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The multifunctionality of soils – who defines soil value?

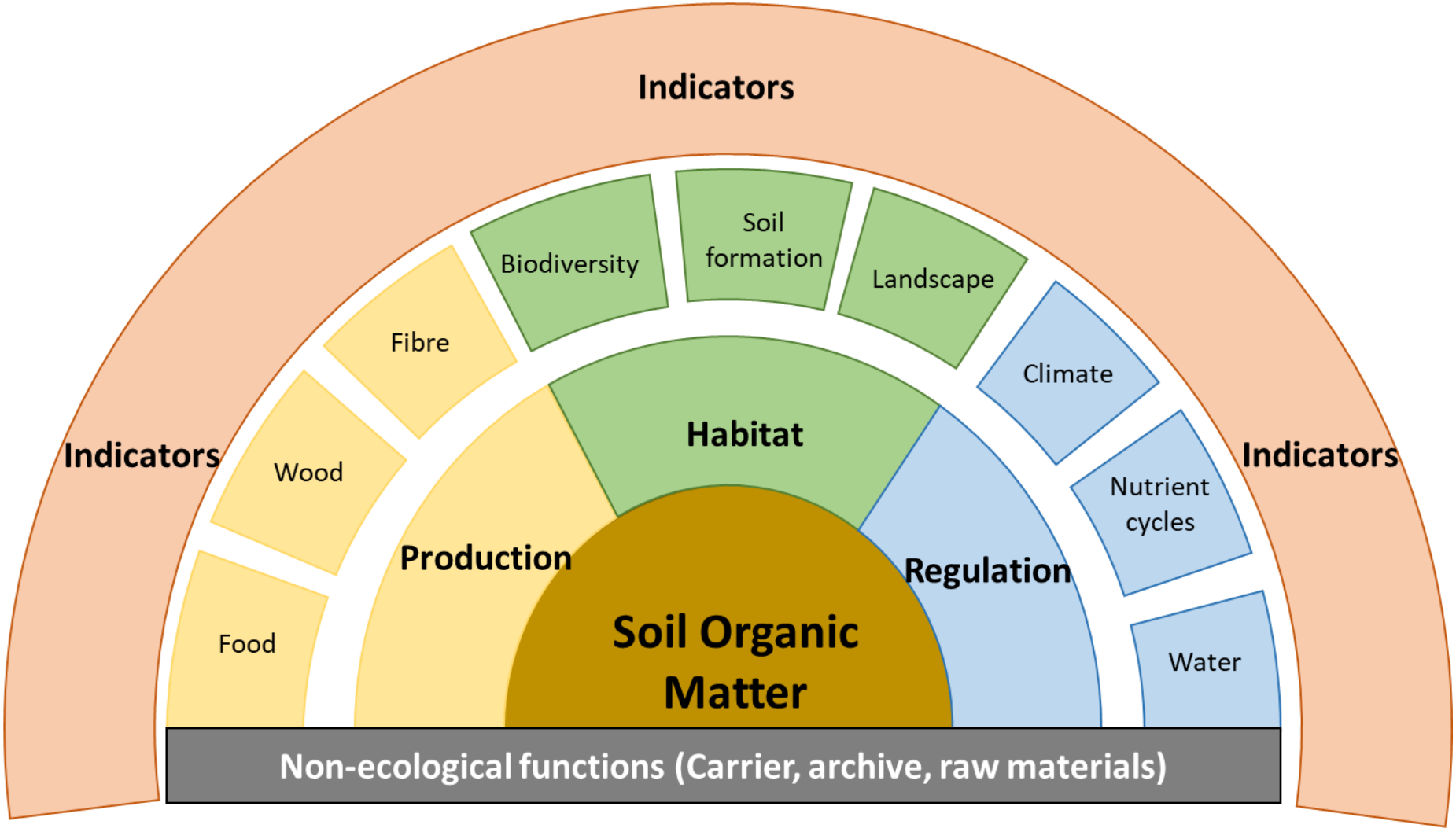
Else Bünemann and Andreas Fliessbach, FiBL

EURAGRI

EURAGRI Conference 2021: Bringing Science to Society through Co-Innovation and Co-Creation – The Soil-Health and Food Mission

