



Soil Quality – between knowledge and practice

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Mission Area - Soil Health and Food

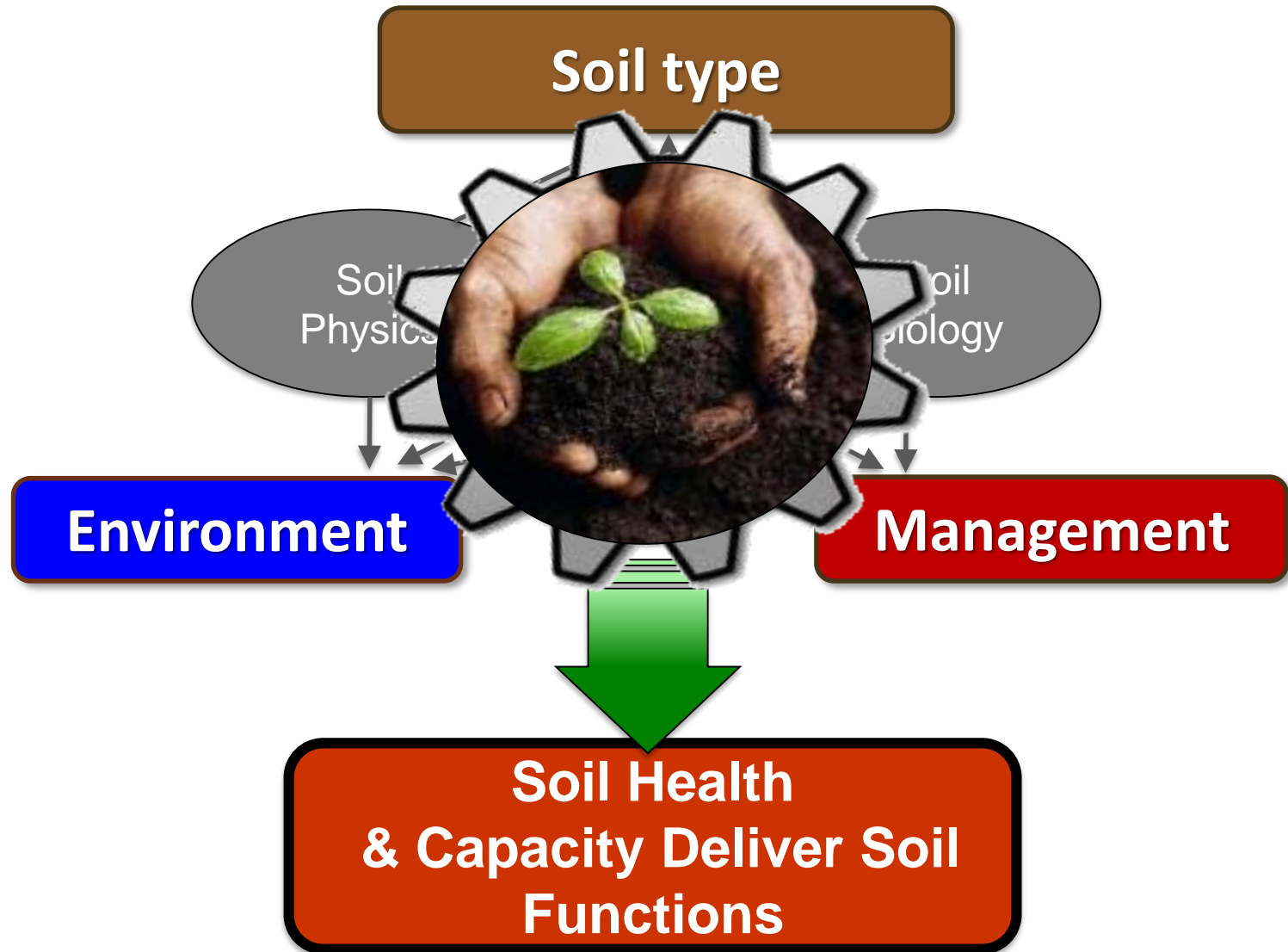
- Aims to create knowledge and develop solutions for restoring soil health and soil functions.
 - help realise the potential of soils to mitigate the effects of climate change.



Soil Quality describes a soil's ability to provide ecosystem services through its capacities to perform vital functions under changing management and climatic conditions (Tóth, 2007).

Soil Health can be defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals & humans (USDA, 2020).

WHAT'S THE CAPACITY OF SOIL TO DELIVER MULTIPLE FUNCTIONS?



THREATS TO SOIL HEALTH

SOIL FUNCTIONS & ECOSYSTEM SERVICES!





CAN WE SUCCEED IN EARLY DIAGNOSIS?

HAVE WE ACCESS TO KNOWLEDGE, INDICATORS & BENCHMARKS

Peat/Organic

Humose

Mineral



Carbon = >20%

Carbon = 12.4%

Carbon = 3.1%

ROLE OF RESEARCH?

Developing knowledge and evidence on the potential of soils to deliver different functions

Method: use labelled $^{13}\text{CO}_2$ to trace the fate of Carbon taken in by plants

Quantifying the Carbon Sequestration potential of soils?



ONE MANAGEMENT DOES NOT FIT ALL SOILS!

Methods of grassland establishment to protect soil Carbon stocks?



