SoilCare
SOILCARE FOR PROFITABLE AND SUSTAINABLE CROP PRODUCTION IN EUROPE

Testing and promoting the adoption of soil-improving cropping systems across Europe

Newsletter 2 November 2017

WELCOME to the second newsletter of the SoilCare project.

In this issue:

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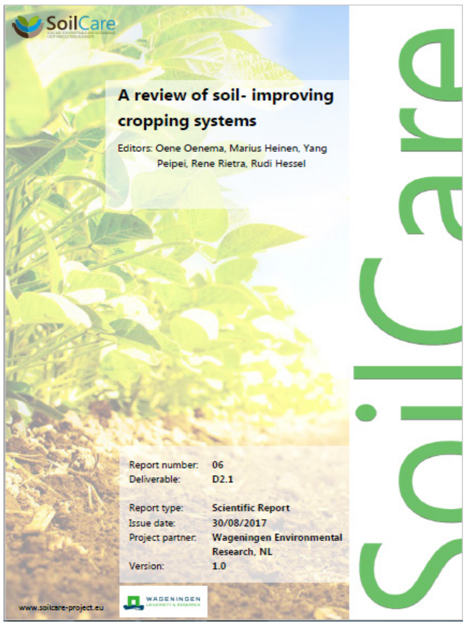
New Report: Review of Soil-improving cropping systems

The overall aim of the EU-funded project SoilCare is *"to assess the potential of soil-improving cropping systems and to identify and test site-specific soil-improving cropping systems that have positive impacts on profitability and sustainability in Europe"*. The term 'soil improving cropping systems' (SICS) is relatively new, and a hypothesis. Cropping systems can be considered soil-improving if they result in an improved soil quality, i.e., in a durable increased ability of the soil to fulfil its functions. Intuitively, the term SICS is well-understood and perceived, but the scientific underpinning as such is still lacking. For this reason Work package 2 of SoilCare has led a Review of SICS based on an extensive literature study and meta-analyses, to provide underpinning of the SICS concept and to make it operational. A summary of the review is now available here. A more detailed report will be available in early 2018.

The review examines: (i) SICS for preventing and remediating specific soil threats, and (ii) SICS that improve soil quality in general.



The first chapter of the report provides an in-depth description of the concept of SICS. A search for the term SICS in literature gives few 'hits'. Therefore, a review and assessment of literature on SICS is indirect. It involves an examination of cropping systems that change soil threats, properties and functions in a positive manner.

Cont. Pg 2 >

SICS encompass soils/land, crops, inputs, and management. The ideal SICS consists of a particular crop rotation and an optimal combination of inputs, techniques and management (see Table 1), as a function of soil type (soil threat), climate, and socio-economic conditions. If there is no optimal combination of crop rotation and inputs, techniques and management, soil quality might be under threat and crop yields will be suboptimal.

	Components of cropping system
A	Crop rotations, including cover crops etc.
B	Nutrient management, techniques and inputs
C	Irrigation management, techniques and inputs
D	Drainage management and techniques
E	Tillage management, techniques and inputs
F	Pest management, techniques and inputs
G	Weed management, techniques and inputs
H	Residue management, techniques and inputs
J	Mechanization management, including planting and harvesting machines
K	Landscape management techniques and inputs

Table 1 Components of cropping systems that can be adjusted so as to create soil improving cropping systems (SICS).

In Chapter 3 soil threat-specific SICS are described. Each has a table providing semi-qualitative scores for changes in farm profitability and in soil quality (soil properties; physical, chemical and biological) for the 10 (A-K) components of cropping systems listed in Table 1.

Chapter 4 deals with SICS that improve soil quality and soil functions in general. The main soil function in cropping systems is crop production, which is mainly determined by the 6 crop yield limiting and reducing factors indicated below:

1. Water retention and delivery to crops, i.e. soil depth and water holding capacity
2. Nutrient retention and delivery to crops, fertility indices,
3. Control of pathogens and weeds, and improve soil biodiversity,
4. Soil structure and tilth,
5. Control of pollutants, and
6. Control of organic matter content and quality

The final chapter provides a general discussion and suggests a selection of the most promising soil threat-specific (see Table 2) and general SICS.

