LIFE Project Number

**<LIFE15 ENV/IT/000641>**

# Deliverable "Action plan developed by demo farmers "

*Sub-action B2.1 "Definition of the Action Plan"*

LIFE+ PROJECT Soil4Wine

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## Abstract

Aim of this Deliverable is the presentation of the SMART (Specific, Measurable, Achievable, Realistic and Time bounded) **Action Plans** for each DEMO farm of the project derived from the use of decision tool (Alfa-version) and the interaction between UCSC, HORTA and Demo farmers.
For each Demo Farm features of selected demonstrative vineyard were presented. In particular soil characteristics (derived from regional soil maps and specific samples analysis), management and topographical features, climate data and information collected from Visual Soil Assessment and farmers interview led to identification of potential and then, effective soil threats.
For each demonstrative vineyard mitigation goals were defined and solutions were proposed. Description of main expected results and monitoring activities close the SMART Action Plan.
Action Plans were elaborated joined with the first version of the DSS (Alfa-tool developed in sub-action B1.1) that allow the identification of soil threats, the indication of assessment indicators and the definition of best solutions.
In Annex A the composition of proposed sowing mixtures are reported.

## 1. Introduction: Project overview

**Soil4Wine** project "*Innovative a-pproach to soil management in viticultural landscape*" is aimed to achieve a better soil management in the whole viticultural eco-system developing and testing an innovative Decision tool and management solution tested in farms located in the Project area and in Europe.
This report presents the structure and main outcomes of sub-action B2.1 *"Definition of the Action Plan"* related to Soil4Wine project Action B.2 "Demonstration in vineyards" from M4 (01.04.2017) until M36 (31.12.2019).
HORTA is the responsible for this action and UCSC is involved in.

Aim of this sub-action is the presentation of the SMART (Specific, Measurable, Achievable, Realistic and Time bounded) Action Plans for each DEMO farm of the project derived from the use of decision tool (Alfa-version) and the interaction between UCSC, HORTA and Demo farmers.

## 2. Definition of Action Plan

In each DEMO Farm HORTA, UCSC and Demo farmers have chosen two vineyards, on which the Alfa-Tool, developed in sub-action B1.1 and described in deliverable B1.1, was tested and the SMART (Specific, Measurable, Achievable, Realistic and Time bounded) Action Plans designed (Figure 1).

*Figure 1: Steps of the Action Plan to be developed by the "demo farmers" group in their vineyards*

**a. Start point**: represents the analysis of the existing situation in the site, the assessment of its characteristics (such as: soil type, condition and management; slope, topography and aspect; hydrology of water flow; native flora; etc.), and the identification of the threat(s) to be addressed.
**b. End point:** represents the definition of the mitigation goal to be achieved and the time to achieve it; it also includes an ex-ante analysis of the expected benefits.
**c. How to go there:** is the roadmap to move from the start to the end point; it includes the choice of the best solution(s) to be applied for achieving the goal, as well as an evaluation of the necessary resources (time, money, expertise, etc.) and constrains.
**d. What to do:** is the definition of the specific actions to be implemented to achieve the goal based on the analysis.
**e. What to check:** is the definition of a monitoring program to check the success of the actions implemented a record keeping program, and a review progress to verify the progress towards the goal.
**f. How to remain there:** is an action list of the monitoring and maintenance activities to be implemented for maintenance of the results obtained.

In Table 1 the selected vineyards are listed (vineyards are coded according to the database of sub-action A1.1).

The project area is characterized by small vineyards, typically less than 1 ha, and with several vine varieties in the same plot, in this context researcher and Demo farmers had selected vineyards smaller that 1 ha and following features have be taken into consideration:
- uniformity of vineyard and soil management;
- uniformity of vine variety to enable the analysis of vine behavior through the data collected during harvest and pruning time.

| Project area | Farm Code | DEMO Farm | Vineyard 1 | Vineyard 2 | DEMO vineyard |
|---|---|---|---|---|---|
| Parco Stirone Piacenziano | **SP1** | Az Barbuti Giuseppe | 31 | 32 | **31** |
| | **SP2** | Az. Podere Le Lame | 104 | 101 | **101** |
| | **SP3** | Az. Visconti Massimo | 62 | 125 | **62** |
| | **SP4** | Az. Vini Colombi | 29 | 127 | **127** |
| Parco Val Trebbia | **VT1** | Az. La Pagliara | 1a | 9 | **1a** |
| | **VT2** | Az. Carrà | 12 | - | **12** |
| Parco del Taro | **TBC1** | Az. Monte delle Vigne | 22 | 27 | **22** |
| Parco dei Boschi di Carrega | **TBC2** | Az. Palazzo | 21 | 19 | **21** |
| Azienda dimostrativa HORTA | **RES** | Res Uvae | 116 | 124 | **116 e 124** |

*Table 1: Vineyards chosen for the demonstration activities of Action B.2*

The application of the Alfa-tool, visual assessments performed by HORTA, UCSC together with Demo farmers in the vineyards and specific analysis on soil samples (see deliverable B2.2), enabled the identification of soil threats (Table 2) and the elaboration of mitigation solutions (Table 3) for each Demo Farm.

| | *Erosion* | *Drought* | *Decline in soil organic matter* | *Compaction* | *Water Logging* | *Soil contamination* | *Decline in soil biodiversity* | *Hardpan* |
|---|---|---|---|---|---|---|---|---|
| ***SP1*** | | | | | | | | |
| ***SP2*** | | | | | | | | |
| ***SP3*** | | | | | | | | |
| ***SP4*** | | | | | | | | |
| ***VT1*** | | | | | | | | |
| ***VT2*** | | | | | | | | |
| ***TBC1*** | | | | | | | | |
| ***TBC2*** | | | | | | | | |
| ***RES1*** | | | | | | | | |
| ***RES2*** | | | | | | | | |

*Table 2: Soil threats identified in the different Demo Farms*

| | *Erosion* | *Drought* | *Decline in soil organic matter* | *Compaction* | *Water Logging* | *Soil contamination* | *Decline in soil biodiversity* | *Hardpan* |
|---|---|---|---|---|---|---|---|---|
| ***Temporary grassing / Leguminouse cover crops*** | | | | | | | | |
| ***Temporary grassing /Brassica cover crops*** | | | | | | | | |
| ***Permanent natural grassing*** | | | | | | | | |
| ***Permanent artificial grassing*** | | | | | | | | |
| ***Underground drainage*** | | | | | | | | |
| ***Superficial water control*** | | | | | | | | |

*Table 3: proposed mitigation solutions in relation to soil threats*

In the following pages the action plans (with threats and proposed solutions) are described in detail for each Demo Farm.

# DEMO FARM SP1_Az. Vitivinicola Barbuti Giuseppe

## a. Start point

### *Vineyard characteristics*

| | |
|---|---|
| ***Vineyard identification (name)*** | Torrazzo |
| ***Place*** | Prato Ottesola (PC) |
| ***Park (Project area)*** | Stirone Piacenziano |
| ***Code A1 Database*** | 32 |
| ***Geographical coordinates*** | 44.835081N; 9.796672E |
| ***Elevation (m.s.l.)*** | 262.5 |
| ***Grapevine variety*** | Barbera |
| ***Rootstock*** | SO4 |
| ***Training system*** | Guyot |
| ***Year of planting*** | 2005 |
| ***Distance between vines (m)*** | 1.2 |
| ***Distance between rows (m)*** | 2.5 |
| ***Vines density (vines/ha)*** | 3333 |
| ***Surface (ha)*** | 0.25 |

### *Soil characteristic*

**1. Soil Map Emilia Romagna Region 1:250.000**

The vineyard is located on soils classified as ***"complesso dei suoli GUSANO/SIGNAROLDI"***. These soils are located in low Apennines and are characterized by slopes between 35-60%. Usually they are extremely rocky, shallow, with medium texture and good oxygen availability, calcareous and moderately alkaline.

- **GUSANO Soil (GUS):**
  - *FAO (1990): Calcaric Regosols*
  - *Soil Taxonomy: loamy, mixed (calcareous), mesic Lithic Ustorthents*
- **SIGNAROLDI (SGD)**
  - *FAO: Haplic Lixisols*

- *Soil Taxonomy: loamy-skeletal, mixed, mesic Typic Haplustalf.*

## 2. Soil Map Emilia Romagna Region 1:50.000

The vineyard is located on soils classified as "***complesso dei suoli SAN FAUSTINO franchi/ MONTE MAGGIORE/ GORGOGNANO - SFA1/MOG0/GOR (Delineation: 10893; Cartographic unit: 0788)***"

| | | |
|---|---|---|
| **SAN FAUSTINO franchi SFA1** | 45% | *Soil Taxonomy:*<br>(2010) Udic Haplusteps fine silty, mixed, active, mesic<br>*WRB:*<br>(2007) Haplic Cambisols (Calcaric) |
| **MONTE MAGGIORE franco argillosi limosi MOG1** | 20% | *Soil Taxonomy:*<br>(2010) Udic Haplusteps fine silty, mixed, active, mesic<br>*WRB:*<br>(2007) Haplic Cambisols (Calcaric) |
| **RIO RUMORE 15-40% pendenti RIR2** | 15% | *Soil Taxonomy:*<br>(2010) Typic Ustorthents coarse loamy, mixed, superactive, calcareous, mesic<br>*WRB:*<br>(2007) Haplic Regosols (Calcaric, Arenic) |
| **MONTE MAGGIORE franchi MOG2** | 10% | *Soil Taxonomy:*<br>(2010) Udic Haplusteps fine silty, mixed, active, mesic<br>*WRB:*<br>(2007) Haplic Cambisols (Calcaric) |
| **GORGOGNANO GOR** | 5% | *Soil Taxonomy:*<br>(2010) Typic Ustirthents loamy, mixed, superactive, calcareous, mesic<br>*WRB:*<br>(2007) Endoleptic Regosols (Calcaric) |
| **RIO RUMORE 40-80% pendenti RIR1** | 5% | *Soil Taxonomy:*<br>(2010) Typic Ustorthents coarse loamy, mixed, superactive, calcareous, mesic<br>*WRB:*<br>(2007) Haplic Regosols (Calcaric, Arenic) |

## 3. Soil samples analysis

A complete chemical and physical analysis of soil samples was performed in October 2017.
In the deliverable B2.4 "*Report on initial data on soil and plan data - Part 1*" complete information are reported; hereafter data considered in the design of the action plan are shown.

| | | |
|---|---|---|
| ***Soil Texture*** | | Loamy |
| ***Sand*** | *%* | 44.6 |
| ***Silt*** | *%* | 36.4 |
| ***Clay*** | *%* | 19 |
| ***Soil acidity (pH in water)*** | | 8.43 |
| ***Total $CaCO_3$*** | *%* | 22 |
| ***Active $CaCO_3$*** | *%* | 12.5 |
| ***Electrical conductivity*** | *µS/cm* | 0.13 |
| ***Organic Carbon*** | *g/kg* | 2.4 |
| ***Organic Matter*** | *g/kg* | 4.1 |
| ***Total Nitrogen*** | *g/kg* | 0.48 |
| ***Available Phosphorus*** | *mg/kg* | 1 |

| | | |
|---|---|---|
| ***Exchangeable Calcium*** | *mg/kg* | 2438 |
| ***Exchangeable Magnesium*** | *mg/kg* | 273 |
| ***Exchangeable Potassium*** | *mg/kg* | 77 |
| ***Exchangeable Sodium*** | *mg/kg* | 1 |
| ***Nitrate*** | *mg/kg* | 78 |
| ***Available Iron*** | *mg/kg* | 11 |
| ***Available Boron*** | *mg/kg* | 0.18 |
| ***Available Manganese*** | *mg/kg* | 5 |
| ***Available Copper*** | *mg/kg* | 8 |
| ***Available Zinc*** | *mg/kg* | 6.5 |

### *Climate features*

| | |
|---|---|
| ***Meteorological station*** | **San Michele (Morfasso)** |
| ***Total rainfall (2016) (mm)*** | 1103.8 |
| ***Rainfall (01.04_30.09 2016) (mm)*** | 468.8 |
| ***HUGLIN Index 2016*** | 1903.22 |
| ***WINKLER Index 2016*** | 1409.44 |

### *Topographical and management features*

| | |
|---|---|
| ***Average slope*** | 11-30% |
| ***Average aspect*** | S-SE-SO |
| ***Farming practice of ploughing*** | Ploughing along maximum slope |
| ***Row length*** | <100 m |
| ***Row orientation*** | Intermediate |
| ***Gravel*** | 0-10% |
| ***Organic matter*** | Low |
| ***Soil texture*** | Loamy |
| ***Floor management between rows*** | Permanent natural grassing |
| ***Floor management along the rows*** | Chemical weeding |
| ***Average roots depth*** | 0.6-1 m |
| ***Groundwater depth*** | Absent |
| ***Drainage*** | Absent |
| ***Total rainfall (mm/year)*** | >800 mm |
| ***Rainfall during grapevine growing season*** | > 300 mm |
| ***Planting operation*** | Ploughing |
| ***Planting operation depth*** | > 1 m |
| ***Soil tillage*** | No tillage |
| ***Number of tractor's traffic*** | < 15 |
| ***Organic fertilization*** | 1 |
| ***Mineral fertilization*** | 0 |
| ***Treatments with plant protection products*** | <10 |
| ***Degree days during growing season*** | 1400-1800 °C |


### *Information on the vineyard (VSA, farmer interview)*

The vineyard is characterized by a severe slope, soil compaction and erosion (evident and deep rills >10-15 cm) in the upper part and with gentle slope and no evident erosion rills in the bottom part.
Vine vigor is not uniform: in the upper part, where slope and erosion have a higher impact, it is significantly lower. For the same reason, the soil in this part is non-structured and it is evident that top layer (organic ones) has moved toward the bottom.
The vineyard floor is characterized by a spontaneous grassing, but usually it is ploughed at the beginning of summer. Grass is virtually absent in the top.

### *Identification of potential soil threats*

The information collected was given as input to the Alfa-tool developed in sub-action B1.1 and a potential soil threats ranking was defined (Table SP1.1):

| **Potential threats** | **Rank** |
|---|---|
| *Erosion* | 1 |
| *Drought* | 1 |
| *Decline in soil organic matter* | 3 |
| *Soil compaction* | 4 |
| *Water logging* | 5 |
| *Soil contamination* | 6 |
| *Decline in soil biodiversity* | 6 |
| *Hard pan* | 8 |

*Table SP1.1: potential threats as indicated by Alfa-version Decision tool (Sub-action B1.1); 1 is the most probable threat and 8 the less probable one.*

### *From potential to real threats*

Observation of vineyard and an initial validation of potential soil threats through *visual assessment* approaches led to the definition of the following actual soil threats:

1. **erosion:**
   - strong erosive evidences in the rows and between rows
   - rills depth >10 cm
   - roots system partially exposed, in particular in the upper part with higher slope
   - non-uniform spontaneous grass cover

2. **decline in soil organic matter**
   - during soil sampling no organic residues were found on the soil surface and along soil profile
   - Soil analyses have confirmed a very low content in organic matter, 0.41%

3. **drought**
   - low precipitation during growing season (vintage 2017 characterized by no rainy days)
   - Initial drought symptoms in shoot tips from July especially in the top vineyard mostly affected by erosion process.

## b. End point

The mitigation goals identified are the following:

- reduction of soil erosion in the inter-row especially in the upper part of the vineyard;
- increase of soil organic matter quality and content, in particular in low vigor areas subjected to higher erosion processes;

While the reduction of soil erosion and soil compaction should be achieved relatively quickly (within the time frame of the project), the improvement of soil organic matter could need several years, and when these goals will be reached the vineyard will be easier to manage and the vines production will increase and be more uniform.

## c. How to go there

For each real threat identified, the Alfa-tool developed in sub-action B1.1 provides possible solutions (Table SP1.2): in the following table, solutions for “erosion”, "drought" and “decline in soil organic matter” are represented.

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| | *Erosion* | *Drought* | *Decline in soil organic matter* | *Compaction* | *Water Logging* | *Soil contamination* | *Decline in soil biodiversity* | *Hardpan* |
|---|---|---|---|---|---|---|---|---|
| *Alternate row grassing* | | | | | | | | |
| *Temporary grassing / Leguminouse cover crops* | | | | | | | | |
| *Temporary grassing /Brassica cover crops* | | | | | | | | |
| *Temporary natural grassing* | | | | | | | | |
| *Permanent natural grassing* | | | | | | | | |
| *Permanent artificial grassing* | | | | | | | | |
| *Soil conditioner* | | | | | | | | |
| *Plant protection products applications optimization* | | | | | | | | |
| *Change in soil management actions (depth)* | | | | | | | | |
| *Change of soil management equipment* | | | | | | | | |
| *Underground drainage* | | | | | | | | |
| *Superficial water control* | | | | | | | | |
| *Permanent mulching in the row (organic/mineral)* | | | | | | | | |

*Table SP1.2: possible solution as indicated by Alfa-version Decision tool (Sub-action B1.1)*

After an evaluation of the needed resources, the solution "**permanent artificial grassing**" was selected to be applied. The seed mixture was carefully chosen and is composed by species (*Poaceae)* with low water and nutritional needs to avoid competition with vines as one of the main threats assesses is drought.
Composition is reported in Annex A at the **Grass B** sowing mixture description.

Grass will cover soil surface, decrease erosion, and reduce compaction and load on soil. Enhancement of organic matter quality and content and reduction of erosion can also preserve soil structure and increase soil water holding capacity, this will minimizing drought effects on vines. Vine vigor problems should be solved and soil organic matter should be preserved and enhanced (in the long term).

## d. What to do

Sowing will be performed in early spring of the second project year and, once established, the grass will be managed by farmers using farm equipments. During the first year (season 2018), cuts should be more frequent, to permit a better stem elongation, but should start not before summer to enable flowering and seed dispersion to enhance grass covering. Fertilization with mineral fertilizer (NPK) is advised to help grass setting-up; row management should be performed as usual.
During the following years the grass should reach equilibrium and should be managed easily with few cuts during the grape-growing seasons depending on the weather conditions.

| | **2017** | **2018** | **2019** |
|---|---|---|---|
| **Jan** | | | |
| **Feb** | | | |
| **Mar** | | Sowing | |
| **Apr** | | | Cut |
| **May** | | Fertilization | |
| **Jun** | | Cut (after flowering and seed dispersion) | Cut |
| **Jul** | | Cut | Cut |
| **Aug** | | Cut | Cut |
| **Sept** | | | |
| **Oct** | | | |
| **Nov** | | | |
| **Dec** | | | |

*Table SP1.3: Operative timetable*

Grassing will be sowed in 7 inter-rows (F1-F8) (Figure SP1.1)

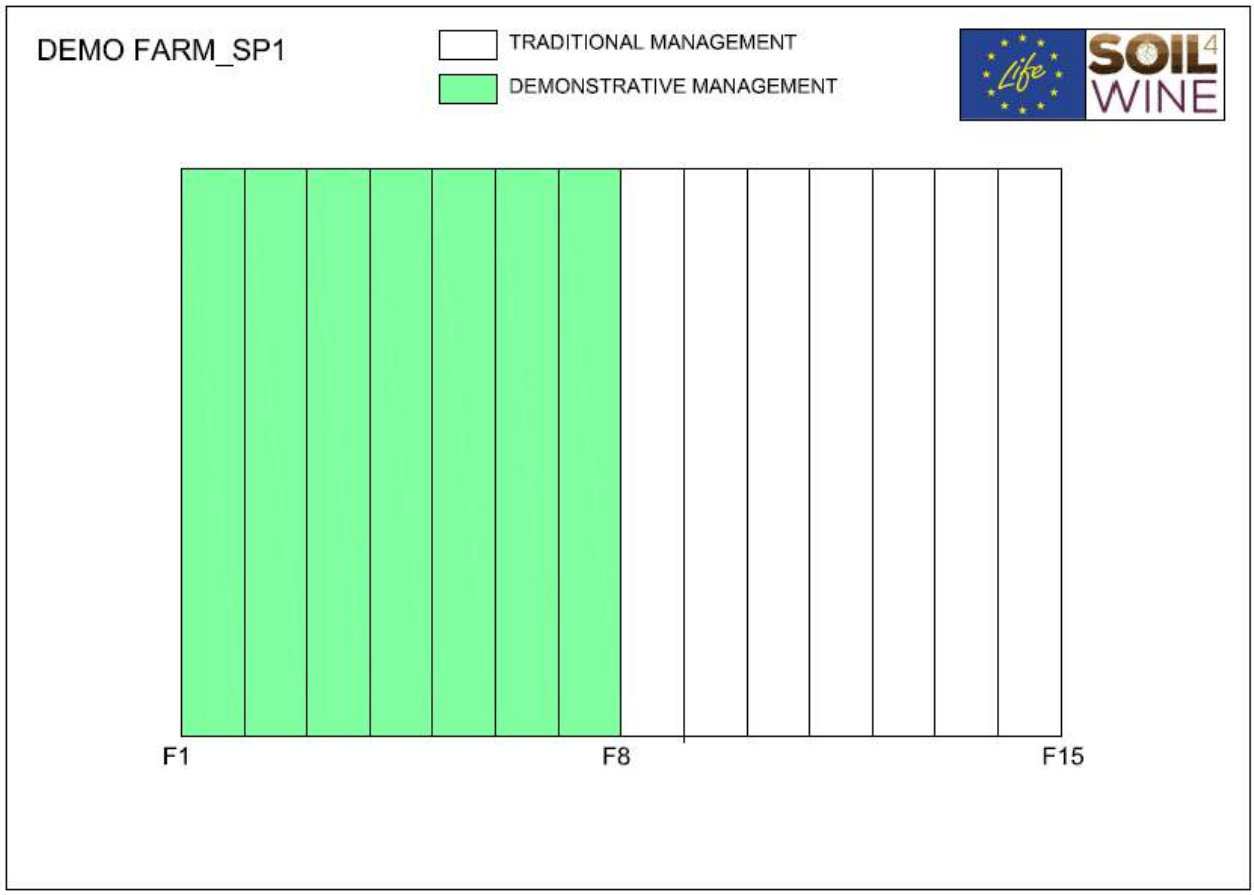



*Figure SP1.1: demonstrative action scheme*

## e. What to check

Project partners will regularly visit the vineyard in order to monitor the grass growing. Grass cover will be evaluated through visual assessment in three representative areas of at least 0.5 $m^2$. A complete floristic survey will be performed in spring to evaluate the colonization of sowed seeds and weeds.
Visual assessment will be used to evaluate the reduction of soil erosion and to verify the absence/reduction of erosion rills.

