iSQAPER
Interactive Soil Quality Assessment

Database of currently applied and promising agricultural management practices

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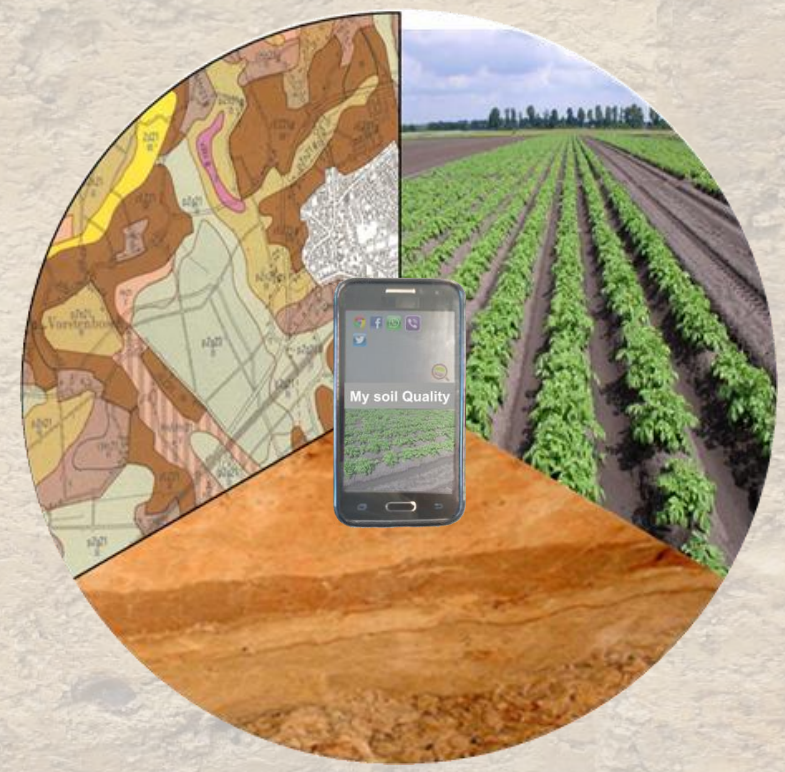

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D5.3 Database of currently applied and promising agricultural management practices [Month 48]

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1. Introduction

This deliverable is part of task 3 “Selection of innovative agricultural management practices”

The selection of innovative agricultural management practices presented in this deliverable was guided by the documented existing practices across the project study sites and from other comparable sites within the WOCAT database.

In order to identify new or ‘improvable’ practices, a structured process of joint selection and negotiation within a multi-stakeholder participative workshop have been conducted at each case study site. Workshop framework was designed to provide the creative environment that enabled to develop new ideas for management improvements and allowed innovations to flourish. The soil quality improvement potential of selected practices was subsequently tested in WP6.

The aim of deliverable 5.3 is to establish a list of currently applied and promising agricultural management practices with the aim to implement the SQAPP with appropriate recommendations. For this purpose, a first set of proposed AMPs was tested, and completed by a second larger set to cover a wider range of soils and management conditions.

2. Selection of a first list of AMPs for testing

A first list of AMPs was selected within the WOCAT database. The selection was based on promising practices that have been shown to positively affect soil quality within the pedoclimatic zones considered (Table 1).

Table 1. Proposed list of AMPs

N.	List / Identification	Description	Expected impacts / Ecological benefits
1	No-till	A system where crops are planted into the soil without primary tillage	Reduces decomposition of OM rates leading to its increase in soil, enhances cycling of nutrients, enhances soil structure and increases water infiltration. Improves soil biological life including disease and weed suppression.
2	Min-till	Tillage operation with • reduced tillage depth • strip tillage • mulch tillage or a combination thereof	Reduces decomposition of OM rates leading to its increase in soil, enhances cycling of nutrients, enhances soil structure and increases water infiltration. Improves soil biological life including disease and weed suppression.
3	Permanent soil cover / Removing less vegetation cover	Avoiding a bare or sparsely covered soil exposed to weather conditions (rain, wind, radiation, etc) by ensuring a permanent cover (at least 30% of the soil surface) throughout the year, e.g. through cutting less grass, leaving a volunteer crop or crop residues, etc.	• Improves infiltration and retention of soil moisture resulting in less severe, less prolonged crop water stress and increases availability of plant nutrients. • Provides source of food and habitat for diverse soil life: created channels for air and water, biological tillage and substrate for biological activity through the recycling of organic matter and plant nutrients. • Increases humus formation.