	Soil threat-specific SICS	Priority crop types	Priority agro-management techniques
1	Acidification	No specific crop type	Liming, manuring
2	Erosion	Permanent ground cover, Deep-rooting crop, Cereals with cover crops, Alfalfa, Agroforestry	Zero-tillage Landscape management Contour traffic Proper timiing of activities
3	Compaction	Deep-rooting crops, Cereals, perennial rye, alfalfa	Controlled traffic Low wheel load, low tyre pressures Proper timing of activities
4	Pollution	Biofuel crops Some fodder crops No leafy vegetables	No use of polluted inputs Tree-lines to scavenge air-borm pollution
5	Organic matter decline	Permanent ground cover, deep-rooting crops Cereals with cover crops, alfalfa	Minimum tillage, Residure return, Mulching, Manuring
6	Biodiversity loss	Crop diversification	Manuring, minimum tillage, residure return, No pesticides Minimal fertilization
7	Salinization	Salt-tolerant crops	Drainage Targeted irrigation Ridging
8	Flooding	Flood-tolerant crops	Drainage Landscape management
9	Landslides	Deep-rooting crops, trees	Landscape management, No arable cropping
10	Desertifica-tion	Deep-rooting C4 crops	Landscape management

Table 2 Prioritization of crop types and agro-management technique in soil threat-specific SICS.

For more details about the report, please email oene.oenema@wur.nl

Selection of soil-improving cropping systems to be tested

A short list of soil-improving cropping systems to be tested in the 16 SoilCare study sites has been produced. The selection process was undertaken through a series of workshops with stakeholders.

Recently in Workshop 3, based on the stakeholder analysis undertaken in Workshop 2 (see Deliverable 3.1 for the outputs of this workshop), a representative range of stakeholders were invited to critically discuss SICS identified in Workshop 1 and Work Package 2 (WP2) ('Review of SICS'), and rank and short-list those they would like to see tested in their study site.

Workshop 3 proceeded with the following steps:

- **Overview of options:** An overview was provided of soil-improving innovations/interventions identified in Workshop 1 and that had been suggested from WP2 for each site. The group was given an opportunity to identify any important missing options at this stage to supplement this initial list of options.

- **Structured discussion of trial options**: Rotating small group discussions was facilitated around tables dedicated to each SICS. This was designed to ensure all participants fully understood each option, could critically discuss and enhance options where relevant, and identify reasons why they might want to prioritise or de-prioritise the cropping system.

Overview of cropping system options in Norway (Photo: Kamilla Skaalsveen)

- **Agreement of criteria for matrix ranking**: based on reasons for prioritizing or de-prioritising options identified in the previous exercise, participants were asked to agree criteria against which cropping systems could be prioritized, for example, farmer profitability, improvement to soil quality, maintenance of the cultural landscape, fits existing farming system and so on. All sites included at least two criteria: the profitability and sustainability of the cropping system. However, based on discussions with stakeholders, additional criteria were added in some sites. These additional criteria differed between sites, to ensure decisions reflected the priorities of stakeholders, whilst retaining a degree of consistency across sites due to the use of two core criteria in all sites. Criteria were all given the same weight (or importance).

- **Matrix ranking of trial options**: Cropping systems discussed by small groups earlier in the workshop were placed in an options:criteria matrix (on flip chart paper, with options along the top and criteria down the side, creating a grid). Each participant, including both SoilCare researchers and other stakeholders, was given 10 sticky dots to prioritise their preferred cropping system option. Using the matrix, participants were able to indicate the reasons why they prioritised one option over another, based on the criteria identified in the previous step. In other words, rather than just placing their sticky dots on their preferred SICS, they placed their dots in the column of their preferred SICS, but in the cell(s) that indicated the criteria against which they had prioritized the SICS e.g. one stakeholder may prioritise SICS 1 because it would be more profitable, while another may prioritise the same SICS for a different reason, such

