SolACE

Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

Proceedings of the First SolACE Stakeholder Event

Montpellier

June 27, 2017

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These proceedings are available for download at https://zenodo.org/communities/solace.

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Cover picture: Participants of the First SolACE Stakeholder Event and Kick-off Meeting in Montpellier. Photo: Simon Bull, LEAF, UK

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The First SolACE Stakeholder Event

The kick-off meeting of SolACE - Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use - took place from June 26 to June 28, 2017, in Montpellier, France.

The meeting included the first SolACE stakeholder event, which was held on June 27. The aim of the event was to exchange views with stakeholders, farmers, farm advisors, breeders and agri-business actors across the entire production chain, beyond those involved as SolACE partners, to identify the most relevant questions and strategies, the most promising traits/genotypes, the most promising management options, and their combinations.

The event began with an introduction to the project by project coordinator Philippe Hinsinger of Eco&Sols at INRA Montpellier and a response by Alice Midmer of SoLACE partner Linking Environment And Farming (LEAF), who commented on the project from a stakeholder perspective.

Helena Gomez-Macpherson of the Institute for Sustainable Agriculture (El IAS-CSIC) in Cordoba, Spain, shared her experience with the EIP Agri Focus Group on Water and Agriculture, which she led.

Then the stakeholders and project partners discussed key project questions in several working groups, the results of which are shared in this document:

- Theme 1: What potential combinations of water and nutrient stress concern you the most (e.g., prolonged drought, extreme events)?
- Theme 2: Which plant traits and characteristics help to improve the efficiency of water and nutrient use?
- Theme 3: Which management tools do you currently use, or are aware of, to improve the efficiency of on-farm water and nutrient use?
- Theme 4: What are the breeding strategies helping to respond to shortages in water and nutrients?
- Theme 5: How can farmers and researchers collaborate to design and test new breeding and management strategies that can be applied across Europe? And where do we need to apply site-specific solutions?

At the event, all project partners that participated in the Kick-off meeting were present. Furthermore stakeholders participated as well as three members of the SoLACE Stakeholder Advisory Board.

At the First SolACE Stakeholder Event, SoLACE partner LEAF took a video[1], and all work package leaders were interviewed.

[1] The video is available at http://www.solace-eu.net/service/videos.html.

Programme of the First SolACE Stakeholder Event

Programme

8:00 – 8:30 am: Registration of Stakeholders

8.30 – 9:30 am: Presentations

- Philippe Hinsinger: About the SolACE project
- Helena Gomez-Macpherson: The experience of the EIP Agri Focus Group on Water and Agriculture
- Alice Midmer: LEAF Stakeholder Response

9:30 – 10:30: Group work – Session 1 (= two 30 min slots)

Each theme was discussed in a single room (with facilitators and minute takers keeping the records), and the audience was split into 5 groups, each attending one theme for 30 minutes, then moving to another theme for another 30 minutes.

Theme 1: What potential combinations of water and nutrient stress concern you the most (e.g., prolonged drought, extreme events)?

- Facilitator: Helena Gomez-Macpherson, El IAS-CSIC
- Rapporteur: Davide Cammarano, James Hutton Institute
- Minute taker: Laura Tippin, LEAF

Theme 2: Which plant traits and characteristics help to improve the efficiency of water and nutrient use?

- Facilitator: Philippe Hinsinger, INRA
- Rapporteur: Xavier Draye, UCL
- Minute taker: Helga Willer, FIBL

Theme 3: Which management tools do you currently use, or are aware of, to improve the efficiency of on-farm water and nutrient use?

- Facilitator: Alice Midmer, LEAF
- Rapporteur: Angela Sessitsch, AT
- Minute taker: Harun Cicek, FiBL

Theme 4: What are the breeding strategies helping to respond to shortages in water and nutrients?

- Facilitator: Glyn Jones, UNEW
- Rapporteur: Nicola Pecchioni, CREA
- Minute taker: Adriana Voicu, INRA Transfert

Theme 5: How can farmers and researchers collaborate to design and test new breeding and management strategies that can be applied across Europe? And where do we need to apply site-specific solutions

- Facilitator: Dora Drexler, ÖMKI
- Rapporteur: Julia Cooper, UNEW
- Minute taker: Simon Moakes, FiBL

10:30 – 11:00: Coffee break

11:00 – 11:30: Group work – Session 2 (= one 30-min slot)

11:40 – 12.30: Summary of group work (10 min per theme)

Each WP leader involved in a theme reported about his/her theme for 10 minutes, allowing time for clarification questions.

- Moderation: Alice Midmer, LEAF and Philippe Hinsinger, INRA
- Minutes: Adriana Voicu, INRA Transfer and Helga Willer, FiBL

About the SolACE project

PHILIPPE HINSINGER[1]

As the coordinator of SolACE, I am pleased to welcome you to Montpellier for this First Stakeholders' Event. There will be three of these during the course of SolACE over the coming 5 years.

SolACE is an H2020-funded multi-actor project, which aims to identify and test novel solutions for improving agroecosystem and crop efficiency for water and nutrient use, i.e., ensuring adequate crop performances under combined stresses, either drought and nitrogen deficit, or drought and phosphorus deficit.

The agroecosystem management innovations we are going to test are diverse, including the use of microbial inoculants, genotype mixtures, legume-based rotations, and reduced tillage practices.

In addition, we are also developing innovative breeding strategies, ideotypes, and genotypes (notably hybrids), with a focus on three major European crops: bread wheat, durum wheat, and potato.

The specific objectives are to:

(i) identify the most probable present-day and future scenarios of combined water and nutrient stresses across the various pedo-climatic zones of Europe,

(ii) identify crop responses to such realistic combined stresses,

(iii) evaluate water and nutrient acquisition efficiency and define the corresponding, relevant below-ground traits (related to roots, rhizosphere microbiome and symbiosis),

(iv) define the combination of below- and above-ground traits for designing resource-efficient crops (ideotypes),

(v) identify genes, molecular markers and genomic selection models for improved yield under combined stresses,

(vi) design novel, resource-efficient ideotypes or genotypes (hybrids for bread wheat and potato),

(vii) evaluate biotic interactions at play in the tested management innovations,

(viii) design efficient microbial inoculants and their combinations, efficient genotype mixtures and legume-based rotation or reduced tillage strategies, and test these in field conditions,

(ix) develop novel enabling technologies for monitoring crop or soil water and nitrogen status, and

(x) evaluate the on-farm agronomic, economic and environmental performances of the tested innovations at the field scale in several networks of farmers to ultimately assess local solutions and barriers for the uptake of the tested innovations.

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As a multi-stakeholder project, SolACE involves a broad diversity of actors amongst its 25 partners, which include 14 academic and 11 non-academic partners, including small and large biotech and seed industries, NGOs, and other actors involved in agriculture (farmers groups, farm advisors, etc.), with the aim to work together with the shared ambition of finding relevant novel solutions to face combined water and nutrient stresses in European agriculture. The aim of this Stakeholders' Event is to exchange views with a broader group of stakeholders (farmers, farm-advisors, breeders, agri-business actors, etc., across the whole production chain) beyond those that are partners of SolACE.

Getting their feedback at the very start of the project shall help identify the most relevant questions, situations and strategies to be tested. The engagement of a wide range of stakeholders will enable us to search and test together the most promising traits and genotypes, the most promising management innovations, and combinations thereof.

Let's work together now!

Further reading

Hinsinger, Philippe (2017): Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use. Presentation at the First SolACE Stakeholder Event, INRA, Montpellier, France, June 27, 2017. Available at https://zenodo.org/record/822499

Overview of EIP-AGRI Focus Group on "Water & Agriculture: adaptive strategies at the farm level"[1]

HELENA GÓMEZ-MACPHERSON[2]

Water is an essential resource for crop and livestock production, and its scarcity is the major limitation of agriculture production in Southern Europe. With climate change, water scarcity has become a major concern for all of Europe. This Focus Group aimed to collect innovative approaches and adaptive strategies to counteract water scarcity at the farm level and identify the related challenges and opportunities. The Focus Group brought together 19 experts (farmers, researchers, and advisors) from 12 countries.

The Focus Group identified current and promising measures, applied at the farm level, and classified these strategies into:

i) Practices to increase water availability for crops and livestock by reducing water losses or increasing the capacity to store the water. Among the identified strategies, conservation agriculture and covering the soil surface by residues were considered the most effective for conserving water.

ii) Practices to increase the efficient use of available water; strategies identified as potentially more effective included: choosing crops with high rooting ability, improved cropping management (fertilizers, pests and diseases, crop rotation, irrigation) aided by decision support systems, and precision irrigation monitored by remote sensing. Any improvement in crop, pasture and grazing management, feeding or crop and animal health will result in an increase in water productivity and output of the system.

iii) Practices to increase farm resilience under water scarcity, mostly profiting from farm spatial differences in large farms. Crop diversification and linking to networks were identified as potentially more effective. Above all, many other factors other than water affect production and the causes of these factors must be understood before taking any action.

Some strategies may require fine-tuning for adaptation to local conditions and may not be economically viable or may pose environmental problems. Some others require research to make them viable on farms. Although not specifically addressed by this group, a major concern of many of its members is that on-farm strategies must be combined with efforts at a higher scale than the farm to be really effective at conserving water and using it efficiently.

Some general failure factors and barriers for adoption were common to several strategies. Little is known about the economic implications of farmers adopting most of the proposed strategies, particularly if these are recently introduced or uncommon. Similarly, there is a lack of evaluation of strategies at the farm level to show the impact on water conservation and the return on investments. There is also a lack of

[1] For slides of this presentation see annex.