		(*see also cover crops and residue maintenance / mulching*)	• Reduces the impact of rain drops on soil surface resulting in reduced crusting and surface sealing. • Reduces runoff and erosion. • Reduces wind erosion. • Increases soil regeneration. • Mitigates temperature variations on and in the soil. • Improves the conditions for the development of roots and seedling growth.
4	Cover crops	a. Cover cropping: planting close-growing crops (usually annual legumes), b. Relay cropping**:** specific form of mixed cropping / intercropping in which a second crop is planted into an established stand of a main crop. The second crop develops fully after the main crop is harvested. c. Better crop cover: selecting crops with higher ground cover, increasing plant density, etc.	a. Protects soil, between perennials or in the period between seasons for annual crops. N-fixation in case of leguminous crops. b. Continuously covered soil. Reduces the insect/mite pest populations because of the diversity of the crops grown. Reduces the plant diseases. Reduces hillside erosion and protected topsoil, especially the contour strip cropping. Attracts more beneficial insects, especially when flowering crops are included in the cropping system. c. Protects soil against the impacts of raindrops or wind and keeps soil shaded; and increases moisture content.
5	Leguminous crop	A leguminous crop is a plant in the family Fabaceae (or Leguminosae) that is grown agriculturally, primarily for their grain seed called pulse, for livestock forage and silage, and as soil-enhancing green manure. Well-known legumes include alfalfa, clover, peas, beans, lentils, lupins, mesquite, carob, soybeans, peanuts, and tamarind.	Provides soil with nitrogen and additional nitrogen from chemical fertilizers is not necessary. *(See also cover crop and green manure)*
6	Green manure / Integrated soil fertility management	Green manure is a crop grown to be incorporated into the ground, while the more general term 'integrated soil fertility management' refers to a mix of organic and inorganic materials, used with close attention to context-specific timing and placing of the inputs in order to maximize the agronomic efficiency.	Increases organic matter content, thereby improving fertility and reducing erodibility. In case of leguminous green manure, tilling it back into the soil allows exploiting the high levels of captured atmospheric nitrogen found in the roots.

7	Manuring[a] / composting[b]	a) Manure is organic matter, mostly derived from animal feces (except in the case of green manure, which can be used as organic fertilizer in agriculture). b) Compost is organic matter that has been decomposed and recycled as a fertilizer and soil amendment. Compost is a key ingredient in organic farming.	a) Contributes to the fertility of the soil by adding organic matter and nutrients, such as nitrogen, that are trapped by bacteria in the soil. b) Improves soil fertility through nutrient content and availability, soil structure and microbiological activity; impacts plant growth and health directly and indirectly.
8	Residue maintenance / Mulching	Maintaining crops residues or spreading of organic (or other) materials on the soil surface.	• Reduces sheet and rill erosion. • Reduces wind erosion. • Maintains or improves soil organic matter content. • Conserves soil moisture. • Provides food and escapes cover for wildlife.
9	Crop rotation[a] / Control or change of species composition[b]	a. Practice of alternating the annual crops grown on a specific field in a planned pattern or sequence in successive crop years so that crops of the same species or family are not grown repeatedly on the same field b. Diversify species in rotation systems or grasslands	a. Reduces risk of pest and weed infestations. • Improves distribution of channels or biopores created by diverse roots (various forms, sizes and depths). • Improved distribution of water and nutrients through the soil profile. • Allows exploration for nutrients and water of diverse strata of the soil profile by roots of many different plant species resulting in a greater use of the available nutrients and water. • Increases nitrogen fixation through certain plant-soil biota symbionts and improved balance of N/P/K from both organic and mineral sources. Increases humus formation. b. Introduces desired / new species, reduces invasive species, controls burning, residue burning.
10	Cross-slope measure	Structural measure along the contour to break slope lengths, such as terraces, bunds, grass strip, trashlines, contour tillage	Reduces surface runoff and erosion (increase infiltration capacity).
11	Measures against compaction •	a) Breaking compacted soil: • e.g. deep ripping, subsoiling (hard pans); • Digging the soil up to twice as deep as normally. b) Growing deep rooted plants in the rotation such as: annual alfalfa, beet, sunflower, okra, flax, turnip. c) Controlled traffic farming: is a system which confines all machinery loads to the least	a-b)Looses soil to improve drainage, infiltration, aeration and rooting characteristics, and brings nutrients up from deep below c-d) Minimizes soil damage and preserves soil function in terms of water infiltration, drainage and greenhouse gas mitigation, and (d) provides useful information for decision making process for site-

