There is no more « undisturbed » soil on the earth…

Feed the soil
To feed men.

But this is not a reason not to do anything!

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The importance of earthworms in making your farm soils more productive

Odette Ménard, agricultural engineer
Soil and water conservation specialist
Minisitry of Agriculture and Food
Québec, Canada
January 9th,2013

Wind and water erosion


Without residus

Why should we do it ?

Yield

x

Market price

Tillage

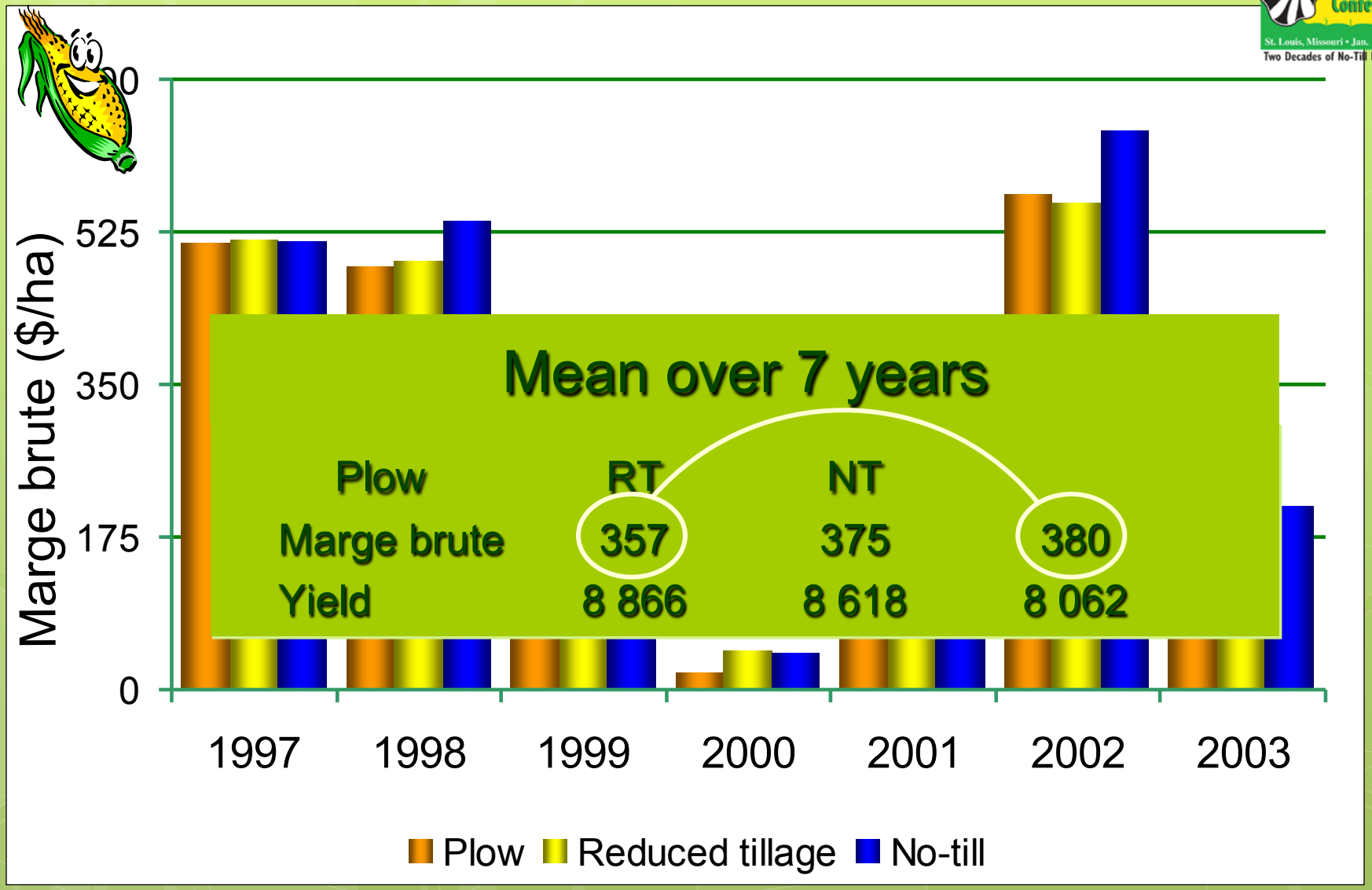
Weeds

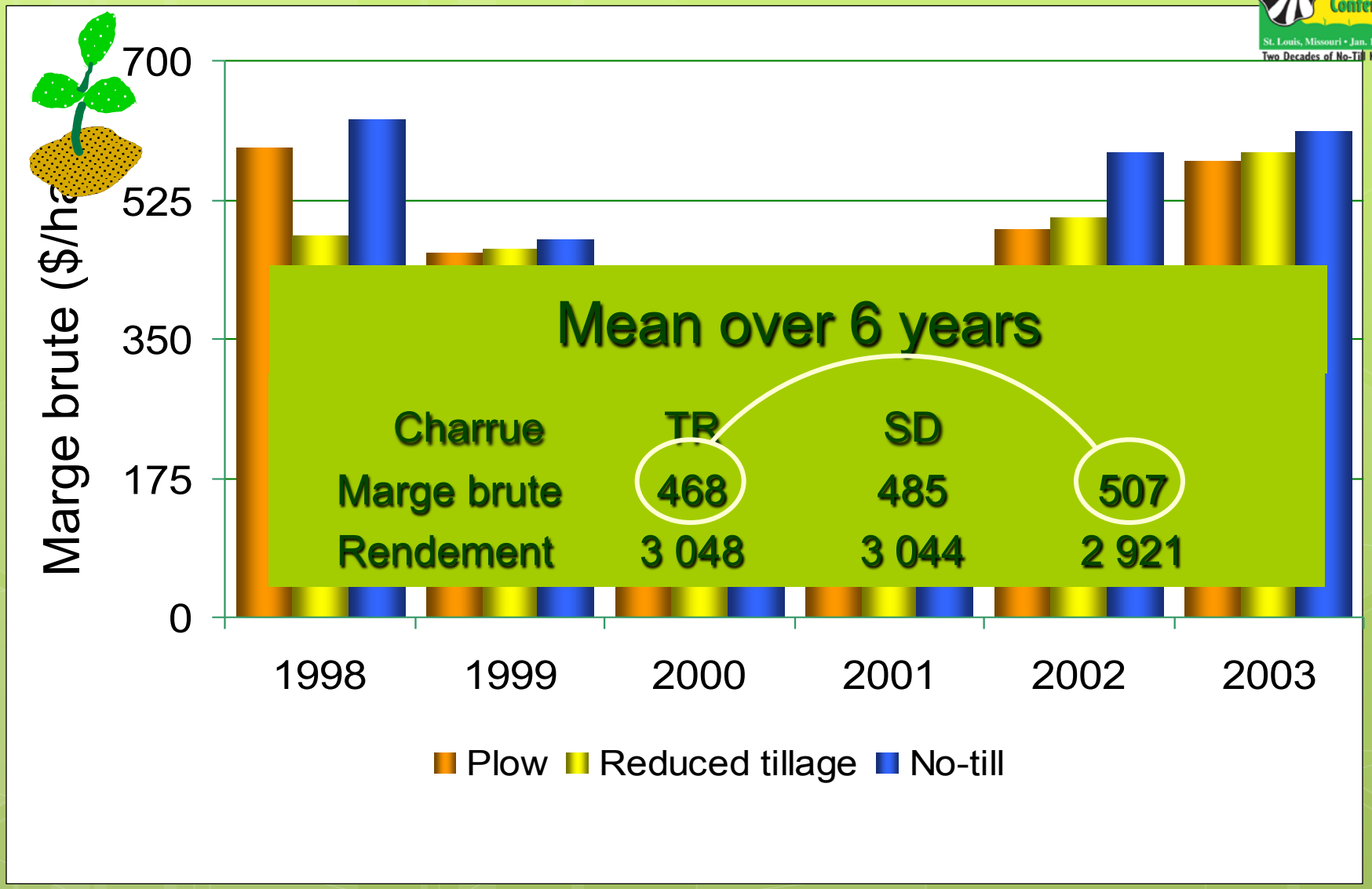
Fertilisation

Seeds

Techno cost

Drying


Marge brute ($/ha)
525
350
175
0
1997
1998
1999
2000
2001
2002
2003
Mean over 7 years
Plow
RT
NT
Marge brute
357
375
380
Yield
8 866
8 618
8 062
Plow
Reduced tillage
No-till


Marge brute ($/ha
700
525
350
175
0
1998
1999
2000
2001
2002
2003
Plow
Reduced tillage
No-till
Mean over 6 years
Charrue
TR
SD
Marge brute
468
485
507
Rendement
3 048
3 044
2 921

Plow	RT	NT	
12	44	25	
Tillage	135	86	42
Fertilisation	270	252	245
Weed	101	92	99
Seed	127	127	128
Techno costs	20	17	12
Expenses	655	574	526