## f. How to remain there

Evaluate every year in late spring the grass coverage, estimating the percentage of soil covered by grass of a defined surface (0.5 $m^2$). If lower than 70%, it is recommended to spread some more seeds in the following autumn.
It is also possible to evaluate the good status of the grass by quantifying the biomass produced. With standard seasonal weather conditions about one trimming per month (March to June) is usually needed to keep the grass shorter than 10 cm.
To check whether the grass is able to reduce erosion processes, erosion rills should be observed: the depth and number of rills should decrease year by year (in standard seasonal weather conditions).
Five years after the main sowing is the time window envisaged to sample some soil (60cm depth) and quantify (through chemical analysis) the organic matter quantity and quality. If this will not have increased compared to the baseline before sowing it could be considered that the applied solution is not able to mitigate this specific threat.

# DEMO FARM SP2_Az. Podere Le Lame

## a. Start point

### *Vineyard characteristics*

| | |
|---|---|
| ***Vineyard identification (name)*** | Bacedasco |
| ***Place*** | Bacedasco Basso |
| ***Park (Project area)*** | Stirone Piacenziano |
| ***Code A1 Database*** | 101 |
| ***Geographical coordinates*** | 44.833487N; 9.9323742E |
| ***Elevation (m.s.l.)*** | 321.5 |
| ***Grapevine variety*** | Barbera |
| ***Rootstock*** | ? |
| ***Training system*** | Guyot |
| ***Year of planting*** | 2006 |
| ***Distance between vines (m)*** | 1.2 |
| ***Distance between rows (m)*** | 2.5 |
| ***Vines density (vines/ha)*** | 3333 |
| ***Surface (ha)*** | 0.6 |


### *Soil characteristic*

**1. Soil Map Emilia Romagna Region 1:250.000**

The vineyard is located on soils classified as "complesso dei suoli ***"complesso dei suoli TERRA DEL SOLE/DOGHERIA/SANT'ANTONIO (Delineation 0664; Cartographic Unit 5Ab)***".

- **TERRA DEL SOLE franco argilloso limosi (TRS1)**
  - *FAO (1990): Calcaric Regosols*
  - *Soil Taxonomy: (1990) fine, mixed (calcareous), mesic, shallow Vertic Ustorthents*

- **SANT'ANTONIO (SAN)**
  - *FAO (1990): Vertic Cambisols*
  - *Soil Taxonomy: (1990) fine, mixed, mesic Vertic Ustochrepst.*

- **DOGHERIA (DOG2)**
  - *FAO (1990): Haplic Calcisols*

- *Soil Taxonomy: (1990) fine, mixed, mesic Fluventic Ustochrepts.*

## 2. Soil Map Emilia Romagna Region 1:50.000

The vineyard is located on soils classified as ***"complesso dei suoli AGELLO franco argillosi limosi/ DOGHERIA, 15-25% pendenti /GRIFONE franco argillosi limosi, Delineation 9448, Cartographic Unit 0664)***

| | | |
|---|---|---|
| **AGELLO franco argilloso limosi AGE1** | 30% | *Soil Taxonomy:*<br>(2010) Typic Haplustepts fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Haplic Cambisols (Calcaric) |
| **GRIFONE franco argilloso limosi GRI3** | 30% | *Soil Taxonomy:*<br>(2010) Typic Haplustepts fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Haplic Cambisols (Calcaric) |
| **DOGHERIA 15-25% pendenti DOG2** | 20% | *Soil Taxonomy:*<br>(2010) Typic Calciustepts fine, mixed, active, mesic<br>*WRB:*<br>(2007) Hypocalcic Haplic Calcisols |
| **BANZOLA franco argilloso limosi, 5-35% pendenti BAN3** | 15% | *Soil Taxonomy:*<br>(2010) Oxyacquic Ustorthents fine, mixed, active, calcareous, mesic<br>*WRB:*<br>(2007) Haplic Regosols (Calcaric, Oxyaquic) |
| **ARCELLI 8-15% pendenti ARC2** | 5% | *Soil Taxonomy:*<br>(2010) Vertic Haplustepts fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Vertic Cambisols (Eutric) |

## 3. Soil samples analysis

A complete chemical and physical analysis of soil samples was performed in October 2017.
In the deliverable B2.4 "*Report on initial data on soil and plan data - Part 1*" complete information is reported; hereafter data considered in the design of the action plan are shown.

| | | |
|---|---|---|
| ***Soil Texture*** | | Clay-Loam |
| ***Sand*** | *%* | 44.6 |
| ***Silt*** | *%* | 36.4 |
| ***Clay*** | *%* | 19 |
| ***Soil acidity (pH in water)*** | | 8.34 |
| ***Total $CaCO_3$*** | *%* | 24.3 |
| ***Active $CaCO_3$*** | *%* | 18.3 |
| ***Electrical conductivity*** | *µS/cm* | 0.15 |
| ***Organic Carbon*** | *g/kg* | 6 |
| ***Organic Matter*** | *g/kg* | 10.4 |
| ***Total Nitrogen*** | *g/kg* | 0.97 |
| ***Available Phosphorus*** | *mg/kg* | 1 |
| ***Exchangeable Calcium*** | *mg/kg* | 4174 |
| ***Exchangeable Magnesium*** | *mg/kg* | 476 |
| ***Exchangeable Potassium*** | *mg/kg* | 138 |
| ***Exchangeable Sodium*** | *mg/kg* | 3 |
| ***Nitrate*** | *mg/kg* | 74 |
| ***Available Iron*** | *mg/kg* | 15 |

| | | |
|---|---|---|
| ***Available Boron*** | *mg/kg* | 1.32 |
| ***Available Manganese*** | *mg/kg* | 7 |
| ***Available Copper*** | *mg/kg* | 3 |
| ***Available Zinc*** | *mg/kg* | 7.6 |

### *Climate features*

| | |
|---|---|
| ***Meteorological station*** | **San Michele (Morfasso)** |
| ***Total rainfall (2016) (mm)*** | 1103.8 |
| ***Rainfall (01.04_30.09 2016) (mm)*** | 468.8 |
| ***HUGLIN Index 2016*** | 1903.22 |
| ***WINKLER Index 2016*** | 1409.44 |

### *Topographical and management features*

| | |
|---|---|
| ***Average slope*** | 11-30% |
| ***Average aspect*** | S-SE-SO |
| ***Farming practice of ploughing*** | Along main slope direction |
| ***Row length*** | 100-200 m |
| ***Row orientation*** | Intermediate |
| ***Gravel*** | 10-40% |
| ***Organic matter*** | Low |
| ***Soil texture*** | Silty |
| ***Floor management between rows*** | Ploughing |
| ***Floor management along the rows*** | Ploughing |
| ***Average roots depth*** | 0.6-1 m |
| ***Groundwater depth*** | Absent |
| ***Drainage*** | Absent |
| ***Total rainfall (mm/year)*** | >800 |
| ***Rainfall during grapevine growing season*** | >300 |
| ***Planting operation*** | Ploughing |
| ***Planting operation depth*** | < 1 m |
| ***Soil tillage*** | Chisel/spade |
| ***Number of tractor's traffic*** | 15-25 |
| ***Organic fertilization*** | 0 |
| ***Mineral fertilization*** | 1 |
| ***Treatments with plant protection products*** | <10 |
| ***Degree days during growing season*** | > 1800 °C |


### *Information on vineyard (VSA, farmer interview)*

Visits in the vineyard during growing season have shown that vines at the bottom have low vigor and that in this vineyard part many plants have been recently replaced.

### *Identification of potential soil threats*

The information collected was given as input to the Alfa-tool developed in sub-action B1.1 and a potential soil threats ranking was defined (Table SP2.1):

| **Potential threats** | **Rank** |
|---|---|
| *Erosion* | 1 |
| *Drought* | 2 |
| *Decline in soil organic matter* | 3 |
| *Soil compaction* | 4 |
| *Water logging* | 7 |
| *Soil contamination* | 8 |
| *Decline in soil biodiversity* | 5 |
| *Hard plan* | 5 |

*Table SP2.1: potential threats as indicated by Alfa-version Decision tool (Sub-action B1.1); 1 is the most probable threat and 8 the less probable one.*

### *From potential to real threats*

Observation of the vineyard and an initial validation of potential soil threats through *visual assessment* approach led to a definition of the following soil threats:

1. **decline in soil organic matter**
   - during soil sampling no organic residues were found on the soil surface and along soil profile
   - non-uniform spontaneous grass growth
   - repeated ploughing
   - during soil sampling poor soil structure was noted
   - Soil analysis have confirmed a low content of organic matter, 1.04%

2. **erosion:**
   - erosive evidences between rows on the top vineyard
   - non-uniform spontaneous grass growth

3. **drought**
   - low precipitation during growing season (vintage 2017 characterized by no rainy days)
   - initial drought symptoms in shoot tips from July

4. **compaction and hard pan.**
   - repeated ploughing
   - during soil sampling hard pan was found at 30-35 cm depth

## b. End point

The mitigation goals identified are the following:

- increase of vine vigor in the bottom part of vineyard;
- increase of soil organic matter quality and content in whole vineyard;
- reduction of soil compaction and hard pan due to repeated ploughing
- reduction of erosion processes
- increase soil water holding capacity to reduce drought effects

While the reduction of soil compaction should be achieved relatively quickly (within the time frame of the project), the improvement of soil organic matter could need several years. First evidence of a recovery in vine vigor should also be recorded during the project time.

## c. How to go there

For each real threat identified, the Alfa-tool developed in sub-action B1.1 provides possible solutions (Table SP2.2): in the following table, solutions for “erosion”, “drought”, “decline in soil organic matter”, “compaction” and “hard pan” are represented.

| | *Erosion* | *Drought* | *Decline in soil organic matter* | *Compaction* | *Water Logging* | *Soil contamination* | *Decline in soil biodiversity* | *Hardpan* |
|---|---|---|---|---|---|---|---|---|
| *Alternate row grassing* | | | | | | | | |
| *Temporary grassing / Leguminouse cover crops* | | | | | | | | |
| *Temporary grassing /Brassica cover crops* | | | | | | | | |
| *Temporary natural grassing* | | | | | | | | |
| *Permanent natural grassing* | | | | | | | | |
| *Permanent artificial grassing* | | | | | | | | |
| *Soil conditioner* | | | | | | | | |
| *Plant protection products applications optimization* | | | | | | | | |
| *Change in soil management actions (depth)* | | | | | | | | |
| *Change of soil management equipment* | | | | | | | | |
| *Underground drainage* | | | | | | | | |
| *Superficial water control* | | | | | | | | |
| *Permanent mulching in the row (organic/mineral)* | | | | | | | | |

*Table SP2.2: possible solution as indicated by Alfa-version Decision tool (Sub-action B1.1)*

After an evaluation of the needed resources, the solution "green manure" was selected to be applied. The seed mixture was carefully chosen and is composed by species of *Brassiceae, Fabaceae* and *Poacea* families.
*Grasses (Poacea*) can enhance soil texture, due to their dense bunched roots that break down aggregates promoting a crumbly soil structure, prevent surface crust and protect soil from erosion; furthermore grasses roots exudates can attract soil organisms improving soil biodiversity.
*Brassicas* are characterized by taproots that can break down soil and enhance water movement, consequently reducing compaction.
*Legumes (Fabaceae*) are characterized by nitrogen fixation capabilities that can enhance vine nutrition and vigor; moreover their deep roots can break down soil aggregates and improve water movements.
Chosen sowing mixture composition is reported in Annex A in **Green Manure B** description.

Having a grassed interrow, tillage operations will be limited and consequently compaction and hard pan reduced, as well as soil organic matter should be preserved and enhanced. Moreover, grass covering during winter should reduce erosion in higher slope side and reduce/avoid water logging at the base. Enhancement of organic matter quality and content and reduction of erosion can also preserve soil structure and increase soil water holding capacity, this will minimizing drought effects on vines.

## d. What to do

Sowing will be performed in Autumn of the first and second project year, while cutting and ploughing in the following Spring just before the beginning of grapevine flowering (when closed flowers are visible), in order to avoid that accumulated nitrogen can be traslocated by the plant and used for the maturation of seeds.
Between cutting and ploughing the sliced grass should be left drying for few days to avoid fermentation processes. Ploughing should not exceed 10-15 cm. Under the row management can be carried out as usual (i.e., applying herbicides). Traditional management is complete ploughing.

Sowing will be made in 7 inter-rows (F1-F10) (Figure SP2.1)

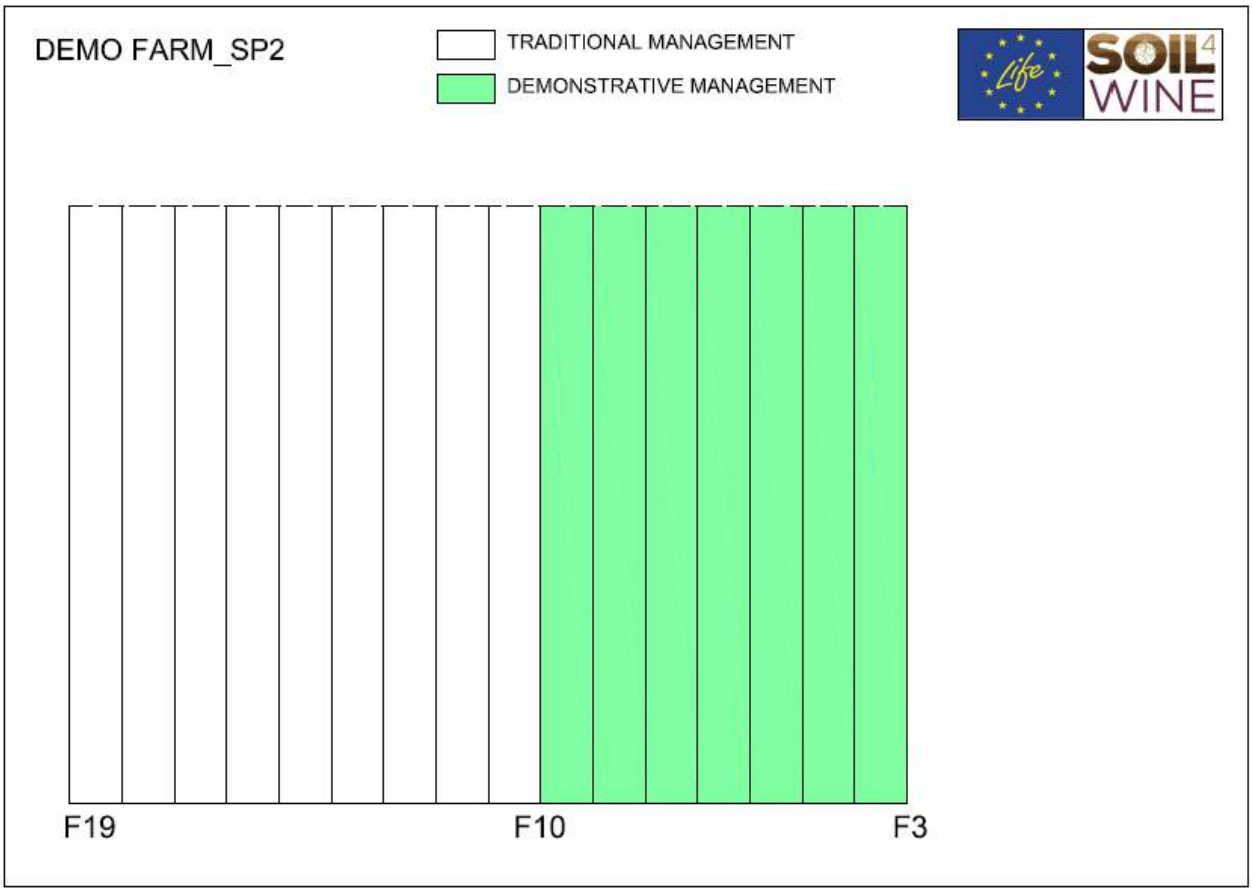



*Figure SP2.1: demonstrative action scheme*

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Jan** | | | |
| **Feb** | | | |
| **Mar** | | | |
| **Apr** | | Cutting and ploughing | Cutting and ploughing |
| **May** | | | |
| **Jun** | | | |
| **Jul** | | | |
| **Aug** | | | |
| **Sept** | | | |
| **Oct** | | Sowing | |
| **Nov** | Sowing | | |
| **Dec** | | | |

*Table SP2.3: Operative timetable*

## e. What to check

Project partners will regularly visit the vineyard in order to monitor the grass growing. Grass cover will be evaluated through visual assessment in three representative areas of at least 0.5 $m^2$.
Before cutting biomass in the test areas will be weighted in order to evaluate the total biomass produced before trimming and soil incorporation. A complete floristic survey will be performed in spring to evaluate the colonization of sowed seeds and weeds. Visual assessment will be used to evaluate the reduction of soil erosion and to verify the absence/reduction of erosion rills.

## f. How to remain there

Green manure has to be sowed, trimmed and ploughed for at least three consecutive years. After this period new soil chemical analysis should be performed to determine amount and quality of organic matter. If this is increased compared to the baseline before the first sowing, green manure can be sowed in the following years on alternate rows, in order to facilitate other vineyard management activities.

# DEMO FARM SP3_Az. Vitivinicola Visconti Massimo

## a. Start point

### *Vineyard characteristics*

| | |
|---|---|
| ***Vineyard identification (name)*** | Pona |
| ***Place*** | Vigoleno |
| ***Park (Project area)*** | Stirone Piacenziano |
| ***Code A1 Database*** | 62 |
| ***Geographical coordinates*** | 44.8299; 9.9083 |
| ***Elevation (m.s.l.)*** | 232 |
| ***Grapevine variety*** | Croatina |
| ***Rootstock*** | 420A |
| ***Training system*** | Guyot |
| ***Year of planting*** | 2002 |
| ***Distance between vines (m)*** | 1.3 |
| ***Distance between rows (m)*** | 2.5 |
| ***Vines density (vines/ha)*** | 3077 |
| ***Surface (ha)*** | 0.2 |


### *Soil characteristic*

**1. Soil Map Emilia Romagna Region 1:250.000**

The vineyard is located on soils classified as ***"complesso dei suoli TERRA DEL SOLE/DOGHERIA/SANT'ANTONIO (Delineation 0664; Cartographic Unit 5Ab)"***.

- **TERRA DEL SOLE franco argilloso limosi (TRS1)**
  - *FAO (1990): Calcaric Regosols*
  - *Soil Taxonomy: (1990) fine, mixed (calcareous), mesic, shallow Vertic Ustorthents*

- **SANT'ANTONIO (SAN)**
  - *FAO (1990): Vertic Cambisols*
  - *Soil Taxonomy: (1990) fine, mixed, mesic Vertic Ustochrepst.*

- **DOGHERIA (DOG2)**

- *FAO (1990): Haplic Calcisols*
- *Soil Taxonomy: (1990) fine, mixed, mesic Fluventic Ustochrepts.*

**2. Soil Map Emilia Romagna Region 1:50.000:**

The vineyard is located on soils classified as ***"complesso dei suoli AGELLO franco argillosi limosi/ DOGHERIA, 15-25% pendenti /GRIFONE franco argillosi limosi, Delineation 9448, Cartographic Unit 0664)"***

| | | |
|---|---|---|
| **AGELLO franco argilloso limosi AGE1** | 30% | *Soil Taxonomy:*<br>(2010) Typic Haplustepts fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Haplic Cambisols (Calcaric) |
| **GRIFONE franco argilloso limosi GRI3** | 30% | *Soil Taxonomy:*<br>(2010) Typic Haplustepts fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Haplic Cambisols (Calcaric) |
| **DOGHERIA 15-25% pendenti DOG2** | 20% | *Soil Taxonomy:*<br>(2010) Typic Calciustepts fine, mixed, active, mesic<br>*WRB:*<br>(2007) Hypocalcic Haplic Calcisols |
| **BANZOLA franco argilloso limosi, 5-35% pendenti BAN3** | 15% | *Soil Taxonomy:*<br>(2010) Oxyacquic Ustorthents fine, mixed, active, calcareous, mesic<br>*WRB:*<br>(2007) Haplic Regosols (Calcaric, Oxyaquic) |
| **ARCELLI 8-15% pendenti ARC2** | 5% | *Soil Taxonomy:*<br>(2010) Vertic Haplustepts fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Vertic Cambisols (Eutric) |

**3. Soil samples analysis**

A complete chemical and physical analysis of soil samples was performed in October 2017.
In the deliverable B2.4 "*Report on initial data on soil and plan data - Part 1*" complete information are reported; hereafter data considered in the design of the action plan are shown.

| | | |
|---|---|---|
| ***Soil Texture*** | | Clay Loam |
| ***Sand*** | *%* | 34.8 |
| ***Silt*** | *%* | 36.2 |
| ***Clay*** | *%* | 29 |
| ***Soil acidity (pH in water)*** | | 8.4 |
| ***Total $CaCO_3$*** | *%* | 35.6 |
| ***Active $CaCO_3$*** | *%* | 20.2 |
| ***Electrical conductivity*** | *µS/cm* | 0.15 |
| ***Organic Carbon*** | *g/kg* | 4.8 |
| ***Organic Matter*** | *g/kg* | 8.3 |
| ***Total Nitrogen*** | *g/kg* | 0.78 |
| ***Available Phosphorus*** | *mg/kg* | 1 |
| ***Exchangeable Calcium*** | *mg/kg* | 3521 |
| ***Exchangeable Magnesium*** | *mg/kg* | 476 |
| ***Exchangeable Potassium*** | *mg/kg* | 181 |
| ***Exchangeable Sodium*** | *mg/kg* | 2 |
| ***Nitrate*** | *mg/kg* | 164 |

| | | |
|---|---|---|
| ***Available Iron*** | *mg/kg* | 16 |
| ***Available Boron*** | *mg/kg* | 0.62 |
| ***Available Manganese*** | *mg/kg* | 12 |
| ***Available Copper*** | *mg/kg* | 3 |
| ***Available Zinc*** | *mg/kg* | 6.5 |

### *Climate features*

| | |
|---|---|
| ***Meteorological station*** | **San Michele (Morfasso)** |
| ***Total rainfall (2016) (mm)*** | 1103.8 |
| ***Rainfall (01.04_30.09 2016) (mm)*** | 468.8 |
| ***HUGLIN Index 2016*** | 1903.22 |
| ***WINKLER Index 2016*** | 1409.44 |

### *Topographical and management features*

| | |
|---|---|
| ***Average slope*** | 0-10% |
| ***Average aspect*** | N-NE-NO |
| ***Farming practice of ploughing*** | Along main slope direction |
| ***Row length*** | < 100 m |
| ***Row orientation*** | Intermediate |
| ***Gravel*** | 10-40% |
| ***Organic matter*** | Low |
| ***Soil texture*** | Clay |
| ***Floor management between rows*** | Ploughing |
| ***Floor management on the rows*** | Ploughing |
| ***Average roots depth*** | > 1 m |
| ***Groundwater depth*** | < 2 m |
| ***Drainage*** | Trenches |
| ***Total rainfall (mm/year)*** | >800 |
| ***Rainfall during grapevine growing season*** | >300 |
| ***Planting operation*** | Ploughing |
| ***Planting operation depth*** | > 1 m |
| ***Soil tillage*** | Tillage |
| ***Number of tractor's traffic*** | < 15 |
| ***Organic fertilization*** | 0 |
| ***Mineral fertilization*** | 0 |
| ***Treatments with plant protection products*** | <10 |
| ***Degree days during growing season*** | > 1800°C |


### *Information on vineyard (VSA, farmer interview)*

The vineyard is located on an old artificial lake used for irrigation: after rain the soil is usually flooded and water remains on soil surface for several days. Vines present phytosanitary problems (flavescence dorée and Esca desease) and stresses due to water excess.

