LIFE Project Number

<LIFE15 ENV/IT/000641>

Deliverable "Decision tool alfa version"

Sub-action B1.1 "Tool development (alfa version)"

LIFE PROJECT Soil4Wine

1. Introduction

Soil4Wine project "*Innovative approach to soil management in viticultural landscape*" is aims to achieve a better soil management in the whole viticultural system developing and testing an innovative Decision tool and management solution tested in farm in Project area and Europe.

This report presents the structure and main outcomes of sub-action B1.1 related to Soil4Wine project Action B.1 " Development of the decision tool " from M1 (01.01.2017) until M6 (30.06.2017).

Action B.1 will continue until M36 of the project (31.12.2019) with the production of other Deliverables for the sub-actions B1.2, B1.3 and B1.4.

UCSC is the responsible for this action with the collaboration of HORTA.

Aim of this sub-action was the development of an alfa version of a Decision tool for grape growers making it possible to implement and maintain the best solutions (i.e., soil management practices) for mitigation of the negative effects of soil and environment problems in each specific situation.

2. Description of the tool (alfa version)

The Decision tool was designed as a stand-alone tool, meaning that it does not require the intervention of external experts (consultants, specialists, etc.), yet it allows the farmers to self-evaluate their specific problem(s), take right decisions about the necessary mitigation measure(s), implement them following good agricultural practices and, finally, check the success of the intervention. The conceptual scheme of the Decision tool is illustrated in Figure 2.1.

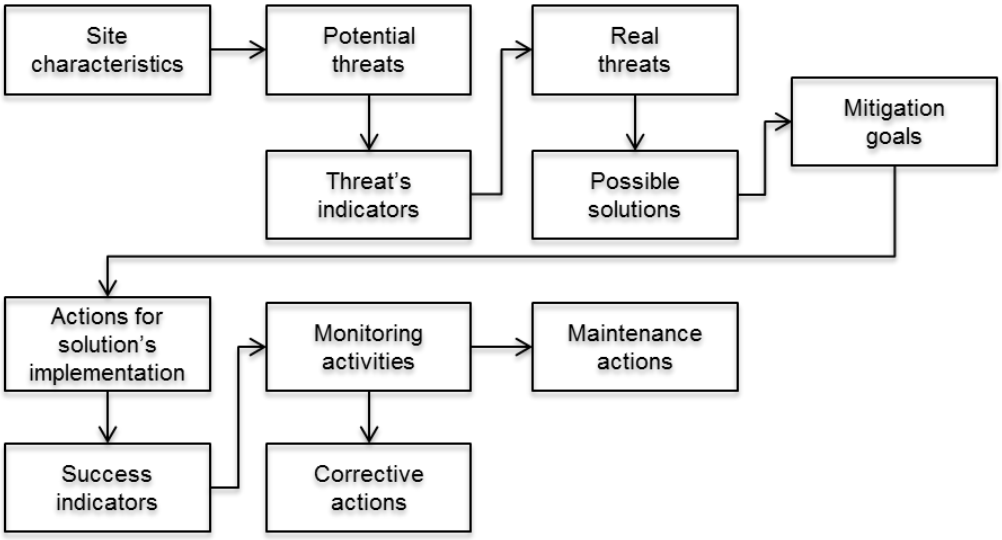

Figure 2.1 - Conceptual scheme of the Decision tool

The alfa version of the tool described in this deliverable was developed as an excel file and includes the first steps of the conceptual scheme, i.e. the definition of the site, the identification of the potential soil threats in that site, the assessment of specific soil threat's indicators, the consequent confirmation of the threats and the definition of possible solutions for their mitigation. Following the single steps are described in details:

a. Definition of the site

In the first step, the farmer defines the site (e.g., a vineyard with its surroundings), for which he wants to use the decision tool, by inputting information on its characteristics. In particular the first two sheets (i.e. "Vineyard information" and "Potential threats") of the excel file has to be completed, there are some "open fields" and some "close choices" (trop down menus) and the information required are

"open fields"

- Name of the farm
- Name of the vineyard
- Geographical coordinates
- Altitude (m.s.l.)
- Grapevine variety
- Rootstock
- Trellis system
- Age of the vineyard
- Distance between rows (m)
- Distance between vines along the rows (m)

"close choices" and trop down menus

- Average slope: 0-10%; 11-30%; >30%
- Average aspect: N-NE-NW; S-SE-SW; E-W
- Farming practices of ploughing: contour plow, plounghing along maximum slope, crossing ploughing Row length: <100 m; 100-200 m; > 200 m

