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European Joint Programme

Towards climate-smart sustainable management of agricultural soils

Fostering soil management PRACtices and uptake and developing decision support TOols through LIVing labs in EU (PRAC2LIV)

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Results from exchanges with stakeholders on the needs for DSTs in soil management

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ABSTRACT

To communicate the results of stock-takes on Decision Support Tools (DSTs), activities were organized with several types of stakeholders around Europe. Four stakeholder workshops, one meeting with a lighthouse farm and a national hub were arranged so far and another national hub is planned. In addition, a novel method 'participatory design' was used to explore ideas for future development of DSTs.

The four workshops were conducted in Sweden, Latvia, Italy and Türkiye. The invited stakeholders were farmers, advisors, DST providers, researchers and policy makers. At the workshops we discussed barriers for adoption and solutions to solve these as well as what features are requested by experienced DST users and what type of DSTs that are missing. There was a variation between workshops in what was indicated as main soil related challenges, with soil fertility and soil organic matter in Italy and Latvia, soil compaction in Sweden and water management in Türkiye. In contrast to this, soil nutrient management was the most common objective for using a DST. The barriers identified for using DSTs included 1) Expensive technology and not enough economic resources for adoption, 2) Not enough user-friendly technology and lack of technical support and 3) old generation sticking to traditions. The suggested solutions to break these barriers were 1) to have positive demonstrations by experienced farmers without economic interests in the tool 2) give financial and technical support for implementation and 3) provide simplified data-entry and tools that all generations can understand. One requested feature was to easily have access to and be able to incorporate data from different data sources such as open databases, soil maps and other datasets from other tools or software. Another was tools to be transparent in the way that the user knows what is behind the recommendations and if they are valid for their type of farm, soil and climate. The tools should be easy to use, and support should be available. The tools should be flexible in the sense that it is possible to elaborate in a PC version at the office when and if you have the time and skills for it but possible to use in a quick mode in an app version in the field. The app version should have access to all field information when you need to make quick decisions or need to update your plans due to new conditions in the field. Many agreed that tools should also provide information on environmental impact as long as the functions are scientifically sound and reliable and don´t limit other functions with unnecessary complexity. Weather is very important for many decisions, and often needs to be included in the tool. However, it is difficult to get reliable weather forecasts, and it is not realistic that all decision support tools can cover all details. The meeting at the lighthouse farm and the Dutch national hubs partly confirmed the findings of the workshops and added the topic of sharing farm data with respect to anonymity and ownership.

The novel participatory design method was unfamiliar for most of the contributing members of PRAC2LIV and involved participants. This novelty brought both confusement and excitement. When using this novel method, the project team should adjust their introduction and desired outcome of the session to the target audience including when to present which state of the development. Once introduced properly the method can serve as a useful additional research tool for conceptual ('vision') data collection and interpretation. The creation of the visualisation can steer and clarify the research direction along the process within the team while the visualized outcome has communication purposes to a broader audience. The use of the participatory design method used in this research showed high potential for inspiring, focussing and accelerating the development of a common vision on complex matters such as soil health in living labs in the EU. Next steps could be the formulation of an IT-architecture that accounts for the aspects of, e.g. farming systems, scale-levels, and economics, matching selected quality criteria for the desired DST/webportal.

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List of acronyms and abbreviations

DST	Decision support tool
SOM	Soil organic matter
EJP	European Joint Programme
WP	Work Package
EU	European Union

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1. Introduction

This is a report about exchanges with stakeholders within the project PRAC2LIV, which is a project within the European Joint Programme on Agricultural Soil Management (EJP Soil) aiming at fostering adoption of support tools. The project involved making stock-takes of Decision Support Tools (DSTs) that focus on soil organic matter (SOM), water retention, and nutrient use efficiency as currently used by EJP Member States. Results of the stocktakes and the wider topic of DSTs for soil health were discussed with stakeholders. The report is divided into two parts. Part 1 presents the results from the stakeholder workshops, and part 2 presents the results of a novel method 'participatory design' for future development of DSTs.

Part 1. Stakeholder workshops and meetings

2. Objectives

The objectives for the exchange with stakeholders were to communicate results from the stocktake with stakeholders in some different countries in order to validate the results and to discuss what steps are needed to get a successful implementation of tools that will improve sustainable soil management.

The objectives were realised with the organisation of 4 workshops, 1 meeting with a lighthouse farm, and 2 meetings of national hubs.

3. Materials and methods

3.1. Workshops

3.1.1 Locations and participants

Four workshops were conducted to communicate results from the stocktake to stakeholders in order to validate the results and to discuss which steps are needed to get a successful implementation of tools for improving sustainable soil management. The workshops were conducted in Sweden, Latvia, Italy and Türkiye. The invited stakeholders were farmers, advisors, DST providers, researchers and policy makers. The number of participants at each workshop was approximately 20-30 persons (Table1) and parts of the discussions were made in smaller groups.

TABLE1. WORKSHOP PARTICIPANTS AT THE DIFFERENT WORKSHOPS.

Profession	Sweden	Latvia	Italy	Türkiye
Farmers	11	2	9	12
Advisors	2	2	10	7
DST providers	4	4		1
Researchers	4	9	5	12
Farmers union representatives		2		
Policy makers		4	1	
Total	21	23	25	32

3.1.2 Workshop script

Each workshop started with a plenary session with an introduction of the EJPSOIl and PRAC2LIV project and a presentation some selected findings and examples from the European and national stocktake of available DSTs. In the first part of the workshop, participants were asked individually what they thought was main soil-related challenge, what was their objective with using a DST and if they had any other DSTs to add to the list.

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In the second part of the workshop, the participants were divided in smaller groups to facilitate the discussions on specific topics. They discussed in smaller groups about barriers to DST adoption, and potential solutions to break them. They were also asked to discuss what features they miss in DSTs that they currently use and for what decisions the tools are still missing but needed and to make a ranking of the most important features of a tool. Some statements (listed below) were submitted to participants for opening a discussion about their agreement/disagreement and why. The elements discussed with stakeholders during small group session were as follows:

1. The most important features of a DST are:
- It doesn't require much information from me
- It has a user-friendly interface
- The decision support delivers results that are easy to apply in real time
- The results are reliable and based on science and calibration on farms in the area
- Easily accessible both in terms of cost and hardware requirements
- It has clear visualization of results
- The design is developed in collaboration with users

2. Do participants agree or disagree with:
- All tools should have an app for a smartphone
- In addition to plant production and soil quality, tools should also provide information on environmental impact
- Tools must be flexible and consider actual weather conditions

3. What are the missing features in the available DSTs ?
4. What missing information is needed to make the right decision?

After the group discussions, the main results were presented to all participants, in order to draw the main conclusions of the workshop. Few interviews were also conducted with selected participants, including farmers, advisors and others, to prepare a short video that summarize the main discussions and results of the workshop.

3.2. Meeting with lighthouse farm

In The Netherlands, a meeting was organised with a lighthouse farm, i.e. Ekoboerderij De Lingehof in the region of the Betuwe. In this particular case a different agenda was followed than the above-mentioned script. Firstly, the initiative and challenge for the Ekoboerderij on becoming a lighthouse was discussed. Already several collaborations exist with local parties. In the future, a living lab may be formed including other farms in the region. Secondly, the use of DSTs by the lighthouse as stand- alone farm and in conjunction with a potential living lab was discussed.

3.3. Meeting with National Hubs

Two meetings with national hubs were organised, in The Netherlands and in Türkiye. The national hub in The Netherlands consists of participants from the national and/or provincial government, farmers' organisation, water board, advisors, and external researchers. The hub meets twice a year. During the 1st year of PRAC2LIV, the participants of the hub had been informed about the project and the questionnaires via the newsletter. In the final year of PRAC2LIV, a short presentation was given and the making of a visualisation via the 'participatory design' introduced. The discussion included both topics, i.e. the questionnaires and the visualisation.

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4. Results and discussion

4.1 Workshops

4.1.1 Soil related challenges and objectives for using DST

The main soil related challenges as indicated by the workshop participants (Table 2Table 2) varied between the different workshops. In Latvia and Italy, soil fertility and soil organic matter was the top mentioned challenges, whereas in Sweden, soil compaction was considered the main challenge (Table 2). In Türkiye, they considered water management the most important challenge. Water availability was also mentioned by several in Italy.

TABLE 2. MAIN SOIL RELATED CHALLENGES IDENTIFIED BY PARTICIPANTS AT THE WORKSHOPS IN THE DIFFERENT COUNTRIES. THE FIGURES INDICATE THE NUMBERS OF PARTICIPANTS VOTING FOR EACH CHALLENGE.

Sweden	Farmers	Advisors	DST providers	Researchers	Policy makers and farmer union representatives	Sum
Soil fertility			1			1
Climate adaption			1			1
Nitrogen efficiency			1			1
Soil organic matter	2					2
Water availability	2					2
Acidification						0
Soil erosion						0
Latvia						
Soil compaction			1			1
Soil fertility	1		1	1		3
Climate adaption						0
Nitrogen efficiency						0
Soil organic matter	1	1		4	3	9
Water availability						0
Acidification			2	1	1	4
Soil erosion		1		1		2
Italy						
Soil compaction	1					1
Soil fertility	1	2	1	2		6
Climate adaption	1			1		2
Nitrogen efficiency						0
Soil organic matter	1	3		2		6
Water availability	1	1	1	2		5
Acidification						0
Soil erosion						0
Türkiye						
Soil compaction	1			1		2
Soil fertility	2	1		2		5
Climate adaption				1		1
Nitrogen efficiency						0
Soil organic matter	3	2		3		8
Water availability						0
Acidification						0
Soil erosion	1			1		2
Soil water management	5	4	1	4		14

Although different challenges were identified, common objectives for using DSTs are related to fertilization, as indicated in all countries (Table 3. Objectives with using a DST as mentioned by the workshop participants in

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the different countries.Table 3). This includes both seasonal adjustments of nitrogen with regard to crop status and fertilization and liming according to soil maps. This applies also to several Italian big or medium companies, involved in industrial crops production, which utilize DSTs to manage their fertilization based on maps. Similarly, by mapping soil moisture, it is possible to anticipate the crop need in terms of water supply and irrigation.

TABLE 3. OBJECTIVES WITH USING A DST AS MENTIONED BY THE WORKSHOP PARTICIPANTS IN THE DIFFERENT COUNTRIES.

	Farmers	Advisors	DST providers	Researchers	Policy makers and farmer union representatives	Sum
Sweden						
Soil compaction	3	1		1		5
Soil fertility			1			1
Climate adaption			1			1
Nitrogen efficiency			1			1
Soil organic matter	2					2
Water availability	2					2
Acidification						0
Soil erosion						0
Latvia						
Soil compaction			1			1
Soil fertility	1		1	1		3
Climate adaption						0
Nitrogen efficiency						0
Soil organic matter	1	1		4	3	9
Water availability						0
Acidification			2	1	1	4
Soil erosion		1		1		2
Italy						
Soil compaction	1					1
Soil fertility	1	2	1	2		6
Climate adaption	1			1		2
Nitrogen efficiency						0
Soil organic matter	1	3		2		6
Water availability	1	1	1	2		5
Acidification						0
Soil erosion						0
Türkiye						
Soil compaction	1			1		2
Soil fertility	2	1		2		5
Climate adaption				1		1
Nitrogen efficiency						0
Soil organic matter	3	2		3		8

The reason behind such a discrepancy between the farming challenge mentioned and the use of DTS for fertilizers, could be that challenges were considered as “major” just because they are still not as easily solved with using a DST. The commonly used DSTs are mainly supporting tools to decision making related to fertilization and irrigation. These are decisions that require a lot of inputs that may vary spatially and in time and therefore a DST with access to detailed and updated data is often very useful. But when it comes to challenges related to soil organic matter content, soil compaction and how to cope with weather fluctuations or drought and flooding, sometimes in the same season, completely different type of decisions and consequently also different types of tools are required. For water, these could include everything from

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planning water regulation through drainage and the construction of dams to adapting the tillage for adequate drying for the upcoming crop or adapting the choice of crops to ones that can withstand strong weather fluctuations. About the soil organic matter, more long-term decisions come into picture, such as regular supply of stable manure, straw return, catch crops, etc.: for this reason, several Italian farmers are asking for advanced DSTs able to adequately support the management of organic inputs (selection of cover crops, organic amendments, time of application) to increase soil organic carbon in function of soil properties and weather conditions.

4.1.2 Barriers and solutions for adoption

The barriers for implementation and suggestions for how to break these barriers were mainly discussed at the two workshops in Latvia and Italy. At both workshops, very similar barriers were addressed (Table 4). Even though DSTs are adopted on larger farms, small farms, which for instance are common in Italy, have more difficulties in using DSTs, mainly due to lower economic resources, lack of easy-to-access solutions for farmers and average age of farmers, not always so friendly with digital tools. In Latvia, farmers use their experience of their farm, passed down through generations, and many of them already think they know what to do, depending on visual characteristics of the crop, their soil tests and weather conditions and that a digital DST would not add anything more useful. Not enough user-friendly technology and lack of technical support was also addressed at the Swedish workshop, and the differences in adoption between generations was mentioned also in the Netherlands.

TABLE 4. BARRIERS IDENTIFIED AND SOLUTIONS SUGGESTED FROM THE WORKSHOPS IN LATVIA AND ITALY.

Identified barriers	Suggested solutions
1) Expensive technology and not enough economic resources for adoption	1) Positive demonstrations by experienced farmers without economic interests in the tool,
2) Not enough user-friendly technology and lack of technical support and	2) Financial and technical support for implementation
3) Old generation with sticking to traditions.	3) Simplified data-entry (also by farmers) and tools that all generations can understand.

Good technical support was addressed as something very important for adoption also at the Swedish workshop. One suggestion to improve the support was to bring farmers using the same tool together into farmers groups that can exchange experiences either in physical meetings or just in a chat group. In Türkiye, they also addressed that the tools need to be user friendly, meaning that the need to be easy to operate, understandable, with available user manual and support in the local language and possible to use also without internet connection. They also addressed the importance of accuracy, reliability and up to date information compatible with the terrain.

4.1.3 Suggested features

At the workshops in Sweden and Türkiye much of the discussion concerned requested features of a tool. In Sweden, where the workshop participants were mainly farmers with large farms with experience of several tool, much of the discussion was based on experiences on tools they already use and the requests they listed were focused on functionality:

<u>Requested features to facilitate functionality of tools:</u>
1) Transparency so that the user can understand what lies behind.
2) To get answers quickly when needed through an app in the mobile phone, at the same time that you have the opportunity to influence settings etc. in a computer version when time is available
3) To access the tools and previous documentation anytime and anywhere, preferably via an app in the phone.

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4) To be able to share data between different tools, so that a soil map made from one company could easily be combined with satellite data from another in any DST most suitable for their purpose.

In the other workshops with larger part of the participants from other stakeholder groups than farmers this discussion was generally broader, but at the Italian workshop importance of accessing different databases on private and public platforms was also addressed. They addressed that functionality and usefulness for farmers is important and that that the tools should:

1) Be user-friendly both concerning interface and operation
2) Benefit yield, quality and environmental impact
3) Be reliable

At the meeting in the Netherlands the following three aspects were considered essential for the development of future DSTs:

1) DSTs must integrate related topics in soil management practices,
2) DSTs must include economic consequences,
3) DSTs must give regionally oriented recommendations.

4.1.4 Responses to statements

The response to the statement “All tools should have an app for a smartphone” had very similar answers at all four workshops (Table 4). The common answer was that it would be useful in many cases as it allows for real-time updates when you are in the field. However, some functions such as more advanced data management may be much better on the computer, so in most cases the tool should be able to use in both a computer version and in an app on the smartphone. The statement “In addition to plant production and soil quality, tools should also provide information on environmental impact” got a bit various response (Table 5). In Türkiye, all agreed that it would be important not only for the sake of the environment, but also for warning to take precautions in case of natural disasters. In Latvia they were also positive and mentioned it would be educating, provided it has a solid scientific base. In Sweden, there were some scepticisms whether it should be mandatory to combine it in all tools, since making it more complex may contribute to that the development of the tool is slowed down and that the tool is unnecessary complicated. At all workshops it was agreed that weather is important for many decisions, and that updated and site-specific weather forecasts therefor are needed. However, it is difficult to get reliable weather forecasts, and it is not realistic that all decision support tools can cover all details.

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TABLE 5. SUMMARY FROM EACH WORKSHOP OF THE RESPONSES IN GROUP DISCUSSIONS TO DIFFERENT STATEMENTS.