[2] Dr. Helena Gómez-Macpherson, Coordinating Expert, Institute for Sustainable Agriculture IAS, CSIC, Córdoba, Spain

knowledge regarding long-term or environmental benefits of strategies in local conditions. This type of demonstration or research is rare as most public agricultural research is focused on frontier knowledge.

Detailed information and results of this Focus Group are available at the EIP Agri website https://ec.europa.eu/eip/agriculture.

Further reading

EIP-Agri Service Point (2017) Water & agriculture: adaptive strategies at farm level. The EIP-Agri Website, European Commission, Brussels. Available at https://ec.europa.eu/eip/agriculture/en/focus-groups/water-agriculture-adaptive-strategies-farm-level

First SolACE Stakeholder Event, 2017: LEAF Stakeholder Response[1]

ALICE MIDMER[2]

Following Phillippe Hinsinger's presentation, LEAF provided a representative stakeholder response to some of the challenges and opportunities set out by the project.

LEAF has a wealth of experience working with farmers to help deliver better food and farming through Integrated Farm Management with over 2,000 members across 35 countries. LEAF has a network of 34 demonstration farms, which are committed to delivering and promoting sustainable farming practices, and 9 innovation centres which are research establishments pioneering new approaches to farming. Prior to the stakeholder event, LEAF discussed the project with a number of farmers and stakeholders and provided an overview of their priorities and interests in relation to SolACE.

LEAF introduced some of the key problems that farmers are facing in the UK in the area of nutrient and water stress. These include the unpredictability and irregularity of weather patterns and increasing extreme weather events such as heavy rainfall and drought conditions, with the UK currently experiencing a very dry year so far. Nutrient stresses of macro and micro nutrients are also an issue which this project will aim to tackle.

Farmers are keen to use different approaches to reduce the effects of combined water and nutrient stresses to crops. The farmers LEAF spoke to were interested in the development and use of more resilient varieties through breeding; a strategy which will be explored in this project through the creation of novel seed mixes. Resilient crops will be able to handle a wider range of environmental conditions and tolerant stress better. Further research into crop rotation and the use of legumes to increase the nitrogen concentration in the soil and improve soil quality, was also welcome. A greater understanding of what crops and varieties are best suited to different conditions and where trade-offs occur is crucial.

There are several considerations that need to be taken into account which will affect the success of new strategies. Soil type and quality will affect the available water to the crop and the subsequent success of new strategies. Management strategies such as what tillage strategy is used as well as water and pest management techniques will also have an important part to play and should be considered within SolACE.

The presentation was concluded by introducing the five questions which were discussed in greater detail during the breakout sessions led by the SolACE Work Package leaders.

[1] For slides see annex of this document.

[2] Alice Midmer, IFM Manager, LEAF (Linking Environment And Farming), Stoneleigh Park, Warwickshire, CV8 2LG, www.leafuk.org, Tel: +44 (0)2476 413911 Mob: +44 (0)7740409218, alice.midmer@leafuk.org

Theme 1: What potential combinations of water and nutrient stress concern you the most (e.g., prolonged drought, extreme events)?

DAVIDE CAMMARANO[1]

- Facilitator: Helena Gomez-Macpherson, Institute for Sustainable Agriculture IAS, CSIC, Córdoba, Spain
- Rapporteur: Davide Cammarano, James Hutton Institute, UK
- Minute taker: Laura Tippin, LEAF, UK

We asked the stakeholders a series of questions based on the main one we selected with project coordinator Philippe Hinsinger ["What potential combinations of water and nutrient stress concern you the most (e.g., prolonged drought, extreme events)?"]

Overall, the main findings were that water is the main concern rather than nutrient stress, unless access to irrigation water is available (but only in some areas). Also, the timing of water stress is an issue, depending on the duration and at which growth stage it happens. Soil type is another determinant of the influence of water stress.

The N management is generally tight with rainfall, as, in some cases, N is matched with yield expectations and with precipitation. However, N can cause quite a bit of financial burden if mismanaged.

Recent changes in climate patterns mean that heat stress (such as an extreme event) can have significant effects on reducing yield. In fact, one issue is that the interaction of multiple stresses under an unpredictable climate means that farmers need tools to adapt and to tackle this.

Theme 1 is related to SoLACE work package 1 - Data management plan and crop modelling.

SoLACE Work package 1: Data Management Plan and crop modelling

Work package 1 (WP1) will take its sources from the accumulated knowledge from recent and ongoing national, European and international phenotyping and genotyping projects, using past data analyses and mining pre-existing datasets. In addition, the expertise of stakeholders and partners will also be included to select relevant panels of genotypes, and decide the restricted range of combined stresses and management innovations to test in various pedo-climatic zones of Europe, and to be used in other Work packages. WP1 will use Crop Simulation Models (CSM) to explore the probability of occurrence of the present-day stress scenarios that will be assessed in other Work packages, as well as alternative scenarios that represent future conditions related to climate change. Finally, WP1 will design the Data Management Plan (DMP), promoting data sharing at the various steps of SolACE implementation, as well as ensuring data quality and inter-comparisons through the definition of standardized protocols for data collection and processing.

More information

http://www.solace-eu.net/about/work-packages/work-package-1.html

[1] Dr. Davide Cammarano, The James Hutton Institute, Invergowrie, Dundee DD2 5DA, Scotland UK, Phone +44 344 928 54 28, davide.cammarano(at)hutton.ac.uk, www.hutton.ac.uk

Theme 2: Which plant traits and characteristics help to improve the efficiency of water and nutrient use?

Xavier Draye[1]

- Facilitator: Philippe Hinsinger, INRA, France
- Rapporteur: Xavier Draye, UCL; Belgium
- Minute taker: Helga Willer, FiBL, Switzerland

Before starting the exchanges on theme 2, the roles and expectations of the stakeholders regarding SolACE was discussed. There was general agreement that the main contributions of the stakeholders should be:

- to question or validate the scientific hypotheses underlying SolACE activities,
- to provide advice on protocols, and
- to be active partners of SolACE in the external communication for the project itself, its goals, activities and results.

The expectation expressed by the participants was to stay informed about the progress of the project.

To initiate the discussion on theme 2 ("Which plant traits and characteristics help to improve the efficiency of water and nutrient use?"), the main tasks of work package 2 ("Understanding crop and microbiome responses to combined water and nutrient limitations") were briefly introduced, namely, trait discovery (crop physiology, microbiome and genetics) and modelling of soil resources capture.

The two objectives for the meeting were clarified:

- to get the stakeholders' visions of valuable traits supporting water and nutrient use efficiency in water and nutrient-limited conditions, and
- to discuss, with the participants, their perception of soil resources capture.

The discussion was enriched by the diverse backgrounds and interests of the participants. Several avenues were explored: plant traits, environment characterization, rhizosphere and combined stress mitigation strategies.

Plant traits

A long list of traits were mentioned by the participants, often guided by their background. From the discussion, these traits were grouped into three categories that correspond to their history or discipline basis.

- The first group comprises generic traits that are classically used in many experiments and capture basic information (photosynthesis, accumulation) about the crop. These include yield components, timing of phenological stages, protein/starch content in different organs, chlorophyll content, early vigour, soil coverage, and leaf senescence.

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- The second group comprises physiological traits which help to disentangle generic traits variations into their physiological counterpart. These include the many descriptors of root/canopy architecture, shoot/leaf/root growth dynamics, biomass dynamics, metabolism, transpiration, hydraulic properties and stress markers (signalling, secondary metabolites, polyphenols, oxydative stress).
- The third group comprises more integrative traits, including the possibility to break organ dependencies (e.g., root number *vs* root depth), the links between plant architecture, N uptake kinetics and transpiration, C isotopes discrimination and the N, P, W efficiencies (and their underlying components such as uptake and utilisation).

Environment

It was clear from the discussion that not all stress scenarios should be considered equal. Therefore, participants insisted on the value of soil monitoring in addition to classical weather variables. The determination of soil depth and detailed soil properties (e.g., water release curve) was deemed to be essential (mandatory). Several participants agree on the added value of a combined analysis of plant and environment data using crop models (for field trials) or Functional Structural Plant Models (FSPM; for platform trials), in addition to the classical statistical analysis.

Rhizosphere

The rhizosphere was mentioned by several partners, who suggested evaluating both the colonisation of the rhizosphere by microbes as well as the rhizosphere competence. The rhizosphere activities of SolACE (work packages 2 and 3[1]) were briefly introduced and were valued by the participants. It is expected that the rhizosphere-centered view of SolACE could be a game changer in abiotic stress management for both research and agriculture.

Combined stresses mitigation strategies

The discussion on mitigation strategies led to scientifically inspiring exchanges. It seemed important to all participants to consider strategies that deal with the inherent spatio-temporal variability of abiotic stresses. To deal with unpredictable constraints, mitigation strategies could develop varieties with the right phenotypic plasticity, which can then respond appropriately to different scenarios. Additionally, strategies could also design genotype mixtures which would offer an adequate production in different scenarios (each variety in the mixture being adapted to a subset of scenarios) or would generate more resilient crops in which the interactions between the different genotypes allow most of them to better cope with the environmental constraints. The discussion was nuanced here as competitive / helper behaviours are also part of monocrops.

Theme 2 is related to SoLACE work package 2 “Understanding crop and microbiome responses to combined water and nutrient limitations”.

