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IMPACT OF SOIL TILLAGE AND LAND USE ON SOIL ORGANIC CARBON DECLINE UNDER MEDITERRANEAN CONDITIONS

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National research project (2004-2008):

Potential of no-tillage for carbon sequestration on agricultural land

Task: Estimation of organic carbon losses under different land use and soil tillage systems

Methodology

Two approaches:

"Land use trial":

Analysis of three paired sites with different land use history; Long-term uncultivated vs. cultivated

"Soil tillage trial":

Effect of three soil tillage intensities applied over three years

Land use trial

Soils: stagnic Alisol (Barrocal), haplic Regosol (Oriola), epileptic Regosol (Comenda)

Measurements: Texture 0-70cm, SOM 0-70cm, bulk density 0-40cm

Land use history

Site	P1 – not cultivated	P2 - cultivated
Barrocal	5 year fallow after extensive rainfed crops	Maize monocropping, irrigated, intensive
Oriola	Long-term silvo-pastoral	Long-term rainfed arable cropping
Commenda	Long-term fallow	20 years of intensive irrigated maize and cereals

Not cultivated		Cultivated
	Barrocal	
	Oriola	
	Comenda	

Tillage trial

Soil: haplic Luvisol, long-term fallow

Soil tillage treatments :

- **Mouldboard plough (30 cm) + disk harrow (10-15 cm)**
- **Chiselling (25 cm) + tine cultivation (10-15 cm)**
- **Fallow**

Measurements: SOM 0-30cm (in 2005 and 2008)

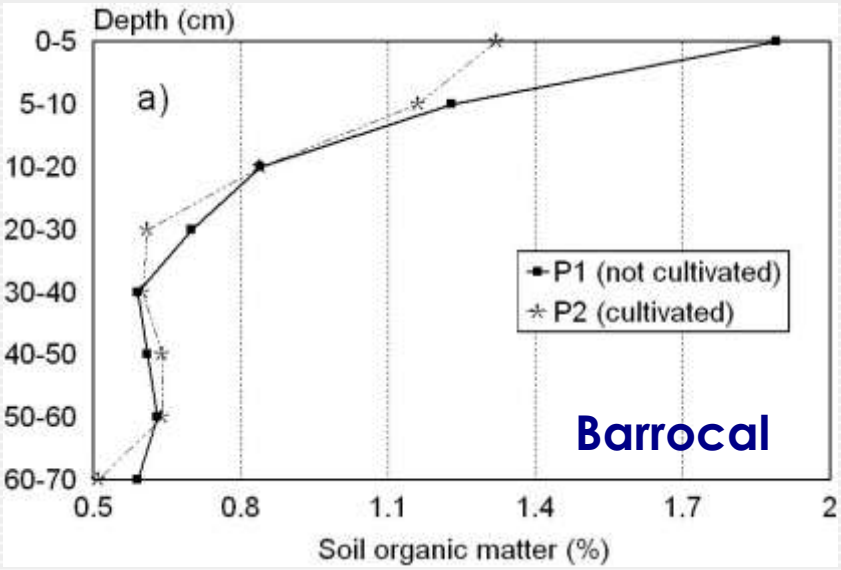
Bulk density 0-30cm (2008)

