Some problems of the determination of best management practices to maintain the quality of agricultural soils

Gema Guzmán, Marta Sáenz de Rodrigáñez, Ana Laguna, Tom Vanwalleghem, Juan Vicente Giráldez, Karl Vanderlinden and Hein ten Berge

ELS03 Sustainable orchard management to face climatic changes

ELS 2014 - the Earth Living Skin: Soil, Life and Climate Changes

Catch-C

Assessment of compatibility of agricultural MPs and types of farming in the EU to enhance climate change mitigation, productivity and soil health

Is there a set of MPs to enhance soil physical quality across the EU?

Overview: why SPQ is a major concern?

Overview: why SPQ is a major concern?

Overview: why SPQ is a major concern?

Aim of the talk

Discussion of the results of a meta-analysis of the effects of agricultural management practices on physical aspects of soil quality, throughout the published research data of countries of Europe

Meta-analysis

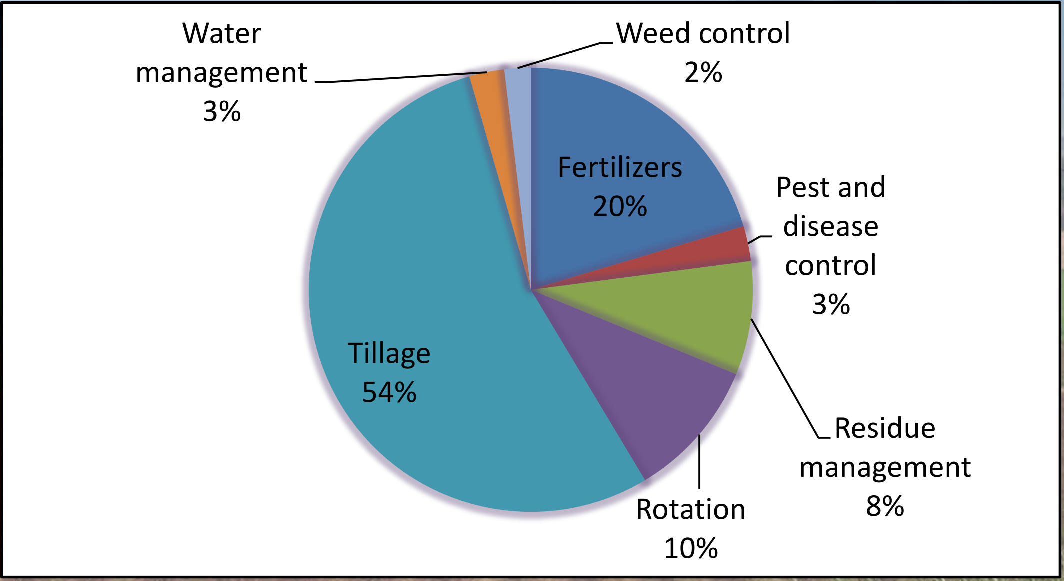
3059 records with data on physical soil quality

Indicators	Acronyms	No. of records	No. of LTEs
Bulk density	bd	930	44
Penetration resistance	pr	978	20
Permeability	pe	209	24
Aggregates stability	as	356	26
Runoff yield	ry	198	23
Sediment yield	sy	191	24

Long term experiments (LTEs) (n=66)

Meta-analysis

Distribution of the bibliography search regarding **SPQ**



Base line treatment	MPs
Monoculture	Crop rotation
Chemical control	Mechanical control
Residue removal	Residue incorporation
Conventional tillage	Minimum tillage Cover crops Deep ploughing Direct drilling

$$RR = \frac{I_{mp}}{I_{bt}}$$

Catch-C

Meta-analysis

Descriptive statistics

One-sample t-test ($p < 0.05$)