Field work

	Plow	RT	NT
fields	541	715	274
passages	8,1	7,4	4,9
Cost $	265	212	166

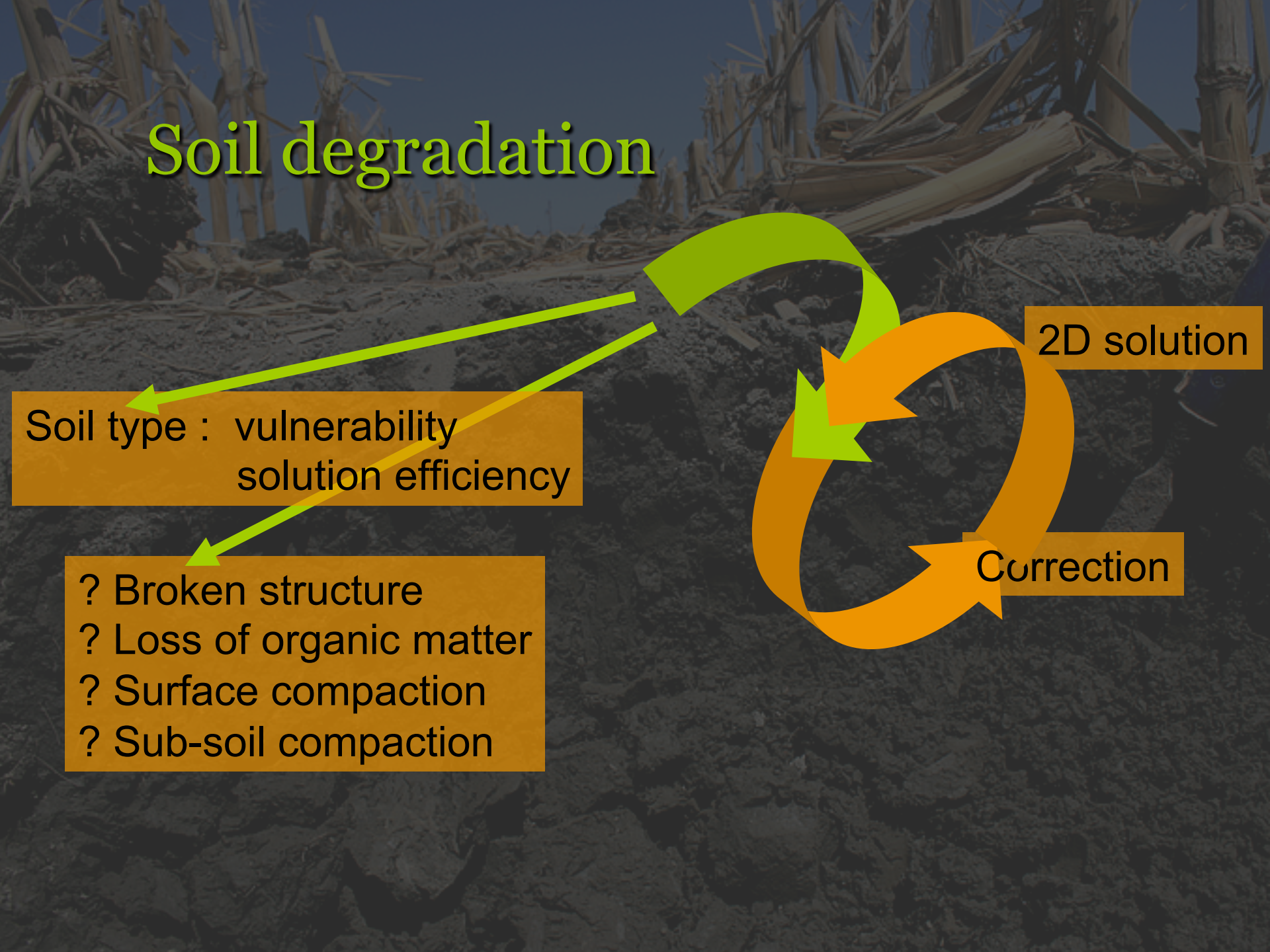
53$

99$

Fuel Consumption

	Plow	RT	NT
Tillage	32,07	18,57	8,18
Planting		1,72	3,9
Mineral fertilisation	0,73	0,71	0,67
Manure	3,36	3,16	2,53
Weeds	2,81	3,07	3,03
Harvesting	15,00	15,00	15,00
Total	53,97	40,51	29,41
		1,33	1,84

Soil degradation



Soil type : vulnerability
solution efficiency

? Broken structure
? Loss of organic matter
? Surface compaction
? Sub-soil compaction

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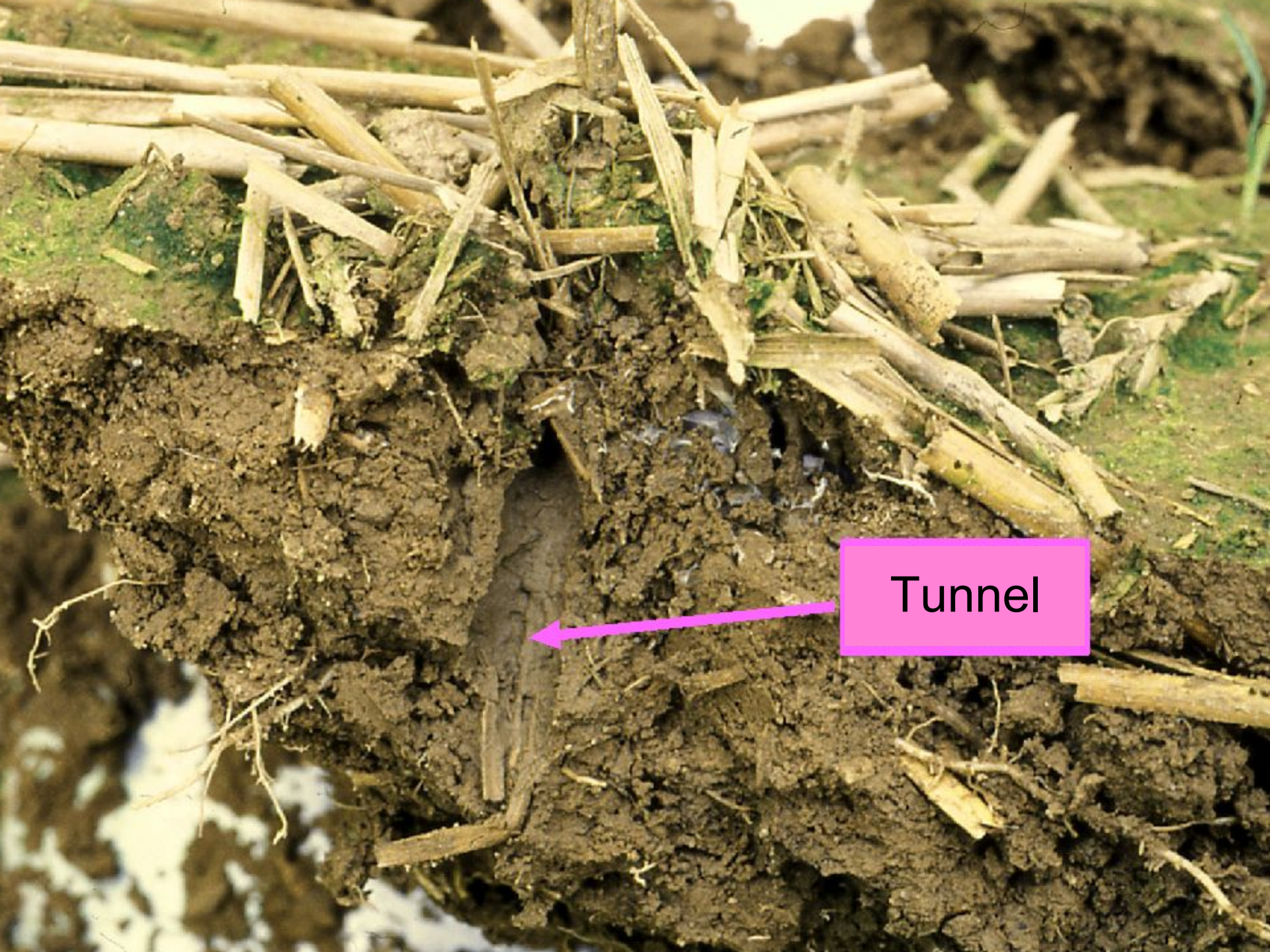
Everything is in the look


Tunnel

What is it that you see now ?