20 cm deep



40 cm deep

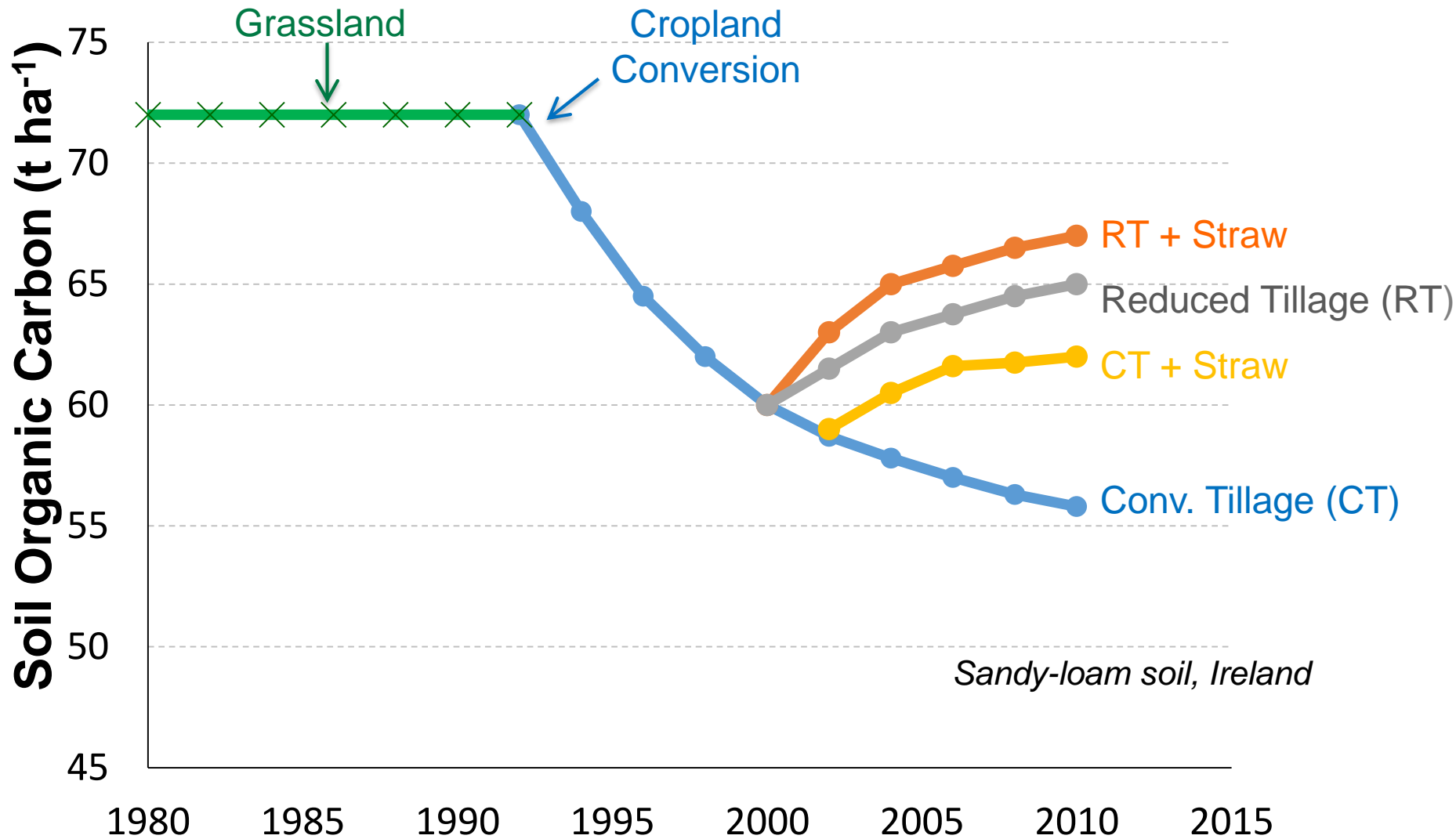
- 3 tillage methods
- Non-inversion tillage
 - Ploughing to 20 cm
 - Ploughing to 40 cm

Teagasc Johnstown Castle Research Farm

Ryegrass Monoculture

Multispecies Swards

SUPPORTING SUSTAINABLE SOIL MANAGEMENT – PROTECTING SOIL CARBON



Sandy-loam soil, Ireland

CAPACITY TO OVERCOME CHALLENGES?

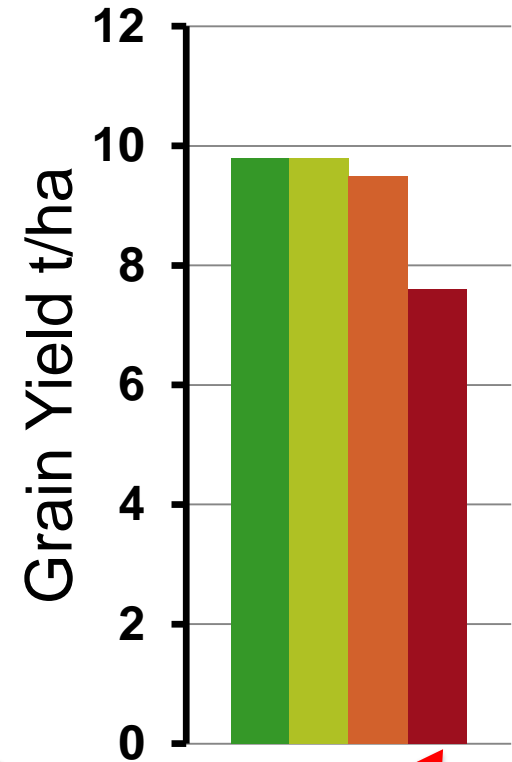
e.g. survey: machinery turning practice on 35 farms

- 30% to 65% of headland had compaction
- ✓ Scope to remediate by altering management



HOW DO WE COMMUNICATE ISSUES TO FARMERS?