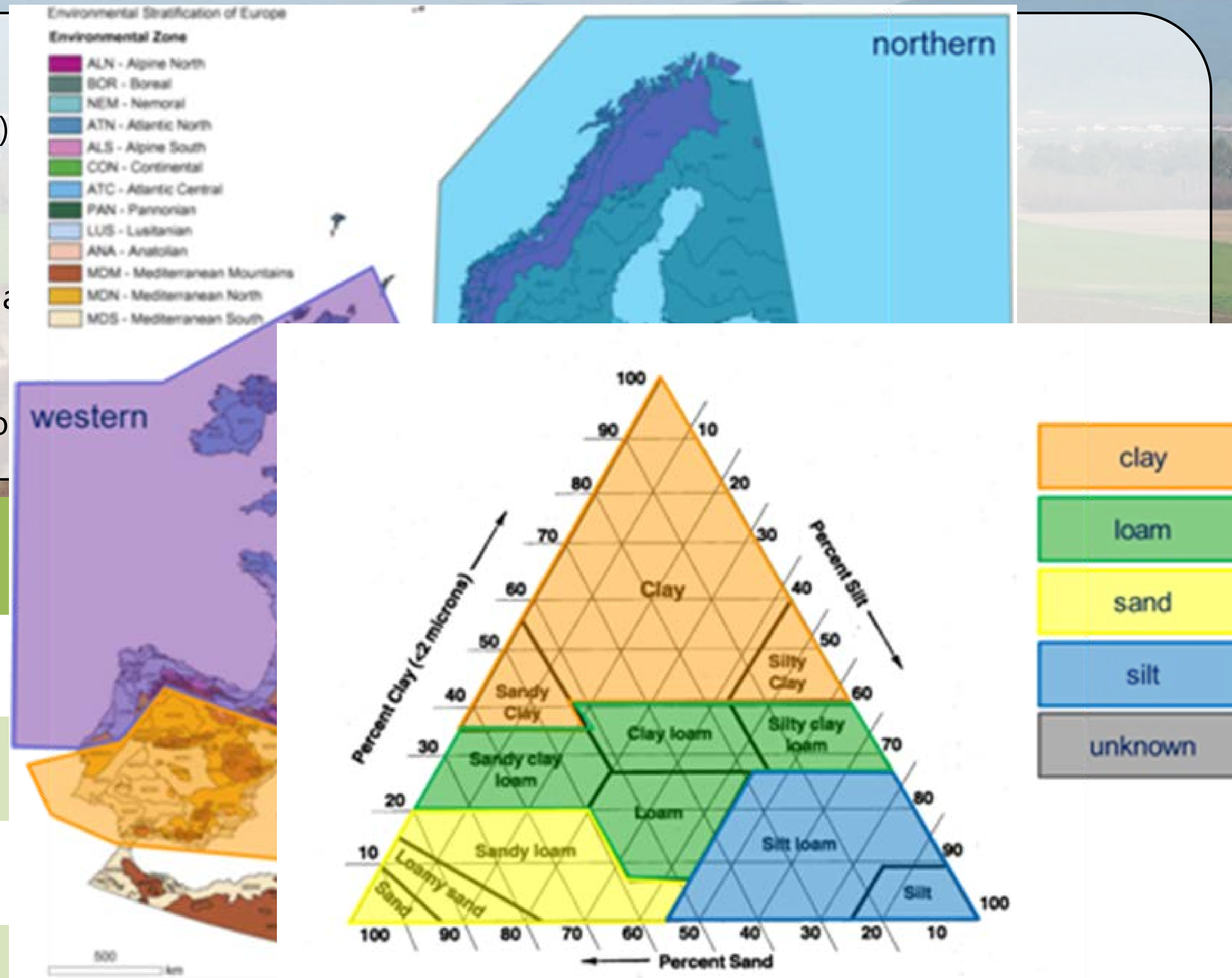
Histograms

Analysis of variance to evalua

practice, separately.