- Row orientation: N-S; E-W; intermediate
- Gravel: 0-10%; 10-40%; >40%
- Soil organic matter: low; medium; high
- Soil texture; sandy; loam; clay; silty
- Floor management between rows: complete tillage; complete grassing; temporary grassing/green manure; strip tillage or grassing; chemical weeding
- Floor management on the row: tillage; grassing; mulching; chemical weeding
- Root depth: <0.6 m; 0.6-1 m; > 1 m
- Groundwater depth: absent; < 2 m; > 2 m
- Drainage: absent; trenches; subsurface drainage
- Total rainfall (mm/year): <500 mm; 500-800 mm; >800 mm
- Rainfall during grapevine growing season: < 200 mm; 200-300 mm; > 300 mm
- Planting operation; ploughing; chisel plowing
- Planting operation depth: < 1 m; > 1 m
- Soil tillage: rotary plough, chisel/spade plough, no tillage, attrezzi alternativi (ripper/vanga);
- Number of tractor's traffic: < 15; 15-25; >25
- Organic fertilization (number/year): 0; 1; 2
- Mineral fertilization (number/year): 0; 1; 2
- Treatments with Plant protection products: <10; 10-20; >20
- Degree days during growing season: < 1400 °g; 1400-1800 °g; > 1800 °g

b. Potential soil threats

For each of the above mentioned factors a score (0-3) was assigned related to the impact of the factor itself on the different soil threats. The tool cumulates the different scores, provides a ranking of the potential soil threats and highlights the five most probable ones.

c. Check of the potential soil threats

Once the potential threats for a specific site are defined, the user has to check whether those threats are potential or real, by using specific indicators for each threat. A literature analysis was performed to identify the best indicators, in terms of easiness of application and result accuracy. Different types of indicators were selected, from very simple (visual assessment) to more complex ones (chemical analysis), some example are described below.

- EROSION

Based on the picture and description provided in table 2.1, the user has to perform a visual assessment in the vineyard and select one of the possible choices of the different trop down menus related to: erosion facts, groove depth, root system, uniformity of the grass.

Table 2.1: description of the categories for the visual assessment of the level of erosion

		None	Low	Medium	High
Erosion					
	erosion evidences	No evidence of soil erosion	Little evidence of soil erosion	Moderate soil erosion	Severe soil erosion
	groove depht	Little difference in height between the mounded row and interrow	grooves < 5 cm	grooves between 5 and 10 cm	grooves > 10 cm
	root system	The root system is completely covered	crescita manto erboso non uniforme	Part of the upper root system is occasionally exposed	The root system is often well exposed and the vine trunk totally undermined in places
	soil coverage	uniform soil coverage (if present)	almost uniform soil coverage (if present)	non uniform soil coverage (if present)	sever problems in soil coverage

Finally, the user has to assess if the facts are related to the vineyard only or also to the areas around the vineyard. The system then cross-checks the data and provides a value (absent, low, medium, or high) for erosion and its distribution.

- SOIL ORGANIC MATTER

To determine the correct amount of organic matter in the soil a chemical analysis is needed, nonetheless, there is a simple method (soil sample and visual assessment) to understand the level: low, medium and high.

1. Dig down to at least 6 inches and examine the soil for organic residue by breaking the soil apart with your finger. Look for evidence of organic residues at various stages of decomposition.

2. Put your nose close to the soil after breaking it apart and note the smell.

3. Lightly moisten some soil with a squirt bottle. Rub this soil between your fingers and see if it leaves a dark stain that is difficult to remove.

4. Select one of the option in table 2.2.

Table 2.2: description of the categories for the visual assessment of the level of organic matter in the soil

	Low	**Medium**	**High**
VSA	Organic residue on or in the soil does not decompose for long periods of time; there is a sour, muck-like smell in the soil; and the soil does not stain the fingers.	A substantial amount of undecomposed material from the previous crop is present; there is no distinct smell in the soil; and there is only slight staining of the fingers	Organic residue from the previous crop is present in the soil in various stages of decomposition; freshly dug soil has a sweet, earthy smell; and fingers are darkly stained after rubbing soil between them.

- PRESENCE OF HARD PLAN

Dig a hole to identify the depth to a limiting layer, where present, and compare with the classes in Table 2.3. As the hole is being dug, note the presence of roots and old root channels, worm channels, cracks and fissures down which roots can extend. Note also whether there is an over-thickening of roots (a result of a high penetration resistance), and whether the roots are being forced to grow horizontally (figure 2.2).

Moreover, note the firmness and tightness of the soil, whether the soil is grey and strongly gleyed owing to prolonged waterlogging, and whether there is a hardpan present such as a human-induced tillage or plough pan, or a natural pan such as an iron, siliceous or calcitic pan. An abrupt transition from a fine (heavy) material to a coarse (sandy/gravelly) layer will also limit root development (Shepherd, T. G., Stagnari, F., Pisante, M. and Benites, J. 2008. Visual Soil Assessment – Field guide for vineyards. FAO, Rome, Italy).