The plow and the earthworm

« The plow is one of the oldest
and most important invention of the man.
But long before man existed himself,
the land was plowed,
and continue to be,
by the earthworms. »

Charles Darwin, 1881

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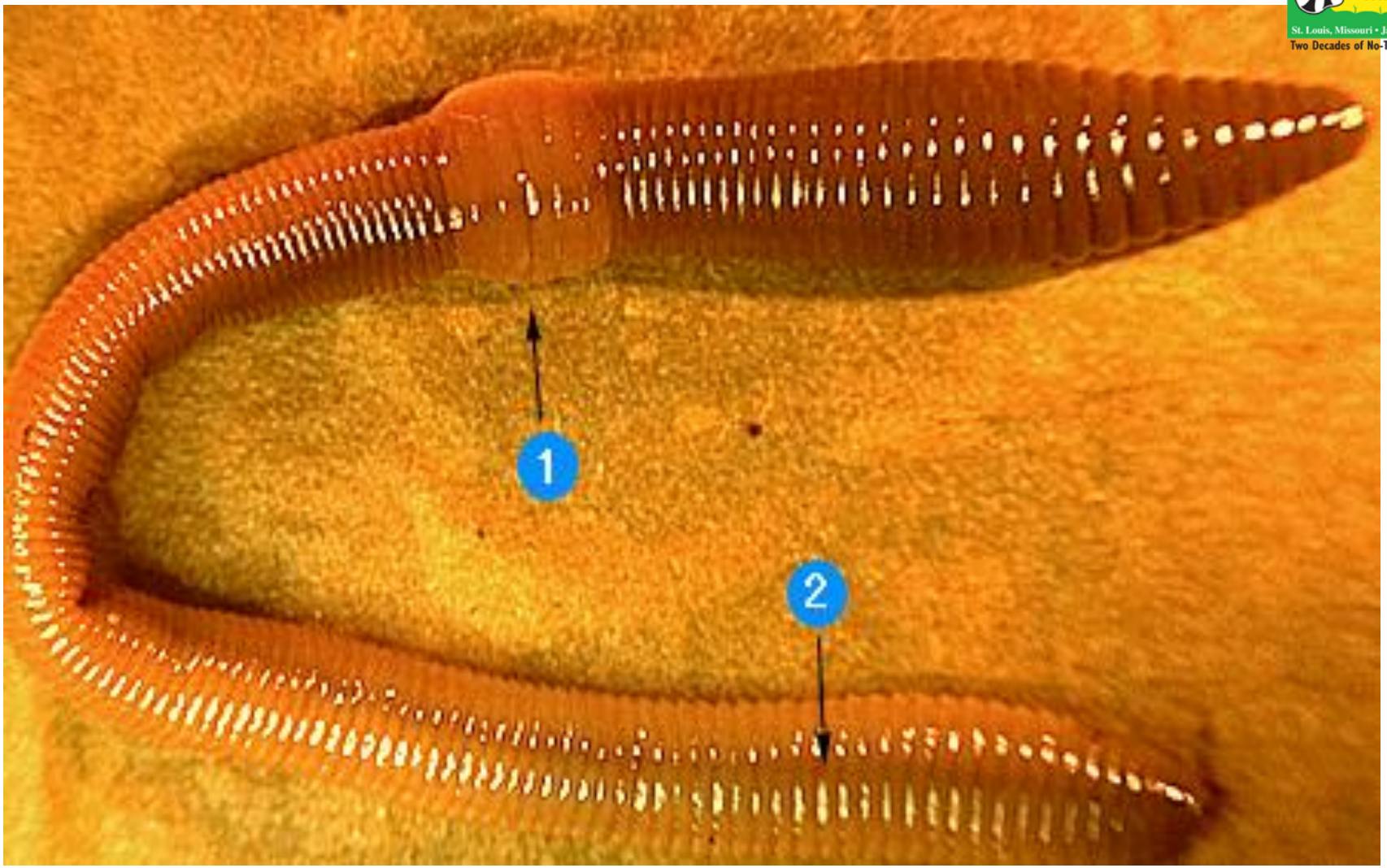