		possible area of permanent traffic lanes d) Soil compaction models (considering tire size, inflation pressure, weather and soil conditions) to predict allowable wheel load and soil compaction maps to show how soil compaction varies at different locations and depths across the field	specific applications such as variable deep tillage to benefit from increased timeliness (and reduced management costs)
12	Integrated pest and disease management incl. organic agriculture	Appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to reduce or minimize risks to human health and the environment.	Emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.
13	Water diversion and drainage	A graded channel with a supportive ridge or bank on the lower side. It is constructed across a slope to intercept surface runoff and convey it safely to an outlet or waterway	Reduces hazard towards adverse events (floods, storms,…), reduces soil waterlogging
14	Irrigation management	Controlled water supply and drainage: mixed rainfed – irrigated; full irrigation; drip irrigation	Improves water harvesting; increased soil moisture; reduces evaporation; improves excess water drainage; recharge of groundwater
15	Major change in timing of activities	Adaptation of the timing of land preparation, planting, cutting of vegetation according weather and climatic conditions, vegetation growth, etc.	Reduced soil compaction, soil loss, improved biomass, increased biomass, increased soil OM
16	Layout change according to natural and human environment/needs	eg exclusion of natural waterways and hazardous areas, separation of grazing types; increase of landscape diversity.	Reduces surface runoff and erosion, increases biomass, nutrients and soil OM, controls pests and diseases
17	Area closure / rotational grazing	Complete or temporal stop of use to support restoration	Improves vegetative cover, reduces intensity of use, and soil compaction and erosion.
18	Change of land use practices / intensity level	eg change from grazing to cutting (for stall feeding), from continuous cropping to managed fallow, from random (open access) to controlled access (grazing land), from herding to fencing, adjusting stocking rates.	Increases biomass, nutrient cycling, soil OM, improves soil cover, beneficial species (predators, earthworms, pollinators), biological pest / disease control, and increases / maintains habitat diversity. Reduces soil loss, soil crusting/sealing, soil compaction, and invasive alien species.

3. Tested promising AMPs at case study sites

The impact of promising AMPs on soil quality was assessed using a Visual Soil Assessment tool (e.g. Shepherd, 2000) in a total of 138 pairs of plots/farms spread across 14 study site areas (SSA), including 10 located in Europe and 4 in China. The full description of the SSA's, the establishment of promising AMPs as well as the criteria used to select these 138 pair of farms/plots within each SSA is provided in Barão et al. (2019).

Each pair includes a farm/plot where a new promising AMP has been used for at least the last 3 years (plot-AMP) and a farm/plot where the corresponding conventional practice was implemented during the last 3 years (plot-control).

The previously selected 138 pair of farms/plots include a myriad of promising AMPs and combinations (Barão et al. 2019***)*** in use by farmers and thus represent the promising management choices undertaken locally. The majority of the evaluated pairs of plots/farms corresponds to arable lands with fewer pairs addressing management practices in pasture and permanent farming systems (Table 2).

Globally, the results show that among 138 sets of paired plots, 104 pairs (75.4 %) show a positive impact of promising AMPs on soil quality, 20 pairs (14.5 %) do not show any difference in soil quality between soils under promising practices and soils in the control plots, and the remaining 14 plots (10.1 %) show an inverse effect. In Europe, positive effects of promising AMPs are present in 73.2% of the paired plots, while in China this value is higher (84.6%). The neutral effects of promising AMPs represent 17% of the plots in Europe and 3.8% in China, while the negative effects are comparable in both continents (9.8% and 11.5% respectively) (Table 2).