Visual assessment detects soil structural damage (compaction) even before yields are impacted

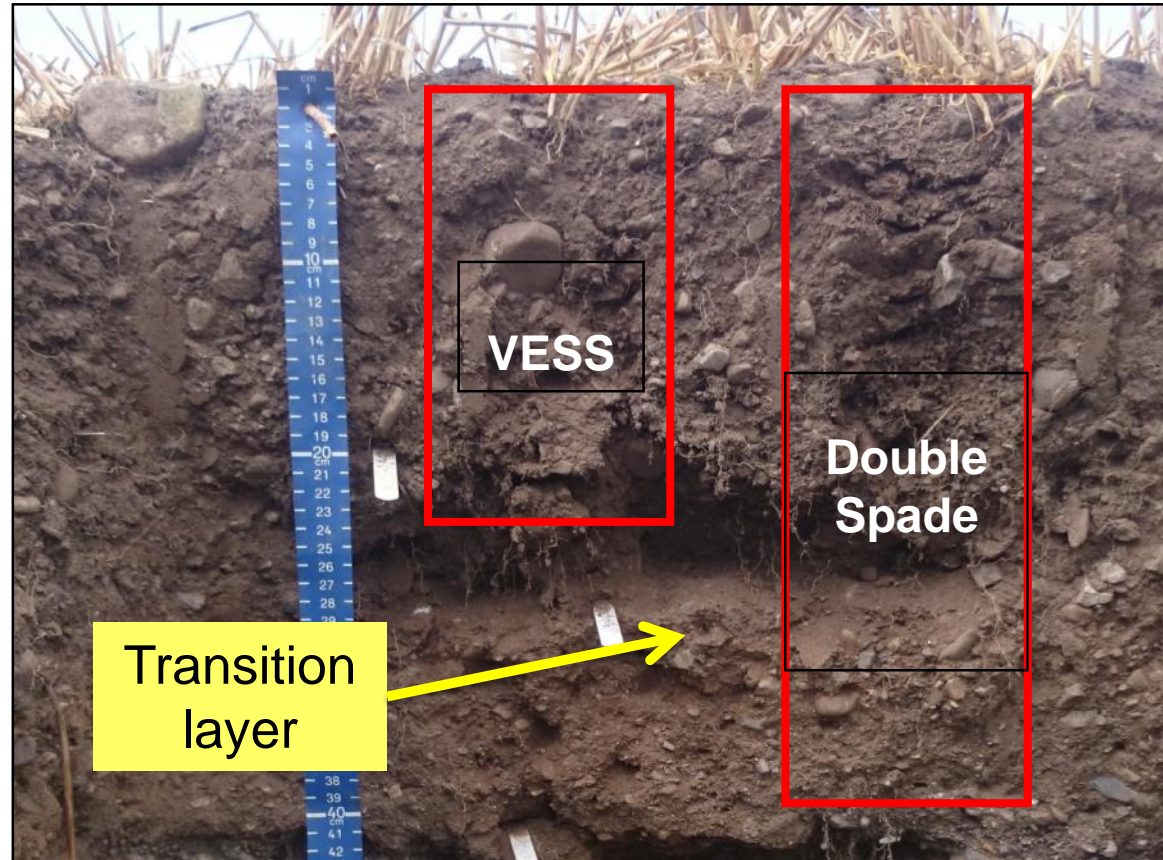


PRACTICAL TOOLS SUPPORTING DIAGNOSIS?

VISUAL SOIL ASSESSMENT FOR ARABLE SOILS

Double Spade method for assessing soil structural quality

- Assesses key transition layer to 40cm.
- ✓ More sensitive than quantitative methods.



STAKEHOLDER CONSULTATION SOIL FUNCTION ASSESSMENT



STAKEHOLDERS LEVEL

- farmers
- regional multi-stakeholders
- ★ national multi-stakeholders
- ★ European multi-stakeholders

