LIFE Project Number

<LIFE15 ENV/IT/000641>

Deliverable "Report on initial soil and plant data in selected vineyards"

Soil and plant data_Part 2

Sub-action B2.4 "SWOT analysis"

LIFE+ PROJECT Soil4Wine

-

Table of contents

Abstract

Aim of the Deliverable *"Report on initial soil and plant data in selected vineyards"* is to present and comment the features of demonstrative vineyards at the beginning of Project, before the implementation of demonstrative solution. Sampling scheme for the entire project period is also presented.
According to characteristics of data that have to be collected in project action this Deliverable will be presented in two parts:
- *Part 1* (M12) presenting chemical and physical soil properties and vines behavior features. Data on vines features concerning harvesting and pruning of season 2017.
- *Part 2* (M21) presenting biological soil properties derived from soil sampling performed in Spring 2018.
For each vineyard statistical analysis on vines behavior related to action plan scheme was performed and discussed.
Conclusions presents preliminary discussion about soil properties.

The subject of this report is so the presentation of the initial data collected by UCSC and HORTA on soil biological properties. Data have been collected after the adoption of Action Plans due to bad weather conditions, so them are refereed to traditional management portion of demonstrative vineyards.

• Materials and Methods

• Soil chemical and physical analyses (0-20 cm depth)

In order to better describe and comment soil biological features of demonstrative vineyards soils a sampling collection was performed. Soils were collected on 8th and 9th May 2018.
Undisturbed soil samples were extracted using a manual Dutch Augers to represent 0-20 cm depth following EN216 protocol.
Soil samples were analyzed in internal laboratory. In Table 1 all the parameters analyzed are reported with indication of units and methods (according to Italian Ministry Decree 13.09.1999).

Parameter	Unit	Method
Sand	*%*	D.M. 13/09/99 Annex II.5
Silt	*%*	D.M. 13/09/99 Annex II.5
Clay	*%*	D.M. 13/09/99 Annex II.5
Soil acidity (pH in water)		D.M. 13/09/99 Annex III.1
Total $CaCO_3$	*%*	D.M. 13/09/99 Annex V.2
Active $CaCO_3$	*%*	D.M. 13/09/99 Annex V.2
Organic Carbon	*%*	D.M. 13/09/99 Annex VII.3
Organic Matter	*%*	D.M. 13/09/99 Annex VII.3
Total Cu	*ppm*	D.M. 13/09/99 Annex XI.1

Table 1: Soil parameters analyzed with indication of analytical methods

- **QBS-ar index and analysis of carbon in microbial biomass**

- *QBS-ar index*

QBS-ar (Parisi, 2001, 2005) is one of the indices largely used in the definition of soil quality based on the following relation: *the higher soil quality, the higher will be the number of micro arthropod groups well adapted to soil habitats* (Parisi, 2005).

Method proposed the extraction of micro arthropod s using a Berlese-Tullgren funnel (Figure 1). Soil is placed on the mesh above the funnel and a bottle filled with preservative liquid (ethanol and glycerol) is inserted beneath the funnel. Extraction duration will be never less than 5 days (according to soil moisture content). Extracted specimens are observed under a stereomicroscope at low magnification. QBS method require searching for biological form (morpho-type) that is most adapted to soil and each one ones will receive an eco-morphological score (EMI) proportionate to its adaptation level. EMI value range between 1 and 20 and QBS results from the sum of individual EMI. QBS-ar should be classified in 7 soil quality classes (Figure 5) with increasing soil adaptation to limitations.