All tools should have an app for a smartphone	
Sweden	Often, but not necessarily. It depends on how quickly you need the answer and for what you need it.
Latvia	Yes, for functions that needs to and can be used in the field, as it allows for real-time changes. But there should also be a PC version, because data management and other databases and programs are more easily available on the computer.
Italy	It was remarked that, even if it is preferable to use DSTs as mobile apps, sometimes the map viewing requires the use of PC.
Türkiye	Yes, it is necessary, accessible and quite practical in the field, provided that it is easy to understand. There may be a computer version for detailed information.
In addition to plant production and soil quality, tools should also provide information on environmental impact	
Sweden	Not necessarily. It could slow down the development of the tool if it is unnecessary complicated and not focused enough. Could be coupled to environmental labelling.
Latvia	Many agree, as it is important and nobody wants to harm the environment and it is mandatory to take the environment into account, considering regulations. It could also be educating. But it is only useful if it has a solid scientific base. Some think it should instead be already built into the algorithm that gives advice to the farmer.
Türkiye	Yes, it should provide information of the negative or positive effects of on crop production and soil quality as well as environmental impacts. Warnings can be given in advance of natural disasters, measuring the economic damage threshold of diseases and pests and taking precautions. For example, it is necessary to investigate whether plant protection products harm bees. The persistence, pollution, etc. of the pesticides we use should also be investigated. Yes. It should be useful in all areas so that a single decision support tool is useful. Yes. It is also necessary to provide information on environmental impacts for sustainable agriculture.
Tools must be flexible and take into account actual weather conditions	
Sweden	Flexibility is important, but not always weather forecast. It is also difficult to get reliable weather forecasts.
Latvia	Yes, farming is greatly influenced by the weather and the more detailed the data in real time, the better the conclusions and the better the decisions. However, only if accuracy can be ensured.
Türkiye	It should be flexible and take into account real weather conditions. Since weather conditions are constantly changing, data should be updated. It is very important to have it in real time. Time is crucial for correct technique application and precaution. But it is difficult to get reliable weather forecasts, and it is not possible for decision support tools to cover every point.

4.1.5 Similarities and differences between workshops outputs Soil related challenges and objectives for using DST

The workshops organized in the various countries involved different types of agricultural stakeholders, which may have influenced what was discussed. In the Swedish workshop most participants were farmers that were all early adopters of DSTs and did not represent an average farmer in Sweden. Their discussions concerned much about how to improve DSTs that they already used and was additional DSTs they would like. At the other workshops it was more difficult to attract farmers, and the discussion was more focused on barriers to use DSTs and have to overcome these barriers.

Common conclusions and differences emerged from the discussions. During the workshops, it was emphasized that simpler, more user-friendly interfaces are needed. Farmers appreciated that the tools should have a smartphone application. However, DST providers, advisors and researchers all agreed that it is preferable to use DSTs in the form of mobile applications, but not always possible. Therefore, using a tool on a smartphone depends on the type of tool. However, with a PC version parallel to the app, there is the possibility to get the advantage of having both the advantage of detailed functions and visualisation in the PC simultaneously as the tool is always at all times and locations in the app.

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It was agreed that DSTs should be flexible and easy to use. Another important point concerns the clear visualization of results. A tool should not require a lot of information to be entered by users. While farmers focus on the ease of use of decision support tools and the real-time application decision. Other stakeholders all underlined the importance of results being reliable and based on science and farm calibration in the region. Another point discussed at the workshops was whether the tools should also provide information on environmental impact. For Italy and Latvia, all stakeholders indicated the importance of this functionality in order to know how practices affect the environment and to ensure food quality and safety. However, in the case of Sweden, participants pointed out that this could make the tool unnecessarily complicated, and that the buyers define what should be done for measures for environmental labelling and the market then decides whether they want to pay extra.

A similarity between the countries was that all stakeholders in the various countries indicated the need for even simpler and more accessible tools. However, in some countries there were at the same time wishes for more complex tools. In the case of Italy, participants would like DSTs to take account not only of SOC, nutrients and water supply, but also of information on introduced cover crop species, inorganic vs organic inputs, weeding strategies, management of crop residues, etc. However, in Latvia, it was noted that it was not possible to combine the different functions of separate tools into a single multifunctional tool, as there are too many actors involved in DST activities and each actor has his or her own format, making it is impossible to combine them successfully.

Discussions on data management and use varied between the different countries. For Italy and Latvia, stakeholders indicated that the tool should be able to interface easily with existing databases. For the Latvian workshop, it was suggested that the tool should be synchronized with a database shared by all institutions and research centers involved in agriculture. This database would contain the latest information from the whole country, and would therefore be relevant for all Latvia, and it would be possible to select locally specific information relevant to each farm. For the Swedish workshop, the discussion on this point focused on access to historical data of the farm. Future DSTs should allow easy access to previous documentation at any time and in any place, preferably via an application on the phone. Finally, only for the atelier in Italy, it was suggested that future tools should enable calculation of the farm's carbon footprint.

4.1.6. Workshops deliverables

During the workshops, interviews were conducted with selected participants, including farmers, advisors and others. These interviews have been turned into short videos that summarize the highlights of each workshop, the main discussions and results. The videos will be published soon on EJPSOIL web page. The workshops activities and their outcomes were also communicated via press releases on the partner web sites as well as in different media (see links bellow) such as Farmers' magazines and television.

The links are :

Latvia workshop: https://www.lu.lv/par-mums/lu-mediji/zinas/zina/t/83451

Italy workshop: https://www.crea.gov.it/web/agricoltura-e-ambiente/-/prende-il-via-il-workshop-promozione-di-strumenti-di-supporto-alle-decisioni-dst-per-l-incremento-della-sostanza-organica-la-ritenzione-idrica-e-l-efficienza-d-uso-dei-nutrienti-nel-suolo-

https://federbioservizi.it/evento/promozione-di-strumenti-di-supporto-alle-decisioni-dst-per-lincremento-della-sostanza-organica-la-ritenzione-idrica-e-lefficienza-duso-dei-nutrienti-nel-suolo/

Sweden workshop: Nya verktyg efterfrågas för att hantera lantbrukets utmaningar | Externwebben (slu.se)

Delin, S. 2024. Framtidens digitala verktyg. Lantmannen nr 5 2024, p.54.

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Türkiye workshop: AB HORIZON 2020 EJP SOIL - PRAC2LIV (Avrupa Birliğinde Yaşayan Laboratuvarlar Aracılığı ile Toprak Yönetim Uygulamalarının Teşviki ve Karar Destek Araçlarının Geliştirilmesi) Projesi Ulusal Çalıştayı gerçekleştirildi. (tarimorman.gov.tr)

PRAC2LIV Projesi için çalıştayı düzenlendi - Genel - Tarım TV

4.2 Lighthouse farm

In The Netherlands, a meeting was organised with a lighthouse farm, i.e. Ekoboerderij De Lingehof in the region of the Betuwe. In this particular case a different agenda was followed than the above-mentioned script. Firstly, the initiative and challenge for the Ekoboerderij on becoming a lighthouse was discussed. Already several collaborations exist with local parties. In the future, a living lab may be formed including other farms in the region. Secondly, the use of DSTs by the lighthouse as stand- alone farm and in conjunction with a potential living lab was discussed.

4.3 National Hubs

As the meeting in Türkiye has not yet taken place, the report will be made available in the near future via the EJP Soil website. Questions from the Dutch National Hub on the stocktakes concerned the inclusion of some particular DSTs, e.g. for Moisture Retention. In the Netherlands, the need for water management is growing due to climate change. Both drought and excess rainfall and flooding rivers may occur. So far, the number of DSTs on these topics is limited. In addition, questions were asked about the availability and ownership of farm data. For this reason, the Dutch Interbranch Organisation for Arable Crops has in consultation a Code of conduct 'Towards a data-ecosystem in open arable fields' to ensure that tools may be used without the need to share data with third parties (https://www.bo-akkerbouw.nl/dit-doen-wij/data-intensieve-akkerbouw, in Dutch).

PART 2. Novel Participatory Design Method

5. Objectives

The major goal of PRAC2LIV is to perform a stocktake of decision-support tools (DSTs) in the EU, of which results and recommendations for further development of tools were discussed with stakeholders in regional workshops (see Part 1 of this report). Important early-stage observations on DSTs were two-fold: 1) most target only one feature, i.e., fertilisation or carbon sequestration, and 2) most are directed at farmers and not at other stakeholders, let alone stakeholder communities. These observations indicate that the current situation regarding use and availability of DSTs does not match very well with EU efforts to promote the integrative concept of soil health (European Commission, 2019, 2023). Nor does it match which the adopted policy to implement, by 2030, 100 living labs that focus on the improvement of soil health (European Commission, 2022). Living lab activities are encouraged to include the "use of multiple methods and tools originating from a range of disciplines and domains." (European Commission, 2022; pg. 2). With this in mind an additional activity was carried out to expand the fcus of PRAC2LIV to the wider topic of "DSTs for Soil Health in Living Labs".

To support soil health in living labs is a complex issue both from registration and planning as from monitoring point of view. Adoption and use of DSTs amongst the farming community may be very useful and play a key role. Therefore, there is a need to not only collect information on DSTs but to also support discussions between different types of stakeholders to understand each other's needs and expectations. This may proof to be vital

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for the development of successful DST's in Living Labs. Such DSTs obviously would need to be relevant for the different contexts of living labs across Europe.

The (potential) use of DSTs for soil health was explored in meetings with stakeholders using an innovative method to inspire the discussion. Narrative mapping is an innovative technique to support and inspire discussion among a variety of stakeholders in complex case studies ((Lapum et al., 2015). The method is derived from the technical design domain in which complex systems are visualised, often complemented with a textual narrative on the discussions and background justification ('pictorial'). A major advantage of this method is the opportunity to document and present qualitative research that would otherwise not be seen in a traditional paper.

The objective of this part of the research was to elaborate with stakeholders a framework for DSTs on soil health in living labs. For this purpose, the novel method on participatory design was used.

6. Materials and methods

The novel participatory design method consists of the following steps (Ooms 2021, Ooms 2022):

(1) extracting key points for a visualisation out of a team discussion
(2) presenting these visualised key points in expert groups to receive feedback
(3) using the visualisation as an inspiration for discussion.

Throughout the process, the visualisation undergoes several iterations, all with the goal of igniting fruitful discussions. The endpoint is reached when major stakeholders groups have been represented and few new discussion points are found. For PRAC2LIV, these steps were as follows:

- Extracting key points for a visualisation out of a team discussion

The leading team organized a one and half hour online meeting to brainstorm important topics within the framework of "DSTs for soil health in living labs" to kick-off the process of creating a visualization to inspire discussion.

The leading team consisted of the initiator of the visualization, a discussion facilitator, and the visualizer, all three members of the PRAC2LIV team. The chosen team for the 1st discussion was the core PRAC2LIV team from EJP soil. This team involves researchers from six partners in EU Member States: UL in Latvia, LUKE in Finland, SLU in Sweden, CREA in Italy, TAGEM in Türkÿe and WUR in The Netherlands (coordinating).

Both the initiator and the facilitator focused on the discussion to get enough input about the presented topic while the visualizer created the first sketches, and, when needed, asked clarifying questions. The sketches were drawn on an iPad in Adobe Fresco and afterwards put together as a poster in Adobe InDesign.

- Presenting the visualized key points in several expert groups to receive feedback

Different iterations were presented to expert groups to discuss and improve the visualisation. The first discussion was with the Dutch National Hub of the EJP soil programme. The Dutch Hub consists of representatives of national bodies from government (Ministry of Agriculture), agriculture lobby, research institutes, agroindustry, and education. The meeting took place in person, with a group of 15 national hub members. The aim of the physical presentation was to (1) validate the emerged topics from the PRAC2LIV team, (2) to check the readability of the sketches in correspondence with the words, and (3) explore missing topics.

After incorporating the feedback from the national hub, a second discussion took place online, with an international soil health/communication expert. The group size, level of expertise, and way of presenting, both online and in real life, were deliberately differed throughout the process, to obtain different perspectives.

- Using the visualisation as an inspiration for discussion

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The visualization was presented at the EJP annual science days to inspire discussion, not only on the topic of DSTs for soil health in living labs, but also on the method of using a visualisation in the realm of soil health to inspire discussion. The visualization is available (e.g. via the EJP Soil website) to third parties for further use to inspire discussions within communities of soil health and/or living labs.

7. Results participatory design

7.1 Input obtained during iterations

The design process of the visualisation was started in the project team of PRAC2LIV, followed by iterations in various expert groups. Finally, the visualisation was used as an inspiration for discussion.

Starting phase: online team discussion

During the initial team discussion, topics that were generated included: What is soil health, Digital Twins, Regional scope (scale levels), definition of Discussion Support Tools, Innovative Business models for Soil Health (e.g. funding), Data sharing, and IT-architecture.

As the discussion unfolded, sketches were created by the visualizer (Figure 1). These were then later transformed into digital sketches (Figure 2).

FIGURE 1. NOTES AND FIRST SKETCHES BY THE VISUALIZER MADE DURING THE TEAM DISCUSSION.

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FIGURE 2. A FEW OF THE FIRST DIGITAL SKETCHES BASED ON THE KEY POINTS OF THE DISCUSSION, LEFT TO RIGHT FARM SCALE, DST WITH AN APPLICATION AND DATA COLLECTION, LIGHTHOUSES AND LIVING LABS, COW.

7.2Iterations

Three iterations were made. The 1st iteration took place after a presentation to, and discussion with, the Dutch National Hub and combined the initial sketches with other input gathered in the discussion (Figure 3).

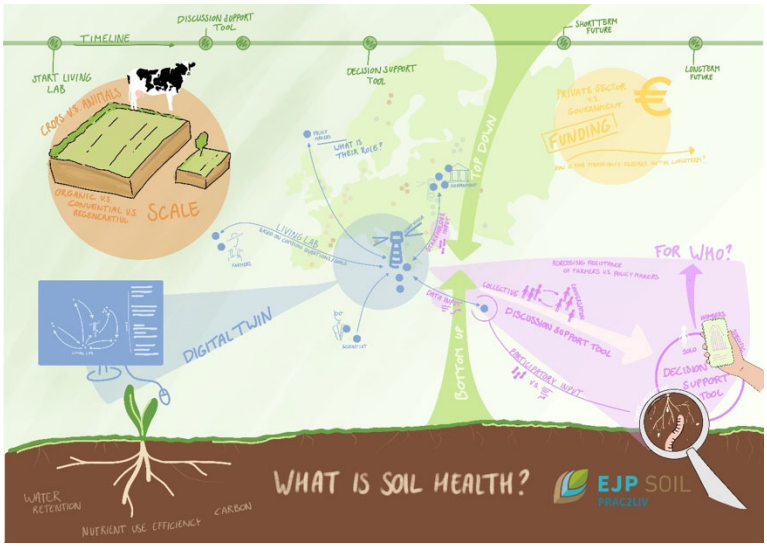

FIGURE 3. FIRST ITERATION OF THE VISUALISATION AS PRESENTED TO THE DUTCH NATIONAL HUB.

As could be expected, there was great overall unfamiliarity with the use of a visualization as a tool to inspire discussion. Some major points of feedback were:

- The layout gave the impression that all topics were derived from one central point (lighthouse) in Europe which would be misleading and not do justice to all contributing Member States.
- There was no clear title which could lead the viewer through the topics.
- A missing topic was 'Ownership of data'.
- A timeline is not needed.

Based on this feedback the leading team added an explanatory title to support viewers in their understanding of its goal (to inspire) and focussed on clearly communicating the following key points:

- Distinction in: Decision and/or Discussion goals of tools (Figure 4a)
- Technical implications for developing a DST or web portal (Figure 4b)
- Farming systems and scale-level (Figure 4c)
- Business aspect of DST (Figure 4d)
- Bottom up and top-down approaches (Figure 4e)

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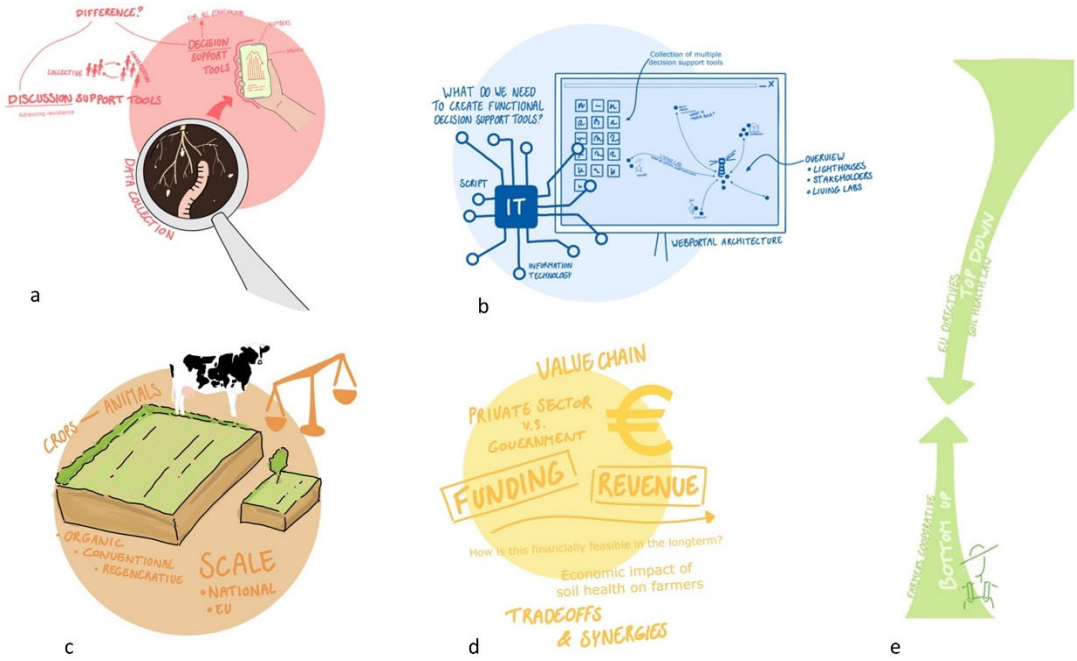

FIGURE 4. VISUALIZED KEY POINTS WHERE A) DISTINCTION IN DECISION AND/OR DISCUSSION SUPPORT TOOL, B) TECHNICAL IMPLICATIONS FOR DEVELOPING A DST OR WEB PORTAL, C) FARMING SYSTEMS AND SCALE LEVELS, D) BUSINESS ASPECTS, AND E) BOTTOM UP AND TOP-DOWN APPROACHES.