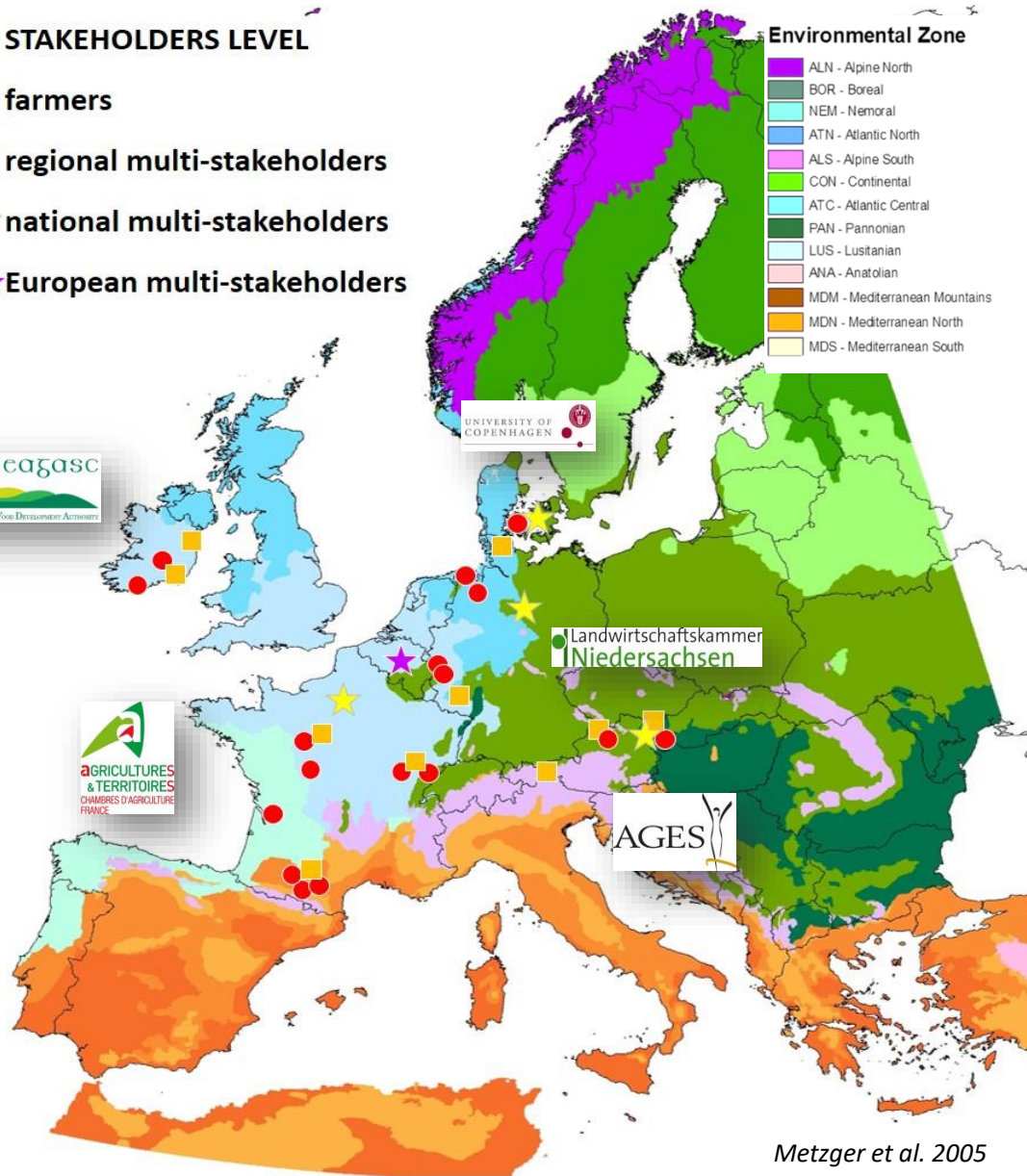
Environmental Zone

- ALN - Alpine North
- BOR - Boreal
- NEM - Nemoral
- ATN - Atlantic North
- ALS - Alpine South
- CON - Continental
- ATC - Atlantic Central
- PAN - Pannonian
- LUS - Lustranian
- ANA - Anatolian
- MDM - Mediterranean Mountains
- MDN - Mediterranean North
- MDS - Mediterranean South

Which is the existing knowledge, knowledge requirements and prioritization of soil functions between stakeholders in Europe?

Workshops

- 5 countries
- 32 workshops
- 473 participants



Soil Use and Management



Special Issue Paper | Full Access

Harvesting European knowledge on soil functions and land management using Multi Criteria Decision Analysis

F. Bampa, L. O'Sullivan, K. Madena, T. Sandén, H. Spiegel, C.B. Henriksen, B.B. Ghaley, A. Jones, J. Staes, S. Sturel, A. Trajanov, R. E. Creamer, M. Debeljak

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Metzger et al. 2005



RANKING SOIL FUNCTIONS:

WHAT DO FARMERS AND FARM ADVISORS CONSIDER IMPORTANT



Workshop			Land Use	Climate zone		PP	WRP	C	NC	BD
Toulouse, Midi-Pyrénées, France	12	CROP	Conservation Agriculture	MED	Mediterranean	9	2	1	1	1
Gascogne, Toulouse, Midi-Pyrénées, France	12	CROP	Conventional Agriculture - cereals	MED	Mediterranean	12	0	0	0	0
Groß Enzersdorf, Lower Austria (NO)	6	CROP	Arable	P	Pannonian	4	3	1	2	1
Montlieu La Garde, Charente-Maritime, France	14	WINE	Wine makers	L	Lusitanian	11	5	1	2	1
Upper Austria (OÖ) - Linz	4	MIX	Mixed	C	Continental	2	0	1	2	0
Valdahon, Doubs, Franche-Comté, France	8	GRAS	Grassland (Dairy farmers)	AN	Continental	4	1	0	0	5
Bad Kreuznach, Rhineland-Palatinate, South-West Germany	9	WINE	Wine makers & vegetable farmers	C	Continental	6	5	2	3	2
Bad Kreuznach, Rhineland-Palatinate, South-West Germany	15	CROP	Arable	C	Continental	13	1	0	1	1
Argenton-sur-Creuse (Indre + agri. de la Creuse et de la Haute-Vienne), France	10	MIX	Mixed	AC	Atlantic Central	9	1	1	0	3
Chemin, Jura, Franche-Comté, France	10	CROP	Mixed crop/grassland (7/10 cereals)	AC	Atlantic Central	8	3	0	0	1
Maves, Loir et Cher, Region Centre, France	16	CROP	Cropland (cereals)	AC	Atlantic Central	13	5	2	4	4
Aurich, Lower Saxony, North-West Germany	11	CROP	Arable (Marsh)	AN	Atlantic North	10	5	3	3	3
Odense, Fyn region, Denmark	10	MIX	Mixed	AN	Atlantic North	7	5	3	4	3
Cloppenburg, Lower Saxony, North-West Germany	8	CROP	Arable	AN	Atlantic North	6	2	2	2	4
Macroom, county Cork, Ireland	10	GRASS	Dairy and beef farmers	AN	Atlantic North	5	1	0	1	0
National ITUS Wexford, Ireland	55	CROP	Cropland	AN	Atlantic North	4.176	2.742	2.131	3.297	2.669

WHAT SOLUTIONS ARE CONSIDERED?

MANAGEMENT PRACTICES TO MAXIMISE MULTI SOIL FUNCTIONS

Farmer workshop results

Soil function considered:

Instructions: fill out 1 form for each soil function; write if the management practices has an impact on the soil function considered (strong, medium, low or no effect).

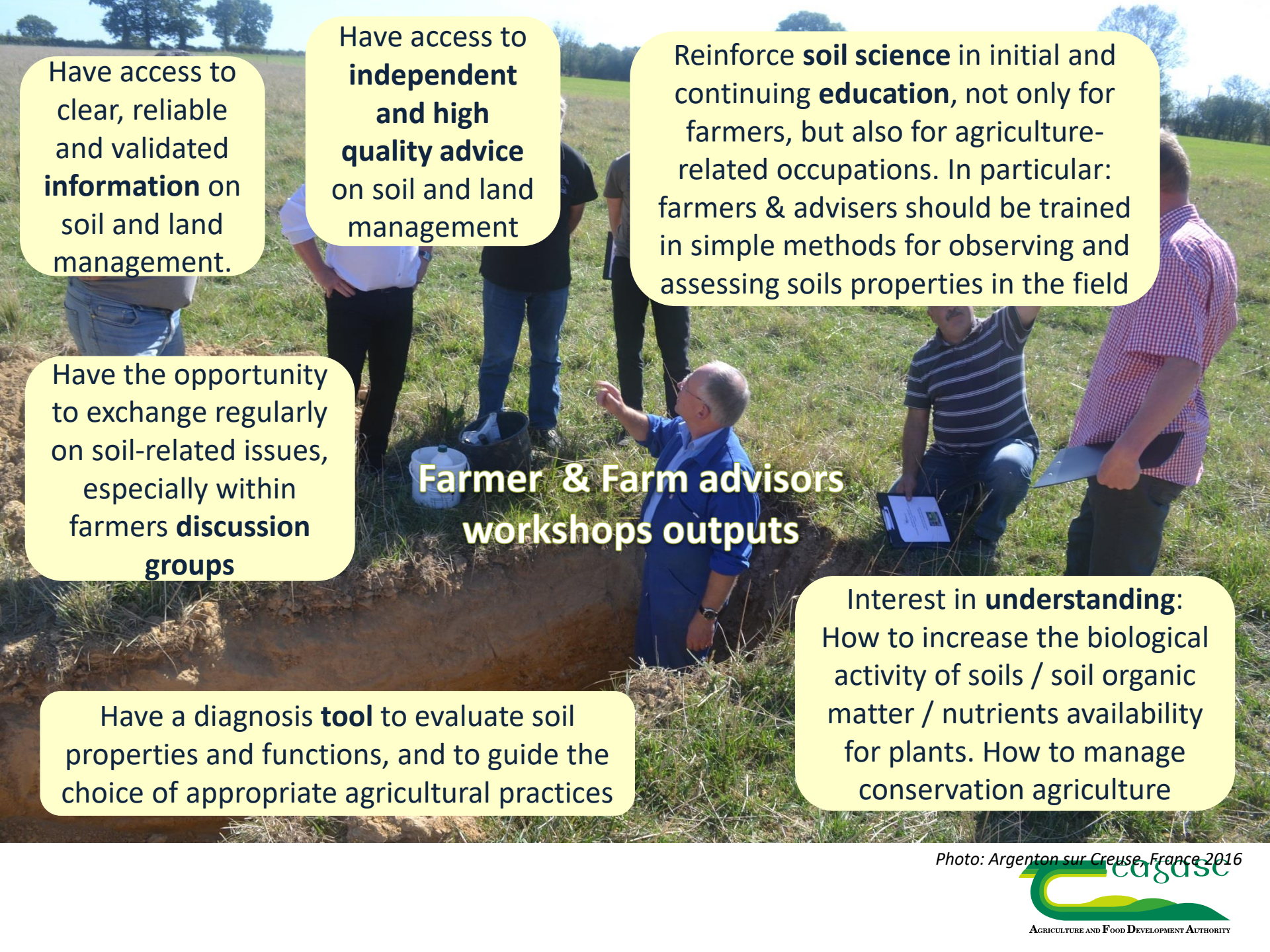
Management practices	Photos (optional)	Effect on soil function
Conventional inversion tillage (20-30 cm)		
Reduced tillage (10-15 cm) non-inversion		
No tillage		
Rotation		
Winter cereals / Spring cereals		
Maize		
Grain legumes		
Oilseed crops (winter rapeseed)		
Root crops – potatoes/ sugar beets		
Orchards / Vineyards		
Grassland (legume based)		
Grassland (non-legume based)		
Clover for seed production		
Lucerne		
Set-aside		
Bare fallow		
Compost application		
Slurry		
Farmyard manure		
Catch/cover crop (legume based)/Green Manure		
Catch/cover crop (non-legume-based)		
Leave crop residues		
Fertilization		
Irrigation		
Drainage		
Plant protection		
Liming		
Other measures applied by farmers:		
.....		
.....		