A pairwise Bonferroni test to

Climate
Northern
Western
Eastern
Southern
Other (non-European LTEs)



Adapted from Metzger et al. 2005

Meta-analysis

MPs/indicators		bd	pr	pe	as	ry	sy	Overall SPQ
Rotation	Monoculture							
	Crop rotation	+	++	+	+	++	NA	++
Crop protection	Chemical control							
	Mechanical control	+	++	-	++	NA	NA	+
Residue management	Residue removal							
	Residue incorporation	-	--	NA	++	NA	NA	0
Tillage	Conventional tillage							
	No tillage	-	+	-	--	--	--	--
	Minimum tillage	0	--	--	++	-	-	-
	Cover crops	--	+	+	++	++	++	++
	Deep ploughing	--	+	+	++	-	++	+
	Direct drilling	-	--	--	++	+	++	++

Why some contradictions?

Limitations

- There are agricultural practices which could be classified as convenient, although their possible advantages are not always evident

Table 1 | Some key benefits and limitations or problems observed from a change to no-till cultivation practices.

Benefits	Potential problems/limitations
Soil properties, crop growth and environmental impacts	
Additional organic C in surface layer—beneficial for soil structure, soil biological activity and seedling emergence	Only small additional total organic C stock in whole soil profile—limited benefit for climate change mitigation
More continuous pores allowing increased rainfall infiltration — beneficial for water availability for crops and climate change adaptation	
Increased crop yields in some situations—probably owing to improved soil conditions and/or water availability	Crop yields decreased or unchanged in some situations, or increases only emerge after several years. Possibly associated with uneven seedling emergence or increased soil density causing inhibited root growth in some environments
Increased soil biological activity–especially if combined with crop residue retention	
Decreased risk of soil erosion—particularly if combined with crop residue retention	
	Nitrous oxide emissions may either increase or decrease—with negative or positive impacts on climate change mitigation
Farm operations	
Labour/time saved through elimination of tillage operations	May need extra labour or use of herbicides for weed control
Earlier sowing of crop often facilitated, leading to possibility of improved growth and yield in some environments	In wet climates delayed planting may occur owing to slower soil drying after rainfall events
Fuel saved through elimination of tillage operations—decreased costs and CO_2 emissions	
	Suitable machinery for planting may not be available, a particular issue for resource-poor farmers in less developed countries
Long-term increases in crop yields and farm incomes—especially if combined with crop residue retention and crop diversification	May be little or no increase in farm income in the short-term, a major limitation for small-holder farmers in less developed countries

Powlson et al. 2014

Limitations

- Lack of data for certain evaluations (SPQ indicators, LTEs characteristics, etc.)

	MPs/indicators		bd RR	pr RR	pe RR	as RR	ry RR	sy RR
LTEs	Rotation	CR	1	1	2	1	1	-
	Crop protection	MCW	5	3	4	3	-	-
	Residue management	IR	4	3	-	2	-	-
	Tillage	NT	3	2	2	1	5	4
		MT	28	8	16	17	11	12
		CC	4	2	5	5	6	5
		DP	4	1	2	2	1	1
		DD	18	14	5	12	1	2