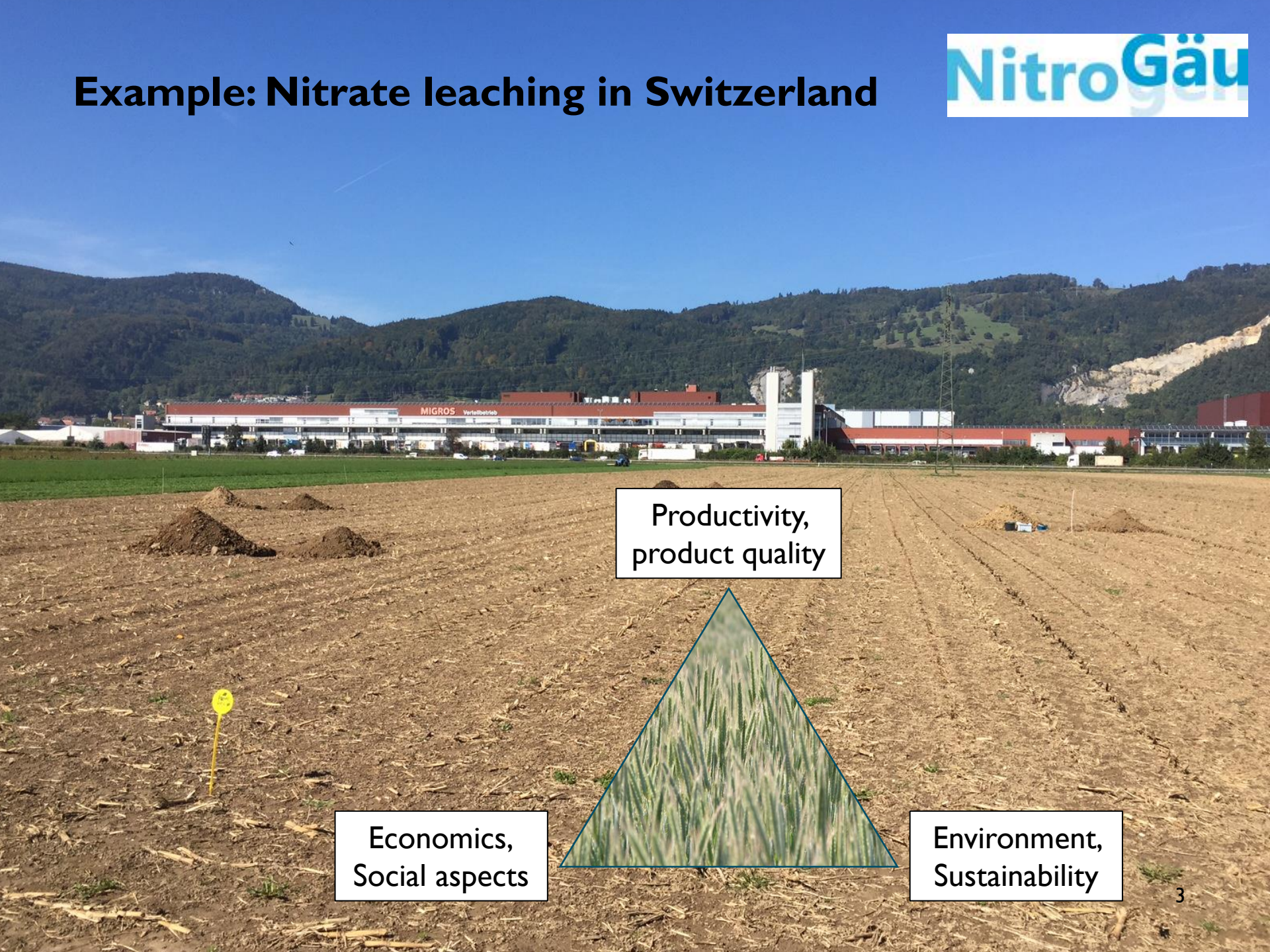
September 27-28, 2021, Evora (Portugal) and online

