Short-term effects of land-use on earthworm communities and soil physico-chemical properties (Belgium)

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« Functional & evolutionary Entomology - *Soil - Water - Plant Exchanges* »

Université de Liège

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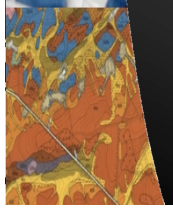


. Soil is an interactive system, in which characteristics are strongly linked

. Soil influenced by mesological and anthropic constraints

. Earthworms drive soil fertility « Ecosystem Engineers » .

. Environmental conditions and human pressures regulated earthworm dynamics.

To better understand interactions between all components of soil.

Industrial scale of production

↓

Increase of the intputs

↓

Intensification of agriculture

→

?

Decrease of soil biodiversity

↓

Decline in soil organic matter

↓

Degradation of soil quality

How to sustain soil fertility ?

↓

New soil conservation management practices are required.

Impact of agricultural practices on earthworm communities and soil properties

Soil fauna
Earthworms

Soil structure,
Physico-chemical properties of soil

1. How is earthworm community influenced by agricultural practices ?

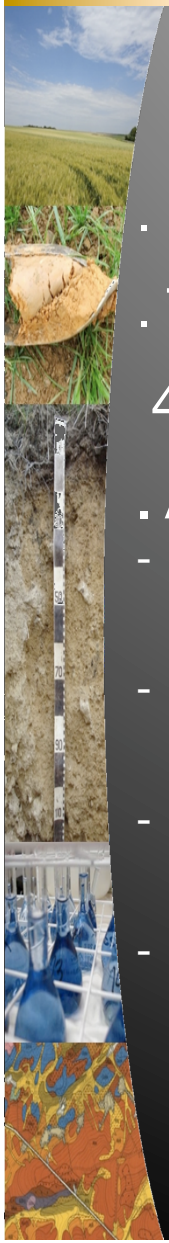
2. How are soil properties and nutrient elements influenced by agricultural practices ?

Some questions

- Changes in the earthworm community in different cropping systems ?

- Link between agricultural practices and earthworms?

- Impact of different agricultural practices on soil properties (Physical / Chemical)?



Study design

. Located in Gembloux, Belgium.

. The experimental design = latin square

4X4 (16 plots: 15*40 m)

. Agricultural practices:

- Conventional-tillage / Residues incorporation (CT/ IN)
- Conventional-tillage / Residues exportation (CT/ OUT)
- Reduced-tillage / Residues incorporation (RT/ IN)
- Reduced-tillage / Residues incorporation (RT/ IN)



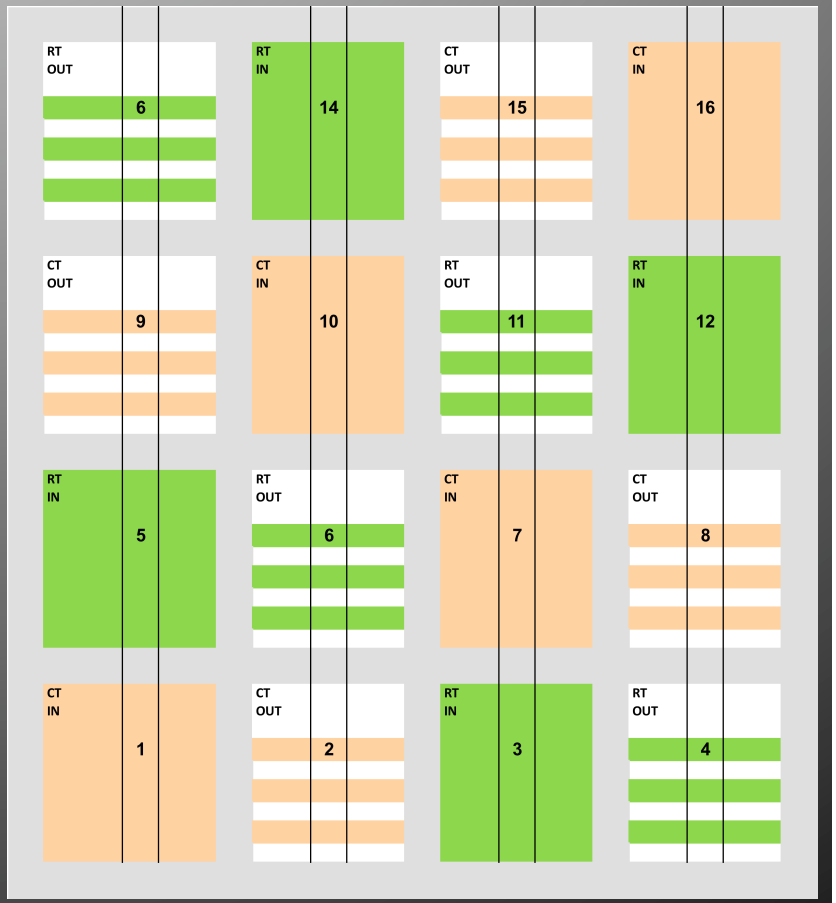


Fig. 1. Experimental design, tillage management, and cropping systems.

