(Projects funded under the Call 2014 onwards must use this format)

LIFE Project Number

LIFE15 ENV/IT/000641

Final Report

Covering the project activities from 01/01/2017[1] to 31/12/2019

Reporting Date[2]

31/03/2020

LIFE PROJECT NAME or Acronym

LIFE+ PROJECT Soil4Wine

Data Project

Project location:	Italy
Project start date:	01/01/2017
Project end date:	31/12/2019 **Extension date:** <dd/mm/yyyy >
Total budget:	€ 1.613.328
EU contribution:	€ 914.999
(%) of eligible costs:	57%

Data Beneficiary

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[1] Project start date

[2] Include the reporting date as foreseen in part C2 of Annex II of the Grant Agreement

1. Table of contents

2. List of key-words and abbreviations

- ART-ER: ART-ER S.Cons.p.a.
- CC: cover crop
- DSS: Decision Support System
- DT: Decision tool
- EC: European Commission
- EGPB: Ente di Gestione per i Parchi e la Biodiversità Emilia occidentale
- ERVET: ERVET SpA - Emilia Romagna Valorizzazione Economica Territorio
- ES: Ecosystem services
- GHG: Greenhouse gases
- HORTA: Horta s.r.l.
- KOM: Kick-off meeting
- KPI: Key Performance Indicators
- PES: Payment for Ecosystem Services
- S4W: Soil4Wine
- UCSC: Università Cattolica del Sacro Cuore
- VIN: Vinidea s.r.l.

3. Executive Summary

This Final report summarizes activities carried out in the whole period of S4W project (LIFE15 ENV/IT/000641) (01/01/2017 - 31/12/2019). "*Soil4Wine - Innovative approach to*

soil management in viticultural landscape". The project aims to achieve better soil management within the whole vineyard ecosystem handling main soil threats, as defined by the Thematic Strategy for Soil Protection [COM(2006)231]. This goal has been pursued through the development of an innovative DT as well as by providing management guidelines able to guide farmers at identifying main soil threats and selecting the best management choice to counteract them within an environmentally friendly and economically valuable scenario. In such a context the assessment of main ecosystem service (ES) and the design of innovative conservation policies represent an innovative goal for viticulture. Project is bound to a participated stakeholders' involvement that has ensured feasibility and effectiveness of demonstration actions as well as enhanced local and regional stakeholders awareness about soil issues.

The project is also related to climate change concerns as most appropriate vineyard floor management might greatly contribute to a reduction of gaseous emissions from agricultural activities enhancing soil carbon stock capacity. According to the European Commission strategy aiming to counteract the loss of biodiversity and improve the offer of ES in EU by 2020, the project has dealt with Target 2 (Maintain and restore ecosystem and their services) and Target 3 (Increase the contribution of agriculture and forestry to maintaining and enhancing biodiversity).

The project has a strong demonstration function and the grapevine was chosen as the most typical and important perennial tree crop cultivated in the hilly districts of the geographical area in which the S4W project takes place. Innovative demonstration activities have involved nine representative vineyard farms located in protected areas (Parchi del Ducato). Farms are characterized by different management systems and soil environment, so soil threats are different. Regarding ES and related payments, S4W project had the ambition to become a pioneer example of application within the viticultural context.

In agreement with project proposal, goal achieved during the project were the followings:

- Identification of main soil threats and related environmental problems in the project area and in European vineyards, through literature review, stakeholders opinion survey and vineyard visits (*Action A1*).
- Definition of stakeholders groups (Demo farmers, Living Labs and Exploitation groups) *(Action A1)*. While the Demo farmers group was active and present at participatory activities, the involvements of others two groups in planned activities such as field visits or DSS evaluation meetings was quite difficult.
- Development of DSS (*Action B.1)* for soil management in vineyards following several steps: i) co-development (α-version) *(Sub-action B1.1)* together with demo farmers group (co-development, *Sub-action B3.1*) and local stakeholders and subsequent testing in two vineyard plots within each demo farm; ii) release of ß-version (already in ICT version) that was evaluated by living labs group (Italian and European stakeholders) during the third year of the project (that sub-action took some more time than scheduled timetable) and presented at sectoral conferences; iii) release of final ICT version of DSS based on users' feedbacks available on project website. Education and training activities for demo farmers. In reform of what indicated in the project proposal, training activities were opened also to farmers outside the stakeholders groups (*Sub-action B3.2*).
- Identification of demonstration vineyards. Each demo was split in two plots, one managed according to a traditional standard and the other one using one or more innovative solutions.
- Definition of main best management practices and implementation of several of them in demonstration vineyards (e.g. different green manure techniques, permanent artificial grassing, drainage). In each plot, soil properties were also characterized at

the beginning and end of the project. For each plot ten vines were chosen to assess vine behaviour during the entire project time *(Action B2*).

- Definition of a specific *Action Plan* for each Demo Farm and implementation of demonstration activities since autumn 2017 (i.e. earlier than in foreseen project activities).
- Data collection in vineyard for assessing advantages (and possible drawbacks) rising from DSS and solution implementations *(Action B2*).
- Definition of Key Performance Indicators through the use of a KPI tool. Such indicators are added to the performance indicator table attached to the project proposal (*Action C1).*
- Evaluation of socio-economic conditions affecting soil management in project areas and assessment of soil ES in the study area. (*Action B4*).
- Identification of main ecosystem services within a viticultural scenario.
- Definition of quali-quantitative procedures for evaluating the value of ES.
- Development of a feasibility study for ecosystem services payment through stakeholders involvements.
- Creation of a project web page (www.soil4wine.eu) regularly updated with project activities, news and documents (milestones and deliverables) and project Facebook page. Informative materials (flyers, notice boards and newsletters) and gadgets were created and distribute during dissemination activities. (*Action D1)*
- Networking with several European project: SOS4LIFE (LIFE ENV/IT/000225), VITISOM (LIFE15 ENV/IT/00003192), ADVICLIM, LIFE GreenGrapes and LIFE ZeoWine projects (*Action D1*).
- Educational trip in France organized to familiarize with the techniques of vineyard soil management in the French regions of Provence and Rhône Valley, acquiring new elements of theoretical and practical knowledge through seminars and visits to important wineries and research centres (*Sub-action B3.6)*
- Technical dissemination activities (congress, webinars, papers) (*Action D1)*
- Final congress (Piacenza 5th December 2019). (*Sub-action B3.6)*

4. Introduction

Environmental problems/issues addressed

S4W project targets soil threats as listed in the Thematic Strategy for Soil Protection and namely: erosion, decline in organic matter, local and diffuse contamination, sealing, compaction, decline in biodiversity and landslides. These threats are indeed relevant in the project area as well as in the whole viticultural landscape in Northern Italy due to environmental (orography and slope, climate and climate change, soil type) and behavioural factors (vineyard and soil management practices currently applied).

- Environmental factors: hilly soils of the study area are usually characterized by fair fertility in terms of nutrients availability, which derives from the lithological composition of the substrate on which they evolved. These soils are prone to the risk of degradation by erosion also due to recent changes in cultivation practices: from pervasive and diverse agriculture with small crop units to larger, monoculture units (mainly vineyards) with an increase of abandoned land and the disappearance of water drainage practices. Site elevation ranges between 100 to 600 m a.s.l. with a high

variability in slopes until maximum of 30-35%. Main soil types, called "Terre rosse antiche", "Terre fossili del Piacenziano", "Terre argillose della Val Tidone" and "Terre del Basso Appennino" are characterized by a prevalence of clay and a fairly low organic carbon content (<1.5%). According to Emilia Romagna Region evaluation, yearly erosion potential is intermediate (20-50 t/ha) or high (>50 t/ha). Climate is temperate (types Csa and Cfa of the Köppen-Geiger classification).

- Behavioural factors: the standard floor management in the vineyards of the study area is tillage causing topsoil erosion leading in turn to landslides and soil fertility losses. Those phenomena worsen several chemical and physical soil properties (including rapid degradation of organic matter, soil compaction and formation of plough soles). Poor management of vineyard surrounds is also quite common.

Outline of the hypothesis to be demonstrated / verified by the project

The general objective of the proposal is to achieve better soil management at the local, regional or national level. The methods used will include monitoring tools and practices and the improvement of administrative and legal frameworks. Proposed solutions will have to be both economically and environmentally sustainable.

Description of the technical / methodological solution

Proposed solutions will focus on improving soil health of the whole vineyard ecosystem including three areas of pertinence: i) between vines spacing (mid-row), ii) in-the-vine row spacing (under the vine strip), iii) headlands around the vineyard block.

1. Solution for mid-row: cover crops (CC) are considered the best solution in sloped vineyards where soils may be eroded by significant rain. Expected benefits from CC are many such as i) prevent erosion; ii) improve soil structure; iii) increase soil organic matter and fertility; iv) increase soil biodiversity and biological activity; v) reduce GHG emissions; vi) reduce weeds and the consequent need of herbicides. CC also have potential drawbacks such as excessive competition with vines for water and nutrients that is also a function of site, topography and water availability.

2. Solution for the soil in the vine row: permanent organic mulching obtained by mechanically piling up under the row the grass swards or using other organic matrices is one solution proposed to replace tillage/herbicides combinations. Advantages related to such technique are multiple and could fight different threats.

3. Solution for the soil in the headlands and surrounds: headlands, usually managed as bare soil, should be seeded to improve soil properties (especially physical ones) and ameliorate habitat for local fauna and limit spray drift.

Aim of S4W project is also to identify and test financial tools able to support the adoption of sustainable soil management practices and enhance the socio-economic conditions at the local level, also giving value to biodiversity and soil functions.

Proposed solutions have been introduced in 9 representative demonstration farms located within the project area. A participatory and promotional approach is used in the involvement of farmers.

A specific DT is under development to guide grape growers in: i) defining specific problem(s); ii) selecting the best solution(s) and assessing the expected benefits; iii) implementing the solution(s) following specific Good Soil Health Practices (GSHPs) and finally iv) evaluating the results after implementation. This DSS and testing methodology in demonstration farms is a novelty at the European scale.

Project actions investigate also ecosystem services provided by good soil management in viticulture, and their provision costs and economic value will be calculated by using international accepted methodologies (research project or others LIFE project). These analyses will lead to PES release (related to the wine production value chain).

Expected results and environmental benefits
Implementation of innovative soil management solutions aim at ameliorating a number of soil quality parameters in demo farms (+10% of organic matter content, +50% soil aggregate stability and microbial activity assessed with QBS-ar index, -10% of soil compaction and -25% of nitrate concentration). Moreover, the project targets a significant reduction of erosion and soil compaction as well as a reduction of carbon footprint (about -20%) and an increase in carbon sequestration (+15%).

Expected longer term results (as anticipated at the start of the project)
S4W project is strongly connected to EU Thematic Strategy for Soil Protection COM(2006)231 whose overall objective is protection and sustainable use of soil and it is inherent that S4W tackles exactly this topic as it is aimed at improving soil management in the agriculture sector and at defining tools and methodologies aimed to support soil function and ES. A longer-term strategy of the S4W project is to increase awareness of soil related issues.
S4W objectives and activities also want to strengthen synergies with other EU policies, in particular related to biodiversity, resource efficiency and climate change (EU Biodiversity Strategy 2020, COM(2011)244; Roadmap to Resource Efficient Europe, COM(2011)571; EU Strategy on adaptation to climate change, COM(2013)216). The project will implement as much as possible the principle of the Green Public Procurement as defined in the Communication COM(2008)400.
The project actions have also the potential to generate several positive effects on local economy and population in Italy and other EU countries.

S4W proposed solutions and the DT have been applied in Italian demonstrative vineyards and then were tested in other EU countries (*Sub-action B3.5*). Networking with other projects (*Sub-action D.3*) is expected to improve and enhance project visibility and application of results among EU stakeholders.
S4W solutions can be extended to other fruit tree orchard featuring hedgerow shaped single rows separated by alleys (i.e. apple, pear, peach) and using floor management comparable with grapevine (*Sub-action B4.5)* .

5. Administrative part

S4W Project management benefits from close collaboration between partners. Project has 5 beneficiaries (UCSC, HORTA, VIN, ART-ER [ex-ERVET] and EGPB) coordinated by UCSC. Project monitor is Dr. Riccardo Giandrini (EASME) whereas Project Officer is Dr. Michel Quicheron.

In particular the project coordinator has carried out the following activities:

- Organisation of KOM (*Milestone E.1)*.
- Definition of Partnership Agreement signed by beneficiaries during first project year after monitor suggestions and review (attached to Progress Report).
- Definition of Agreement between UCSC and demo farmers.
- Organization of Progress and Monitoring meetings.
- Co-ordination of project activities, collection and sharing of project outcomes through DropBox folder and project website.
- Each month partners filled a shared table with indication of monthly activities. Coordinator checked this table to verify project development.
- Management of the financial and administrative aspects of the project activities reporting.
- Contacts with EASME monitor (Dr. Riccardo Giandrini) and sharing of commission letters and advice among partners.
- Contacts with other related projects, European Working Group and Italian Minister of Agriculture.
- Co-ordination of reporting documents (Progress Report, Mid-Term Report and the present Final Report).

S4W beneficiaries defined, during KOM, the following management structures (as reported in project proposal):

- **Steering committee:** composed by the Project Leader (Dr. Stefano Poni), Project Manager (Dr. Matteo Gatti) and a Delegate for each partner as follow: Delegate of HORTA (Dr. Sara Elisabetta Legler), Delegate of EGPB (Mrs. Sonia Anelli), Delegate of ART-ER (Mr. Enrico Cancila), Delegate of VIN (Mr. Gianni Trioli).
- **Technical committee:** devoted to the organisation and coordination of project actions, it is composed by one Action Manager for each project action. Action Manager A.1 UCSC (Dr. Irene Diti), Action Manager B.2 UCSC (Dr. Tito Caffi), Action Manager B.2 HORTA (Dr. Sara Elisabetta Legler), Action Manager B.3 EGPB (Mrs. Sonia Anelli), Action Manager B.4 ART-ER (Dr. Alessandro Bosso), Action Manager C.1 HORTA (Dr. Sara Elisabetta Legler), Action Manager D.1 VIN (Mr. Gianni Trioli).

By the end of the project partners have carried out several meetings aimed to verify the progress of S4W project, according with project proposal (*Action E*). The following meetings were held:

- Kick-off meeting (M1:12.01.2017): KOM took place in Piacenza and consisted in presenting all actions, partners' roles and financial management.
- 1st annual progress meeting (M11: 29.11.2017): the first annual meeting took place in Piacenza as scheduled. During this meeting advances in action and future activities were presented by partners.
- 2nd annual project meeting (M26: 14.02.2019): the second annual meeting took place in Piacenza. .
- Monitoring meetings (*Figure 1*):
    - 1st monitoring visit (M6:26.06.2017).
    - 2nd monitoring visit (M18: 27-28.06.2018). During this two-day visit, some demonstration vineyards were shown to the Monitor and project progress explained during meeting.
    - 3rd monitoring visit (M30: 17-18.06.2019). During this two-day visit, some demonstration vineyards were shown to the Monitor and Officer. Project

progress and future development were presented during meeting in Piacenza. Memorandum and documents related to these meetings are available as attachments to this report.

a)  b) 

c)  d) 

e)  f) 

Figure 1: photos from monitoring visits (2017:a,b; 2018:c,d; 2019:e,f)

During the KOM formal errors in the project text were noted and corrected as it follows: i) Dr Matteo Gatti is the Project Manager and not the Financial Manager, and ii) VIN is not involved in action B1.
In accordance with Monitor Dr. Riccardo Giandrini and Officer Dr. Michel Quicheron the reporting schedule was modified so that the reporting date of progress report was delayed at M12 (31.12.2017) and Mid-Term Report reporting period at M21 (30.09.2018).