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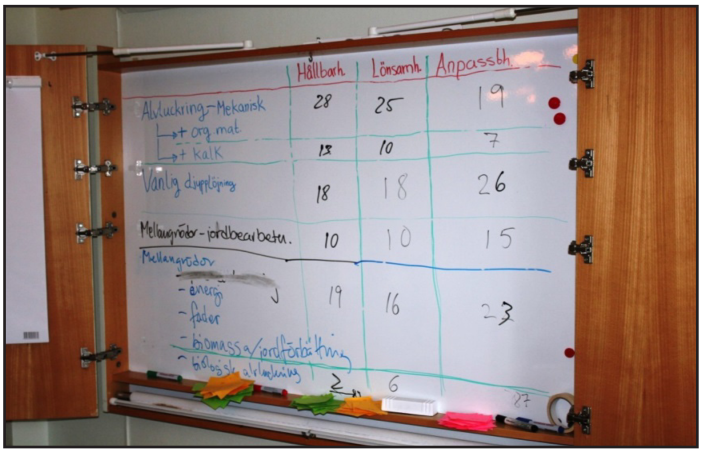
as an improvement in sustainability (see the picture below).

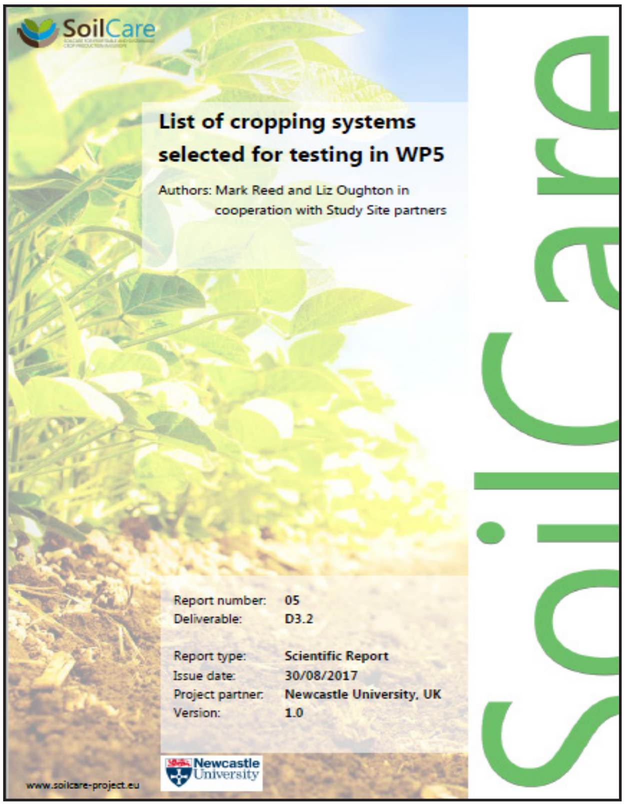


Counts of sticky dots allocated to each of six cropping system options, based on three criteria in Sweden - (a) sustainability, (b) profitability and (c) fit to the system

Discussion and shortlisting of top ranked options: Finally, participants discussed the ranking of options that emerged from the matrix ranking exercise, to short-list a smaller number of options that could be implemented in trials. In most cases this was a simple arithmetic ranking, based on the number of sticky dots allocated to each SICS across all criteria. In some cases, a large number of SICS received similar scores, and so the reasons why stakeholders preferred one SICS over another, based on the criteria against which each SICS had been prioritized, was used to facilitate discussion to help choose the most important SICS for field trial. The goal was to shortlist 2 or 3 options only. There was flexibility in the number that could be short-listed, based on the level of resources required to trial different SICS.