### *Identification of potential soil threats*

The information collected was given as input to the Alfa-tool developed in sub-action B1.1 and a potential soil threats ranking was defined (Table SP3.1):

| **Potential threats** | **Rank** |
|---|---|
| *Erosion* | 1 |
| *Drought* | 3 |
| *Decline in soil organic matter* | 2 |
| *Soil compaction* | 4 |
| *Water logging* | 5 |
| *Soil contamination* | 8 |
| *Decline in soil biodiversity* | 6 |
| *Hard plan* | 6 |

*Table SP3.1: potential threats as indicated by Alfa-version Decision tool (Sub-action B1.1); 1 is the most probable threat and 8 the less probable one.*

### *From potential to real threats*

Observation of the vineyard and an initial validation of potential soil threats through *visual assessment* approach led to a definition of real soil threats:

1. **water logging:**
   - water permanence after rain in the bottom part
   - differences in yield between dry and humid areas of vineyard

2. **decline in soil organic matter**
   - during soil sampling no organic residues have been found on the soil surface and along soil profile.
   - non-uniform spontaneous grass growth
   - repeated ploughing
   - Soil analysis have confirmed a low content of organic matter, 0.83%

3. **compaction and hard pan**
   - repeated ploughing
   - during soil sampling hard pan was found at 30-35 cm of depth

## b. End point

The mitigation goals identified are the following:

- reduction of water logging and related vines problems;
- increase of soil organic matter quality and content in whole vineyard;
- reduction of soil compaction due to repeated ploughing

While the reduction of soil compaction should be achieved relatively quickly (within the time frame of the project), the improvement of soil organic matter could need several years. First evidence of the reduction of water logging and recovery of vines should also be recorded during the project time.

## c. How to go there

For each real threat identified, the Alfa-tool developed in sub-action B1.1 provides possible solutions: in the following table, solutions for “decline in soil organic matter”, “compaction”, “water logging” and “hardpan” are represented.

| | *Erosion* | *Drought* | *Decline in soil organic matter* | *Compaction* | *Water Logging* | *Soil contamination* | *Decline in soil biodiversity* | *Hardpan* |
|---|---|---|---|---|---|---|---|---|
| *Alternate row grassing* | | | | | | | | |
| *Temporary grassing / Leguminouse cover crops* | | | | | | | | |
| *Temporary grassing /Brassica cover crops* | | | | | | | | |
| *Temporary natural grassing* | | | | | | | | |
| *Permanent natural grassing* | | | | | | | | |
| *Permanent artificial grassing* | | | | | | | | |
| *Soil conditioner* | | | | | | | | |
| *Plant protection products applications optimization* | | | | | | | | |
| *Change in soil management actions (depth)* | | | | | | | | |
| *Change of soil management equipment* | | | | | | | | |
| *Underground drainage* | | | | | | | | |
| *Superficial water control* | | | | | | | | |
| *Permanent mulching in the row (organic/mineral)* | | | | | | | | |

*Table SP3.2: possible solution as indicated by Alfa-version Decision tool (Sub-action B1.1)*

After an evaluation of the needed resources, the solution "green manure" was selected to be applied. The seed mixture was carefully chosen and is composed by species of *Brassiceae, Fabaceae* and *Poacea* families.
*Grasses (Poacea*) can enhance soil texture, due to their dense bunched roots that break down aggregates promoting a crumbly soil structure, prevent surface crust and protect soil from erosion, furthermore grasses roots exudates can attract soil organisms improving soil biodiversity.
*Brassicas* are characterized by taproots that can break down soil and enhance water movement, consequently reducing compaction.
*Legumes (Fabaceae*) are characterized by nitrogen fixation capabilities that can enhance vine nutrition and vigor, moreover their deep roots can break down soil aggregates and improve water movements.
The presence of *Phacelia tanacetifolia* can attract bees and other pollinating insects, promoting ecosystem biodiversity.
Sowing will be performed using 50% of **Green Manure A** and 50% of **Green Manure B** mixture. Compositions are indicated in Annex A **in Green Manure A and B** description.

With a grassed interrow, tillage operations will be limited and consequently compaction and hard pan reduced, as well as soil organic matter should be preserved and enhanced. Moreover grass covering during winter should reduce erosion in higher slope side and reduce/avoid water logging at the base.

## d. What to do

Sowing will be performed in autumn of the first and second project year, while cutting and ploughing in the following spring just before the beginning of grapevine flowering (when closed flowers are visible), in order to avoid that accumulated nitrogen can be traslocated by the plant and used for the maturation of seeds.
Between cutting and ploughing the cut grass should be left drying for few days to avoid fermentation processes. Ploughing should not exceed 10-15 cm. Under the row management can be carried out as usual (i.e., applying herbicides). Traditional management is complete ploughing.

Sowing will be made in 7 inter-rows (F1-F10) (Figure SP3.1)

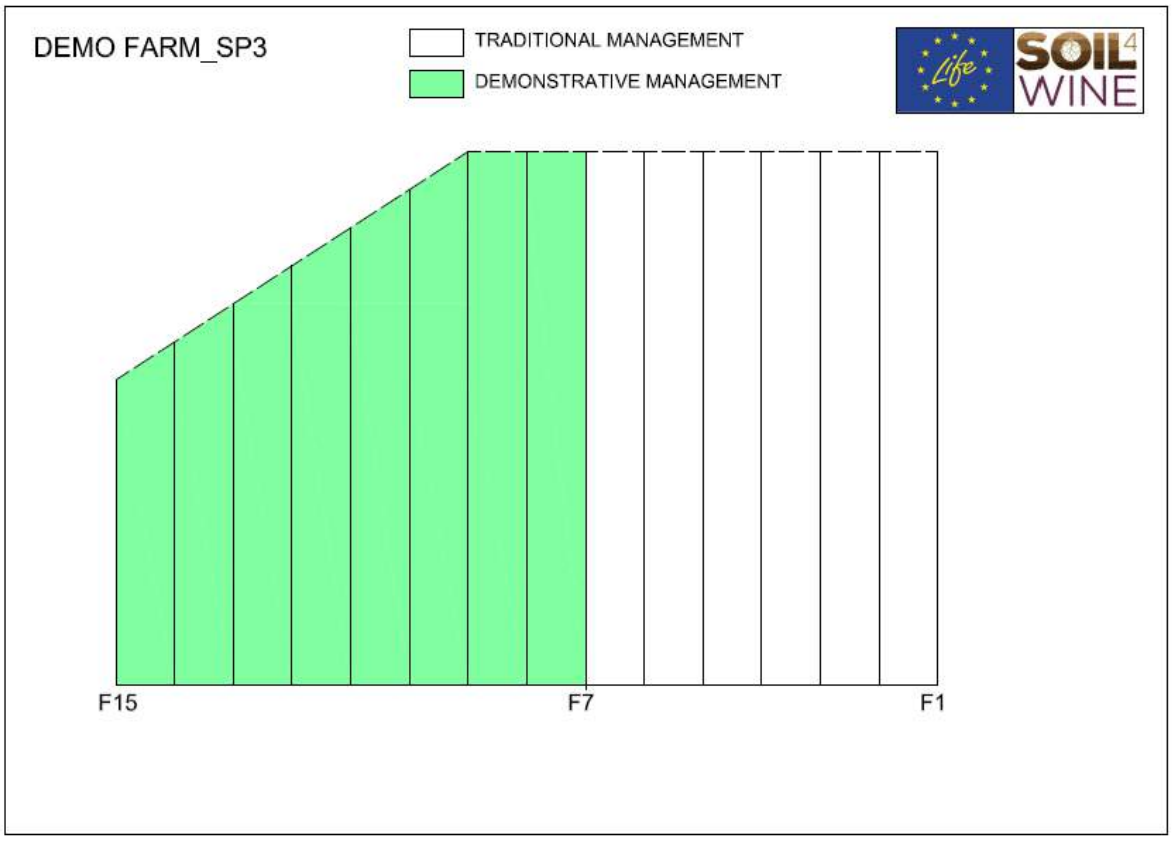


*Figure SP3.1: demonstrative action scheme*

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Jan** | | | |
| **Feb** | | | |
| **Mar** | | | |
| **Apr** | | Cutting and ploughing | Cutting and ploughing |
| **May** | | | |
| **Jun** | | | |
| **Jul** | | | |
| **Aug** | | | |
| **Sept** | | | |
| **Oct** | | Sowing | |
| **Nov** | Sowing | | |
| **Dec** | | | |

*Table SP3.3: Operative timetable*

## e. What to check

Project partners will visit regularly the vineyard to monitor the grass growing. Grass cover will be evaluated through visual assessment in three representative areas of at least 0.5 $m^2$. Before cutting biomass in the test areas will be weighted in order to evaluate the total biomass produced before trimming and soil incorporation. A complete floristic survey will be performed in spring to assess the colonization of sowed seeds and weeds.

## f. How to remain there

Green manure has to be sowed, trimmed and phloughed for at least three consecutive years. After this period new soil chemical analysis should be performed to determine amount and quality of organic matter. If this is increased compared to the baseline before the first sowing, green manure can be sowed in the following years on alternate rows, in order to facilitate other vineyard management activities.

# DEMO FARM SP4_Az. Vini Colombi

## a. Start point

### *Vineyard characteristics*

| | |
|---|---|
| ***Vineyard identification (name)*** | Campo del Lupo |
| ***Place*** | Diolo |
| ***Park (Project area)*** | Stirone Piacenziano |
| ***Code A1 Database*** | 127 |
| ***Geographical coordinates*** | 44.8633; 9.6687 |
| ***Elevation (m.s.l.)*** | 232 |
| ***Grapevine variety*** | Barbera |
| ***Rootstock*** | ? |
| ***Training system*** | Double Guyot |
| ***Year of planting*** | ? |
| ***Distance between vines (m)*** | 1.80 |
| ***Distance between rows (m)*** | 2.20 |
| ***Vines density (vines/ha)*** | 2525 |
| ***Surface (ha)*** | 0.1 ha |


### *Soil characteristic*

**1. Soil Map Emilia Romagna Region 1:250.000**

The vineyard is located on soils classified as ***"complesso dei suoli "CITTADELLA/TAVASCA"***.
In this cartographic unit soils are moderately steep (12-30%), stony, very deep on shingle alluvium. Soils have good oxygen availability, they are not calcareous, and pH is neutral or weak alkaline. Texture is highly variable.

- **CITTADELLA franco limosi, 5-10% pendenti (CTD2)**
  - *FAO (1990): Haplic Luvisols*
  - *Soil Taxonomy: (1994) fine silty, mixed, mesic Aquic Paleustalf*

- **TAVASCA (TAV3)**
  - *FAO (1990): Haplic Lixisols*
  - *Soil Taxonomy: (1990) loamy-skeletal, mixed, mesic Typic Haplustalf*

**2. Soil Map Emilia Romagna Region 1:50.000**

The vineyard is located on soils classified as ***"complesso dei suoli CITTADELLA franco limosi/ RIVERGARO franco argilloso limosi / ARCELLI (Delineation 8543, Cartographic Unit 0507)***"

| | | |
|---|---|---|
| **RIVERGARO franco limosi RIV1** | 25% | *Soil Taxonomy:*<br>(2010) Aquertic Haplustalf fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Cutanic Stagnic Luvisols (Ferric, Clayic) |
| **ARCELLI 15-40% pendenti ARC1** | 20% | *Soil Taxonomy:*<br>(2010) Vertic Haplustepts fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Vertic Cambisols (Eutric) |
| **CITTADELLA franco limosi 1-5% pendenti CTD1** | 20% | *Soil Taxonomy:*<br>(2010) Aquic Paleustalf fine silty, mixed, superactive, mesic<br>*WRB:*<br>(2007) Cutanic Stagnic Luvisols |
| **ARCELLI 8-15% pendenti ARC2** | 15% | *Soil Taxonomy:*<br>(2010) Vertic Haplustepts fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Vertic Cambisols (Eutric) |
| **CANTALUPO 8-15% pendenti CAT2** | 10% | *Soil Taxonomy:*<br>(2010) Vertic Calciustepst fine, mixed, active, mesic.<br>*WRB:*<br>(2007) Hypocalcic Vertic Calcisols |
| **TAVASCA TAV** | 10% | *Soil Taxonomy:*<br>(2010) Typic Haplustepts clayey skeletal, mixed, superactive, mesic<br>*WRB:*<br>(2007) Haplic Cambisols (Eutric, Endoskeletric) |

## 3. Soil samples analysis

A complete chemical and physical analysis of soil samples was performed in October 2017.
In the deliverable B2.4 "*Report on initial data on soil and plan data - Part 1*" complete information are reported; hereafter data considered in the design of the action plan are shown.

| | | |
|---|---|---|
| ***Soil Texture*** | | Clay Loam |
| ***Sand*** | *%* | 32.7 |
| ***Silt*** | *%* | 38.1 |
| ***Clay*** | *%* | 29.2 |
| ***Soil acidity (pH in water)*** | | 6.73 |
| ***Total $CaCO_3$*** | *%* | 1.8 |
| ***Active $CaCO_3$*** | *%* | 1 |
| ***Electrical conductivity*** | *µS/cm* | 0.1 |
| ***Organic Carbon*** | *g/kg* | 7.5 |
| ***Organic Matter*** | *g/kg* | 12.9 |
| ***Total Nitrogen*** | *g/kg* | 0.89 |
| ***Available Phosphorus*** | *mg/kg* | 1 |
| ***Exchangeable Calcium*** | *mg/kg* | 3037 |
| ***Exchangeable Magnesium*** | *mg/kg* | 513 |
| ***Exchangeable Potassium*** | *mg/kg* | 72 |
| ***Exchangeable Sodium*** | *mg/kg* | 39 |
| ***Nitrate*** | *mg/kg* | 87 |
| ***Available Iron*** | *mg/kg* | 27 |
| ***Available Boron*** | *mg/kg* | 0.44 |

| | | |
|---|---|---|
| ***Available Manganese*** | *mg/kg* | 29 |
| ***Available Copper*** | *mg/kg* | 5 |
| ***Available Zinc*** | *mg/kg* | 10 |

### *Climate features*

| | |
|---|---|
| ***Meteorological station*** | **San Michele (Morfasso)** |
| ***Total rainfall (2016) (mm)*** | 1103.8 |
| ***Rainfall (01.04_30.09 2016) (mm)*** | 468.8 |
| ***HUGLIN Index 2016*** | 1903.22 |
| ***WINKLER Index 2016*** | 1409.44 |

### *Topographical and management features*

| | |
|---|---|
| ***Average slope*** | 0-10% |
| ***Average aspect*** | N-NE-NO |
| ***Farming practice of ploughing*** | Along main slope direction |
| ***Row length*** | < 100 m |
| ***Row orientation*** | Intermediate |
| ***Gravel*** | 0-10% |
| ***Organic matter*** | Low |
| ***Soil texture*** | Clay |
| ***Floor management between rows*** | Alternate row grassing |
| ***Floor management on the rows*** | Ploughing |
| ***Average roots depth*** | 0.6-1 m |
| ***Groundwater depth*** | Absent |
| ***Drainage*** | Absent |
| ***Total rainfall (mm/year)*** | >800 |
| ***Rainfall during grapevine growing season*** | >300 |
| ***Planting operation*** | Ploughing |
| ***Planting operation depth*** | < 1 m |
| ***Soil tillage*** | Chisel/spade plough |
| ***Number of tractor's traffic*** | 15-25 |
| ***Organic fertilization*** | 0 |
| ***Mineral fertilization*** | 1 |
| ***Treatments with plant protection products*** | <10 |
| ***Degree days during growing season*** | > 1800 °C |


### *Information on vineyard (VSA, farmer interview)*

The vineyard is small and almost flat, and it is characterized by water logging after rain. Vine vigor is not uniform and clearly weaker in the area were water logging is more frequent. Soil is repeatedly ploughed and compaction is evident.

### *Identification of potential soil threats*

The information collected was given as input to the Alfa-tool developed in sub-action B1.1 and a potential soil threats ranking was defined:

| **Potential threats** | **Rank** |
|---|---|
| *Erosion* | 1 |
| *Drought* | 2 |
| *Decline in soil organic matter* | 3 |
| *Soil compaction* | 4 |
| *Water logging* | 4 |
| *Soil contamination* | 8 |
| *Decline in soil biodiversity* | 7 |
| *Hard plan* | 6 |

*Table SP4.1: potential threats as indicated by Alfa-version Decision tool (Sub-action B1.1); 1 is the most probable threat and 8 the less probable one.*

### *From potential to real threats*

Observation of the vineyard and an initial validation of potential soil threats through *visual assessment* approach led to a definition of real soil threats:

1. **decline in soil organic matter**
   - during soil sampling no organic residues have been found on the soil surface and along soil profile
   - non-uniform spontaneous grass growth
   - repeated ploughing
   - Soil analysis have confirmed a medium- low content of organic matter, 1.29%
   -
2. **water logging:**
   - water permanence after rain in the bottom
   - large yield differences between dry and humid areas of vineyard.

3. **compaction and hard pan**
   - repeated ploughing
   - repeated traffic with track, also after rainy days.
   - during soil sampling hard pan was found at 30-40 cm of depth

## b. End point

The mitigation goals identified are the following:

- reduction of water logging and related vines problems;
- increase of soil organic matter quality and content in whole vineyard;
- reduction of soil compaction and hard pan due to repeated ploughing and traffic

While the reduction of soil compaction should be achieved relatively quickly (within the time frame of the project), the improvement of soil organic matter could need several years. First evidence of a reduction of water logging and recovery of vines should also be recorded during the project time.

## c. How to go there

For each real threat identified, the Alfa-tool developed in sub-action B1.1 provides possible solutions: in the following table, solutions for “decline in soil organic matter”, “compaction", "water logging” and “hardpan” are represented.

| | *Erosion* | *Drought* | *Decline in soil organic matter* | *Compaction* | *Water Logging* | *Soil contamination* | *Decline in soil biodiversity* | *Hardpan* |
|---|---|---|---|---|---|---|---|---|
| ***Alternate row grassing*** | | | | | | | | |
| ***Temporary grassing / Leguminouse cover crops*** | | | | | | | | |
| ***Temporary grassing /Brassica cover crops*** | | | | | | | | |
| ***Temporary natural grassing*** | | | | | | | | |
| ***Permanent natural grassing*** | | | | | | | | |
| ***Permanent artificial grassing*** | | | | | | | | |
| ***Soil conditioner*** | | | | | | | | |
| ***Plant protection products applications optimization*** | | | | | | | | |
| ***Change in soil management actions (depth)*** | | | | | | | | |
| ***Change of soil management equipment*** | | | | | | | | |
| ***Underground drainage*** | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Superficial water control*** | | | | | | | | |
| ***Permanent mulching in the row (organic/mineral)*** | | | | | | | | |

*Table SP4.2: possible solution as indicated by Alfa-version Decision tool (Sub-action B1.1)*

After an evaluation of the needed resources, the solution "permanent grassing" was selected to be applied. The seed mixture was carefully chosen and is composed by species belonging to *Poaceae* and *Fabaceae* families. Main aim is to avoid frequent tillage between rows, reduce compaction and water logging, and consequently uniform vine vigor and preserved/enhanced soil organic matter.
Chosen seeding mixture is **Grass A** described in Annex A.

