liters of wine packaged and ready for sale were considered.

Main water hotspots identifies:
Energy

ACTIONS IMPLEMENTED

The calculation and monitoring of those indicators underlined the main direct and indirect impact of the winery entire value chain in regard of water based on an LCA approach.

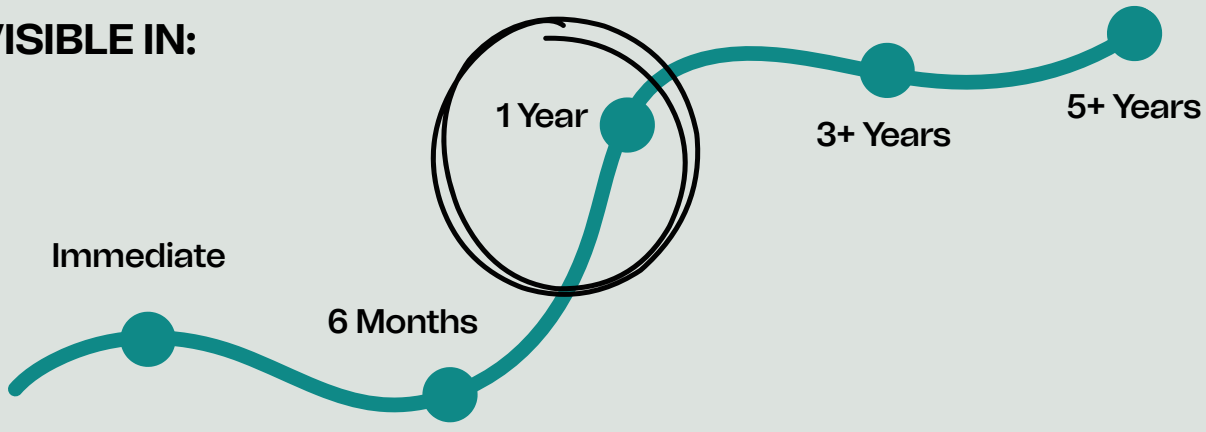
The main direct impact regards water scarcity, where the use use of a lake to collect rain water together with the one depurated once out of the winery operations, has been the major improvement.

The main indirect impacts regarding the ecosytem acidification, eutrophication and ecotoxicity rise from the production of glass bottles, the use of energy and the consumption of fertilizers.

Fertilizers and diesel fuel are also the main impact sources regardin human toxicity.

The winery has since 2010 implemented several solutions such as light glasses (370gr for a 750ml) and alternative packagings (such as Bag in Boxes) but also through the reduction of energy, both in the cellar (which is energy independent) than in the vineyards (multi operations machineries and DSS and precision interventions), together with a significan reduction in the use of fertilizers (for example by autoproducing compost).