Since 01/05/2019 the associate partners ERVET SpA has ceased to exist after merging in ART-ER S.Cons.p.a.. An amendment was presented to EASME, approved with letter Ref.Ares(2019)6932586 - 08/11/2019 attached to this report.

6. Technical part

6.1. Technical progress, per Action

Action A1 - Study of the soil threats and constitution of the stakeholders groups

Foreseen start date	01/01/2017	Actual start date	01/01/2017
Foreseen end date	30/06/2017	Actual end date	30/06/2018

A1.1: Soil threats distribution in the project area

In order to define main soil threats in the project area a systematic survey of vineyards was performed. With the collaboration of EGPB, UCSC and HORTA visited 124 vineyards (therefore more than the 100 foreseen) in the project area and in bordering municipalities during M2-M3. Among the 124, 12 were located in "Trebbia" Valley, 22 in "Taro" and "Boschi di Carrega" Park and 90 in "Stirone-Piacenziano" areas.
Surveyed vineyards were geo-referenced and an excel database was created with all the information collected as planned in project proposal. Moreover, a photographic database was created (*Annexes of Deliverable A1.1)*.
Survey was composed by:
i) a *questionnaire* for winegrowers aimed at describing vineyards characteristics and identifying main agronomical practices performed, as well as investigating winegrowers perception of their own vineyards soil health status. At the time of interview (March 2017), however, local conditions were not suitable to observe or estimate water logging effects; therefore, the same observations were post-poned to the next spring. ii) a *visual assessment score-card* for the listing and scoring of vineyard features and conditions (such as year of planting, rootstock type, vines density, presence/absence of drainage and irrigation system, tillage, floor management, fertilization practices etc.) was prepared.
During this phase information about soil features and main threats was collected through visual assessment according to FAO guidelines (FAO, 2008). Data about soil classification, organic carbon content, elevation and slope were derived by open-access soil thematic maps of the Emilia Romagna Region. Due to the extension of project area, variability of soil characteristics and budget resources, soil sample analysis were performed only in demonstrative vineyards that are located inside the project area.
Results of soil sampling and chemical, physical and biological analyses are part of *B2.4 sub-action* activities and results were included in *B2.4 Part 1-2 Deliverables*. Due to weather conditions and needs of sampling protocols, physical and chemical soil analyses were performed at M10, whereas biological properties were investigated at M16-17. Therefore, Action A1 stayed open until M18 to complete soil analyses budgeted in this action.

Most of the surveyed vineyards were planted 10-20 years ago (48.0%) and vine density assessment shows that most of the vineyards fall between 2500 and 3500 vines/ha and are mostly located on moderately steep soils (47.6%) and rolling (27.9%) lands. "Stirone-Piacenziano" Park is characterized by vineyards in high slope areas with maximum slope reaching 35.2%. Such condition creates severe problems of soil erosion, especially at the top of slopes and difficulties in management operations.
Assessment of water management systems revealed that only 35 vineyards over the 124 assessed have drainage solutions (drains, trench systems or mole plows). About soil

management, tillage is by far the most common practice with rotary tillage, ripping and grubbing used between rows. In winter, soil is covered by spontaneous grass and inter-row is usually tilled in spring and, sometimes, before winter. Vine growers feel that grassing could be very suited in vineyards with high slope, in that it allows reducing soil erosion and facilitates vineyard's operations.

Assessment of soil threats was made through assignment to 4 classes according to FAO classification, ranging from 0 (no threat) to 3 (severe threat). Threats were assessed also in term of localization among different vineyard zones and in more details:

- *Erosion*: it generally impacts the whole vineyard ecosystem (rows, inter-rows, headlands) with higher intensity in vineyards surroundings.
- *Compaction:* it is mainly located in the headlands and inter-rows of moderately steep vineyards.
- *Crust:* survey revealed that "Stirone-Piacenziano" vineyards are the most subjected to crust threat due to high soil clay and/or silt content. In general, wine growers interviews reported crusting as a limiting factor especially during dry summer seasons.
- *Water logging:* this threat was reported mostly at the bottom part of moderately steep and rolling vineyards.
- *Other problems:* vine-growers have reported severe problems with boars that are numerous in the protected areas. Moreover, the presence of wild areas with aggressive species (such as *Robinia pseudoacacia*) and abandoned spots close to the vineyard might create problems of competition for water.

Considered parameters and main findings from the literature survey were used to define the α-version of the DSS tool (*Sub-action B1.1*). Moreover, collected data on demo farm vineyards were useful for the definition of the Action Plan (*Sub-action B2.1*).

A1.2: Soil threats in Europe

In order to identify mail soil threats in Europe, UCSC performed an investigation based on two different methodologies:

- systematic literature review of documents and papers about action topic;
- questionnaire aiming to assess stakeholders' perception of soil threats.

Literature review:
Literature search was performed using common scientific databases (Science Direct, Scopus and Google Scholar) while search keywords were those corresponding to soil threats as defined by the European Union [COM(2002)179 final]. Review included more than 100 papers and documents regarding soil threats in vineyards across Europe vs. a project milestone set at not less than 50 (a database with all items is reported in *Deliverable A1.2* with indication of Journal, Author(s), keywords, main soil threats analyzed and case study area). Considering only scientific papers, 90 case studies were analyzed (*Figure 2*) located mainly in Spain (27), France (20) and Italy (14) but a considerable number of contributions also refer to Central-East Europe viticultural zones.
Review reveals that, among the 8 soil threats defined from EU, a different weight is given to each of them depending on conditions. In particular "*erosion*" is the most cited one and, conversely, "*decline in soil biodiversity"* and "*contamination*" are less frequently considered. Surveying erosion made it clear that the magnitude of the phenomenon can be assessed with many methods, using different units (i.e. g m^{-2} for single events or t ha^{-1} y^{-1} for general vineyard measurements) and this makes uneasy comparing and summarize data and results.

Moreover, scale of analysis highly affects the obtained results yet, in general, magnitude of this soil threat is not sustainable and largely exceeds the defined tolerable thresholds (0.3-12 t ha^{-1} y^{-1}).

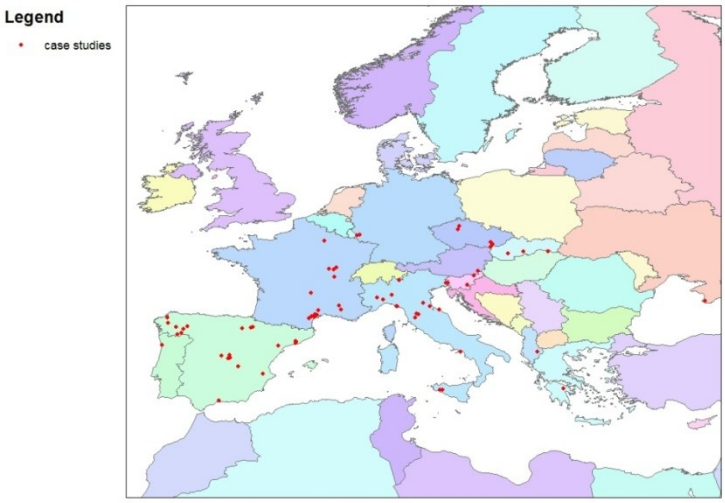

Figure 2: Case studies distribution)

European stakeholders' soil threats perception

A questionnaire aiming to assess stakeholders perception of soil threats was prepared by UCSC, VIN and ERVET and sent in 4 languages (Italian, English, Spanish and French) to more than 10.000 bodies (wine growers, researchers, actors of the wine market chain) taken from the VIN database between M5 and M7. The form was also shared on website and Facebook pages (project and EGPB). Three e-mailing recalls (one for each of the 3 months of the action) were done on the Italian database in order to increase the respondent number. Target number of responses was at least 300. Answered questionnaires were only 157 and fillers were from Italy (68%), Spain (15%), France (11%) and other countries (6%). After a discussion with partners it was decided to avoid additional sending because the α-tool had already been developed using the information collected insofar. Anyway, the fairly low number of responses as compared to the very large database used can be indirectly inferred as a sign of low level of interest to soil problems from the wine chain actors.

Questionnaire was structured in different sections (https://it.surveymonkey.com/r/5328NGQ for English version) and questions were referred to the wine region in which stakeholders work.
First part of survey was devoted to understand the incidence and impact of soil threats (as defined by EC) on vineyards and which are main effective agronomical practices aiming at reducing them, while last part of the questionnaire was about the assessment of the sensitivity of stakeholders to policies aimed to support sustainable vineyard soil management and to evaluate which factors contribute more to the determination of vineyard economic benefits for the community that are not remunerated by the market.

Deliverable A1.2 was submitted after the analyses of stakeholders' interview responses at M10 with some delay versus the foreseen date (M6) to allow more questionnaires to be answered. Deliverable is available on the website and was sent with Progress Report at M12.

A1.3: Formation of the stakeholders groups

Project foresees a new participatory approach for stakeholders involvement aimed to ensure the effectiveness of proposed activities meeting real farmers' needs, increase the future exploitation of the results ensuring replicability and transferability and create local agreement and regional partnership about soil health.
To reach these goals 3 groups of stakeholders were created as follow:

- *"Demo farmer" group*: identification of 9 farms in the project area. The group was identified within foreseen time (M3, *Milestone A1*), reunited at M2 and it was involved in training and co-development actions (*Action B3*).
- *"Living labs group"*: 41 farms in project area and bordering municipalities were contacted. At progress report time only 4 farms accepted the proposal. At mid-term period 24 farms have accepted to participate to the project after new contacts in spring 2018 reaching the project expected number (*Milestone A1*) . This group was invited to the field visit in M17 (*Action B3*).
- *"Exploitation group"*: main stakeholders (local and regional bodies and associations) were identified (*Milestone A1)* and a first meeting was carried out in Piacenza at M9 (20.09.2017). The respondents to the questionnaire in *sub-action A1.2* who left their data were also included in the Exploitation Group.

List of above cited groups are available in revised *Deliverable A1.3* (*Milestone A.1*).

Action B1: Development of the decision tool

Foreseen start date	01/01/2017	Actual start date	01/01/2017
Foreseen end date	31/12/2019	Actual (or anticipated) end date	31/12/2019

B1.1: Tool development (α version)

The core of the action was the development of the α-version of the DT in the form of a simple excel document made of different sheets each devoted to single steps of a DSS. The descriptive deliverable of the α-tool (*Deliverable B1.1*) is available on the website *(Milestone B1)*. The α-tool was designed to allow the identification of potential soil threats ranked from 1 to 8 according to vineyard information (management, climate, soil type) and delivered to demo farmers in the form of a simple pull-down menu. After the definition of main potential soil threats farmers are supposed to use simple indicators (visual assessment and chemical analysis) to assess whether those threats are potential or real. After preliminary test of the α-version with demo farmers some of proposed indicators resulted to be not enough user-friendly.

In the α-version an identification of potential solutions (indicating also the efficiency of each one for the selected threat) were envisaged. Information regarding action that farmer has to implement in his vineyard and monitoring indicators are available in the Action Plan of each demonstrative vineyard.

B1.2: Tool's improvement (β-version)

During 2018, Demo Farmers were invited to use the α-version of the tool, but they found extremely complicated to deal with the excel file. Since this feedback was quite general and spread among all the tested farmers, the S4W board decided not to work on a β-version of the DSS tool and rather starting with the implementation of the ICT-version *(Milestone B1:* M35*)*. This version contained the technical feedbacks collected in demo fields during 2018 and was available as planned in February 2019 (*Milestone B1:* M26). The same ICT-version was then made available to living labs and demonstrative actions in vineyards as indicated in project proposal.

Briefly, the ICT tool allows to characterize specific vineyards through the compilation of a simple checklist; a calculation module which provides potential risk indexes for the various soil threats (erosion, loss of organic substance, compaction, hard-pan, contamination, water shortage, loss of biodiversity and water stagnation), basing on site specific characteristics described during the previous step. The user is then guided in the vineyard evaluation of the real presence of one or more threats through the consultation of simple protocols, which can be downloaded as hard-copy files or directly online in the tool. Once the presence of one or more threats has been confirmed, the system indicates the possible mitigation actions to be taken to improve soil conditions (for each mitigation action there is a descriptive sheet in which all the information necessary for its implementation in the vineyard is provided); all the activities carried out in the vineyard can then be recorded in the system through a registration form. At the end of the mitigation process that can last even more years depending on the chosen action, the user is invited to repeat the evaluation of the soil conditions in the vineyard (through the use of specific protocols) to evaluate the effectiveness of the mitigation actions

implemented. Details and sanpshots of the system are provided in Deliverables B1.2 and B1.3.

B1.3: Final tool (release version)

Based on the feedbacks received by the living lab components (Sub-action B3.4 and B3.5) on the ICT tool (β-version) reported in *Deliverable B3.4*, the final ICT release version was finished and published. Drop down menus of some Crop Unit attributes were improved, as well as scores of different soil threats pre-disposing factors were modified. Graphical outputs were changed in order to be more user-friendly and easily interpretable and links between different tool functions' were added to facilitate the use of the tool itself by final users.

B1.4: ICT tool

This activity has been anticipated because of the difficulties of the demo farmers to deal with excel sheets (α-version). A first version of the ICT tool was ready for the season 2019 (instead of the β-version) (*Milestone B1)* while the final version of the ICT tool was released at the end of the project (*Milestone B1)*.

The DT developed during the project is available either as stand-alone version or as component of the DSS vite.net®. Registered users will have free access to the DT within the After-Life period.

The tool is accessible via the project website, from the following page:

http://www.soil4wine.eu/en/decision_support_tool/soil4wine_decision_support_tool_sc_18297.htm

To access a "Demo" use the following account:
Username: demosoil4wine
Password: demosoil4wine

HORTA has already identified elements for tool improvement and future activities; these have been included in a project proposal submitted to call H2020-SFS-2018-2020 (Sustainable Food Security) Topic: SFS-04-2019-2020.

Action B2: Demonstration in vineyards

Foreseen start date	01/01/2017	Actual start date	01/01/2017
Foreseen end date	31/12/2019	Actual (or anticipated) end date	31/12/2019

B2.1: Definition of the Action Plan

In early summer 2017 HORTA and UCSC visited all Demo farms and together with the farmers identified at least two plots on which the α-version of the DT developed in *Action B1* was going to be tested. One of them was tagged as a demonstration vineyard for project solutions. By integrating data collected during surveys of *Action A1* and *Sub-action B2.4,* Visual Soil Assessments and farmers interviews, potential and then true soil threats were identified for each vineyard through the α-tool and a SMART (Specific, Measurable, Achievable, Realistic and Time bound) *Action Plan* was designed for each one.