### d. What to do

Sowing will be performed (by hand) once, in early spring of the second project year, and once established, the grass will be managed by farmers using farm equipments. During the first year (season 2018), cuts should be more frequent to permit a better stem elongation, but they should start not before summer to enable flowering and seed dispersion to enhance grass covering. During the following years the grass should reach equilibrium and should be managed easily with few cuts during the grape-growing seasons depending on the weather conditions. Row weeds will be managed with herbicides or ringing.
Traditional management is strip ploughing.

Seed will be scattered in 5 inter-rows (F6-F11) (Figure SP4.1)

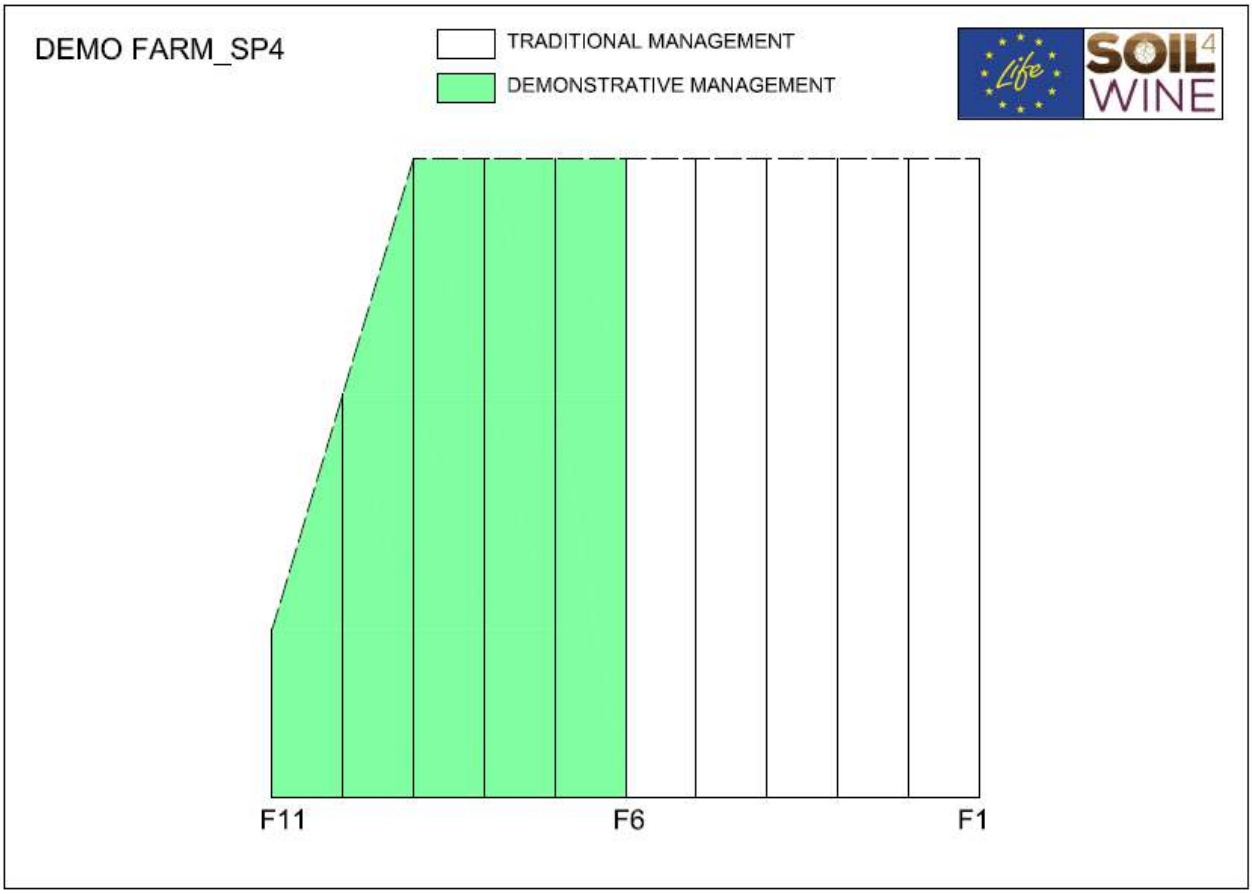



*Figure SP4.1: demonstrative action scheme*

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Jan** | | | |
| **Feb** | | | |
| **Mar** | | Sowing | Cut |
| **Apr** | | | Cut |
| **May** | | | |
| **Jun** | | Cut (after flowering and seed dispersion) | Cut |
| **Jul** | | Cut | Cut |
| **Aug** | | Cut | Cut |
| **Sept** | | | |
| **Oct** | | | |
| **Nov** | | | |
| **Dec** | | | |

*Table SP4.3: Operative timetable*

### e. What to check

Project partners will visit regularly the vineyard to monitor the grass growing. Grass cover will be evaluated through visual assessment in three representative areas of at least 0.5 $m^2$. A complete floristic survey will be performed in spring to assess the colonization of sowed seeds and weeds.

### f. How to remain there

Evaluate every year in late spring the grass coverage, estimating the percentage of soil covered by grass of a defined surface (0.5 $m^2$). If it is lower than 70% it is recommended to spread some more seeds in the following autumn.
It is also possible to evaluate the good status of the grass by quantifying the biomass produced. With standard season-al weather conditions about one trimming per month (March to June) is usually needed to keep the grass shorter than 8-10cm.
Five years after the main sowing is the time window envisaged to sample some soil (60cm depth) and quantify (through chemical analysis) the organic matter quantity and quality. If this will not have increased compared to the baseline before sowing it could be considered that the applied solution is not able to mitigate this specific threat.

# DEMO FARM VT1_Az. Agr. La Pagliara

## a. Start point

### *Vineyard characteristics*

| | |
|---|---|
| ***Vineyard identification (name)*** | Campolungo |
| ***Place*** | Donceto |
| ***Park (Project area)*** | Val Trebbia |
| ***Code A1 Database*** | 1a |
| ***Geographical coordinates*** | 44.83630277; 9.513344 |
| ***Elevation (m.s.l.)*** | 200 |
| ***Grapevine variety*** | Ortrugo |
| ***Rootstock*** | 1103 |
| ***Training system*** | Guyot |
| ***Year of planting*** | 2011 |
| ***Distance between vines (m)*** | 1.3 |
| ***Distance between rows (m)*** | 2.3 |
| ***Vines density (vines/ha)*** | 3344 |
| ***Surface (ha)*** | 0.5 |


### *Soil characteristic*

**1. Soil Map Emilia Romagna Region 1:250.000**

The vineyard is located on soils classified as ***"complesso dei suoli BADI/PIANELLA"***.
In this cartographic unit soils are moderatly steep (8-20%), very deep with medium coarse texture and moderate oxygen avaiablity. Soils are calcareous and moderately alkaline.

- **BADI (BAD):**
  - *FAO (1990): Calcaric Regosols*
  - *Soil Taxonomy: (1990) fine-loamy, mixed (calcareous), mesic, shallow Typic Udorthents.*

- **PIANELLA (PIA)**
  - *FAO (1990): Calcaric Cambisols*
  - *Soil Taxonomy: (1990) fine, mixed, mesicAquic Eutrochrepts*

**2. Soil Map Emilia Romagna Region 1:50.000**

Soil map for mountain areas of Emilia Romagna region at 1:50.000 scale are not available yet.

## 3. Soil samples analysis

A complete chemical and physical analysis of soil samples was performed in October 2017.
In the deliverable B2.4 "*Report on initial data on soil and plan data - Part 1*" complete information are reported; hereafter data considered in the design of the action plan are shown.

| | | |
|---|---|---|
| ***Soil Texture*** | | Silty Clay |
| ***Sand*** | *%* | 17.4 |
| ***Silt*** | *%* | 41.8 |
| ***Clay*** | *%* | 40.8 |
| ***Soil acidity (pH in water)*** | | 8.42 |
| ***Total $CaCO_3$*** | *%* | 17.7 |
| ***Active $CaCO_3$*** | *%* | 10 |
| ***Electrical conductivity*** | *µS/cm* | 0.25 |
| ***Organic Carbon*** | *g/kg* | 4.2 |
| ***Organic Matter*** | *g/kg* | 7.2 |
| ***Total Nitrogen*** | *g/kg* | 0.83 |
| ***Available Phosphorus*** | *mg/kg* | 2 |
| ***Exchangeable Calcium*** | *mg/kg* | 3717 |
| ***Exchangeable Magnesium*** | *mg/kg* | 835 |
| ***Exchangeable Potassium*** | *mg/kg* | 218 |
| ***Exchangeable Sodium*** | *mg/kg* | 76 |
| ***Nitrate*** | *mg/kg* | 202 |
| ***Available Iron*** | *mg/kg* | 17 |
| ***Available Boron*** | *mg/kg* | 4.13 |
| ***Available Manganese*** | *mg/kg* | 8 |
| ***Available Copper*** | *mg/kg* | 6 |
| ***Available Zinc*** | *mg/kg* | 10 |

### *Climate features*

| | |
|---|---|
| ***Meteorological station*** | **Perino (PC)** |
| ***Total rainfall (2016) (mm)*** | 745.4 |
| ***Rainfall (01.04_30.09 2016) (mm)*** | 282.6 |
| ***HUGLIN Index 2016*** | N.D. |
| ***WINKLER Index 2016*** | N.D. |

### *Topographical and management features*

| | |
|---|---|
| ***Average slope*** | 11-30% |
| ***Average aspect*** | S-SE-SO |
| ***Farming practice of ploughing*** | Parallel to main slope direction |
| ***Row length*** | <100 |
| ***Row orientation*** | Intermediate |
| ***Gravel*** | >40% |
| ***Organic matter*** | Medium |
| ***Soil texture*** | Clay |
| ***Floor management between rows*** | Alternate row grassing |
| ***Floor management on the rows*** | Ploughing |
| ***Average roots depth*** | >1 m |
| ***Groundwater depth*** | > 2 m |
| ***Drainage*** | Subsurface drainage |

| | |
|---|---|
| ***Total rainfall (mm/year)*** | 500-800 mm |
| ***Rainfall during grapevine growing season*** | 200-300 mm |
| ***Planting operation*** | Ploughing |
| ***Planting operation depth*** | < 1 m |
| ***Soil tillage*** | Chisel/spade plough |
| ***Number of tractor's traffic*** | < 15 |
| ***Organic fertilization*** | 1 |
| ***Mineral fertilization*** | 0 |
| ***Treatments with plant protection products*** | <10 |
| ***Degree days during growing season*** | 1400-1800 °C |


### *Information on vineyard (VSA, farmer interview)*

The vineyard is located on the left side of the Trebbia River. The slope is moderately high and erosion is evident. The soil presents a high percentage of gravel with big stones increasing towards the river. Vine vigor is uniform and in some seasons (such 2017) vines are irrigated by flowing river water.

### *Identification of potential soil threats*

The information collected was given as input to the Alfa-tool developed in sub-action B1.1 and a potential soil threats ranking was defined (Table VT1.1):

| **Potential threats** | **Rank** |
|---|---|
| *Erosion* | 2 |
| *Drought* | 1 |

| | |
|---|---|
| *Decline in soil organic matter* | 5 |
| *Soil compaction* | 3 |
| *Water logging* | 6 |
| *Soil contamination* | 8 |
| *Decline in soil biodiversity* | 7 |
| *Hard plan* | 3 |

*Table VT1.1: potential threats as indicated by Alfa-version Decision tool (Sub-action B1.1); 1 is the most probable threat and 8 the less probable one.*

### *From potential to real threats*

Observation of the vineyard and an initial validation of potential soil threats through *visual assessment* approach led to a definition of the following soil threats:

1. **erosion:**
   - erosive evidences between rows, in particular located in the bottom of vineyard.
   - non-uniform spontaneous grass growth
   - rills depth 5-10 cm
   - spontaneous grass with moderately problems of growth

2. **decline in soil organic matter**
   - during soil sampling no organic residues were found on the soil surface and along soil profile.
   - non-uniform spontaneous grass growth
   - repeated ploughing
   - erosion of superficial organic layer
   - Soil analyses have confirmed a low content of organic matter (0.72%)

3. **compaction and hard pan.**
   - repeated ploughing
   - during soil sampling hard pan was found at 35-40 cm of depth

4. **drought**
   - low precipitation during growing season (vintage 2017 characterized by no rainy days)
   - initial drought symptoms in vines from July
   - demo farmer during dry season has regularly irrigate vineyard

## b. End point

The mitigation goals identified are the following:

- reduction of erosion processes;
- increase of soil organic matter quality and content in whole vineyard;
- reduction of compaction and hard pan due to traffic and repeated ploughing
- enhancing of vineyard ecosystem biodiversity (organic agriculture)
- increase soil water holding

While the reduction of erosion processes should be achieved relatively quickly (within the time frame of the project), the improvement of soil organic matter could need several years. First evidence of vineyard ecosystem biodiversity should also be recorded during the project time.

## c. How to go there

For each real threat identified, the Alfa-tool developed in sub-action B1.1 provides possible solutions: in the following table, solutions for "erosion", "decline in soil organic matter", "compaction" and "hardpan" are represented.

| | *Erosion* | *Drought* | *Decline in soil organic matter* | *Compaction* | *Water Logging* | *Soil contamination* | *Decline in soil biodiversity* | *Hardpan* |
|---|---|---|---|---|---|---|---|---|
| ***Alternate row grassing*** | | | | | | | | |
| ***Temporary grassing / Leguminouse cover crops*** | | | | | | | | |
| ***Temporary grassing /Brassica cover crops*** | | | | | | | | |
| ***Temporary natural grassing*** | | | | | | | | |
| ***Permanent natural grassing*** | | | | | | | | |
| ***Permanent artificial grassing*** | | | | | | | | |
| ***Soil conditioner*** | | | | | | | | |
| ***Plant protection products applications optimization*** | | | | | | | | |
| ***Change in soil management actions (depth)*** | | | | | | | | |
| ***Change of soil management equipment*** | | | | | | | | |
| ***Underground drainage*** | | | | | | | | |
| ***Superficial water control*** | | | | | | | | |
| ***Permanent mulching in the row (organic/mineral)*** | | | | | | | | |

*Table VT1.2: possible solution as indicated by Alfa-version Decision tool (Sub-action B1.1)*

After an evaluation of the needed resources, the solution "green manure" was selected to be applied. The seed mixture was carefully chosen and is composed by species of *Brassiceae, Fabaceae* and *Poacea* families. As drought is one of the main threats, sowing mixture was choose considered species with low water needs to avoid water competition with vines.
*Grasses (Poacea*) can enhance soil texture, due to their dense bunched roots that break down aggregates promoting a crumbly soil structure, prevent surface crust and protect soil from erosion, furthermore grasses roots exudates can attract soil organisms improving soil biodiversity.
*Brassicas* are characterized by taproots that can break down soil reducing compaction and enhance water movement and allow roots penetration favoring water and nutrients adsorbiption.
*Legumes (Fabaceae*) are characterized by nitrogen fixation capabilities that can enhance vine nutrition and vigor; moreover their deep roots can break down soil aggregates and improve water movements.
The presence of *Phacelia tanacetifolia* can attract bees and other pollinating insects, promoting ecosystem biodiversity.
Sowing mixture chooser is **Green Manure A** described in Annex A.

Having a grassed interrow, tillage operations will be limited and consequently compaction and hard pan reduced, as well as soil organic matter should be preserved and enhanced. Moreover grass covering during winter should reduce erosion in higher slope side.
Green manure will contributes to humification processes that can enhance soil porosity and water holding capacity that is related also with organic matter content and quality.

To increase vineyard ecosystem biodiversity, a buffer area (about 50-60 $m^2$, close to the selected vineyard) will be sowed with flowering and melliferous species (such as *Phacelia tanacetifolia* and *Trifolium spp.)* in spring to create a shelter zone for pollinating insect after the green manure ploughing.

## d. What to do

Sowing will be performed in autumn of the first and second project year, while cutting and ploughing in the following spring just before the beginning of grapevine flowering (when closed flowers are visible), in order to avoid that accumulated nitrogen can be traslocated by the plant and used for the maturation of seeds.
Between cutting and ploughing the sliced grass should be left drying for few days to avoid fermentation processes. Ploughing should not exceed 10-15 cm. Under the row management can be carried out as usual (i.e., ringing).
*Phacelia* will be sowed with other melliferous species in March, flowering will be after 30 days and go on for almost 40 days. Cut will be after flowering to enhance the seed pool for the following year.

Sowing will be made in 8 inter-rows (F5-F9 and F13-F17) (Figure VT1.1)

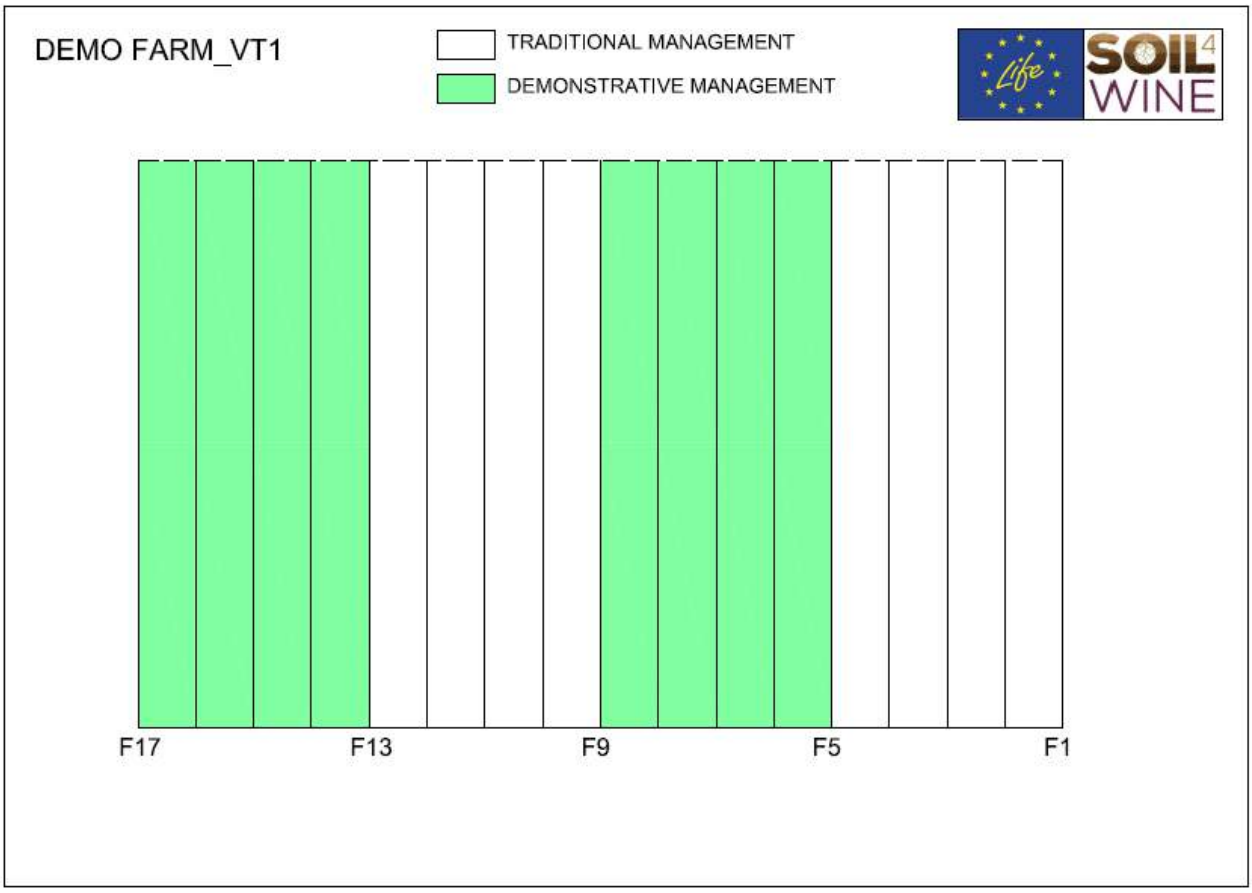



*Figure VT1.1: demonstrative action scheme*

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Jan** | | | |
| **Feb** | | | |
| **Mar** | | Buffer area sowing | Buffer area sowing |
| **Apr** | | Green manure cutting and ploughing | Green manure cutting and ploughing |
| **May** | | | |
| **Jun** | | | |
| **Jul** | | Cut of flowering species | Cut of flowering species |
| **Aug** | | | |
| **Sept** | | | |
| **Oct** | | Green manure sowing | |
| **Nov** | Green manure sowing | | |
| **Dec** | | | |

*Table VT1.3: Operative timetable*

## e. What to check

Project partners will regularly visit the vineyard in order to monitor the grass growing. Grass cover will be evaluated through visual assessment in three representative areas of at least 0.5 $m^2$. Before cutting biomass in the test areas will be weighted in order to evaluate the total biomass produced before trimming and soil incorporation. A complete floristic survey will be performed in spring to assess the colonization of sowed seeds and weeds. Visual assessment will be used to evaluate the reduction of soil erosion and to verify the absence/reduction of erosion rills.

## f. How to remain there

Green manure has to be sowed, trimmed and ploughed for at least three consecutive years. After this period new soil chemical analysis should be performed to determine amount and quality of organic matter. If this is increased compared to the baseline before the first sowing, green manure can be sowed in the following years on alternate rows, in order to facilitate other vineyard management activities.