Soils have many functions – soil organic matter is central

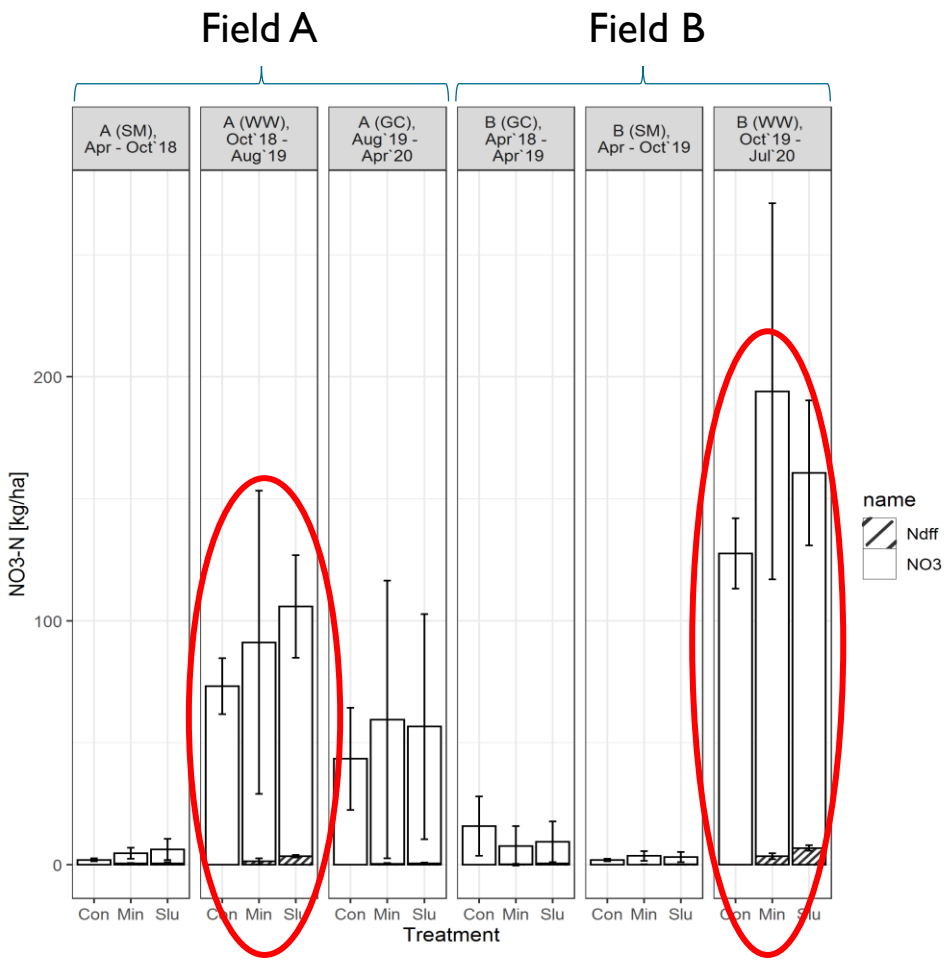


A. Fliessbach, unpublished

Example: Nitrate leaching in Switzerland



High nitrate leaching, but not from applied fertilizers



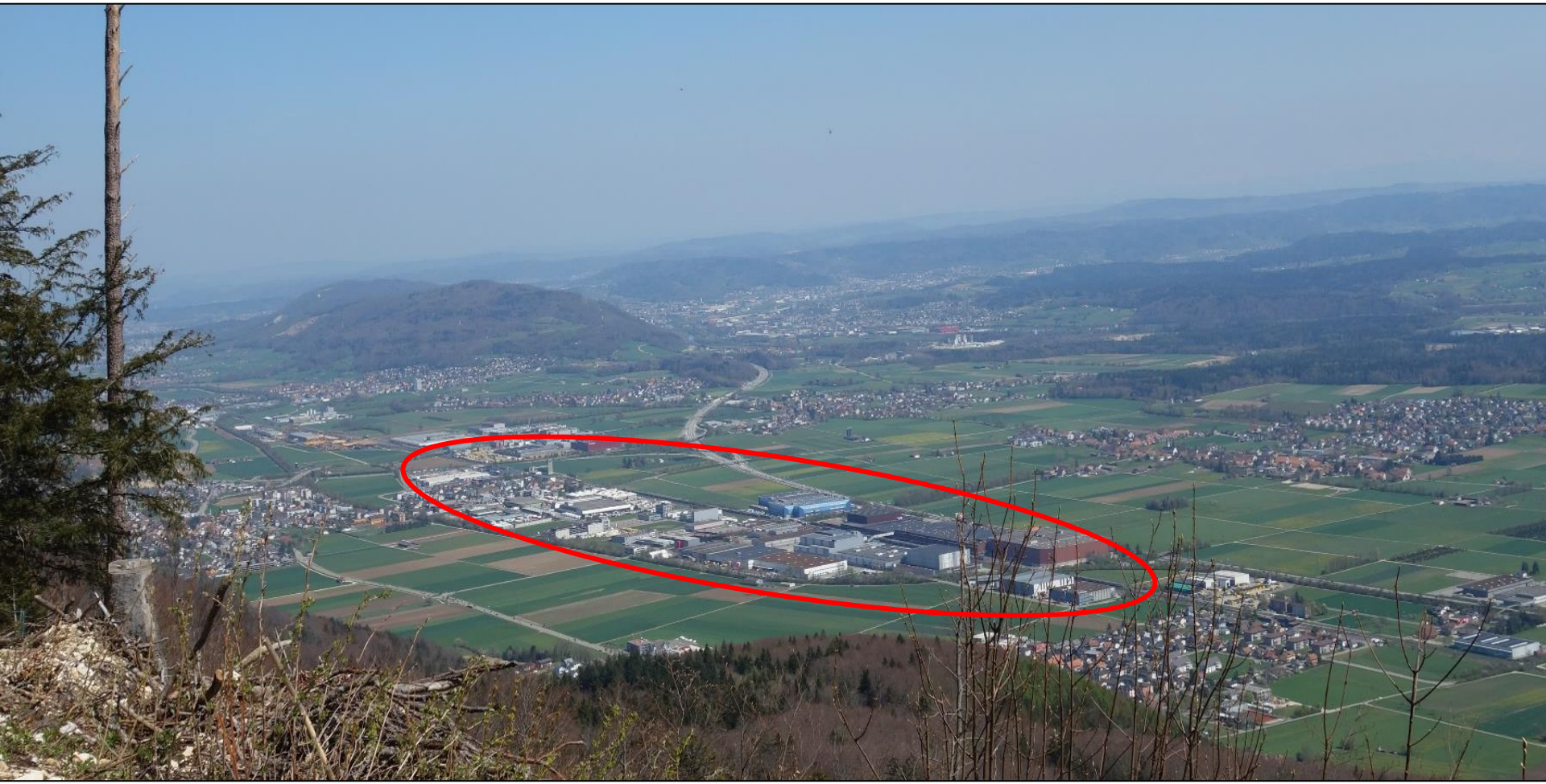
Main nitrate leaching period in the winter after ley termination

Frick et al., in preparation

Message to farmers: reduce N inputs to avoid buildup of large soil N reserves

But what about carbon sequestration?

Who defines the value of soils?



Fertile soils suitable for arable production are lost to store houses and distribution centres

What is soil quality?

"The capacity of a soil to function within ecosystem and land-use boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health"

(Doran & Parkin, 1994; 1996)

«Capacity of soils to fulfill their functions in ecosystems»

(Swiss National Research Program 'Soil as a resource' 2018)

Soil quality

= soil health ?

- more associated with biological soil properties
- preferred by farmers (Romig et al. 1996)

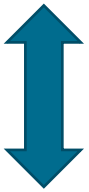
but often used synonymously with soil quality

= soil fertility ?

- more associated with chemical and physical soil properties
- predominantly aligned to yields (Patzel et al. 2000)

but often used synonymously with soil quality