Demonstration vineyards were therefore set up (*Milestone B2)*: they are representative of vineyards features in project area, yet they are characterized by a small surface (less than 1 ha). Mitigation goals were then defined and solutions to be implemented in the vineyards to reach these goals discussed with the Demo Farmers. All details about demonstration vineyards characteristics, SMART Action Plans (i.e., soil threats, mitigation goals and solutions) are described for each Demo Farm in *Deliverable B2.1 "Action plans developed by Demo farmers"*. In particular, the main soil threats identified were: soil erosion, decrease of organic matter, water logging and compaction/hardpan. Conversely, main counter-acting solutions proposed were inter-row grassing with either temporary grassing (green manure using two different seed mixtures), permanent grassing and water drainage improvement. Moreover, an additional action to preserve vineyard biodiversity (pollinating insects) was proposed in one of the demo farm (VT1) and biological weed control under the row using mowed inter-row biomass was tested in VT2 demo farm.

Indication on assessments to be performed over the next years to monitor the success of the implemented solutions and on actions to be taken to maintain the improvements reached are also given in *Deliverable B2.1* as part of the SMART Action Plans.

The SMART Action Plans were accomplished accordingly and the mitigation solutions were applied in the demo vineyards. Therefore, this sub-action was successfully completed..

B2.2: Implementation of the soil management solutions

Despite the start of this sub-action was foreseen for the second project year, considering some mitigation solutions defined in *sub-action B2.1*, it was decided to start the implementation of soil management solutions already at the end of 2017. In particular, in the Demo Farms in which temporary grassing/green manure were chosen as mitigation solutions (VT1_La Pagliara, VT2_Castello di Montichiaro, SP2_Podere Le Lame, SP3_Az. Vitivinicola Visconti Massimo and Res Uvae) sowing was performed at M11 to allow two grapevine growing seasons for the demo trials. Mowing was performed in May 2018 (M17) in these vineyards while the residues were incorporated into the soil only one month later because of unfavourable weather conditions *(Figure 3)*.

a)  b) 

c)  d) 

e)  f) 

Figure 3: some photos of demonstrative action implementation in demo vineyards (a-c: sowing; d: drainage installation, e: green manure mowing; f: green manure biomass soil incorporation)

The mitigation solution adopted in the other Demo farms was permanent grassing of graminaceous species (SP1) or a mixture of graminaceous and legumes species (TBC1 and SP4). During summer 2018 one or two mowings were necessary to control the permanent grassing of the innovation plots.

Hand sowing of *Phacelia tanacetifolia,* a melliferous flower species appreciated by pollinators, was carried out at M22 in the boundaries of VT1 demonstrative vineyard as shelter zone for insects after green manure (and relative flowers) was slashed in late spring.

In TBC1 demonstrative vineyard a secondary objective of the permanent grassing in the space between rows was the control of weeds in the row obtained by mechanically moving the trimmed biomass under the vine strip, therefore reducing or preventing the use of herbicides or tillage. An additional vineyard was selected at Res Uvae in which all the tested cover crops and grass seeds mixtures were sown to evaluate growing phases, soil colonization rate and performances.

The last mitigation solution was the installation of underground drainage at RES1 in May 2018 (M17) and at RES2 in October 2018 (M22): both the installations were made after appropriate soil preparation and management performed over the previous months.

B2.3: Corrective actions and maintenance

A stunted growth of the permanent grassing sown during the first year of the project was observed in some demo farms. As a corrective action a re-sowing was carried out in October 2018, as detailed hereafter:

- Supplemental manual sowing in the higher part of SP1 demo vineyard (*Figure 4*);
- Supplemental manual sowing in the inter-rows of SP4 where relevant problems of water logging were still in place limiting the growth of the first sowing;
- Supplemental mechanical sowing of the inter-rows where a stunted growth was observed in TBC1;

Moreover, the sowing of the permanent grassing in TBC2 demo farm was not performed in fall 2017 (M10) because of adverse weather conditions; therefore, it was necessary to carry it out on October 2018 (M22).

Figure 4: manual sowing in SP1 demo vineyard as corrective action

Temporary grassing (different green manure) in VT1, VT2, SP2, and Res Uvae (demonstrative vineyard) were sown in M22 for the second grapevine growing season of the project. The grass was then trimmed at M29 and incorporated into the soil after few days based on the weather conditions; in general, all inter-row sowed mixtures grew better than in the first year.

For detailed information about these activities see *Deliverable B2.3 "Report on maintenance of action plans in the demo farms".*

After meeting with farmers some of them accepted to maintain demonstrative actions (Res Uvae as foreseen in the project proposal; VT1, SP1, TBC1) after project end.
In those farms HORTA will take care of the maintenance of weather stations and demonstrative activities will go on according to first or renewed *Action Plans*. Cover crops will be maintained also in demonstrative vineyard in Res Uvae farm. Demonstrative action will be maintained for at least 3 years and, in the end, soil analyses will be made to assess medium-period effects. Obtained results will be implemented in DT.

B2.4: SWOT analysis

First round of data collection for assessing advantages (and possible drawbacks) rising from using the DT and from solution implementation was launched as foreseen in this first project year. In particular, first feedbacks from Demo farmers on α-tool were collected during the co-development meeting (M8: 01/08/2017 at Res Uvae) and, considering the nature of the α-tool itself (i.e., not yet user-friendly and excel sheet based) it was decided to collect feedbacks about the usefulness and expectation by means of a questionnaire. Details are provided in *Deliverable B3.1 "Report on involvement of "demo farmers" (co-development and education and training)"* in which all the activities and discussions held during the co-development meetings are described. Moreover, a specific questionnaire was submitted to the demo farmers in order to obtain information about the strengths, weaknesses, opportunities and threats of the implemented innovative techniques (*Milestone B2)*.

Briefly, the average satisfaction among demo farmers is quite good (score 3.2 out of 5) and they are confident that the positive results can increase with time (3.5). They were able to highlight some possible weakness factors of the tested solutions as well as some opportunities arising from their applications. The detailed results of this first SWOT analysis are included into the *Deliverable B2.4* "*First report on SWOT analysis of soil and plant data in the considered vineyards*".

A sampling plan was also developed by UCSC and HORTA to collect soil and plant parameters (as foreseen in the proposal) in the demonstration vineyards. Soil samples were collected at M10 and physical/chemical analyses were externalized to a specific laboratory and at M16-17 other samples for biological analysis were processed by an external laboratory in 2018. Report on initial plant and soil data, referred to traditional management plot of each demonstration vineyard *(Deliverable B2.4 - Report on initial soil and plant data in the selected vineyards)* was prepared in two steps: the former part of the deliverable was finished on M12 (instead of M10 in order to allow the elaboration and inclusion of vine pruning data) while the latter part was prepared at M21. In 2019, the sampling plan of soil physical, chemical and biological parameters was repeated. Results allowed to assess effectiveness of action plans activities on soil function (organic matter content, chemical fertility) and biodiversity (by means of different indices such as QBS-ar (for arthropods) and QBS-e (for earthworms)). Data of soil biome were assessed thanks to the collaboration with another UCSC project (www.ecoresiliente.com). Data on earthworms presence were collected by UCSC and HORTA during spring 2018 and 2019 (*Figure 5*).

a)  b)  c) 

Figure 5: soil sampling in demonstrative vineyards (a) and earthworms hunting (b-c)

Vine behaviour parameters were collected each year from demonstrative vineyards during harvest and winter pruning (*Figure 6*). Further vine behaviour parameters, such as regularity of sprouting along the cane, were assessed in spring 2018. Number of buds per vine, number of bunches per vine, yield (in kg) per vine and must sugar concentration (°Brix) were assessed in both standard and innovative plots of all the demo farms during harvesting and pruning weight per vine was assessed winter. Weather stations with soil temperature and humidity sensors were installed at M12 and real-data monitoring started (*Figure 7*).






4

Figure 6: harvesting and pruning in some of demonstrative vineyards

a)  b)  c) 

d) 

Figure 7: some of the weather station (a-c) and soil sensor (d) in demonstrative vineyards

This sampling procedure allowed to calculate indices on the environmental impacts of the different management solutions by means of the DSS vite.net for the grape growing season 2018 and 2019. For instance, the carbon footprint (tons CO_2 equivalent / tons of grape production / hectare), water footprint (m^3 irrigation water / tons of grape production / hectare), ecological footprint (global ha / tons of grape production) and carbon sequestration (tons of Carbon / hectare) were calculated for both the standard and innovative solutions in all the demo farms. Summary of performed SWOT analysis is reported in Table 1. Details about all these data collections and relative results are provided in *Deliverables B2.4 "First report on SWOT analysis of soil and plant data in the considered vineyards"* (season 2018) and *"Second report on SWOT analysis of soil and plant data in the considered vineyards"* (season 2018 and 2019 altogether).

	Green manure vs. Tillage	***Green manure vs. Spont. grassing***	***Sown permanent grassing vs. Sp. grassing***
***S**trenghts*	-increase of yield -increase of vine fertility	-reduction of soil erosion -increase of soil structure stability -reduction of water logging	-improvement of soil structure stability -decrease of superficial erosion, water logging and compaction. -increase soil walkability and biodiversity
***W**eaknesses*	-possible higher susceptibility to bunch rot (higher bunch weight) -increased fuel consumption -increase in water and	-increased fuel consumption -increase in water, carbon and ecological footprint	-low establishment rate -increased fuel consumption

	ecological footprint		
***O**pportunities*	Better grapes health and vine performances	Better grapes health and vine performances	Better grapes health and vine performances
***T**hreats*	-cost of implementation and maintenance -obstacle in performing pesticides treatments before biomass cutting.	-cost of implementation and maintenance	-cost of implementation and maintenance

Table 1: SWOT analysis (end of the project)

During the third season of the project (2019) a visual assessment of soil areas colonized by cover crops was performed (*Figure 8*), as well as a floristic study of the grass population in the demonstration vineyard in Res Uvae (*Figure 9*). Moreover, in seasons 2018 and 2019 an assessment of biomass produced by green manure plots was made. Green manure production was highly variable in time and space and according to seed mixture composition (*Figure 10*). Soil biome assessment of each vineyards managed with different strategies (standard and innovative) was performed in early summer 2019 and the different types and amount of microorganism (fungi, bacteria and protozoa) were assessed by a real time molecular technique. This assessment showed that tilled soils contained about 21% more of *Ascomycota* organisms compared to the green manure innovative management. In particular, phytopathogenic species such as *Cadophora luteo-olivacea* (causal agent of Petri disease), *Phaeomoniella chlamydospora (*causal agent of Esca complex), *Seimatosporium vitis* (causal agent of Botryosphaeria dieback) and *Diaporthe sp*. (causal agent of Phomopsis dieback) were identified. In spontaneous grassing vineyards, the amount of *Ascomycota* is still predominant (5.4% more) compared to selected cover cropping and also causal agents of foliar diseases were detected (i.e. *Botrytis cinerea*, causal agent of grey mould). Furthermore, *Actinobacteria*, which are fundamental in rotting of low biodegradable compounds (i.e. lignin and some pesticides) were 21% lower in spontaneous grassing compared to controlled cover crop management.

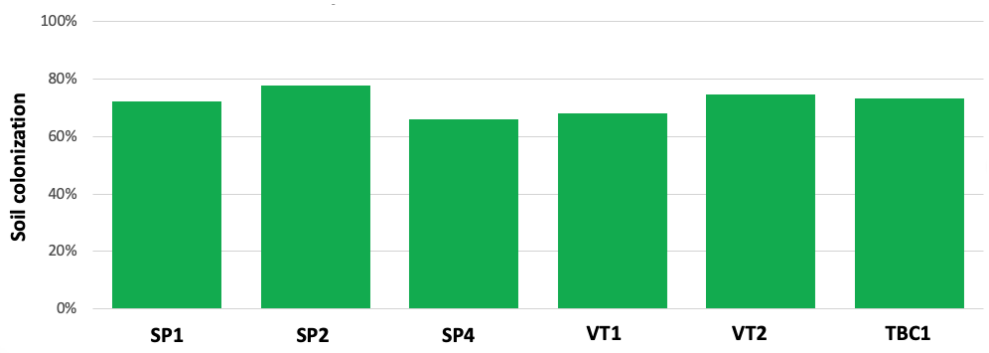

Figure 8: Soil colonization by different grassing techniques in the demo farms during season 2019

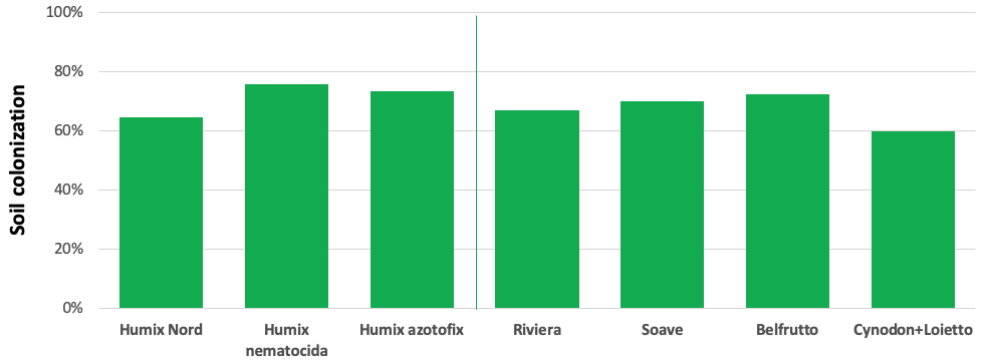

Figure 9: Soil colonization by different mixtures tested in 2019 at the demo farm Res Uvae (PC)

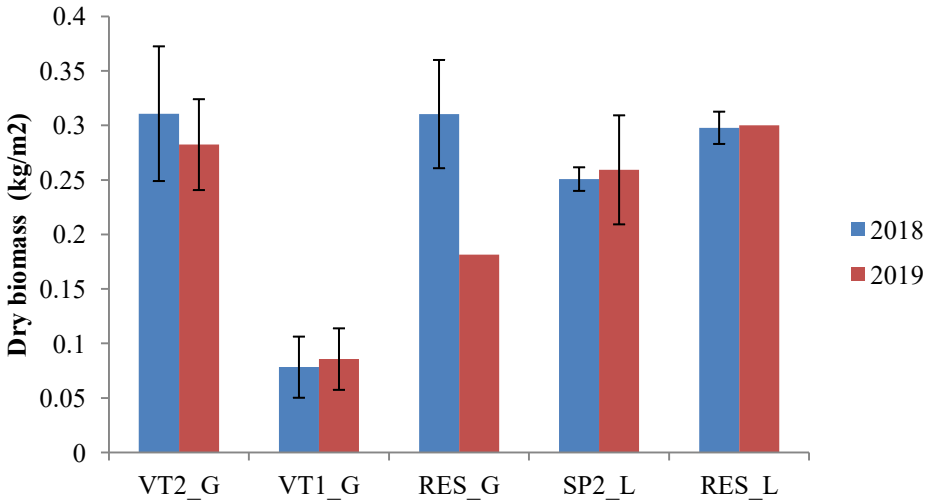

Figure 10: dry biomass produced by green manure in demonstrative vineyards (G:prevalence of graminaceous species; L: prevalence of legumes species)

Action B3: Interaction with stakeholders

Foreseen start date	01/01/2017	Actual start date	21/03/2017
Foreseen start date	31/12/2019	Actual end date	31/12/2019

During the first year of the project EGPB produced dissemination materials (gadgets) used by project partners during events/fairs/congresses as indicated in the project.
After a direct treaty between 6 companies invited to the selection, "Primo Piano srl" prepared gadgets as foreseen in the project and offered us extra gadgets (points d, e, f) included in the budgeted cost. Gadgets are the following:

a) N. 6.000 pins;
b) N. 2 roll-up;
c) N. 1 gazebo;
d) N. 4.000 pencils;
e) N. 4.000 notebooks;
f) N. 300 "Erbolino" a sort of small vase containing "ready to grow" seeds.