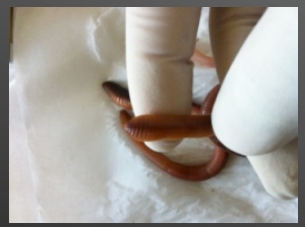
Experimental protocols

. Earthworm sampling

Formalin method

Soil excavation

Extraction of earthworms by hand



Species identification (Key of Cluzeau, 1996)

Counting and weighing of earthworms, preservation in formalin 4%

Experimental protocols

. *Soil sampling*

Composite samples from soil plough layer

Soil analysis

Soil bulk density, Penetration resistance

Total Organic Carbon, pH,…

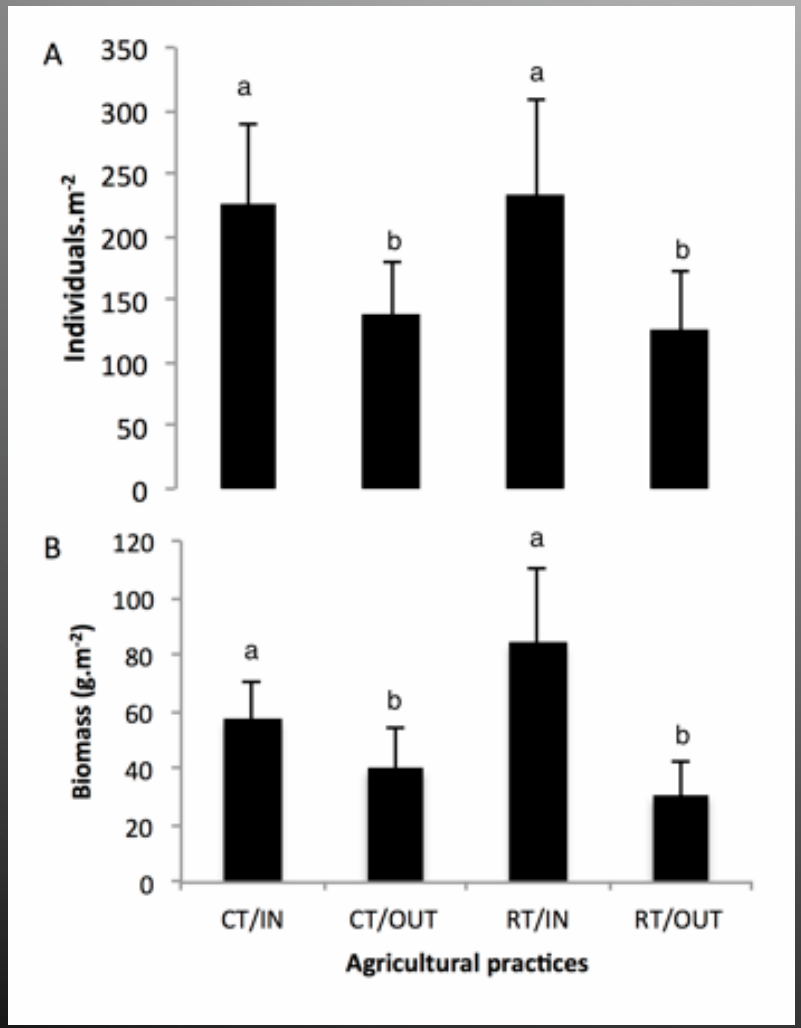
Nutrient elements water- extraction

Impact of agricultural practices on earthworm communities and soil properties

Soil fauna
Earthworms

1. How is earthworm communities influenced by agricultural practices ?

Earthwom abundance and biomass



No significant difference in earthworm abundance and biomass between CT and RT

Exportation of crop residues affect significantly earthworm abundance and biomass

Fig. 2. Earthworm abundance and biomass in four agricultural practices (mean ± S.D).

Earthwom abundance and biomass

. No effect of conv. tillage on earthw. abund and biom.