Table 2. Tested AMPs at case study sites

Promising AMP tested	Farming System			Total
	Arable	Pasture	Permanent	plots/farms
No-till	4		6	10
Min-till	8		2	10
Permanent soil cover / Removing less vegetation cover		3		3
Cover crops	3		1	4
Residue maintenance / Mulching	7		1	8
Cross-slope measure	1		2	3
Measures against compaction	2			2
Leguminous crop	5			5
Green manure / Integrated soil fertility management	2			2
Manuring & composting	12			12
Crop rotation / Control or change of species composition	12		1	13
Integrated pest and disease management incl. organic agriculture	3		4	7
Water diversion and drainage			1	1
Irrigation management	4			4
Major change in timing of activities	1			1
Area closure / rotational grazing		3		3
Change of land use practices / intensity level	2	8		10
Total single promising AMP tested	**66**	**14**	**18**	**98**
Crop rotation / Control or change of species composition; Integrated pest and disease management incl. organic agriculture	1			1
Integrated pest and disease management incl. organic agriculture; Major change in timing of activities	1			1
Leguminous crop; Residue maintenance / Mulching			1	1
Manuring & composting; Crop rotation / Control or change of species composition	1			1
Manuring & composting; Integrated pest and disease management incl. organic agriculture			1	1
Manuring & composting; Change of land use practices / intensity level		1		1
Manuring & composting; Crop rotation / Control or change of species composition	1			1
Manuring & composting; Cross-slope measure			1	1

Manuring & composting; Integrated pest and disease management incl. organic agriculture	1			1
Min-till ; Crop rotation / Control or change of species composition	1			1
Min-till; Crop rotation / Control or change of species composition	1			1
Min-till; Irrigation management			1	1
Min-till; Manuring & composting	1		2	3
Min-till; Residue maintenance / Mulching	1			1
No-till ; Crop rotation / Control or change of species composition	1			1
No-till; Residue maintenance / Mulching	1			1
Permanent soil cover / Removing less vegetation cover; Leguminous crop			1	1
Permanent soil cover / Removing less vegetation cover; Manuring & composting	1	2		3
Residue maintenance / Mulching; Irrigation management	1			1
Total combination of 2 promising AMP tested	**13**	**3**	**7**	**23**
Green manure / Integrated soil fertility management; Integrated pest and disease management incl. organic agriculture; Irrigation Management	1			1
Manuring & composting; Crop rotation / Control or change of species composition; Irrigation management	1			1
Min-till; Cover crops; Green manure / Integrated soil fertility management			1	1
Min-till; Manuring & composting; Crop rotation / Control or change of species composition	1			1
Min-till; Permanent soil cover / Removing less vegetation cover; Manuring & composting			1	1
Permanent soil cover / Removing less vegetation cover; Manuring & composting; Residue maintenance / Mulching			1	1
Total combination of 3 promising AMP tested	**3**	**0**	**3**	**6**
Manuring & composting; Residue maintenance / Mulching; Crop rotation / Control or change of species composition; measures against compaction	1			1
Min-till; Cover crops; Green manure / Integrated soil fertility management; Integrated pest and disease management incl. organic agriculture			1	1
Min-till; Residue maintenance / Mulching; Crop rotation / Control or change of species composition; Measures against compaction	1			1
Total combination of 4 promising AMP tested	**3**	**0**	**1**	**3**
Cover crops; Green manure / Integrated soil fertility management; Residue maintenance / Mulching; Crop rotation / Control or change of species composition; Measures against compaction	1			1
Min-till; Leguminous crops; Residue maintenance / Mulching; Crop rotation / Control or change of species composition; Measures against compaction	1			1
Min-till; Manuring & composting; Residue maintenance / Mulching; Crop rotation / Control or change of species composition; Measures against compaction	1			
Total combination of 5 promising AMP tested	**3**	**0**	**0**	**3**
Min-till; Manuring & composting; Residue maintenance / Mulching; Crop rotation / Control or change of species composition; Cross-slope measure; Measures against compaction	1			1
Min-till; Manuring & composting; Residue maintenance / Mulching; Crop rotation / Control or change of species composition; measures against compaction; Measures against compaction	1			1
Total combination of 6 promising AMP tested	**2**	**0**	**0**	**2**
Min-till; Leguminous crops; Manuring & composting; Residue maintenance / Mulching; Crop rotation / Control or change of species composition; Measures against compaction; Water diversion and drainage	1			1
Min-till; Permanent soil cover / Removing less vegetation cover; Leguminous crops; Manuring & composting; Residue maintenance / Mulching; Crop rotation / Control or change of species composition; Measures against compaction	2			2
Total combination of 7 promising AMP tested	**3**	**0**	**0**	**3**

4. Expanded list of AMPs

To cover a wider range of soil and land management conditions, the first list of AMPs was expanded (Table 3). 72 AMPs are considered in the SQAPP and served for the recommendations provided by SQAPP for specific needs at the farm scale. Promising AMPs in the case study areas were documented using the WOCAT format. Annex 1 provides an overview of the 34 example technologies described. These technologies may be included as examples in SQAPP. A first qualitative evaluation of the plausibility and consistency of AMPs, was done by WP6 during the field assessment of 2019.