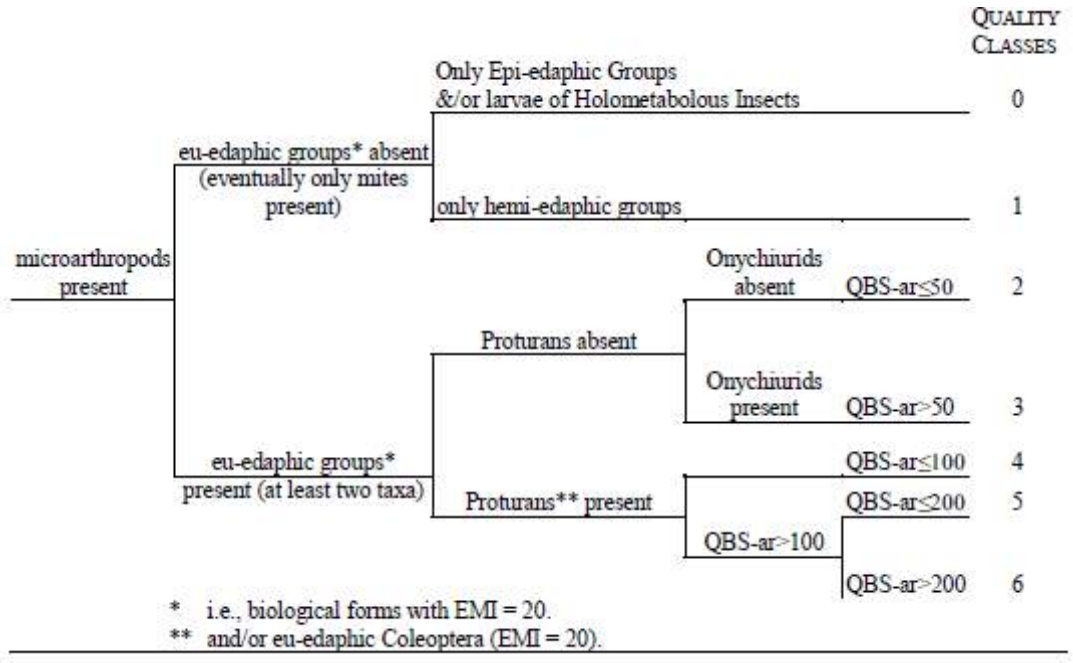

Figure 1: Transformation of QBS-ar values into Soil Quality Classes (Parisi, 2001)

Samples were collected on 8th May and 19th June 2018 when soil conditions were almost optimal in terms of soil moisture (around 40-80% of field capacity). . Three randomly samples were collect in top, medium and bottom position and each samples measuring 10 x 10 x 10 cm, removing litter and grass. Samples were send to laboratory within 24 hours from sampling.

- *Carbon in microbial biomass (B_c)*

Measure of Carbon in microbial biomass indicates the Carbon contained in the living soil biomass (fungi and bacteria mostly). It is an indicator of changes in total soil Carbon due to soil management.

Microbial biomass content is affected by several factors such as soil water content, pH, organic C content, and clay content and also management of crop residues.

In order to better understand the meaning of Carbon in microbial biomass content is useful to relate it to Microbial quotient (MQ) that is the ratio of microbial biomass to soil organic carbon (B_c/TOC) that indicates the how efficiently soil organic matter is being used by microorganism (Sparling, 1992) and so the soil system tendency to increase soil organic matter content. In fact TOC explains the amount of C substrate available for microbial biomass.

To determine QBS-ar and carbon in microbial biomass soil samples were analyzed in an external laboratory. Each sample was coded (*Table 2*) to maintain anonymity of Demo Farms with soil laboratory. Codes and date of sampling are reported in the attached analysis report provided by the laboratory.

Farm Code	Farm name	Code	Date of sampling
SP1	Az. Vitivinicola Barbuti Giuseppe	2366	08th May 2018
SP2	Az. Podere Le Lame	2367	08th May 2018
SP3	Az. Vitivinicola Visconti Massimo	2381	19th June 2018
SP4	Az. Vini Colombi	2370	08th May 2018
VT1	Az. Agr. La Pagliara	2368	08th May 2018
VT2	Az. Agr. Carrà Stefano	2382	19th June 2018
TBC1	Az. Monte delle Vigne	2369	08th May 2018
TBC2	Az. Vitivinicola Palazzo	2383	19th June 2018
RES1	Az. Res Uvae	2384	19th June 2018
RES2	Az. Res Uvae	2385	19th June 2018