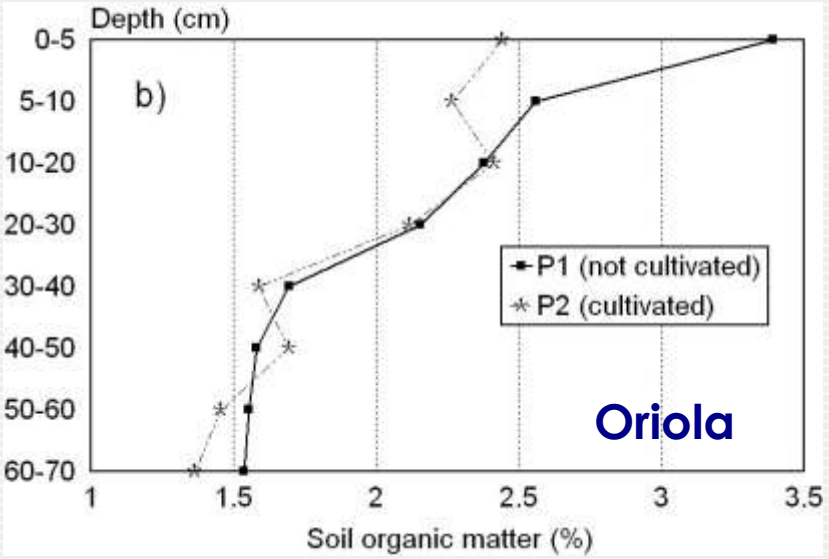
- ✓ During 3 years
- ✓ Twice a year
- ✓ Sampling before
- ✓ Sampling after 3 years