Remarks: the list of measures is derived and adapted from EU FP7 SMARTSOIL & CATCH-C projects. Each country can illustrate each measure with a country-specific picture in order to make the different cases more concrete.

Farmers local workshop – final 11

Management practices	Effects on soil functions				
	Primary Production	Water regulation	Carbon sequestration	Nutrient cycling	Habitat biodiversity
Ploughing (20-30 cm)	+++		-	++	-
Reduced tillage - non-inversion(10-15 cm)	+++	++ ↑	+	++	++
No tillage	+++	+++	+++	++	+++
Crop rotation	+++	++	++	++	++
Winter cereals	+++			++	+
Spring cereals	++			+	++
Corn	+++		-	- t +	
Grain legumes (spring)	++	-		+++	+
Oil seed rape (winter)	+++	+++	++	++	++
Potatoes	+++	-	-	-	
Sugar beets	+++	+++	++	++	++
Grass (with clover)	+++	+++	+++	-	+++
Grass (without clover)	+++	+++	+++		++
Grass outside rotation			+++		++
Grass seeds	+++	+++	+++		++
Spinach	+			+++	+
Environmental protection zones / extensive management of sensitive areas			+++	+	++
Tree alleys for wind protection	+		++	-	+++
Slurry	+++	-	+	+++	+++
Farmyard manure	+++	+	+++	+++	+++
Catch/cover crop with legumes / green manure	+	-	++	+++	++
Catch/cover crop without legumes (mandatory by law)	++	+	++	++	++
Leave crop residues	+	++	++	++	++
Fertilization	+++	++	+++	+++	+++
Irrigation	+++	+++	+++	+++	+++
Drainage	+++	+++	+++	+++	+++
Plant protection - chemical	+++	+	+	+	+
Plant protection - mechanical	+++	- t +	-	+	++
Liming	+++	+	-	+++	

Bampa *et al.* (2019) Harvesting European knowledge on soil functions and land management using multi-criteria decision analysis. *Soil Use Manage.* 2019;35:6–20.
 Ghaley, B.B. *et al.* (2018). Assessment of Benefits of Conservation Agriculture on Soil Functions in Arable Production Systems in Europe. *Sustainability*, 10, 794.



Have access to clear, reliable and validated **information** on soil and land management.

Have access to **independent and high quality advice** on soil and land management

Reinforce **soil science** in initial and continuing **education**, not only for farmers, but also for agriculture-related occupations. In particular: farmers & advisers should be trained in simple methods for observing and assessing soils properties in the field

Have the opportunity to exchange regularly on soil-related issues, especially within farmers **discussion groups**

Farmer & Farm advisors workshops outputs

Have a diagnosis **tool** to evaluate soil properties and functions, and to guide the choice of appropriate agricultural practices

Interest in **understanding**: How to increase the biological activity of soils / soil organic matter / nutrients availability for plants. How to manage conservation agriculture

Photo: Argenton sur Creuse, France 2016

Farmer & Farm advisors, Regional and National stakeholders workshops outputs

Requests for the establishment of a harmonized national system for soil monitoring (in countries where it doesn't exist)

Monitor Soil functions would be appreciated

Include Long Term experiments in soil monitoring schemes

Take into account different soils functions in **land use planning**. For example, in urbanization projects, be careful to preserve land with the best farming potential.

Future policies: propose **voluntary measures** to encourage farmers to change their farming practices.

Improve existing regulations, taking better account of soils and harmonize these regulations, rather than creating new.

Propose payments to encourage farmers to increase **carbon sequestration**.