Table 2: Soil samples codes and date of sampling

- **Earthworms abundance**

Earthworms are known as good bio-indicators of soil quality and fertility (Falco et al., 2015; Paoletti et al., 1991) as they have low mobility and so they are strongly connected to soil. Earthworms are highly sensible to soil changes due to soil management (tillage, chemical products, compaction and so on) and impact on soil in, at least, three ways:

1. *physical effects:* influence on soil aggregates and porosity resulting from the digging of burrows and cast production;
2. *chemical effects:* decomposition of soil litter, contribution to soil weathering and humification processes;
3. *biological effects*: interaction with micro and macro fauna and dispersion of litter from ingestion processes.

Method used for earthworms sampling is *hand-sorting technique* (Paoletti et al., 2013, ISO No. 11268-3) that consist in an accurate and laborious method that allow to quantify earthworms in a given location.
This method physically destruct soil and earthworm community age structure, seasonal temperature and moisture trends were the factors most integral to the efficiency of each technique.

For each vineyards three soil plot (30 x 30 x 20 cm, 18.000 cm^3) were analyzed, one for each position considered (top, middle and bottom) and features of earthworms were noted. To a better extraction a mustard powder water suspension (concentration 10 g/l), considered as not dangerous irritant suspension, was used.

Figure 2: hand-sorting in DEMO farm soils

Parameters considered were: position, depth, number of earthworms, color, dimension and age (young or adult according to the presence of "clitellum")
Best sampling periods are spring and fall and, according to weather conditions, sampling were made between 19th April and 9th May 2018 (*Table 3*).

Farm Code	Farm name	Date of sampling
SP1	Az. Vitivinicola Barbuti Giuseppe	19th April 2018
SP2	Az. Podere Le Lame	19th April 2018
SP3	Az. Vitivinicola Visconti Massimo	9th May 2018
SP4	Az. Vini Colombi	19th April 2018
VT1	Az. Agr. La Pagliara	20th April 2018
VT2	Az. Agr. Carrà Stefano	18th April 2018
TBC1	Az. Monte delle Vigne	18th April 2018
TBC2	Az. Vitivinicola Palazzo	18th April 2018
RES1	Az. Res Uvae	20th April 2018
RES2	Az. Res Uvae	23th April 2018

Table 3: Date of earthworms hunting in demonstrative farms

- ## DEMO FARMS Soil chemical and physical properties (0-20 layer)

1. DEMO FARM SP1_Az. Vitivinicola Barbuti Giuseppe

Parameter	Unit	Value
Sand	*%*	36
Silt	*%*	48
Clay	*%*	16

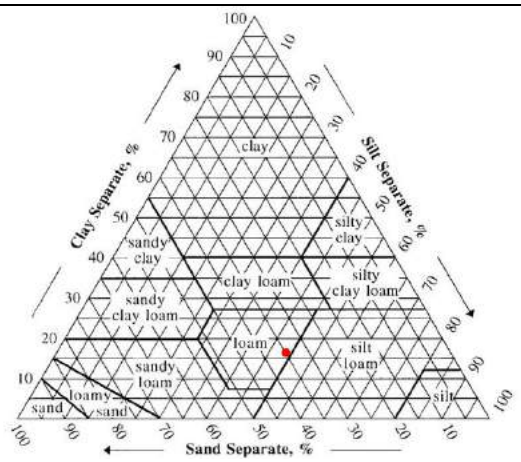

Figure 3: Soil texture triangle (USDA). Red dot identifies soil texture of the DEMO farm.