A "kit" contained gadgets was given to each demo farmer (*Figure 11*).

Figure 11: gadget of Soil4Wine project

Because partner ERVET S.p.A. have changed his corporate structure (now ART-ER), EGPB decided to update the gadgets with the new logo ordering a new supply to "Primo Piano srl" (the company selected by a direct treaty during the first supply) (*Figure 12*). Moreover folders for the final congress with project layout were printed in M36 (*Figure 13*).
Below the supply list:

a) N. 2 roll up;
b) N. 200 paper pens with project and LIFE logo

c) N.250 notebooks
d) N.100 folders

Figure 12: updated roll-up, notebook and pens

Figure 13: folder of Soil4Wine final congress

Dissemination material was distributed also during the final congress and remaining material will be used during events schedule of the After-LIFE period.
During the After-LIFE period the involvement local stakeholders will continue with activities aimed to DSS and "Regulation for Logo use" presentation.

B3.1: Co-development

The meetings planned during the project involved eight companies located within the “Parchi del Ducato” boundaries and, in addition, the ResUvae company HORTA (DEMO farms) .

These farms have been involved in the definition, use and validation of the DSS developed by UCSC and HORTA to optimize the management of the vineyard soil and promote the ES provided by them.
The four scheduled meetings were held on 02.05.2017, 23.05.2017, 13.06.2017 and 01.08.2017 with the involvement of EGPB, UCSC and HORTA and the coordination of "Genius Loci, Facilitation & Development", an animation company selected by a direct treaty (5 companies were invited to the selection) .
The meetings were organized with a "BarCamp" approach, i.e. a quite informal way where "Genius Loci" solicited Demo farmers to present their experience and to explain their opinion. In every meeting a light "buffet" was set up to facilitate open discussion among stakeholders. (*Figure 14)*
Details of co-development meetings (agenda, signatures of participants, presented materials) and outcomes are included in *Deliverable B3.1-B3.2*.

Figure 14: moments of co-development meetings

SUMMARY OF MEETINGS

1. SOIL PROBLEMS
The first meeting with Demo farmers gathered information about their vineyards' soil health status and factors that they felt as true limiting factors. In pursuing this objective, the main concerns of farmers in relation to the soil have emerged both in terms of the effectiveness of the solutions to be implemented and the commitment of resources that they require (money, time, and labour).

2. THE PRESENTATION OF THE FLOW OF THE INSTRUMENT - THE INDICATORS
During the second meeting the flow of the tool was presented and feedbacks clarified that some issues are not really felt urgent by growers and among them: the loss of biodiversity, the formation of a hardpan plough sole and the decline in soil organic matter. In this meeting two contrasting positions clearly emerged: recommendation for a *long-term approach*, which aims to find and adapt new techniques to the pressure of climate change, and a *short-term approach*, focused on the farms' enterprise budget.

3. SOIL PROBLEMS AND PRACTICAL SOLUTIONS
In the third meeting, ecosystem issues and new floor management solutions were discussed against current main limitations preventing or limiting their adoption and, among these:

- excessive cost also in terms of human labour;
- treatments requiring to be periodically executed and reiterated over several years;
- lack or delay of immediate, visible effects.

The scheme below (*Figure 15)* shows the correspondences between the problems of soil and solutions as they have been quoted by Demo farmers during the co-development meetings. Solutions were sometimes already applied in vineyards by farmers and sometimes were only known as possible interventions.

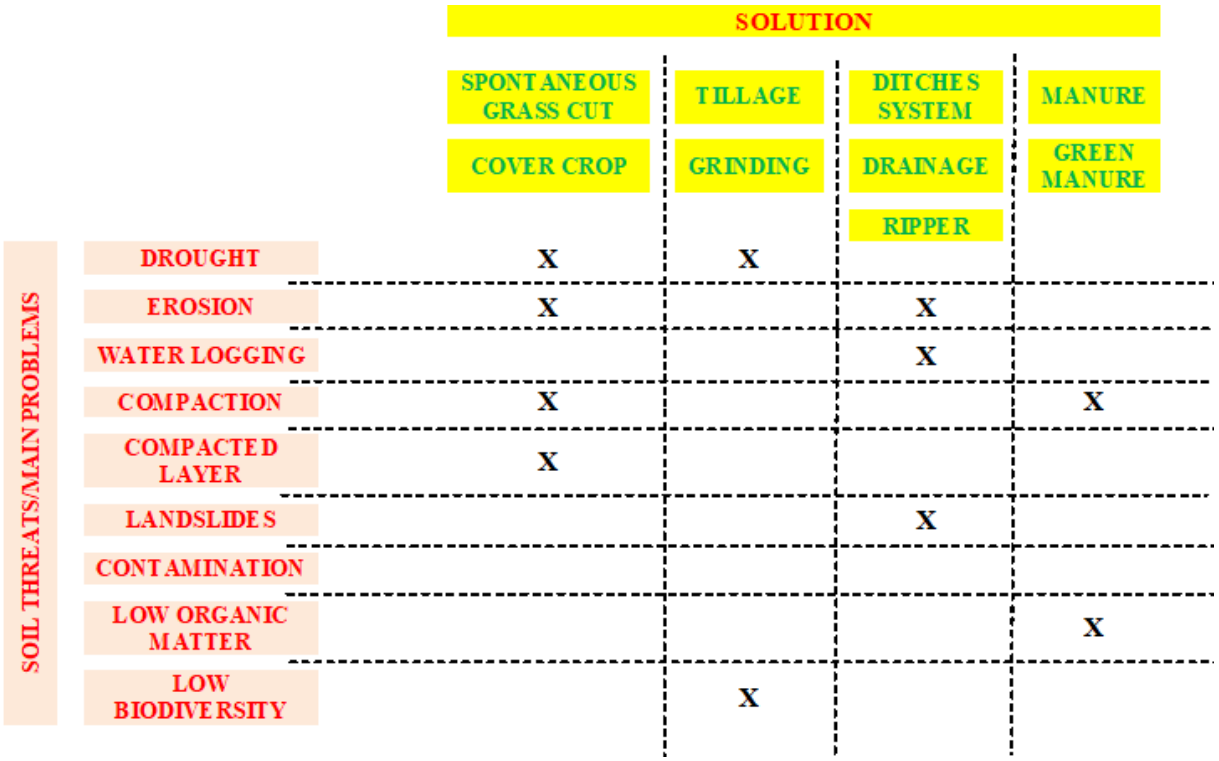

Figure 15: scheme of correspondence between soil threats/main soil problems and solution as indicated by Demo farmers before adoption of Action Plans.

4. THE "DECISION-MAKING INSTRUMENT"

The fourth meeting focused on understanding the purposes and main outcomes of co-development activities, evaluation of the co-designed tool and interest of demo farmers in using it in their vineyards.

In short, the tool is intended as a useful guide to make decisions in vineyard soil management and two different views were clearly shown within the demo farmers group: younger winegrowers would consider it more effective as "app", while older farmers would still appreciate a traditional support (i.e. a booklet).

B3.2: Education and training

Three training courses (*Figure 16*) were organized in collaboration with UCSC according to the schedule reported in *Table 2 (Milestone B).* This timetable was preferred to the original proposal (two 3-day long courses) to better meet availability of growers according to their working activities. Invitation to these meetings was also extended to farmers of the living lab group and to the members of the exploitation group.

Project proposal had scheduled that those events would have been held at Res Uvae; though, the fourth event only was organized in Castell'Arquato due to restoration works in the Res Uvae location that ended at M5 (May 2017).

DATE	VENUE	MAIN TOPICS
21/03/2017	Sala Gasparini – UCSC	1. Project presentation and winegrowers' role. 2. Presentation of the 4 parks. 3. General introduction on the soil main threats.
4/04/2017	Sala Gasparini – UCSC	1. Soil problems in the Parks territory. 2. Agronomic management of the soil in vineyard.
06/04/2017	Corte di Giarola – Strada Giarola 11 - Collecchio (PR)	1. Soil problems in the Parks territory. 2. Agronomic management of the soil in the vineyard
01/08/2017	"Res Uvae" Castell'Arquato – PC – loc. Costa Gravaghi 7	1. Soil management 2. Presentation of the α-version of the DSS.

Table 2: Education and training meeting schedule

The activities foreseen by the Sub-action B3.2 supported the co-development meetings (sub-action B3.1) to improve the knowledge of demo farmers about soil health and corrective solutions. Details of education and training meetings (agenda, signatures of participants, presented materials) are shown in *Deliverable B3.1-2. (Milestone B.3)*

Figure 16: Training meeting of 06.04.2018 in Collecchio

B3.3: Field Visit

During the second year of the project field visits in the "Demo" farms were opened also to the "living lab" and "exploitation" groups. Visits aimed at showing demonstrative vineyards and the activities carried out as a realization of *Action Plans* following the tool suggestions. Field visits were also an opportunity to promote an open discussion on applied techniques, methods and results about activities and the tool. For each field visit, UCSC and HORTA prepared a description leaflet with information about vineyard features and *Action Plan* activities.
Due to the bad weather conditions, that caused delays in starting field's working and sowing, field visits started during the second year (M22) and finished in M31 (third year).
EGPB decided to involve the groups mentioned above in the following way:

1. Drawing up an invitation's leaflet to the field visit;
2. Publishing the event on the project and partner websites;

3. Sending email to the groups ("demo farms", "living labs" and "exploitation");
4. Telephone calls to the invited participants to remind the event and to verify the participation.

Details on field visits are shown in *Deliverable B3.3 "Report on field visit with "demo farmers" and "living labs" groups"* attached to this report. Below a short description of the field visits (Table 3, *Figure 17*):

DATE	VENUE	MAIN TOPICS	N. OF PARTICIPANTS
12/04/2018	Az. Agr. Res Uvae (RES)	The meeting was organised like a "DEMOday": the first part was organised indoor with different talks about the advantages of grassing in vineyard soil management. At the event companies whose activities were related to soil management in vineyards were invited. Companies displayed and presented machinery for sowing and for grass mulching as well as different seeds mixtures. The second part of the day was organized in the field to visit the demonstrative . The invitation to this event was extended to other winegrowers, to private and public technicians and, consultants and to policy makers at the regional level.	27
17/10/2018	Az. Carrà Stefano and Az. Agricola "La Pagliara"(VT1-VT2)	The main topic of the visit was the sowing of seed mixture for green manure in the vineyard. During this meeting UCSC and HORTA presented the *Action Plans* developed for each farm.	5 (only project partners and farm owners).
30/05/2019	Az. Agr. "Podere Le Lame" (SP2)	The main topic of the visit was the soil incorporation of the biomass produced by the winter grass.. During this meeting UCSC presented the *Action Plan* developed for the	13

		demonstrative vineyard. A wine tasting followed the visit.	
06/06/2019	Az. Agr. Monte delle Vigne (TBC1)	The main topic of the visit was “Cutting and mulching in the vineyard”. During the visit grass was cut using And concurrently conveyed under the rows as a mulching purpose During this meeting HORTA and UCSC presented the *Action Plan* developed for the demonstrative vineyard.	8
25/06/2019	Az. Barbuti Giuseppe and Az. Vini Colombi (SPI, SP4)	The main topic of the visit was the different techniques and seed mixtures used for artificial permanent grassed vineyards. During this meeting HORTA and UCSC presented the *Action Plans* activity plans developed for each farms.	14
23/07/2019	Az. Agr. Palazzo (TBC2)	The main topic of the visit was the different techniques and seed mixtures used for artificial permanent grassed vineyards During the meeting HORTA presented, at the EGPB headquarter, the ß-version of the DSS to collect feedbacks from the participants. A wine tasting followed the visit.	10

Table 3: description of field visits in demo farms

a) RES_Az. Res Uvae: 12/04/2018

b) RES_Az. Res Uvae: 12/04/2018

c) VT1/VT2: Az. Carrà&Az.La Pagliara:17/10/2018

d)SP2_Az. Podere Le Lame: 30/05/2019

e) TBC1_Az. Monte delle Vigne: 06/06/2019

f) TBC2_Az. Agr. Palazzo: 23/07/2019

g) SP1_Az. Barbuti Giuseppe:25/06/2019 h) SP4_Az. Vini Colombi: 25/06/2019

Figure 17: photos of field visits in Demo farms

B3.4: Living labs in the study area

The "living lab in the project area" group was formed within Sub-action A1.3 during the first year of the project and it is composed by farmers operating within the 4 protected areas. In total 41 farmers were contacted and 24 accepted to be further involved..
Within sub-action B3.4 these farmers were invited to several meetings during which the DT (ß-version) developed within Sub-action B1.2 was presented and simulations of the use of the DT were performed with the participants. At the end of the meeting farmers were asked to fill out a feedback questionnaire prepared within Sub-action B2.4.
The number, location and participant composition of the meetings were slightly modified in respect to the project proposal, in order to better meet farmers needs and try to increase the number of participants. In total 5 meetings were organized ad-hoc and in two occasions the DT was presented (and feedbacks collected) within broader events (see detail in *Deliverable B3.4 "Report on living labs in the study area and across Europe*").
In total 69 persons attended these events, not just farmers, yet different stakeholders of the entire wine value chain. 21 persons filled in the questionnaire and provided a feedback to the DT presented.

During the After-LIFE period DT will be presented during congresses, fairs and dedicated demo days to enhance awareness of stakeholders on soil quality assessment..

B3.5: Living labs across Europe

As indicated in the project proposal, to test the DT (ß-version) across Europe, local advisors in representative EU grape-growing areas were sub-contracted through a professional assignment. Local advisors were selected based on their expertise and reputation in the specific viticultural area. In total 7 advisors were subcontracted, covering 7 different EU Countries and several grape-growing areas (see detail in *Deliverable B3.4 "Report on living labs in the study area and across Europe*").
The advisors were trained to the use of the DT through personal and group Skype call conferences. Then, local advisors selected interested farmers, visited them, showed them how the DT works in their specific context, and asked them to respond to the feedbacks' questionnaire.