Focus on *dynamic* soil properties in the topsoil



Land quality, land evaluation:

Focus on *inherent* soil properties in the soil profile

How to assess soil quality?

Cornell Soil Health Assessment

Jane Grower
Main St
Yourtown, NY, 12345

Agricultural Service Provider:
Schindelbeck, Bob
Ag Services
rrs3@cornell.edu

Sample ID: M_1
Field/Treatment: Veg field
Tillage: No Till
Crops Crown: COG, COG
Date Sampled: 3/2/2015
Given Soil Type: Lima
Given Soil Texture: Silt Loam
Coordinates: Coordinates Not Provided

Measured Soil Textural Class: Sandy Loam Sand: 65% Silt: 26% Clay: 9%

Test Results

	Indicator	Value	Rating	Constraint
Physical	Available Water Capacity	0.14	53	
Physical	Surface Hardness	240	22	Rooting, Water Transmission
Physical	Subsurface Hardness	310	53	
Physical	Aggregate Stability	56.6	47	
Biological	Organic Matter	3.3	55	
Biological	ACE Soil Protein Index	5.8	25	Organic Matter Quality, Organic N Storage, N Mineralization
Biological	Respiration	0.37	26	Soil Microbial Abundance and Activity
Biological	Active Carbon	366	28	Energy Source for Soil Biota
Chemical	pH	6.9	100	
Chemical	Phosphorus	7.5	100	
Chemical	Potassium	65.3	91	
Chemical	Minor Elements (Mg: 213 Fe: 13.7 Mn: 7.8 Zn: 1.4)		100	
	Overall Quality Score		58	Medium

Visual methods:

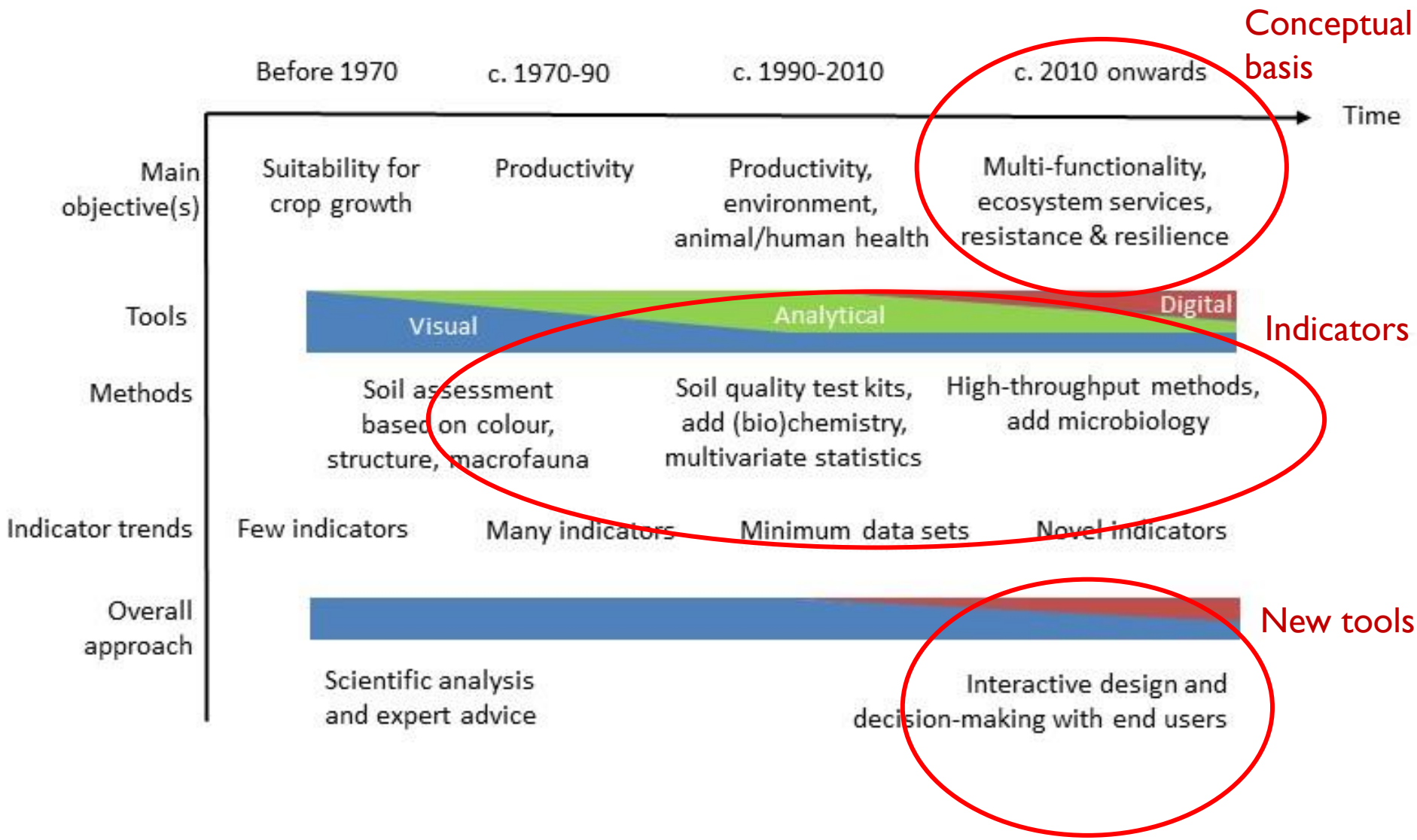
+ instant results
+ simple, holistic
- qualitative, subjective, standardisation difficult
- soil chemistry not included

Analytical methods:

+ quantitative, objective
+ soil chemistry covered especially
- time, money, lab needed
- soil physics, rooting pattern rarely included