Soil texture		Loamy
Soil acidity (pH in water)		8.27
Total $CaCO_3$	*%*	25
Active $CaCO_3$	*%*	6.3
Organic Carbon	*%*	1.02
Organic Matter	*%*	1.76
Total Copper	*ppm*	52.16

2. DEMO FARM SP2_Az. Podere Le Lame

Parameter	Unit	Value
Sand	*%*	14
Silt	*%*	47
Clay	*%*	39

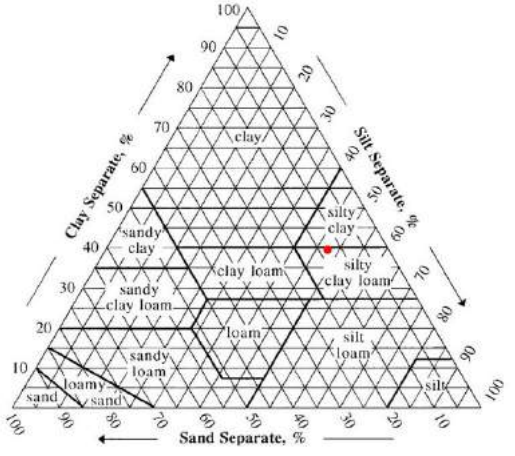

Figure 4: Soil texture triangle (USDA). Red dot identifies soil texture of the DEMO farm.

Soil texture		Silty Clay Loam
Soil acidity (pH in water)		8.23
Total $CaCO_3$	*%*	24
Active $CaCO_3$	*%*	12.3
Organic Carbon	*%*	1.00
Organic Matter	*%*	1.72
Total Copper	*ppm*	49.89

3. DEMO FARM SP3_Az. Vitivinicola Visconti Massimo

Parameter	Unit	Value
Sand	*%*	24
Silt	*%*	43
Clay	*%*	33

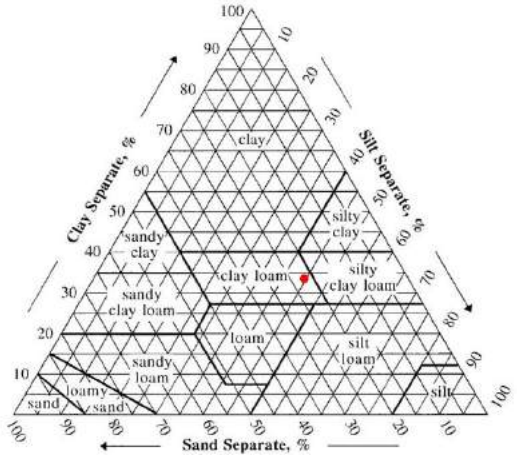

Figure 1: Soil texture triangle (USDA). Red dot identifies soil texture of the DEMO farm.

Soil texture		Clay Loam
Soil acidity (pH in water)		8.21
Total $CaCO_3$	*%*	33
Active $CaCO_3$	*%*	12.6
Organic Carbon	*%*	0.96
Organic Matter	*%*	1.65
Total Copper	*ppm*	42.58

4. DEMO FARM SP4_Az. Vini Colombi

Parameter	Unit	Value
Sand	*%*	22
Silt	*%*	47
Clay	*%*	31

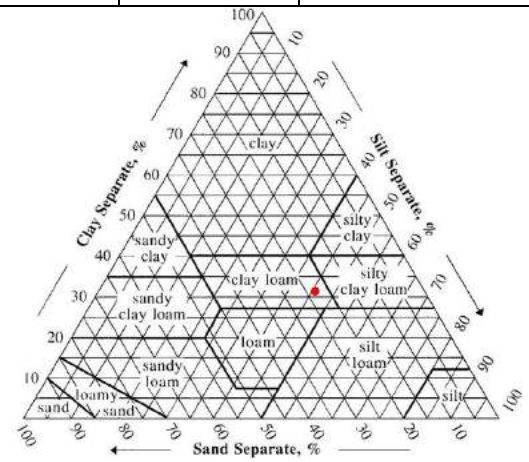

Figure 6: Soil texture triangle (USDA). Red dot identifies soil texture of the DEMO farm.