In total (sub-action B3.4 and B3.5) 63 questionnaires were collected and analysed: currently, stakeholders manage the soil in their vineyards following their knowledge/experience (61%), guidelines provided by an advisor (28%), or common practices in the area (11%); none of them uses guidelines provided by an ICT system. The large majority of the respondents were satisfied with the content (more than 80%) and with the user-interface (icons, graphs, symbols) (more than 80%) of the tool. Opinions on easiness, speed of use and comprehension/clarity, usefulness, and confidence of the given information were also substantially positive. Benefits possibly arising from the use of the DT were also asked to evaluators and detailed results are described in *Deliverable B3.4 "Report on living labs in the study area and across Europe*" attached to this report.

B3.6: Trips, fairs and congresses

a) *Local fairs*

EGPB coordinated the participation into local events where to display Soil4Wine project to the public.. Project has scheduled at least 3 events and partners reached this goal participating to 5 local events.
The events were mainly wine fairs. Soil4Wine project was presented with exposition stands in which dissemination material were distributed and information was given by partners to visitors.

List of participated fairs is listed below (Table 4):

Fair name	**Date and venue**	**Number of participants**	**Involved partners**
Ecomondo	Rimini, 2018-2019	N/A	ART-ER
Mostra dei Vini (FIVI)	24/25th November2018: Piacenza	18.500	EGPB, UCSC, VIN
La terra è madre del vino	8th June 2019: Rivergaro (PC)	50	UCSC, ART-ER, HORTA, VIN
Borgofood	4/6thOctober 2019: Fidenza (PR)	150.000	EGPB, HORTA
Vini di Vignaioli	3/4th November 2019: Fornovo Taro (PR)	> 2.000	EGPB, HORTA

Table 4: fairs in which Soil4Wine was present

Details on each fair are reported in *Deliverable D1.2 "Report on activities to increase stakeholders awareness (congresses, fairs, webinars)"* attached to this report.

b) *Educational trip*

At M35 a study trip was organised with the aim to know more about the techniques of vineyard soil management in the French regions of Provence and Rhône Valley, acquiring new elements of theoretical and practical knowledge through seminars and visits to important wineries and research centres.
During the 3-day trip, the group of 27 participants (*Figure 18*), composed of winegrowers, agronomists, oenologists and researchers, visited 6 renowned wineries from very different wine-producing areas - from Côtes de Provence to the "extreme" wine-growing areas on the steep slopes of L'Hermitage and Côte-Rôtie.

In addition to visits, the trip was also rich in educational activities. The agronomist Jean Andres, a consultant of the ICV group (the largest viticulture and oenology consultancy centre in Europe), presented various techniques on soil management used in the Provence region. The seminar of geologist George Truc on the different terroirs of Châteauneuf-du-Pape was focused on the geological formation of the soils, the main characteristics of each terroir and the strengths and constraints of viticulture on these soils.
Diary of educational trip is attached to this report (Milestone B3.6)

Figure 18: photos of educational trip in France

b) *Final congress*

On M36 (5th December 2019) the Soil4Wine final congress was organized in Piacenza (Figure). The conference was on the World Soil Day to outline the important role of soil in viticultural context. To promote farmers and technicians participation, partners decided to organized a 1 day-long event in Piacenza instead of 2 day-long one in Res Uvae farm as foreseen in the project proposal. Congress was organised with the support of UCSC offices.

Congress agenda follow the project main topics:
- presentation of main results of demonstration activities and socio-economic assessment;
- feedbacks from demo farmers to highlight the participatory approach of the whole project;
- roundtable with main stakeholders involved in local and regional agronomical and viticultural policies;
- networking with other project on same topics.

Participant to the congress were 73 (*Figure 19*) and main organisation present were:
Emilia – Romagna Region, Tuscany Region, ARPAE Piemonte, Coldiretti (large national farmer association), several local municipalities, Consorzio di Bonifica Piacentino, wineries (consortia and individuals), private farms, consortium of the "Colli Piacentini" DOC wines, consortium of the "Colli di Parma" DOC wines.

Figure 19: photos of S4W final congress

Congress agenda, slides of oral presentations , summary of Q&A sessions and signatures of participants are collected in *Deliverable B3.6 "Report on final Soil4Wine congress"* and also as part of *Deliverable D1.2 "Report on activities to increase stakeholders awareness (congresses, fairs, webinars)".*

Action B4 - Economic, social and policy evaluation

Foreseen start date	01/07/2017	Actual start date	01/01/2017
Foreseen end date	31/12/2019	Actual (or anticipated) end date	31/12/2019

B4.1: Socio-economic conditions affecting soil management

A preliminary study of socio-economic conditions affecting soil management was carried out. As a first step, a survey to investigate which factors influence farmer's choices was conducted among the "demo farmers", while a second survey was prepared for the "Living Labs". Difficulties were encountered in the investigation of this second group due to the problems and delay in their involvement in the project. The exploitation group was involved through a verbal discussion during dedicated meetings..
Therefore, *Deliverable "Report on socio-economic condition affection soil management"* was completed at M19 instead of M14. The main results show that farmers' age, their level of education, and farm size are the most important variables affecting the willingness to adopt new soil management approaches, with a positive correlation against education level and farm size and negative versus age of the farmer. Results allowed to better select growers more open to innovation and therefore more willing to adopt new technologies and new tools.

B4.2: Evaluation of socio-economic effects on the wine value chain and on local development

A cost-benefit analysis was carried out with reference to the implementation of *Action Plan* by demo farmers and living labs in *Action B2*. All the implementation costs due to demonstrative actions for demo farmers were recorded also with the support of other partners. The effects in terms of change in quantity and quality of the grape produced by demo farmers in trial fields were also recorded in order to consider the potential further costs (income loss) or benefits due to changes in yields due to new soil management practices.
For this economic analysis production data were also collected and analyzed up to the last year of the project, i.e. 2019; therefore the analysis spans over three years. Nevertheless, this period is still too short to evaluate the effects of different soil management techniques as, they typically require a longer period of time to clearly differentiate. However, even if these data cannot be considered as conclusive, main results were described in terms of changes in yields and quality of the harvested grape (*Deliverable "Cost-benefit evaluation"*). The quality of grape, measured as sugar concentration (°Brix) at harvest showed little differences between demo and traditional plots and vine yield was quite erratic. This, in the lack of clear and fast return in terms of yield and quality, farmers remained e skeptical and/or reluctant to introduce new soil management practices.. On the other hand, if some support can be granted to farmers through PES that can transfer to them the social value of the ES provided using these new more sustainable soil management practices, farmers decision could change radically. In other words, these results support that more sustainable soil management techniques, and permanent grass cover in particular, could be more easily implemented if additional economic support can be granted through PES or public support.

One the other hand, the potential economic benefits of the implemented new approach to soil management on the entire value chain and local economy were also estimated.: . Results have shown that 99% of total grape production cost refers to factors of production bought locally and 89% of the wine making costs refers has the same origin. Therefore, considering the

decreasing trend in hectares of agricultural land used for grape growing in the area, it is easy to estimate that the potential impact on local economy could be dramatic. According to the estimation, the current level of production (hectares cultivated and wine produced) is generating an overall impact on the local economy of 68 million of €.

B4.3: Assessment of soil ecosystem services in the study area

Most important soil Ecosystem Services (ES) in vineyards have been identified: *erosion protection, carbon sequestration, water yield, landscape quality, biodiversity preservation*.
Used methodologies for biophysical assessment were: RUSLE for erosion protection (tons of avoided soil loss), UNFCCC for carbon sequestration (tons of CO2 absorbed), effective infiltration for water yield (mc of stored groundwater), visual impact for landscape quality, QBS-ar for biodiversity preservation (n° of species).
Used methodologies for economic assessment were: substitution method for erosion protection and fresh water storage, voluntary carbon credit market price for carbon sequestration, contingent evaluation for landscape quality and biodiversity preservation.
The quantification of the ES, in physical and monetary terms was carried out for pilot vineyards of demo farmers: 9 farmers have been involved (the project target was 4). After the demonstration phase, yearly average values for pilot vineyards were:

- erosion protection: € 700/ha (27 ton of soil per hectare)
- carbon sequestration: € 44/ha (2,8 ton of CO_2 per hectare)
- water yield: € 600/ha (516 cube meter per hectare)
- landscape quality: € 50/ha (qualitative evaluation)
- biodiversity preservation: € 60/ha (better class of QBS-ar)

The activity did not highlight particular problems in terms of target achievement; yet the selection of the more suitable methodologies and the data collection from farmers has been quite complex and time demanding. The involved human resources have been higher than expected. The activity started on the third quarter of 2017. The final *Deliverable "Final economic evaluation of soil ecosystem services"* was completed on July 2019 and it is attached to this report.

B.4.4 Innovation in soil conservation policies

An assessment of existing policies on soil conservation and ecosystems services has been carried out: Rural Development Programme, Forest Regional Plan, Protected areas management Programme, Regional Territorial Plan, Regional Landscape Plan, Regional Operational Programme on structural funds, Regional Climate Change Strategy.

4 PES feasibility test have been carried out (Table 5). Details are reported in *Deliverables "PES feasibility study".*

Ecosystem service	***Soil erosion protection***	***Water yeld***	***Landscape quality***	***Biodiversity preservation***
PES	***Reclamation tribute***	***Supply chain valorization***	***Tourist tax***	***Park's museums ticket***
Geographical location	Province of Piacenza	Trebbia valley	Municipalities of Parma Piedmont Union	Municipalities involved by Taro and Boschi di Carrega natural areas

Involved protected area	Stirone and Piacenziano Regional Park	Trebbia river Regional Park	Taro river Park and Boschi di Carrega Park	Taro river Park and Boschi di Carrega Park
Suppliers, buyers, other beneficiaries	farmers (demo farm:SPI, SP2, SP3, SP4), citizen, municipalities and Reclamaton Consortium	farmers (demo farm VT1, VT2), citizens and companies (wine producer Cantine Bonelli)	farmers (demo farm TBC1, TBC2), tourists and companies of tourism sector, Parma Piedmont Union	farmers (demo farm TBC1, TBC2), citizens, tourists and public authorities, Western Emilia Park
Financial tools	reclamation tribute	contract between farmers and wine producer	tourist tax	museums ticket (tomato and wheat museum)
Rewarding mechanism	Piacenza Reclamation Consortium could reduce the amount of the tribute, for farmers able to demonstrate the adoption of techniques able to enhance slope stability.	- +9% of grapes prices paid by winery - +20% wine bottle price - project's logo, the slogan "soil for wine" and a QR code linked to an environmental declaration that describes the ecosystem service, the sustainable viticulture techniques and the environmental performances.	Parma Piedmont Union could allocate part of tourist tax income to reward sustainable farmers that adopt Soil4wine techniques that improve landscape.	The Park could allocate part of tickets income to reward sustainable farmers that adopt Soil4wine techniques that preserve biodiversity.

Table 5: PES feasibility study

The activity has been successful, yet troublesome. Some effort had to be dedicated to involve regional officers representing the Services responsible for the different plans and programme. The cooperation with public officers progressed through the exploitation group meetings as well as through vis-a-vis meetings to face specific issues (06.02.2019, 14.02.2019 13.05.2019, 09.10.2019, 31.10.2019); signatures of attendance to meetings are attached to this report). Demo farmers were engaged with field activities at the end of the summer and beginning of autumn, so the project timing was adjusted to their needs and availability.

In particular, the development of PES design with Reclamation consortium of Piacenza, Parma Piedmont Union of Municipalities and Cantine Bonelli srl (wine producer) was complex in terms of technical issues (e.g. legal and procedural aspects), but really satisfying in terms of stakeholders involvement.

During the project one of the PES assessed ("supply chain valorization") was developed and now it is applicable by farmers. For the application of PES related to water yield developed in collaboration with wine producers , partners approved a "Regulation for Logo use" (accompanied by evaluation and validation methods), available on the project website (documents are also attached to this report). Registration of Soil4Wine logo for its use on wine label is underway by Italian Patent and Trademark Office.

Finally, a guideline for the integration of soil PES into regional policies was developed, considering the strengths and the weaknesses of processes assessed during the project and the

framework of existing policies. The final *Deliverables "PES feasibility study"* and *"Guidelines for the integration of soil PES in regional policies"* were finished at the end of the project and are attached to this report.
During the after-LIFE period partners will continue activities for implementation of feasible PES and they also will cooperate with a credit institute for the development of a financial tool aimed at supporting ES and they will be also involved in activities aimed to promote PES and integration of policies to public authorities.

B.4.5 Evaluation of project transferability to other sectors

The transfer potential from vineyards to other orchard systems was related to the following items:
- tackled soil threats;
- cultivation techniques and soil management practices
- ecosystem services descending from cultivation techniques
- applicable payments for ecosystem services.

Considered crops were: Peach, Apple, Hazelnut, Olive and Citrus as main tree crops comparable with Grapes in terms of floor management techniques. Results were presented in the form of a matrix (as foreseen in the project proposal) accompanied by maps (developed with ArcGIS and InVest software) describing the transfer potential considering a regional scale.
The final *Deliverable "Report on project transferability to other sectors"* is attached to this report.

Action C1 - Monitoring of the impact of project actions

Foreseen start date	01/01/2017	Actual start date	01/01/2017
Foreseen end date	31/12/2019	Actual (or anticipated) end date	31/12/2019

C1.1 - Project performance indicators

During first partners meeting (M11) HORTA and the other involved partners confirmed the list of performance indicators inserted in the proposal and specified that no further indicators would have been added *(Milestone C1)*.
During the project some changes were applied to performance indicators list. Assessment of "*penetrometric measurement*" and "*infiltration rate*" were not possible with partners resources, moreover after a consultation with microbiologists of UCSC, it was concluded that due to high variability in results of indicators "soil enzyme" and "microbial biomass C" it was better to shift from a direct soil enzyme analyses to a soil biome assessment, so these indicators were removed. Details about biome analysis are reported in this document.
Many of the indicators useful for project evaluation are part of parameters collected for SWOT analysis and vineyard characterization in *Sub-action B2.4* and are presented in *Deliverable B2.4 "Second report on SWOT analysis of soil and plant data in the considered vineyards".*
At Progress Report time Key indicators for LIFE project were filled in the KPI Tool and then they were updated at Final report time. Key indicators for LIFE table were updated and attached to this report. Comments to KPI indicators are in Paragraph 6 of this report.
In Table 6 shown below there is a summary of impact of indicators (updated Table C2 of project proposal).
Data are presented in different ways to present the overall impact of Soil4Wine project but also to highlight the effects of innovative solutions. Values refer to sampling made at 0-20 cm and 60-80 cm depth during last year of the project (2019) comparing traditional and innovative soil management.
Parameters collected and used for impacts assessment were grouped in a single spreadsheet reporting also comparison in time and space of indicators. Table is attached to this report.