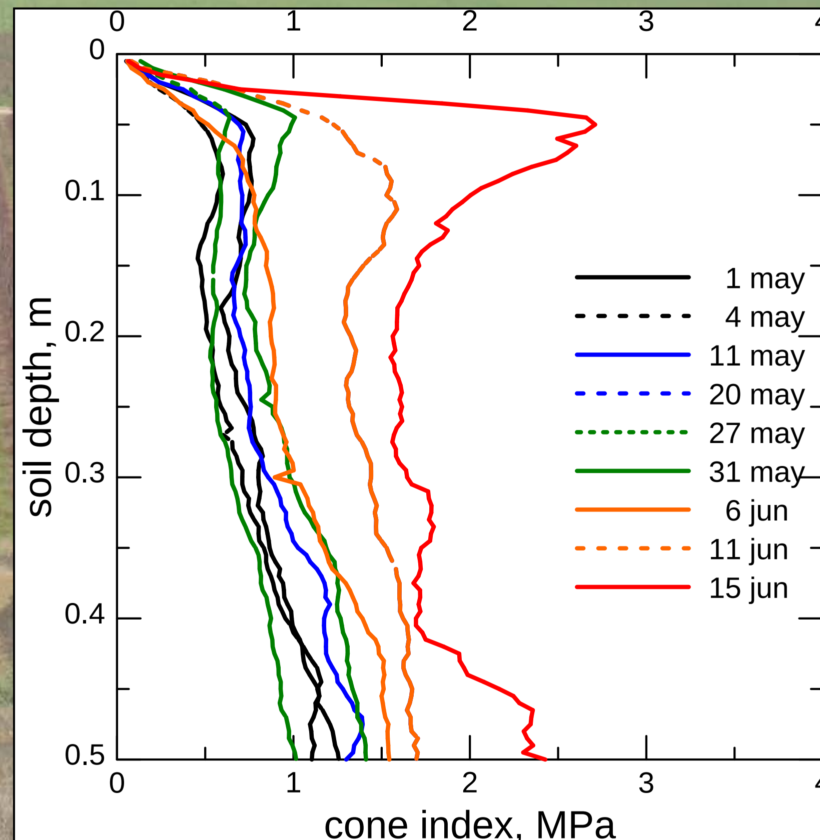
	MPs/indicators		bd RR	pr RR	pe RR	as RR	ry RR	sy RR
Nº. of records	Rotation	CR	2	8	8	20	8	-
	Crop protection	MCW	42	85	12	43	-	-
	Residue management	IR	60	105	-	51	-	-
	Tillage	NT	15	7	5	4	25	23
		MT	287	299	63	50	34	31
		CC	34	13	12	38	39	33
		DP	38	6	10	10	2	2
		DD	110	248	24	76	3	5

Limitations

- There is a strong influence of environmental conditions such as, time scale on physical quality

Tomejil LTE

Annual precipitation: 535 mm
Clay content: 70 %
Cereals-sunflower-legumes



Conclusions

- The followed methodology does not guarantee that all indicators correspond to the same field conditions (soil type, crop, etc...).
- Explanations for certain contradictions among indicators or strange effects of certain management systems, cannot be given.
- The apparently contradictory results are probably due to different numbers of observations for each indicator, made under different field conditions.

Instituto de Investigación y Formación Agraria y Pesquera
CONSEJERÍA DE AGRICULTURA, PESCA Y DESARROLLO RURAL