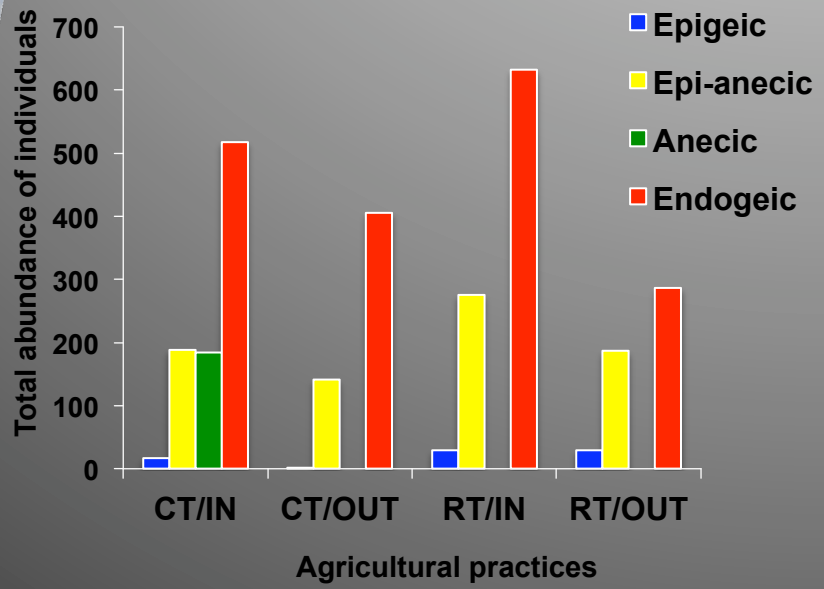
Tolerance of tillage and species mobility

. Significant effect of crop residues exportation on earthw. abund and biom.

Reduction of SOM : primary food source of earthw

Stimulation of earthworm activity by reduced soil disturbance and incorporation of residues.

Earthwom diversity



Species	Functional group	CT/IN	CT/OUT	RT/IN	RT/OUT
Dendrobaena mammalis	Epigeic	16			
Lumbricus rubellus castaneus		1	2	29	29
Lumbricus terrestris	Epi-anecic	189	142	276	187
Aporrectodea caliginosa meridionalis	Anecic	184			
Aporrectodea caliginosa caliginosa	Endogeic	390	354	599	284
Allolobophora chlorotica chlorotica typica		48	17		
Allolobophora rosea rosea		78	35	33	3
Octolasium cyaneum		2			

Fig. 3. Total abundance of functional groups and earthworm species recorded at Belgian sites in 2012 in the four agricultural practices.

. Despite their sensitivity, Epi- anecic and endogeic species were dominants.

. Epigeic species are sensitive to tillage → residue incorporation at a 25 cm depth + Conv. tillage + wheat monoculture

. Eight species were recorded from belgian parcels → similar to north western Europe samples.

Impact of agricultural management on earthworm community and physical properties of soil