(Projects funded under the Call 2014 onwards must use this format)

				Impact (2019)									
Key indicators and parameters	**Descriptors**	**Function**	**Indicators**	**Innovative vs. Traditional soil management**		***Green manure vs. Tillage***		***Green manure vs. Spont. grassing***		***Sown permanent grassing vs. Sp. grassing***		***Underground pipe drains***	
				(0-20 cm depth)	**(60-80 cm depth)**	**(0-20 cm depth)**	**(60-80 cm depth)**	**(0-20 cm depth)**	**(60-80 cm depth)**	**(0-20 cm depth)**	**(60-80 cm depth)**	**(0-20 cm depth)**	**(60-80 cm depth)**
Resource efficiency - soil	organic matter	nutrient retention	*Total N*	-8%	-2%	-5%	-16%	+6%	-10%	-24%	+7%	-2%	+13%
			P available	+79%	+3%	+300 %	=	-14%	=	+60%	+11%	-10%	=
			K exchangeable	-2%	-21%	+6%	-9%	-8%	-30%	-5%	-28%	+3%	+13%
			soil nitrate	-13%	+11%	-11%	+41%	-14%	+2%	+3%	+4%	-29%	+18%
		soil fertility	*mass organic matter/total mass soil*	-3%	-6%	+6%	+18%	+2%	-13%	-10%	-33%	-13%	+6%
		soil stability	*stability of soil aggregate*	+8%		-7%		-14%		+12%		+24%	
	physical properties	retention and transport of water nutrients	*bulk density*	=	=	=	-3%	=	+4%	-2%	=	=	=
			soil structure	+50%		+50%		+50%		+50%		+50%	
			water holding capacity	-11%	-2%	-10%	+3%	-8%	-9%	-25%	-7%	+3%	+5%
		compaction, plow pan, water movement	*bulk density*	=	=	=	-3%	=	+4%	-2%	=	=	=
			water holding capacity	-11%	-2%	-10%	+3%	-8%	-9%	-25%	-7%	+3%	+5%
		porosity	*bulk density*	=	=	=	-3%	=	+4%	-2%	=	=	=
			water holding	-11%	-2%	-10%	+3%	-8%	-9%	-25%	-7%	+3%	+5%

			capacity										
	chemical properties	nutrient retention, availability and dynamics, mineralisation, soil biology, quality and fertility	*soil pH*	=	+3%	=	-1%	=	-1%	=	-1%	+2%	+19%
			soil nitrate	-13%	+11%	-11%	+41%	-14%	+2%	+3%	+4%	-29%	+18%
			electrical conductivity	-44%	+26%	-5%	-16%	+6%	-10%	-24%	+7%	-48%	+131 %
			Total N	-8%	-2%	+300 %	=	-14%	=	+60%	+11%	-2%	+13%
			P available	+79%	+3%	+6%	-9%	-8%	-30%	-5%	-28%	-10%	=
			K exchangeable	-2%	-21%	-11%	+41%	-14%	+2%	+3%	+4%	+3%	+13%
	biological properties	microbial catalytic potential and repository for C and N	*earthworms*	+20%		+25%		+27%		+4%		+30%	
		biodiversity/soil quality	*QBS-ar*	+33%		+65%		+48%		+35%		+7%	
GHG emission			*carbon footprint*	-4%		-30%		+24%		-2%		n/a	
Carbon sequestration	terrestrial		*metric tons CO_2/year*	+13%		+74%		-6%		+8%		n/a	
Ecosystem	sparsely vegetated land		*ecosystem status and trend*	favourable and improving		favourable and improving		favourable and improving		favourable and improving		favourable and improving	

Table 6: updated Table C2 of project proposal

C1.2 - Socio-economic impact reporting

Due to the nature of the project, we could not expect to obtain nor to measure real effects on the local economy "during" the project: first of all because of the very limited size of the pilot areas. Results of the test have been made available at the end of the project and therefore the opportunity of implementing these results and obtain the expected socio-economic effects should be evaluated at during the after-life period of the project. According to the conclusions of *Sub-action B4.2*., the implementation of new soil management techniques requires an economic support through actual and effective PESs; without these payments, it will be quite difficult to promote the adoption of new techniques. For this reason, most of the socio economic impact will depend upon the effective implementation of these PESs after the end of the project.
However, with reference to the list of socio-economic indicators presented in Milestone C1, at the end of the research we have been able to develop the following evaluations (Table 7).

	Socio-economic indicators	**Actual value**	**Trend**
1	N° of (total) farms in the pilot area	10,635	-1.60%
2	Turnover of the farms in the pilot area for the last 3 years (€/ha)	6,100	stable
3	N° employees of the farms in the pilot area (labor units)	570	-5%
4	UAA (Utilized Agricultural Area) of the farms in the pilot area (ha)	5,703	-7.40%
5	Export rate of wine in the last 3 years (export/production)	16.0%	3.1%
6	Investments for sustainable practices in the last 3 years (percentage of total production cost)	2.0%	4%
7	Investments for training in the last 3 years (percentage of total production cost)	1.0%	2%
8	N° employees with environmental protection practices knowledge (percentage of total employees)	10%	20%
9	N° employees with age under 30 years	2,3-3%	stable
10	Surface (Ha) dedicated to sustainable production (i.e. organic)	999	+8-10%
11	Sales volume of sustainable products (i.e. organic) in 100 kg of grape	65,894	+6-12%

Table 7: socio-economic indicators assessment

With reference to the evolution of the number of farmers and farms, it is well known that the trend is decreasing, both with reference to the total number of farms and farmers and with reference to the number of farms and farmers cultivating vines. The total number of active farms (source: Chamber of Commerce) in the pilot area (Provinces of Parma and Piacenza) in 2018 is 10.635, and the compound annual growth rate (CAGR) is -1.6%. The estimated number of farms with vines in the same year is about 2800 units. Even in this case the estimated CAGR, at the national level, is about -1.5%. These values are not necessarily

negative since the average size of these farms is still too low to allow most of them to survive. Therefore, we can consider these structural changes as not negative, per se. What is more relevant with respect to the present analysis is the evolution of the Utilized Agricultural Area dedicated to vines in the pilot provinces. This data (index 4) is even more negative: in the period 2015-2018 there has been a reduction of the UAA for vines that decreased to 5.703 hectares, and the trend for the next few years is decreasing (CAGR= -7,4%). As explained previously, this is the reason why the present project is so relevant for this area: without and effective implementation of new technologies (DSS) and without the implementation of effective PESs, it will be very difficult to stop this decreasing trend. In this case we must expect with strong negative effects on the local economy and on the environment (due to the high risk of abandonment of land in hilly areas). And among negative effects there will be also a decrease in the number of employees (indicator 3).

Some positive trends are also present: the average turnover per hectare seem to be stable in the last few years since yields and price variability tend to compensate each other. But this data is the result of a quite dichotomous evolution: there are grape growers who are improving their competitiveness, in particular when they are able to implement sustainable practices like organic production, and there are others, more traditional ones, who are fighting to survive. From this point of view the positive evolution of wine export from the pilot area (index 5) is important: the share of exported wine has reached 16% of local production, and the last three years there has been an increase by 3,1% points. This has been due to an increase of export of +16,2% in terms of quantity and +10,8% in terms of value.

On the other hand also the number of hectares of organic vines has been increasing in the last three years, reaching 999 hectares in 2018 in the pilot area, equal to 18,5% of total vines. The trend is steadily increasing. Therefore, also the amount of organic grape produced in the pilot area has been increasing and is expected to continue to increase (indicator 10 and 11).

The other indicators are showing the difficult condition characterizing the socio-economic scenario in the area of the pilot action: the level of investments for sustainable practices (organic production excluded) and for training in the last three years have been very low and because of similar reasons (economic and competitive pressure) (see indicators 6 and 7), but increasing. Also the number of employees with a knowledge of environmental practices is very low but, again, increasing (indicator 8). Up to this moment, these trends are positive mainly because they are pulled by the development of demand for organic production and by new opportunities available on the final market (increasing demand for “sustainable” products”). The availability of new tools, like the DSS tested in this project, and new PESs, could play a very positive role in the near future in supporting further developments in this direction.

The effectiveness in the implementation of PESs and in diffusion of DSS and new more sustainable soil management techniques will play, in the near future, a key role in supporting the socio-economic development of the wine grape sector and a better soil management in vineyards with positive effects on the rural environment.

Action D1 - Public awareness and dissemination of results

Foreseen start date	01/01/2017	Actual start date	01/01/2017
Foreseen end date	31/12/2019	Actual end date	31/12/2019

D1.1 - Information and awareness raising activities

- By M3 project specific web pages in four languages (EN, IT, ES, FR) were created and periodically updated (*Deliverable "Project web pages":* www.soil4wine.eu). They show project objectives, actions planned, main activities and information about consortium composition demonstrative vineyard and farms features *(Milestone D.1)*. The possibility of co-editing was activated, so all the members of the S4W communities created in *Sub-action A3.1* had the possibility to upload texts and documents on the website *(Milestone D.1)*. The DT, being the main output of the project, can be accessed directly from the dedicated section of the Website. All the deliverables of the Project, classified by action, are also available in the corresponding section. Website will be maintained over the after-LIFE period, focusing on the main outputs of the project (DT and Regulation and methods of quantification of ecosystem services).The project web pages were interfaced with the internet journal site "Infowine", so all the news and other information related to the project could appear simultaneously on soil4wine.eu and infowine.com, greatly increasing visibility of contents posted. Since the website was launched, it reached the auditory of 6.500 unique visitors and 23.702 total number of views.75% of new visitors were reached through publications on infowine.com. Mirroring between Infowine and soil4wine.eu will continue in After-LIFE period.
- Four dedicated e-mailings were performed in four languages (EN, IT, ES, FR) using the InfoWine database (21430 stakeholders):
    - i) dedicated to the launch of the project and the S4W survey (M6)
    - ii) presenting the video of 2 seminars recorded during the special session dedicated to S4W held at the Enoforum congress (M10),
    - iii) presenting state of the art of the project and preliminary results (M30),
    - iv) dedicated to the conclusion of the Project and presenting its results and educational video online (M36).

  Supplementary e-mailings n.5 were performed in IT for Italian stakeholders in order to promote other dissemination activities, such as DEMOday - "*Gestione del suolo: i vantaggi dell'inerbimento"* (Field Visit Progetto Soil4Wine Life+), the "*La Terra è madre del vino*" event, study trip Soil4wine, digital seminars, Final project conference.
- Projects flyers were created and printed in IT and EN languages (2000 copies per language). By April 2019 all of them were distributed by Partners, so it was decided to re-print a slightly modified version of leaflet (2000 copies in IT, 500 copies in EN). VIN distributed more than 1,000 flyers at the international congress Enoforum (held in 2017, 2019 in Italy; 2018 in Spain), and in occasion of n.25 training courses and seminars organised by VIN.
- At beginning of M6, notice boards on the project were created, printed and installed in demo farms.
- Facebook page was also opened (https://www.facebook.com/Soil4Wine-Life-322068778239319/) and regularly updated by UCSC. At the end of the project page has 238 followers

- Press:
  - Article "*Soil4wine: la Ue sostiene la viticoltura innovativa nei parchi*" in online newspaper parmadaily.it (September 2016)
  - An article about the project was published in Storie Naturali magazine (Storie Naturali, 10/2018, p.74,) attached to this report
  - Episode *"SOIL4WINE: il futuro del vino passa dalla conservazione del suolo*" of the program Smart City on the Radio24 (December 2018)
  - Article "*Un approccio innovativo nella diagnostica della salute e la gestione del terreno*" in Corriere Vitivinicolo magazine (Corriere Vitivinicolo n. 4 February 2019, p.20) attached to this report
  - Article *«Come migliorare le funzioni del suolo agricolo e i servizi ecosistemici: l'esperienza del progetto SOIL4WINE"* in online newsletter Eurolettera (Eurolettera n.1 March 2019)
  - Article "*Valutare e tutelare la qualità del suolo in vigneto: una scelta possibile grazie al progetto LIFE Soil4Wine*" in online magazine Pianeta PSR (Pianeta PSR n. 79 April 2019)
  - Article "*Con Soil4Wine la viticoltura di collina migliora ambiente e reddito dei produttori*" in online newspaper Il Piacenza (December 2019)
  - Article *"Fare della sostenibilità un marchio europeo: Soil4Wine ha tracciato la strada*" in online newspaper Il Piacenza (December 2019)
  - Article "*Più produzione e biodiversità nei vigneti non lavorati*" devoted to project results was published in L'informatore Agrario magazine (L'informatore Agrario, 2/2020, p.55)
  - Article "*Vino e ricerca, viticoltura sostenibile: un approccio innovativo alla gestione del suolo nel paesaggio viticolo*" in the blog You wine magazine (December 2019)

- A bilingual Layman's report (IT and EN) was prepared in the end of the Project (*Deliverable "Layman's report")* and it is available on the project Web Pages

Sub-Action D1.2 - Technical dissemination activities

- Project activity and results were presented at the following technical congresses:
  - Dedicated session at *Enoforum 2017* (Vicenza, Italy, ~ 1000 participants)
  - Dedicated session at *Enoforum 2019* (Vicenza, Italy, ~ 1200 participants)
  - Final conference Soil4Wine (December 2019, Piacenza, Italy, ~ 80 participants)
  - Poster at *Enoforum 2018* (Zaragoza, Spain, ~ 500 participants)
  - Poster at "*Quercetina e vino*" conference (July 2018, Montalcino, Italy, ~ 190 participants)
  - "*Buone pratiche per la conservazione dei suoli e le produzioni vitivinicole di qualità*" - Toblino winery (February 2019, Trento, Italy)
  - *IOBC-WRPS* Meeting of the Working Group "Integrated Protection in Viticulture" (November 2019, Villa Real, Portugal)
  - International Summer School "*Sustainable Soil Management in Viticulture*" (September, 2017, Firenze - Italy)
- Oral presentations of seminars held during the special session devoted to the project at

Enoforum congresses (May 2017, May 2019) were recorded and dubbed. The videos of seminars are available on the project web pages and internet journal Infowine website in Italian and English languages:

- Chemical, physical and biological characteristics of vineyard soil (1861 views in IT; 570 views in EN)
- Modulate vigor, productivity and grape quality through soil management (1333 views in IT, 301 views in EN)
- Managing and protecting soil in the vineyard: experience of the Soil4Wine LIFE+ project (328 views in IT, 78 views in EN)
- An innovative and interactive tool for soil management in viticulture (107 views in IT, 50 views in EN)
- Wine for soil: an example of a green economy (110 views in IT, 65 views in EN)

- Two digital seminars were held in M34 (October 2019) in Italian and English, aiming to deliver the project results to Italian and international stakeholders.
  - Innovative and interactive tool for the soil management in viticulture (Speaker: Sarah Elisabetta Legler, HORTA; 46 participants)
  - Sustainable viticulture and ecosystem services: an opportunity for agricultural enterprises and the environment (Speaker: Alessandro Bosso, ART-ER; 33 participants)

  The recordings of webinars of the Soil4Wine online training course are available in IT and EN on the project's website.