Encourage **soil-friendly farming practices** by paying a better price to these producers (i.e. better economic valorization)

National stakeholders workshops outputs

Photo: National Chamber of Agriculture, Paris, France, 2016

Soil conservation techniques to minimize **erosion** and indirectly as the transfer of **pollutants**

Impact of **agri-environment schemes**

Identification of **critical areas** and highly multifunctional land

Flood mitigation

The impact of **urban expansion** on supply of soil functions and the eventual redistribution of supply

Reducing unnecessary inputs to soil reduce the risk of these leaching, eroding and being carried into nearby **water bodies**

Increased resilience of soils in response to **climate change**

The competing demands for other functions on **carbon sequestration potential**



Photo: COPA-COGECA, Bruxelles, Belgium 2016

<http://cloudstorage.ijs.si/navigator/#/app/navigator>

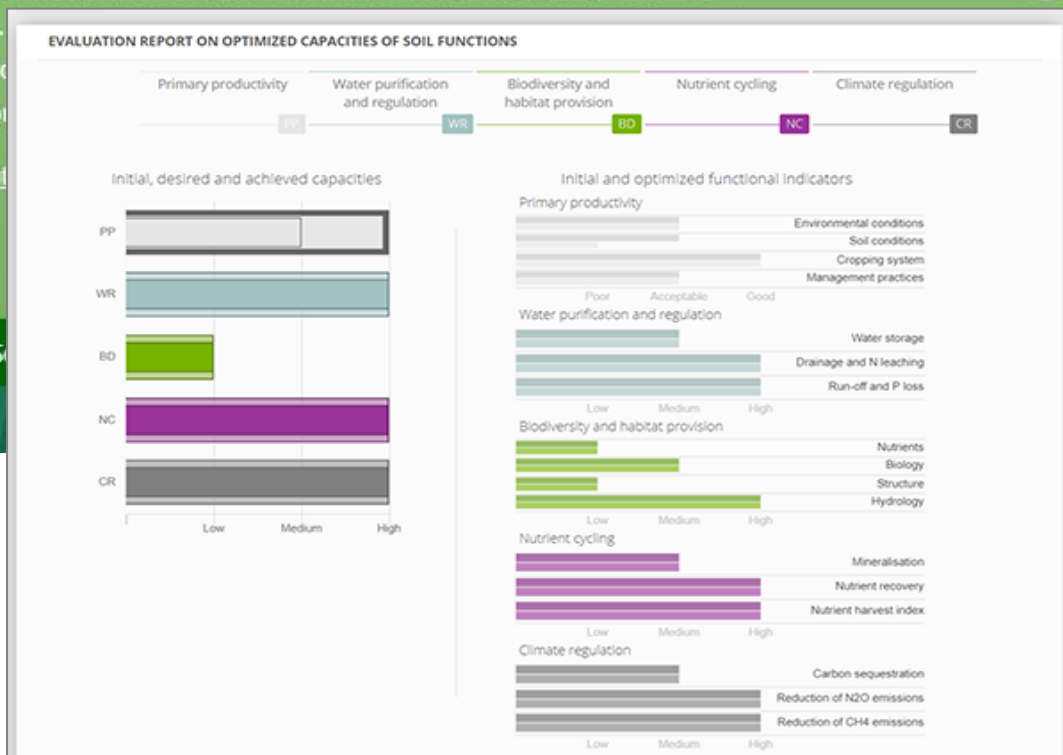
A Decision Support System for assessing and optimizing soil functions

The Soil Navigator decision support system (DSS) was developed in the Horizon 2020 project **LANDMARK**. It assesses the initial capacities of five soil functions within a field including primary productivity, nutrient cycling, water purification and regulation, carbon sequestration and climate regulation, as well as biodiversity and habitat provision. It provides management recommendations to assist farmers and farm advisors.

Current version is a prototype that was tested in (Denmark, France, Ireland).