Soil physico-chemical, properties

2. How are soil properties and nutrient elements influenced by agricultural practices ?

Soil penetration resistance

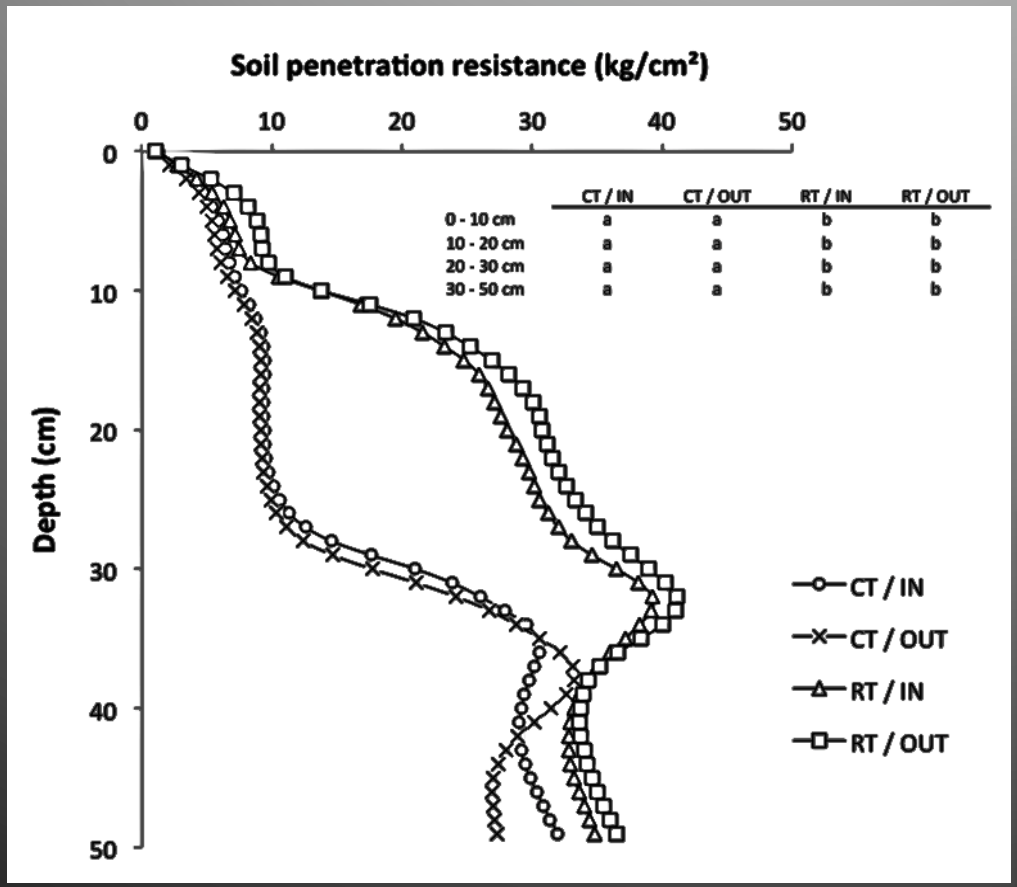


Fig. 5. Penetration resistance determined in the field at 0 – 50 cm depth for the four agricultural practices

PR increased with soil depth at all agricultural practices

Soil compaction significantly higher in RT compared with CT

. Natural compaction (4 years of RT).

. Tillage practice decreased the soil strength.

. Association of decompacting and compacting species.

Soil properties

Depth	EC	RH	HWC	P	K	Mg	Na	Ca
0 – 10 cm								
	S m^{-1}	%			mg kg^{-1}			
CT/IN	81.5	16.3	411	4.2 a	16.5 ac	3.7	26.2	54.0
CT/OUT	79.2	16.3	448	4.2 a	14.5 a	3.7	32.3	52.3
RT/IN	76.5	17.3	463	5.8 b	21.7 b	3.6	22.4	48.8
RT/OUT	73.7	16.8	443	4.9 ab	18.5 bc	3.4	22.6	47.3
Depth								
10 – 20 cm								
CT/IN	68.8	17.7	434	3.8 a	13.2 a	3.4	24.5	50.3
CT/OUT	69.1	17.6	403	3.8 a	12.1 a	3.3	22.3	47.8
RT/IN	71.0	17.4	388	3.9 a	11.6 b	3.3	21.5	52.1
RT/OUT	66.7	17.0	397	3.7 b	9.1 b	3.1	20.8	45.8
Depth								
20 – 30 cm								
CT/IN	68.5 a	18.2 a	384	4.0 a	14.9 a	3.4 ab	23.5	50.2 ab
CT/OUT	67.6 a	18.2 a	378	4.1 a	14.8 a	3.1 a	23.0	44.3 a
RT/IN	84.5 b	17.1 ab	380	3.3 b	14.1 ab	4.1 b	21.7	58.5 b
RT/OUT	77.4 b	17.0 b	382	3.2 b	12.3 b	3.7 ab	21.5	52.9 ab

Table.1. Mean of soil physical and chemical properties among the four agricultural practices

. K and P concentrations were significantly higher at the 0 – 10 cm depth → harvest residues incorporated and earthworms activity.

. Increase of HWC (0 – 10 cm) → Indicator of earthworm dynamics + soil fertility

. Higher conc. Ca → Earthworm gut processes (humif, mineraliz,…)

. Our findings don't confirm the negative impacts of conv. tillage on earthw. abund and biom.

. The exportation of crop residues affect significantly earthw. abund and biom.

. Exportation of crop residues effect was strong than tillage effect.

. Endogeic and epi-anecic groups were impacted by exportation of crop residues.

. The CT treatment was depressive for epigeic group.

. R- tillage depth caused an increase in: PR, P, K and HWC conc.

Acknowledgments

. Prof. COLINET Gilles

. Prof. FRANCIS Frédéric

. Dr. ALABI Taofic

. Prof. CLUZEAU Daniel

Thank you for your attention…