Work package 2: Understanding crop and microbiome responses to combined water and nutrient limitations

Work package 2 will determine the traits influencing (i) resource acquisition (below-ground dynamics of soil exploration by roots and leveraging of microbial activity, including that of root symbionts) and (ii) resource utilisation (above-ground growth and resource allocation), as well as their interactions, through phenotyping under combined realistic limitations of water and nutrients (as defined in Work package 1)

[1] SoLACE work package 3: Novel agroecosystem management strategies and tools. For more information see http://www.solace-eu.net/about/work-packages/work-package-3.html.

in high-throughput platforms, as well as through the implementation of novel modelling solutions, including Functional Structural Plant Models (FSPM) and CSM. Phenotyping for yield and yield-related traits will also be conducted in semi-field and field trials involving optimal conditions and combined limitations of water and nutrients for large panels of genotypes as needed for genetic analyses in Work package 4. This will enable the SolACE consortium to draw links between crop performance, above- and below-ground traits, including the root-associated beneficial microbiome, involved in the response to combined water and nutrient stresses. Finally, Work package 2 will evaluate the functioning of novel genotypes (e.g., hybrid wheat and potato) produced in Work package 4 to validate the implemented breeding process and/or stacking of traits in those genotypes.

More information

› http://www.solace-eu.net/about/work-packages/work-package-2.html

Theme 3: Which management tools do you currently use or are aware of to improve the efficiency of on-farm water and nutrient use?

ANGELA SESSITSCH[1]

- Facilitator: Alice Midmer. LEAF, UK
- Rapporteur: Angela Sessitsch, AIT, Austria
- Minute taker: Harun Cicek, FiBL, Switzerland

In total, 24 representatives from the academic, public and agri-business sector participated in the workshop. The workshop was organized in two sessions. The first session (13 participants) was dedicated to the available experience with management practices/tools to alleviate combined plant stresses (typically water and nutrient stress), whereas participants in the second session (11) discussed the advantages / disadvantages of these practises. The following practises and tools were identified and discussed:

- Management-related: practises based on minimal soil disturbance using strategic/minimal tillage, crop residue management, permanent soil cover, mixed cropping systems, intercropping, or animal grazing. Many of these practises rely on the cultivation of legumes, having some advantages and disadvantages:
    - Advantages: beneficial crop effects and N supply, can be used as animal feed, and they are supported by current policies
    - Disadvantages: low perception, the value of additional benefits is not recognized, loss of yields, lack of knowledge and tradition, lack of value chain for legumes
- Product-based: Microbial inoculants and fertilizers improved by the addition of amendments, e.g., nitrification inhibitors, were identified, with the following advantages and disadvantages:
    - Advantages: improve yield stability, low regulatory requirements as compared to chemical pesticides, efficacy to be demonstrated according to regulations and the application versatility of some products
    - Disadvantages: price and distrust of farmers, high regulatory demand for small companies, and, until now, low reliability
- Sensors, improved analytics: various sensors, e.g., N sensors, optical sensors, foliar sensors, ground sensors, hand sensors, as well as photovoltaic panels, drones, satellites and aeroplanes were suggested as powerful tools. Additional tools include nutrient analysis, soil tests, and the analysis of soil health indicators contributing to improved models. Advantages and disadvantages of modelling were discussed.
    - Advantages: allow for better management and predictions
    - Disadvantages: reliable models for P are still missing and people generally do not trust models

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Theme 3 is related to SoLACE work package 3: Novel agroecosystem management strategies and tools.

SoLACE Work package 3 on novel agroecosystem management strategies and tools,

Work package 3 will investigate the diversity and functioning of roots/rhizosphere microbiomes and their interactions with the plant, notably

- in rotations with legumes (in bread wheat and potato),
- through growing mixtures of crop genotypes (in durum wheat), or
- by applying microbial inoculants containing combinations of strains of bacteria, including endophytic bacteria (e.g., Pseudomonas or Bacillus) and fungi (e.g. Arbuscular Mycorrhizal Fungi (AMF) or Trichoderma), with fertilizer additives and placement strategies (in wheat and potato).

On-station experiments will be conducted in the context of both conventional and organic farming conditions, as well as through the implementation of reduced tillage practices and conservation agriculture systems. This will result in a selection of management innovations to be tested on farms in a broader range of pedo-climatic conditions (work package 5). Work package 3 will also contribute to refining decision support systems (DSS) that are most promising for improving resource efficiency in crops, being based on "real-time" remote-sensing and models incorporating genotype-dependent information.

More information

- http://www.solace-eu.net/about/work-packages/work-package-3.html

Theme 4: What are the breeding strategies helping to respond to shortages in water and nutrients?

NICOLA PECCHIONI[1]

- Facilitator: Glyn Jones, Newcastle University,
- Rapporteur: Nicola Pecchioni, CREA, Italy
- Minute taker: Adriana Voicu, INRA Tansfert, France

The event was attended by a mix of scientists and industry actors (e.g. public and private breeders, advisors), and was divided into two sessions.

The discussions that arose in the two sessions were quite different, focusing on different aspects of the impact of breeding strategies, and this highly depended on stakeholder composition. This led us to conclude, in general, that future stakeholder events should strive for a balanced composition of actors along the supply chain, in order to keep the discussion as broad as possible.

On June 27, the first session particularly discussed the roles of public and private breeders. For the private breeders, it was discussed whether they were really interested in low-input solutions. They breed major crops under a range of conditions, but these are linked to agrochemicals and to high-input agriculture. In some cases, breeders belong to companies, which also sell agrochemicals. This could create a conflict of interest, unless the agrochemical business is directed towards innovative sustainable molecules and fertilizers. The public breeders seem more interested in breeding for a wider group of commodities and to address sustainability issues. These can also be bred with other varieties so they can endure local conditions and smaller markets, like organic food, which might be less interesting for private breeders.

The role of organic growers was discussed. It was discussed that their political influence is far greater than the economic scale of their operations. While it might seem they would reject hybrids out of hand, their interest in new approaches is growing. They are more interested in participatory breeding in Italy than in France.

The discussion also focused on mixtures: Will they have a role in future research and commercial breeding? No opinion was widely held. Some farmers already use their own mixtures (e.g., wheat in France) as a form of insurance against stress. However, the industry wants to combine the traits of different strains, and it seems that there are also technical and practical aspects for seed companies that cannot be underestimated.

Finally, stakeholders asked about the timing and level of stress needed for new solutions to appear. It is crucial that plant breeders innovate to reduce stress levels and obtain replicable results that can be applied on an average farm.

Theme 4 is related to SolACE work package 4 “Novel breeding strategies and tools”.

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Work package 4: Novel breeding strategies and tools

Work package 4 will incorporate below-ground traits, either related to roots or to the rhizosphere microbiome, as derived from the phenotyping efforts achieved in work package 2.

Novel tools, such as molecular markers targeting these unconventional traits, will be developed and released to breeders. Novel breeding strategies, strongly involving breeders and other stakeholders along the production chain, will consist of conducting genomic selection for bread and durum wheat on the one hand, and participatory, evolutionary breeding for durum wheat on the other hand.

For bread, wheat and potato, designing hybrids will be another novel strategy developed in work package 4, to exploit heterosis for above- and below-ground traits involved in crop performance under combined stresses. This novel genetic material will be used by other work packages, from controlled lab, semi-field or field conditions (work packages 2 and 3) to farmers' networks across Europe (work package 5), both in conventional and organic farming systems.

More information

› http://www.solace-eu.net/about/work-packages/work-package-4.html

Theme 5: How can farmers and researchers collaborate to design and test new breeding and management strategies that can be applied across Europe? And where do we need to apply site-specific solutions?

JULIA COOPER[1]

- Facilitator: Dora Drexler, ÖMKI, Hungary
- Rapporteur: Julia Cooper, Newcastle University, UK
- Minute taker: Simon Moakes, FiBL, Switzerland

Key members of SolACE work package 5 (for information see below) hosted a stimulating and enjoyable stakeholder event on 27 June in Montpellier, France. Interested stakeholders from within the SolACE project, as well as outside representatives from science and industry participated in an informal, round-table discussion about the challenges and opportunities associated with conducting on-farm experimentation in the SolACE project. Discussions were framed around the mind-map presented in Figure 1, which was designed to promote discussion that would produce constructive feedback for work package 5 members.

A total of 16 people participated in two workshop sessions. These included representatives from academia, advisory services, breeding companies, NGOs and the French Ministry of Agriculture.

Many of the participants had experience in on-farm experimentation.

Key messages were:

- The need to fit on-farm research activities into the farmer calendar. In winter months farmers may be easy to reach and engage, but when they get busy during the growing season, communication can breakdown and problems with delivery of the agreed plan can develop.
- Social media may represent an effective way to communicate with farmers more rapidly, e.g., set up a WhatsApp group for communicating within a network.
- It is important that new crops are introduced within the context of a realistic supply chain; there needs to be a market for new crops or farmers won't be interested in growing them.
- It is preferable to use existing networks, rather than to try to establish a new network for SolACE.
- Costs of translation of materials for farmer networks should be included to ensure language does not become a barrier to successful on-farm research programmes.