The 2nd iteration was made by combining the visualized key points taken from the Dutch National Hub and discussions with the project team (Figure 5).

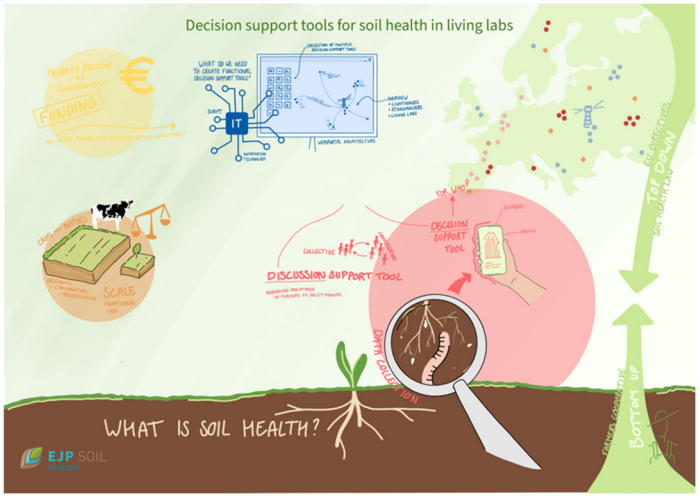

FIGURE 5. THE 2ND ITERATION WITH ALL TOPICS TOGETHER.

The 3rd iteration was made with the input from one-on-one discussion the Communication manager of the Soil Health Institute in the U.S.A. (Figure 6). The discussion started with the observation that, without being involved in the EJP soil programme, the terms “living labs” and “light houses” are not clear. An explanation of Decision Support Tools is needed to understand the discussion, therefor it is included in the visualisation.

The 3rd iteration is evolved from this one-on-one discussion as well as the preparation with the project team for the Annual Science days 2024. A poster version of the visualization needed to be prepared that would be

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presented during the poster session. This changed the format & lay-out of the resulting visualisation considerably.

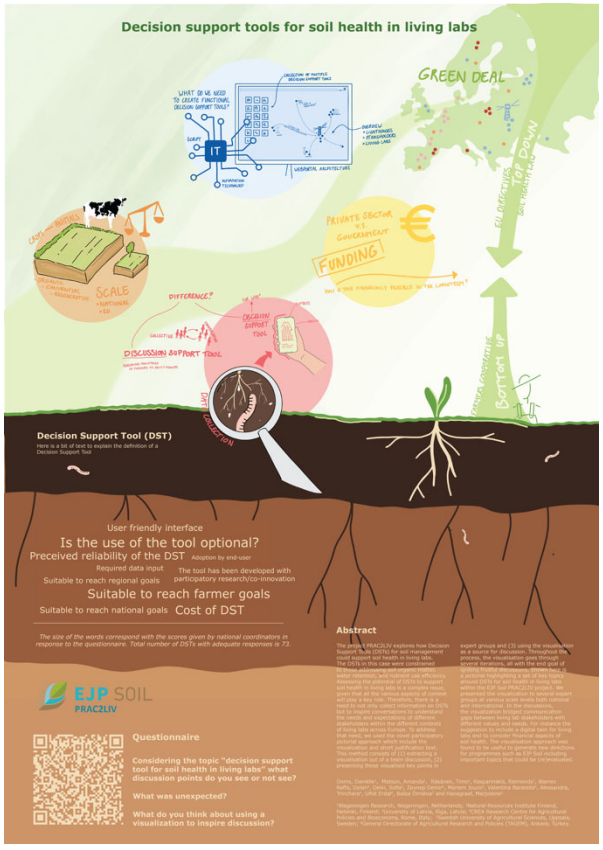

FIGURE 6. THE 3RD ITERATION. FIRST POSTER VERSION OF THE VISUALIZATION.

Before going to the EJP soil Annual science days the poster was presented back to the PRAC2LIV team to include some last details, such as changing all the colours on the map of Europe to green to not mislead the viewer with the fictional livings labs and lighthouses.

7.3 Using the visualisation as an inspiration for discussion

The final version of the poster was used to discuss the topic of “DSTs for Soil Health in Living Labs” with different type of stakeholders.

At the EJP Soil Annual science days, during the poster session, it was the first time the visualisation was presented (Figure 7) to a wider audience, aiming to inspire discussion about DST for soil health in living labs among the soil health research community. To receive and guide the feedback from peers at the Annual science days the leading team included three questions in the poster: (1) Considering the topic “decision support tool for soil health in living labs” what discussion points do you see or not see? (2) What was unexpected? (3) What do you think about using a visualization to inspire discussion?

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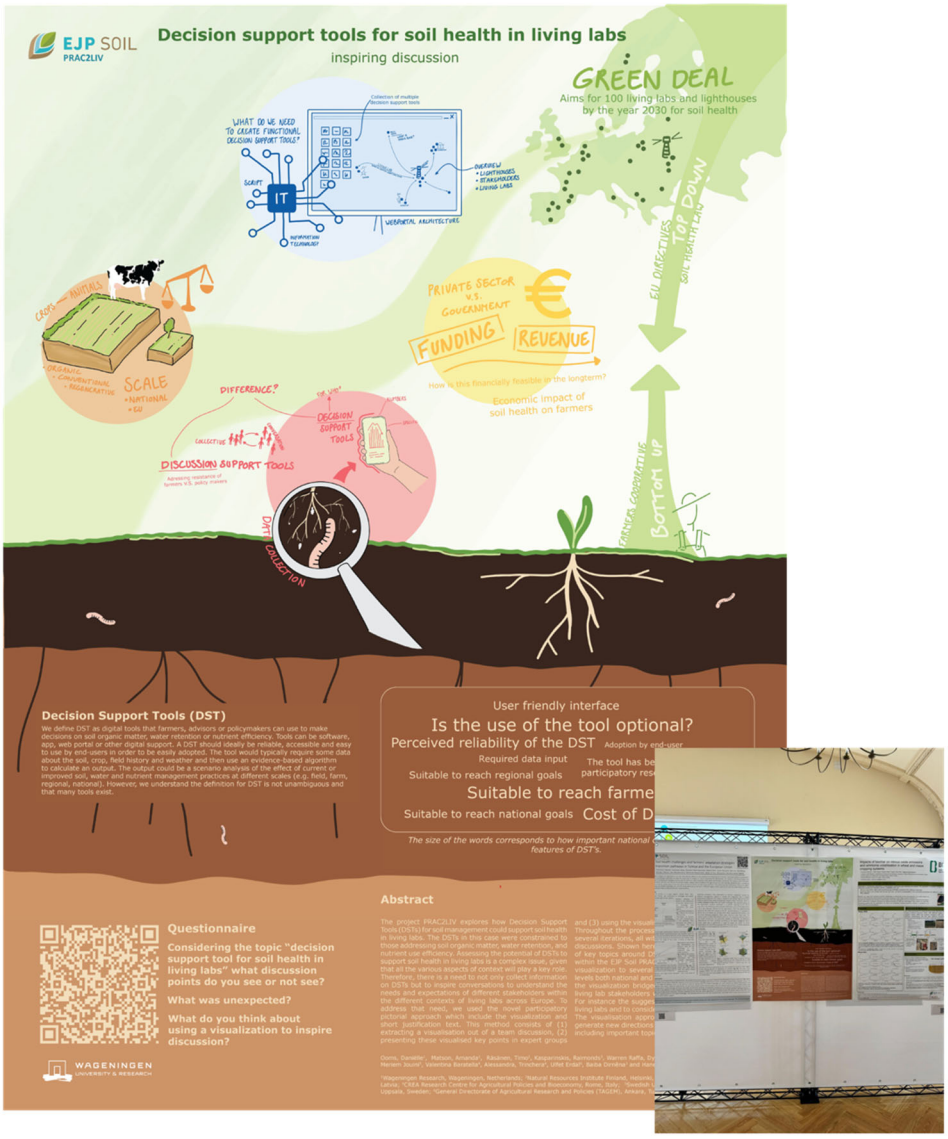

FIGURE 7. POSTER PRESENTED DURING THE EJP SOIL ANNUAL SCIENCE DAYS IN VILNIUS; INSERT: PICTURE OF THE SETTING DURING THE POSTER SESSION.

At first it did seem to be a misfit, this visualization among all the scientific posters with elaborate data. However, it turned out that the poster was received by many as a refreshing and an inspiring take on the topic of soil health. It ignited conversations on how to communicate among scientist and reach out to a broader audience. "*This week I could not follow a presentation due miscommunication about a word, had I seen a picture of it I would have understood immediately*" was one of the comments made by a participant. It did not only inspire people to talk about it, but some even turned it into action. A participant transformed her presentation in a visually appealing stop motion video made from sketches.

The poster presentation at the EJP soil Annual Science days, the conversations with peers and their feedback led to the final version of the drawing (Figure 8). A figure explaining "soil health and ecosystem services" from the EJP Soil-project SIREN (Faber et al., 2022) was included.

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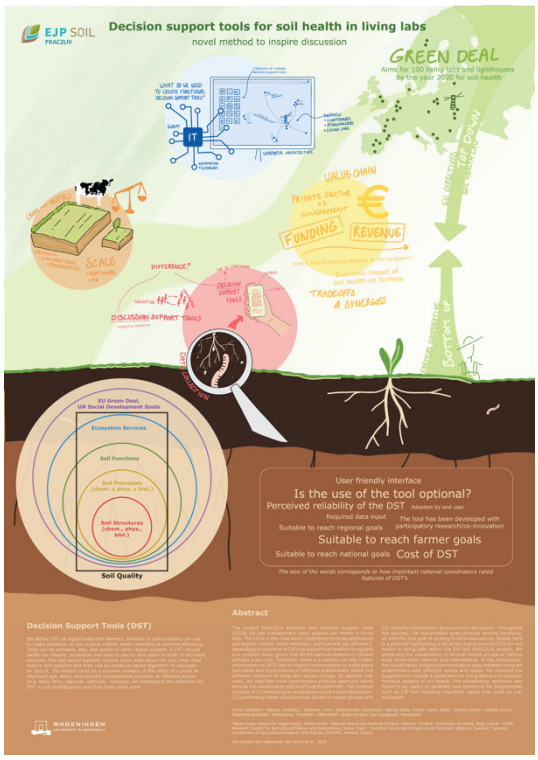

FIGURE 8. FINAL VERSION OF THE VISUALISATION IN A POSTER FORMAT.

The results of the activity to use a participatory method for developing ideas about “DSTs for Soil Health in Living Labs”, including the visualization, explanatory text, and user guidelines, which will be submitted as “short communication’ for publication.

8. Conclusions

8.1 Workshops

Soil nutrient management was the most common objective for using a DST and also often the most common type of DST. In contrast to this, the main soil related challenges were usually related to other things, such as soil organic matter, soil compaction or water management. Maybe that was not as big a challenge, as it already could be solved with functioning DSTs and often has to do with simpler decisions such as how much and when to fertilize. Decisions to improve or sustain soil properties may be more complex.

The main barriers for using DSTs identified were 1) Expensive technology and not enough economic resources for adoption 2) Not enough user-friendly technology and lack of technical support and 3) old generation sticking to traditions. The suggested solutions to break these barriers were 1) to have positive demonstrations by experienced farmers without economic interests in the tool 2) give financial and technical support for implementation and 3) provide simplified data-entry and tools that all generations can understand.

Farmers would like to be able to easily access and incorporate data from different data sources. They want tools to be transparent in the way that the user knows what is behind the recommendations and if they are valid for their type of farm, soil and climate. The tools should be easy to use and with available support. Many tools would benefit from being available both in a computer version and in an app. In that way those that have the time and skills for it may modify and accustom the settings in the office, while everybody can easily access it in a quick mode in an app version in the field. The app version should have access to all field information when quick decisions are needed, or plans need quick updates due to new conditions in the field.

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8.2 Participatory design "DSTs for Soil Health in Living Labs"

The novel participatory design method was unfamiliar for most of the contributing members of PRAC2LIV and involved participants. This novelty brought both confusion and excitement. When using this novel method, the project team should adjust their introduction and desired outcome of the session to the target audience including when to present which state of the development. Once introduced properly the method can serve as a useful additional research tool for conceptual ('vision') data collection and interpretation. The creation of the visualisation can steer and clarify the research direction along the process within the team while the visualized outcome has communication purposes to a broader audience. A visualization can be seen as more inspirational than written reports and therefore could accelerate the development of a common vision on complex matters such as soil health in living labs in the EU. Next steps could be the formulation of an IT-architecture that accounts for the aspects of, e.g. farming systems, scale-levels, and economics, matching selected quality criteria for the desired DST/webportal.

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Fostering soil management PRACtices and uptake and developing decision support TOols through LIVing labs in EU (PRAC2LIV)

Report from Workshop in Sweden

Jönköping

2023-11-27

Introduction

This workshop is a part of the project PRAC2LIV, which is one of several projects within the European Joint Programme on Agricultural Soil Management (EJP Soil) aiming at fostering adoption of support tools. Other parts of the project PRAC2LIV involve making a stock-take of Decision Support Tools (DSTs) that focus on soil organic matter (SOM), water retention, and nutrient use efficiency as currently used by EJP Member States. The objective with this workshop was to communicate results from the stocktake with stakeholders in Sweden in order to validate the results and to discuss what steps are needed to get a successful implementation of tools that will improve sustainable soil management. Similar workshops will be conducted in other parts of Europe during the remaining project period.

Material and methods

Invitation of participants

Three experienced and interested farmers' advisors representing three different advisory organisations in the northern Götaland region in Sweden was invited and asked to invite a few farmers each, which they considered could be interested in discussing development of decision support tools. In addition, some representatives for organisations providing DSTs and some researchers working with related research were invited. In the end there were in total 22 persons (three advisors, eleven farmers, four representatives for DST providers and four researchers (including two facilitators)) that signed up for the workshop. One of the advisors got ill and had to cancel and all other turned up.

Figure 1. Location of the Venue and the area in Sweden where the advisors and farmers were coming from.

The workshop took place on the 27th of November 2023 at a hotel in Jönköping, Sweden. Part of the program was performed in one common room, and group discussions in three separate rooms. Coffee and lunch was served in the hotel restaurant.

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Program

The program consisted of three main sessions including 1) introduction and presentation of stocktake results, 2) group discussions and 3) presentation from and discussion with DST providers (Table 1).

Table 1. Workshop schedule

9.30	Coffee
10.00	Introduction - Introduction of participants and workshop objectives
10.20	Results from Stocktake in Europe and Sweden - Which tools are used where and how well does it work?
11.00	Short break
11.10	Group discussions - What tools are used? - Need for improvements? - What is missing?
12.00	Lunch
13.00	News from DST providers (GREPPA, Yara, Dataväxt, Hushållningssällskapet)
14.00	Short break
14.10	Summary of the day
14.30	Coffee

Group discussions

For the group discussions, the participants were divided into three groups with 6-7 participants in each out of which there were 3-4 farmers, 1-2 DST providers, 1 researcher and 1 advisor. Before joining the groups, each participant was asked to write down on a piece of paper 1) what feature is crucial for me to implement a certain DST and 2) what feature would stop me from using a DST despite its benefits. These notes were brought to the group discussions. During the group discussions, the participants were asked to:

1. Rank together what are the most important features of a tool
   - It doesn't require much information from me
   - It has a user-friendly interface
   - The decision support delivers results that are easy to apply in real time
   - The results are reliable and based on science and calibration on farms in the area
   - Easily accessible both in terms of cost and hardware requirements
   - It has clear visualization of results
   - The design is developed in collaboration with users
2. Discuss the following statements and why you may agree or disagree
   - All tools should have an app for a smartphone
   - In addition to plant production and soil quality, tools should also provide information on environmental impact
   - Tools must be flexible and take into account actual weather conditions
3. Discuss what features you miss in DSTs that you currently use
4. For what decisions are tools missing but needed?