All study sites successfully evaluated a range of soil-improving cropping systems, and reached a short-list of interventions for field trials which include:

- Application of different types of organic material e.g. farmyard manure, urban sludge; woodchip, crop residues
- Cover crops, green manures, catch crops
- Leguminous crops
- Tillage systems - no-tillage, minimum tillage, strip tillage
- Sub-soil loosening with straw incorporation
- Precision farming
- Row (Alley) cropping systems
- Undersowing with grass fertilizers, cover crops
- Controlled traffic
- Amendments e.g. lime
- Novel crops e.g. perennial cereals, soya
- New rotation systems
- Grass ley management
- Deficit irrigation strategies
- Terracing
- Contour ridging



For more details about the report, please contact Mark Reed mark.reed@newcastle.ac.uk

SICS Focus: Erosion-specific SICS

Each issue of the SoilCare newsletter will focus on soil threat-specific SICS. In this newsletter the focus is on erosion-specific SICS.

Erosion refers to the transport of soil particles by water and wind, and the subsequent deposition of the soil particles elsewhere. Erosion by water is most likely to occur on sloping land, with erodible soil and low soil cover, during heavy rains.

The SoilCare review of SICS (see previous news item) has identified numerous erosion-specific SICS that prevent erosion or lower erosion rates, relating to both water and wind erosion. The most promising erosion-specific SICS will be highly site, climate and soil specific. They may include the following substitution mechanisms:

- **Minimum** or **zero tillage** instead of conventional tillage
- **Mulching** - the covering of the soil, usually with plant residue, which protects the soil from raindrop impact, reduces the velocity of wind and water and can enhance soil structure, thereby greatly reducing erosion. It also decreases soil temperature and increases soil moisture. Mulches are usually made from crop residue, or from plant material brought in from elsewhere, but they can also be made from inorganic materials and gravel.
- **Organic manures**, such as farmyard manure and **green manures** which are crops grown intentionally to improve the soil. These organic and green manures improve the soil structure and water holding capacity, thereby lowering soil erodibility.

Mulch in sugar been field in Bern, Switzerland (Photo: Volker Prasuhn)

Redesign mechanism are also important and relate to:

- the replacement of annual short cycle crops by **perennial crop**s
- **relay cropping** - the growing of two or more crops on the same field with the planting of the second crop after the first one has completed its development.
- **strip cropping** - grass strips, hedges or strips of crops are placed on the contour, or perpendicular to the wind direction. In strip-cropping, low cover strips are alternated with high cover strips (such as grasses and legumes). Crops can be rotated, but some strips might also have perennial vegetation (buffer strips)
- **cover crops** - a temporary vegetative cover that is grown to provide protection for the soil. Many types of plants can be used as cover crops. Legumes and grasses (including cereals) are the most extensively used, but there is increasing interest in brassicas (such as rape, mustard, and forage radish) and continued interest in other crops, such as buckwheat.

Agroforestry (maize and chestnuts), France (Photo: DEFI-Écologique)

- **agroforestry** – a system in which trees or shrubs are grown around or among crops
- management of **landscape elements** (terracing, contour planting and ridging, planting hedges, permanent cropping strips, field borders, etc.).

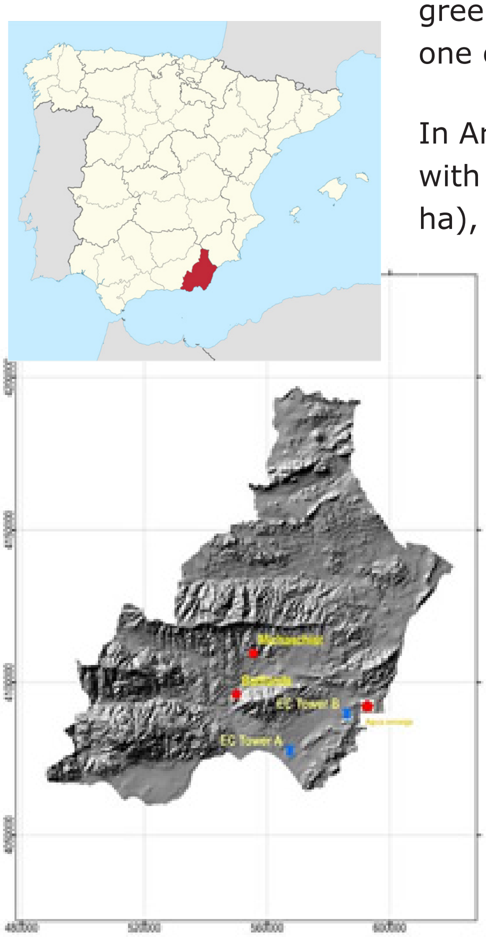
For more information about these different SICS, please visit the SoilCare website https://soilcare-project.eu/soil-improving-cropping-systems