[1] Dr. Julia Cooper, School of Agriculture, Food and Rural Development, Newcastle University, NE1 7RU, Newcastle upon Tyne, UK. Phone +44 191 208 6883, julia.cooper(at)ncl.ac.uk, www.ncl.ac.uk/afrd/staff/profile/juliacooper

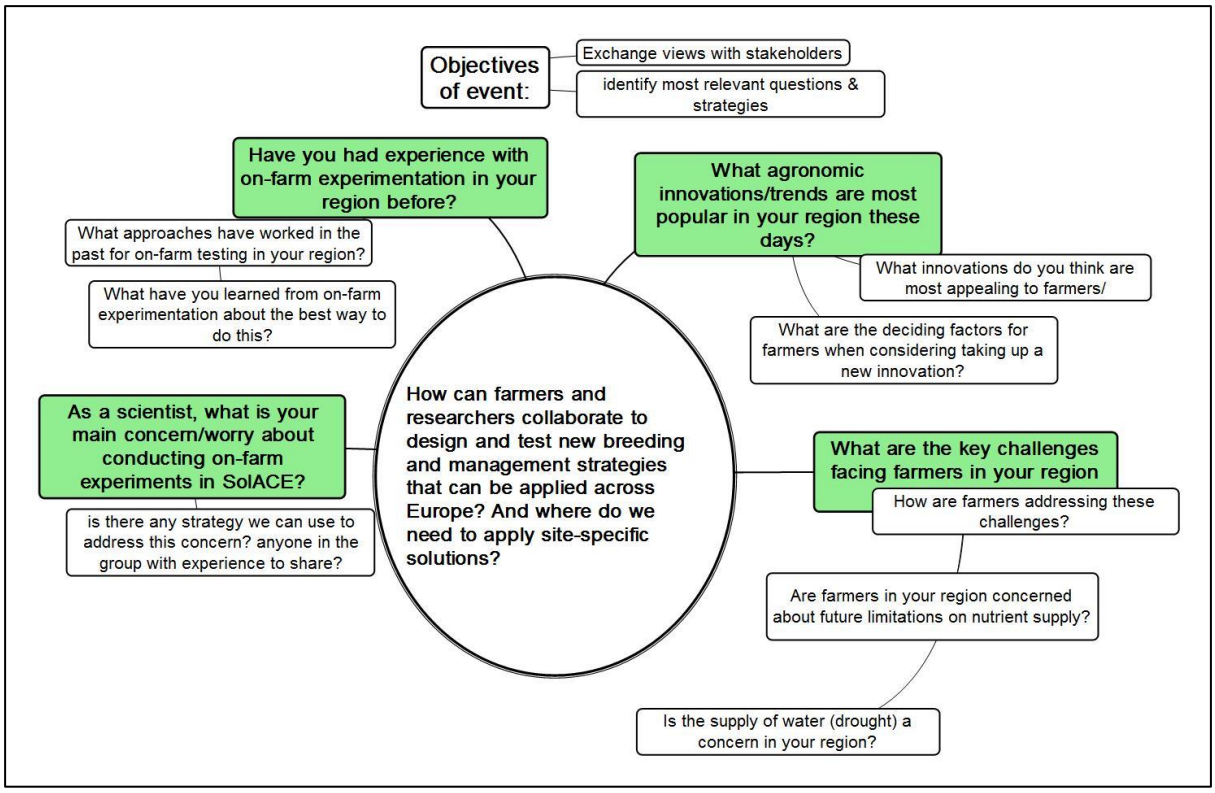


Figure 1. Mind map used as a framework for discussions in the SolACE stakeholder workshop

The main concerns of scientists about conducting on farm research revolve around:

- Implementation of agreed protocols by the farmers and the reliability of the data collected in the on-farm trials. This can be partially addressed by adopting a co-creation approach to experimental design and implementation – this will ensure the participants have real ownership of the trials and the final results.
- Reliability of the data can also be addressed by ensuring that an agronomist/researcher is on hand at critical stages for data collection.

We began to identify the types of innovations that may be tested in the networks. These included conservation agriculture (where appropriate equipment is available), cover crops, sensors, using mobile phone technology and image analysis, intercropping, and varietal mixtures.

Theme 5 is related to SolACE work package 5, Co-assessment of novel crop genotypes and management innovations in farmers' networks.

SolACE Work package 5: Co-assessment of novel crop genotypes and management innovations in farmers' networks

In farmers' networks across European pedo-climatic zones, in conventional, organic and conservation agriculture systems, SolACE partners involved in work package 5 will assess the impact of the innovations identified in work packages 3 and 4 on single crop and agroecosystem resource use efficiency for water and N or P. The assessment of such innovations and their combinations will include agronomic (e.g., yield, quality, resource use efficiency), economic (e.g., profit, resilience, stability) and environmental (e.g., land use, energy demand, climate impact, acidification, eutrophication) criteria on both single crop and rotational scales. Activities will involve SolACE partners and other stakeholders at all phases of the work, from treatment selection and experimental design for evaluation of the efficacy and acceptability of

innovations. A special attention will be dedicated to promote the exchange of knowledge and practices among actors of the various sectors, from conventional to organic agriculture, including conservation agriculture, and vice-versa. Ultimately, work package 5 will provide feedback and inputs to work package 1 and 6 on those novel traits, genotypes and management strategies that prove to be effective and acceptable on-farms for improving resource use efficiency at the single crop and rotational scales within specific agroecosystems.

More information

› http://www.solace-eu.net/about/work-packages/work-package-5.html

About SolACE - Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

SolACE – Key information

Funding: Horizon 2020, European Union and Swiss State Secretariat for Education, Research and Innovation (SERI)
Call: Increasing production efficiency and coping with climate change, while ensuring sustainability and resilience
Topic: SFS-01-2016 - Solutions t3o multiple and combined stresses in crop production
Grant agreement: No 727247
Coordinator: Dr. Philippe Hinsinger, Institut National de la Recherche Agronomique INRA, UMR Eco&Sols, Montpellier, France
Duration: May 2017 to April 2022
www.solace-eu.net

Objectives

The goal of SolACE - Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use - is to help European agriculture face major challenges, notably increased rainfall variability and reduced use of N and P fertilizers for both economic and ecological purposes. SolACE will design solutions (strategies and tools) that combine novel crop genotypes and agroecosystem management innovations to improve water and nutrient use efficiency. It will look at a range of agricultural contexts across pedo-climatic regions and farming systems of Europe.

To achieve this goal, SolACE will focus its activities on three major European crops - potato, bread and durum wheat - and will identify the

- optimum combinations of above- and below-ground traits for improving resource use efficiency,
- best-performing genotypes under combined water and N or P stresses, and
- novel practices that make better use of plant-plant and plant-microbe interactions to access water, N and P resources in conventional, organic and conservation agriculture.

Specific objectives

- identify the most probable present day and future scenarios of combined water and nutrient stresses across the various pedo-climatic zones of Europe,
- identify crop responses to such realistic combined stresses,
- evaluate water and nutrient acquisition efficiency and define the corresponding, relevant below-ground traits (related to roots, rhizosphere microbiome and symbiosis),
- define the combination of below- and above-ground traits for designing resource-efficient crops (ideotypes),
- identify genes, molecular markers and genomic selection models for improved yield under combined stresses,
- thereby, design novel, resource-efficient ideotypes or genotypes (hybrids for bread wheat and potato),

- evaluate biotic interactions at play in the tested management innovations,
- design efficient microbial inoculants and their combinations, efficient genotype mixtures and legume-based rotation or reduced tillage strategies, and test these in field conditions,
- develop novel enabling technologies for monitoring crop or soil water and nitrogen status,
- evaluate on-farm the agronomic, economic and environmental performances of the tested innovations at the field scale in several networks of farmers to ultimately assess local solutions and barriers for the uptake of the tested innovations.

Approaches

SolACE will implement complementary approaches, from data mining, modelling, and phenotyping in high throughput platforms and field conditions, to experiments in research stations and farmer networks in contrasting pedo-climatic zones.

Innovations

The tested innovations will include crop genotype mixtures, legume-based crop rotations and cover crops, microbial inoculants, as well as improved decision support systems and hybrids, or products from genomic selection and participatory evolutionary breeding schemes.

Involvement of actors and stakeholders

SolACE will implement a double interactive innovation loop, based on agroecosystem management and breeding strategies, and will imply the engagement of diverse end-users, across the production chain, from farmers and farm advisors to NGOs, SMEs and larger industries in the agri-business sector, through the SolACE consortium and a range of stakeholder events.

Dissemination

Through the co-design and co-assessment with the end-users of the selected novel breeding and management strategies to increase the overall system resource use efficiency, the findings of SolACE will be available for dissemination to a broad spectrum of stakeholders, including policy-makers.

Partners

The SolACE project has 25 partners in 14 countries and is funded under the European Union's research and innovation programme Horizon 2020.