Sub-Action D1.3 - Networking with other projects

- Detailed scouting of projects related to soil management and protection was performed in M4-M5 (Milestone 1).
- Some of the projects (VITISOM LIFE15/ENV/IT/000392; PROVITERRE PSR 16.01.1 n. 5004519; WINETWORK H2020 ISIB-02-2014 n. 652601) participated together with S4W to Enoforum.
- One of the demo farms (Res Uvae) is included in the inventory of demonstrative activity of PLAID Project (H2020-RUR-2016-2727388)
- S4W project activity was explored as a case study of the AgriLink project (H2020-RUR-2016-2 -727577) (M17-M23)
- Contributions were sent to Pillar-1 of the European Soil Partnership (M17)
- Contributions were sent to EU Pollinators initiative (M17)
- Contacts were established with the following projects: ADVICLIM (LIFE13 ENVFR/001512), SOS4LIFE (LIFE15 ENV/IT/000225), LIFE HELPSOIL (LIFE12 ENV/IT/000578), RESOLVE (ERA-Net CORE Organic Plus No. 618107)
- Networking session between LIFE and Erasmus+ projects (M23, Giarola, Italy). Participating projects: SOIL4WINE, LIFE BARBIE (LIFE13 NAT/IT/001129) – LIFE EREMITA (LIFE 14 NAT/IT/000209) – Erasmus EQUAP – Erasmus SIDEIS – Erasmus STTfT – Erasmus PANHERA
- Networking activity with other LIFE projects organized by CREA - Agricultural Research Council at the pavilion of the Ministry of Agriculture and Tourism during Vinitaly (April 2019, Verona, Italy, participating projects: SOIL4WINE, VITISOM (LIFE15/ENV/IT/000392), LIFE GREEN GRAPES (LIFE16-ENV-IT-000566), ZEOWINE (LIFE17 ENV/IT/000427)

- Networking session “PEI-AGRI for viticulture and winemaking: research and innovation experiences” organized by National Rural Network in collaboration with EIP-Agri service point in the framework of Enoforum 2019 (May 2019, Vicenza, Italy).
  Invited 22 Operational Groups, including PRO-VITERRE, VALORINVITIS, UVA PRETIOSA, VINTEGRO, VINCAPTER, WISHELI, VINSACLIMA and others)
- Participation in Interregional Learning event of INTERREG DELTA LADY project (M33, Comacchio, Italy)
- Networking activity during the Project Study trip to France: exchange with the VINCAPTER PSR Emilia-Romagna 16.01.1 (M35)
- Networking session during the Final conference of the SOIL4WINE Project “Viticulture, soil and ecosystem services: projects in comparison” M36, Piacenza, Italy). Invited projects: LIFE SOS4LIFE (LIFE15 ENV/IT/000225) - LIFE VITISOM (LIFE15/ENV/IT/000392) - LIFE GREENGRAPES (LIFE16-ENV-IT-000566) – BIOVINE PROJECT (H2020 ERA-net project, CORE Organic) - INTERREG DELTA LADY PROJECT
- Networking session during the Final Conference of LIFE VITISOM (LIFE15/ENV/IT/000392) Project (M36, Milan, Italy). Invited projects: SOIL4WINE - ZEOWINE (LIFE17 ENV/IT/000427) - LIFE GREEN GRAPES (LIFE16-ENV-IT-000566) – LIFE DOP (LIFE15 ENV/IT/000585) – LIFE IPNOA (LIFE11 ENV/IT/000302) – FARESUBIO (PSR Lombardia 16.01.1)

6.2. Main deviations, problems and corrective actions implemented

S4W project have followed the planning timetable. There were only minor deviations from the foreseen activities. During actions implementation some constrains were found and classified according to their potentially negative impact, probability of occurrence and measures envisaged for overcoming them.
A list follows with main deviations and suggested mitigation actions (Table 8).

Constrains and risk (and action affected by)	Impact	Probability	Deviations from initial estimates
Invited stakeholders decline or do not participate actively to Project's groups and activities (Action A1, B2, B3)	High	Low	Yes
Lack of consensus for the elaboration of innovative policies about conservation of soil (Action B4)	High	Low	No
Loss of critical competencies of key people in the project	High	Medium	No
Delays in critical components of the works (all Actions)	High	Medium	Yes
Stakeholders participation to survey results lower than expected (Action A1, B4)	Medium	Low	Yes
Project results and related documents are not finalized and ready for dissemination in due time (Action D1)	Medium	Low	Yes
Loss of internal communication and awareness (all Actions)	Medium	Medium	No
Stakeholders willingness to provide economic data is lower than expected (Action B4)	Medium	Medium	Yes
Non performance of Staff (all Action)	Medium	Medium	No
Unfavourable weather conditions for implementation of some soil management solutions (Action B2)	Low	Medium	Yes
Exceptional and unmanageable biotic and abiotic stress	Low	Low	Yes
Foreseen meetings are not sufficient for managing the project (Action E1)	Low	Low	No
Inflation (all Action)	Low	Low	No

Table 8: updated risk evaluation table

In the following paragraphs, constrains, deviations and corrective actions are explained in more details.

A1: Study of the soil threats and constitution of the stakeholders groups

Completion of *Action A1* was postponed from M6 to M18. Characterization of the whole project area soils was made using thematic maps from Emilia-Romagna Region website, while detailed soil analysis to investigate chemical, physical and biological features were

made in demonstrative vineyards after their identification at M7. According to climate conditions of the first project year, marked by quite severe drought during spring and summer, soil sampling was performed at M10 (for physical features) and at M16-M17 (for biological properties).
Part of the study of soil threats in Europe was performed through a survey among stakeholders. A questionnaire was designed from UCSC and VIN and sent to more than 10.000 bodies, yet only 157 were answered. After a discussion with partners it was decided to avoid additional sending because the α-tool had already been developed using the information collected insofar.

To constitute "Living Labs" group (*Sub-action A1.3*), 41 farms in project area and bordering municipalities were contacted. At Progress Report time only 4 farms accepted the proposal. At mid-term period 24 farms accepted to participate to the project after new contacts in spring 2018 reaching the project expected number.

B1: Development of the decision tool

During project implementation, an issue emerged about difficulties encountered by demo farmers in using the α-version of the DSS tool, mostly because their inexperience for understanding and using excel sheets. The main corrective action consisted in anticipating the development of the ICT-version (*Sub-action B1.3*) in order to provide users (i.e. demo farmers, living labs, etc.) with a more user-friendly tool for the 2019 season and all testing by living labs in project area and across Europe.

B2: Demonstration in vineyards

Demonstration vineyards are representative of viticulture features in the project area but they are generally characterized by a small surface (less than 1 ha). Demo vineyards were selected in cooperation with Demo farmers and it was agreed that they should have shared soil management technique and action.
Linked to the previous issue, useful data for the SWOT analysis about the α-version evaluation could not be collected from the demo farmers. The corrective action implemented was to build a new questionnaire in order to catch up for this weakness.

Sub-action B2.2 was anticipated at the end of first year of project, instead of second year, to get one more year of solution implementation, as sowing of seed mixture for cover crops used as green manure has to be performed at the beginning of the fall season.
At the end of 2018, SP3 vineyard was explanted due to the high incidence of wood disease that compromised production. A letter with the justifications of the farmer was sent to the Project Coordinator in May 2019. The farm has remained part of "demo farms" group.
Delayed sowing due to unfavourable weather conditions (exceptional drought season in spring-summer 2017 and rainy spring and early summer in 2018) and seeds shipment delays caused also a delay in collecting field data for providing a complete and exhaustive SWOT analysis. This issue represented a deviation from the project flow but all the necessary information was collected during the growing season 2019. All the demo-farms were considered within the SWOT analysis.
Regarding biological data of demonstrative vineyards' soil, HORTA and UCSC decided to change also the modalities in which soil samples were analyzed. In particular assessment of QBS-ar index was supposed to be made in UCSC labs but, due to problems in laboratory and

personnel availability, samples were sent to an external laboratory in 2018. On the contrary, the assessment of samples in 2019 was performed by UCSC personnel at university facilities. Due to high variability in results of soil enzyme analysis between different years and weather conditions, after consultation with microbiologists of UCSC, it was decided to shift from a direct soil enzyme analyses to a soil biome assessment. This assessment was performed by the same research group but within another UCSC project (www.ecoresiliente.com).

B3: Interaction with stakeholders

EGPB supported ART-ER in *Sub-action B.4.4* to promote PES at the local level involving the consortium of the "Colli di Parma" DOC wines and the "Unione Montana Parmense" (a consortium of public bodies) to carry out a PES's action in their territory.
Furthermore, the beginning of the *Sub-action B3.5 "Living lab across Europe"* and the trip in France allowed to disseminate the project across Europe.

Sub-action B3.1: Co-Development/Sub-action B3.2: Education and training

Three 1-day long courses were held by EGPB with the collaboration of UCSC and HORTA instead of two 3-day long ones to permit higher and more active farmers participation. Change in foreseen activity was decided after farmers consultation and checking of their availability.
The project foresees "Education and Training" events at Res Uvae, but only the fourth event was organized in the planned venue due to restoration work in the farm buildings until M5, other meetings were held in Piacenza and Lugagnagno.
End of field visit activities (and related documents) was postponed at M31.

Sub-action B3.3:Field visits

Due to bad weather conditions, establishment of innovative solutions was somewhat delayed and field visits started during the second year (M22) and finished in M31 (third year).
Unfortunately, the participation to the field visits by the "living lab" was quite poor. Partners increased efforts to involve them sending email or by directly phone calls. Moreover, a wine tasting at the end of each visit was planned to present winery and to encourage the participation. To reduce travel time and facilitate farmers presence, visits with the same topic were repeated in each park area.

Sub-action B3.6: Trips, fairs and congresses

To promote farmers and technicians participation to events, partners decided to organized a 1 day event in Piacenza instead of 2 day-long one in Res Uvae farm as foreseen in the project proposal

B4: Economic, social and policy evaluation

With reference to the assessment of soil ES in the study area, the start of the scientific review with specific reference to services of soil (*Sub-action B4.3)* was anticipated at M1, due to the fact that empirical evidence in this field is very limited and issues are quite complicated.

Action D1:Public awareness and dissemination of results

Sub-action D1.1 envisaged the production of Layman's report by M36, but due to the fact that not all of the results were completely finalized and available for dissemination in the indicated period, the Layman's report production and publication was postponed to the reporting period.

Action E1:Project management

- According to actual regulation, external accounting auditor is no longer required.
- Final project meeting (*Milestone E1*) was replaced by partners meeting aimed to Final congress organisation (M33)

6.3. Evaluation of Project Implementation

Action	Foreseen in the revised proposal	Achieved	Evaluation
A1	**Objectives:** *achieve better soil management in the whole vineyard ecosystem*		
	Expected results: Structured open-source database of main soil threats and relevant environmental problems in at least 100 vineyards	VSA of main soil threats in 124 vineyards in project area and bordering municipalities	In line
	Systematic literature review (min 50 papers dealing with main soil threats) and REPs in EU viticulture and on effective solutions	Review of more than 100 documents and scientific papers about soil threats and analysis of 90 case studies in as many papers.	In line
	Structured questionnaire inquiring for interest and outlooks for soil threats across Europe: at least 300 questionnaires answered	Definition of questionnaire that was send to more than 10.000 SH, only 157 was answered.	Not completely reached
B1	**Objectives:** *development of DSS for achieving better soil management.*		
	Expected results: DT able to guide grape growers in self-evaluation soil threats, choosing and implementing the best solution(s).	ICT-release version of the DT with the characteristics described in the project proposal.	in line
	Web-based DSS as i) stand-alone application accessible through the S4W website, ii) component of an existing web-based DSS for sustainable viticulture.	Web-based DSS available on a specific page of the project website as stand-alone tool. For users of the full DSS for sustainable viticulture (vite.net) the DT is available as included	in line

		functionality	
	Data on usability of DSS and on the interest of farmers in using it (min 24 farmers involved in the study area and 40 across Europe)	The tool was presented to 69 people in the project area and 47 people across Europe. A total of 84 evaluations were obtained.	in line
B2	**Objectives:** *increase soil health in the Demo farms*		
	Expected results: +10% organic matter content, +10% water soil aggregate stability, +50% QBS-ar, -10% compaction, -25% soil nitrate concentration	Considering all the demonstrative vineyards, the comparison between data collected in traditional and innovative plots at the end of the project yielded the followings: -8% organic matter content; +8% soil stability; + 33% QBS-ar; +13% compaction, -13% soil nitrate concentration. Considering the average value for each demo type activity: <u>*Spontaneous grassing vs. sown cover crops:*</u> -10% organic matter content; +12% water soil aggregate stability; + 35% QBS-ar; +2% compaction, +3% soil nitrate concentration. <u>*Tillage vs. green manure*</u>: +6% organic matter content; -7% water soil aggregate stability; +65% QBS-ar, +18% compaction; -11% soil nitrate concentration <u>*Spontaneous grassing vs. green manure:*</u> +2% organic matter content; -14% water soil aggregate stability; +48% QBS-ar; +16% soil compaction; -14% soil nitrate concentration	Goals were not fully reached. - *organic matter content*: green manure could be considered a good management technique to enhance SOM content. - *water soil aggregate stability*: sowing of grasses with dense root could reduce erosion and enhance soil aggregate stability. - *QBS-ar*: all the innovative techniques (in particular green manure) enhance QBS-ar index. - *compaction*: all the innovative techniques impacted on compaction index. Green manure impact more due to repeated operation during season (sowing, cutting and soil incorporation). - *soil nitrate concentration:* strong reduction in the adoption of green manure.
B3	**Objectives:**		

	Methodology for participatory and promotional involvement of different stakeholders in the process of innovation transfer; 3 stakeholder group formed		
	Expected results: promote new participation and promotional approaches for stakeholder involvement;	Demo farmers were involved in the development of the DT (α-version).	in line
	coordinate the activities of the three stakeholder groups, created within sub-action A1.3	Stakeholders groups were defined and invited at training meetings, field visits and meetings related to Action B1 and B4.	Involvement of local stakeholders and living lab groups presented some difficulties resulting in quite low attendance to planned meetings.
	Increase the awareness of stakeholders about soil-related problems in the viticultural areas and increase their ability to face and solve them effectively	• Several events were organized to present the Decision tool developed in Action B1 and evaluations of the tool itself by participants were collected. For testing of the tool by stakeholders in Italy (outside the project area) and in other EU Countries several Skype meetings were organized to train local advisors on the use of the tool and spread the knowledge acquired. • 7 field visits with a participation of 77 farmers in total • 3-day educational trip in a foreign country organized • Participation to 3 local fairs	Involvement of the living lab presented difficulties so we decided to organized a sort of door to door visit instead of a 3 days meeting as planned In line 3-day trip, from the clayey lands of C*ô*tes de Provence to the steep slopes of L'Hermitage and C*ô*te-R*ô*tie. In line
	create local agreements and regional partnerships about	• Stakeholders group were invited to	In line: congress held in Piacenza close the

	soil, biodiversity and ecosystem services	educational meetings and field visits. • Final congress	headquarter of UCSC to allow a greater turnout of participants, not only the stakeholders of the territory as foreseen
B4	**Objectives:** *carry out a study of socio-economic conditions affecting soil management*		
	Expected results: collect data on the social and economic constraints that may affect farmers' decision to introduce the new solutions proposed by the project.	A study of socio-economic conditions affecting soil management has been carried out. Main results show that younger, more educated and professional farmers are more keen to implement innovation. At the same time it seems that professional farmers are becoming more aware of the opportunities for marketing as being comprised within the Regional Park area	The study allowed to identify the main problems at local level for future implementation of innovative soil management practices. The high fragmentation of vineyards and the average age of grape growers, represent a strong constraint to the possible diffusion of these new technologies in this area.
	determine soil ecosystem services in the study area and their improvements ensured by the proposed solutions		
	Expected results: Evaluation (in physical and monetary terms) of the soil ecosystem services and indirect effects on the landscape value of the proposed solutions in the study area; min 4 farms.	5 soil ecosystem services have been identified, in relation to the adoption of proposed agronomic practices. The ecosystem services have been quantified in physical and monetary terms for 9 farms.	The project objectives have been reached and the results exceeded the expected ones. The topic generated interest in regional officers and policy makers.
	design innovative soil conservation policies based on PES		
	Expected results: Feasibility study of policy tools for Payments for Ecosystem Services (PES) to ensure sustainable financing of soil conservation and protection solutions; at least 4 PES considered.	4 feasibility studies related to PES have been realised, aimed at rewarding farmers sustainable techniques adoption	The project objectives and expected results have been reached. The tools have been considered interesting by stakeholders
	assess transferability of project solutions to other sectors		