Study site feature: Almeria, Spain

There are 16 study sites within the SoilCare project each focused on trialing soil-improving cropping systems relevant to their local contexts. In this newsletter we focus on the study site in Spain

The Spanish study site is located in the province of Almería, in south-east Spain. In this area rainfall is very scarce, usually below 300 mm per year The study site contains two areas. Area **A** is located in the Sorbas-Tabernas Basin and Area **B** in the Cabo de Gata Natural Park. Agricultural land uses include tree and annual crop cultivation, occasionally in protected structures (greenhouses and under mesh) and pasture, especially for goat herding.

Agriculture is one of the main activities in the area. The abandonment of some agricultural areas and simultaneous intensification in certain others (i.e., water fed agricultural systems and greenhouses) are one of the main causes of degradation in the area.



In Area **A** there are conventional and also some organic olive orchards with a tree density labelled as intensive for this crop (200-300 trees/ha), although this density is considered low for many other fruit trees. Modern new super high density orchards (1500-2500 trees/ha) with mechanised harvesting using adapted grape harvesters are in development in the area. In Area **B**, the most interesting new development is focused on intensive (600-800 trees/ha) very large orchards of stone fruits (peaches, nectarines, apricots, plums). Trees are commonly trained in a vase shape, with 4-5 main scaffolds where productive wood is formed.

Non-tillage and weed control with herbicides or reduced tillage is usually applied in most modern olive and stone fruit orchards in the study site. Most of these orchards are drip irrigated. Conventional fertilizers are normally used, continuously applied by drip irrigation (fertigation). Conventional or the chemical control of pest and diseases is used, with Integrated Pest Management becoming more common. Main pests and disease in olive orchards are olive fruit fly, prays, black scale, peacock spot, and verticillium wilt. There is no effectivie control of verticillium and excessive irrigation and runoff contribute to the dispersion of this lethal disease.

In Area **A**, the main issue affecting soil quality and the profitability of crop production is the high content of salts which causes yield reduction. Excessive nitrogen fertilization further contributes to this problem, whilst also increasing the sensitivity to pests and diseases and crop costs.

In the intensive stone fruit orchards of Area **B**, the control of weeds is achieved by herbicides and reduced or non-tillage in areas where infiltration problems occurs, and where gullies are formed.

Stone fruit orchards in Area B trained in vase shape (Photo: Julián Cuevas)

Large blocks of stone fruit crops (peaches, nectarines and plums) in Almeria Province (Photo: José Requena Nieto)

The main SICS that the stakeholders are interested in testing in the study area are:

- cover crops;
- increasing organic matter by chopping pruning wood; and
- the implementation of deficit irrigation strategies on stone fruit trees and olives

The main stakeholders who are involved in the study site are:

- Farmers
- Technicians of Local Action Groups
- Staff of Natural Park Cabo de Gata-Nijar
- Andalusian Ministry of Agriculture, Fisheries and Rural Development

Stakeholders involved in third SoilCare workshop to select SICS for testing in study area

For more information about the Almeria province study site, please contact: Julián Cuevas González jcuevas@ual.es

New Publications

Project deliverables

D2.1 A review of soil-improving cropping systems

D3.2 List of cropping systems selected for testing in WP5

Journal articles

Peltre, C., Nyord, T., Christensen, B.T., Jensen, J.L., Thomsen, I.K. and Munkholm, L.J., 2016. Seasonal differences in tillage draught on a sandy loam soil with long-term additions of animal manure and mineral fertilizers. *Soil Use and Management*, 32(4), pp.583-593.
doi:10.1111/sum.12312