combination of visual and laboratory methods is ideal

How to assess soil quality: Development over time



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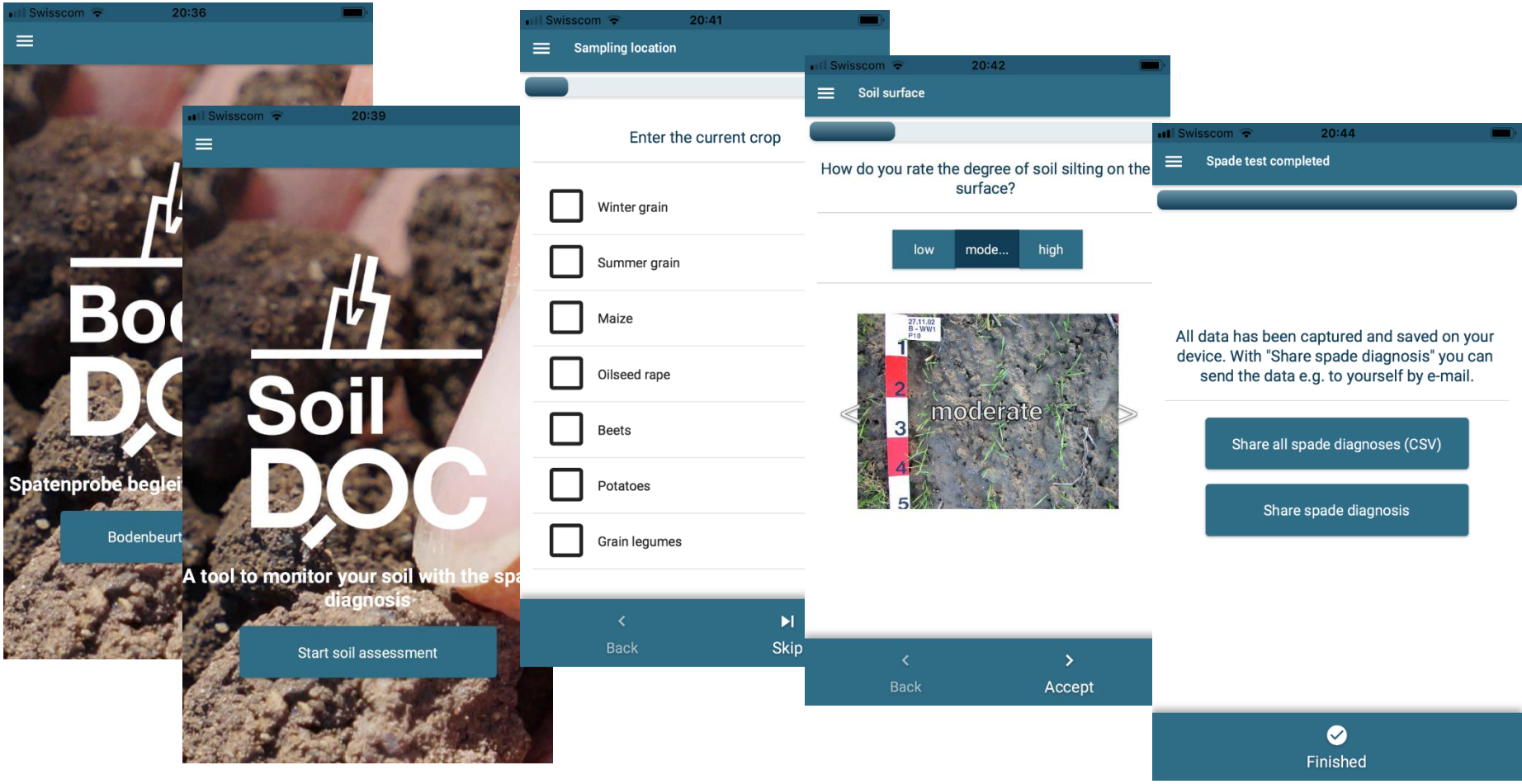
Bünemann et al. SBB 2018


New tools

BodenDOK / SoilDoc – an app for spade diagnosis



Developed in collaboration with

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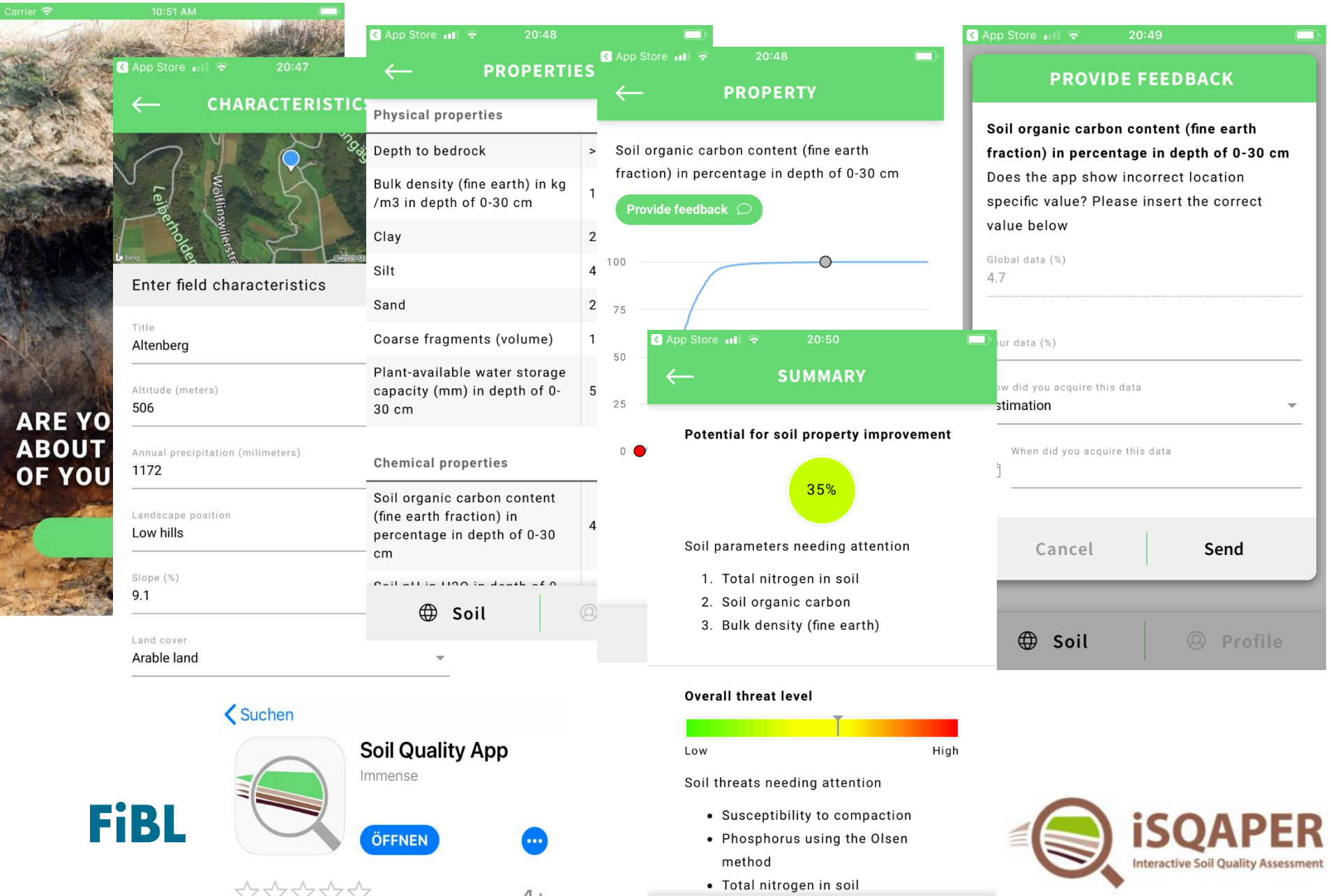
Fachhochschule Nordwestschweiz
Hochschule für Technik