Soil texture		Clay Loam
Soil acidity (pH in water)		7.05

Total $CaCO_3$	*%*	0
Active $CaCO_3$	*%*	0.9
Organic Carbon	*%*	0.99
Organic Matter	*%*	1.7
Total Copper	*ppm*	34.75

5. DEMO FARM VT1_Az. Agr. La Pagliara

Parameter	Unit	Value
Sand	*%*	23
Silt	*%*	30
Clay	*%*	47

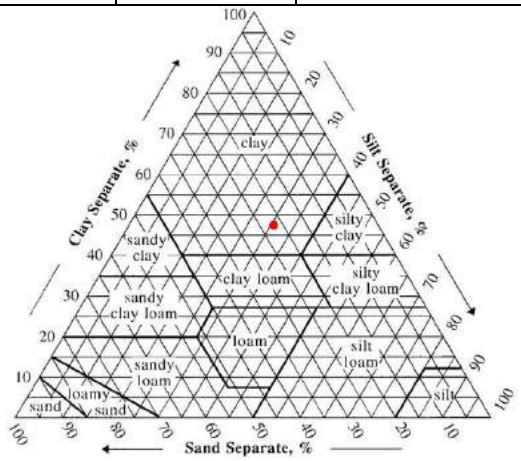

Figure7: Soil texture triangle (USDA). Red dot identifies soil texture of the DEMO farm.

Soil texture		Clay
Soil acidity (pH in water)		8.19
Total $CaCO_3$	*%*	16
Active $CaCO_3$	*%*	7.9
Organic Carbon	*%*	0.88
Organic Matter	*%*	1.52
Total Copper	*ppm*	57.76

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

Parameter	Unit	Value
Sand	*%*	24
Silt	*%*	45
Clay	*%*	31

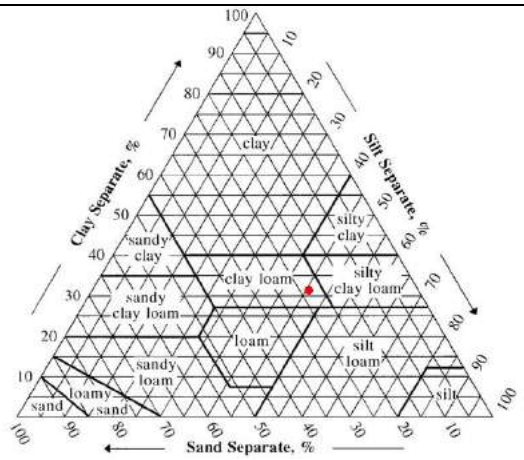

Figure 8: Soil texture triangle (USDA). Red dot identifies soil texture of the DEMO farm.

Soil texture		Clay Loamy
Soil acidity (pH in water)		8.13
Total $CaCO_3$	*%*	32
Active $CaCO_3$	*%*	12.6
Organic Carbon	*%*	1.47
Organic Matter	*%*	2.53
Total Copper	*ppm*	109.85

7. DEMO FARM TBC1_Az. Monte delle Vigne

Parameter	Unit	Value
Sand	*%*	12
Silt	*%*	47
Clay	*%*	41

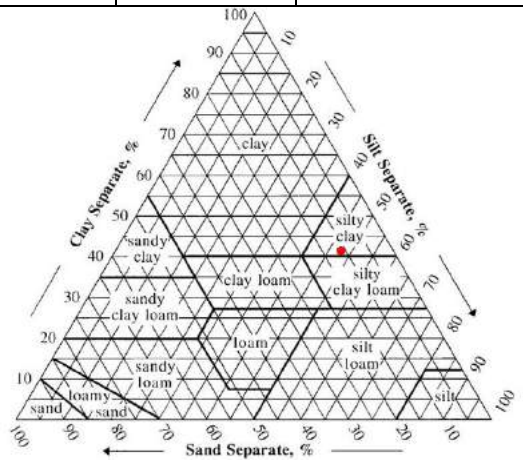

Figure9: Soil texture triangle (USDA). Red dot identifies soil texture of the DEMO farm.