	Expected results: identify other orchards	The transferability of project practices and tools have been assessed for 5 orchards	The project objectives and expected results have been reached
D1	**Expected results:** Project specific web pages (IT-EN-ES-FR) and Facebook page	Project web site (6.500 unique visitors and 23.702 total number of views) continuously updating. Facebook page, at the end of the project, had 238 followers.	Not completely reached only in terms of visitors (were programmed 12000 unique visitors, for the moment there are 6.500). But we expect that the number will continue to grow also in After Life
	Dedicated e-mailings to specialized database (n.4)	4 dedicated e-mailings in IT-EN-FR-ES were sent via Infowine database (21430 stakeholders)	In line
	Notice boards and project flyer production and distribution (IT-EN)	Notice boards were produced and installed in demo farms, 2000 (IT) and 2000 EN) copies of project flyers were printed and distributed	In line
	Layman's report in IT and EN	Bilingual Layman's report was prepared and made available through project web pages and online journal InfoWine	In line
	Written documents	Education and training documents, dissemination articles and deliverables are available on the web pages of the project.	In line
	Digital seminars	5 videos of congress sessions (in IT and EN) available on the website. 2 videos of training (in IT) available on the project web pages. 2 digital seminars in IT and EN performed at M34.	In line
	Dedicated sessions in congresses	Dedicated session at Enoforum 2017 (~ 1000 participants), Enoforum 2019 (~ 1200 participants)	In line

	Identification of other EU initiatives on the same topic	Contact established with 24 EU projects related to the S4W topic	In line
E1	**Expected results:** Management of project activities	Continuous contact between partners	Good collaboration and fair respect of deadlines from all the partners
	Monitoring of project activities	Monthly summary of project partners activities	

6.4. Analysis of benefits

1. Environmental benefits

a. *Direct / quantitative environmental benefits:*

- Implementation of demonstration action drastically reduced also the impact of soil erosion (t/ha calculated with RUSLE equation), -84% (tilled vs. green manure) and -75% (considering the innovative solution altogether).
- Green manure increased organic matter content (+6% compared to tillage and +2% compared to spontaneous native grass) and reduced soil nitrate concentration (-11% compared to tillage and -14% compared to spontaneous native grass). Soil stability in water (assessed with "Slake test") showed that replacement of spontaneous grass with sown grass increased aggregate stability by 12%.
- QBS-ar increased with all the innovative solution (+35% spontaneous grassing vs. sown cover crops, +65% tillage vs. green manure and +48% spontaneous grassing vs. green manure). Number of earthworms increased with all the innovative solution by around 25%.
- Considering GHG emission, comparison between traditional management (tillage and spontaneous grass cover) and innovative solutions (green manure and artificial permanent grass cover) showed that implementation of sustainable management techniques aimed to enhance soil quality led to a reduction of environmental impacts on vineyard ecosystem (Table 6)
- Direct benefits in terms of ecosystem services obtained in pilot vineyards (total surface 1,44 ha) are: 627 m^3 of fresh water stored in the ground, 16 tons of CO_2 emissions avoided, 55 tons of soil loss avoided.

b. Qualitative environmental benefits

S4W pursues three main goals in terms of qualitative environmental benefits and namely:

- S4W puts a great emphasis on green manure and sowed grass to help solving the contradiction still persisting between the use of native weed species (by far the most adopted in the project area and in Italy as well) and chances to benefit from the undeniable and inherent advantages related to a permanent grass cover and, on the other hand, competition for water and nutrients. The former is a constant threat due to climate change. Choosing grass species having a lag of growth in summer is the solution that S4W plans to test and propose.
- Soil deterioration due to excessive recourse to tillage is still a major problem in the project area. Green manure and artificial sod are the tools to diminish the use of tillage with a consequent benefit in terms of soil structure and improvement in organic matter.

- Recycling sward grass and piling it up under the vine strip in order to form organic mulch is likely the best example of environmental benefit in S4W. Potentially, this solution, in the long run and provided that enough biomass is available at each slash, implies very little or no use of tillage and herbicides.
- SOIL4WINE raised awareness on the vineyard ecosystem issues and the potential role for farmers to have positive effects on environment.

2. Economic benefits
   - Business opportunities due to the testing of PES have to be highlighted. Feasibility tests that gave positive feedback represent an opportunity for farmers and wine producers. In the future, some of these PES could give real acknowledgment to farmers: the use of SOIL4WINE logo is already a possibility and the Parma Piedmont Union is interested in the tourist tax reinvestment. This PES, related to landscape, has a great replicability potential.

3. Social benefits
   - Exchange of advice and best practices between "demo farmers";
   - Improve the awareness that the suggestions of farmers are fundamental especially when the goal is setting up a DT;
   - Increase knowledge and personal satisfaction of farmers able to better manage the soil in their vineyards.

4. Replicability, transferability, cooperation:
   - Developed DSS routine, as indicated in the project, was tested across EU in 40 selected vineyards in more than 10 different viticultural areas and the evaluation confirmed that the project approach and DT developed fully respond also to their needs. Integration of developed tool as a functionality of vite.net® web-based DSS previously developed by HORTA and currently marketed across Italy and EU will greatly increase the transferability of this innovative approach.
   - The transferability potential of sustainable viticultural practices and PES have been assessed for 5 fruit tree orchards: Peach, Apple, Hazelnut, Olive and Citrus. The project's likelihood of replication is high from the technical point of view. Its replication could be both market-driven and policy-dependant; in fact some PES are related to the choices of public authorities, but other are managed by farmers and wine producers. The label related to ecosystem services could be a strong market vehicle for replication and could be also used by public bodies as evidence of ecosystem services improvement in case of public PES.
     Soil4Wine demonstrative activities have been included as case study in several european initiative (PLAID Project (H2020-RUR-2016-2727388), AgriLink project (H2020-RUR-2016-2 -727577), Pillar-1 of the European Soil Partnership, EU Pollinators initiative)

5. Best Practice lessons:
   Innovative soil management solutions implemented within project area can be grouped into three main categories: permanent cover crops, temporary cover crops and better water drainage systems.

6. Innovation and demonstration value:

- Implementation of demonstrative actions proposed by the project represents a totally new approach in the project area, especially in regard to green manure and sown cover crops. A participative approach to increase farmers awareness about soil health problems and the use of a DSS tool to manage vineyards was a real challenge for local viticulture.
- The assessment in physical and monetary terms of effects of sustainable agricultural techniques on ecosystems is a strong innovation. This approach can support decision making of farmers and public bodies, because it enables evaluation both at company level and at community level (costs/benefits analysis of environmental externalities).
  These calculations represent the starting point for the design and testing of payments for ecosystem services, that have been implemented through feasibility studies.
  The testing of assessment methods is necessary for their future diffusion and assert the strong demonstrative character of the project.
  The PES represent an innovative way to find financial resources for farmers and, at the same time, develop sustainable solutions that generate environmental benefits that can integrate traditional conservation policies.

7. Policy implications:

- The assessment in physical and monetary terms of effects of sustainable agricultural techniques on ecosystem services represent a useful tool to measure and reach the targets of the EU Strategy on soil protection and of the EU Biodiversity Strategy. These strategies do not foresee obligations in terms of soil ecosystem services quality but fix objectives and targets. A more proper tool for this aim is represented by the new Common Agricultural Policy, actually in discussion at EU level, which could introduce some commitments not only in terms of measures, but also considering performance indicators (e.g. soil organic matter, biodiversity index). SOIL4WINE results could give quantitative indications for this aim.
- At regional level, the SOIL4WINE approach represents a basic step to the exploitation of market tools in regional policies and measures, as Rural Development policy, Land use policy and Parks and natural protected areas policy. In particular, the tested PES mechanisms could give indications for the application of the Emilia Romagna regional law on land use, that foresees the soil ecosystem services as element to consider for offset and of the Emilia Romagna regional forest plan, which promotes the use of PES in natural protected areas. Both of these policies tools lack of operative solutions that SOIL4WINE has analysed through the feasibility test. Through meetings with regional officers, the methods for ecosystem services quantification have been already shared and the awareness and interest on this topic has grown during the project. Too, local policy makers have demonstrated interest in PES.
- The policy stakeholders that have been involved in exploitation meetings are the Emilia Romagna Regional Assessor for Environment, the General Director of Emilia Romagna Agriculture Department and the Mayors of Municipalities involved by pilot areas.

7. Key Project-level Indicators

Project performance indicators were updated with final assessment of collected data and project impacts. A table is annexed to this report completed with missing or updated values. Soil parameters values reported in attached table are referred to average values obtained by 0-

20 cm depth analysis. Due to high variability in weather conditions between the beginning and the end of the project and lack of parameters during first year soil assessment feature, data are refereed only to 2019 analysis considering sampling made in traditional management as "start point" and samples of innovative solution as "end point".
Below key indicators are described and results are compared with foreseen targets.

Resource efficiency:

- *soil* (Table 9)*:*

Key indicators and parameters	**Indicators**	**Target foreseen at the beginning of the project**	**Results obtained at the end of the project**	**Comments**
Resource efficiency - soil	Total N	+10%	-8%	Considering demo vineyards altogether targets was not reached. *Green manure* vs. *spontaneous native grassing* led to an increase of N of about 6%. (0-20 cm depth)
	P available	+10%	+79%	
	K exchangeable	+10%	-2%	*Green manure* vs. *tillage* has enhanced K in soil (+6%)
	soil nitrate	-25%	-13%	*Green manure* has showed higher effectiveness in reduction of soil nitrates.
	mass organic matter/total mass soil	+10%	-3%	Considering demo vineyards altogether targets was not reached. *Green manure* (compared to *traditional tillage* or *spontaneous grassing*) has increased soil organic matter content. *Sown grasses* need more years to reach equilibrium in SOM in strong degraded soils.
	stability of soil aggregate	+50%	+8%	*Artificial grassing* has increased stability of soil aggregate more than other demonstrative technique due to the absence of operation in soil after sowing that enhanced the development of soil aggregate.
	erosion (VSA-FAO)	1.5	1.7	*Green manure* vs. *tillage* reduce erosion by 84% considering t/ha of soil loss.
	bulk density	-10%	=	
	water holding	+10%	-11%	

	capacity			
	soil pH	-2%	=	
	electrical conductivity	n/a	-44%	
	earthworms	n/a	+20%	Earthworms density was enhanced with innovative techniques.
	QBS-ar	+50%	+33%	All the demonstrative activities impacted positively on QBS-ar but only "*Green manure* vs. *Tillage"* reached the foreseen goal enhanced QBS-ar by 65%.

Table 9: assessment of soil parameters performance after project demonstrative activities.

Biodiversity:

- *Ecosystems:* innovative technique applied in demonstrative vineyard acted positively on ecosystems components and ecosystem services. Ecosystem status can be considered, at the end of the project, *favourable*. Assessment of ecosystem services (*Action B4*) shown that implementation of innovative techniques could enhance soil biodiversity, reduce soil loss by erosion and increase water storage, so at the end of the project ecosystem status was improved and continuous use of sustainable practices will increase positive effects.

Mitigation:

- *GHG emissions:* target at the beginning of the project was -20%. Considering all demonstrative vineyards reduction was -4%, but abandonment of tillage technique and implementation of green manure technique led to a reduction of GHG by 30%.
- *Carbon sequestration:* at the beginning of the project target was +15% and after three years the overall increase was +13%. Green manure vs. Tillage techniques reached + 74%. Other techniques shown different results according to vineyards locations.

Coverage of the environmental impact: considering people that were directly involved in project demonstrative and dissemination activities the foreseen target was reached and overcome. Planned After-LIFE activities will enlarge the number of vineyards in which best practices proposed by the project will be applied, increasing the total area affected by the project. In the same way the amount of individuals affected by project results will increase.

Governance: Soil4Wine project worked with an innovative approach based on stakeholders involvement (demo farmers, living labs, policymakers, actors of value chain). Foreseen target for the involvement of private enterprises was largely exceeded (130 vs. 11) even that the participation to some of the foreseen activities (such as field visits) was lower than the expected. Local authorities (municipalities majors, Regional authorities, wine producer associations) were involved as foreseen. NGO were not involved in project activities, target for After-LIFE period is 2.

Information and awareness: dissemination tools (websites, Facebook page, leaflets, and newsletters) were effective at hitting foreseen targets, overcoming them abundantly. Less effectiveness was shown from surveys of *Action A* as answered ones were less than what expected.

Capacity building: training and workshop involved professionals and stakeholders in different ways (education and training meetings, webinars, DSS training meetings, field visits and educational trip). Webinars and video uploaded on website (in Italian and English) enlarge the audit of project dissemination activities. Technical dissemination activities involved more than 350 stakeholders.

Jobs: temporary researchers were recruited by UCSC (4 FTE workers) for the implementation of Soil4Wine actions.

Economic growth: about 150.000€/year were invested during the project in the development of DSS and implementation of sustainable practices in demonstrative vineyards. Budget for continuation of activities in After-LIFE period has been assessed.
Revenues obtained in case of application of sustainable practices are related to implementation of one of the PES (logo for wine produced in vineyards managed with soil4wine best practices) in the project area and in other geographical areas.

Continuation/replication/transfer scope: Soil4Wine project issues were also subject of studies of an internal academic project "ECORESILIENTE" (www.ecoresiliente.com) aimed to support activities for assessment and enhancing of ecosystems resilience. UCSC is also involved in "BIOVINE" project (www.biovine.eu) aims to develop natural solutions (cover crops) based on plant diversity to control pests, reduce pesticide dependence, increase plant health and services provided from the ecosystems to humans. For After-LIFE period HORTA has already identified elements for tool improvement and future activities regarding this issue have been included in a project proposal submitted to call H2020-SFS-2018-2020 (Sustainable Food Security) Topic: SFS-04-2019-2020. Regarding entries into new geographical areas, DSS was presented in 7 European countries. Future goal is the field application of DSS suggestion by farmers of Living Labs foreign groups and spreading of developed tool in others geographical areas.

Others: cost-benefit evaluation, co-development and feedbacks from demo farmers shown that farmers might invest part of farm's income in sustainable practices, asking for supporting by external funding.
During project farmers were involved in training and education meetings improving knowledge about soil health and ecosystem protection.
Implementation of sustainable soil management techniques led to a reduction of natural resources (as reported in soil ecosystem services assessment - *Action B4*)