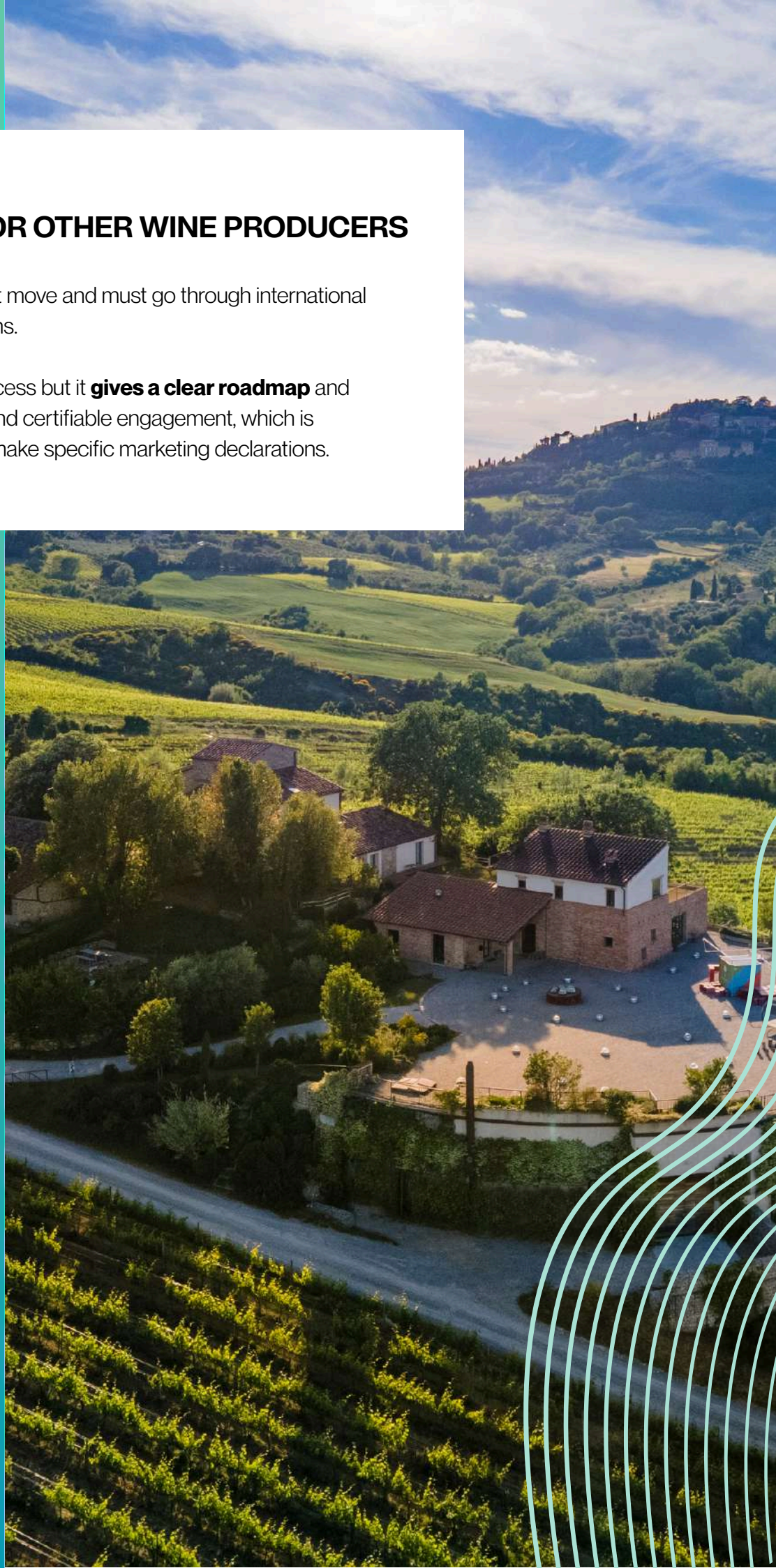
BENEFITS VISIBLE IN:



LESSONS FOR OTHER WINE PRODUCERS

Awarness is the first move and must go through international standard calculations.

It is a long term process but it **gives a clear roadmap** and also proves a real and certifiable engagement, which is necessary to then make specific marketing declarations.



ALPAMANTA
MENDOZA, ARGENTINA

ESTATE WINES
ALPAMANTA

Solution | Drip Irrigation

Application

In the Vineyard

Average Annual Precipitation

250 mm (10 inches) - 500 mm (20 inches)

Average Temperatures in growing season

19oC and above (Hot climate) | 66.2oF

Vineyard Size

10 ha - 50 ha (24,7 - 123 acres)

Type of Soil

Gravel (Stony)

Water Supply

well Water
Fully Irrigated

THE SOLUTION

First year of implementation:2006

Specific water-related challenge: Irrigation Demand

Frequency: Since 2023

Solution Description:
we use a specialised company to monitor water consumption and plant dehydration across different vineyard sections to improve irrigation efficiency.