Soil texture		Silty Clay
Soil acidity (pH in water)		8.12
Total $CaCO_3$	*%*	12
Active $CaCO_3$	*%*	8.5
Organic Carbon	*%*	0.89
Organic Matter	*%*	1.54
Total Copper	*ppm*	49.95

8. DEMO FARM TBC2_Az. Vitivinicola Palazzo

Parameter	Unit	Value
Sand	*%*	18
Silt	*%*	61
Clay	*%*	21

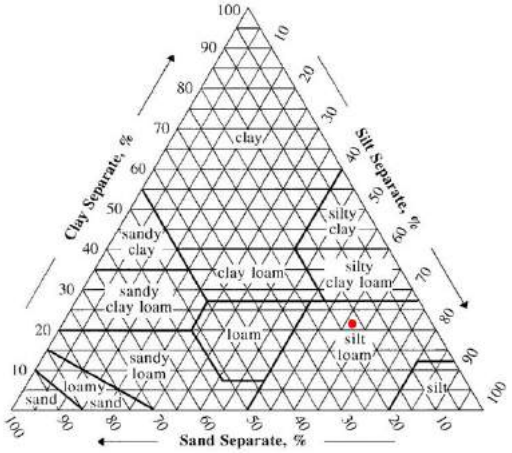

Figure10: Soil texture triangle (USDA). Red dot identifies soil texture of the DEMO farm.

Soil texture		Silt Loamy
Soil acidity (pH in water)		6.46
Total $CaCO_3$	*%*	0
Active $CaCO_3$	*%*	0.6
Organic Carbon	*%*	1.66
Organic Matter	*%*	2.86
Total Copper	*ppm*	24.88

9. DEMO FARM RES1_Az. Res Uvae (Fertirrigazione)

Parameter	Unit	Value
Sand	*%*	19
Silt	*%*	51
Clay	*%*	30

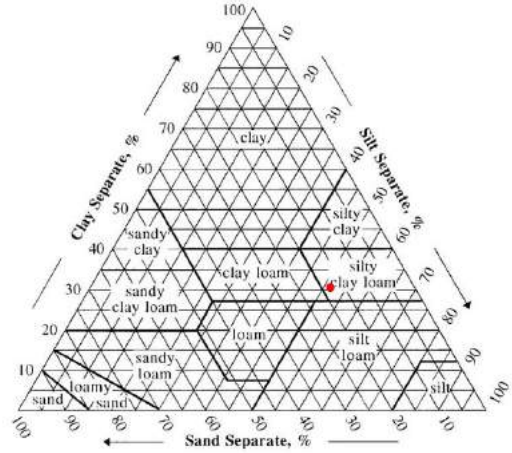

Figure11: Soil texture triangle (USDA). Red dot identifies soil texture of the DEMO farm.

Soil texture		Silty Clay Loam
Soil acidity (pH in water)		7.05

Total $CaCO_3$	*%*	0
Active $CaCO_3$	*%*	0.9
Organic Carbon	*%*	0.45
Organic Matter	*%*	0.77
Total Copper	*ppm*	48.95

10. DEMO FARM RES2_Az. Res Uvae (Riva)

Parameter	Unit	Value
Sand	*%*	26
Silt	*%*	41
Clay	*%*	33

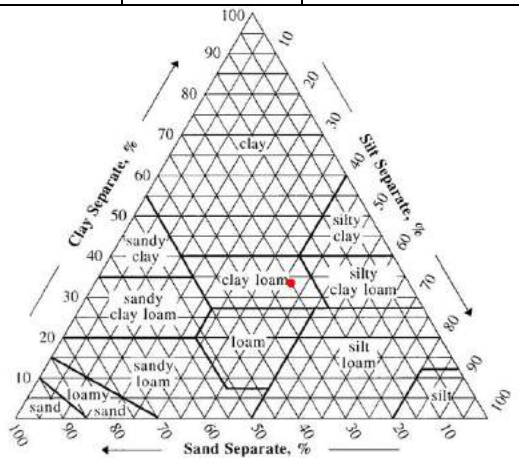

Figure12: Soil texture triangle (USDA). Red dot identifies soil texture of the DEMO farm.