Catch-C

SEVENTH FRAMEWORK PROGRAMME

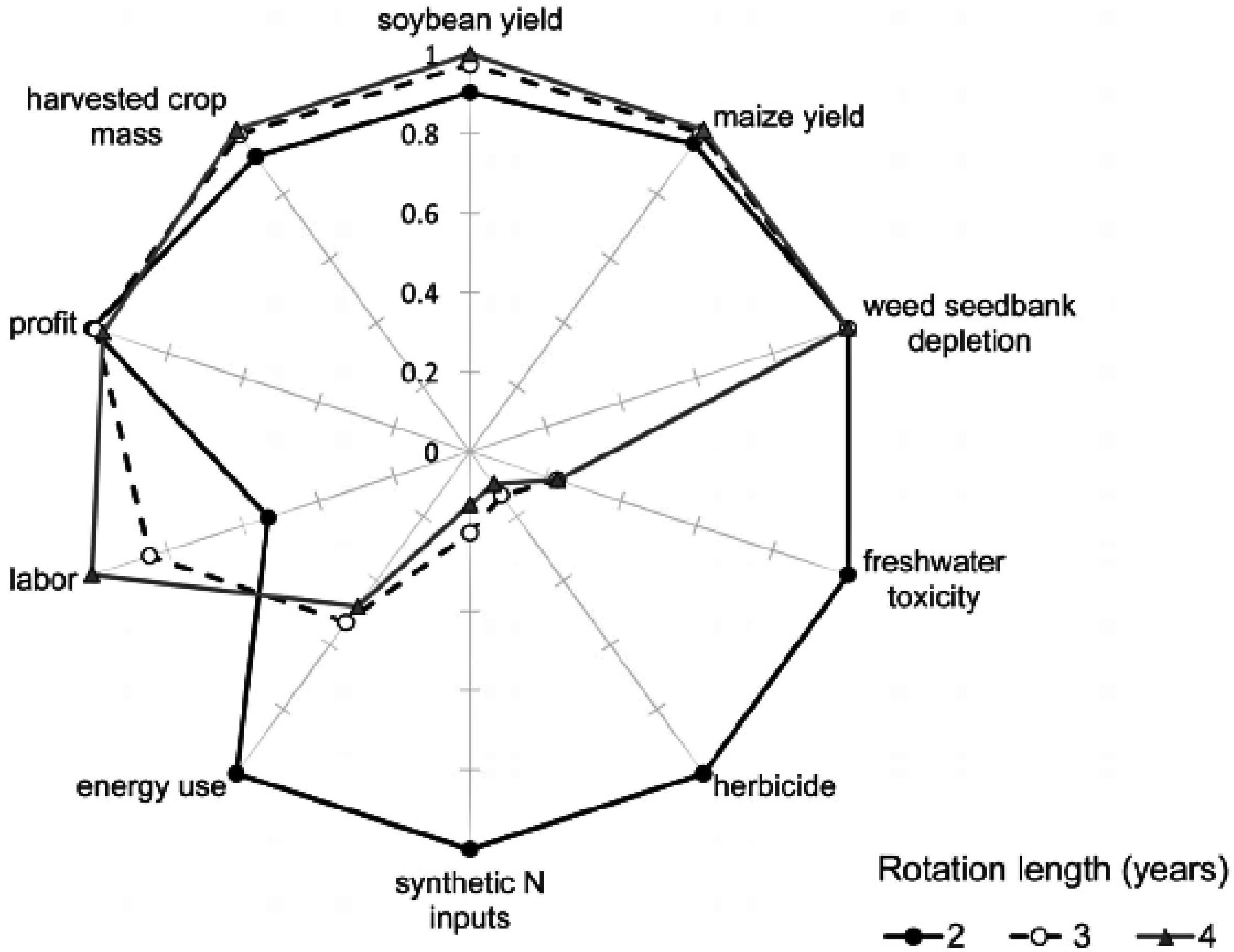
Thank you for your attention

http://www.catch-c.eu/

ELS03 Sustainable orchard management to face climatic changes

ELS 2014 - the Earth Living Skin: Soil, Life and Climate Changes

the crop rotation management still presents advantages (Davis et al. 2012): it is possible to keep similar yields reducing inputs



PLoS ONE 7(10): e47149. doi:10.1371/journal.pone.0047149

why do farmers adopt conservation tillage (Andrews et al. 2013. J. Soil Water Conserv. 68:501-511.)

Table 7
Importance of considerations in farmers' decision to use no-till/strip till or conservation tillage. The corresponding question wording follows: "Please indicate how important the following considerations were in your decision to use no-till / strip till or conservation tillage in 2009 OR 2010 for any acres listed in question 3 (figure 1)."

Considerations	Not important 1	2	Somewhat important 3	4	Very important 5	Mean (standard deviation)
Concern about water quality	5.6	6.8	28.4	26.2	32.9	3.74 (1.15)
Concern about soil erosion	0.8	1.8	9.0	26.7	61.7	4.47 (0.80)
Concern about improving soil productivity	0.6	1.5	8.2	29.1	60.5	4.47 (0.76)
Lower labor/fuel costs	0.8	2.7	16.5	27.5	52.5	4.28 (.89)
Lower equipment/capital costs	1.4	5.8	21.0	27.1	44.7	4.08 (1.01)
Concern about carbon (C) storage to address climate change	23.3	23.5	30.0	14.7	8.5	2.62 (1.23)
Carbon offset payments for conservation tillage	39.5	20.9	22.5	10.7	6.3	2.23 (1.25)
Hearing about other farmers' success with conservation tillage	14.1	15.5	34.3	23.2	12.9	3.05 (1.21)
Personal or family history of using conservation tillage	12.5	12.3	26.1	27.5	21.6	3.33 (1.29)

Note: Table entries are percentages. n = 1,301.

there is a great numbers of farmers reluctant to adopt 'best management practices' at the global scale