Documentation

One researcher or advisor in each group took notes during the group discussions and one of them also during the common session. Photos were also taken and short interviews filmed with three of the stakeholders. Some input from participants were collected by letting them write individual answers on post-it notes that was saved and summarized afterwards.

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Communication

In addition to a personal invitation, each participant received a flyer with a brief description of the workshop. We also communicated during the workshop the general objective of the EJPsoil and Prac2liv projects, the results of the questionnaires from national coordinators and farmers in Sweden and other European countries involved in the project, in order to share the main results and integrate them into the process. For a wider audience, we plan to publish a press release and a newsletter on the SLUs web page. Additionally, we used photos and short films to document the various workshop activities and to share the experience with different stakeholders. For the workshop in Sweden, we conducted interviews with some of the participants, farmers and experts, about their personal experiences with decision-support tools, difficulties and opportunities. Similar short films will be made for other workshops in the countries involved in the Prac2liv project. All these materials will then be used to create a film that summarizes the process of the various workshops and highlights the different activities carried out as part of the project.

Results

Objectives with Decision support tools

When asked to mention the objectives with using a decision support tools, most farmers referred to objectives related to fertilization (Table 2), such as prediction of optimum fertilization rates. But several of them also mentioned soil moisture related objectives, both concerning how to keep a soil structure that enable favourable soil conditions and advice on when it is time to irrigate (Table 2). One farmer also mentioned getting a clearer strategy for improved organic matter content. The advisors also mentioned objectives in another sense, i.e. that the incentive to use them is for improved profitability, to facilitate daily work, to help comply with regulations and for long term planning.

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Table 2. Participants were asked to write down what the main objective with using a DST was. Answers are sorted by their profession.

Farmers	DST providers	Advisors	Researchers
• Know optimal fertilization • Distribution of fertilizers between fields • Detect deficiencies in nutrients, pH, humus content, etc • Choose the right type of fertilizer economically and nutritionally based on current price and needs • Estimation of soil N mineralization at field level via, for example, satellite images • Plant nutrient efficiency Increased profitability/harvest, minimize inputs, optimize production • Follow-up of plant development • Choose the right tillage for optimising soil moisture based on the season • Keep an eye on soil compaction and water content • Optimizing soil moisture • When it is justifiable to irrigate • When to irrigate? • Clearer strategy for improved soil organic matter content	• Measure efficiency in production • Optimum nitrogen supply for the field and the year per application	• Plant nutrition; Need for top dressing, Distribution within the field • Fertility: SOM content, soil structure • Improved profitability • Facilitate daily work • Comply with regulations • Long-term planning	• The yield potential with a certain soil • Optimum harvest time for ley • Yield forecast in different crops during the season

Soil related challenges

When the farmers were asked what their main soil related challenge was, they mentioned soil compaction, soil organic matter and water availability (Table 3). The DST providers on the other hand instead mentioned other challenges more related to fertilization.

Table 3. Participants were asked to write down what they considered was the main soil related challenge is in their area. Answers are sorted by their profession.

	Farmer	Advisor	DST provider	Researcher	Total
Soil compaction	3	1		1	5
Soil fertility			1		1
Climate adaption			1		1
Nitrogen efficiency			1		1
Soil organic matter	2				2
Water availability	2				2

Decision support tools in Sweden

During the workshop introduction, the decision support tools (DSTs) reported for Sweden in the European stocktake were presented. Seven of them concerned water, two soil organic matter and nine nutrient efficiency (Table 4, DST 1-15). The workshop participants added another two DSTs about water and five about nutrient efficiency (Table 4, DST 16-22).

Table 4. Digital DSTs used in Sweden, where 1-15 were included in the European stocktake and 16-22 were added by workshop participants.

1	Water	Vattennivå i brunn	A real-time ground water monitoring system for water level in wells with app.

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2	Water	Raindancer	Irrigation management and monitoring system with app.
3	Water	Soil Moisture Sensor	Soil moisture sensor system for real time- monitoring.
4	Water	P-T Soil Station service	Real-time monitoring system for soil conditions.
5	Water/SOM	Hur mår min jord?	An application on soil properties for improving soil quality
6	SOM	Odlingsperpektiv	Advisory service with simulation of humus content.
7	Nutrient efficiency	Atfarm	fertilization maps from satellite images
8	Nutrient efficiency	Yara N-sensor	fertilization from sensor measurements
9	Nutrient efficiency	CropSat	fertilization maps from satellite images
10	Nutrient efficiency	Kvävevågen	N fertilization to winter oilseed rape
11	Nutrient efficiency	Gödselkalkylen	compare different fertilization strategies of manure
12	Nutrient efficiency	Vera	Nutrient balance
13	Nutrient efficiency	Växtnäringsbalans på nätet	Nutrient balance, web based
14	Nutrient efficiency	Yara Växtnäringsberäkning	field balance of nutrients
15	Nutrient efficiency	Yara Checkit	Help to identify nutrient deficiency symptoms in various crops
16	Water		
17	Water		
18	Nutrient efficiency	Soyl	Partly satellite image based tool for soil and fertilization mapping. Easy to use and good for quantity management of fields.
19	Nutrient efficiency	Solvi.ag	Drone-based tool that can also make fertilization maps
20	Nutrient efficiency	Dataväxt	Software for planning of crops including several tools for fertilization
21	Nutrient efficiency	Näsgård mark	Software for planning of crops including several tools for fertilization
22	Nutrient efficiency	Markkartering.se	Website to present soil maps and calculate fertilization maps

Group discussions

One of the topics discussed in the group discussions were how current tools could be improved. The discussions concerned several aspects such as 1) available technical support and network of other users to exchange experiences with, 2) transparency of what is behind the calculations of recommendations, so that the user can judge whether it is calibrated for the circumstances at his/her farm and 3) possibilities to influence the settings of the calculations (Table 5).

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Table 5. In the group discussions, suggestions for improvements in currently used tools were suggested.

Group 1	Group 2	Group 3
- Tools that do not have good support are not good - Good with group discussions/exchange of experiences (possibly online) to update yourself before the season	- Yara N-tester: The recommendation it gives for N top dressing to reach optimal protein content of 11.5% has been developed based on trials with current varieties. Better info on how it is calibrated and that no price ratio is needed. Also applies to other tools, Better if you have an understanding of what lies behind the tool...	- CropMap: We would like to 1) be able to influence interpolation, i.e. control the data resolution and to what degree the variation between measurement points should be smoothed out. 2) draw own field boundaries and 3) have automatic selection of reliable satellite images that do not have clouds.

There are already many well functioning tools for fertilization (Table 4), but they are mainly developed for winter wheat and to some extent adapted a few other cereals. In one of the groups, it was discussed that it would be useful if there were similar tools available also for other crops, if possible by calibrating the ones already available (Table 6).
Soil compaction is a great challenge for many farmers (Table 3), especially if they rely on heavy machinery and have their land on clay soils with limited drainage. In one group, they concluded that it would be useful with a tool that helps to evaluate how soil structure may be affected by different measures in different situations (Table 6). The same group also would like a tool to evaluate how different measures affect soil organic matter content, carbon storage and soil fertility. There is one such tool available already (Table 4), but it is very complicated and is only reasonable to use together with an advisor who had time to learn how it works. Another group raised that soil maps showing variation in SOMn could also highlight areas with SOM below a recommended threshold and/or areas with a trend of reduced SOM content, where they need to put in measures to improve levels or break the falling trend.

Table 6. In the group discussions, suggestions were given for what type of decisions for which tools needed but missing

Group 1	Group 2	Group 3
- Tools for plant nutrition in more crops. There are no targets and target values for many crops in various stages of development. - Better weather forecasts	- Soil structure, a tool that rates what damage different measures may do to soil structure - SOM content is also uncertain as to what effect you get with different measures... - Tools for effect on carbon storage and fertility	SOM content: Indication on the SOM content map where levels are too low and measures are required and which measures that can be useful.

From the discussion made from different statements (Table 7), it was clear that nobody thinks that it is not mandatory that all tools have an app for smartphones. Still, some thought that many tools should and it was clear that it is very appreciated to have it in an app, since the phone is always with you. The farmers find that being able to make quick decisions with all field data easy available at all times in their phone is a big advantage.
Regarding if tools should always consider environmental aspects on top of the economical, there was a concern that adding too many features to the same tool may make it unnecessary complicated with the risk that it would slow down the process of getting it accurate enough with reliable outputs.
Weather is a very important factor for many decisions, but not all and it is often rather unpredictable. When weather is a known and important factor it is good if the tool has the flexibility to include that as a factor.

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Table 7. Short notes from group discussions made from different statements.

Statement	**All tools should have an app for a smartphone**	**In addition to plant production and soil quality, tools should also provide information on environmental impact**	**Tools must be flexible and take into account actual weather conditions**
Group 1 comments	- No, it depends on what kind of tool it is	- No, it depends. Can slow down development of the tool if it is not focused enough	- Flexibility is important, but not always weather.
Group 2 comments	- Depends on how quickly you need the answer/ what you need it for...	- Not clear how different management affect the environment. Must be better defined....It is the buyers who define what should be done for measures for environmental labelling and the market then decides whether they want to pay extra....More information about what is behind the additional payment is desired, so that you can be motivated to do the measure for that reason in addition to the extra payment you get.	- yes
Group 3 comments	- Yes, often, but of course it depends on what the tool is about.	- Can make the tool unnecessarily complicated.	- Good when they can, but difficult to get reliable weather forecasts.

None of the three groups chose to rank the whole list of characteristics (Table ??), but all selected a few characteristics they agreed in the group was especially important. All three groups ranked "Reliable results based on science and calibration on farms in the area" as very important. On top of that they wanted the tools to be flexible, easy to use and apply in real time. Considering the flexibility versus the simplicity, one group wanted to divide the tools in two parts:

1. One part for planning where you dig into more information when you have time. This could be a flexible software in the computer used in the office for planning during winter.

2. A second part which can be quickly and simply applied in real time when you sit in the tractor. This could be an easy-to-use app for a smartphone that has access to the information you entered earlier in the software. In the app there should also be default values available for those who did not yet enter their own data in the software.

Table 7. The groups were asked to rank important characteristics from a list, but all chose to list the top 2-3 characteristics without ranking in-between them.

Group 1	Group 2	Group 3
- Results are reliable and based on science and calibration on farms in the area. - Easy to use = good support	- User friendly and based on science and calibration on farms in the area	- The decision support delivers results that are easy to apply in real time

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- Flexible and possible to adapt based on the situation	- Don't demand so much from me - Easily accessible, The cost, Free fast help/service	- The results are reliable and based on science and calibrations on farms in the surrounding area

Comments during presentations from DST providers:
To Dataväxt: We would like to be able to combine images from several years, for example be able to show three yield maps and combine them into a fourth which would be an average of several years can be useful as an estimate of harvest potential.

Summary of what all groups would like from coming DST development:

- Transparent tools where you understand what lies behind
- Available support
- That it is possible to get answers quickly when needed, without having to press a lot of buttons and give large amount of data input, at the same time that you have the opportunity to influence settings etc. when you have time.
- That it is possible to access the tools and previous documentation anytime and anywhere, preferably via an app in the phone.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 862695

Workshop in Latvia

Introduction

This workshop is a part of the project PRAC2LIV, which is one of several projects within the European Joint Programme on Agricultural Soil Management (EJP Soil) aiming at fostering adoption of support tools. Other parts of the project PRAC2LIV involve making a stock-take of Decision Support Tools (DSTs) that focus on soil organic matter, water retention, and nutrient use efficiency as currently used by EJP Member States. The objective with this workshop was to discuss what steps are needed to get a successful implementation of tools that will improve sustainable soil management. Similar workshops will be conducted in other parts of Europe during the remaining project period.

Material and methods

Invitation of participants

Various farmers' organizations and cooperatives were approached and asked to spread information about the workshop to their stakeholders. In addition, the current EJP stakeholders and their represented organizations, which have already participated in similar seminars in the past, were addressed. Representatives from various Latvian DST distributor companies were purposefully sought out in order to ensure multifaceted involvement of people in the seminar discussions.

In the end there were in total 23 persons (two advisors, two farmers, four representatives for DST providers, nine researchers (including four facilitators), two farmer union representatives and four policy makers) that signed up for the workshop. Eight participants (including four farmers) cancelled last minute due to the early start of farming spring season, illness or scheduling conflict.

Venue

The workshop took place on the 15th of March 2024 at the University of Latvia, Latvia. The whole program was delivered in common room. Coffee and lunch were served.

Program

The program consisted of three main sessions including 1) introduction and presentations from facilitators, 2) presentation from and discussion with DST providers and 3) group discussions (Table 1).

Table 1. Workshop schedule

Registration and coffee

- Introduction
    - Presentation about the workshop and the EJP SOIL research program
    - Presentation "Risks of soil degradation in agricultural lands in the European Union and Latvia''
    - Presentation “Decision support tools/instruments for sustainable soil management of agricultural lands”

Lunch break

- Presentation “Digitization in plant fertilization. Yara tools.”

- Group discussion “Decision-making support tools/instruments in the aspect of the efficiency of the use of organic matter, water retention and nutrients of agricultural lands in relation to the reduction of soil degradation risks”
    - What decision support tools or instruments are used in Latvia?
    - What are the requirements for using decision support tools?
    - What limits the application of decision support tools? How do stakeholders manage without decision support tools?
    - What methods and sources of information are used and replace specific decision support tools?
    - What else would be needed for the fuller use of the existing decision support tools in Latvia?
    - What problems would you need decision support tools to solve but are not currently available? What would be the proposals for their implementation?

Summary of the day

Group discussions

During the group discussion, the participants were invited to express their opinion both in writing and in an open discussion. In writing, the participants were asked to:

1. Rank together what are the most important features of a tool
   - It doesn't require much information from me
   - It has a user-friendly interface
   - The decision support delivers results that are easy to apply in real time
   - The results are reliable and based on science and calibration on farms in the area
   - Easily accessible both in terms of cost and hardware requirements
   - It has clear visualization of results
   - The design is developed in collaboration with users

2. Discuss the following statements and why you may agree or disagree
   - All tools should have an app for a smartphone
   - In addition to plant production and soil quality, tools should also provide information on environmental impact
   - Tools must be flexible and take into account actual weather conditions

Open discussions were used to determine what stops farmers from using more DSTs in Latvia, what are the alternative means used in farming, how to make usage of DSTs in Latvia more popular and what would be the suggestions for future DSTs.

Documentation

One UL researcher took notes during the group discussions. Photos and videos were also taken and short interviews filmed with four stakeholders. Some input from participants were collected by letting them write individual answers on post-it notes that was saved and summarized afterwards.

Results

Table 2. Participants were asked what the main objective with using a DST was.

- First of all, nitrogen fertilization doses, in order to save money and not fertilize fields unnecessarily.
- Soil agrochemical analyses to monitor the general condition of the field, but also because regulation requires it.
- Soil pH to plan initial and repeated liming and to be able to apply for support.
- GPS systems to bypass obstacles and accurately draw boundaries between fields.
- To follow the development of the crop and the health of the plant.
- To improve the efficiency of work volume planning.

Table 3. Participants were asked to write down what they considered was the main soil related challenge is in their area. Answers are sorted by their profession.

	Farmer	Advisor	DST provider	Researcher	Policy makers and farmer union representatives	Total
Soil compaction			1			**1**
Soil fertility	1		1	1		**3**
Soil erosion		1		1		**2**
Soil organic matter	1	1		4	3	**9**
Acidification			2	1	1	**4**

Table 4. Participants were asked to name DSTs available in Latvia (including all information sources that could be used as DSTs even without special program or phone app).

- Agriport.com tools for fertilization
- Linasgro tool for fertilization
- YARA atfarm tool for fertilization
- the electronic system of the national rural support service and available fertilization plans
- LVMGEO app which contains data layers and maps of agricultural land geospatial information
- ONESOIL app for precision agriculture
- NEXTFARMING digital system
- JDlink digital system
- Precision livestock feed ration calculation systems
- Local weather stations that provide farmers with up-to-date, local weather information

- Manual tools and sensors - Agrochemical analyses - Warning systems for the spread of diseases and pests from Latvian Plant Protection Research Centre Comment was made that these are only few of the DSTs that farmers use, because these are the ones that participants of this particular workshop know about. The problem in Latvia is that the marketing for DSTs is quite bad so there might be a lot of tools that farmers simply do not know about. The circulation of information should be improved on the level of education. Advisors should have the newest information about the newest tools that are out there.