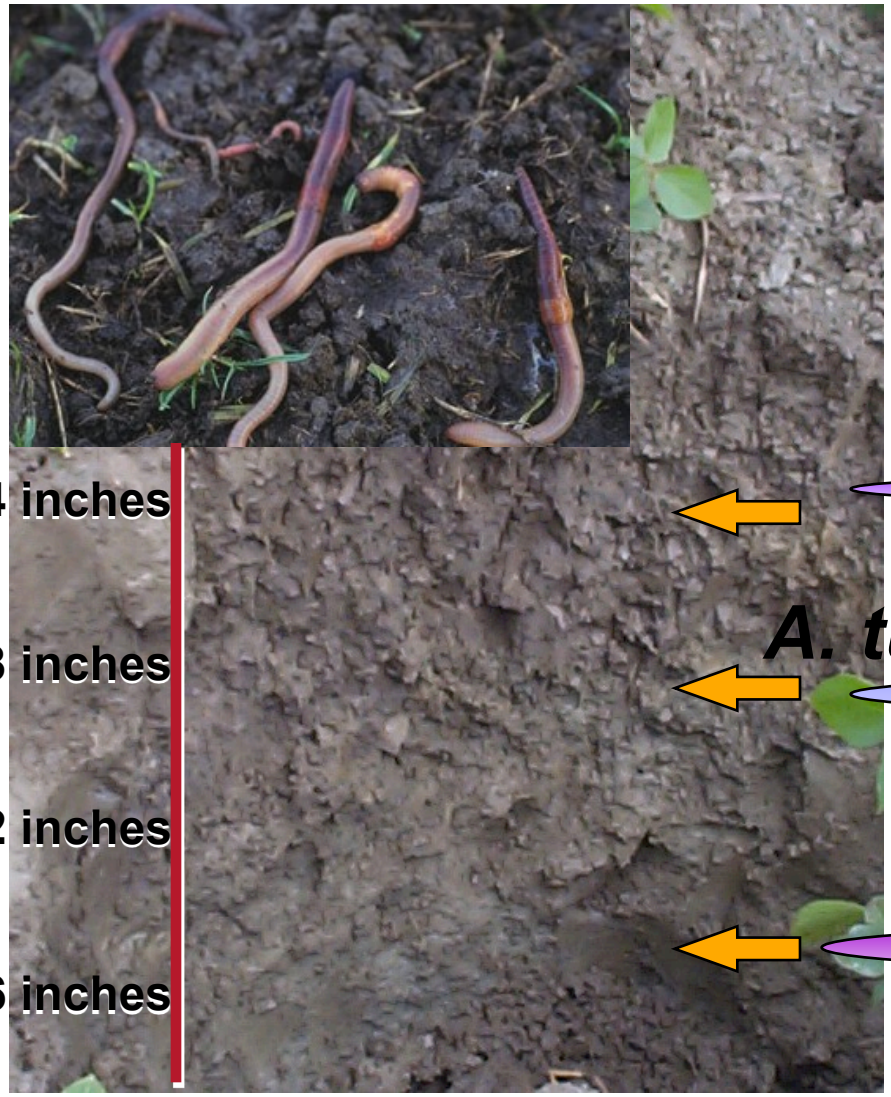
Guiness earthwo

3 à 5 pieds de long

1 pouce de diamètre

1,3 livre

Hémisphère sud



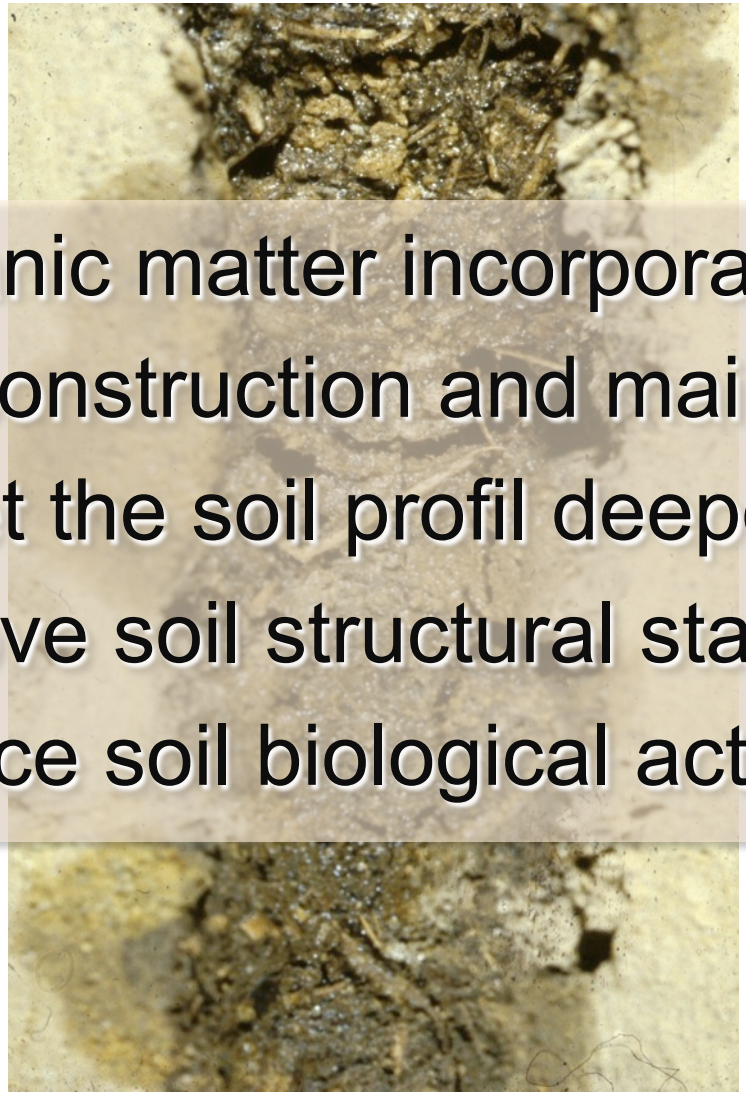
Soil workers

***L. rubellus* - epigeic**

***A. tuberculata* -endogeic**

***L. terrestris* - anecic**

- Too dry
- To cold



Organic matter incorporation

Channel construction and maintenance

Get the soil profil deeper

Improve soil structural stability

Enhance soil biological activities

1 ton of earthworms

100 tons of excrements

$^{2}/_{3}$ inch of manure

4 000 feet of 6 inches drain

4 pounds N

30 ponds P

72 pounds K

90 pounds Mg

500 pounds Ca

1 ton of earthworms

100 tons of excrements

$^{2}/_{3}$ inch of manure

4 000 feet of 6 inches drain

4 pounds N

30 ponds P

72 pounds K

90 pounds Mg

500 pounds Ca

1 ton of earthworms

100 tons of excrements

$^{2}/_{3}$ inch of m

4 000 f drain

ands N

30 ponds P

72 pounds K

90 pounds Mg

500 pounds Ca

25 earthworms / ft^2

Earthworms and food availability

Short term:

Better availability of nutrients from residus and soil organic matter

Long term:

Increase nutrient storage in soil aggregats

Eearthworms and nitrogen

- Indirect
  - Microorganisms interactions
  - Breaking down of organic residus
  - Soil aggregation
- Direct
  - Death and excretion
- Direct flux of N du to earthworms
  - 10-80 kg N / ha / year

Worst fields (without sand)

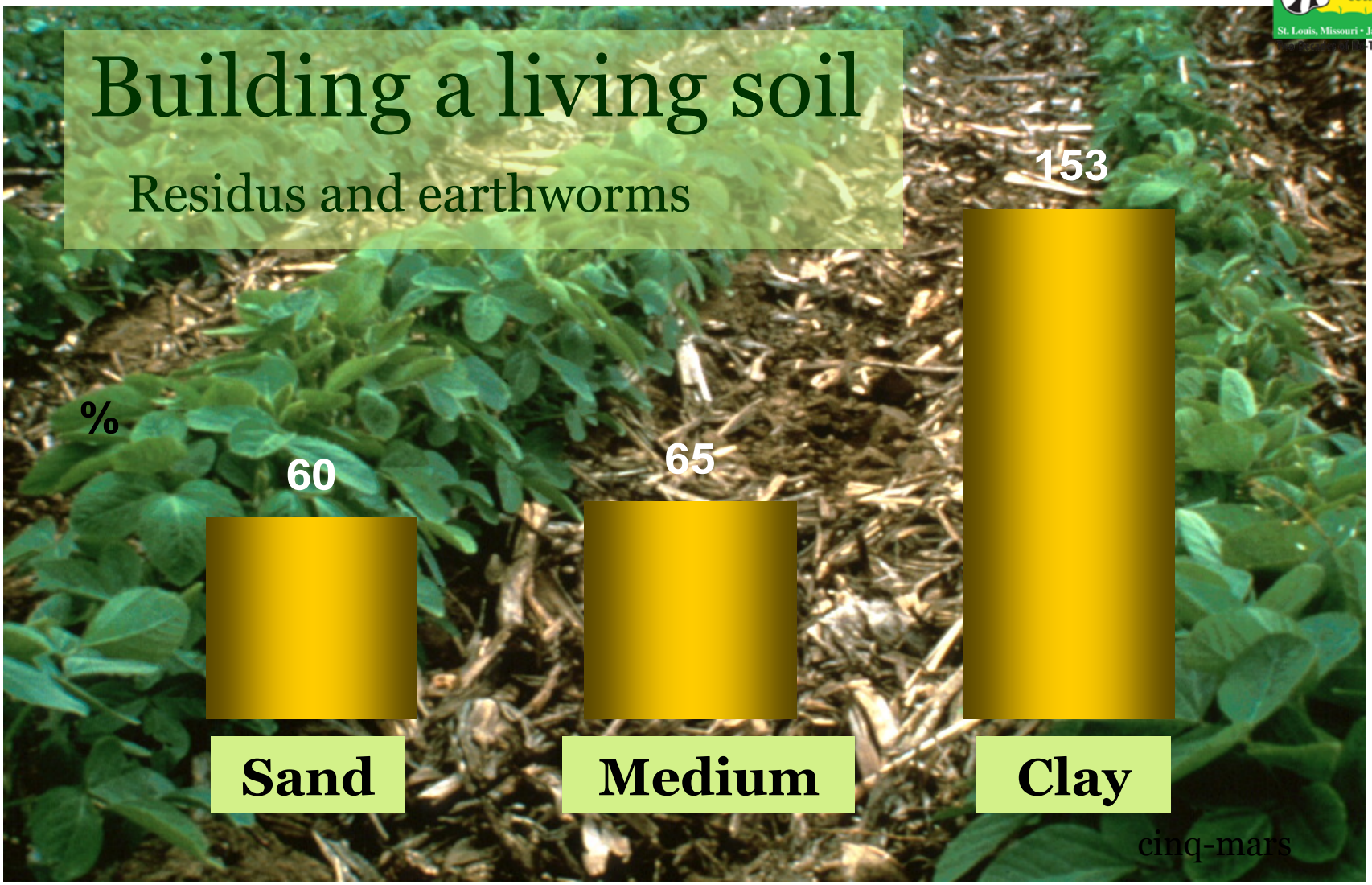
Earthworms/ft^2	40	20	20	1
% Adults	58	75	25	100
Tillage	Chisel	Plow	Chisel	Plow
Rotation	M/M	Alf/M	M/M	M/M

The best ones

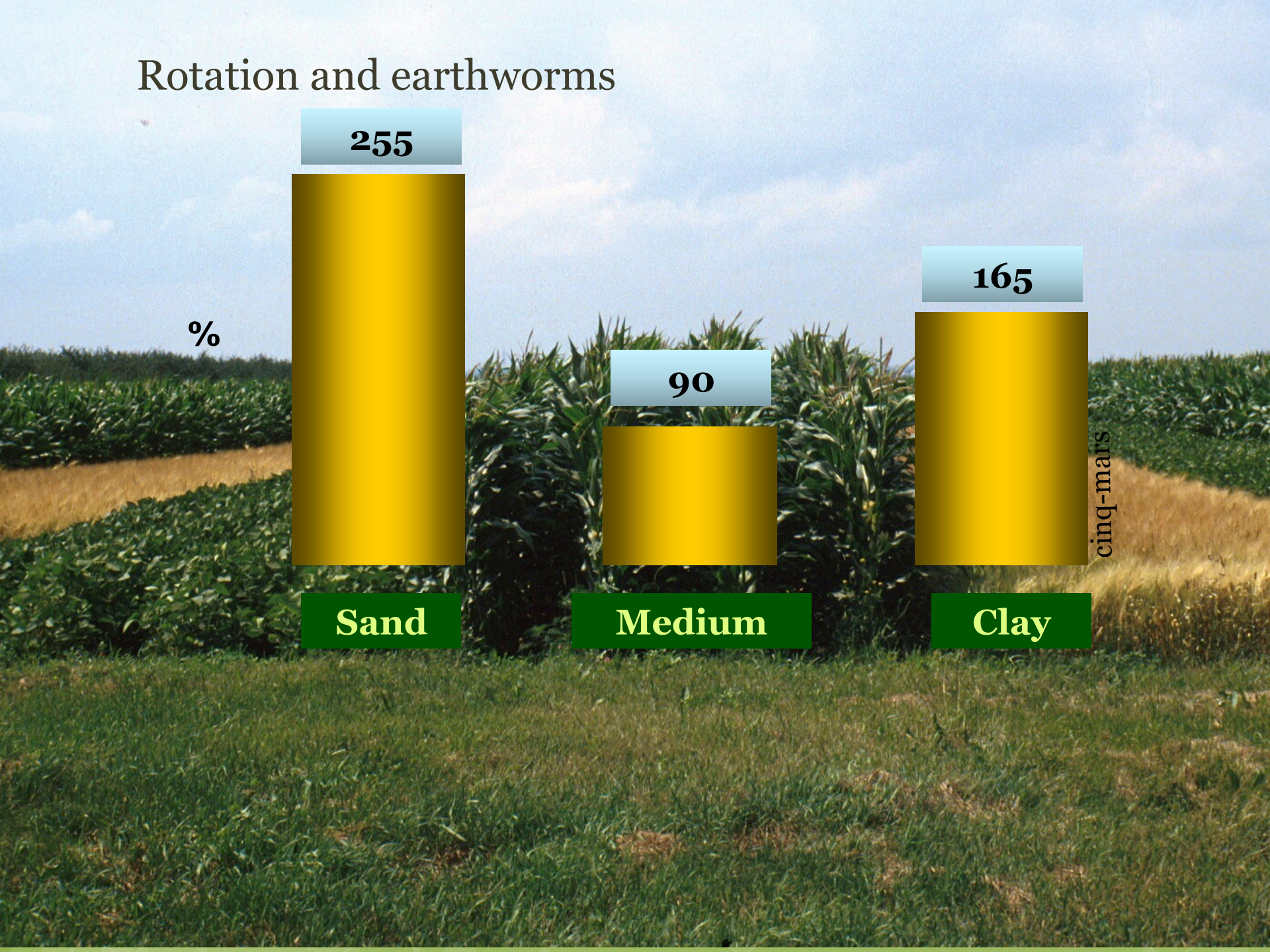
Earthworms/ft^2	253	510	680	650
% Adults	72	20	24	75
Tillage	NT	Ridges	Ridges	NT
Rotation	M/M	Strip	Strip	M/S