# DEMO FARM VT2_Az. Agr. Carrà Stefano (Castello di Montichiaro)

## a. Start point

### *Vineyard characteristics*

| | |
|---|---|
| ***Vineyard identification (name)*** | Castello di Montichiaro |
| ***Place*** | Rivergaro |
| ***Park (Project area)*** | Val Trebbia |
| ***Code A1 Database*** | 12 |
| ***Geographical coordinates*** | 44.877881 9.563567 |
| ***Elevation (m.s.l.)*** | 218 |
| ***Grapevine variety*** | Croatina |
| ***Rootstock*** | ? |
| ***Training system*** | Guyot |
| ***Year of planting*** | ? |
| ***Distance between vines (m)*** | 1.3 |
| ***Distance between rows (m)*** | 2.3 |
| ***Vines density (vines/ha)*** | 3344 |
| ***Surface (ha)*** | 0.6 |


### *Soil characteristic*

**1. Soil Map Emilia Romagna Region 1:250.000**

The vineyard is located on soils classified as ***"complesso dei suoli CAMINATA/CORTICELLI/STROGNANO".***
In this cartographic unit soils are moderatly steep (10-25%), stony with fine texture, calcareous and moderately alkaline.

- **CAMINATA (CMN):**
  - *FAO (1990): Calcaric Regosols*
  - *Soil Taxonomy: (1990) fine, mixed (calcareous), mesic Typic Ustorthens*

- **CORTICELLA (CRT)**
  - *FAO (1990): Vertic Cambisols*
  - *Soil Taxonomy: (1990) fine, mixed, mesic Vertic Ustochrepts*

- **STROGNANO (STG)**
  - *FAO (1990): Calcaric Regosols*
  - *Soil Taxonomy: (1990) fine, mixed (calcareous), mesic Aquic Ustorthents*

## 2. Soil Map Emilia Romagna Region 1:50.000:

The vineyard is located on soils classified as ***"complesso dei suoli CAMINATA/CORTICELLI - CMN/CRT, Delineation 13078, Cartographic Unit 0682)***"

| | | |
|---|---|---|
| **CORTICELLI argilloso limosi**<br><br>**CRT** | 55% | *Soil Taxonomy:*<br>(2010) Vertic Haplustepts fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Vertic Cambisols (Calcaric) |
| **CAMINATA**<br><br>**CMN** | 45% | *Soil Taxonomy:*<br>(2010) Typic Ustorthents fine, mexed, superactive, calcareous, mesic<br>*WRB:*<br>(2007) Endolptic Regosols (Calcaric) |

## 3. Soil samples analysis

A complete chemical and physical analysis of soil samples was performed in October 2017.
In the deliverable B2.4 "*Report on initial data on soil and plan data - Part 1*" complete information are reported; hereafter data considered in the design of the action plan are shown.

| | | |
|---|---|---|
| ***Soil Texture*** | | Clay Loam |
| ***Sand*** | *%* | 24.7 |
| ***Silt*** | *%* | 40.7 |
| ***Clay*** | *%* | 34.6 |
| ***Soil acidity (pH in water)*** | | 8.26 |
| ***Total $CaCO_3$*** | *%* | 22.6 |
| ***Active $CaCO_3$*** | *%* | 12.8 |
| ***Electrical conductivity*** | *µS/cm* | 0.14 |
| ***Organic Carbon*** | *g/kg* | 10.2 |
| ***Organic Matter*** | *g/kg* | 17.6 |
| ***Total Nitrogen*** | *g/kg* | 1.05 |
| ***Available Phosphorus*** | *mg/kg* | 1 |
| ***Exchangeable Calcium*** | *mg/kg* | 6418 |
| ***Exchangeable Magnesium*** | *mg/kg* | 246 |
| ***Exchangeable Potassium*** | *mg/kg* | 130 |
| ***Exchangeable Sodium*** | *mg/kg* | 1 |
| ***Nitrate*** | *mg/kg* | 166 |
| ***Available Iron*** | *mg/kg* | 27 |
| ***Available Boron*** | *mg/kg* | 0.81 |
| ***Available Manganese*** | *mg/kg* | 9 |
| ***Available Copper*** | *mg/kg* | 22 |
| ***Available Zinc*** | *mg/kg* | 17.1 |

### *Climate features*

| | |
|---|---|
| ***Meteorological station*** | **Perino (PC)** |
| ***Total rainfall (2016) (mm)*** | 745.4 |
| ***Rainfall (01.04_30.09 2016) (mm)*** | 282.6 |

| | |
|---|---|
| ***T MAX (01.04_30.09 2016) (°C)*** | N.D. |
| ***T AVERAGE (01.04_30.09 2016) (°C)*** | N.D. |
| ***HUGLIN Index 2016*** | N.D. |
| ***WINKLER Index 2016*** | N.D. |

### *Topographical and management features*

| | |
|---|---|
| ***Average slope*** | 0-10% |
| ***Average aspect*** | N-NE-NO |
| ***Farming practice of ploughing*** | Transversal |
| ***Row length*** | 100-200 m |
| ***Row orientation*** | N-S |
| ***Gravel*** | >40% |
| ***Organic matter*** | Low |
| ***Soil texture*** | Sandy |
| ***Floor management between rows*** | Alternate row grassing |
| ***Floor management on the rows*** | Herbicides |
| ***Average roots depth*** | 0.6-1 m |
| ***Groundwater depth*** | < 2 m |
| ***Drainage*** | Absent |
| ***Total rainfall (mm/year)*** | 500-800 mm |
| ***Rainfall during grapevine growing season*** | 200-300 mm |
| ***Planting operation*** | Ploughing |
| ***Planting operation depth*** | < 1 m |
| ***Soil tillage*** | Chisel/spade plough |
| ***Number of tractor's traffic*** | >25 |
| ***Organic fertilization*** | 0 |
| ***Mineral fertilization*** | 1 |
| ***Treatments with plant protection products*** | <10 |
| ***Degree days during growing season*** | 1400-1800 °C |


### *Information on vineyard (VSA, farmer interview)*

The vineyard is located below the Montichiaro Castle on the right side of the Trebbia River. In the upper part, the soil is characterized by high percentage of gravel, both on surface and in depth, and the vines vigor is lower than in the other vineyard's areas.

### *Identification of potential soil threats*

The information collected was given as input to the Alfa-tool developed in sub-action B1.1 and a potential soil threats ranking was defined (Table VT2.1):

| **Potential threats** | **Rank** |
|---|---|
| *Erosion* | 1 |
| *Drought* | 2 |
| *Decline in soil organic matter* | 5 |
| *Soil compaction* | 4 |
| *Water logging* | 3 |
| *Soil contamination* | 6 |
| *Decline in soil biodiversity* | 7 |
| *Hard pan* | 7 |

*Table VT2.1: potential threats as indicated by Alfa-version Decision tool (Sub-action B1.1); 1 is the most probable threat and 8 the less probable one.*

### *From potential to real threats*

Observation of the vineyard and an initial validation of potential soil threats through *visual assessment* approach led to a definition of following soil threats:

1. **erosion:**
   - erosive evidences between rows, in particular located in the bottom of vineyard.
   - non-uniform spontaneous grass growth
   - spontaneous grass with moderately problems of growth
   - low vigor in the top of vineyard

2. **decline in soil organic matter**
   - during soil sampling no organic residues have been found on the soil surface and along soil profile.
   - non-uniform spontaneous grass growth
   - repeated ploughing
   - erosion of superficial organic layer
   - Soil analyses have confirmed low organic matter content (1.76%)

3. **drought**
   - low precipitation during growing season (vintage 2017 characterized by no rainy day)
   - initial symptoms of drought in shoot tips since July.

4. **compaction and hard pan.**
   - repeated ploughing
   - during soil sampling hard pan was found at 35-40 cm of depth

## b. End point

The mitigation goals identified are the following:

- reduction of erosion processes;
- increase of soil organic matter quality and content in whole vineyard;
- reduction of compaction and hard pan due to continuous ploughing
- increase of soil water holding capacity

While the reduction of erosion processes should be achieved relatively quickly (within the time frame of the project), the improvement of soil organic matter could need several years.

## c. How to go there

For each real threat identified, the Alfa-tool developed in sub-action B1.1 provides possible solutions:

| | *Erosion* | *Drought* | *Decline in soil organic matter* | *Compaction* | *Water Logging* | *Soil contamination* | *Decline in soil biodiversity* | *Hardpan* |
|---|---|---|---|---|---|---|---|---|
| *Alternate row grassing* | | | | | | | | |
| *Temporary grassing / Leguminouse cover crops* | | | | | | | | |
| *Temporary grassing /Brassica cover crops* | | | | | | | | |
| *Temporary natural grassing* | | | | | | | | |
| *Permanent natural grassing* | | | | | | | | |
| *Permanent artificial grassing* | | | | | | | | |
| *Soil conditioner* | | | | | | | | |
| *Plant protection products applications optimization* | | | | | | | | |
| *Change in soil management actions (depth)* | | | | | | | | |
| *Change of soil management equipment* | | | | | | | | |
| *Underground drainage* | | | | | | | | |
| *Superficial water control* | | | | | | | | |
| *Permanent mulching in the row (organic/mineral)* | | | | | | | | |

*Table VT2.2: possible solution as indicated by Alfa-version Decision tool (Sub-action B1.1)*

After an evaluation of the needed resources, the solution "green manure" was selected to be applied. The seed mixture was carefully chosen and is composed by species of *Brassiceae, Fabaceae* and *Poacea* families.
*Grasses (Poacea*) can enhance soil texture, due to their dense bunched roots that break down aggregates promoting a crumbly soil structure, prevent surface crust and protect soil from erosion; furthermore grasses roots exudates can attract soil organisms improving soil biodiversity.
*Brassicas* are characterized by taproots that can break down soil reducing compaction and enhance water movement and allow roots penetration favoring water and nutrients adsorbiption.
*Legumes (Fabaceae*) are characterized by nitrogen fixation capabilities that can enhance vine nutrition and vigor, moreover their deep roots can break down soil aggregates and improve water movements.
The presence of *Phacelia tanacetifolia* can attract bees and other pollinating insects, promoting ecosystem biodiversity.
Sowing mixture chooser is **Green Manure A** described in Annex A.

Having a grassed interrow, tillage operations will be limited and consequently compaction and hard pan reduced, as well as soil organic matter should be preserved and enhanced. Moreover grass covering during winter should reduce erosion in higher slope side.
Green manure will contributes to humification processes that can enhance soil porosity and water holding capacity that is related also with organic matter content and quality.

## d. What to do

Sowing will be performed in autumn of the first and second project year, while cutting and ploughing in the following Spring just before the beginning of grapevine flowering (when closed flowers are visible), in order to avoid that accumulated nitrogen can be traslocated by the plant and used for the maturation of seeds.
Between cutting and ploughing the sliced grass should be left drying for few days to avoid fermentation processes. Ploughing should not exceed 10-15 cm. Under the row management can be carried out as usual (i.e., ringing).
Sowing will be made in 4 inter-rows (F5-F9) (Figure VT2.1)

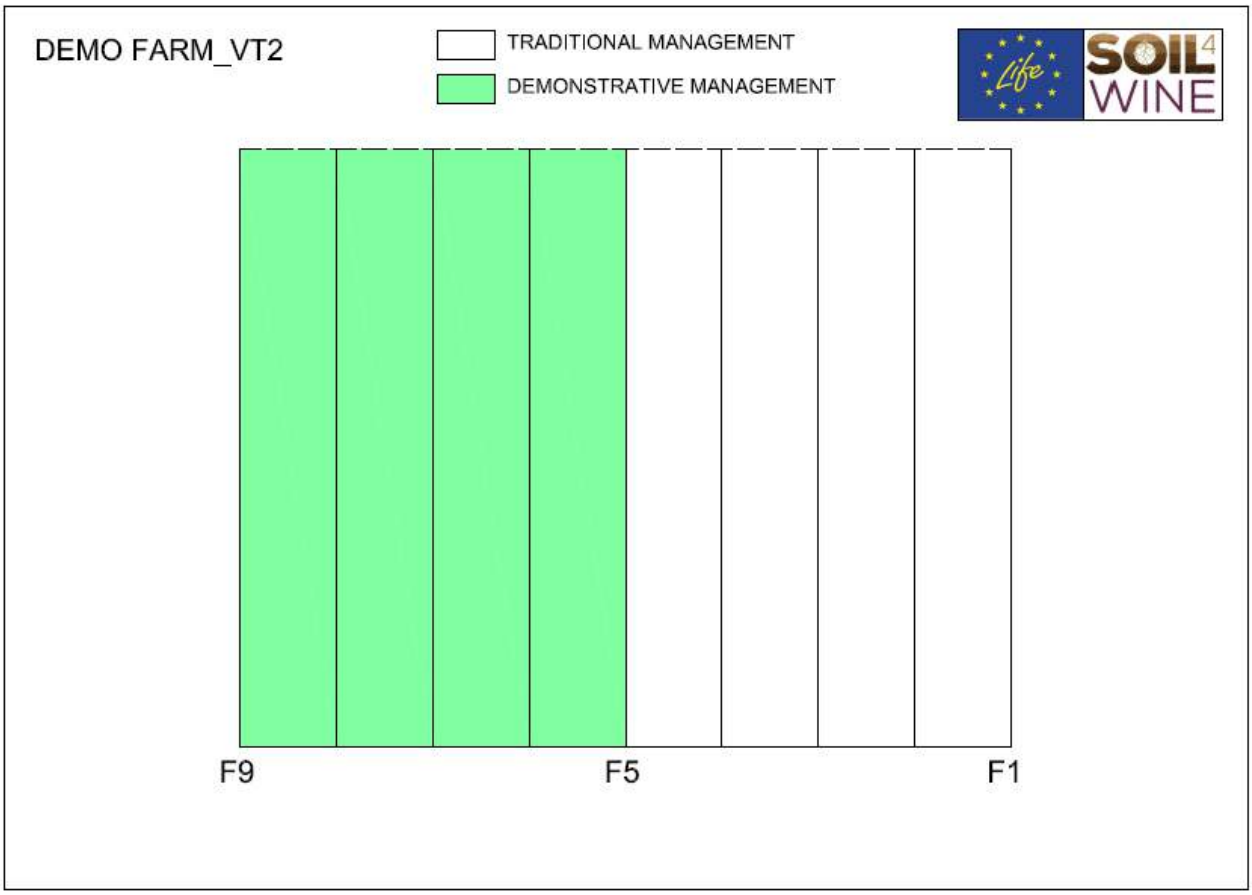



*Figure VT2.1: demonstrative action scheme*

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Jan** | | | |
| **Feb** | | | |
| **Mar** | | | |
| **Apr** | | Cutting and ploughing | Cutting and ploughing |
| **May** | | | |
| **Jun** | | | |
| **Jul** | | | |
| **Aug** | | | |
| **Sept** | | | |
| **Oct** | | Sowing | |
| **Nov** | Sowing | | |
| **Dec** | | | |

*Table VT2.3: Operative timetable*

## e. What to check

Project partners will regularly visit vineyard in order to monitor the grass growing. Grass cover will be evaluated through visual assessment in three representative areas of at least 0.5 $m^2$. Before cutting biomass in the test areas will be weighted in order to evaluate the total biomass produced before trimming and soil incorporation. A complete floristic survey will be performed in spring to assess the colonization of sowed seeds and weeds. Visual assessment will be used to evaluate the reduction of soil erosion and to verify the absence/reduction of erosion rills.

## f. How to remain there

Green manure has to be sowed, trimmed and phloughed for at least three consecutive years. After this period new soil chemical analysis should be performed to determine amount and quality of organic matter. If this is increased compared to the baseline before the first sowing, green manure can be sowed in the following years on alternate rows, in order to facilitate other vineyard management activities.

# DEMO FARM TBC1_Az. Monte delle Vigne

## a Start point

### *Vineyard characteristics*

| | |
|---|---|
| ***Vineyard identification (name)*** | Cantina |
| ***Place*** | Ozzano Taro |
| ***Park (Project area)*** | Parco del Taro |
| ***Code A1 Database*** | 22 |
| ***Geographical coordinates*** | 44.701724; 10.14752 |
| ***Elevation (m.s.l.)*** | 206.5 |
| ***Grapevine variety*** | Sauvignon Blanc |
| ***Rootstock*** | ? |
| ***Training system*** | Guyot |
| ***Year of planting*** | 2008 |
| ***Distance between vines (m)*** | 0.8 |
| ***Distance between rows (m)*** | 2.2 |
| ***Vines density (vines/ha)*** | 5682 |
| ***Surface (ha)*** | 0.65 ha |


### *Soil characteristic*

**1. Soil Map Emilia Romagna Region 1:250.000**

The vineyard is located on soils classified as "complesso dei suoli ***"complesso dei suoli TERRA DEL SOLE/DOGHERIA/SANT'ANTONIO (Delineation 5366; Cartographic Unit 0077)"***:

- **TERRA DEL SOLE franco argilloso limosi (TRS1)**
  - *FAO (1990): Calcaric Regosols*
  - *Soil Taxonomy: (1990) fine, mixed (calcareous), mesic, shallow Vertic Ustorthents*

- **SANT'ANTONIO (SAN)**
  - *FAO (1990): Vertic Cambisols*
  - *Soil Taxonomy: (1990) fine, mixed, mesic Vertic Ustochrepst.*

- **DOGHERIA (DOG2)**
  - *FAO (1990): Haplic Calcisols*

- *Soil Taxonomy: (1990) fine, mixed, mesic Fluventic Ustochrepts.*

- ***consociazione dei suoli MONFALCONE***

- **MONTEFALCONE franco argillosi, 1-5% pendent**
  - *WRB: (2007) Vertic Cambisols (Eutric)*
  - *Soil Taxonomy: (2010) Udertic Haplustepts fine, mixed, superactive, mesic*

**2. Soil Map Emilia Romagna Region 1:50.000:**

The vineyard is located on soils classified as:

- ***"complesso dei suoli DEMANIO/BANZOLA 5-35% pendenti / DOGHERIA - DEM/BAN3/DOG0 (Delineation 8784, Cartographic Unit 0580)"***

| | | |
|---|---|---|
| **DEMANIO DEM** | 40% | *Soil Taxonomy:* (2010) Oxyacquic Haplustepts fine, mixed, active, mesic *WRB:* (2007) Haplic Cambisols (Calcaric, Oxyaquic) |
| **BANZOLA Franco argilloso limosi, 5-35% pendenti BAN3** | 30% | *Soil Taxonomy:* (2010) Oxyacquic Ustorthents fine, mixed, active, calcareous, mesic *WRB:* (2007) Haplic Regosols (Calcaric, Oxyaquic) |
| **GRIFONE Franco argilloso limosi GRI3** | 10% | *Soil Taxonomy:* (2010) Typic Haplustepts fine, mixed, superactive, mesic *WRB:* (2007) Haplic Cambisols (Calcaric) |
| **DOGHERIA 15-20% pendenti DOG2** | 10% | *Soil Taxonomy:* (2010) Typic Calciustepts fine, mixed, active, mesic *WRB:* (2007) Hypocalcic Haplic Calcisols |
| **DOGHERIA 7-15% pendenti DOG1** | 10% | *Soil Taxonomy:* (2010) Typic Calciustepts fine, mixed, active, mesic *WRB:* (2007) Hypocalcic Haplic Calcisols |

- ***"consociazione dei suoli MONTEFALCONE argilloso limosi, 1-5% pendenti"***

| | | |
|---|---|---|
| **MONTEFALCONE franco argilloso limosi, 1-5% pendenti MFA1** | 75% | *Soil Taxonomy:* (2010) Udertic Haplusteps fine, mixed, superactive, mesic *WRB:* (2007) Vertic Cambisols (Eutric) |
| **GHIARDO franco limosi GHI1** | 20% | *Soil Taxonomy:* (2010) Typic Haplustepts fine, mixed, superactive, mesic *WRB:* (2007) Haplic Cambisols (Calcaric) |
| **MONTEFALCONE franco argilloso limosi, 5-20% pendenti MFA2** | 5% | *Soil Taxonomy:* (2010) Udertic Haplusteps fine, mixed, superactive, mesic *WRB:* (2007) Vertic Cambisols (Eutric) |

**3. Soil samples analysis**

A complete chemical and physical analysis of soil samples was performed in October 2017.

In the deliverable B2.4 "*Report on initial data on soil and plan data - Part 1*" complete information are reported; hereafter data considered in the design of the action plan are shown.