Table 5. Participants were asked, what is the reason why farmers would not use common DSTs (programs, apps) and what would be the means to make usage of DSTs more popular?

Barriers to using DST	• **Finances** - precision agriculture technology is expensive and it is necessary to periodically update the license, although there are various tools that do not require excessively large investments, there is an opinion among farmers that the introduction of new technologies requires a large financial investment, which may or may not pay off. • **Knowledge and human resources** - It takes time to learn all the possibilities offered by a new technology, as well as to adapt to the successful use of the technology and see results. This time depends on the farmer's education level as well as his age. For older farmers, mobile apps and computer programs are not self-evident, everyday things, so it takes longer to learn them and additional specialist help and initial supervision in order to properly use the offered aids. A lot of DSTs are just too complicated, the input information and the results are difficult to understand and they are not comfortable or easy enough to use in every day farming. • **Technical support** – many apps require specific operating systems and not all farmers have the same technological support. For example, a smartphone is a technology that many people think is an unnecessary extra, but it is necessary to operate a large number of available DSTs. There are also differences between iPhone and android systems and older model PCs and laptops. • **Traditions** - Latvian farmers have a long history and farms are often passed down from generation to generation. Along with this history,

	agricultural traditions have been preserved and passed down. These traditions are often regularities between the weather, the visual characteristics of the crop, the mutual influence of neighbouring plants and the agrochemical information of the soil. Putting all this information together, farmers can predict the result themselves. If a farmer has this traditional knowledge, they do not see the point of geospatial information, which is the only aspect that DST programs and apps add to the decision making. Many farmers, especially smaller ones (up to 150 - 200 ha), do not see the benefit of using DST and often do not trust the decision made by DST or worse – AI.
Solutions	• **Positive demonstrations** - farmers trust only other farmers who can honestly and without personal gain tell about their experiences (both good and bad) and demonstrate the tool in action or, on the contrary, warn about spending unnecessary financial resources. For this reason, demonstration farms are the best means of promoting the use of DST in agriculture. • **Financial and technical support**. • **A simplified tool** that all generations can understand. • **Time itself will put farmers in place** - the increase in the prices of materials (fertilizers, seeds, etc.) will drive them to use DSTs, because the use of mineral fertilizers and other products will have to be rationalized.

Table 6. In the group discussion, alternative methods for DSTs were discussed.

- Traditions and education – knowledge and ability to make decisions based on available information, passed down through generations and proven to be effective.
- Experience, both my own and that of other farmers - making observations and drawing conclusions based on available information both in nature, on the Internet, and in consultations with a neighbour.
- Consultations – Advice from professional people to find the best solution for the given situation.
- Support from agricultural organizations - seminars and available information on the website.

Table 7. Short notes from discussions made from different statements. The results were sorted by profession.

Statement	**All tools should have an app for a smartphone**
Farmers	Yes! Everything should be in one program, but the most important functions should also be available in the phone app, so that the farmer can be mobile.
DST providers	Farming is too complicated to manage from a smartphone; only certain operations are possible in a phone application. As one of the variants of the respective DST, there can also be a mobile variant. However, it is more convenient to work on a larger screen.
Advisors	No, maybe some functions should also be on a smartphone, but in principle no.
Researchers	• Not always, because other databases and programs are more easily available on the computer, which can help in deciding at the same time. • For those that can only be used in the field, yes, because it is currently the most convenient way to use and easy to use anywhere, however, it is easier to work with data on a computer.
Policy makers and farmer union representatives	Agree, because it makes farming easier, saves time. It allows for real-time changes, allowing important information to be preserved, but the application cannot be assumed to be the only control tool.
Statement	**In addition to plant production and soil quality, tools should also provide information on environmental impact**
Farmers	Yes, agree! Each activity must be directed towards some result or contribution.
DST providers	Yes, because no farmer wants to harm the environment. But you also don't want to be misled by pseudo-science from environmentalists, but such information would be useful if it has a solid scientific base.

Advisors	Yes, it makes sense.
Researchers	• Yes, and for profit as well. The economic factor is also a very important aspect. Mandatory, considering EU requirements for water, soil and air protection. It would be educational and actionable. • No, it should already be built into the algorithm that gives advice to the farmer.
Policy makers and farmer union representatives	• Agree, because it is important to know how my methods affect the environment, and therefore society. As well as this would be desirable, considering the challenges of the future. • An important awareness-raising function, enabling improved reporting of environmental information. The problems of environment and ecosystem services have become more and more relevant, it is better to address them in time.
Statement	**Tools must be flexible and consider actual weather conditions**
Farmers	Yes, of course!
DST providers	Definitely!
Advisors	Yes, it shows the professionalism of the tool and the point of using it at all.
Researchers	• I definitely agree - farmers are greatly influenced by the weather and the more detailed the data in real time, the better the conclusions and the better the decisions. However, how realistic is it to ensure high accuracy. This information may not be of much importance as all tools may have +/- errors. • I agree, the tool should be adapted to the existing situation at the place of use.
Policy makers and farmer union representatives	Agree, because weather is one of the important factors, especially for local weather. However, are there sufficiently accurate weather forecasting tools?

Table 8. The participants were asked to rank important characteristics from a list, for better presentation of results, it was decided to report the most important feature and the least important feature from each participant. The results were sorted by profession.

Farmers	Most important	– Easily accessible both in terms of cost and hardware requirements – The decision support delivers results that are easy to apply in real time
	Least important	– It has clear visualization of results – It doesn't require much information from me
DST providers	Most important	– The results are reliable and based on science and calibration on farms in the area – The decision support delivers results that are easy to apply in real time
	Least important	– Easily accessible both in terms of cost and hardware requirements – The design is developed in collaboration with users
Advisors	Most important	– Easily accessible both in terms of cost and hardware requirements – The results are reliable and based on science and calibration on farms in the area
	Least important	– It has a user-friendly interface – The design is developed in collaboration with users
Researchers	Most important	– The results are reliable and based on science and calibration on farms in the area – Easily accessible both in terms of cost and hardware requirements – The decision support delivers results that are easy to apply in real time
	Least important	– It doesn't require much information from me – It has clear visualization of results – The design is developed in collaboration with users – It has a user-friendly interface

Policy makers and farmer union representatives	Most important	– The results are reliable and based on science and calibration on farms in the area – Easily accessible both in terms of cost and hardware requirements – The decision support delivers results that are easy to apply in real time
	Least important	– The design is developed in collaboration with users – It has a user-friendly interface – It has clear visualization of results

Summary of what all participants would like from coming DST development:

All the functions of the separate tools are combined into one multifunctional tool, but this is not possible because there are too many actors involved in the DST business and each actor has their own goals and desires, so it is impossible to successfully combine them.

This tool should synchronize with a database shared by all institutions and research centres involved in agriculture. In this database, the latest information from the whole country would be available, therefore it would be relevant throughout Latvia and it would be possible to select specific and relevant information for each farm locally. A tool that is designed and calibrated for one region does not work as well in other completely different regions, so a tool that uses versatile and up-to-date information is needed. Only when the problems with the basic information and reliability of the tool are solved, one can think about its interface and technological simplicity.

Fostering soil management PRACtices and uptake and developing decision support TOols through LIVing labs in EU (PRAC2LIV)

Report from Workshop in Italy

Virtual Workshop

“Promozione di strumenti di supporto alle decisioni (DST) per l'incremento della sostanza organica, la ritenzione idrica e l'efficienza d'uso dei nutrienti nel suolo”

2024-04-10

Introduction

This workshop was carried out within the participatory activities of the European project EJPSOIL-PRAC2LIV, one of the projects financed by the Joint European Program on Agricultural Soil Management (EJP Soil), which aims to promote the adoption of support tools in agriculture. One of the activities of the PRAC2LIV project involves making a stock-take of Decision Support Tools (DSTs), currently available or already used in Member States, focusing on soil organic matter (SOM), water retention and nutrient use efficiency. The objective of this workshop was threefold: (i) to share the results of a preliminary questionnaire, already submitted to EU experts, (ii) to broaden the experience on DTS by involving conventional and organic farmers, consultants, and technical assistance, and (iii) to refine and validate the results obtained, in particular to identify the future steps needed to achieve a successful implementation of tools that will improve the sustainable management of organic agrosystems in the long term. The participation of a researcher from EJPSoil CarboseqC further assured a joining action among EJPsoil projects.

Material and methods

Invitation of participants

The PRAC2LIV workshop was held on 10th April 2024 in mixed modality (in presence and virtually, by Teams platform), since Italian farmers and farm advisors preferred to guarantee their presence at the proposed training (presentations) and participatory (open discussion) activities without leaving their fields in spring. The event, organized by CREA, was supported by Federbio (one of the main Italian organic farmer associations: https://feder.bio/) and OpenFields (private association of consultants, working on innovation in agri-food systems such as with Barilla® group: https://www.openfields.it/). It was held in Italian and opened to advisors and both conventional and organic farmers. Hereafter, the leaflet of the PRAC2LIV Workshop:

FEDERBIO crea

Virtual Workshop PRAC2LIV

EJP SOIL PRAC2LIV

Promozione di strumenti di supporto alle decisioni (DST) per l'incremento della sostanza organica, la ritenzione idrica e l'efficienza d'uso dei nutrienti nel suolo

10 aprile 2024

Ore 10.00-13.00

Il progetto europeo EJPSOIL *"Fostering soil management PRACtices and uptake and developing decision support TOols through LIVing labs In EU* (PRAC2LIV)" intende promuovere l'adozione di strumenti di supporto alle decisioni (DST) nell'agricoltura europea, con l'obiettivo di incrementare nei suoli agricoli la sostanza organica (SOM), la ritenzione idrica e l'efficienza nell'uso dei nutrienti.

Gli obiettivi di questo workshop sono: i) comunicare i risultati di un preliminare questionario, sottoposto ad alcuni esperti in Italia ed in Europa, sull'uso dei DST, ii) rappresentare casi di utilizzo virtuoso di DST in Italia, condividendoli con le esperienze degli agricoltori e degli assistenti agricoli (produzione convenzionale e biologica), iii) identificare quali passi sono necessari in futuro per ottenere un'implementazione di successo di tali strumenti per una gestione sostenibile degli agrosistemi biologici a lungo termine.

Comunicare l'adesione al seguente link entro il 9 aprile:
https://forms.gle/X5XzHwJ3dLYVZLF8

Per partecipare, connettersi al seguente link Partecipa alla riunione ora

Per informazioni, contattare: valentina.baratella@crea.gov.it

FEDERBIO crea

Programma

Sessione 1
Presentazioni
(Ore 10.15-11.15)

Saluti e apertura dei lavori - Alessandra Trinchera, CREA (*convener*)

- Gli obiettivi del progetto PRAC2LIV - Alessandra Trinchera, CREA
- Sistemi di supporto alle decisioni; vantaggi e potenziali rischi - Roberta Farina, CREA
- Sistemi di supporto alle decisioni in agricoltura: la parola agli esperti europei - Dylan Warren Raffa, CREA-
- Utilizzo pratico di un sistema di supporto alle decisioni su grano tenero – Paolo Pizzocheri, OpenFields

Sessione 2
Attività partecipata (modalità "*virtual* café")
(Ore 11.15-12.30)

Saranno formati 2/3 sottogruppi, ognuno rappresentativo della comunità multi-attoriale presente (agricoltori, consulenti, assistenza tecnica, ricercatori), che si riuniranno in camere virtuali, ai quali verranno poste alcune domande, tra le quali:

1) Hai mai avuto l'opportunità di utilizzare un DST? Se sì, che tipo di DST?
2) Sequestro del carbonio, gestione dell'acqua ed efficienza nell'uso dei nutrienti: per quale di questi argomenti ti piacerebbe avere un DST?
3) Che tipo di DST ritieni possa essere maggiormente utile per la gestione sostenibile delle risorse nei sistemi produttivi di tuo interesse?

I gruppi avranno 30 minuti per rispondere al questionario e confrontarsi in merito alle risposte. Ogni gruppo nominerà un proprio rapporteur, che dovrà relazionare sulle risposte raccolte. Al termine dei 30 minuti, i gruppi si riuniranno nella stanza principale ed i rapporteur descriveranno i risultati del "virtual café".

Sessione 3 – Sintesi e conclusioni
(Ore 12.30- 13.00)

- Sintesi dei risultati emersi e eventuali domande aperte
- Conclusioni e chiusura dei lavori

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Farmers/consultants involvement

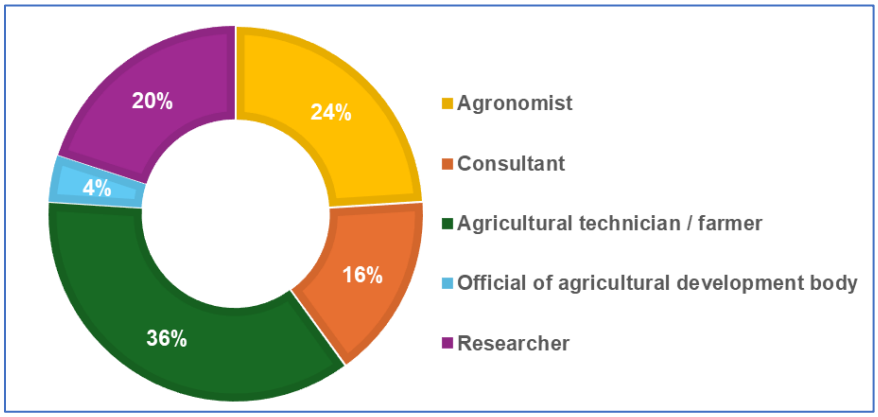
Each participant to the workshop was invited to provide:

- Name
- Surname
- Affiliation (facultative)
- Profession [- 1) researcher; 2) farmer; 3) consultant/assistant; 4) other]
- E-mail contact
- Approval for the use of supplied information and workshop pictures

Participants to PRAC2LIV IT Workshop

On 9th April, twenty-six participants were registered.
The distribution of participant' professional skills is reported il Figure 1.

Figure 1. Professional skills of participants to PRAC2LIV IT Workshop



In Figure 2, a photo of participants to Italian PRAC2LIV workshop – 10th April 2024.

Figure 2. Participants to PRAC2LIV IT Workshop

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 862695

IT Workshop - Groups discussion

The IT workshop was structured in two sessions:

Session 1 – Information about PRAC2LIV and DST

- Objectives of PRAC2LIV project (Alessandra Trinchera, CREA - EJPSoil PRAC2LIV)
- Advantages and risks using DST (Roberta Farina, CREA - EJPSoil CarboseqC)
- European results from PRAC2LIV questionnaire (Dylan Warren Raffa, CREA - EJPSoil PRAC2LIV)
- Example of a decision support system utilization on soft wheat (Paolo Pizzocheri, OpenFields consultant).

Session 2 – World Café - groups discussion

- Two multi-actor groups, representative of farmers, consultants, agronomists, researchers, etc. were generated and divided into two separate virtual rooms, and asked to answer to the following four questions (Q):
-

  Q1. What are the most important features of a DST
  - It doesn't require much information from me
  - It has a user-friendly interface
  - The decision support delivers results that are easy to apply in real time
  - The results are reliable and based on science and calibration on farms in the area
  - Easily accessible both in terms of cost and hardware requirements
  - It has clear visualization of results
  - The design is developed in collaboration with users

  Q2. Discuss the following statements and why you may agree or disagree
  - All tools should have an app for a smartphone
  - In addition to plant production and soil quality, tools should also provide information on environmental impact
  - Tools must be flexible and consider actual weather conditions

  Q3. Discuss what features you miss in DSTs that you currently use

  Q4. For what decisions are tools missing but needed?

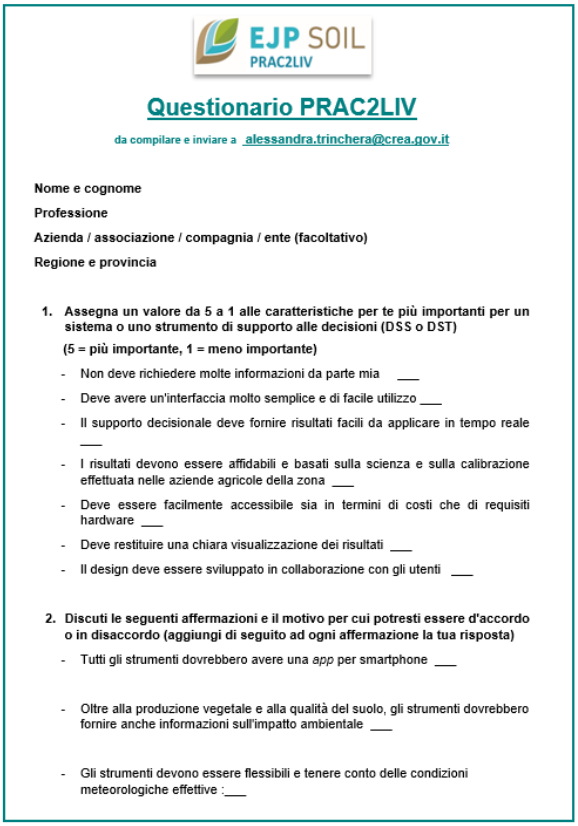
- Each group had 30 minutes to discuss the questions above-mentioned. Each group appointed its own rapporteur, who reported the collected answers. At the end of the 30 minutes, the groups were gathered in the common room and the rapporteurs described the "virtual café" results, dedicating the last part of the workshop to an open discussion.