Results

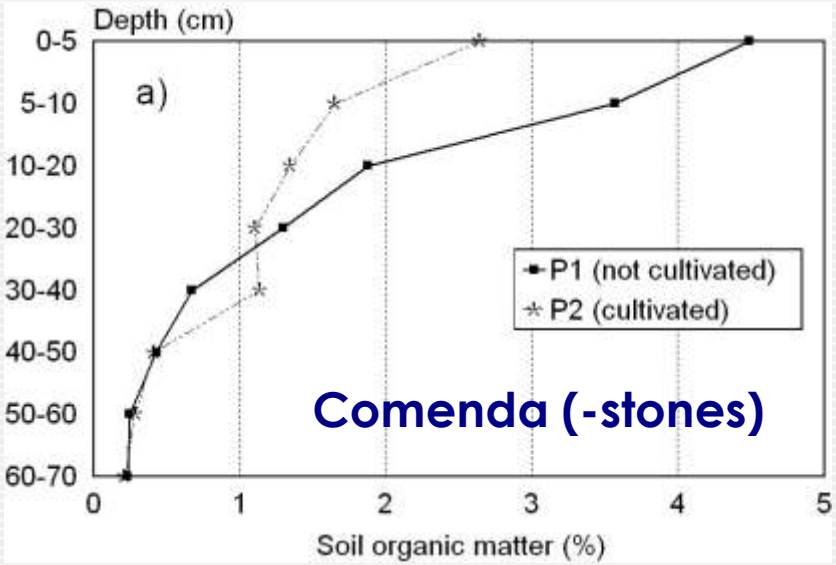
Land use trial

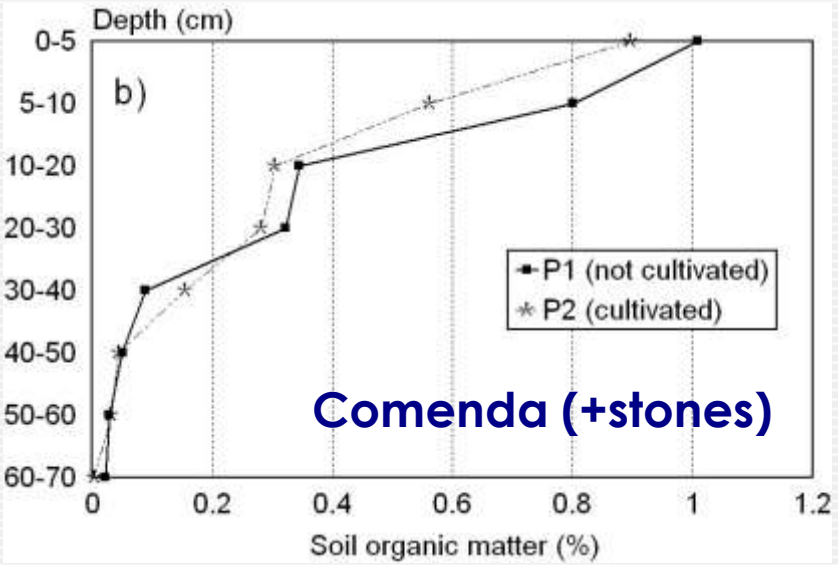
	Site→	Barrocal			Oriola			Comenda		
	Depth	Sand	Silt	Clay	Sand	Silt	Clay	Sand	Silt	Clay
Profile (P1) (without cultivation)	0-10	69,5	15,7	14,8	20,1	22,5	57,4	68,6	14,7	16,7
	10-20	68,2	15,9	15,8	20,5	22	57,5	71,4	13,1	15,5
	20-30	65,4	17,1	17,5	19,1	22,2	58,7	70,4	13,6	16
	30-40	62,7	16,1	21,1	19,7	21,5	58,8	71,6	14,2	14,2
	40-50	49,8	11,8	38,4	19,8	22,2	58	73,6	13,1	13,3
	50-60	51,9	13,4	34,7	20,8	21	58,2	72,6	13,9	13,5
	60-70	55,5	15,4	29,1	17,6	21,3	61,1	76,4	11,3	12,3
Profile (P2) (under cultivation)	0-10	69,8	14,5	15,7	31,1	24,1	44,7	76,2	11,6	12,2
	10-20	73,7	13,2	13,1	33,3	23,5	43,2	73,6	12,7	13,7
	20-30	68,2	12,3	19,5	31,3	23,7	44,9	72,6	13,3	14,1
	30-40	62,2	12	25,8	24,9	22,1	53	74,8	12,3	12,9
	40-50	48,2	14,1	37,7	29,7	21	49,3	78	9,8	12,2
	50-60	47,7	13,1	39,2	27	21,9	51,1	79,4	8,6	12
	60-70	47,7	13,8	38,5	24,9	22,2	52,9	80,9	8,6	10,5





Soil organic matter content (%) along the soil profiles





Soil bulk density used for the calculation of soil carbon stocks

Site	Profile	Depth (cm)			
		0-10	10-20	20-30	30-40
Barrocal	P1 (not cultivated)	1,50	1,63	1,69	1,68
	P2 (cultivated)	1,53	1,59	1,74	1,68
Oriola	P1 (not cultivated)	1,26	1,29	1,28	1,33
	P2 (cultivated)	1,35	1,44	1,42	1,32
Comenda*	P1 (not cultivated)	1,50*	1,50*	1,50*	1,50*
	P2 (cultivated)	1,50*	1,50*	1,50*	1,50*

Carbon stocks (Mg C ha^{-1}) of the different soil profiles

	Barrocal		Oriola		Comenda	
Depth (cm)	**P1**	**P2**	**P1**	**P2**	**P1**	**P2**
0-10	13,6	11,0	21,8	18,4	11,4	8,6
10-20	7,9	7,7	17,8	20,1	4,5	3,8
20-30	6,9	6,2	16,1	17,4	4,0	3,5
30-40	5,7	5,8	13,1	12,1	1,2	2,0
Sum (0-40)	**34,1**	**30,7**	**68,8**	**68,0**	**21,1**	**17,9**