- ***"complesso dei suoli DEMANIO/BANZOLA 5-35% pendenti / DOGHERIA - DEM/BAN3/DOG0 (Delineation 8784, Cartographic Unit 0580)"***

| | | |
|---|---|---|
| ***Soil Texture*** | | Silty Clay |
| ***Sand*** | *%* | 13.3 |
| ***Silt*** | *%* | 46.1 |
| ***Clay*** | *%* | 40.6 |
| ***Soil acidity (pH in water)*** | | 8.44 |
| ***Total $CaCO_3$*** | *%* | 17.7 |
| ***Active $CaCO_3$*** | *%* | 10 |
| ***Electrical conductivity*** | *µS/cm* | 0.16 |
| ***Organic Carbon*** | *g/kg* | 4.1 |
| ***Organic Matter*** | *g/kg* | 7 |
| ***Total Nitrogen*** | *g/kg* | 0.65 |
| ***Available Phosphorus*** | *mg/kg* | 1 |
| ***Exchangeable Calcium*** | *mg/kg* | 3886 |
| ***Exchangeable Magnesium*** | *mg/kg* | 353 |
| ***Exchangeable Potassium*** | *mg/kg* | 193 |
| ***Exchangeable Sodium*** | *mg/kg* | 14 |
| ***Nitrate*** | *mg/kg* | 168 |
| ***Available Iron*** | *mg/kg* | 12 |
| ***Available Boron*** | *mg/kg* | 0.48 |
| ***Available Manganese*** | *mg/kg* | 9 |
| ***Available Copper*** | *mg/kg* | 2 |
| ***Available Zinc*** | *mg/kg* | 5.2 |

- ***"consociazione dei suoli MONTEFALCONE argilloso limosi, 1-5% pendenti"***

| | | |
|---|---|---|
| ***Soil Texture*** | | Silty Clay Loamy |
| ***Sand*** | *%* | 15.7 |
| ***Silt*** | *%* | 47.4 |
| ***Clay*** | *%* | 36.9 |
| ***Soil acidity (pH in water)*** | | 8.22 |
| ***Total $CaCO_3$*** | *%* | 6.6 |
| ***Active $CaCO_3$*** | *%* | 3.8 |
| ***Electrical conductivity*** | *µS/cm* | 0.17 |
| ***Organic Carbon*** | *g/kg* | 5.8 |
| ***Organic Matter*** | *g/kg* | 9.9 |
| ***Total Nitrogen*** | *g/kg* | 0.8 |
| ***Available Phosphorus*** | *mg/kg* | 2 |
| ***Exchangeable Calcium*** | *mg/kg* | 5553 |
| ***Exchangeable Magnesium*** | *mg/kg* | 913 |
| ***Exchangeable Potassium*** | *mg/kg* | 151 |
| ***Exchangeable Sodium*** | *mg/kg* | 35 |
| ***Nitrate*** | *mg/kg* | 98 |
| ***Available Iron*** | *mg/kg* | 12 |
| ***Available Boron*** | *mg/kg* | 0.55 |
| ***Available Manganese*** | *mg/kg* | 5 |
| ***Available Copper*** | *mg/kg* | 4 |
| ***Available Zinc*** | *mg/kg* | 6.6 |

### *Climate features*

| | |
|---|---|
| ***Meteorological station*** | **Medesano (PR)** |
| ***Total rainfall (2016) (mm)*** | N.D. |
| ***Rainfall (01.04_30.09 2016) (mm)*** | 136.8 |
| ***HUGLIN Index 2016*** | 2593.9 |
| ***WINKLER Index 2016*** | 1915.29 |

### *Topographical and management features*

| | |
|---|---|
| ***Average slope*** | 0-10% |
| ***Average aspect*** | N-NE-NO |
| ***Farming practice of ploughing*** | Along main slope direction |
| ***Row length*** | 100-200 |
| ***Row orientation*** | E-O |
| ***Gravel*** | 10-40% |
| ***Organic matter*** | Low |
| ***Soil texture*** | Loamy-Clay |
| ***Floor management between rows*** | Alternate row grassing |
| ***Floor management on the rows*** | Herbicides |
| ***Average roots depth*** | 0.6-1 m |
| ***Groundwater depth*** | Absent |
| ***Drainage*** | Absent |
| ***Total rainfall (mm/year)*** | 500-800 |
| ***Rainfall during grapevine growing season*** | < 200 |
| ***Planting operation*** | Ploughing |
| ***Planting operation depth*** | < 1 m |
| ***Soil tillage*** | Chisel/Spade |
| ***Number of tractor's traffic*** | 15-25 |
| ***Organic fertilization*** | 0 |
| ***Mineral fertilization*** | 1 |
| ***Treatments with plant protection products*** | <10 |
| ***Degree days during growing season*** | > 1800 ° C |


### *Information on vineyard (VSA, farmer interview)*

The vineyard is located on two different soils, this difference is evidently correlated to vine vigor and soil surface characteristics. Three classes of vigor were identified (High, Medium and Low).
About 30 meters from the top there is an area with very high percentage of gravel.
Control of weeds on the row is considered a management problem.

### *Identification of potential soil threats*

The information collected was given as input to the Alfa-tool developed in sub-action B1.1 and a potential soil threats ranking was defined (Table TBC1.1):

| **Potential threats** | **Rank** |
|---|---|
| *Erosion* | 2 |
| *Drought* | 1 |
| *Decline in soil organic matter* | 3 |
| *Soil compaction* | 3 |
| *Water logging* | 5 |
| *Soil contamination* | 7 |
| *Decline in soil biodiversity* | 6 |
| *Hard plan* | 7 |

*Table TBC1.1: potential threats as indicated by Alfa-version Decision tool (Sub-action B1.1); 1 is the most probable threat and 8 the less probable one.*

### *From potential to real threats*

Observation of the vineyard and an initial validation of potential soil threats through *visual assessment* approach led to a definition of the following soil threats:

1. **decline in soil organic matter**
   - during soil sampling no organic residues have been found on the soil surface and along soil profile.
   - non-uniform spontaneous grass growth
   - repeated ploughing
   - erosion of superficial organic layer
   - Soil analysis has confirmed that in both soil samples organic matter is very low. In "complesso dei suoli DEMANIO/BANZOLA 5-35% pendenti / DOGHERIA - DEM/BAN3/DOG0" content is 7 g/kg while in "consociazione dei suoli MONTEFALCONE argilloso limosi, 1-5% pendenti" value is 9.9 g/kg.

2. **Erosion**
   - erosive evidences between rows, in particular located in the bottom of vineyard.
   - non-uniform spontaneous grass growth

3. **low vine vigor**
   - in the upper part of the vineyard
   - in correspondence of gravel strip
   - severe presence of weeds on the row and between vines
4. **drought**
   - low precipitation during growing season (vintage 2017 characterized by no rainy day)
   - initial symptoms of drought in shoot tips since July.

## b. End point

The mitigation goals identified are the following:

- reduction of potential erosion processes;
- increase of soil organic matter quality and content in whole vineyard;
- control of row weeds
- reduce drought effects on vines

While the reduction of erosion processes and control of weeds on the row should be achieved relatively quickly (within the time frame of the project), the improvement of soil organic matter could need several years.

## c. How to go there

For each real threat identified, the Alfa-tool developed in sub-action B1.1 provides possible solutions: in the following table, solutions for “erosion”, "drought" and “decline in soil organic matter” are represented.

| | *Erosion* | *Drought* | *Decline in soil organic matter* | *Compaction* | *Water Logging* | *Soil contamination* | *Decline in soil biodiversity* | *Hardpan* |
|---|---|---|---|---|---|---|---|---|
| ***Alternate row grassing*** | | | | | | | | |
| ***Temporary grassing / Leguminouse cover crops*** | | | | | | | | |
| ***Temporary grassing /Brassica cover crops*** | | | | | | | | |
| ***Temporary natural grassing*** | | | | | | | | |
| ***Permanent natural grassing*** | | | | | | | | |
| ***Permanent artificial grassing*** | | | | | | | | |
| ***Soil conditioner*** | | | | | | | | |
| ***Plant protection products applications optimization*** | | | | | | | | |
| ***Change in soil management actions (depth)*** | | | | | | | | |
| ***Change of soil management equipment*** | | | | | | | | |
| ***Underground drainage*** | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Superficial water control*** | | | | | | | | |
| ***Permanent mulching in the row (organic/mineral)*** | | | | | | | | |

*Table TBC1.2: possible solution as indicated by Alfa-version Decision tool (Sub-action B1.1)*

After an evaluation of the needed resources, the solution "permanent grassing" was selected to be applied. The seed mixture was carefully chosen and is composed by species belonging to *Poaceae* and *Fabaceae* families. Main aim is to avoid frequent tillage between rows, reduce compaction and consequently uniform vine vigor and preserved/enhanced soil organic matter.
A permanent grass is not the best solution in presence of drought but sowing mixture was chosen selecting species with low water needed. The spontaneous grasses/weeds in the row and inter-row are vigorous and probably had high impact on vines in terms of water and nutrient competition.
*Grasses (Poacea*) can enhance soil texture, due to their dense bunched roots that break down aggregates promoting a crumbly soil structure, prevent surface crust and protect soil from erosion; furthermore grasses roots exudates can attract soil organisms improving soil biodiversity.
*Legumes (Fabaceae*) are characterized by nitrogen fixation capabilities that can enhance vine nutrition and vigor; moreover their deep roots can break down soil aggregates and improve water movements.
Sowing mixture chosen was **Grass A** which composition is described in Annex A.

Cut off biomass will be distributed on the row in order to create a natural mulching, that can control weeds by reducing photosyntetical activity of weeds and produces allelopatic compound.

### d. What to do

Traditional management is alternate row grassing.
In October 2017 manure was stripy distributed so it will be possible to assess the effect of organic fertilizer on grass growth.

Sowing will be performed only one time, in early spring of the second project year, and once established, the grass will be trimmed using a machine able to distribute the sliced grass under the vine plants (on the row). During the first year (season 2018), cuts should be more frequent, to permit a better stem elongation, but should start not before summer to enable flowering and seed dispersion to enhance grass covering.
During the following years the grass should reach equilibrium and should be managed easily with few cuts during the grape-growing seasons depending on the weather conditions.

Sowing will be made in 12 inter-rows (F6-F12 and F17-F23) (Figure TBC1.1)

Row weeds will be managed with distribution of trimmed biomass under vines.

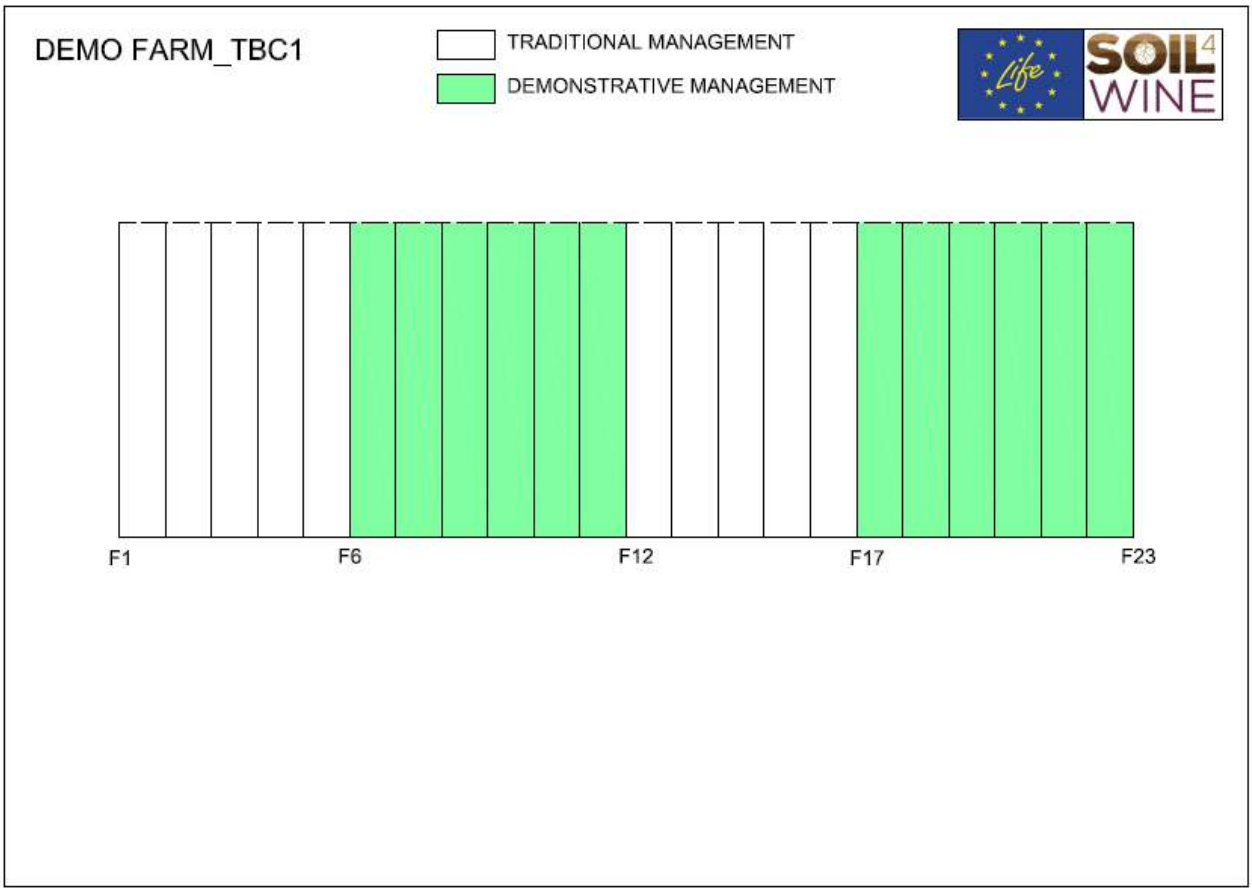



*Figure TBC1.1: demonstrative action scheme*

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Jan** | | | |
| **Feb** | | | |
| **Mar** | | Sowing | Trimming<br>Mulching |
| **Apr** | | | |
| **May** | | | |
| **Jun** | | | |
| **Jul** | | Trimming<br>Mulching | Trimming<br>Mulching |
| **Aug** | | | |
| **Sept** | | | |
| **Oct** | Manure distribution | | |
| **Nov** | | Trimming<br>Mulching | Trimming<br>Mulching |
| **Dec** | | | |

*Table TBC1.3: Operative timetable*

## e. What to check

Project partners will regularly visit the vineyard in order to monitor the grass growing. Grass cover will be evaluated through visual assessment in three representative areas of at least 0.5 $m^2$.

Before cutting biomass in the test areas will be weighted in order to evaluate the total biomass produced before trimming and distribution on the vines rows.

A botanical survey of weeds on the row and an assessment of abundance will be made before and regularly after the mulching.
Visual assessment will be used to evaluate the reduction of soil erosion and to verify the absence/reduction of erosion rills.

## f. How to remain there

Evaluate every year in late spring the grass coverage, estimating the percentage of soil covered by grass of a defined surface (0.5 $m^2$). If it is lower than 70% it is recommended to spread some more seeds in the following autumn.
It is also possible to evaluate the good status of the grass by quantifying the biomass produced. With standard season-al weather conditions about one trimming per month (March to June) is usually needed to keep the grass shorter than 8-10cm.
Five years after the main sowing is the time window envisaged to sample some soil (60cm depth) and quantify (through chemical analysis) the organic matter quantity and quality. If this will not have increased compared to the baseline before sowing it could be considered that the applied solution is not able to mitigate this specific threat.
Development of weeds on the row should be avoided by the green mulching guaranteed by the grass sliced and moved under the row, if this is not the case, alternative should be searched to solve this problem.
To check whether the grass is able to reduce erosion processes, erosion rills should be observed: the depth and number of rills should decrease year by year (in standard seasonal weather conditions).

# DEMO FARM TBC2_Az. Vitivinicola Palazzo

## a. Start point

### *Vineyard characteristics*

| | |
|---|---|
| ***Vineyard identification (name)*** | Collecchio |
| ***Place*** | Collecchio |
| ***Park (Project area)*** | Boschi di Carrega |
| ***Code A1 Database*** | 21a |
| ***Geographical coordinates*** | 44.73893; 10.211507 |
| ***Elevation (m.s.l.)*** | 147 |
| ***Grapevine variety*** | Malvasia |
| ***Rootstock*** | N.D. |
| ***Training system*** | VSP |
| ***Year of planting*** | 2010 |
| ***Distance between vines (m)*** | 0.7 |
| ***Distance between rows (m)*** | 2.2 |
| ***Vines density (vines/ha)*** | 6494 |
| ***Surface (ha)*** | 0.35 ha |



### *Soil characteristic*

**1. Soil Map Emilia Romagna Region 1:250.000**

The vineyard is located on soil classified as ***"complesso dei suoli GHIARDO/BARCO"***.

- **GHIARDO franco limosi Soil (GHI1):**
  - *FAO (1990): Haplic Luvisols*
  - *Soil Taxonomy: silty, mixed, mesic Aquic Haplustalf*
- **BARCO franco limosi (BAR1)**
  - *FAO: Chromic Luvisols*
  - *Soil Taxonomy: silty, mixed, mesic Kanhaplic Haplustalf*

**2. Soil Map Emilia Romagna Region 1:50.000:**

The vineyard is located on soil classified as ***"consociazione dei suoli MONFALCONE argilloso limosi, 1-5% pendenti - MFA1 (Delineation: 7320 ; Cartographic unit 0077)"***

| | | |
|---|---|---|
| **MONFALCONE franco argilloso limosi, 1-5% pendenti MFA1** | 100% | *Soil Taxonomy:*<br>(2010) Udertic Haplustepts fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Vertic Cambisols (Eutric) |

## 3. Soil samples analysis

A complete chemical and physical analysis of soil samples was performed in October 2017.
In the deliverable B2.4 "*Report on initial data on soil and plan data - Part 1*" complete information are reported; hereafter data considered in the design of the action plan are shown.

| | | |
|---|---|---|
| ***Soil Texture*** | | Silty Clay Loamy |
| ***Sand*** | *%* | 19.8 |
| ***Silt*** | *%* | 53.1 |
| ***Clay*** | *%* | 27.1 |
| ***Soil acidity (pH in water)*** | | 7.53 |
| ***Total $CaCO_3$*** | *%* | 1.4 |
| ***Active $CaCO_3$*** | *%* | 0.8 |
| ***Electrical conductivity*** | *µS/cm* | 0.1 |
| ***Organic Carbon*** | *g/kg* | 3 |
| ***Organic Matter*** | *g/kg* | 5.1 |
| ***Total Nitrogen*** | *g/kg* | 0.44 |
| ***Available Phosphorus*** | *mg/kg* | 1 |
| ***Exchangeable Calcium*** | *mg/kg* | 3843 |
| ***Exchangeable Magnesium*** | *mg/kg* | 722 |
| ***Exchangeable Potassium*** | *mg/kg* | 82 |
| ***Exchangeable Sodium*** | *mg/kg* | 2 |
| ***Nitrate*** | *mg/kg* | 66 |
| ***Available Iron*** | *mg/kg* | 16 |
| ***Available Boron*** | *mg/kg* | 0.39 |
| ***Available Manganese*** | *mg/kg* | 5 |
| ***Available Copper*** | *mg/kg* | 1 |
| ***Available Zinc*** | *mg/kg* | 5.8 |

### *Climate features*

| | |
|---|---|
| ***Meteorological station*** | **Medesano (PR)** |
| ***Total rainfall (2016) (mm)*** | N.D. |
| ***Rainfall (01.04_30.09 2016) (mm)*** | 136.8 |
| ***HUGLIN Index 2016*** | 2593.9 |
| ***WINKLER Index 2016*** | 1915.29 |

### *Topographical and management features*

| | |
|---|---|
| ***Average slope*** | 0-10% |
| ***Average aspect*** | N.NE-NO |
| ***Farming practice of ploughing*** | Transversal |
| ***Row length*** | 100-200 m |
| ***Row orientation*** | N-S |
| ***Gravel*** | 0-10% |
| ***Organic matter*** | Low |
| ***Soil texture*** | Loamy-Silty-Clay |
| ***Floor management between rows*** | Permanent grassing |
| ***Floor management on the rows*** | Permanent grassing |

| | |
|---|---|
| ***Average roots depth*** | 0.6-1 m |
| ***Groundwater depth*** | Absent |
| ***Drainage*** | Absent |
| ***Total rainfall (mm/year)*** | 500-800 mm |
| ***Rainfall during grapevine growing season*** | < 200 mm |
| ***Planting operation*** | Plowing |
| ***Planting operation depth*** | < 1 m |
| ***Soil tillage*** | No tillage |
| ***Number of tractor's traffic*** | < 15 |
| ***Organic fertilization*** | 0 |
| ***Mineral fertilization*** | 0 |
| ***Treatments with plant protection products*** | <10 |
| ***Degree days during growing season*** | > 1800 °C |


### *Information on vineyard (VSA, farmer interview)*

The vineyard soil is almost flat (slope < 2% perpendicular to row direction).
Vineyard was planted near to an oak forest that partially covers (with canopy and shadow) some rows that show strong vegetative and productive deficiencies. In that problematic area soil is also strongly compact and grass struggles to grow.
In the remaining vineyard, two different vigor classes was surveyed (High and Low)
The vineyard is equipped with drop irrigation system.

It has been decided to concentrate project activities and data collection in the part of vineyard not directly affected by forest, because vigor problems in that area cannot be solved by soil management actions and it is not possible to act on the forest.

### *Identification of potential soil threats*

The information collected was given as input to the Alfa-tool developed in sub-action B1.1 and a potential soil threats ranking was defined (Table TBC2.1):

| **Potential threats** | **Rank** |
|---|---|
| *Erosion* | 2 |
| *Drought* | 1 |
| *Decline in soil organic matter* | 3 |
| *Soil compaction* | 5 |
| *Water logging* | 3 |
| *Soil contamination* | 7 |
| *Decline in soil biodiversity* | 6 |
| *Hard plan* | 8 |

*Table TBC2.1: potential threats as indicated by Alfa-version Decision tool (Sub-action B1.1); 1 is the most probable threat and 8 the less probable one.*

### *From potential to real threats*

Observation of the vineyard and an initial validation of potential soil threats through *visual assessment* approach led to a definition of the following soil threats:

1. **decline in soil organic matter**
   - during soil sampling no organic residues have been found on the soil surface and along soil profile.
   - soil analysis have reveal degree of humification as 4.9%
   - soil analysis have confirmed a low organic matter content (0.5%)

- **low vine vigor**

- **drought**
  - no drought symptoms were visible in vines due to drop irrigation system that demo farmers had installed to avoid those problems. We consider just the same drought as main threats to reduce the need of external water for vines growth.

- **soil compaction**
  - during soil sampling hard pan was found at 35-40 cm of depth

## b. End point

The mitigation goals identified are the following:

- increase of soil organic matter quality and content in whole vineyard;
- decrease of soil compaction and promotion of water fluxes
- reduction of drought effects on vineyards in absence of irrigation system.

The improvement of soil organic usually needs several years to be achieved; nonetheless first evidence of an increase of vine vigor is expected during the project.