SQAPP – an app which makes soil data available



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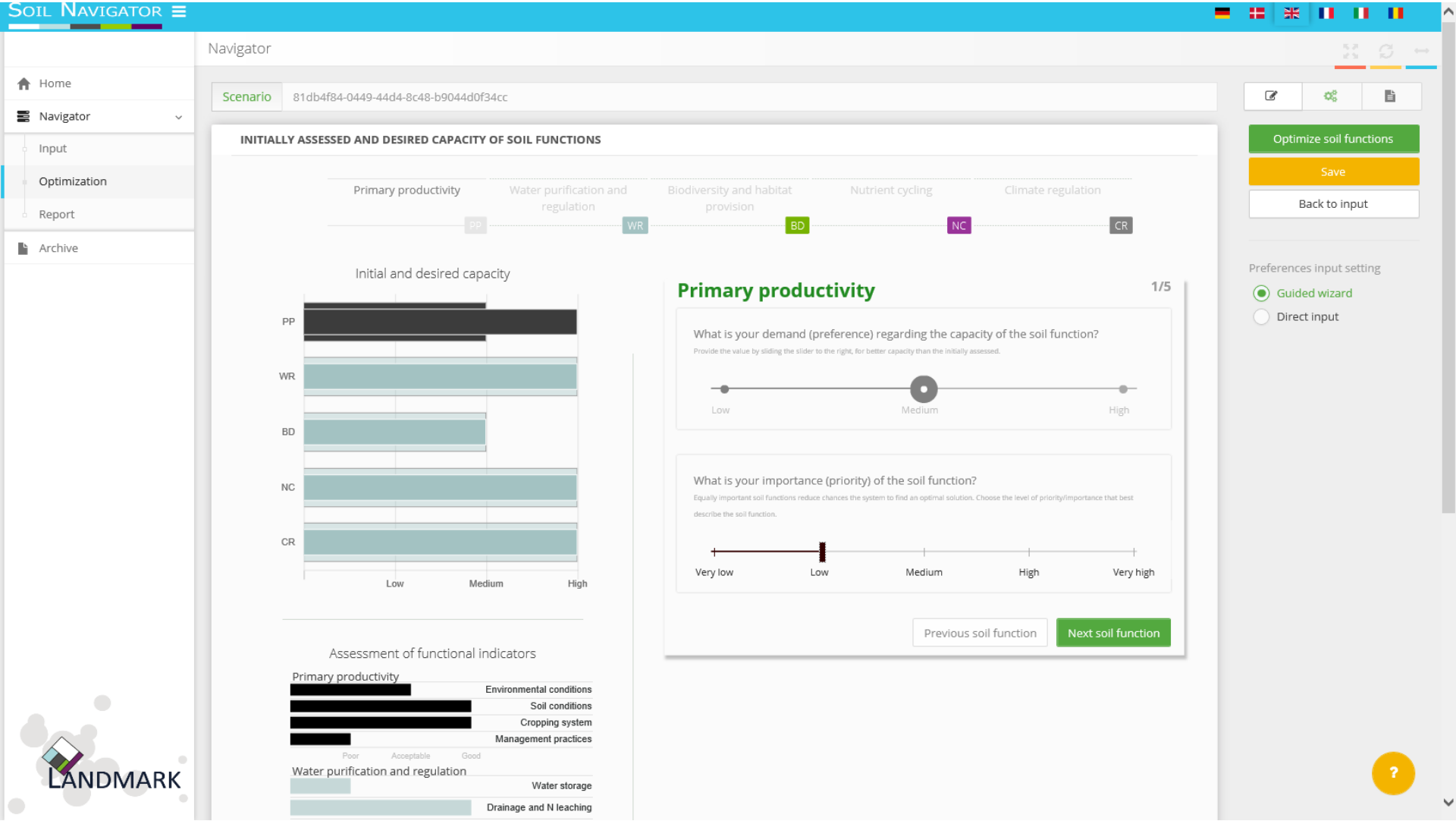
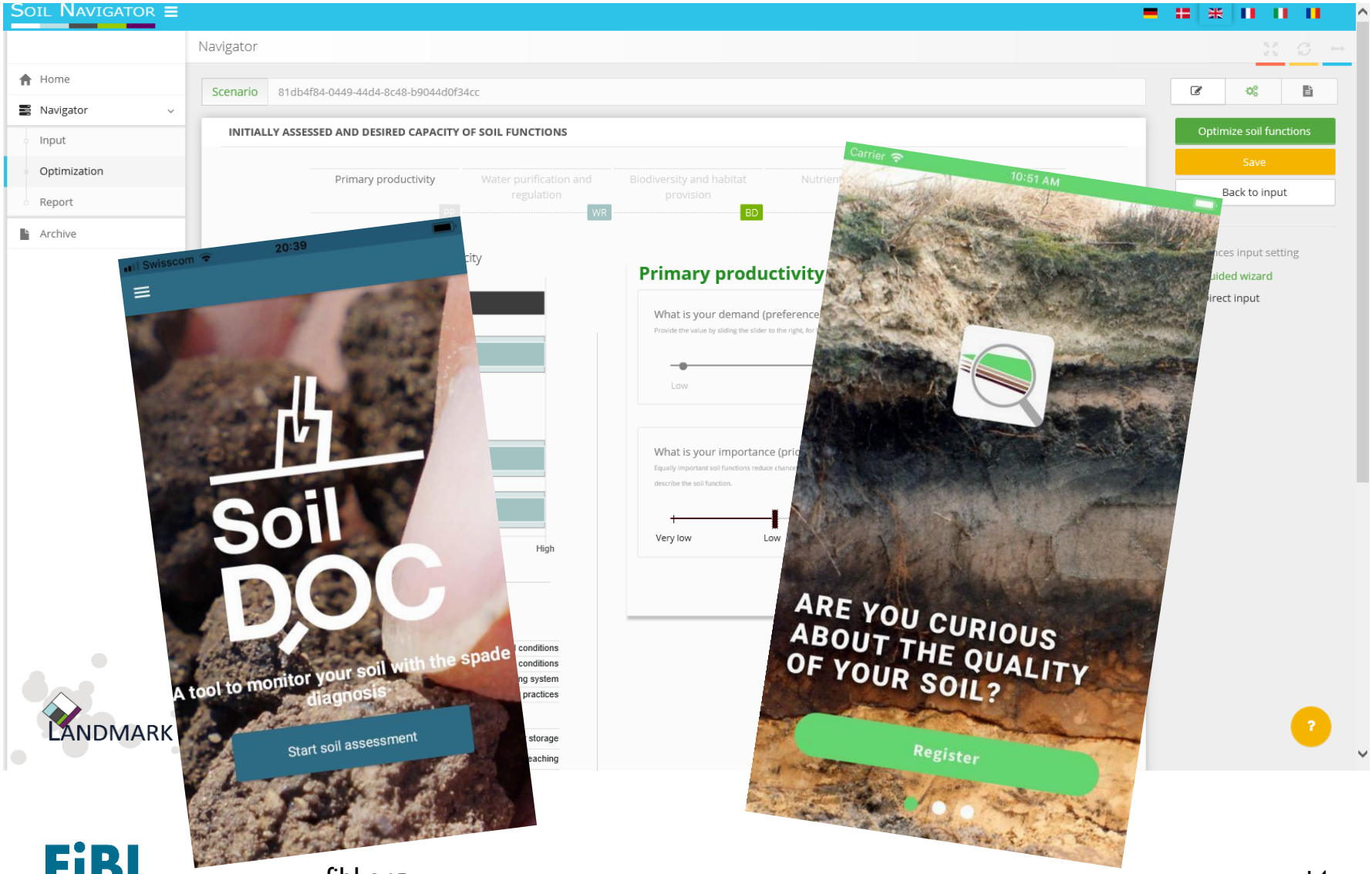
iSQAPER
Interactive Soil Quality Assessment