Building a living soil

Residus and earthworms

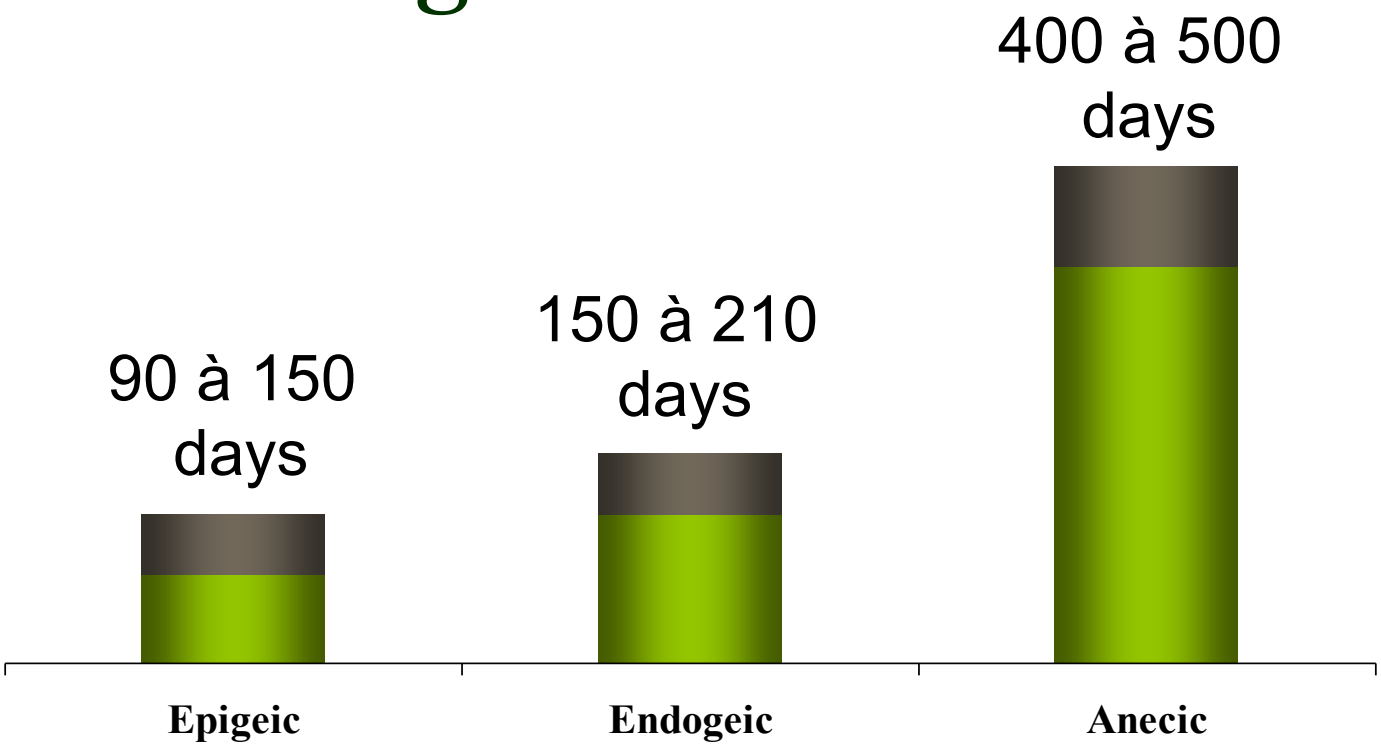


Rotation and earthworms



The next generation

The next generation



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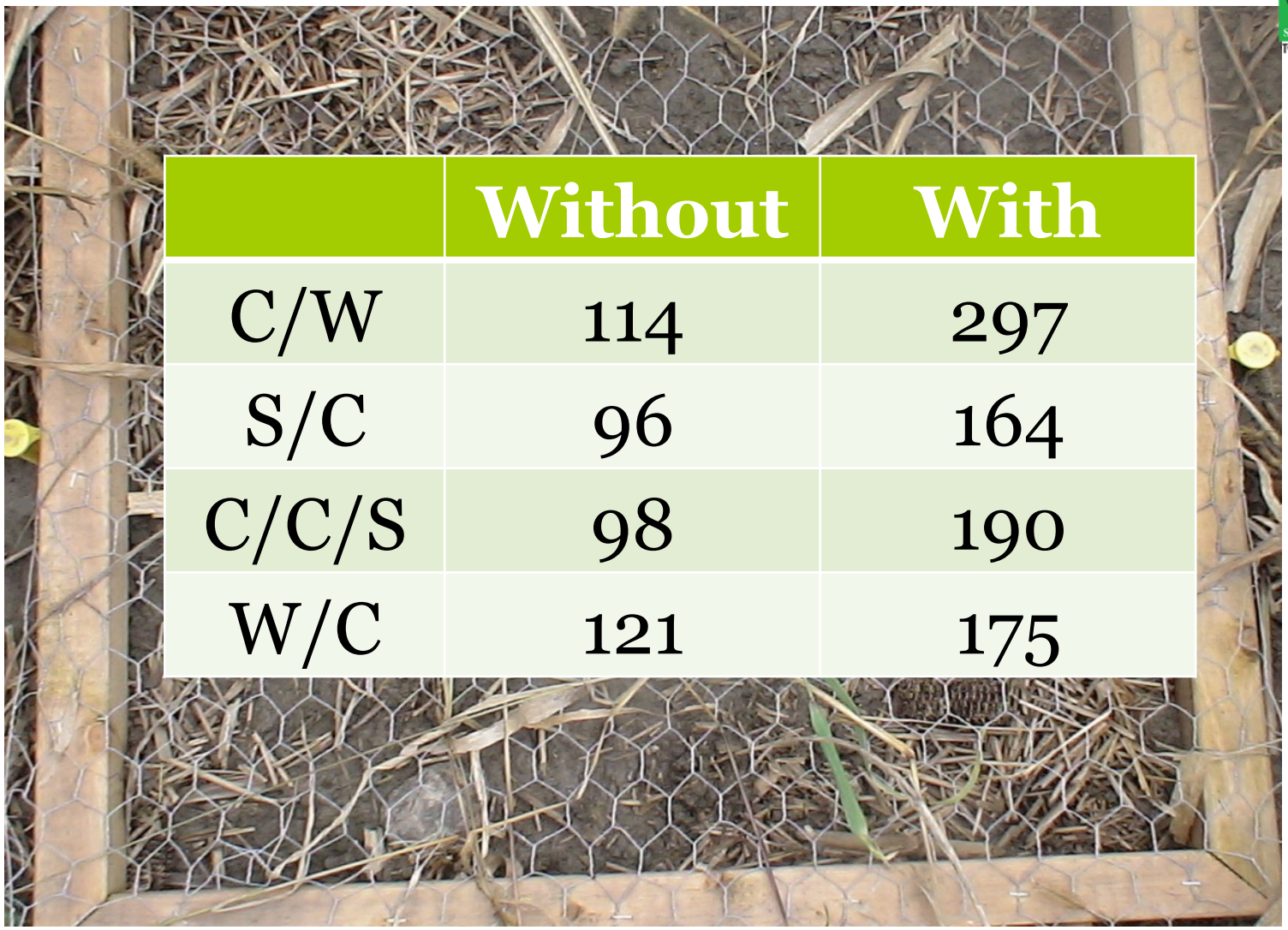
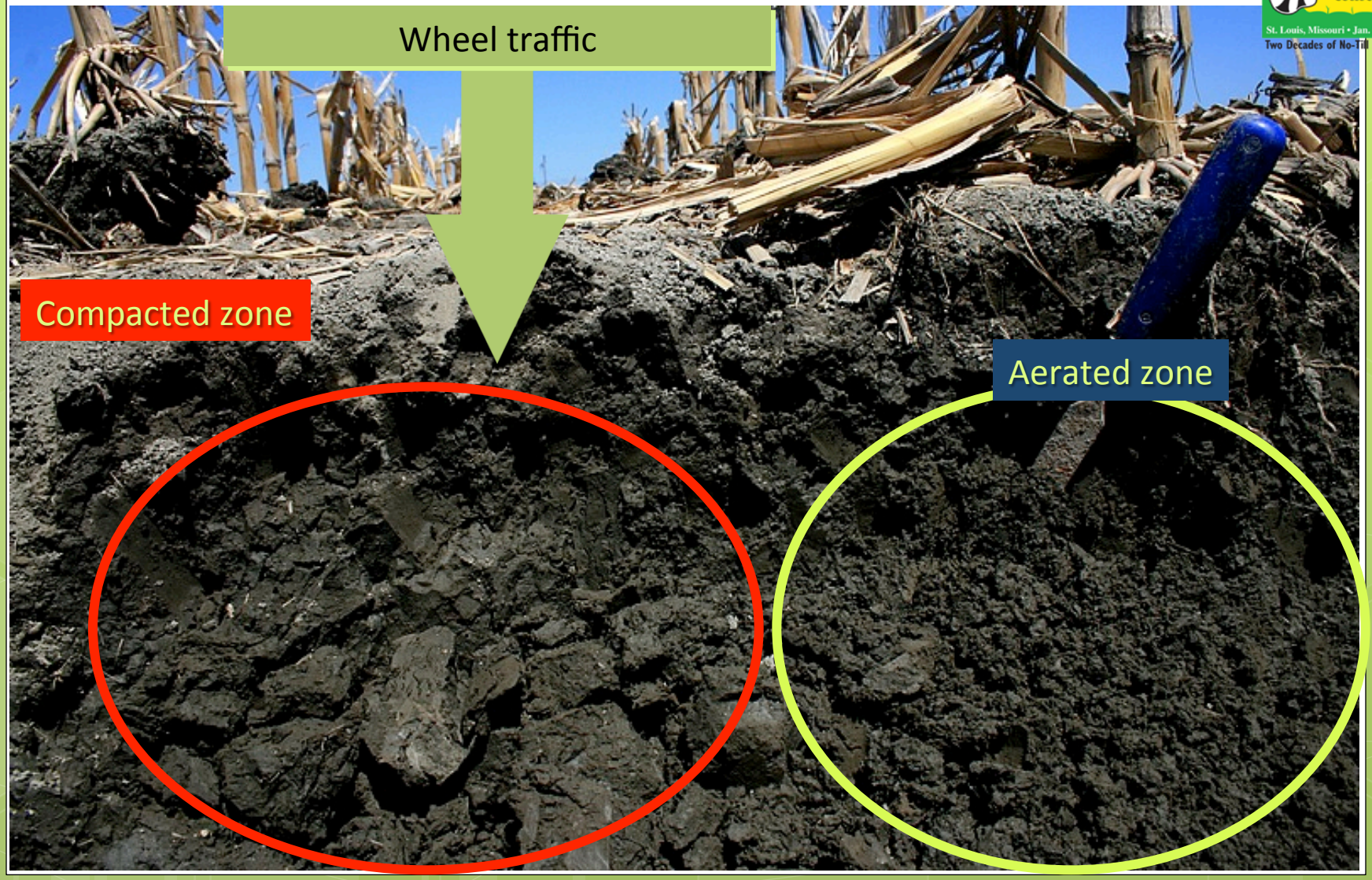
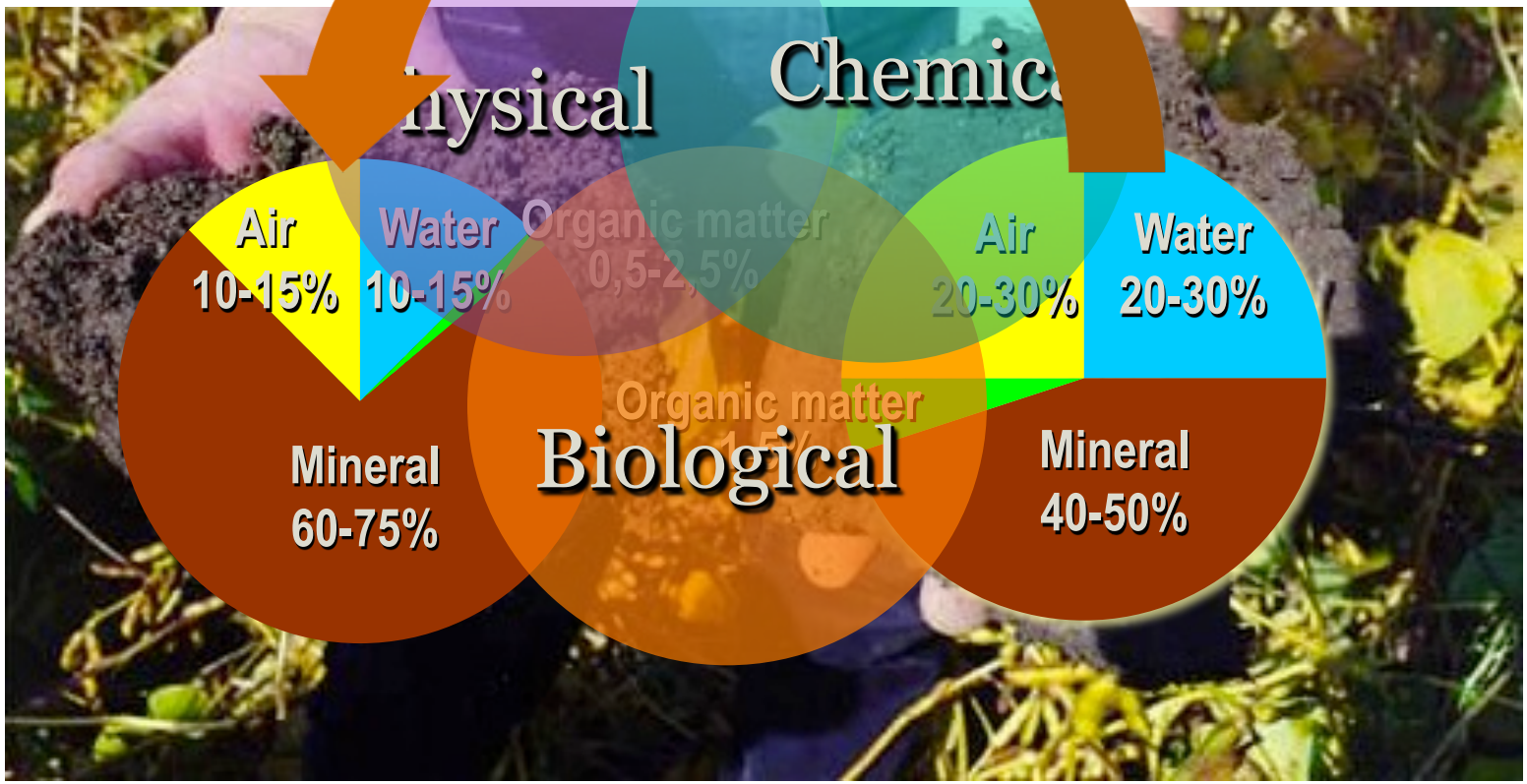


	Without	With
C/W	114	297
S/C	96	164
C/C/S	98	190
W/C	121	175

How is your soil doing ?


Wheel traffic
Compacted zone
Aerated zone

Which one is the best ?

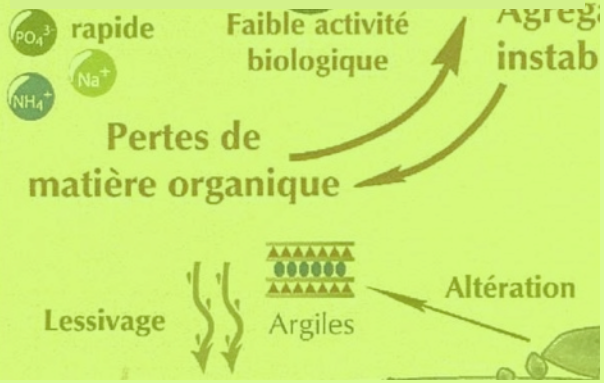

hysical
Chemica
Air
10-15%
Water
10-15%
Organic matter
0,5-2,5%
Air
20-30%
Water
20-30%
Organic matter
Biological
Mineral
60-75%
Mineral
40-50%