Documentation

The collection of information from rapporteurs during the group discussions was made in a shared room during the common session, taking a photo during the discussion. Discussion was also registered and a derived document, reporting the main outcomes of the workshop, was drawn up. Regarding the answer to the submitted questionnaire, we gave the chance to answer within 10 days after the workshop, then collecting answers from participants by the PRAC2LIV research group, to be saved and summarized afterwards.

Figure 3. PRAC2LIV questionnaire.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 862695



EJP SOIL
PRAC2LIV

Questionario PRAC2LIV

da compilare e inviare a alessandra.trinchera@crea.gov.it

Nome e cognome

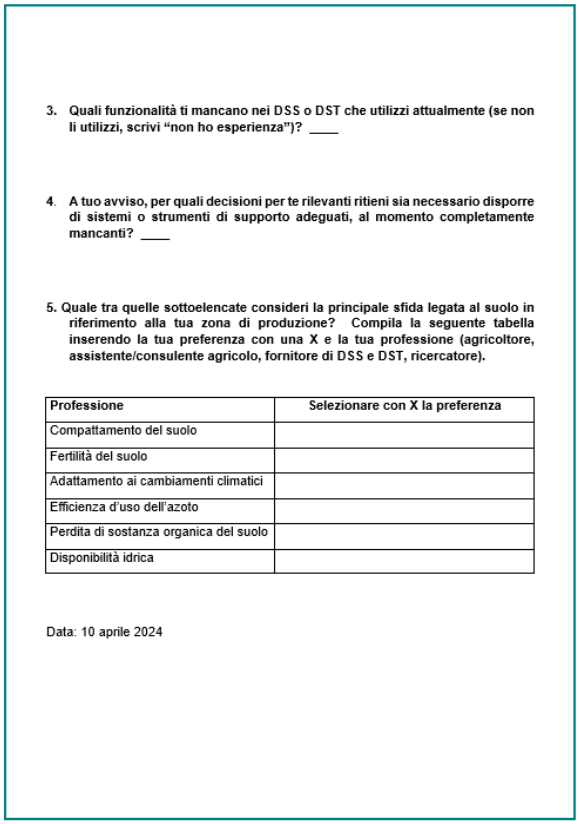
Professione

Azienda / associazione / compagnia / ente (facoltativo)

Regione e provincia

1. **Assegna un valore da 5 a 1 alle caratteristiche per te più importanti per un sistema o uno strumento di supporto alle decisioni (DSS o DST)**
   (5 = più importante, 1 = meno importante)
   - Non deve richiedere molte informazioni da parte mia ___
   - Deve avere un'interfaccia molto semplice e di facile utilizzo ___
   - Il supporto decisionale deve fornire risultati facili da applicare in tempo reale ___
   - I risultati devono essere affidabili e basati sulla scienza e sulla calibrazione effettuata nelle aziende agricole della zona ___
   - Deve essere facilmente accessibile sia in termini di costi che di requisiti hardware ___
   - Deve restituire una chiara visualizzazione dei risultati ___
   - Il design deve essere sviluppato in collaborazione con gli utenti ___

2. **Discuti le seguenti affermazioni e il motivo per cui potresti essere d'accordo o in disaccordo (aggiungi di seguito ad ogni affermazione la tua risposta)**
   - Tutti gli strumenti dovrebbero avere una *app* per smartphone ___
   - Oltre alla produzione vegetale e alla qualità del suolo, gli strumenti dovrebbero fornire anche informazioni sull'impatto ambientale ___
   - Gli strumenti devono essere flessibili e tenere conto delle condizioni meteorologiche effettive :___



3. **Quali funzionalità ti mancano nei DSS o DST che utilizzi attualmente (se non li utilizzi, scrivi "non ho esperienza")? ___**

4. **A tuo avviso, per quali decisioni per te rilevanti ritieni sia necessario disporre di sistemi o strumenti di supporto adeguati, al momento completamente mancanti? ___**

5. **Quale tra quelle sottoelencate consideri la principale sfida legata al suolo in riferimento alla tua zona di produzione? Compila la seguente tabella inserendo la tua preferenza con una X e la tua professione (agricoltore, assistente/consulente agricolo, fornitore di DSS e DST, ricercatore).**

Professione	Selezionare con X la preferenza
Compattamento del suolo	
Fertilità del suolo	
Adattamento ai cambiamenti climatici	
Efficienza d'uso dell'azoto	
Perdita di sostanza organica del suolo	
Disponibilità idrica	

Data: 10 aprile 2024

Communication

In addition to a personal invitation, each participant received a flyer with a brief description of the workshop. To push Italian farmers' participation to the workshop, both CREA and Federbio promoted the event through the following news:
https://www.crea.gov.it/web/agricoltura-e-ambiente/-/prende-il-via-il-workshop-promozione-di-strumenti-di-supporto-alle-decisioni-dst-per-l-incremento-della-sostanza-organica-la-ritenzione-idrica-e-l-efficienza-d-uso-dei-nutrienti-nel-suolo-

https://federbioservizi.it/evento/promozione-di-strumenti-di-supporto-alle-decisioni-dst-per-lincremento-della-sostanza-organica-la-ritenzione-idrica-e-lefficienza-duso-dei-nutrienti-nel-suolo/
We also communicated during the workshop the general objective of the EJPsoil and Prac2liv projects, the results of the questionnaires from national coordinators and farmers in Italy and other European countries involved in the project. For a wider audience, we plan to publish a press release and a newsletter on the CREA web page. We took some photos and recorded the virtual workshop to document the Workshop activities to share the experience with different stakeholders.

Results

Objectives with Decision support tools

After the presentations on PRAC2LIV objectives, advantages and the critical issues on DST application, together with results from EU questionnaires were shown. The European questionnaires served to stimulate discussion in the following phases of the workshop. Specifically, the responses of the questionnaire indicated that DST have low adoption among end-users. While effective for farmer goals, they're perceived as less suitable for regional and national objectives. Typically, users have minimal

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 862695

involvement in their design, low data input requirements and user-friendly interfaces. DSTs are generally seen as reliable, with low associated costs and optional usage. Notably, DSTs for nutrient management require more improvement compared to those for water and organic matter management.

The last presentation by OperField gave an example on how, in Italy, some large companies utilize Decision Supporting Systems (DSS), more than DST, mainly in relation to water (to optimize crop protection and water use efficiency) and nutrient management, while DSS are less frequently used to monitor and increase SOC accrual.

During the World Cafè, several agronomists and consultants remarked that DSTs represents a great opportunity for farmers, although they need several inputs to work well and avoid misleading interpretation of the real situation in field. As a matter of fact, the value of a DST is effective in function of available information (farmer inputs ↓) on the system to be managed: the more the inputs are precise, the more useful and complete the tool's outputs (DST: →) will be. Description of agricultural unit (e.g., farm/field), pedological data, soil analysis (if possible), cultural precession, sowing dates, crop, and variety, etc. constitute the minimum dataset useful to well apply the DST. This point led some agronomists/farmers to underline the costs for farmers not only to have access to DTSs, but also to collect water-soil-climatic data (this implies funds dedicated to soil analysis, pedological classification of the soil, etc.). It was argued that the participation of farmers/companies in future EU research programs or projects could be a chance for farmers to receive a financial support and improve their familiarity with DSTs, also supplying relevant information to develop them.

It was objected that several Italian big or medium companies, involved in industrial crops production, utilize DSSs (https://www.agrosat.it/it) to manage their fertilization plan and optimize the crop nutrient use efficiency, based on a graphical mapping of the field, where the soil N content is associated to a colour gradient. Similarly, mapping soil water moisture it is possible to anticipate the crop need in terms of water supply and irrigation mode for saving water. Contrastingly, medium, small or very small companies / farms have more difficulties in using DST, mainly due to: i) lower economic resources facilitating the adoption towards the use of DSTs; ii) lack of easy-to-access solutions for farmers: iii) average age of farmers, not always so friendly with digital tools. About the chance of using DSTs via website access by PC or via app by mobile, several participants pushed on the need to interface the field data inputs to PC with simple mobile apps to promptly receive message warnings, for example in the event of anticipated climate emergencies.
At last, but not least, the discussion was dedicated to the theme of the Carbon credits: apart from the environmental advantages due to the accrual of SOM in field on long term, farmers and advisors stressed their important agronomic and economic opportunity. Nevertheless, the difficulty of accessing to these credits caused by the blockchain systems was also highlighted.

Table 2. In group discussions, starting from submitted questions, some suggestions emerged by the groups about DST / DSS use, exploitation, and improvement.

Group 1	Group 2
Q1: Need to collect too much information by farmers to use DSTs. Open-source DSTs are a solution to avoid elevated costs for farmers: in Italy, some Regions offer free DSSs to farmers (e.g., AGRONICA in Emilia-Romagna region to manage water and nutrient). Researchers' and farmers' experience may help to design and calibrate DSTs (cover crops choice, weed managements, residues termination, selection of organic inputs, etc.).	**Q1:** Sometimes, difficult to upload data into DSTs: more user-friendly interfaces are needed. Often, existing DSTs were designed for conventional farming. Outlined "organic" options should be considered (cover crops and intercropping introduction, organic fertilizer and bioinputs, etc.). In organic farming, mechanical interventions for weeding are crucial: using NDVI and NDMI acquired via satellite, DST could give very useful alerts to farmers.

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	Mapping is considered a very effective decision support tool on water management, although it requires a deep knowledge of the soil properties in the farms.
Q2: It was remarked that, even if it is preferable to use DSTs as mobile apps, sometimes the map viewing requires the use of PC. For example, regional DSTs calibrate the N amount and inputs (up to 170 kg/ha, as threshold value), in function of available soil pedological maps	Q2: Simplify the data-entry for farmers, often aged and not always used to unfamiliar software. DST are strongly requested for organically manage crop protection to assure quality and safety food (for example, in horticulture, green manuring with netting species can be recommended).
Q3: Costs of laboratory analyses and systematization of collected data into organized database could be a relevant economic burden for farmers, especially for smallest organic farms. There is a need to merge data and use them to populate databases that can be used by DSTs, which should function as collectors of information to be appropriately rationalized and functionalized.	Q3: DST should have default access to available regional databases (daily rainfalls, temperatures) and farm data (N supply, type of crops, weeding, etc.), instead of asking for manual data-entry by the farmer
Q4: farmers are asking for DSTs as mobile app to give prompt alerts about adverse weather events	Q4: DSTs able to calculate the farm carbon footprint by uploading data on C inputs – C outputs (cover crop, organic fertilization, residue management)

Soil related challenges

When the farmers were asked what their main soil related challenge was, they mentioned soil compaction, soil organic matter and water availability (Table 3). The DST providers on the other hand instead mentioned other challenges more related to fertilization.

Table 3. Participants were asked to write down what they considered was the main soil related challenge in their area. Answers are sorted by their profession.

	Farmer	Advisor	DST provider	Researcher	Total
Soil compaction	1				1
Soil fertility*	1	2	1	2	6
Climate adaption	1			1	2
Nitrogen efficiency					0
Soil organic matter	1	3		2	6
Water availability	1	1	1	2	5

*The term “Soil fertility” was intended by several interviewees as comprehensive of soil biodiversity, a very relevant issue, especially for organic farmers.

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Summary of what all groups would like from coming DST development:

- Simple and high accessible DST by a mobile app for supporting farmers on water and nutrient management, weather alerts and potential pathogen attacks
- Flexible DSTs, able to easily interface existing databases on public (as Regional or Province informatic systems) and private platforms (advisors, private company, farmers) about irrigation data, fertilization inputs, weeding and plant protection calendars, used cover crops, termination mode, etc., to optimize the used provisional models.
- DST should not only consider in the set models SOC, nutrient and water supply, but also information on introduced cover crop species, inorganic vs organic inputs, weeding strategies, management of crop residues, etc.
- Future tools should profitably address the calculation of farm carbon footprint
- Future tools should be designed in collaboration with end users

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Fostering soil management PRACtices and uptakeand developing decision support TOols through LIVing labs in EU
(PRAC2LIV)

Report from Workshop in TÜRKİYE

2024-06-25

Annex 4 Report from workshop in Türkiye

Introduction

This workshop is a part of the project PRAC2LIV, which is one of several projects within the European Joint Programme on Agricultural Soil Management (EJP Soil) aiming at fostering adoption of support tools. Other parts of the project PRAC2LIV involve making a stock-take of Decision Support Tools (DSTs) that focus on soil organic matter, water retention, and nutrient use efficiency as currently used by EJP Member States. The objective with this workshop was to communicate results from the stocktake with stakeholders in Türkiye in order to validate the results and to discuss what steps are needed to get a successful implementation of tools that will improve sustainable soil management.

Material and methods

Invitation of participants

Ankara Provincial Directorate of Agriculture and Forestry has been informed that a workshop will be held in our Directorate on 25 June 2024 within the scope of our PRAC2LIV (Promotion of Soil Management Practices and Development of Decision Support Tools through Living Laboratories in the European Union) project carried out between 2022-2024 within the scope of the EU HORIZON 2020 European Joint Programme for Agricultural Soil Management (EJP SOIL). Through the Department of Administrative Affairs and Coordination, engineers who can reach the lead farmers in three different district Agriculture Directorates of Ankara were contacted. They were asked to invite farmers who they thought might be interested in discussing the development of decision support tools. A total of 15 farmers, 5 farmers each from Polatlı, Çubuk and Sincan districts of Ankara, and 7 agricultural advisors were invited. 12 farmers and 7 agricultural advisors attended the workshop. The other 3 farmers who were invited could not come because of excuses (fire in their villages). A total of 12 researchers from different institutes involved in EJP SOIL projects and from our institute attended the workshop. One decision support provider attended to explain TAGEM-SUET. As a result, a total of 32 people (12 farmers, 7 agricultural advisors, 1 decision support tool provider, 12 researchers) attended the workshop. All of the workshop participants were farmers and other participants from the districts of Ankara in the Central Anatolia Region.

Venue

The workshop was held on 25 June 2024 at the Directorate of the Central Research Institute of Soil, Fertiliser and Water Resources in Ankara, Türkiye. Tea and lunch were served.

Program

The program consisted of three main sessions including 1) introduction and presentations of stocktake results and presentation from DST provider, 2) group discussions and 3) Evaluation of group discussions and discussion about DTSs. The leaflet of the PRAC2LIV Workshop:

Table 1. Türkiye Workshop schedule

9.30	Welcome to the PRAC2LIV Workshop (Dr. Mehmet KEÇECİ, Institute Director)
09.40	Introduction Information about EJPSoil PRAC2LIV and Decision Support Tools (DST)

	- Goals of the PRAC2LIV project and survey results on DST in Türkiye and Europe (Assoc.Prof.Dr. Zeynep DEMİR, TGSKMAE - EJPSoil PRAC2LIV) - Advantages and difficulties of using Decision Support Tools (Ülfet ERDAL, UTAEM, EJPSoil PRAC2LIV) - Decision support system usage example - TAGEM suET (Cenk AKŞİT)
10.40	Cofee
10.50	Group discussions - Which DST is used and what are the most important features of DST? - What are the areas of improvement of the current DST? - Which decisions are used to make DST and what are the shortcomings of these tools?
12.30	Lunch
13.30	Evaluation of group discussions
14.30	Cofee
15.00	Closing (Summary of the day)

Annex 4 Report from workshop in Türkiye

PRAC2LIV Çalıştayı

Avrupa Birliğinde Yaşayan Laboratuvarlar Aracılığı İle Toprak Yönetim Uygulamalarının Teşviki ve Karar Destek Araçlarının Geliştirilmesi PRAC2LIV

25 Haziran 2024
09:30 – 15:00

Çalıştay programı

09.30	Açılış (Dr. Mehmet KEÇECİ, Enstitü Müdürü)
09.40	**EJPSoil PRAC2LIV ve Karar Destek Araçları (KDA) hakkında bilgilendirme** - PRAC2LIV projesinin hedefleri ve Türkiye ve Avrupadaki KDA ile ilgili anket sonuçları (Doç.Dr.Zeynep DEMİR, TGSKMAE - EJPSoil PRAC2LIV) - Karar Destek Araçları kullanmanın avantajları ve zorlukları (Ülfet ERDAL, UTAEM, EJPSoil PRAC2LIV) - Karar destek sistemi kullanım örneği-TAGEM suET (Cenk AKŞİT)
10.40	Kahve Molası
10.50	**Grup tartışmaları** - Hangi KDA kullanılıyor ve KDA'nın en önemli özellikleri nelerdir? - Mevcut KDA'nın iyileştirme açık yönleri nelerdir? - Hangi kararları almak için KDA kullanılmakta ve bu araçlardaki eksiklikler nelerdir?
12.30	Öğle yemeği
13.30	**Grup tartışmalarının değerlendirilmesi**
14.30	Kahve molası
15.00	Kapanış

İletişim: zeynep.demir@tarimorman.gov.tr
Cep tel: 0 505 291 45 48
ADRES: Toprak, Gübre ve Su Kaynakları Merkez Araştırma Enstitüsü Müdürlüğü-
Gayret Mahallesi Fatih Sultan Mehmet Bulvarı (İstanbul Yolu) No: 32 P.K:5 Yenimahalle / ANKARA
06172 / TÜRKİYE

Farmers/consultants involvement

Each participant to the workshop was invited to provide:

- Name
- Surname
- Affiliation (facultative)
- Profession [- 1) researcher; 2) farmer; 3) consultant/assistant; 4) other]
- E-mail contact

In Figure 1, a photo of participants to Türkiye PRAC2LIV workshop – 25th June 2024.