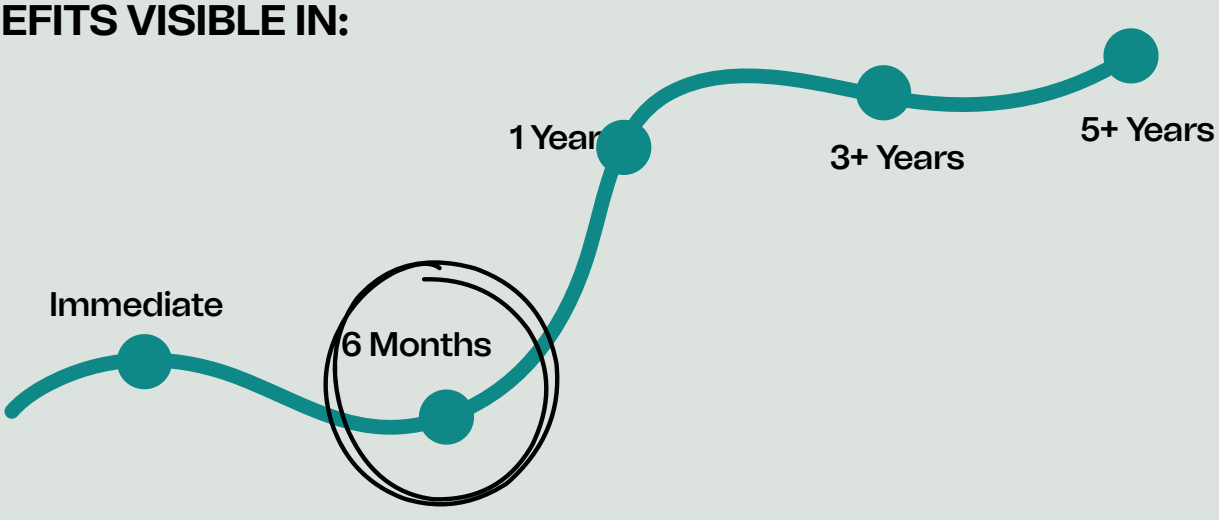
This system measures rainfall, soil humidity, and other environmental inputs to determine the exact amount of supplemental water required for each block of vines. Because the vineyard contains different soil types, water use is adjusted on a zone-by-zone basis to match local conditions and vine needs.

This approach is part of precision viticulture, allowing for more targeted irrigation management by combining environmental data with soil variability. It helps optimise water use, reduce waste, and ensure each section of the vineyard receives the appropriate level of irrigation support throughout the growing season.

WATER IMPACT & OUTCOMES

- Different soil types receive adjusted irrigation levels, preventing both under- and over-watering.
- Targeted application reduces over-irrigation, runoff, and deep percolation beyond the root zone.
- Water is only applied where and when it is needed, avoiding unnecessary irrigation.
- Natural precipitation is integrated into irrigation decisions, reducing dependence on supplemental water.

BENEFITS VISIBLE IN:



COSTS & SAVINGS

Implementation complexity

1 2 3 4 5

Recommendation to a peer

1 2 3 4 5

Human effort

(time and difficulty)

1 2 3 4 5

Initial Cost

(per hectare or winery operation)

<100€/USD

Annual Cost

(per hectare or winery operation)