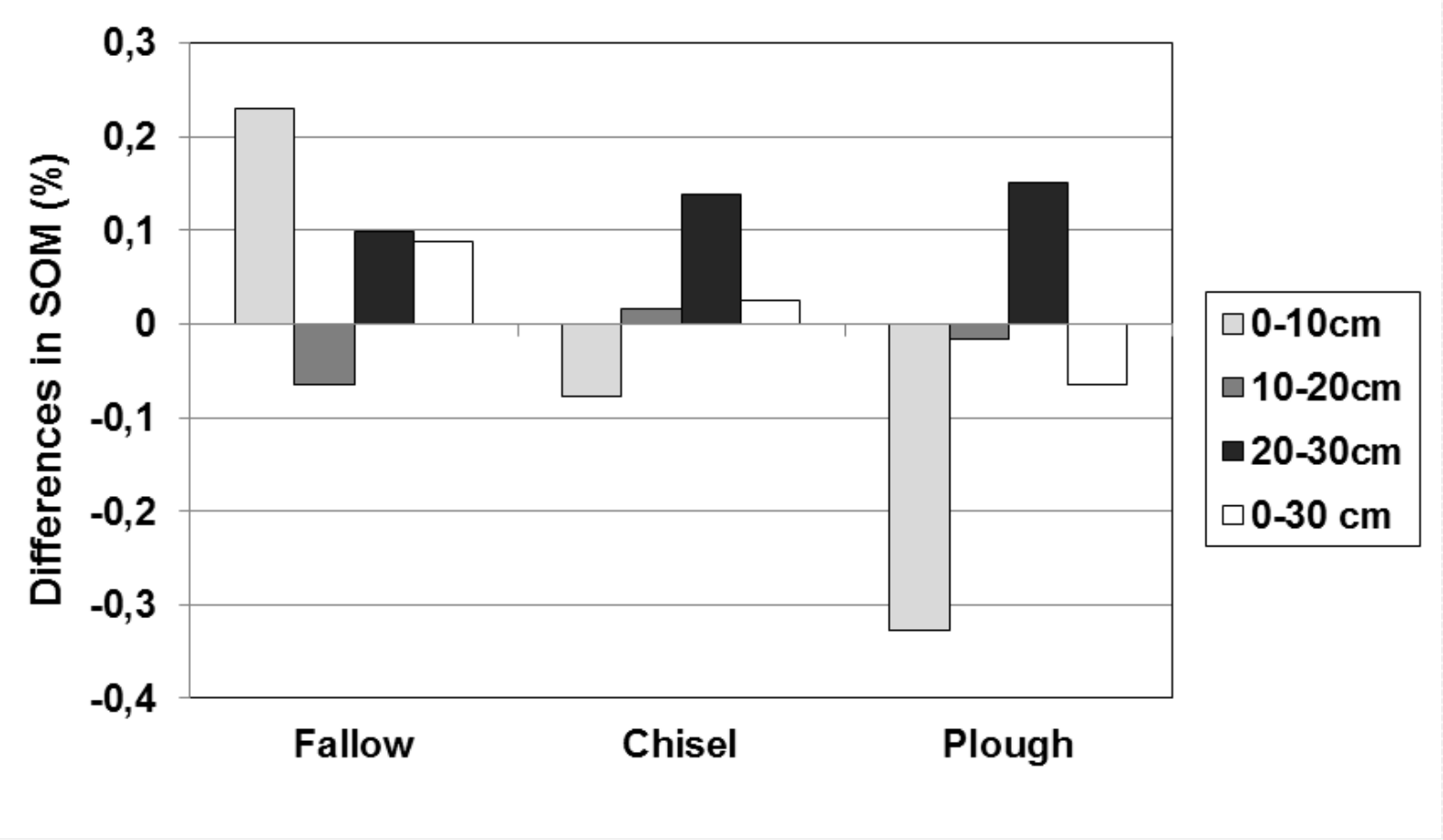
Results

Tillage trial

Soil organic matter content (%) before the first tillage operation (2005) and at the end of the experiment (2008).

		Field 1			Field 2		
Year	Depth	Fallow	Chisel	Plough	Fallow	Chisel	Plough
2005	0-10 cm	1,27	1,41	1,27	1,81	1,79	1,97
	10-20 cm	0,90	0,92	0,90	1,61	1,52	1,69
	20-30 cm	0,78	0,79	0,76	1,13	1,03	1,22
	0-30 cm	0,98	1,04	0,98	1,52	1,45	1,63
2008	0-10 cm	1,43	1,21	0,94	2,11	1,84	1,64
	10-20 cm	1,00	1,14	0,92	1,38	1,33	1,64
	20-30 cm	0,83	0,87	0,90	1,28	1,23	1,38
	0-30 cm	1,09	1,07	0,92	1,59	1,47	1,55