- AIT – Austrian Institute of Technology GmbH, Austria
- Agrobiota, Germany
- Agroscope – Federal Department of Economic Affairs, Education and Research, Switzerland
- ARVALIS – Institut du végétal, France
- CON.CER – Societa Cooperativa Agricola, Italy
- CREA – Council for Agricultural Research and Economics, Italy
- DCM – De Ceuster Meststoffen NV, Belgium
- ECAF – European Conservation Agriculture Federation, Spain
- FiBL – Research Institute of Organic Agriculture, Switzerland
- INRA – French National Institute for Agricultural Research, France
- IT – INRA Transfert, France

- JHI – James Hutton Institute, United Kingdom
- KU – University of Copenhagen, Denmark
- LEAF – Linking Environment And Farming, United Kingdom
- ÖMKi – Hungarian Research Institute of Organic Agriculture, Hungary
- SOLYNTA – Ontwikkelingsmaatschappij Het Idee, The Netherlands
- SP – Sourcon Padena GmbH, Germany
- SLU – Swedish University of Agricultural Sciences, Sweden
- SU – Sabancı University, Turkey
- SYNGENTA, France
- UCL – Université catholique de Louvain, France
- UE – University of Évora, Portugal
- UHO – University of Hohenheim, Germany
- UNEW – University of Newcastle – United Kingdom
- UPM – Technical University of Madrid – Universidad Politécnica de Madrid, Spain

Weblinks

www.solage-eu.net: Project website

zenodo.org/communities/solace: SoLACE community on Zenodo

twitter.com/SolACE_EU_NET: SolACE on Twitter

Annex: Slides

About the SolACE project; Philippe Hinsinger[1]

[1] Dr. Philippe Hinsinger, Institut National de la Recherche Agronomique INRA, UMR Eco&Sols, 2 place Viala, 34060 Montpellier Cedex 2, France, Phone +33 4 99 61 22 49, philippe.hinsinger(at)inra.fr,www.umr-ecosols.fr/index.php/en/

Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

SolACE

Stakeholders' Event

Kick-Off Meeting June 26-28th 2017

Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

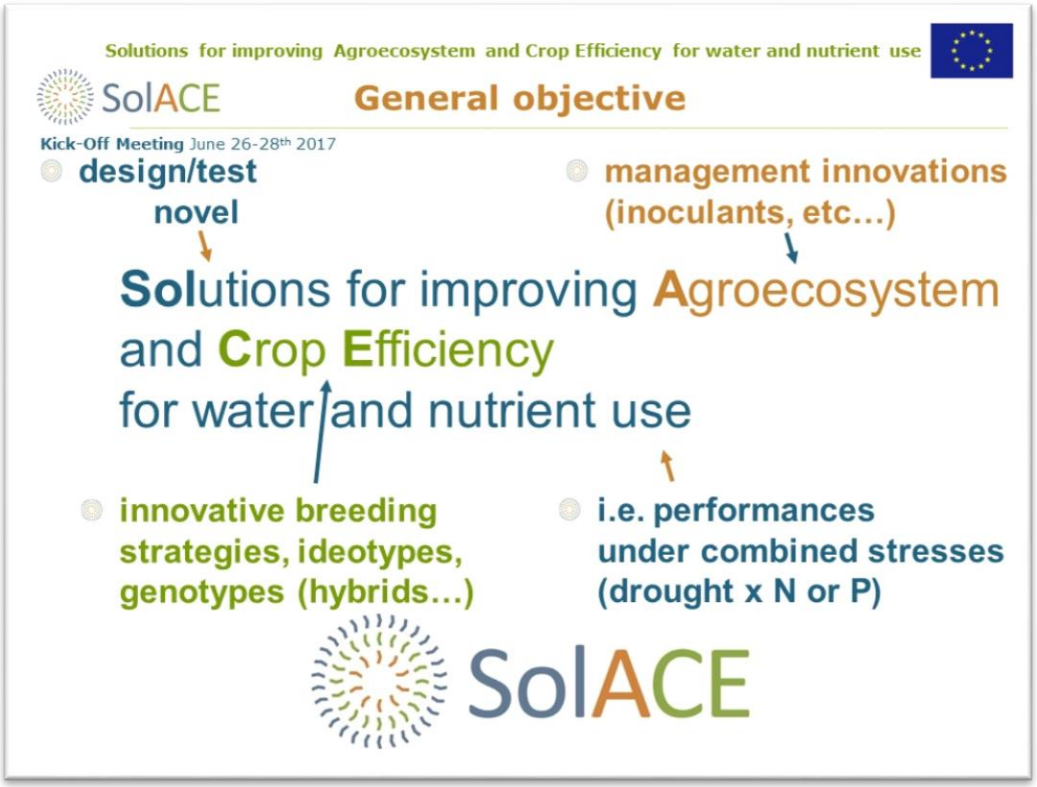
SolACE

General objective

Kick-Off Meeting June 26-28th 2017

Solutions for improving **A**groecosystem
and **C**rop **E**fficiency
for water and nutrient use

SolACE


Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use
SolACE
General objective
Kick-Off Meeting June 26-28th 2017
design/test novel
management innovations (inoculants, etc…)
Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use
innovative breeding strategies, ideotypes, genotypes (hybrids…)
i.e. performances under combined stresses (drought x N or P)
SolACE


Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use
SolACE
General objective
Kick-Off Meeting June 26-28th 2017
Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use
focus on three major European crops:
bread wheat, durum wheat and potato
SolACE

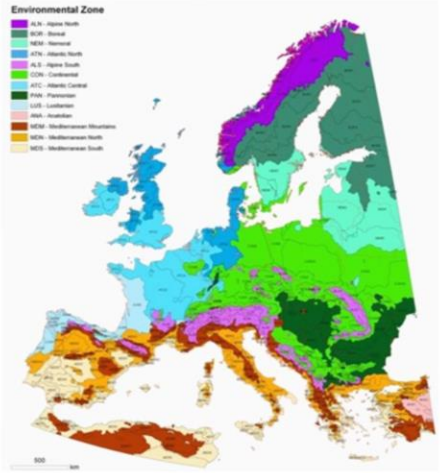
Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

SolACE

Specific objectives

Kick-Off Meeting June 26-28th 2017

- **Identify most probable present-day and future scenarios of combined water and nutrient stresses**, across the various pedo-climatic zones of Europe



Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

SolACE

Specific objectives

Kick-Off Meeting June 26-28th 2017

- **Identify crop responses to combined stresses**, i.e. realistic simultaneous limitation by water and N or P availabilities

  - Water x N : bread and durum wheat
  - Water x P : potato

Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

SolACE

Specific objectives

Kick-Off Meeting June 26-28th 2017

- **Identify crop responses to combined stresses**, i.e. realistic simultaneous limitation by water and N or P availabilities
- **Evaluate resource (water, N and P) acquisition efficiency** and define the corresponding, relevant **below-ground traits** (root / rhizosphere microbiome / symbiosis)

Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

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Specific objectives

Kick-Off Meeting June 26-28th 2017

- **Define the combination of traits**, including below- and above-ground, for resource (water, N and P) use efficient cropping systems (**ideotypes** coping/combined stresses)

Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

SolACE

Specific objectives

Kick-Off Meeting June 26-28th 2017

- Identify genes / molecular markers involved in combined stress response
- Define genomic selection models for improving yield under combined stress

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Specific objectives

Kick-Off Meeting June 26-28th 2017

- Identify genes / molecular markers involved in combined stress response
- Define genomic selection models for improving yield under combined stress
- Design novel, resource efficient ideotypes or hybrids

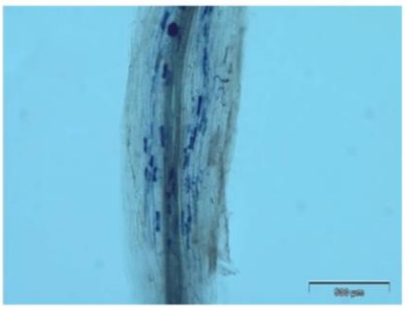
Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

SolACE

Specific objectives

Kick-Off Meeting June 26-28th 2017

- **Evaluate biotic** (plant-plant, plant-microbe) **interactions** at play in novel crop management techniques (cover crop genotype mixtures, microbial inoculants)



Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

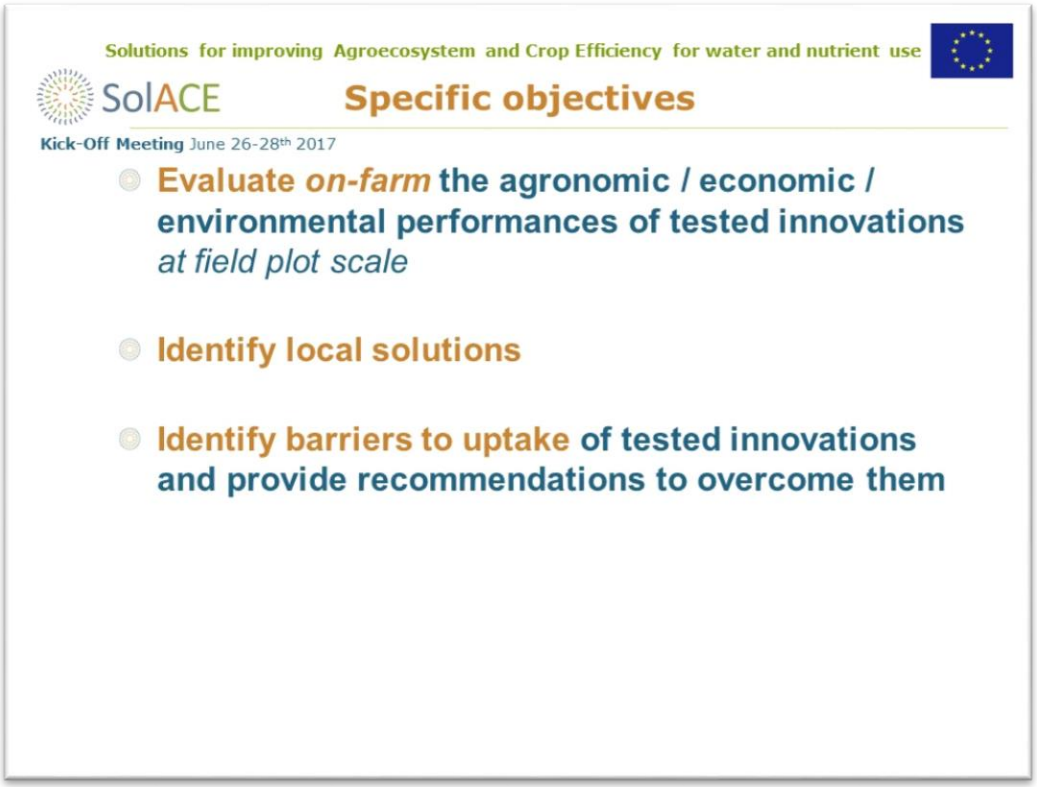
SolACE

Specific objectives

Kick-Off Meeting June 26-28th 2017

- **Design efficient microbial inoculants**, and evaluate them *in field conditions*
- **Design efficient genotype mixtures**
- **Test legume-based crop rotation and reduced tillage/no till strategies** *in field conditions*


Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use
SolACE
Specific objectives
Kick-Off Meeting June 26-28th 2017
Design efficient microbial inoculants, and evaluate them in field conditions
Design efficient genotype mixtures
Test legume-based crop rotation and reduced tillage/no till strategies in field conditions
Develop novel enabling technologies for crop/soil monitoring and management of water and N status


Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use
SolACE
Specific objectives
Kick-Off Meeting June 26-28th 2017
Evaluate on-farm the agronomic / economic / environmental performances of tested innovations at field plot scale
Identify local solutions
Identify barriers to uptake of tested innovations and provide recommendations to overcome them

Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

SolACE

Specific objectives

Kick-Off Meeting June 26-28th 2017

- Evaluate *on-farm* the agronomic / economic / environmental performances of tested innovations *at field plot scale*
- Identify local solutions
- Identify barriers to uptake of tested innovations and provide recommendations to overcome them
- **Communicate to end-users**
  - *practice abstracts*

Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

SolACE

General Approach

Kick-Off Meeting June 26-28th 2017

- **multi-actor approach**
- field-relevant levels of combined stresses

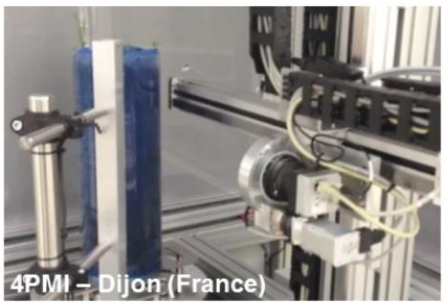
Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

SolACE

General Approach

Kick-Off Meeting June 26-28th 2017

- multi-actor approach
- field-relevant levels of combined stresses
- largely relying on field (incl. on-farm) experiments
  + unique phenotyping facilities (for belowground traits)



4PMI – Dijon (France)

RadiMax – Copenhagen (Denmark)

Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

SolACE

General Approach

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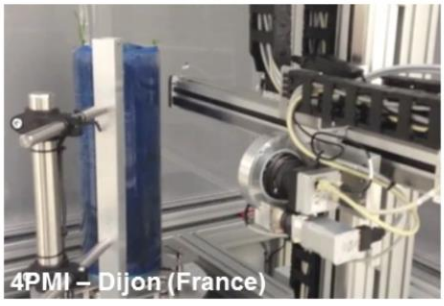
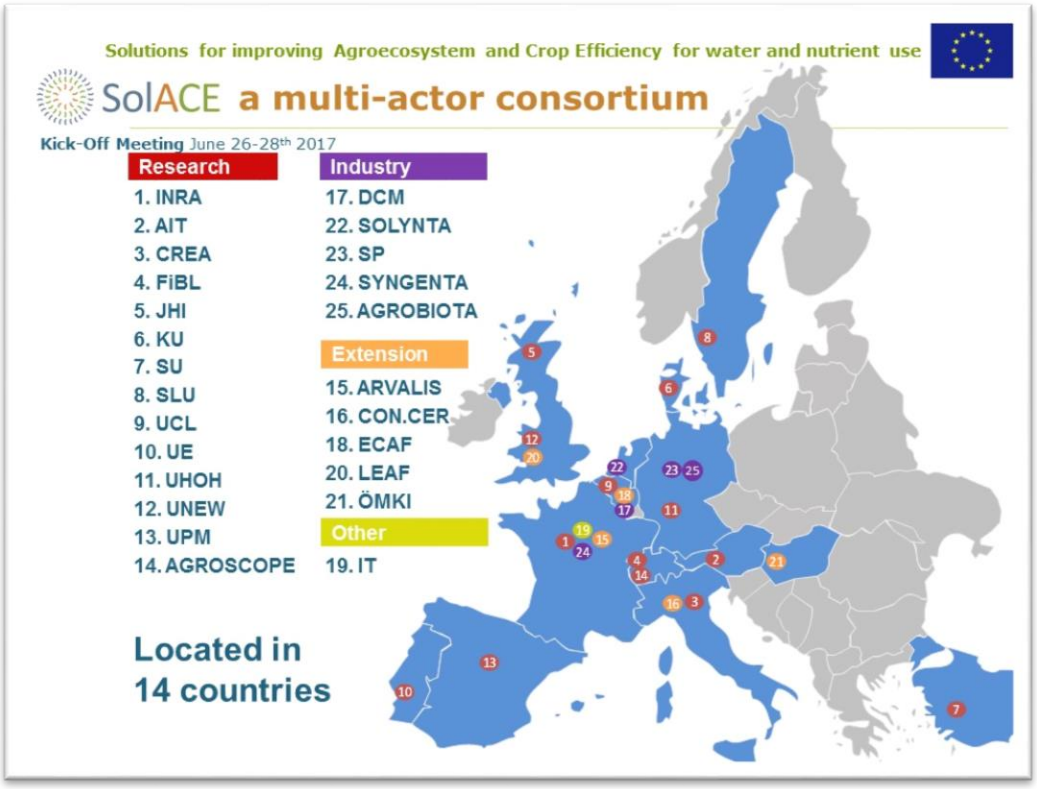
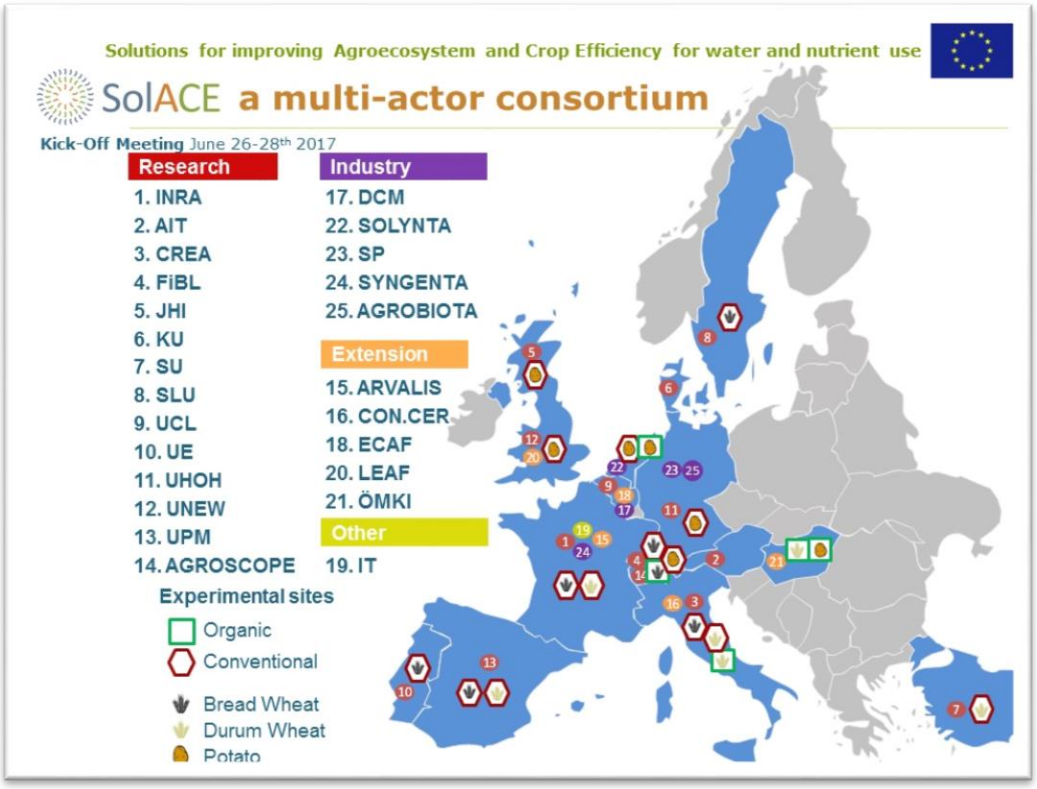


4PMI – Dijon (France)

RadiMax – Copenhagen (Denmark)

- focus on three major European crops:
  bread wheat, **durum wheat** and **potato**


Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use
SolACE a multi-actor consortium
Kick-Off Meeting June 26-28th 2017
Research
1. INRA
2. AIT
3. CREA
4. FiBL
5. JHI
6. KU
7. SU
8. SLU
9. UCL
10. UE
11. UHOH
12. UNEW
13. UPM
14. AGROSCOPE
Industry
17. DCM
22. SOLYNTA
23. SP
24. SYNGENTA
25. AGROBIOTA
Extension
15. ARVALIS
16. CON.CER
18. ECAF
20. LEAF
21. ÖMKI
Other
19. IT
Located in
14 countries


Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use
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24. SYNGENTA
25. AGROBIOTA
Extension
15. ARVALIS
16. CON.CER
18. ECAF
20. LEAF
21. ÖMKI
Other
19. IT
Experimental sites
Organic
Conventional
Bread Wheat
Durum Wheat
Potato


Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use
SolACE Objectives of the Stakeholders' Event
Kick-Off Meeting June 26-28th 2017
exchange views with stakeholders
farmers, farm advisors
breeders, agri-business actors
across the whole production chain
SolACE


Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use
SolACE Objectives of the Stakeholders' Event
Kick-Off Meeting June 26-28th 2017
exchange views with stakeholders
farmers, farm advisors
breeders, agri-business actors
across the whole production chain
beyond those involved as SolACE partners,
to identify most relevant questions and strategies
most promising traits / genotypes
most promising management options
and their combinations
SolACE

Overview of EIP-AGRI Focus Group on "Water & Agriculture: adaptive strategies at farm level"; Helena Gómez-Macpherson[1]

[1] Dr. Helena Gómez-Macpherson, Coordinating Expert, Institute for Sustainable Agriculture IAS, CSIC, Córdoba, Spain

Focal Group"Water & Agriculture: adaptive strategies at farm level"

EIP-AGRI FGs: tackling agricultural challenges

Climate change → water scarcity becomes a global European problem

- **What farm level adaptation strategies exist or can be developed to deal with water scarcity?**

NO: ~~molecular~~ or ~~plant organ~~ or ~~beyond farm~~ scales

funded by the European Commission

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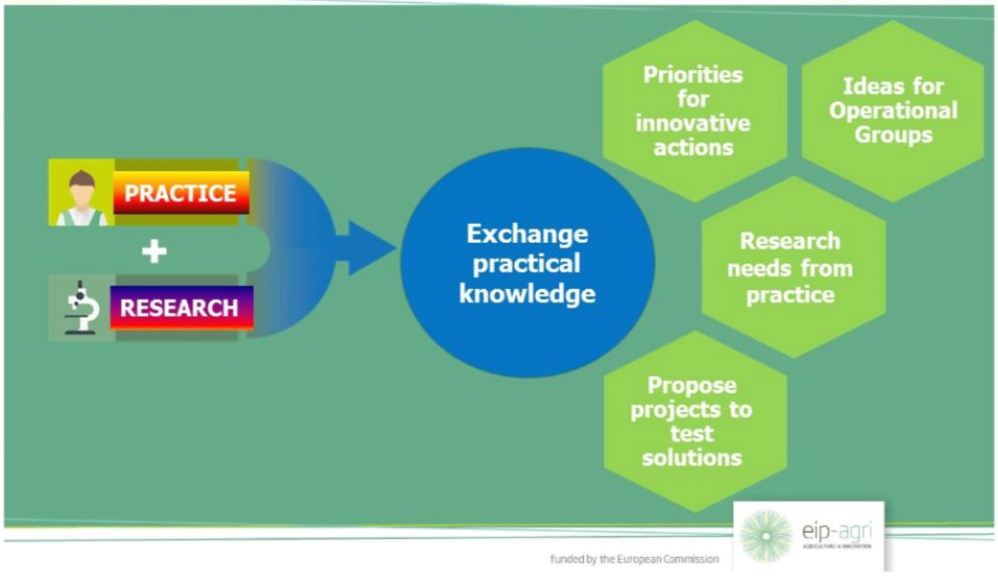
What farm level adaptation strategies exist or can be developed to deal with water scarcity?



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Process

- Selection of expert coordinator & 19 members
- Starting paper + survey → inventory
- Fiumicino meeting: validate inventory and prioritize
- Homework: mini-papers
- Ciudad Real meeting: barriers for adoption, future actions, potential OGs
- Final report and Promotion

Focal Group "Water & Agriculture: adaptive strategies at farm level"

June 2015 – September 2016

- **19 members**

Researchers, Farmers, Advisors

Germany	1A
Belgium	1A/F
Spain	2R; 1A
Greece	1R/F; 1R/A
The Netherlands	1R
Hungary	1R/F
Italy	2R; 1R/A
Lithuania	1A
Poland	1A
Portugal	1A; 1R
United Kingdom	2A
Sweden	1A

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Focal Group "Water & Agriculture": **INVENTORY** what is available?

Farming management practices and strategies to **increase**...

1. available water for crops and livestock
   (↓ losses; ↑ stored water in soil and farm)
2. the efficient use of water, including irrigation efficiency
3. farm resilience under water scarcity

Name of practice/strategy	Agronomic aspects	Economic aspects	Environmental aspects	Success factors	Fail factors	Applied in:

1) Which strategies at farm level increase water availability ?

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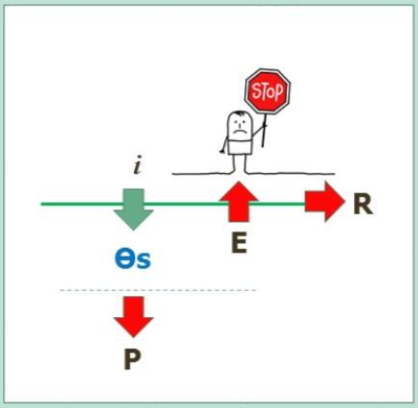
AGRICULTURE & INNOVATION

How to reduce water losses?



- **Conservation Agriculture**
- **Mulch**
- **Early ground cover**
  ↑ *i* (P) ↓E,R
- **Subsoiling if hardpan**
  ↑ *i* (P) ↓R
- **Effective weed control**
  ↑θs

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1) Which strategies at farm level increase water availability ?

How to increase soil capacity to store water & how to access to that water?

- ↑ Soil organic matter ← CA
  ↑ capacity
- ↓ Compaction:
  ← controlled traffic
- Deep rooting / rootstocks
  ↑ access

1) Which strategies at farm level increase water availability ?

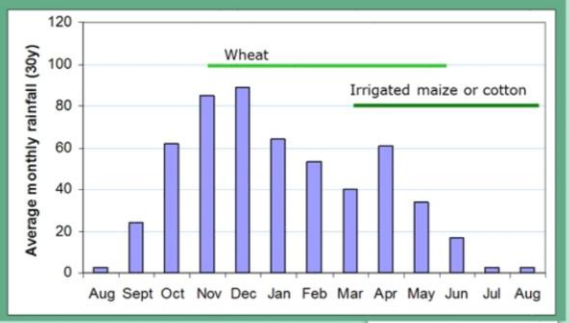
How to increase water supply ?

- Renovation of systems
- Use of waste-water
- New water sources
  - rainwater harvest
  - drainage harvest
- Controlled drainage

2) Which strategies at farm level increase the efficient use of water?

Which management options will help to use water more efficiently?

- **Growing when the evaporative demand is lower**
  - match the rain
  - shading nets



2) Which strategies at farm level increase the efficient use of water?

Which management options will increase irrigation efficiency?

IRRIGATION SCHEDULING

- **Water balance**
  e.g. soil/crop sensors
- **Supplemental irrigation**
- **Regulated deficit irrigation**

Water on demand
Cost *vs* water savings?
Complexity / autonomy?
Risks?

Water & agriculture: adaptive strategies at farm level

- **WATER EFFICIENCY TRAP**
  precision irrigation and more efficient systems may be accompanied by more intensive cropping or more irrigated area
  ➔ **↑ consumptive water use**

Working scales!

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2) Which strategies at farm level increase the efficient use of water?

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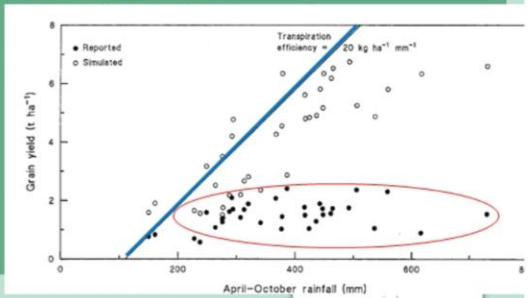
AGRICULTURE & INNOVATION

Which management options will help to use water more efficiently?

- **Understanding and closing yield gap**
  OTHER LIMITATIONS THAN WATER

e.g. tactical management (DSSs; check points)