Table 3. Expanded list of AMPs

AMP broad class	AMP category		AMP
Terrain management	Cross-slope barriers	1	Bunds
		2	Terraces
	Runoff control	3	Half moon terraces
		4	Gully rehabilitation
Soil management	Tillage	5	Minimum tillage
		6	No-tillage
		7	Contour ploughing
		8	Subsoiling
		9	Roughening the soil surface
		10	Seedbed placement
		11	Straw interlayer burial
	Traffic management	12	Avoidance of traffic
		13	Controlled traffic
		14	Respect wheel load carrying capacity
	Soil replacement	15	Claying soils
	Soil amendments	16	Soil conditioners
		17	Liming
	Conservation agriculture	18	Conservation agriculture
Vegetation management	Vegetation cover	19	Permanent soil cover in orchards
		20	Cover crops
		21	Rangeland rehabilitation
	Fallow management	22	Planted fallow
	Vegetation bands	23	Vegetative strips
		24	Shelterbelts
		25	Buffer zones/landscape elements
		26	Strip cropping
	Crop choice	27	Deep rooting crops
		28	Intercropping
		29	Growing halophytes
	Crop rotation/diversification	30	Crop rotation/diversification
	Multi-layered vegetation	31	Agroforestry
Water management	Diversion	32	Diverting water flow
	Drainage	33	Intercepting drains
		34	Submerged drains
		35	Drains
	Water harvesting	36	Planting pits
		37	Ridge-furrow systems
	Water conservation	38	Inorganic mulching
	Irrigation	39	Drip irrigation
		40	Flood irrigation
		41	Pivot irrigation
		42	Sprinkler irrigation
	Irrigation management	43	Leaching salts
		44	Minimise saline water irrigation
	Irrigation scheduling	45	Irrigation optimization
		46	Supplemental irrigation
	Runoff conveyance	47	Grassed waterways

Table 3 – continued

Nutrient management	Organic amendments	48	Liquid manure or slurry
		49	Apply animal manures
		50	Compost application
		51	Biochar application
	Inorganic amendments	52	Inorganic fertilisers
	Green manuring	53	Green manure
		54	Leguminous crops
	Retain crop residues	55	Retain crop residues
	Mulching	56	Chipped branches
		57	Straw mulch
Pest management	Weed management	58	Mechanical weed control
		59	Chemical weed control
			Biological weed control
	Pest management	60	Biological pest control
		61	Physical pest control
		62	Chemical pest control
	Disease management	63	Physical disease control
		64	Chemical disease control
			Biological disease control
Pollutant management	Remediation	65	Phytoremediation
	Balanced applications	66	Integrated pest and disease management
		67	Integrated nutrient management
			Automated targetting
Grazing management	Grazing management	68	Controlled and rotational grazing
		69	Area closure

5. Summary and conclusions

In this report, a first set of AMPs was selected and tested at the case study sites. This list has been completed by additional AMPs to take wider range of conditions into account.

For the first set of indicators, the VSA was applied in 138 paired/plots where different promising AMPs (single or in combination) are in use by local farmers. Among the 138 sets of paired plots, 75.4 % show a positive impact of promising AMPs on soil quality, 14.5 % do not show any difference in soil quality between soils under promising practices and soils in the control plots, and the remaining 10.1 % show inverse negative effect on soil quality. A second assessment was done in 2018 and will be evaluated soon to check these results.

The stakeholders tested the recommendations of the AMPs provided in the SQAPP (expanded list) to verify their plausibility and consistency. The first results have been provided by WP6.

References

Barão, B., Basch, G., Alaoui, A., Schwilch, G. et al. 2019. Promising Agricultural Management Practices (AMP) Assessment in Europe and China. Science of the Total Environment 649, 610-619.

Shepherd, G. 2000. Visual Soil Assessment. Volume 1. Field guide for cropping and pastoral grazing on flat to rolling country. horizons.mw & Landcare Research, Palmerston North. 84p, ISBN 1-877221-92-9, horizons.mw Report Number 20/EXT/425

Annex 1: 34 AMPs documented in WOCAT format