Christensen, B.T., Jensen, J.L. and Thomsen, I.K., 2017. Impact of Early Sowing on Winter Wheat Receiving Manure or Mineral Fertilizers. Agronomy Journal.
doi:10.2134/agronj2016.11.0677

Suarez-Tapia, A., Kucheryavskiy, S.V., Christensen, B.T., Thomsen, I.K. and Rasmussen, J., 2017. Limitation of multi-elemental fingerprinting of wheat grains: Effect of cultivar, sowing date, and nutrient management. *Journal of Cereal Science.*
doi.org/10.1016/j.jcs.2017.05.015

Reed, M.S., Vella, S., Challies, E., de Vente, J., Frewer, L., Hohenwallner-Ries, D., Huber, T., Neumann, R.K., Oughton, E.A., Sidoli del Ceno, J. and van Delden, H., 2017. A theory of participation: what makes stakeholder and public engagement in environmental management work?. *Restoration Ecology.*
doi:10.1111/rec.12541

Past Events/Presentations

17th May 2017 Presentation on SoilCare at the final conference of the LIFE project, Operation CO2, in Palencia, Spain by Zuzana Lukacova from Milieu.

1st June 2017 Presentation on SoilCare at the DG Clima Workshop on "Climate Action and Agriculture and Forestry" in Brussels by Melanie Muro from Milieu.

28-30th June 2017 Poster presentation on SoilCare by the Romanian team at the 21st International Exhibition of Inventics, INVENTICA 2017 in Iasi, Romania

29-30th June 2017 Poster presentation from Polish team entitled "Fungal metagenomes of soil amended with waste organic matter" at II Microbiological Symposium "Metagenoms of different environments" in Lublin, Poland

30-31 June 2017 Poster presentation from SoilCare Polish team on "Fungal metabarcoding of soil fertilized with chicken manure" at conference: "Biodiversity of the environment - Significance, problems, challenges" in Pulawy, Poland.

24-29 August 2017 SoilCare leaflets distributed at the high profile Bread Basket event in the Czech Republic

27th-31st August 2017 Poster at Wageningen Soil Conference, The Netherlands

5-8th September 2107 Poster presentation by Polish team at the 51st National Scientific Conference "Environmental microbiology - an opportunity for safe living and biotechnological progress" in Torun - Ciechocinek, Poland.

28-29th September 2017 Presentation on 'Soil education and advisory services' at the ENSA workshop 'Give Soils a Voice' in Bratislava by Jane Mills from University of Gloucestershire

16th October, 2017 Presentation at Science Policy Dialogue event 'Harnessing Research and Innovation for FOOD 2030 in Brussels by Robert Pederson from Milieu.

PROJECT PARTNERS

The SoilCare project has brought together a transdisciplinary team of 28 different organisations to identify, test and promote the adoption of soil-improving cropping systems across Europe.

PROJECT PARTNERS

1 Wageningen Environmental Research (Alterra), The Netherlands
2 University of Newcastle upon Tyne, United Kingdom
3 KU Leuven, Belgium
4 University of Gloucestershire, United Kingdom
5 University Hohenheim, Germany
6 Research Institute for Knowledge Systems, The Netherlands
7 Technical University of Crete, Greece
8 Joint Research Centre, Italy
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13 Aarhus University, Denmark
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24 Agro Intelligence ApS, Denmark
25 Crop Research Institute, Czech Republic
26 University of Almeria, Spain
27 Fédération Régionale des Agrobiologistes de Bretagne, France
28 Scienceview Media B.V., The Netherlands

Participants at the SoilCare 2nd Plenary meeting 13th - 17th March 2017 in Crete, Greece (Photo: Erik van den Elsen)

The SoilCare project is funded by the European Union's Horizon 2020 research and innovation programme, under grant agreement No. 677407. Project officer Arantza Uriarte Iraola.

For further details about the project please email rudi.hessel@wur.nl

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