## c. How to go there

For each real threat identified, the Alfa-tool developed in sub-action B1.1 provides possible solutions: in the following table, solutions for “decline in soil organic matter”, "drought" and “compaction” are represented.

| | *Erosion* | *Drought* | *Decline in soil organic matter* | *Compaction* | *Water Logging* | *Soil contamination* | *Decline in soil biodiversity* | *Hardpan* |
|---|---|---|---|---|---|---|---|---|
| ***Alternate row grassing*** | | | | | | | | |
| ***Temporary grassing / Leguminouse cover crops*** | | | | | | | | |
| ***Temporary grassing /Brassica cover crops*** | | | | | | | | |
| ***Temporary natural grassing*** | | | | | | | | |
| ***Permanent natural grassing*** | | | | | | | | |
| ***Permanent artificial grassing*** | | | | | | | | |
| ***Soil conditioner*** | | | | | | | | |
| ***Plant protection products applications optimization*** | | | | | | | | |
| ***Change in soil management actions (depth)*** | | | | | | | | |
| ***Change of soil management equipment*** | | | | | | | | |
| ***Underground drainage*** | | | | | | | | |
| ***Superficial water control*** | | | | | | | | |
| ***Permanent mulching in the row (organic/mineral)*** | | | | | | | | |

*Table TBC2.2: possible solution as indicated by Alfa-version Decision tool (Sub-action B1.1)*

After an evaluation of the needed resources, the solution "permanent grassing" was selected to be applied. The seed mixture was carefully chosen and is composed by species belonging to *Fabaceae* family.
*Legumes (Fabaceae*) are characterized by nitrogen fixation capabilities that can enhance vine nutrition and vigor; moreover their deep roots can break down soil aggregates favoring root penetration and improve water movements.
Sowing mixture chosen is **Grass C** which composition is described in Annex A.
Due to the presence of superficial irrigation system, green manure was discarded because tillage is not possible.
At the moment grass in the interrow is highly vigorous and the replacement of it with a composition of different species characterized by imitated growth should reduce water competition with vines and need of transit for cutting.

## d. What to do

Sowing will be performed in early spring of the second project year and, once established, the grass will be managed by the farmer using farm equipments. Cuts should be more frequent, to permit a better stem elongation, but should start not before summer to enable flowering and seed dispersion to enhance grass covering.
During the following years the grass should reach equilibrium and should be managed easily with few cuts during the grape-growing seasons depending on the weather conditions.

In accordance with the farmer, sowing will be performed also in the area affected by forest and researchers will monitor the vine response during project time.
Row weeds will be managed traditionally.

Traditional management is permanent spontaneous grassing.
Sowing will be made only one time in the second year of project (Spring 2018) in 6 inter-rows (F1-F14 and F7-F10) (Figure TBC2.1)

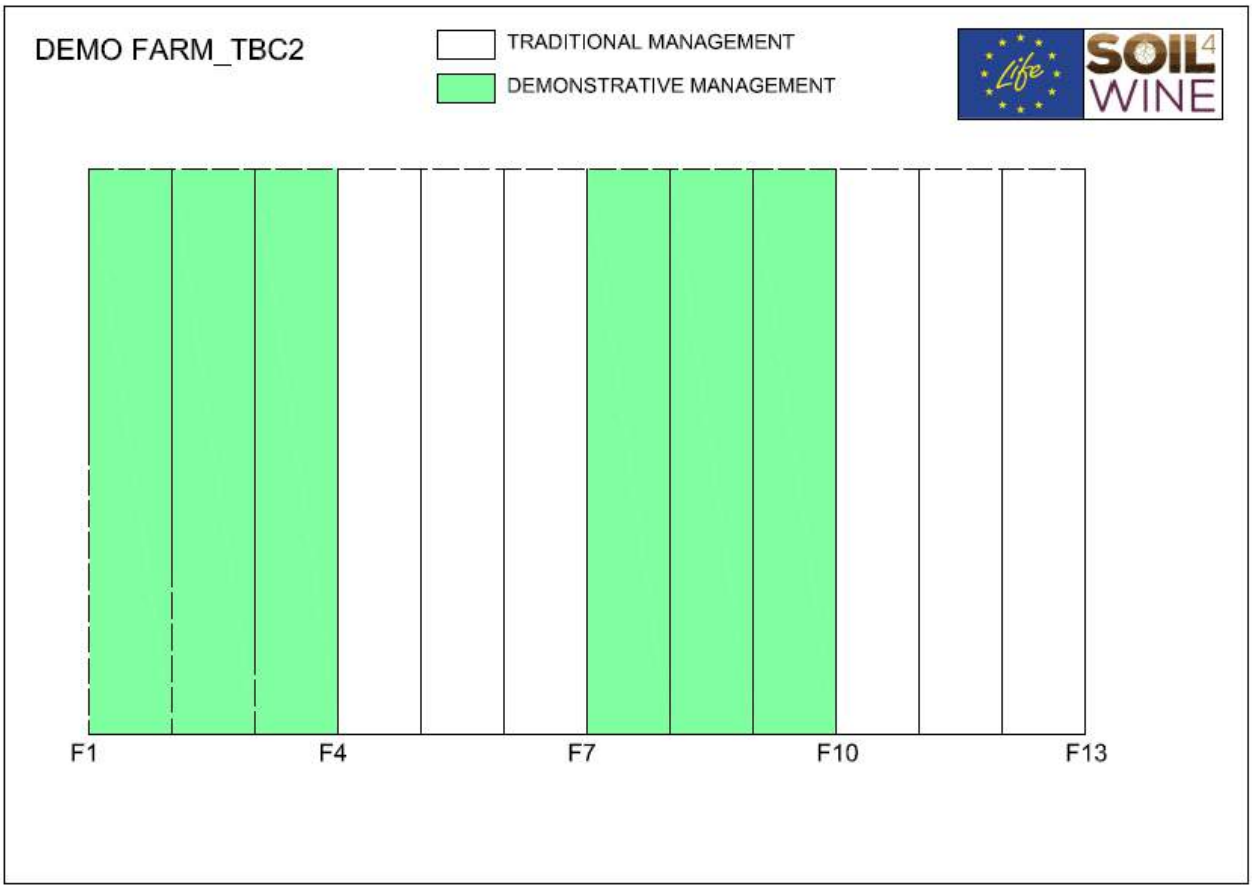



*Figure TBC2.1: demonstrative action scheme*

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Jan** | | | |
| **Feb** | | | |
| **Mar** | | Sowing | Cutting |
| **Apr** | | | |
| **May** | | | |
| **Jun** | | | |
| **Jul** | | Cutting | Cutting |
| **Aug** | | | |
| **Sept** | | | |
| **Oct** | | Cutting | Cutting |
| **Nov** | | | |
| **Dec** | | | |

*Table TBC2.3: Operative timetable*

## e. What to check

Project partners will regularly visit the vineyard in order to monitor the grass growing. Grass cover will be evaluated through visual assessment in three representative areas of at least 0.5 $m^2$.

A complete floristic survey will be performed in spring to assess the colonization of sowed seeds and weeds.

## f. How to remain there

Evaluate every year in late spring the grass coverage, estimating the percentage of soil covered by grass of a defined surface (0.5 $m^2$). If it is lower than 70% it is recommended to spread some more seeds in the following autumn.
It is also possible to evaluate the good status of the grass by quantifying the biomass produced. With standard season-al weather conditions about one trimming per month (March to June) is usually needed to keep the grass shorter than 8-10cm.
Five years after the main sowing is the time window envisaged to sample some soil (60cm depth) and quantify (through chemical analysis) the organic matter quantity and quality. If this will not have increased compared to the baseline before sowing it could be considered that the applied solution is not able to mitigate this specific threat.

# DEMO FARM RES1_Az. Res Uvae (Fertirrigazione)

## a. Start point

### *Vineyard characteristics*

| | |
|---|---|
| ***Vineyard identification (name)*** | Fertirrigazione |
| ***Place*** | Castell'Arquato |
| ***Park (Project area)*** | |
| ***Code A1 Database*** | 116 |
| ***Geographical coordinates*** | 44.856497, 9.854577 |
| ***Elevation (m.s.l.)*** | 259.5 |
| ***Grapevine variety*** | Croatina |
| ***Rootstock*** | SO4 |
| ***Training system*** | Guyot |
| ***Year of planting*** | 2001 |
| ***Distance between vines (m)*** | 1 |
| ***Distance between rows (m)*** | 2.30 |
| ***Vines density (vines/ha)*** | 4348 |
| ***Surface (ha)*** | 0.4 ha |


### *Soil characteristic*

**1. Soil Map Emilia Romagna Region 1:250.000**

The vineyard is located on soils classified as ***"complesso dei suoli "CITTADELLA/TAVASCA"***.

- **CITTADELLA franco limosi, 5-10% pendenti (CTD2)**
  - *FAO (1990): Haplic Luvisols*
  - *Soil Taxonomy: (1994) fine silty, mixed, mesic Aquic Paleustalf*

- **TAVASCA (TAV3)**
  - *FAO (1990): Haplic Lixisols*
  - *Soil Taxonomy: (1990) loamy-skeletal, mixed, mesic Typic Haplustalf*

**2. Soil Map Emilia Romagna Region 1:50.000:**

The vineyars is located on soils classifed as:

- ***"consociazione dei suoli RIVERGARO franco limosi, 1-5% pendenti - RIV1 (Delineation 7316, Cartographic Unit 0464)"***

| | | |
|---|---|---|
| **RIVERGARO franco limosi RIV1** | 100% | *Soil Taxonomy:*<br>(2010) Aquertic Haplustalf fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Cutanic Stagnic Luvisols (Ferric, Clayc) |

- ***"complesso dei suoli RIO RUMORE/ARCELLI/CANTALUPO - RIR0/ARC0/CAT0 (Delineation 7317, Cartographic Unit 0509)"***

| | | |
|---|---|---|
| **ARCELLI 15-40% pendenti ARC1** | 30% | *Soil Taxonomy:*<br>(2010) Vertic Haplustepst fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Vertic Cambisols (Eutric) |
| **RIO RUMORE 40-80% pendenti RIR1** | 25% | *Soil Taxonomy:*<br>(2010) Typic Ustorthents coarse loamy, mixed, superactive, calcareous, mesic<br>*WRB:*<br>(2007) Haplic Regosols (Calcaric, Arenic) |
| **ARCELLI 15-18% pendenti ARC2** | 15% | *Soil Taxonomy:*<br>(2010) Vertic Haplustepst fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Vertic Cambisols (Eutric) |
| **CANTALUPO 8-15% pendenti CAT2** | 12% | *Soil Taxonomy:*<br>(2010) Vertic Calciustepst fine, mixed, active, mesic<br>*WRB:*<br>(2007) Hypocalcic Vertic Calcisols |
| **MASCONI MAS** | 7% | *Soil Taxonomy:*<br>(2010) Typic Haplustepts coarse loamy, mixed, active, mesic<br>*WRB:*<br>(2007) Haplic Cambisols (Eutric) |
| **CITTADELLA franco limosi, 5-10% pendenti CTD2** | 6% | *Soil Taxonomy:*<br>(2010) Aquic Plaeustalfs fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Cutanic Stagnic Luvisols |
| **TAVASCA TAV** | 5% | *Soil Taxonomy:*<br>(2010) Typic Haplustepts clayesly skeletal, mixed, superactive, mesic<br>*WRB:*<br>(2007) Haplic Cambisols (Eutric, Endoskeletic) |

**3. Soil samples analysis**

A complete chemical and physical analysis of soil samples was performed in October 2017.
In the deliverable B2.4 "*Report on initial data on soil and plan data - Part 1*" complete information are reported; hereafter data considered in the design of the action plan are shown.

- ***"consociazione dei suoli RIVERGARO franco limosi, 1-5% pendenti - RIV1 (Delineation 7316, Cartographic Unit 0464)"***

| | | |
|---|---|---|
| ***Soil Texture*** | | Loam |
| ***Sand*** | *%* | 38.3 |
| ***Silt*** | *%* | 38.7 |
| ***Clay*** | *%* | 23 |
| ***Soil acidity (pH in water)*** | | 6.92 |
| ***Total $CaCO_3$*** | *%* | 1.1 |
| ***Active $CaCO_3$*** | *%* | 0.6 |
| ***Electrical conductivity*** | *µS/cm* | 0.09 |
| ***Organic Carbon*** | *g/kg* | 5.1 |
| ***Organic Matter*** | *g/kg* | 8.7 |
| ***Total Nitrogen*** | *g/kg* | 0.64 |
| ***Available Phosphorus*** | *mg/kg* | 2 |
| ***Exchangeable Calcium*** | *mg/kg* | 2972 |
| ***Exchangeable Magnesium*** | *mg/kg* | 532 |
| ***Exchangeable Potassium*** | *mg/kg* | 113 |
| ***Exchangeable Sodium*** | *mg/kg* | 36 |
| ***Nitrate*** | *mg/kg* | 76 |
| ***Available Iron*** | *mg/kg* | 22 |
| ***Available Boron*** | *mg/kg* | 0.37 |
| ***Available Manganese*** | *mg/kg* | 30 |
| ***Available Copper*** | *mg/kg* | 8 |
| ***Available Zinc*** | *mg/kg* | 12.9 |

- ***"complesso dei suoli RIO RUMORE/ARCELLI/CANTALUPO - RIR0/ARC0/CAT0 (Delineation 7317, Cartographic Unit 0509)"***

| | | |
|---|---|---|
| ***Soil Texture*** | | Clay Loamy |
| ***Sand*** | *%* | 35.9 |
| ***Silt*** | *%* | 33.7 |
| ***Clay*** | *%* | 30.4 |
| ***Soil acidity (pH in water)*** | | 6.63 |
| ***Total $CaCO_3$*** | *%* | 1.1 |
| ***Active $CaCO_3$*** | *%* | 0.6 |
| ***Eletrical conductivity*** | *µS/cm* | 0.04 |
| ***Organic Carbon*** | *g/kg* | 2.6 |
| ***Organic Matter*** | *g/kg* | 4.6 |
| ***Total Nitrogen*** | *g/kg* | 0.47 |
| ***Available Phosphorus*** | *mg/kg* | 1 |
| ***Exchangeable Calcium*** | *mg/kg* | 3315 |
| ***Exchangeable Magnesium*** | *mg/kg* | 604 |
| ***Exchangeable Potassium*** | *mg/kg* | 131 |
| ***Exchangeable Sodium*** | *mg/kg* | 23 |
| ***Nitrate*** | *mg/kg* | 197 |
| ***Available Iron*** | *mg/kg* | 22 |
| ***Available Boron*** | *mg/kg* | 0.45 |
| ***Available Manganese*** | *mg/kg* | 24 |
| ***Available Copper*** | *mg/kg* | 4 |
| ***Available Zinc*** | *mg/kg* | 12.5 |

### *Climate features*

| | |
|---|---|
| ***Meteorological station*** | **Res Uvae** |

| | |
|---|---|
| ***Total rainfall (2016) (mm)*** | 1095 |
| ***Rainfall (01.04_30.09 2016) (mm)*** | 409 |
| ***HUGLIN Index 2016*** | 2526.58 |
| ***WINKLER Index 2016*** | 2032.31 |

### *Topographical and management features*

| | |
|---|---|
| ***Average slope*** | 0-10% |
| ***Average aspect*** | N-NE-NO |
| ***Farming practice of ploughing*** | Along main slope direction |
| ***Row length*** | 100-200 m |
| ***Row orientation*** | N-S |
| ***Gravel*** | 0-10 |
| ***Organic matter*** | Low |
| ***Soil texture*** | Clay |
| ***Floor management between rows*** | Alternate row grassing |
| ***Floor management on the rows*** | Herbicides |
| ***Average roots depth*** | 0.6-1 m |
| ***Groundwater depth*** | < 2 m |
| ***Drainage*** | Absent |
| ***Total rainfall (mm/year)*** | 500-800 |
| ***Rainfall during grapevine growing season*** | 200-300 |
| ***Planting operation*** | Ploughing |
| ***Planting operation depth*** | < 1 m |
| ***Soil tillage*** | Tillage |
| ***Number of tractor's traffic*** | 15-25 |
| ***Organic fertilization*** | 2 |
| ***Mineral fertilization*** | 0 |
| ***Treatments with plant protection products*** | <10 |
| ***Degree days during growing season*** | >1800°C |


### *Information on vineyard (VSA, farmer interview)*

The main problem reported is the bad water drainage (water logging is evident even after short precipitation and water remains several days over the soil surface), that makes agronomical practices difficult and influences the health of the vines.
Two main headlands are present in the vineyard: one that crosses the vineyards in half and one that represents the boundary of the vineyard to the NW end.

The vineyard is subject to different nutritional thesis.
In particular row are such arranged:
F1-F3: 100% mineral fertilization with granular fertilizer
F4-F6: 100% mineral fertilization distributed on the row associated with drop irrigation system
F7-F9:50% mineral fertilization distributed on the row associated with drop irrigation system and 50% mineral fertilization with granular fertilizer
.

### *Identification of potential soil threats*

The information collected was given as input to the Alfa-tool developed in sub-action B1.1 and a potential soil threats ranking was defined (Table RES1.1):

| **Potential threats** | **Rank** |
|---|---|

| | |
|---|---|
| *Erosion* | 1 |
| *Drought* | 2 |
| *Decline in soil organic matter* | 3 |
| *Soil compaction* | 5 |
| *Water logging* | 3 |
| *Soil contamination* | 7 |
| *Decline in soil biodiversity* | 6 |
| *Hard plan* | 7 |

*Table RES1.1: potential threats as indicated by Alfa-version Decision tool (Sub-action B1.1); 1 is the most probable threat and 8 the less probable one.*

### *From potential to real threats*

Observation of the vineyard and an initial validation of potential soil threats through *visual assessment* approach led to a definition of the following soil threats:

1. **Erosion**
   - erosive evidences between rows, in particular located in the bottom of vineyard.
   - non-uniform spontaneous grass growth

2. **Water logging**
   - water permanence after rain in the bottom part even if slope is limited

3. **Soil compaction**
   - evidences of compaction especially in headland due to repeated traffic on bare soil

4. **Decline in soil organic matter**
   - during soil sampling no organic residues have been found on the soil surface and along soil profile.
   - non-uniform spontaneous grass growth
   - water erosion of superficial organic layer

   .

## b. End point

The mitigation goals identified are the following:

- reduction of water logging, especially in the bottom part of vineyard;
- reduction of erosion processes in headlands and between rows.
- reduction of soil compaction due to repeated ploughing and traffic in vineyard and especially in the headlands

First evidence of a better water drainage in the vineyard is expected during the project. Also headlands soil conditions should improve within few years.

## c. How to go there

For each real threat identified, the Alfa-tool developed in sub-action B1.1 provides possible solution.

| | *Erosion* | *Drought* | *Decline in soil organic matter* | *Compaction* | *Water Logging* | *Soil contamination* | *Decline in soil biodiversity* | *Hardpan* |
|---|---|---|---|---|---|---|---|---|
| *Alternate row grassing* | | | | | | | | |
| *Temporary grassing / Leguminouse cover crops* | | | | | | | | |
| *Temporary grassing /Brassica cover crops* | | | | | | | | |
| *Temporary natural grassing* | | | | | | | | |
| *Permanent natural grassing* | | | | | | | | |
| *Permanent artificial grassing* | | | | | | | | |
| *Soil conditioner* | | | | | | | | |
| *Plant protection products applications optimization* | | | | | | | | |
| *Change in soil management actions (depth)* | | | | | | | | |
| *Change of soil management equipment* | | | | | | | | |
| *Underground drainage* | | | | | | | | |
| *Superficial water control* | | | | | | | | |
| *Permanent mulching in the row (organic/mineral)* | | | | | | | | |

*Table RES1.2: possible solution as indicated by Alfa-version Decision tool (Sub-action B1.1)*

After an evaluation of the needed resources, the solutions "superficial water control" and "permanent grassing of headlines" was selected to be applied.

On the headlands a demonstration of effects of grass cover on wheels and tracks traffic will be performed.
Grass covering will be permanent and will be made with microtherms and macrotherms species.
Grass on headlands should enhance soil permeability and reduce soil compaction.

In particular headlands in the middle of vineyard and in the bottom will be sowed as indicate in the attached scheme.
Species and mixture sowed in autumn are the following:

- **Grass A**
- **Grass B**
- **Grass D**
- **Grass E**

In spring 2018 other species will be sowed:

- **Grass H**
- **Grass I**
- **Grass J**
- **Grass K**
- **Grass L**

## d. What to do

Sowing of headlands will be performed in autumn of the first year and, once established; grass will be managed by farmer using farm equipment.
Cuts should be more frequent, to permit a better stem elongation, but should start not before summer to enable flowering and seed dispersion to enhance grass covering.
During the following years the grass should reach equilibrium and should be managed easily with few cuts during the grape-growing seasons depending on the weather conditions.
Vineyard will be managed traditionally with strip ploughing.

Sowing will be made in correspondence of 3 or 4 inter-rows. (Figure RES1.1) and regularly trimmed by wine-growers using farm equipment.