Annex 4 Report from workshop in Türkiye

Figure 1. Participants to PRAC2LIV Türkiye Workshop

Figure 2. PRAC2LIV Türkiye Workshop presentations

Annex 4 Report from workshop in Türkiye

Figure 3. PRAC2LIV Türkiye Workshop presentations

Figure 4. PRAC2LIV Türkiye Workshop presentations

Group discussions

For the group discussions, the participants were divided into three groups with 11-12 participants in each and with 4 farmers, 1 DST provider, 4 researcher and 2-3 advisor. Before the group discussion each participant was asked to write down on a piece of paper 1) what feature is crucial for me to implement it and 2) what feature did stop me from using a DST despite its benefits. These notes were brought to the group discussions. During the group discssions the participants were asked to:

1. Rank together what are the most important features of a tool
   - It doesn't require much information from me
   - It has a user-friendly interface
   - The decision support delivers results that are easy to apply in real time
   - The results are reliable and based on science and calibration on farms in the area
   - Easily accessible both in terms of cost and hardware requirements
   - It has clear visualization of results
   - The design is developed in collaboration with users
2. Discuss the following statements and why you may agree or disagree
   - All tools should have an app for a smartphone
   - In addition to plant production and soil quality, tools should also provide information on environmental impact
   - Tools must be flexible and take into account actual weather conditions
3. Discuss what features you miss in DSTs that you currently use
4. For what decisions are tools missing but needed?

Documentation

One researcher or advisor in each group took notes during the group discussions and one of them also during the common session. Some input from participants were collected by letting them write individual answers on post-it notes that was saved and summarized afterwards.

Results

Table 1. Participants were asked to write down what the main objective with using a DST was. Answers are sorted by their profession.

Farmers	DST providers	Advisors	Researchers
In order to increase yield and quality For production purposes Fertilisation Irrigation Pesticides I do not use	Optimum fertilisation and irrigation The yield potential with a certain soil Yield increase	Saving time Applying the right fertiliser and irrigation Reducing costs Increasing yields Contributing to the ecosystem To be more conscious Fertilising at the right dose For the purpose of implementation in	For optimum fertilisation and watering To provide convenience in fertilisation and irrigation Regular and correct use of fertilisers and pesticides in plant development stages Regular and correct use in the developmental stages of pests and diseases Reducing costs and inputs Growing healthy products Prevent environmental pollution

		sustainable agricultural policies To plan fertiliser, water and production patterns Increasing agricultural inputs Sustainability To determine the amount of irrigation water For fertilisation For spraying To complete the lack of information Getting help Decision making Weather forecast Obtaining information Providing convenience	To obtain meteorological data Saving time and inputs Effective fertilisation Plant nutrition Increasing yields Optimising soil moisture Determine the watering time Calculating the amount of irrigation Soil compaction Creating a script Access to information and documents For projects, farmer and production consultancy For support in research studies To determine the optimum yield potential of the soil. Predicting an event in advance. Facilitating an effective result in fertilization.

Table 2. Participants were asked to write down what they considered was the main soil related challenge is in their area. Answers are sorted by their profession.

	Farmer	Advisor	DST provider	Researcher	TOTAL
Soil compaction	1			1	2
Soil fertility	2	1		2	5
Climate adaption				1	1
Nitrogen efficiency					0
Soil organic matter	3	2		3	8
Water availability					0
Soil water management	5	4	1	4	14
Soil erosion	1			1	2

Annex 4 Report from workshop in Türkiye

Figure 5. PRAC2LIV Türkiye Workshop group discussions

Figure 6. PRAC2LIV Türkiye Workshop group discussions

Figure 7. PRAC2LIV Türkiye Workshop group discussions

Table 3. Participants were asked to add DSTs available but not mentioned in the Stock-take.

Water	SOM	Nutrient efficiency
- Meteos (agricultural forecast early warning system) - Meteorology database	- Digital soil analyzer	- Onesoil - SoilScanner - Doktar company iOT - Gübretaş fertilization guide

Group discussions

Table 4. In the group discussions, suggestions for improvements in currently used tools were suggested.

Group 1	Group 2	Group 3
Provide ease of use Mobile phone applications should be free of charge It should be easier to understand Results must be accurate, real-time and reliable Provide more efficient use in the field Different fertiliser recommendations Software should be easy to use Cost should be low Ensure high efficiency It should be more understandable and easy to use Free of charge and open access Data set is up-to-date and detailed Training should be provided for the use of these devices	Must be practically usable There should be a user manual on the vehicles for information The vehicle must have a manual for farmers to understand More data available Must be up to date Must be easily accessible Must be available to everyone free of charge Plant variety selection should provide also provide information on the biological state of the soil Provide information about the slope It should be easy, understandable and applicable Must be compatible with the terrain Must be updated It should be plain and simple to use Lack of unnecessary information Having user manual Having applications that will answer many questions with the farmer's handbook Add data to tools for optimisation	Provide information on optimum fertiliser and pesticide use It should be simple and add-ons that each individual can easily perceive and use Data must be updated Provide easy operation Easy access should be provided Provide support in every language Must be artificial intelligence supported Must be free of charge It should also be able to work in areas without internet reception Good support must be provided Price should be affordable Correct calibration Automatic selection of reliable satellite images Keeping up with technology

Table 5. In the group discussions, suggestions were given for what type of decisions for which tools needed but missing

Group 1	Group 2	Group 3
Decision support tools are not ubiquitous Easy to understand Grading the impact of applications on the physical, chemical and biological structure of the soil.	The software does not appeal to farmers. Lack of trainings on decision support tools Technological problems. Lack of adequate plant nutrition tools related to plant nutrition.	Limited conditions. Technical results prepared according to ideal conditions may not be economically feasible. Lack of up-to-date weather forecasts.

Tools for plant nutrition or impact on productivity. Lack of dissemination Inadequate infrastructure and inexperience Ancestral stereotypes Difficulty in evaluating the different groups covered by the models together Insufficient information on software and hardware.	Inadequacy of dissemination Farmers' adoption Requires internet access Increased likelihood of errors in use due to lack of technical knowledge. The most important challenge: Unsustainable use due to lack of knowledge. Never used. Limited conditions.	Problems encountered in use despite the decision support tools used. Never used. Lack of adequate technical support for problem solving. Possible problem: To be able to input all necessary data. Never used.

Table 6. Short notes from group discussions made from different statements.

Statement	All tools should have an app for a smartphone	In addition to plant production and soil quality, tools should also provide information on environmental impact	Tools must be flexible and take into account actual weather conditions
Group 1 comments	Yes, you must have all the apps. Yes, you need an app for your smartphone. No, it would not be descriptive. There may be a computer version for detailed information. Yes, it is necessary. But can the farmer use it? It is necessary. Yes, it is necessary for practicality in the field.	Yes, it should. It is necessary for the protection of the environment. Of course it should. Yes, it should. it is needed. The negative or positive effects of the practices on the environment and nature should be monitored. Yes, it should. Warnings can be given in advance of natural disasters, measuring the economic damage threshold of diseases and pests and taking precautions. It should be ensured. The natural environment is a whole. Agree. It is important in terms of the contribution of practices to the environment. If it informs us of all the negativities in advance, it contributes to taking precautions.	It is very important to have it in real time. Time is crucial for correct technique application and precaution. It is necessary, but difficult to get reliable weather forecasts. Yes, there should be, so that we can make clearer determinations. It can be flexible. Agree. It should be flexible and take into account real weather conditions. Instant and real is important for deciding whether to apply or not. Weather conditions should be taken into account. It should be flexible. However, it is not possible for decision support tools to cover every point.

			Real weather conditions should be taken into account along with flexibility.
Group 2 comments	Yes, it is necessary. Because it is easily accessible and usable. Yes, it is necessary to save time. It is very practical. I agree. For example, a fruit grower can learn about early spring frosts. Since he takes the necessary precautions, his crops will not be damaged. Yes, people of all ages and socio-economic classes already use smartphones. Yes, it would be easier to use if it is available as an application on smartphones. Yes, it is very practical in terms of use. There should be an application provided that it is easy to understand. It must be available for instant information. It is absolutely necessary for the development of agriculture in terms of application.	Provide information about the environment. Because it should provide information about the protection of the natural resources used. Yes, I agree. It should be a must. Monitoring of environmental impact is necessary. Agree. Information about environmental forces can be provided. However, I think this information should be superficial so that it can be understood. Yes. It would be useful to include information on possible side effects of each practice. Yes, I agree. Research on the active ingredients of medicines is necessary. It is also necessary to investigate the environmental impact of excessive fertilizers used. It should provide information on crop production and soil quality as well as environmental impacts. For example, it is necessary to investigate whether plant protection products harm bees. The persistence, pollution, etc. of the pesticides we use should also be investigated. Yes. It should be useful in all areas so that a single decision support tool is useful. Yes. It is also necessary to provide information on	Yes. In case of natural disasters, it is in the interest of farmers to have meteorological stations close to fields, vineyards and gardens. I agree. Having local meteorological stations due to insufficient weather stations. Real weather conditions should be taken into consideration. Results are affected. Yes. Since weather conditions are constantly changing, data should be updated. Yes Should be taken into account. Decision support tools should be flexible. There should be instant local weather conditions. Actual weather conditions should be taken into account.

		environmental impacts for sustainable agriculture. Pesticides disrupt bees' sense of direction, so they cannot find their hive and die. For such reasons, environmental impacts should be monitored from all angles and information should be provided.	
Group 3 comments	I agree, it is the most effective tool for everyone to access the application from an accessible source. It certainly does. It provides ease of application and ease of access to information on smart phones. It is necessary because it is easy to access. Yes, it is necessary, accessible and quite practical.	It must be provided. All systems support each other. Warning and warning systems can be good. Yes. Yes, they can. It should work. It would be useful to determine the impact of each action in decision support tools. In this way, the current situation can be monitored and information about potential hazards can be obtained. Definitely yes. If it is an earthquake zone or a holistic approach in defining the balance in the ecosystem. I don't know.	It has to be flexible. To be suitable for all real circumstances. Real weather conditions should be used. Absolutely yes. Instantaneous data should be taken. Of course the weather conditions must match. Of course it should. Instant changes are very important in production. Instant meteorological data at points close to the determined locations should be utilized. It should be flexible. However, it is difficult to get reliable weather forecasts. It should be necessary.

Table 7. The groups were asked to list the most important features of decision support tools. Answers:

Group 1	Group 2	Group 3
Saves time in agricultural production planning.	Increases yield quality.	Being informative and guiding.

Provides benefit in production planning. Results are reliable. Provides easy access to fast information. Based on science and calibration on farms in the region Immediate access and giving ideas Helping the producer Making more conscious production Continued smooth operation of the decision support mechanism. Provides convenience to farmers (producers) Facilitates the use of applications at the right time and dose.	Prevents environmental pollution. Helps to make decisions in situations where we cannot make a decision. Provides easy access to information. It saves fertilizer. Saves water. Decision support tools enable the farmer to carry out production activities through the system in order to regulate all processes from efficient production to soil and environmental protection. It provides the opportunity to learn the right technique and apply it at the right time. Open to everyone. It has a user-friendly interface	Produced and supported by public and private units. Decision support tools help in guiding farmers and ensuring optimum production conditions. Having concrete data for output. Efficient use of natural resources. Development of environmentally sound agricultural systems. Sustainable, adaptable and resilient. It does not require much information. Provides statistical support and computerized interpretation.

Summary of what all groups would like from coming DST development:

- Decision support systems are needed and effective for all groups.
- They should be user-friendly, detailed, and customizable for farmers, consultants, researchers, and engineers, with simpler mobile applications.
- Systems should be low-cost, practical, and simple with good support and an affordable price.
- Accurate calibration and reliable satellite images are essential.
- Some decisions should be regulated rather than made individually.
- A barcode system and centralized data collection for monitoring should be improved.
- Current non-users are interested in using developed decision support tools.

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Draft Report Meeting Ekoboerderij De Lingehof, 20 augustus 2024

Andre Jurrius, initiator and farm manager
Linda Calciolari, co-worker and designer of soil health game
Marjoleine Hanegraaf, coordinator PRAC2LIV

Discussion topics:

- Introduction PRAC2LIV, Ekoboerderij de Lingehof and goal of the meeting
- Ideas on decision support tools for soil health in lighthouse and living labs

Ekoboerderij de Lingehof

Introduction

Ekoboerderij de Lingehof is a biodynamic arable farm adjacent to the Linge river in Randwijk, municipality of Overbetuwe, part of the estate 'Heerlijkheid Hemmen' as a tenant farm. André Jurrius has been growing crops at the farm since 2005 and lives there with his wife Marieke and their three daughters. The farm is organically developing into a lighthouse farm for regenerative agriculture.

The region 'Betuwe' has traditionally been an area where a lot of fruit is grown thanks to the fertile clay soil. In the past there were only standard fruit trees. However, since it has become possible to grow fruit on low stems, almost all growers have switched to this. Low stem is easier to prune and harvest. The standard fruit trees contribute to biodiversity and ensure the preservation of a piece of authentic Betuwe landscape.

More than 10 crops are grown on more than 90 hectares located in and around the village of Hemmen in the municipality of Randwijk. The great diversity of crops betrays the passion for growing. There are smaller plots bordered by hedges and trees around the village of Hemmen and larger plots more towards the Rhine. The meandering of the Rhine in the distant past gives a whimsical pattern in the weight of the clay. Most plots consist of heavy to very heavy clay. These conditions partly determine the cultivation plan with both arable crops such as grain and onions and large vegetable crops such as pumpkins and red cabbage. A sixth of the area is in dormant grass-clover for two years. This is very important for good soil fertility and plant health.

Becoming a Lighthouse

From the start of Ekoboerderij de Lingehof, collaboration has been an important value. Farm management aims for an open atmosphere and creating conditions in which everyone can flourish and enjoy working every day to grow healthy plant-based food with an eye for people and nature. The overall vision focuses on balanced plant growth and efficient business operations by combining care for soil health with the use of technology and precision agriculture. All crops are harvested in one go and then stored or delivered directly to the buyer. The various collaborations and initiatives

have led the Ekoboerderij to develop into a lighthouse (knowledge centre) for other farmers and entrepreneurs in the region. To function as a lighthouse and develop the business model, the Ekoboerderij works closely with Wageningen University, among others in the EU-project InBestSoil (Valentina Materia). A major focus for the lighthouse is the cultivation of lupine. White lupine has been cultivated at Ekoboerderij de Lingehof since 2008, and from 2020 this is done in collaboration with local parties (e.g., the regional bank) that together formed the product organisation "Lekker Lupine" (tasty lupine). Aim is to stimulate the consumption of lupine and to organise the cultivation and sales of organic lupine beans in the Netherlands, thus contributing to the protein transition (more for more information the textframe and https://www.lekkerlupine.nl). Presently, a large glasshouse construction is being built at the farm that will serve as information room to receive groups, directly overlooking the fields.