Soil texture		Clay Loam
Soil acidity (pH in water)		6.09
Total $CaCO_3$	*%*	0
Active $CaCO_3$	*%*	0.7
Organic Carbon	*%*	0.57
Organic Matter	*%*	0.99
Total Copper	*ppm*	44.36

- **DEMO FARMS QBS-ar index**

Farm Code	Farm name	EMI score	Soil Quality class
SP1	Az. Vitivinicola Barbuti Giuseppe	91	4
SP2	Az. Podere Le Lame	100	4
SP3	Az. Vitivinicola Visconti Massimo	51	3
SP4	Az. Vini Colombi	120	5
VT1	Az. Agr. La Pagliara	81	4
VT2	Az. Agr. Carrà Stefano	81	4
TBC1	Az. Monte delle Vigne	96	4
TBC2	Az. Vitivinicola Palazzo	46	3_2*
RES1	Az. Res Uvae	61	3
RES2	Az. Res Uvae	60	4

**Class with EMI lower than 50 but with the presence of Onychiurids*

Table 4: QBS-ar demonstrative farms

- ## DEMO FARMS Carbon in microbial biomass (B_c)

Farm Code	Farm name	Carbon in microbial biomass (µg/g)
SP1	Az. Vitivinicola Barbuti Giuseppe	415
SP2	Az. Podere Le Lame	205
SP3	Az. Vitivinicola Visconti Massimo	225
SP4	Az. Vini Colombi	458
VT1	Az. Agr. La Pagliara	393
VT2	Az. Agr. Carrà Stefano	234
TBC1	Az. Monte delle Vigne	190
TBC2	Az. Vitivinicola Palazzo	262
RES1	Az. Res Uvae	194
RES2	Az. Res Uvae	196

Table 5: Carbon in microbial biomass in demonstrative farms

Farm Code	Farm name	Microbial quotient (MQ)
SP1	Az. Vitivinicola Barbuti Giuseppe	4.32
SP2	Az. Podere Le Lame	2.07
SP3	Az. Vitivinicola Visconti Massimo	2.56
SP4	Az. Vini Colombi	3.12
VT1	Az. Agr. La Pagliara	8.73
VT2	Az. Agr. Carrà Stefano	2.36
TBC1	Az. Monte delle Vigne	2.13
TBC2	Az. Vitivinicola Palazzo	1.57
RES1	Az. Res Uvae	1.90
RES2	Az. Res Uvae	4.36

Table 6: Microbial quotient in demonstrative farms

- ## DEMO FARMS Earthworms abundance

Farm Code	Farm name	Average density (n/m^3)
SP1	Az. Vitivinicola Barbuti Giuseppe	203.7
SP2	Az. Podere Le Lame	129.6
SP3	Az. Vitivinicola Visconti Massimo	351.9
SP4	Az. Vini Colombi	361.1
VT1	Az. Agr. La Pagliara	148.1
VT2	Az. Agr. Carrà Stefano	500.0
TBC1	Az. Monte delle Vigne	296.3
TBC2	Az. Vitivinicola Palazzo	592.6
RES1	Az. Res Uvae	370.4
RES2	Az. Res Uvae	18.52

Table 6: earthworms abundance (n°/m^3) demonstrative farms

• Preliminary discussion

Vineyards are located on different soils influencing chemical and physical characteristics. From 0-20 soil analysis, most Demo Farms have a clay loam soil (SP3, SP4, VT2 and RES2). Other Demo farms have loam soil (SP1), silty clay loam soil (SP2 and RES1), clay soil (VT1), silty clay (TBC1) and silty loam soil (TBC2). Comparing results with analysis performed at 60-80 depth no differences in soil textures classes are evident, except for TBC1 in which presence of silt is higher (61% in respect of 53%), RES1 in which clay content is nearly double in the superficial soil layer and in RES 2 that is classified as Clay Loam instead of Loamy.