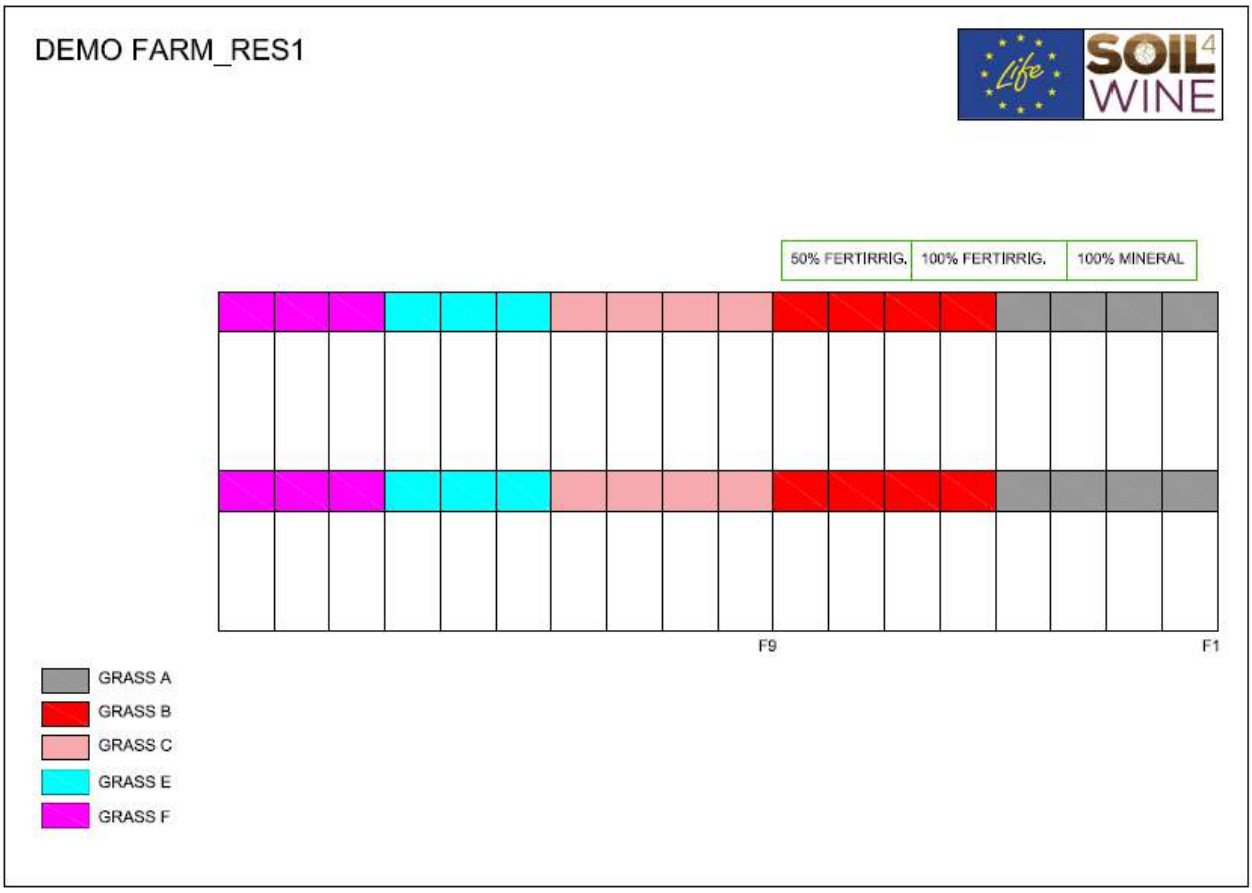



*Figure RES1.1: demonstrative action scheme*

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Jan** | | | |
| **Feb** | | | |
| **Mar** | Sowing | Cutting | Cutting |
| **Apr** | | | |
| **May** | | | |
| **Jun** | | | |
| **Jul** | Cutting | Cutting | Cutting |
| **Aug** | | | |
| **Sept** | | | |
| **Oct** | Cutting | Cutting | Cutting |
| **Nov** | water drainage control operations | | |
| **Dec** | | | |

*Table RES1.3: Operative timetable*

## e. What to check

Project partners will regularly visit the vineyard in order to monitor the grass growing and aspect in order to evaluate the leaf resistance to wheel traffic. Moreover water infiltration tests will be performed on headlands in order to assess effects of grass cover on water movements.

Assessment of vine behavior in the vineyard part affected by water logging should provide information about reduction of roots asphyxia.

Visual assessment will be used to evaluate the reduction of soil erosion and to verify the absence/reduction of erosion rills.

### f. How to remain there

The most resistant grass to machine movements should be selected and sowed on the entire headlands

Moreover, to check whether the water drainage control operations were able to reduce erosion processes, erosion rills should be observed: the depth and number of rills should decrease (in standard seasonal weather conditions). Moreover day of water logging after abundant rainy day have to be monitored.

# DEMO FARM RES2_Az. Res Uvae (Riva)

## a. Start point

### *Vineyard characteristics*

| | |
|---|---|
| ***Vineyard identification (name)*** | Riva |
| ***Place*** | Castell'Arquato |
| ***Park (Project area)*** | N.D. |
| ***Code A1 Database*** | 124 |
| ***Geographical coordinates*** | 44.868822; 9.853697 |
| ***Elevation (m.s.l.)*** | 202 |
| ***Grapevine variety*** | Croatina |
| ***Rootstock*** | ? |
| ***Training system*** | Double Guyot |
| ***Year of planting*** | ? |
| ***Distance between vines (m)*** | 1.2 |
| ***Distance between rows (m)*** | 2.4 |
| ***Vines density (vines/ha)*** | 3472 |
| ***Surface (ha)*** | 0.2 |


### *Soil characteristic*

**1. Soil Map Emilia Romagna Region 1:250.000**

The vineyard is located on soils classified as ***"complesso dei suoli "CITTADELLA/TAVASCA".***

- **CITTADELLA franco limosi, 5-10% pendenti (CTD2)**
  - *FAO (1990): Haplic Luvisols*
  - *Soil Taxonomy: (1994) fine silty, mixed, mesic Aquic Paleustalf*

- **TAVASCA (TAV3)**
  - *FAO (1990): Haplic Lixisols*
  - *Soil Taxonomy: (1990) loamy-skeletal, mixed, mesic Typic Haplustalf*

**2. Soil Map Emilia Romagna Region 1:50.000**

The vineyard is located on soils classified as ***"complesso dei suoli CITTADELLA/RIVERGARO franco limosi, 1-5% pendenti - RIV1 (Delineation 7316, Cartographic Unit 0464)"***

| | | |
|---|---|---|
| **CITTADELLA franco limosi 1-5% pendenti CTD1** | 45% | *Soil Taxonomy:*<br>(2010) Aquic Paleustalf fine silty, mixed, superactive, mesic<br>*WRB:*<br>(2007) Cutanic Stagnic Luvisols |
| **RIVERGARO franco limosi RIV1** | 30% | *Soil Taxonomy:*<br>(2010) Aquertic Haplustalf fine, mixed, superactive, mesic<br>*WRB:*<br>(2007) Cutanic Stagnic Luvisols (Ferric, Clayc) |
| **CITTADELLA franco limosi 5-10% pendenti CTD2** | 15% | *Soil Taxonomy:*<br>(2010) Aquic Paleustalf fine silty, mixed, superactive, mesic<br>*WRB:*<br>(2007) Cutanic Stagnic Luvisols |
| **RIO RUMORE 40-80% pendenti RIR1** | 10% | *Soil Taxonomy:*<br>(2010) Typic Ustorthents coarse loamy, mixed, superactive, calcareous, mesic<br>*WRB:*<br>(2007) Haplic Regosols (Calcaric, Arenic) |

## 3. Soil samples analysis

A complete chemical and physical analysis of soil samples was performed in October 2017.
In the deliverable B2.4 "*Report on initial data on soil and plan data - Part 1*" complete information are reported; hereafter data considered in the design of the action plan are shown.

| | | |
|---|---|---|
| ***Soil Texture*** | | Loamy |
| ***Sand*** | *%* | 35.8 |
| ***Silt*** | *%* | 38.4 |
| ***Clay*** | *%* | 25.8 |
| ***Soil acidity (pH in water)*** | | 5.53 |
| ***Total $CaCO_3$*** | *%* | 0.7 |
| ***Active $CaCO_3$*** | *%* | 0.5 |
| ***Electrical conductivity*** | *µS/cm* | 0.06 |
| ***Organic Carbon*** | *g/kg* | 4.3 |
| ***Organic Matter*** | *g/kg* | 7.4 |
| ***Total Nitrogen*** | *g/kg* | 0.59 |
| ***Available Phosphorus*** | *mg/kg* | 1 |
| ***Exchangeable Calcium*** | *mg/kg* | 1725 |
| ***Exchangeable Magnesium*** | *mg/kg* | 477 |
| ***Exchangeable Potassium*** | *mg/kg* | 102 |
| ***Exchangeable Sodium*** | *mg/kg* | 7 |
| ***Nitrate*** | *mg/kg* | 123 |
| ***Available Iron*** | *mg/kg* | 38 |
| ***Available Boron*** | *mg/kg* | 0.55 |
| ***Available Manganese*** | *mg/kg* | 100 |
| ***Available Copper*** | *mg/kg* | 2 |
| ***Available Zinc*** | *mg/kg* | 12.3 |

### *Climate features*

| ***Meteorological station*** | **Res Uvae** |
|---|---|
| ***Total rainfall (2016) (mm)*** | 1095 |
| ***Rainfall (01.04_30.09 2016) (mm)*** | 409 |
| ***HUGLIN Index 2016*** | 2526.58 |
| ***WINKLER Index 2016*** | 2032.31 |

### *Topographical and management features*

| | |
|---|---|
| ***Average slope*** | 0-10% |
| ***Average aspect*** | N-NE-NO |
| ***Farming practice of ploughing*** | Along main slope direction |
| ***Row length*** | 100-200 m |
| ***Row orientation*** | N-S |
| ***Gravel*** | 0-10 |
| ***Organic matter*** | Low |
| ***Soil texture*** | Loamy |
| ***Floor management between rows*** | Alternate row grassing |
| ***Floor management on the rows*** | Herbicides |
| ***Average roots depth*** | 0.6-1 m |
| ***Groundwater depth*** | < 2 m |
| ***Drainage*** | Absent |
| ***Total rainfall (mm/year)*** | 500-800 |
| ***Rainfall during grapevine growing season*** | 200-300 |
| ***Planting operation*** | Ploughing |
| ***Planting operation depth*** | < 1 m |
| ***Soil tillage*** | Ploughing |
| ***Number of tractor's traffic*** | 15-25 |
| ***Organic fertilization*** | 2 |
| ***Mineral fertilization*** | 0 |
| ***Treatments with plant protection products*** | <10 |
| ***Degree days during growing season*** | >1800°C |


### *Information on vineyard (VSA, farmer interview)*

The vineyard is characterized by a severe slope and evident erosion (deep rills >10-15 cm, vine root system visible), that makes agronomical practices difficult and influences the health of the vines.

### *Identification of potential soil threats*

The information collected was given as input to the Alfa-tool developed in sub-action B1.1 and a potential soil threats ranking was defined (Table RES2.1):

| **Potential threats** | **Rank** |
|---|---|
| *Erosion* | 1 |
| *Drought* | 2 |
| *Decline in soil organic matter* | 4 |
| *Soil compaction* | 4 |
| *Water logging* | 3 |
| *Soil contamination* | 6 |
| *Decline in soil biodiversity* | 6 |
| *Hard plan* | 8 |

*Table RES2.1: potential threats as indicated by Alfa-version Decision tool (Sub-action B1.1); 1 is the most probable threat and 8 the less probable one.*

### *From potential to real threats*

Observation of the vineyard and an initial validation of potential soil threats through *visual assessment* approach led to a definition of the following soil threats:

1. **erosion:**
   - erosive evidences between rows and on the row
   - non-uniform spontaneous grass growth
   - rills depth > 10 cm
   - root system partially exposed
   - spontaneous grass with moderately problems of growth

2. **decline in soil organic matter**
   - during soil sampling no organic residues have been found on the soil surface and along soil profile.
   - non-uniform spontaneous grass growth
   - erosion of superficial organic layer
   - Soil analysis have confirmed a low organic matter content (0.74%)

5. **drougth**
   - low precipitation during growing season (vintage 2017 characterized by no rainy day)
   - initial symptoms of drought in shoot tips since July.

## b. End point

- reduction of erosion processes
- regulation of water and enhancing of soil water holding capacity
- restoring of inter-row damaged due to severe erosion processes

Reduction of erosion processes can enhance organic matter formation processes that now are limited due to soil deplatation in superficial layers.

## c. How to go there

For each real threat identified, the Alfa-tool developed in sub-action B1.1 provides possible solutions: in the following table, solutions for “erosion”, "drought" and “decline in soil organic matter” are represented.

| | *Erosion* | *Drought* | *Decline in soil organic matter* | *Compaction* | *Water Logging* | *Soil contamination* | *Decline in soil biodiversity* | *Hardpan* |
|---|---|---|---|---|---|---|---|---|
| ***Alternate row grassing*** | | | | | | | | |
| ***Temporary grassing / Leguminouse cover crops*** | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Temporary grassing /Brassica cover crops*** | | | | | | | | |
| ***Temporary natural grassing*** | | | | | | | | |
| ***Permanent natural grassing*** | | | | | | | | |
| ***Permanent artificial grassing*** | | | | | | | | |
| ***Soil conditioner*** | | | | | | | | |
| ***Plant protection products applications optimization*** | | | | | | | | |
| ***Change in soil management actions (depth)*** | | | | | | | | |
| ***Change of soil management equipment*** | | | | | | | | |
| ***Underground drainage*** | | | | | | | | |
| ***Superficial water control*** | | | | | | | | |
| ***Permanent mulching in the row (organic/mineral)*** | | | | | | | | |

*Table RES2.2: possible solution as indicated by Alfa-version Decision tool (Sub-action B1.1)*

After an evaluation of the needed resources, the solutions "underground drainage" joined with the restoration of damaged inter-row due to severe erosion processes.
Indeed main problem is the bad water drainage that create problems to tillage or agronomical practices in vineyard and difficult in vines.
Control of superficial and underground water movement and restoration of terrain in vines interrows and rows can reduce also drought symptoms in most damaged vine rows (that at the moment present exposed roots).

## d. What to do

Underground drainage will be laid after a technical design aimed to reduce water fluxes in vineyard.

Vineyard will be managed traditionally with strip ploughing.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Jan** | | | |
| **Feb** | | Design of underground drainage | |
| **Mar** | | | |
| **Apr** | | | |
| **May** | | | |
| **Jun** | | | |
| **Jul** | | | |
| **Aug** | | | |
| **Sept** | | | |
| **Oct** | | | |
| **Nov** | | | |
| **Dec** | | | |

*Table RES2.3: Operative timetable*

## e. What to check

Project partners will visit regularly vineyard in order to monitor the reduction of soil erosion and to verify the absence of erosion rills.
Analysis on vines behavior should confirm the efficacy of solution implemented.

## f. How to remain there

To check whether the underground drainage was able to reduce erosion processes, erosion rills should be observed: the depth and number of rills should decrease (in standard seasonal weather conditions). If this is the case, the mitigation solution was successfully.

# DEMONSTRATIVE VINEYARD

All the proposed seed mixtures sowed in Demo Farms and additional sowing mixtures have been sowed in a demonstrative vineyard at Res Uvae farm in order to compare seed mixtures features and behavior with the same environmental conditions and verify the suitability of several permanent grass solutions (microtermal and macrotermal species) to track movement.

The vineyard rows will be managed according to the mixture features as indicated in each demo farms action plans.

This vineyard will be visited during Res Uvae Demo Farm "field visit" (Sub-Action B3.4).

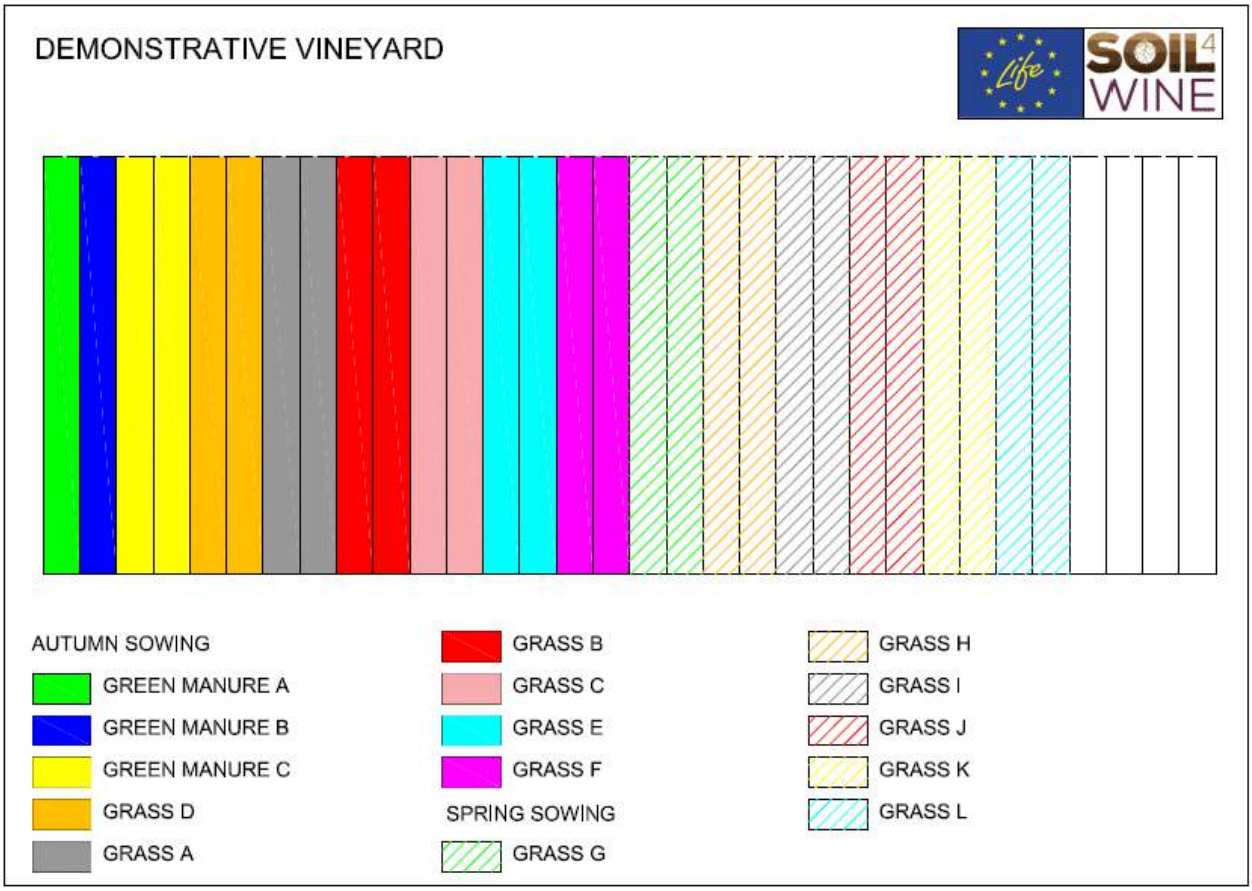



*Figure DEMO1: demonstrative action scheme*

# Annex A: List of sowing mixture

## 1. Green manure

### Green Manure A

| | |
|---|---|
| *Avena sativa* | 10% |
| *Avena strigosa* | 16% |
| *Brassica juncea* | 1% |
| *Faba minor* | 9% |
| *Lolium italicum* | 15% |
| *Phacelia tanacetifolia* | 3% |
| *Pisum sativum ssp* | 10% |
| *Raphanus sativum* oleiformis | 4% |
| *Sinapsis alba* | 1% |
| *Trifolium squarrosum* | 4% |
| *Vicia sativa* | 10% |
| *x Triticosecale* | 17% |

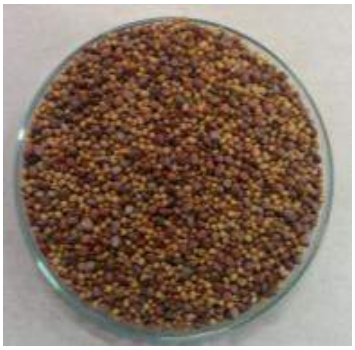
- **Sowing dose**: 90 Kg/ha

### Green Manure B

| | |
|---|---|
| *Hordeum vulgare* | 35% |
| *Pisum sativum* | 40% |
| *Raphanus sativum* oleiformis | 7% |
| *Sinapsis spp.* | 5% |
| *Vicia sativa* | 8% |
| *Vicia villosa* | 5% |

- 

### Green Manure C



| | |
|---|---|
| *Brassica juncea* | 10% |
| *Raphanus sativum* oleiformis | 45% |
| *Sinapsis alba* | 45% |

- **Sowing dose**: 25 Kg/ha

## 2. Permanent grass

### Grass A

| | |
|---|---|
| *Dactylis glomerata* Amba | 5% |
| *Festuca arundinacea* Segna | 20% |
| *Festulolium* Lofa | 20% |
| *Lolium hybridum* Leonis | 10% |
| *Lolium italicum* Energyl | 10% |
| *Lolium perenne* Prana | 20% |
| *Onobrychis viciifolia* Taya | 5% |
| *Trifolium pratense* Nike | 7% |
| *Trifolium repens* Huia | 3% |

- **Sowing dose**: 55 Kg/ha

### Grass B

| | |
|---|---|
| *Festuca ovina* | 20% |
| *Festuca rubra* | 40% |
| *Lolium perenne* | 30% |
| *Poa pratensis* | 10% |

- **Sowing dose**: 90 Kg/ha

### Grass C

*Trifolium squarrosum*
*Trifolium subterraneum*
*Trifolium repens*
*Trifolium incarnatum*
*Onibrychis viciifolia*
*Medicago sativa*

- **Sowing dose**: 50 Kg/ha

### Grass D

| | |
|---|---|
| *Festuca arundinacea* | 67% |
| *Lolium perenne* | 25% |
| *Poa pratensis* | 5% |
| *Trifolium repens* | 3% |

- **Sowing dose**: 55 Kg/ha

## Grass E

*Lolium perenne*
*Avena spp*

- **Sowing dose**: 50 Kg/ha

## Grass F

*Lolium perenne*

- **Sowing dose**: 50 Kg/ha

## Grass G

*Medicago sativa*

- **Sowing dose**: 40 Kg/ha

## Grass H

*Cynodon spp*

- **Sowing dose**: 50 Kg/ha

## Grass I

*Cynodon spp* 70%
*Lolium perenne* 30%

- **Sowing dose**: 50 Kg/ha

## Grass J

*Pennisetum spp.*

- **Sowing dose**: 50 Kg/ha

## Grass K

*Paspalum spp*

- **Sowing dose**: 50 Kg/ha

## Grass L

*Zoysya spp*

- **Sowing dose**: 50 Kg/ha