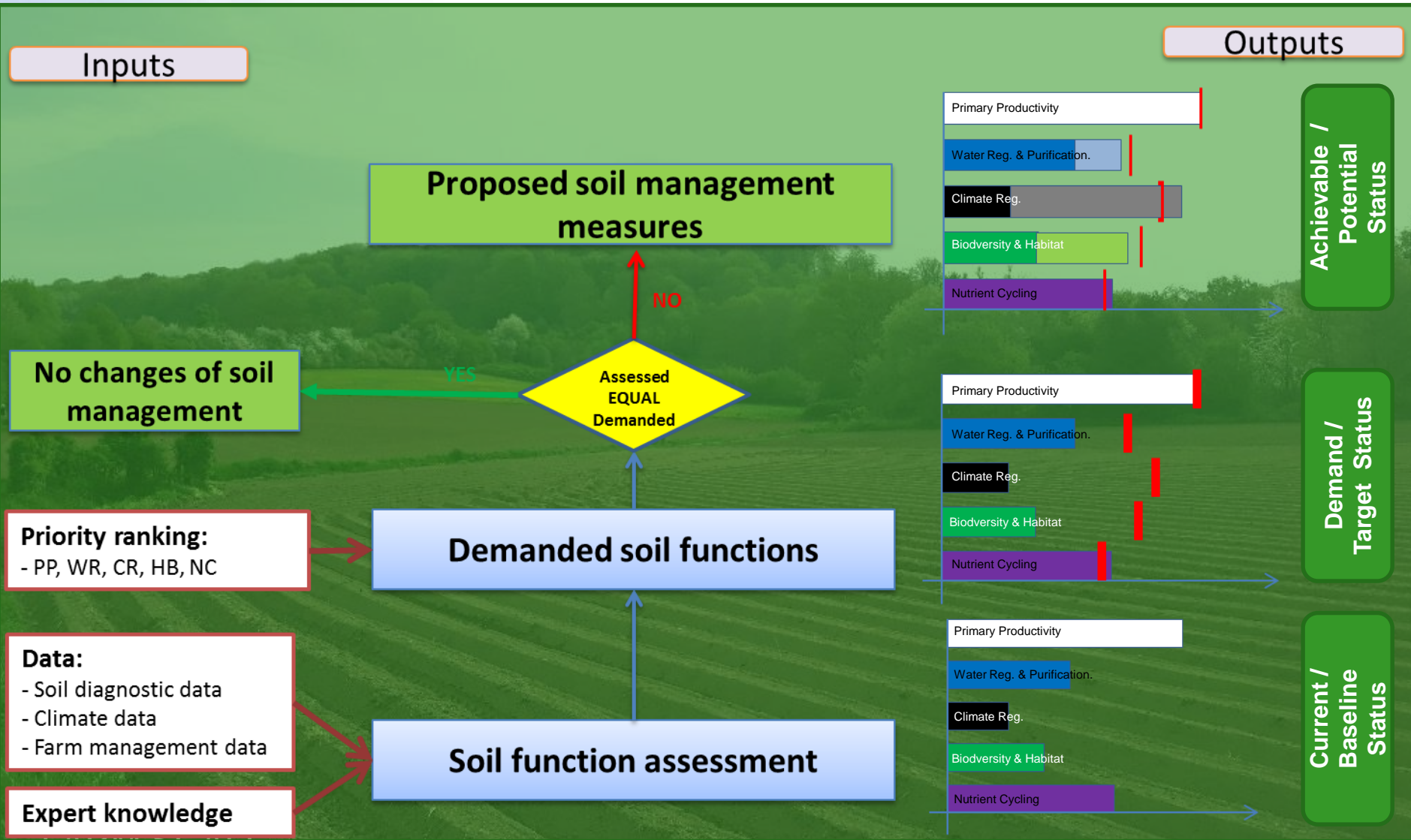
Watch video

Run S...



Funding from the European Union's Horizon 2020 research & innovation programme under grant agreement No 635201.

TOOLS:FARM SCALE DECISION SUPPORT FOR ACHIEVEING MULTIPLE OBJECTIVES



IDENTIFYING ENTRY POINTS FOR POLICY INTERVENTIONS AND/OR INCENTIVISATION

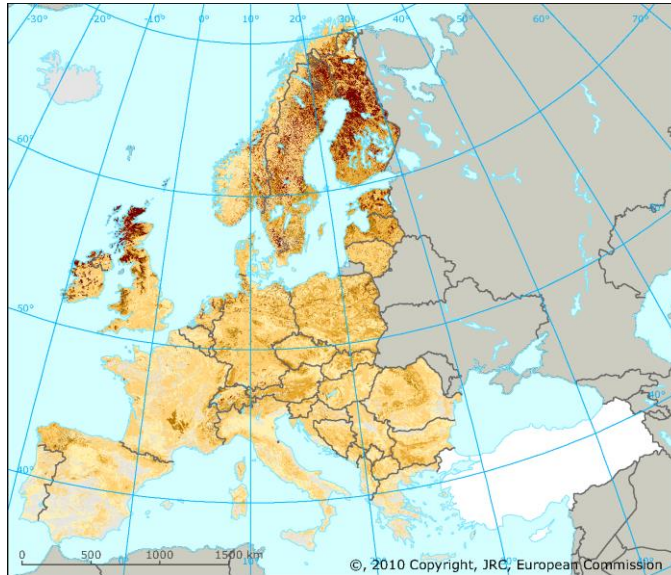
- Functional fit – governance gaps, are different units of government contradictory - need to assess policy (in)coherence.
- Putting the people into Functional Land Management:
 - What is the current network of signals for sustainable soil management?
 - WHO are the actors and what bridges (incentives, measures etc.) are necessary to reach target
 - Gaps or opportunities in networks



SUPPORTING CHANGE IN SOIL MANAGEMENT

THROUGH POLICY & INCENTIVISATION

GAEC 2– Protection for carbon-rich soils



- On average, soils in Europe are most likely to be accumulating carbon.
- Arable land are a smaller carbon source
- Drainage of organic soils, leading to 20–40 tonnes of CO₂ emissions per hectare per year
- Most effective option to preserve existing stocks in soils with high content of organic carbon

EIP-locally led Organic soil re-wetting scheme

Scheme to target climate action on drained peatland under agricultural management.

Its aim is to develop new ways of approaching the challenges being faced by these lands and which offer a new way forward.

The scheme will look for sustainable land management options for farms to meet some or all of the following objectives:

1. Protect carbon stock and restore sequestration associated with drained peatlands under agricultural management
 2. Maximise other ecosystem service co-benefits such as protection of biodiversity, water quality and water regulation
 3. Build resilience to the impacts of climate change at catchment/landscape level
-
- A close-up photograph of a hand holding a dark, crumbly piece of peat soil. The background is a blurred green field.

Thank You

Questions ?