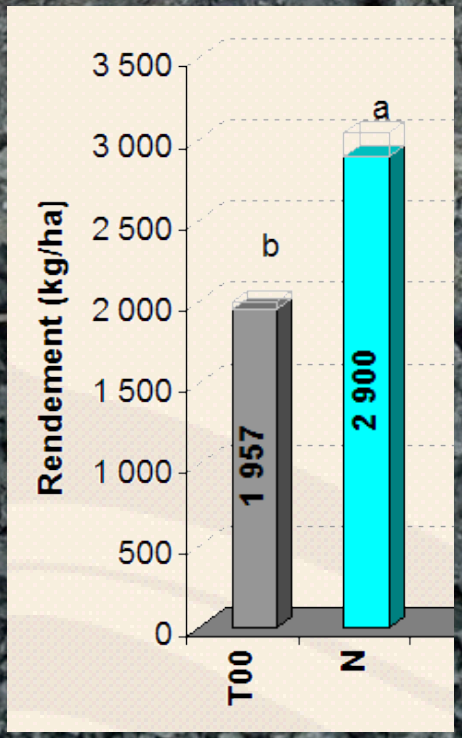
Conventionnal management

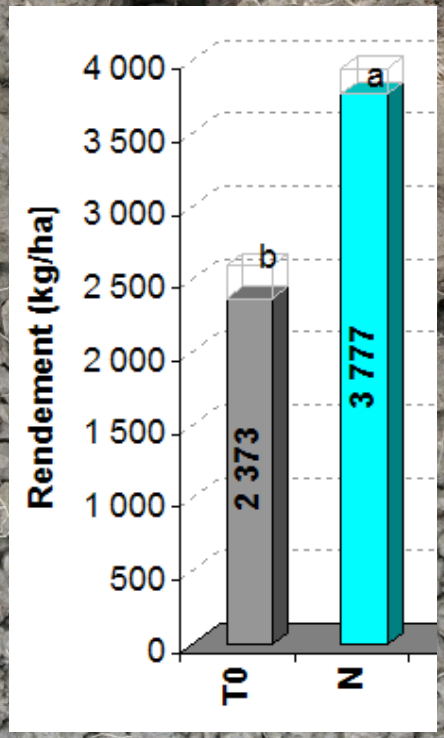
- Improvement of [illegible] soil structure only at the worked [illegible]e
- Temporary im[illegible]vement
- Erosion

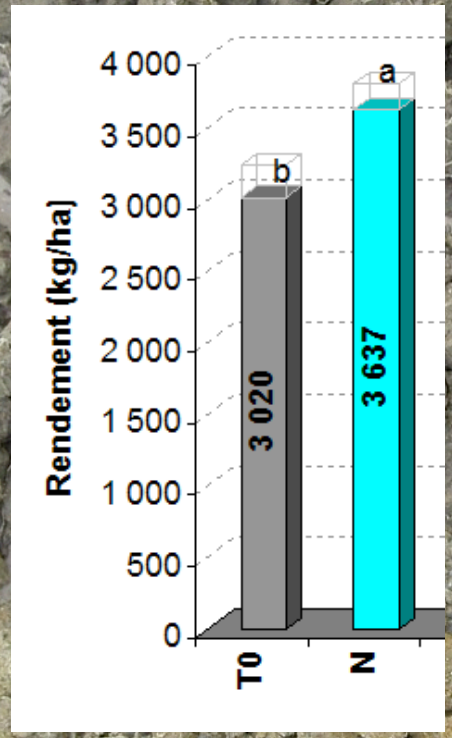
No-till and cover crops management

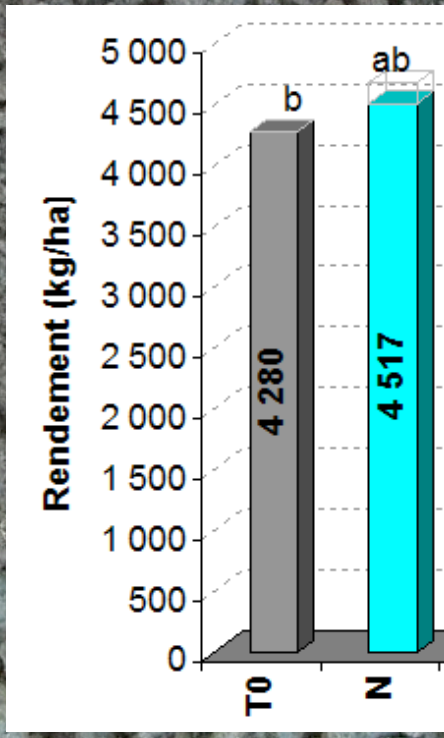
- Protection [illegible] residues ar[illegible]over crops
- Aeration and restructuration
- Formation of stables aggregates