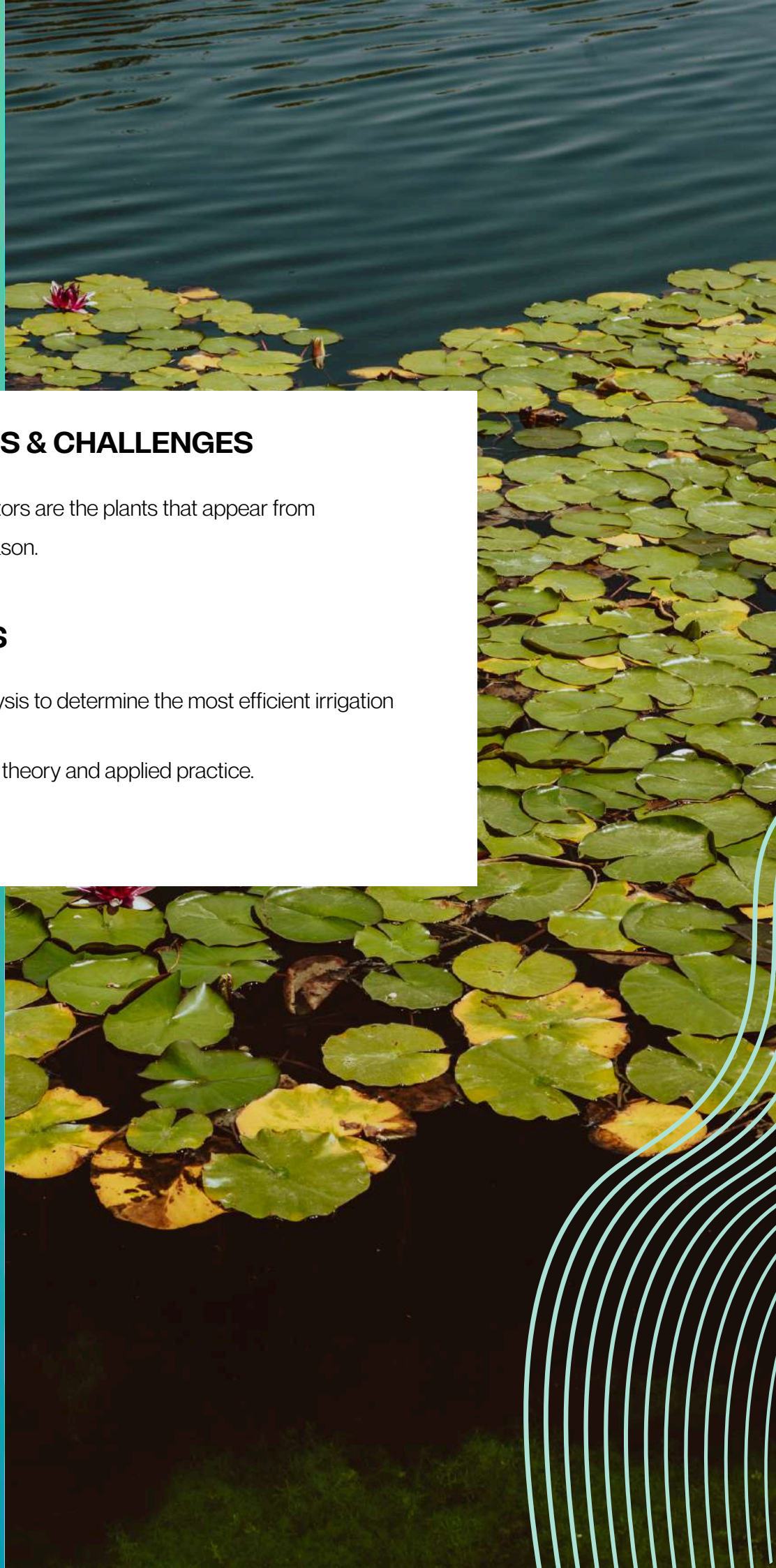
<100€/USD

Savings Per Year

(estimated economic benefits)

100-500€/USD

Index



LIMITATIONS & CHALLENGES

- Our bioindicators are the plants that appear from season to season.

LEARNINGS

- Soil type analysis to determine the most efficient irrigation timing.
- Verification of theory and applied practice.

CHARLES KRUG

NAPA VALLEY, UNITED STATES

Solution | Drip Irrigation with moisture monitoring and DRI

Application

In the Vineyard

Average Annual Precipitation

750 - (30 inches) - 1000 mm (40 inches)

Average Temperatures in growing season

17ºC - 19ºC (Warm climate) | 62.5ºF - 66.2ºF

Vineyard Size

100 ha - 250 ha (247 -617 acres)

Type of Soil

Loam

Water Supply

Wells
Partially Irrigated

THE SOLUTION

First year of implementation: 1990's to current--modifying as better systems become available

Specific water-related challenge: water table changing

Frequency: We drip 6-8 times per year at night for 8-10 hours

Solution Description:

We monitor the moisture content in the soil regularly, looking at temperature variations and forecasts for several weeks at a time, and monitoring vine health to retain vigor. This determines how many times we water and for the length of time of the watering.