Table 2.3: description of the categories for the visual assessment of the presence/absence of hardpan

	Absence	**Presence**
VSA	No roots penetration problem	Visible obstacles to roots and instruments penetration
	Roots are uniformly distributed along soil profile	Roots are NOT uniformly distributed along soil profile
	Cunicules, porosity are visible	No roots under hard pan
	No hard pan is visible	clear difference in color between above and below hard pan

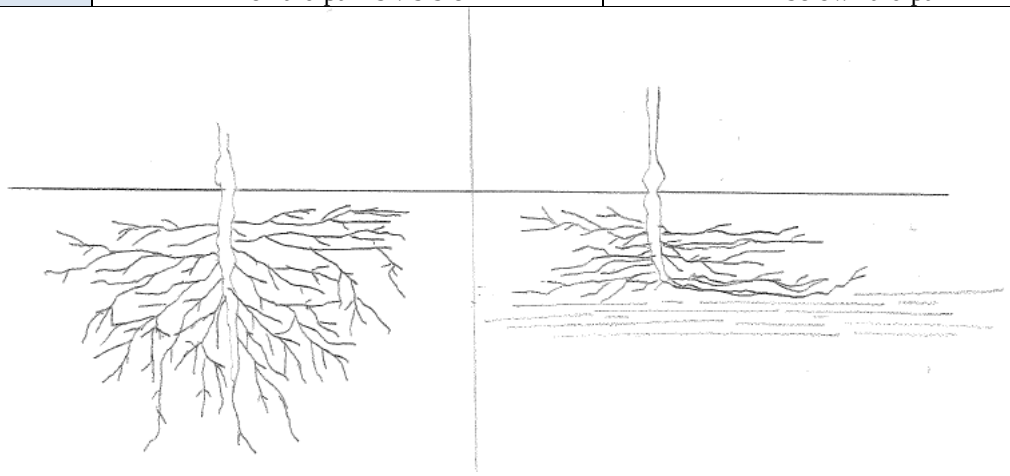

Figure 2.2 – typical distribution of roots in an optimal growth (left) in presence of high penetration resistance/presence of hardpan (right).

- SOIL BIODIVERSITY

Earthworms provide a good indicator of the biological health and condition of the soil because their population density and species are affected by soil properties and management practices. Through their burrowing, feeding, digestion and casting, earthworms have a major effect on the chemical, physical and biological properties of the soil. They shred and decompose plant residues, converting them to organic matter, and so releasing mineral nutrients.

Earthworm numbers (and biomass) are governed by the amount of food available as organic matter and soil microbes, as determined by the amount and quality of surface residue, the use of cover crops including legumes, and the cultivation of inter-rows (Shepherd, T. G., Stagnari, F., Pisante, M. and Benites, J. 2008. Visual Soil Assessment – Field guide for vineyards. FAO, Rome, Italy).

To assess the presence and abundance of earthworms take a sample of soil of 20 cm^3, expand it in a plastic towel by breaking it with the hands and count the earthworms and compare it with the categories described in Table 2.4.

Table 2.3: description of the categories for the visual assessment of the presence/absence of hardpan

	Low	Medium	High
VSA	less than three earthworms are visible and no tunnels are identified	between three and five earthworms are visible and some few tunnels are identified	more than five earthworms are visible and a lot of tunnels are identified

For each indicators the systems performs different cross-checks and provides error messages if the data inputted by the user cannot be correct. For example, it is not possible to insert a high number of counted earthworms and select that no tunnels are visible.

d. Real soil threats

Based on the information inputted by the user about the different indicators related to the potential threats identified, the system confirms the threads and provides a list of real threats.

e. Possible solutions

For each real threat possible solutions were identified and are provided by the system; the same solution can be implemented for several threats, therefore the efficacy of each solution for each threat is also specified (figure 2.3).

	erosion	*decline in organic matter*	*soil compaction*	*hardpan*	*contamination*	*water scarsity*	*decline in biodiversity*	*water ponding*
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 (depht)								
change of soil management equipment								
underground drainage								
superficial water control								
permanent mulching on the row (organic/mineral)								

Figure 2.3 – list of possible solutions and their efficacy to reduce/eliminate soil threats: green=high efficacy, yellow=moderate efficacy, blue=low efficacy, white=no efficacy, red= not advised.

3. Further developments

This tool's alfa version will be used by UCSC, HORTA and Demo farmers to define the action plans to be implemented in the vineyard during the second project year. Thanks to the feedbacks received by the demo farmers the project partners will improve the version and provide a beta version by the end of the second project year.