Lupine offers many benefits:

- Sustainable alternative to soy: In this Dutch regional climate, lupine is easier to grow than soy and is an excellent alternative to the import of soy from distant regions such as the Amazon rainforest, where soy is often grown under less sustainable climate and working conditions.
- Rich in high-quality proteins: Dry lupine beans contain 36% high-quality proteins. This makes them extremely suitable for the production of vegetarian meat substitutes.
- Improves soil fertility: The lupine plant belongs to the legumes. This means that the plant, in collaboration with soil bacteria, is able to fix nitrogen from the air for its own growth, making fertilization unnecessary. The nitrogen fixed in this way remains in the soil and is available for subsequent crops, leading to a reduced need for fertilizer for future crops.

Decision Support Tools for soil health in living labs

Given its potential as lighthouse, André and Linda have great interest in the PRAC2LIV topic ' DSTs for soil health in living labs'. Regarding farm management in general and the use of DSTs in particular it is discussed that differences in opinions on DSTs are partly the result of differences in generations. Younger people are much more fluent in using digital applications than older ones, and may also rely more on such tools that the experienced older colleague who uses his knowledge. At the Ekoboerderij many aspects of soil health, also in the context of living labs, are taken into account. However, different opinions may exist as to what a light house and living lab entail. It is argued that the Green Deal and the sharing of data within living labs may lead the EU to pose more restrictions on farm management and/or free entrepreneurship. The Ekoboerderij does not strive to be a lighthouse within the context of the Green Deal per sé, but to act as a local source of inspiration. For the development of future DSTs three aspects are considered essential:

1) DSTs must integrate related topics in soil management practices,
2) DSTs must include economic consequences,
3) DSTs must give regionally oriented recommendations.

The method of participatory design is explained by Marjoleine and the result for PRAC2LIV in the poster 'DSTs for soil health in living labs' presented. The method is considered very useful for including different types of stakeholders in discussions and have their opinions noted. Major comments regarding the poster are:

- It is implicit in the poster that 'we all live by eating plants', but not all people are aware of this. The suggestion is given to include this awareness in the instruction for the facilitator of discussion groups using the poster.
- The text in the poster is neutral. It could have been an option to include bold statements (controversies) to evoke discussion;
- The top layer of soil, in the poster visualised in a black band, is the living layer for plant growth and should be preserved. The interdependency could be emphasized. Likewise, the circles around the subthemes could be connected for better clarification.

Finally, Linda makes an extra contribution and explains the 'Living Soils' workshop, co-created by Ludi Soli, a NGO founded by two students from Wageningen University (www.livingsoilworkshop.nl). In this workshop, participants play a card game, get insight in the soil system, and discuss soil management practices. The workshop is led by a trained facilitator.

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Annex 6 Report from meeting National Hub NL

Report on the PRAC2LIV discussion during a meeting of the National Hub in The Netherlands

Participants live-meeting: Margot de Cleen (Rijkswaterstaat), Gerben Zijlstra (Cumela), Reinier Gerrits (Meststoffen NL), Ineke Nusselder (Prov. Gelderland), Michelle Talsma (STOWA), Saskia Keesstra (WUR/Climate KCIK), Ardi Saarloos (WUR), Chantal Hendriks (WUR), Anna Besse (WUR), Janjo de Haan (WUR)

Online participants: Pieter Brooijmans (Cosun Beet company), Silko Merghenthal (Min I&W), Peter Sloot (Aequator), Adinda Lodders (BO-Akkerbouw), Albert de Vries (Min. LNV).

Agenda

Date: March 28, 2024, 1:30 PM-4:30 PM,
Location: Hybrid meeting: GAIA building 101, room 1, Droevendaalsesteeg 3, Wageningen and Online
Parking on campus: parking garage P1

1. Opening and establishing agenda

2. Report of previous meeting October 3, 2023, See appendix

3. Notices, See also the attached update

4. Overview of current affairs, Anna Besse

5. EJP SOIL roadmap, Janjo de Haan and Ardy Saarloos
In preparation for discussing the Roadmap, we have drawn up a survey. The question is to complete this survey no later than March 21.

6. PRAC2LIV, Marjoleine Hanegraaf
PRAC2LIV makes an inventory of decision support tools in the field of carbon, water and nutrient management through living labs in Europe to promote sustainable soil management. The bottleneck is that many tools are rarely used. Guidelines for the development of decision support systems and designs for (mock-ups of) web portals and/or dashboards are discussed with stakeholders. During the meeting, PRAC2LIV is briefly explained and designed visualizations are presented. From the National Hub we ask for feedback on the visualizations to create more applicable tools.

7. Closure

Notes on the PRAC2LIV presentation and discussion

The project PRAC2LIV was introduced by means of a short powerpoint presentation. The last slide showed the draft visualisation which was the key point for the discussion. The aim of the physical presentation to the national hub was threefold: to (1) validate the emerged topics from the PRAC2LIV team, (2) check the readability of the sketches in correspondence with the words, and (3) explore missing topics.

Input obtained during and from the discussion:

- Is the Waterwijzer Natuur en Landbouw included in the list of tools?
- Does the questionnaire evaluate how many tools are being used?
- Who are the target groups within PRAC2LIV?
- A living lab could be a learning community, something to be included.
- The layout gave the impression that all topics were derived from one central point (lighthouse) in Europe which would be misleading and not do justice to all contributing Member States of PRAC2LIV.
- There was no clear title which could lead the viewer through the topics.
- A missing topic was 'Ownership of data'.
- How may anonymity of farmer data be secured? The Dutch Interbranch Organisation for Arable Crops has in consultation a Code of conduct 'Towards a data-ecosysteem in open arable fields' to ensure that tools may be used without the need to share data with third parties.

Overall, the discussion on the draft visualisation was less dynamic than anticipated. Upon reflection, this may have been due to:

- Order in the agenda of the National Hub meeting: This was the last topic of the 3-hour meeting with an intensive discussion about the Roadmap and no break before this agenda point; energy had disappeared among those present.
- Absence of PRAC2LIV coordinator Marjoleine who was ill. Her part was now taken over by Amanda, English speaking soil scientist, and Danielle, trainee who made the visualisation. The change in language was unexpected.
- Possible incorrect expectations by the PRAC2LIV team about the role, knowledge and possible contribution of the National Hub. The National Hub only meets twice a year and members are only familiar with the program in general terms.
- The method 'participatory design' was unknown to the participants and maybe required introduction. Also, the visualisation was perhaps too premature for the participants to give useful comments; ; many comments touched on the look and layout of the visualisation rather than the content.

Annex 1, PDF of presentation PRAC2LIV.

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PRAC2LIV

Fostering soil management PRACtices and uptake and developing decision support TOols through LIVing labs in EU (PRAC2LIV)

Marjoleine Hanegraaf, Timo Räsänen, Raimonds Kasparinskis Dylan Waren Raffa, Sofia Delin, Zeynep Demir, Meriem Jouini, Valentina Barratella, Alessandra Trinchera, Ciska Nienhuis,Ulfet Erdal

EJP SOIL
European Joint Programme

EJP SOIL has received funding from the European Union's Horizon 2020 research and innovation programme: Grant agreement No 862695

Introduction

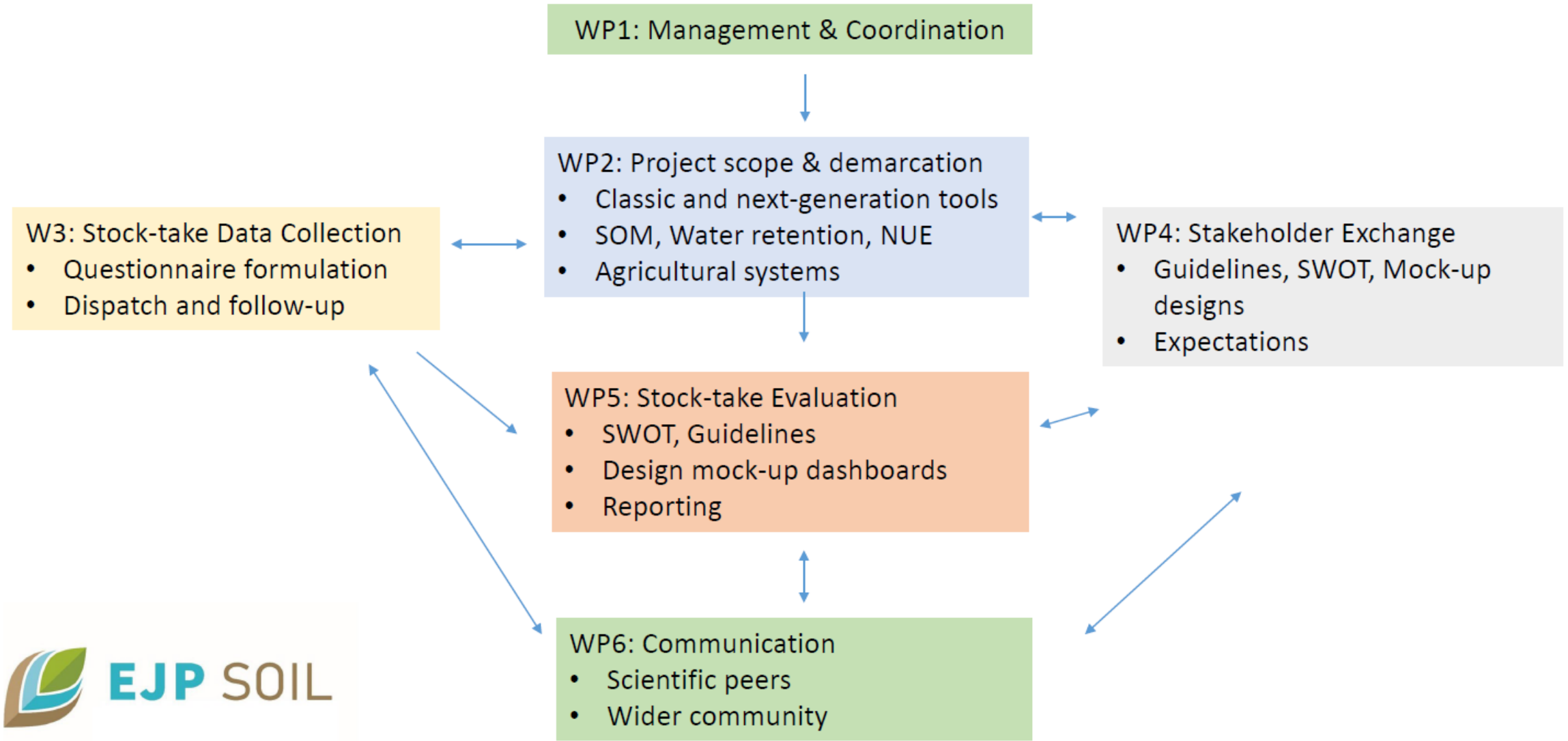
AD3 - Soil specific guidelines and decision support tools with focus on soil organic matter, water retention and nutrient efficiency

Partners: six lead partners (WR, LUKE, CREA, SLU, UL, TAGEM). In addition, contributing partners are the national coordinators of EJP SOIL member states.

Objectives:

- To take stock and evaluate Decision Support Tools (DSTs) as currently used by EJP Member States for SOM, WR, and NUE
- To have a (mock-up) functional design for a webportal and/or DSTs

PRAC2LIV Workpackages



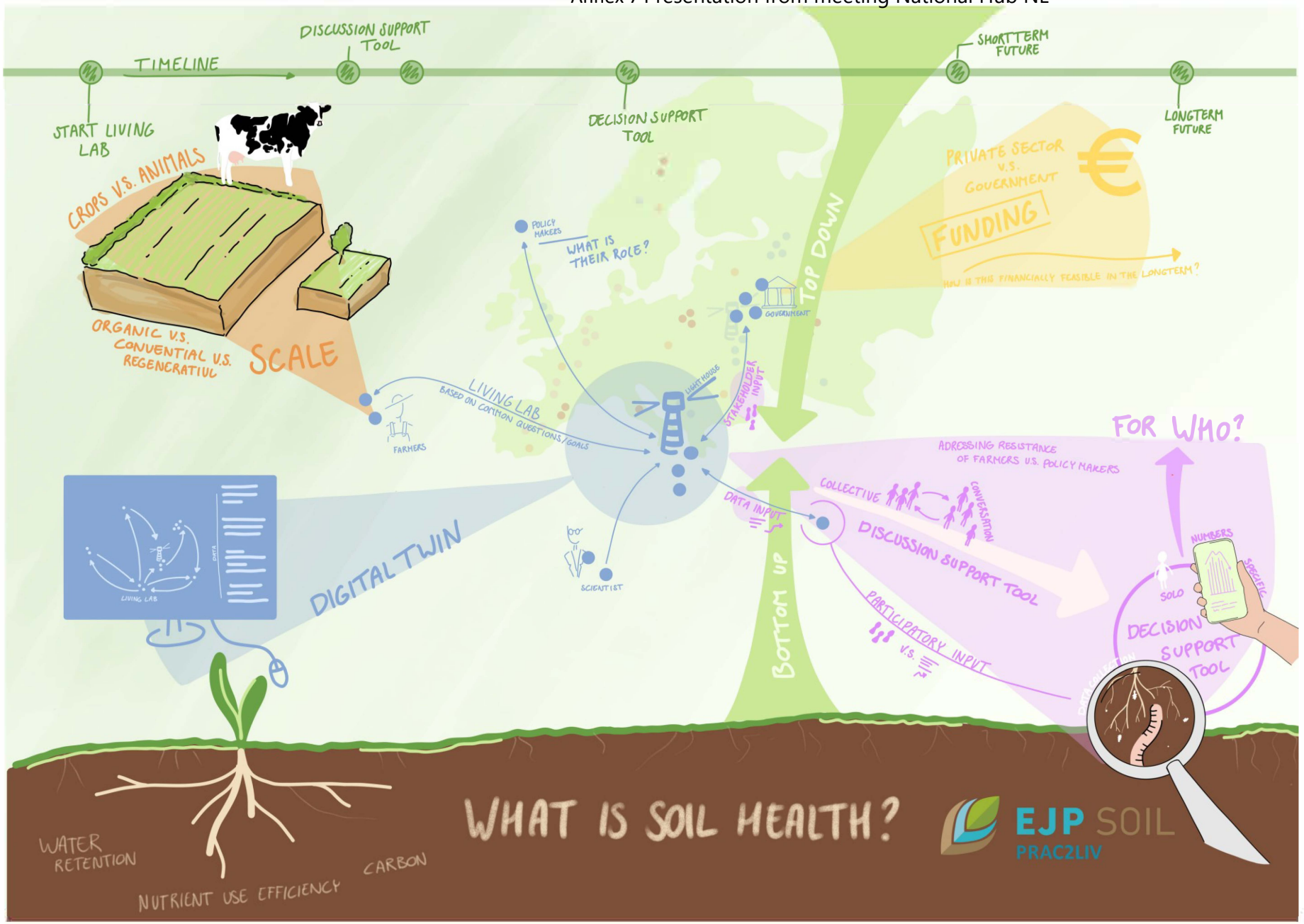
EJP SOIL

Objectives:

- To take stock and evaluate Decision Support Tools (DSTs) as currently used by EJP Member States for SOM, WR, and NUE
- To have a (mock-up) functional design for a webportal and/or DSTs

- Stocktake includes about 200 tools, scored on various qualities: user-friendliness, accuracy, user groups, etc
- Inspirational visualization of the topic
  - Decision support tools for Soil Health in Living Labs
    - Always *decisions* or sometimes *discussions?*
    - Soil health is more than *just* SOM, WR, NUE
    - LL acting as a bridge; decreasing the gap between policy and farmers
    - Scale (temporal and spatial) and context

- What do you see? What do you miss? What would you highlight more/less?


TIMELINE
START LIVING LAB
DISCUSSION SUPPORT TOOL
DECISION SUPPORT TOOL
SHORTTERM FUTURE
LONGTERM FUTURE
CROPS V.S. ANIMALS
ORGANIC V.S. CONVENTIAL V.S. REGENERATIVE
SCALE
POLICY MAKERS
WHAT IS THEIR ROLE?
TOP DOWN
PRIVATE SECTOR V.S. GOVERNMENT
FUNDING
HOW IS THIS FINANCIALLY FEASIBLE IN THE LONGTERM?
GOVERNMENT
LIVING LAB
BASED ON COMMON QUESTIONS/GOALS
FARMERS
LIGHT HOUSE
STAKEHOLDER INPUT
SCIENTIST
DIGITAL TWIN
DATA
LIVING LAB
DATA INPUT
BOTTOM UP
FOR WHO?
ADRESSING RESISTANCE OF FARMERS V.S. POLICY MAKERS
COLLECTIVE
CONVERSATION
DISCUSSION SUPPORT TOOL
PARTICIPATORY INPUT
V.S.
NUMBERS
SOLO
SPECIALIST
DECISION SUPPORT TOOL
WATER RETENTION
NUTRIENT USE EFFICIENCY
CARBON
WHAT IS SOIL HEALTH?
EJP SOIL
PRAC2LIV