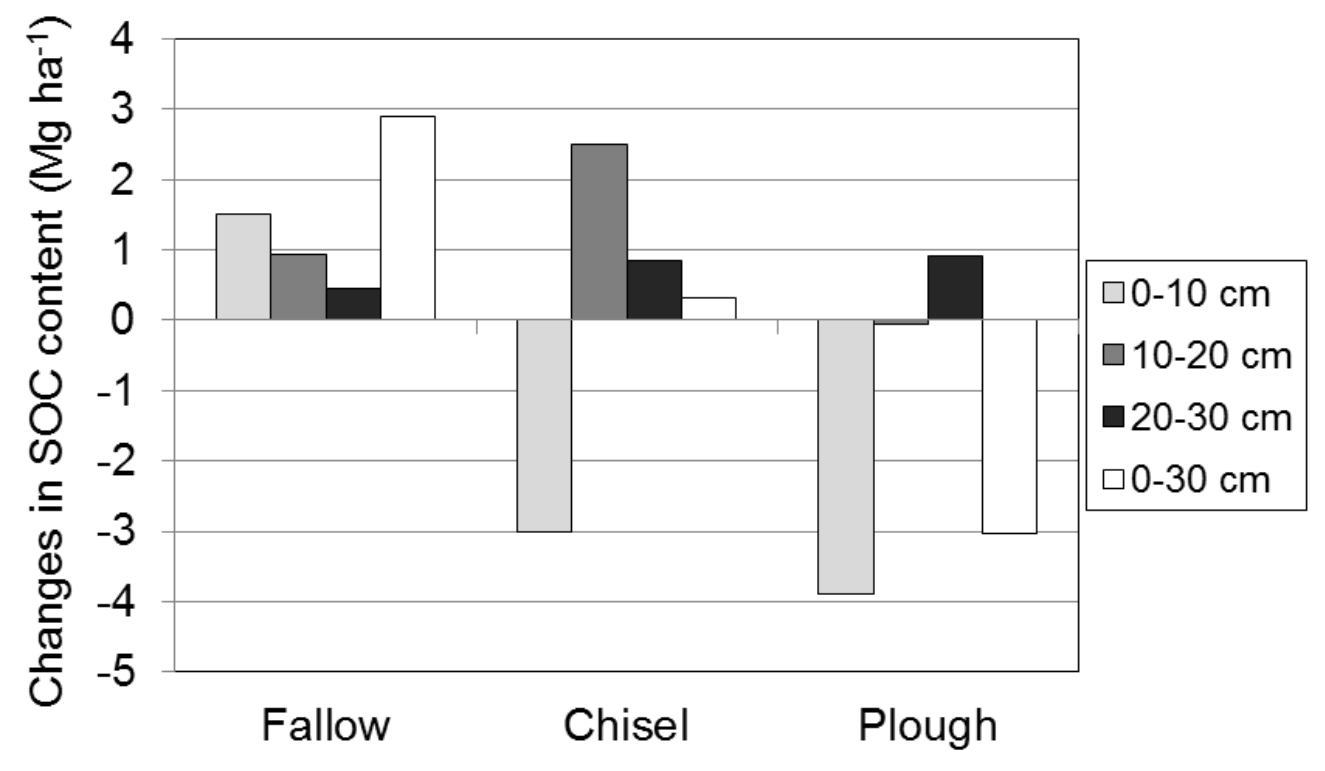
Changes in soil organic matter (%) between 2008 and 2005 (average of field 1 and 2)



Depth	Fallow	Chisel	Plough
0-10 cm	1,68	1,52	1,55
10-20 cm	1,64	1,71	1,59
20-30 cm	1,57	1,59	1,50

Soil bulk density at the final soil sampling (2008)

Soil organic carbon (Mg ha^{-1}) in the top 30 cm as affected by different soil tillage systems between 2005 and 2008



Conclusions

- Land use trial confirmed that type of land use has a strong effect on SOC content and stocks
- Paired-site comparisons are a useful approach to detect differences in the effect of land use on SOC stocks
- Intensive soil tillage is capable to induce strong SOC losses in a very short term
- Absence of soil disturbance and the maintenance of vegetation residues (in combination) are capable to increase SOC

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Thank you for your attention

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