At Charles Krug Winery, we complement this approach with DRI (Direct Root-zone Irrigation), which delivers water directly below the surface to the vine roots. By targeting the root zone instead of the soil surface, this method significantly reduces evaporation and improves water-use efficiency. Our side-by-side observations show that vines under DRI can maintain comparable vigor while using substantially less water—about half compared to traditional drip irrigation—allowing for more precise and sustainable vineyard management.

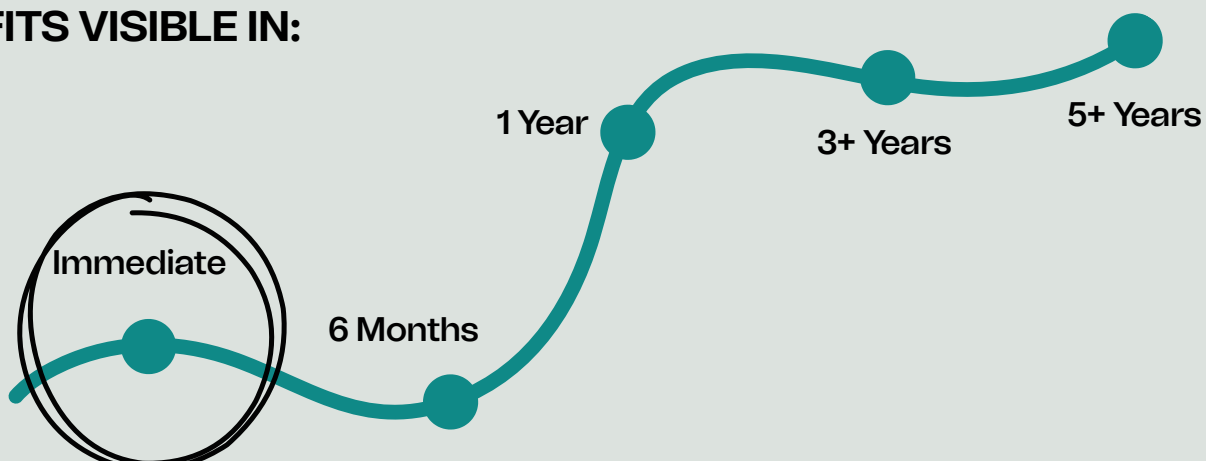
BENEFITS

- Less cost and water wastage.
- Supports more sustainable vineyard practices, especially in drought-prone regions

WATER IMPACT & OUTCOMES

- Reduce and conserve water in general Maintain healthy soil by leaching impurities from annual rainfall
- Directs energy and nutrients to the vine
- Cover crops help to provide additional nutrients and compost
- Our winery operates on 80% solar power for our energy needs
- Watering at night reduces evaporation and energy costs
- Vineyards are a single crop per year, so managing each vintage based on mother nature is important to our approach--one solution is not always viable year over year
- We see the results when do we replant. Normally you would need to add ample compost, but because we maintain with compost, cover crops and smart irrigation our soils remain healthy

BENEFITS VISIBLE IN:



COSTS & SAVINGS

Implementation complexity

1 2 3 4 5

Recommendation to a peer

1 2 3 4 5

Human effort

(time and difficulty)

1 2 3 4 5

Initial Cost

(per hectare or winery operation)

2000-5000€/USD

Annual Cost

(per hectare or winery operation)

500-2000€/USD

Savings Per Year

(estimated economic benefits)

<100€/USD

LIMITATIONS & CHALLENGES

Requires maintenance and not every vine is the same. In the future smart emitters would be able to monitor vine by vine and apply exactly what each plant needs.

LEARNINGS

The main issues are the costs associated with managing and maintaining drip irrigation in order to maintain vigor and maximize potential on an acre-by-acre basis

the PORTO PROTOCOL

SAVING EVERY DROP IN WINE

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