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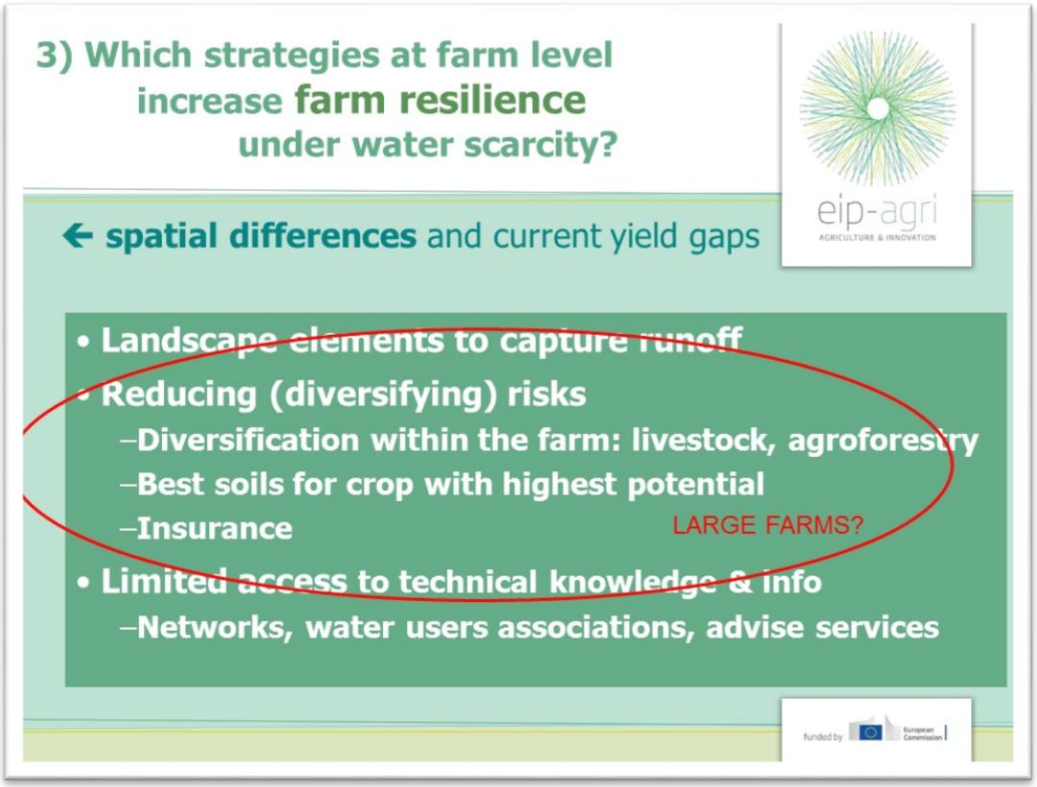
3) Which strategies at farm level increase farm resilience under water scarcity?
eip-agri
AGRICULTURE & INNOVATION
← spatial differences and current yield gaps
• Landscape elements to capture runoff
• Reducing (diversifying) risks
–Diversification within the farm: livestock, agroforestry
–Best soils for crop with highest potential
–Insurance
LARGE FARMS?
• Limited access to technical knowledge & info
–Networks, water users associations, advise services
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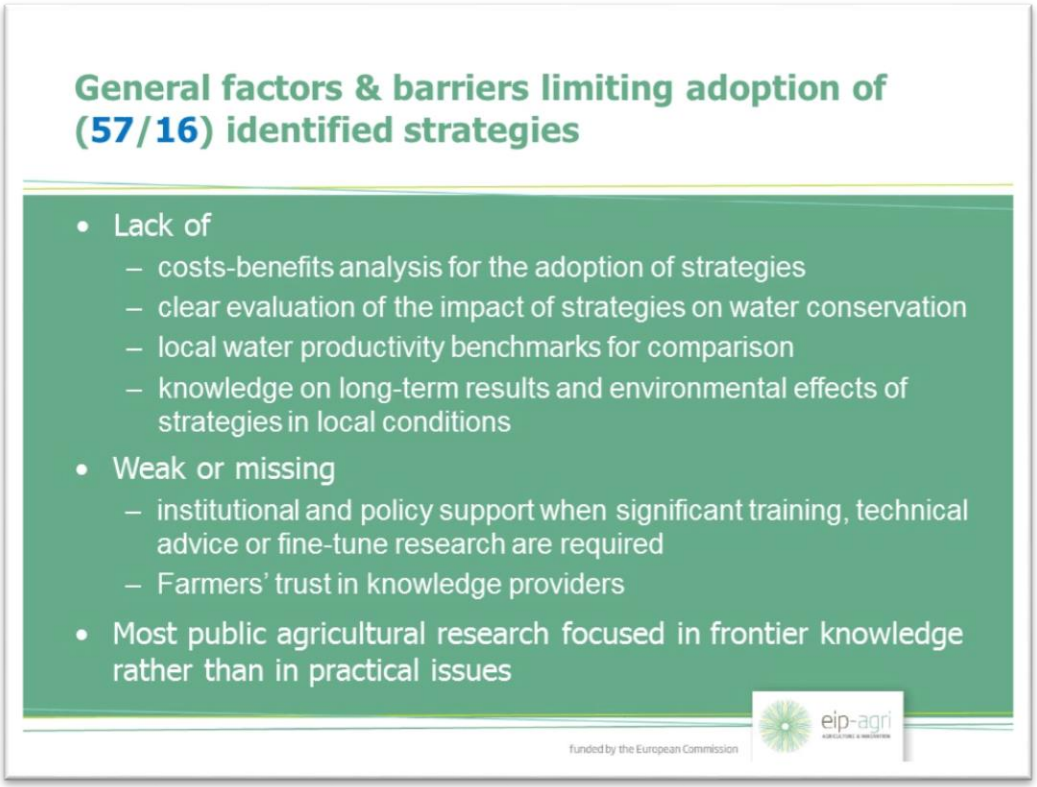
General factors & barriers limiting adoption of (57/16) identified strategies
• Lack of
– costs-benefits analysis for the adoption of strategies
– clear evaluation of the impact of strategies on water conservation
– local water productivity benchmarks for comparison
– knowledge on long-term results and environmental effects of strategies in local conditions
• Weak or missing
– institutional and policy support when significant training, technical advice or fine-tune research are required
– Farmers' trust in knowledge providers
• Most public agricultural research focused in frontier knowledge rather than in practical issues
funded by the European Commission
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How to facilitate adoption?

- **Providing benefits transparently**
  - water conservation, economic - environmental terms, short & long term
- **Thinking and acting together**
  - knowledge exchange among all actors
  - fine-tuning options, considering farmers' needs
  - training for farmers and advisors on complex technologies
- **"Seeing is believing"**
  - representative demonstrations of field conditions
  - long-term demonstrations to show benefits related to soil improvements
- **Linking partnership and involving stakeholders**
- **Using friendly tools**
  - clear guides to facilitate use of complex strategies
- **Producing effective policies (and evaluate them)**
- **And thinking outside the box!**

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Focal Group "Water & Agriculture"
Ideas for Operational Groups

- Local adaptation of conservation agriculture with emphasis in permanent ground cover and proper tillage practices
- Improved crop rotation and crop diversification
- Spring-summer tolerant crops to low T^{o} for earlier sowing
- Local benchmarks as references for irrigation performance and crop productivity
- Optimization of irrigation with crop water balance supported by soil sensors for adopting supplemental irrigation and/or adopt regulated deficit irrigation
- Precision irrigation aided by remote sensing
- Innovative solutions for using alternative water sources, maybe with poor water quality

funded by the European Commission

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Focus Group "Water & Agriculture: adaptive strategies at farm level"

More info in: ec.europa.eu/eip/agriculture

FINAL REPORT ALSO INCLUDES:

- Research needs from practice
- New developments
- Minipapers

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AGRICULTURE & INNOVATION

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funded by

LEAF Stakeholder Response; Alice Midmer[1]

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About LEAF

LEAF (Linking Environment And Farming) is a leading global organisation delivering more sustainable food and farming.

We work with farmers, the food industry, scientists and consumers, to inspire and enable sustainable farming that is prosperous, enriches the environment and engages local communities. We do this through developing and promoting Integrated Farm Management (IFM), a whole farm business approach that delivers sustainable farming.

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What we do

LEAF's vision…

A world that is farming, eating and living sustainably.

Our mission…

inspiring and enabling sustainable farming that is prosperous, enriches the environment and engages local communities.

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LEAF Network

The **LEAF Network** consists of:

- **LEAF Demonstration Farms**
working farms committed to delivering & promoting sustainable farming practices and

- **LEAF Innovation Centres**
research establishments pioneering new approaches to push forward the boundaries of IFM through research & development

Hosting walks & talks these sites proudly demonstrate sustainable farming through Integrated Farm Management to a wide range of groups

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IFM delivering sustainable farming

Integrated Farm Management, delivers a site-specific farming system supporting the integration of the environment, society and farm economic viability over the long term.

LEAF 2012

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LEAF Demonstration Farms

LEAF currently has **35 Demonstration Farms** across the UK covering a wide range of farm types, including arable, horticulture, dairy, beef and sheep.

LEAF Demonstration Farms are:

- Commercial Farms
- Forward-thinking Farmers
- Volunteers
- Proudly demonstrating best practice IFM
- Host visits to a range of audiences but primary focus is farmers
- Eager to learn – leaders in the industry

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Problem

- Unpredictability/irregularity of weather
  - Irrigating Cereals in May in the UK
- Extreme weather events
- Drought
- Heavy rainfall
  - Rain damage
  - Flooding
- Nutrient stress
  - Macro and micro
  - Interactions

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Solutions

- Breeding
  - Crops that can handle a range of conditions
  - Resilience
- Rotations
  - Better use of legumes
- Understanding
  - What plants and varieties are best placed for different conditions
  - Where are the trade-offs?
  - Where are the pinch points

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Considerations

- Conditions
  - Soil type
  - Soil conditions/quality
  - Weather
- Management
  - Soil management
  - Reduced tillage
  - Soil conditions/quality
  - Pest management
  - Water management
  - Fit with wider approach and strategies

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Questions

- **What potential combinations of water and nutrient stress is your biggest concern (e.g. prolonged drought, extreme events)?**

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Questions

- **Which plant traits and characteristics help to improve the efficiency of water and nutrient use?**
  - Field trials will implement a scenario combining water and N deficit. Which scenario should we consider?
  - Platform and potato trials will explore root traits in details. Should we place our efforts on specific traits?
  - Trials may have the possibility to record more traits in specialised field trials. Again, are there any root or shoot traits we should focus on?
  - What is your understanding of crop modeling?

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Questions

- Which management tools do you currently use or are aware of to improve the efficiency of water and nutrient use on farm?

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Questions

- What are the breeding strategies helping to respond to shortages in water and nutrients?

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LINKING ENVIRONMENT AND FARMING
Questions
SolACE
• How can farmers and researchers collaborate to design and test new breeding and management strategies that can be applied across Europe? And where do we need to apply site-specific solutions
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