Another important parameter of soil is Soil Organic Matter (SOM) that have to be preserved and monitored because it is involved as main actor in physical and biological soil processes. In Demo vineyards the SOM content in the soil is medium-low, exception for RES1, RES2 that have a low SOM instead TBC2 and VT2 that have high and medium-high SOM. Considering project sub-areas, average value for "Stirone Piacenziano" demonstrative vineyards is 1.71%, in "Trebbia Valley" is 2.03% and in "Parco del Taro and Boschi di Carrega" is 2.2% , in "Res Uvae" average value is 0.9%.

Also Soil Organic Carbon content (SOC) influences many soil characteristics including nutrients and water holding capacity, nutrients turnover, soil stability and micro-organisms nutrition. In Demo vineyards the SOC content is poor or medium ranging from 0.45 to 1.02%, exception for TBC2 and VT2 that have high content 1.66 and 1.47% respectively.

These parameters influence the soil quality and biodiversity. In fact, Demo vineyards TBC2 and VT2 have the higher concentration of earthworms. SP1 and SP4 have the higher concentration of Carbon in microbial biomass (μg/g).

Microbial quotient (MQ) results extremely high in VT1 farm (8.73) , while VT2 and TBC2 that have higher values of B_c (respectively 500 and 592 μg/g) have low values of MQ (2.36% and 1.57%).

QBS-ar index shows that the soil quality class is on average around 4, exception for Demo farm SP4 where it is 5.

According to classification made from "CCPB - Biodiversity alliance" certification- (already used as reference in LIFE project HelpSoil LIFE12 ENV/IT/000578) is possible to evaluate soil quality in vineyards from EMI score that identifies 7 evaluation (from "Great" to "Absent"). No Demo vineyard achieve an evaluation higher than "Quiet". RES1, RES2, SP3 and TBC2 have low scores and evaluation nearly "Absent", VT1 and VT2 present the same score (81) and fall in "Modest" class while SP1, SP2 and SP4 obtain a "Quiet" classification. TBC2 Demonstrative vineyard have to be clearly analyzed at the end of project activities, in fact its features may suggest high soil quality as it shows higher SOM content and abundance of earthworms, soil management is spontaneous grass from several years and microbial biomass is quite high but QBS-ar index obtained is classified as "absent" considering soil quality.

No correlation between those parameters have been identified.

Analysis after the implementation of demonstrative actions should increase initial values correlated to soil quality.

• Annex A: Demo Farms Soil Analysis Reports

• References

- ISO 11268-3 *Advanced risk assessment on earthworm populations in natural environment.*Paoletti, G., Sommaggio, D., Fusaro S., (2013). *Proposta di Indice di Qualità Biologica del Suolo (QBS-e) basato sui Lombrichi e applicato agli Agroecosistemi Biologia Ambientale*. 27 (2): 25-43.
- Parisi, V. (2001). *La qualità biologica del suolo. Un metodo basato sui microartropodi.* Acta Naturalia de l'Ateneo Parmense, 37, 97–106, 2001.
- Parisi, V., Menta, C., Gardi, C., Jacomini, C., Mozzanica, E. (2005). *Microarthropod community as a tool to asses soil quality and biodiversity: a new approach in Italy.* Agriculture Ecosystem and Environment, 105, 323-333.
- Pelosi, C., Bertand, M., Capowiez, Y., Boizard, H., Roger-Estrade, J. (2009). *Earthworm collection from agricultural fields: Comparisions of selected expellants in presence/absence of hand sorting.* European Journal of Soil Biology, 45, 176-183. Sparling, G.P. (1992). *Ratio of microbial biomass*

carbon to soil organic carbon as a sensitive indicator of changes in soil organic matter. Australian Journal of Soil Research, 30(2), 195-207.