The Soil Navigator – a web-based decision support tool



New tools require maintenance beyond project lifetime



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How to do research that will be adopted?

Mali: alley cropping systems with *Gliricidia sepium*

Why do farmers not adopt promising innovations?

Innovation	Reasons for poor adoption
Integrated soil fertility management (ISFM)	• Recommended fertilizer rates unaffordable • Knowledge intensive
New legume species for soil fertility	• Not multipurpose, some not palatable • Compete for space, nutrients, water
Agroforestry	• Surface area limiting • Land tenure rights *(who plants trees owns the land)*
Animal manure, compost	• Poorly managed → low quality manure, compost • Messages unclear or even controversial/confusing
Conservation agriculture	• High cost of equipment and inputs • Inability to market/store bumper yield

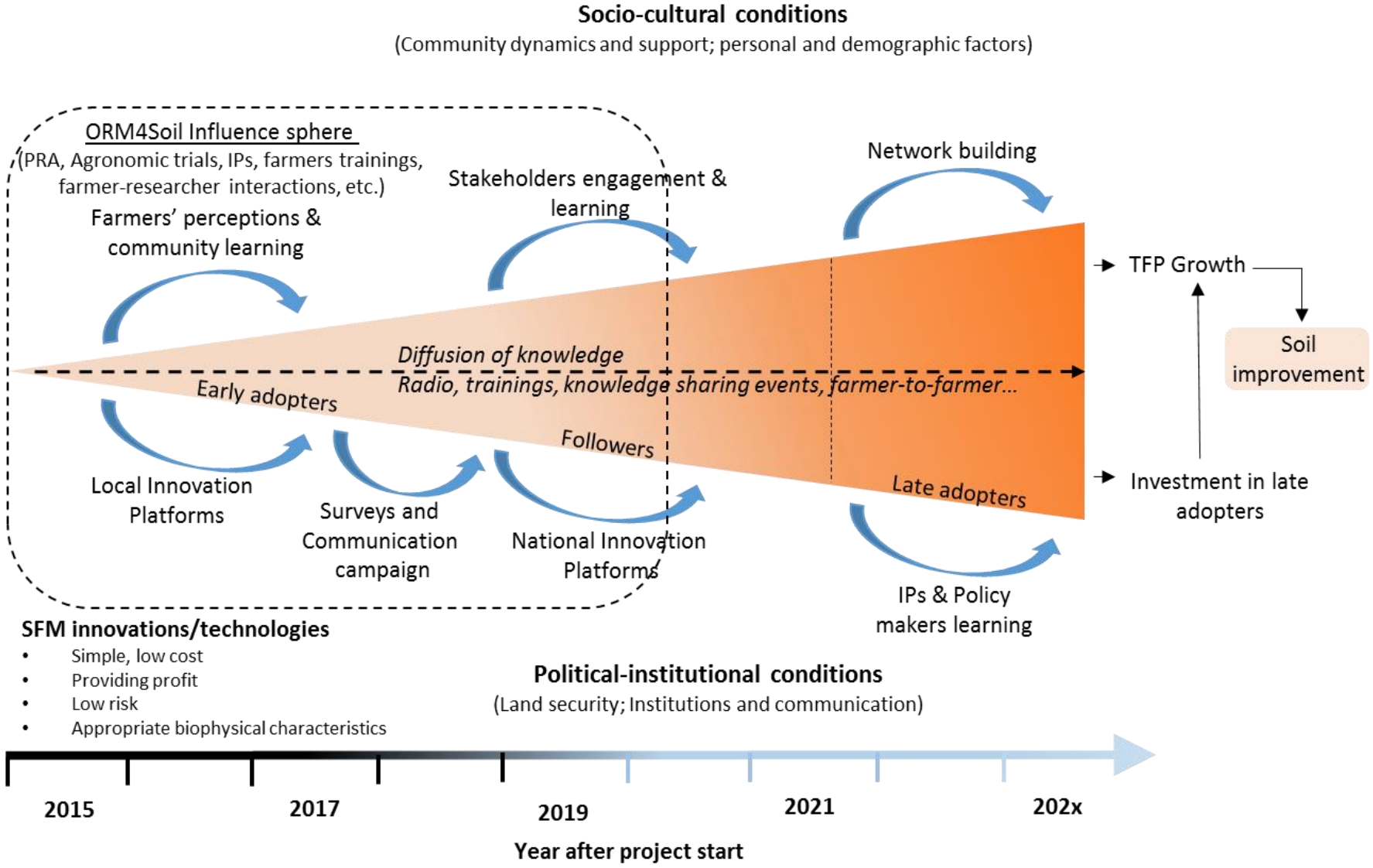
=> Important to understand the reasons

Four countries – eight sites

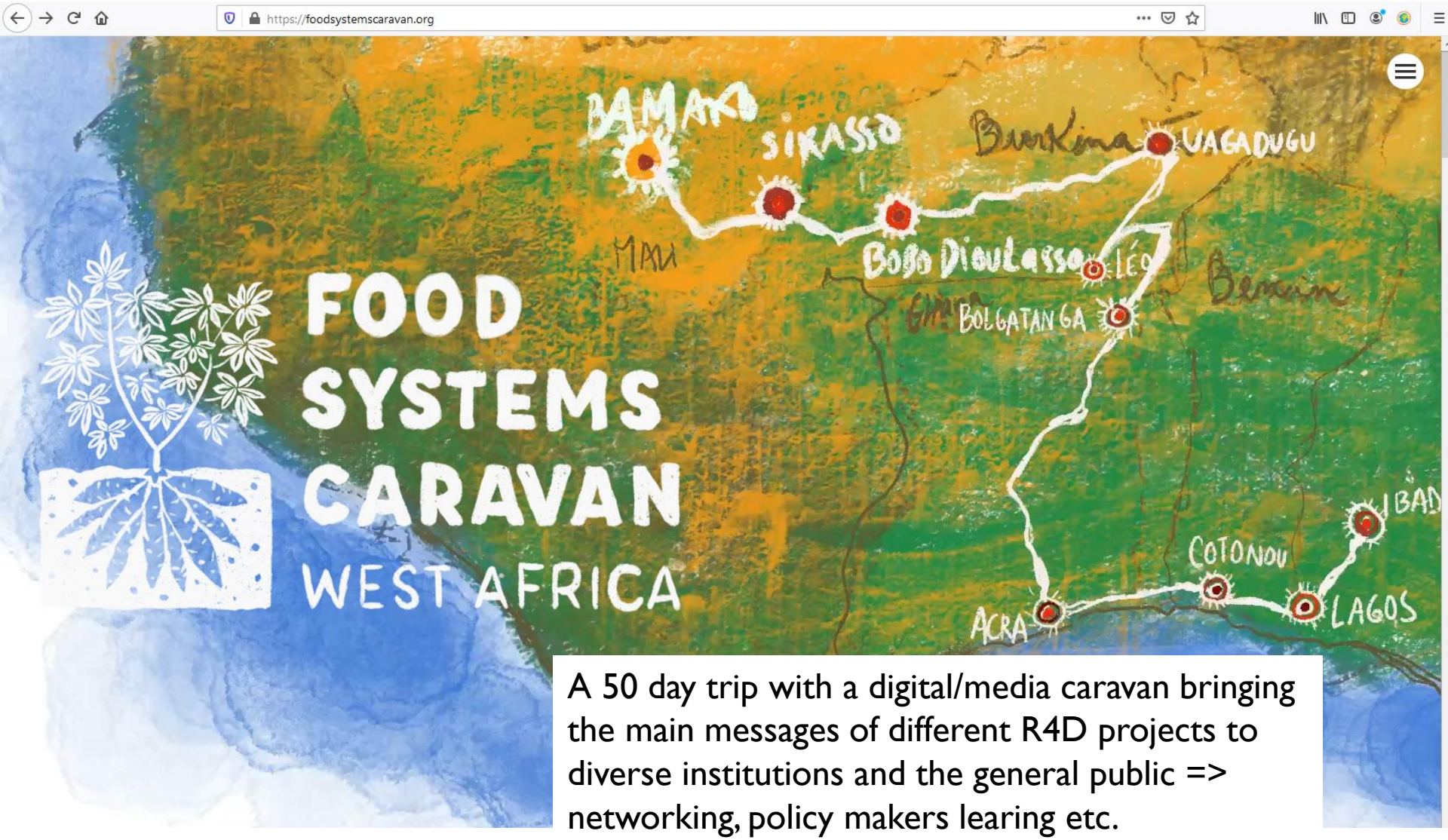
Technologies tested on-station and on-farm

ORM4Soil

Pathway to adoption of an ORM technology



www.foodsystemscaravan.org



A 50 day trip with a digital/media caravan bringing the main messages of different R4D projects to diverse institutions and the general public => networking, policy makers learing etc.

The success of organic agriculture

- Organically cultivated area in Switzerland:
  from 10'000 ha in 1990 to 170'000 ha in 2019
- DOK trial (long-term trial since 1978) founded together with farmers
- Farming system rather than single measures – benefits for soil quality, tradeoffs concerning productivity
- Market development, consumers!

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Conclusions

- Soils have many functions; soil organic matter is central for the ecological functions
- There are trade-offs between the different soil functions
- Farmers are under pressure and hear different messages (political interests, subsidies, and facts from knowledge and experience)
- Tools and solutions need to be developed together with the users; support beyond project lifetime needed
- Adoption of innovations requires stakeholder engagement and joint efforts of policy, research and practice beyond project lifetime

Thank you for your attention!