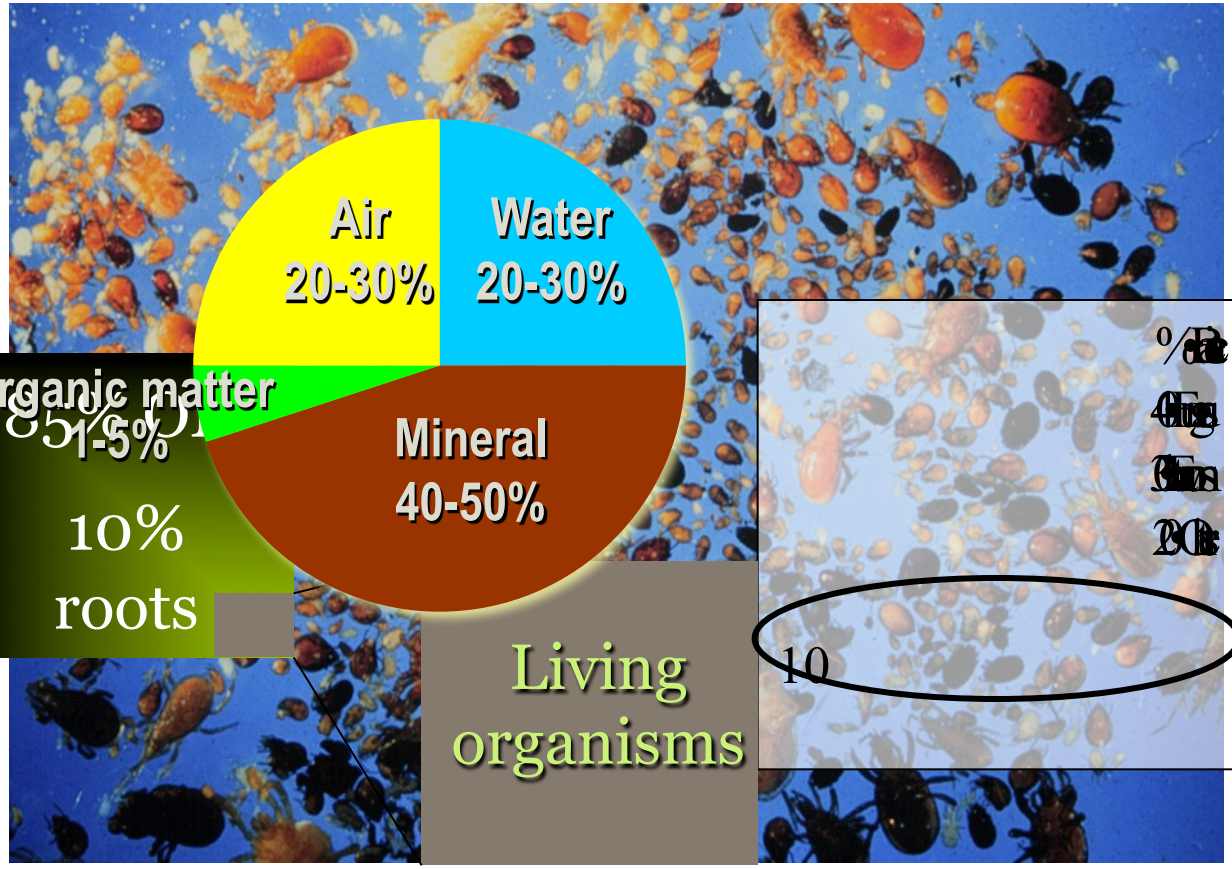


Diapositive de Jean Cantin

The ecology of soil

95% mineral

water and air



Estimated amount

ns

s

ns

ns

Biodiversity

- Fungie
- Actinomycetes
- Bacterias

- 1000-1500 kg/ha
- 60-700 kg/ha
- 1-2 tonnes/ha

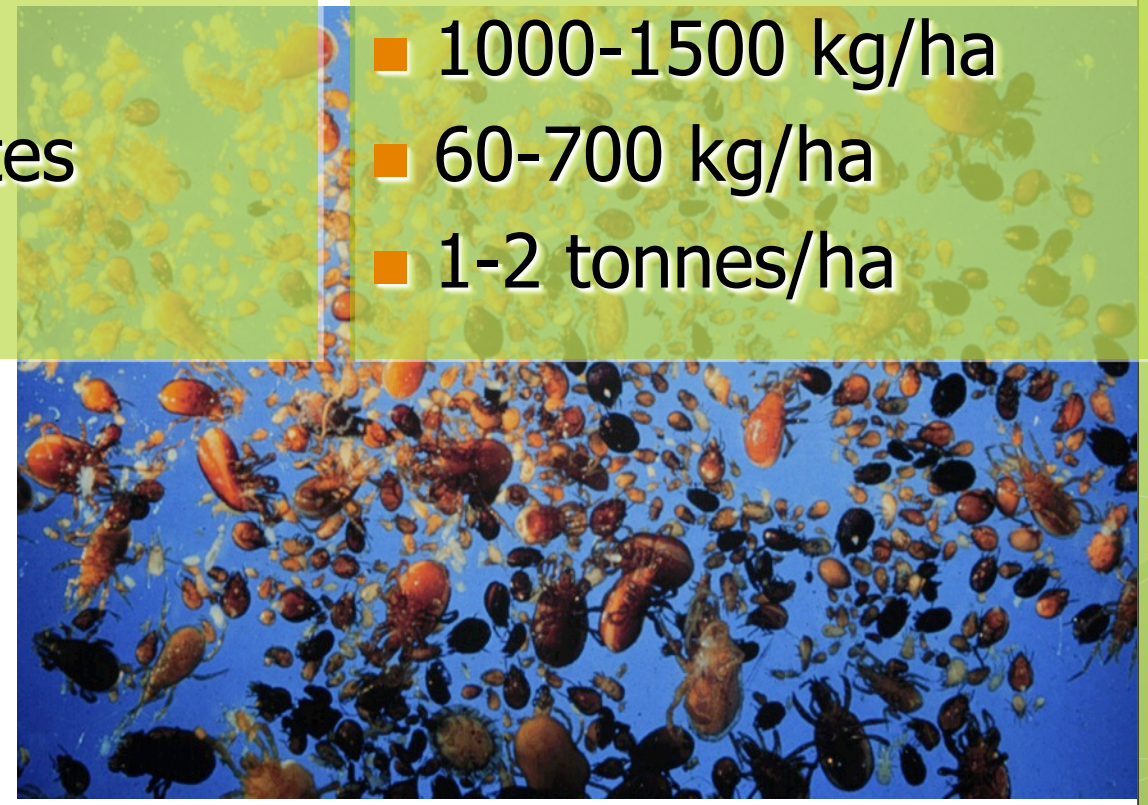


Photo by V. Behan-Pelletier
AAFC

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Mychorhizia

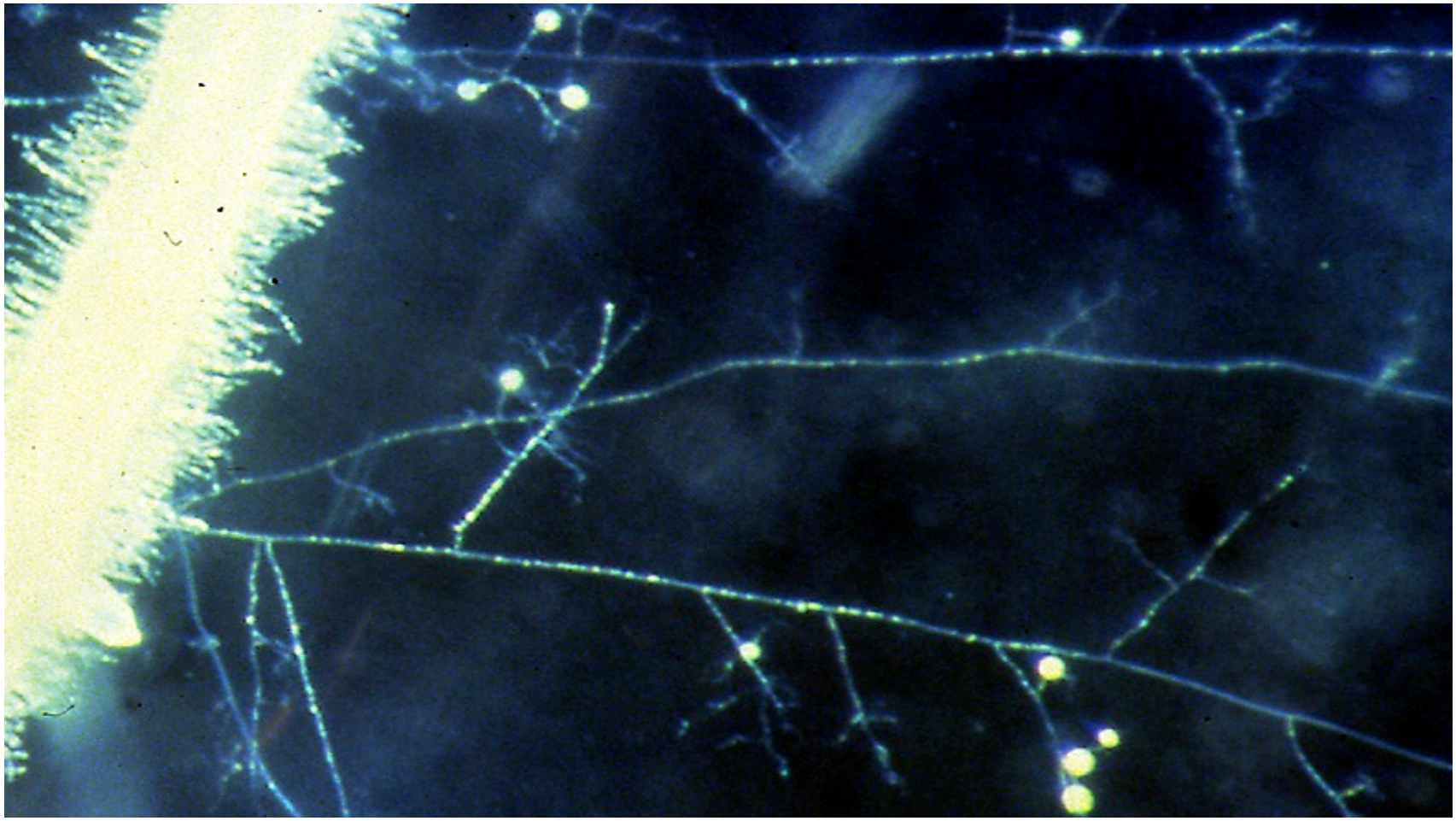


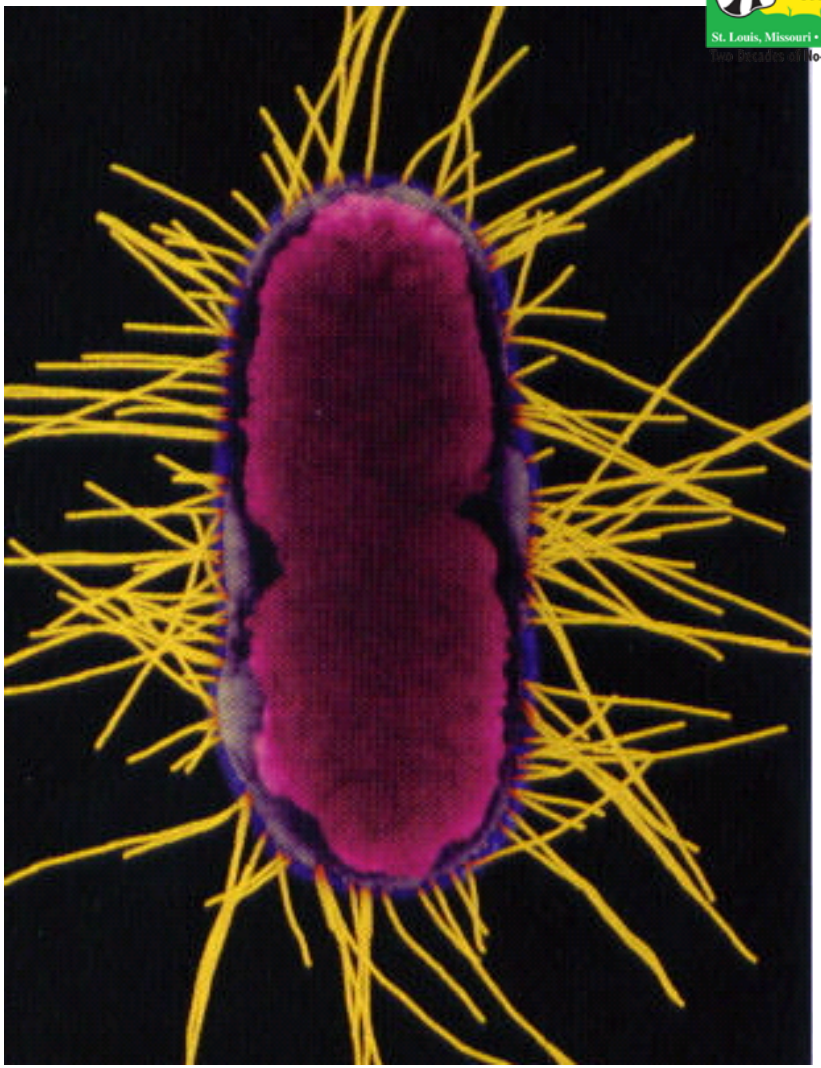
Photo: C. Hamel

Mychorhizia

System	Mycorhizia(%)	Lenght of mycelium (mm)
Ridge	65,3	31,3
Conventionnel	35,1	16,7

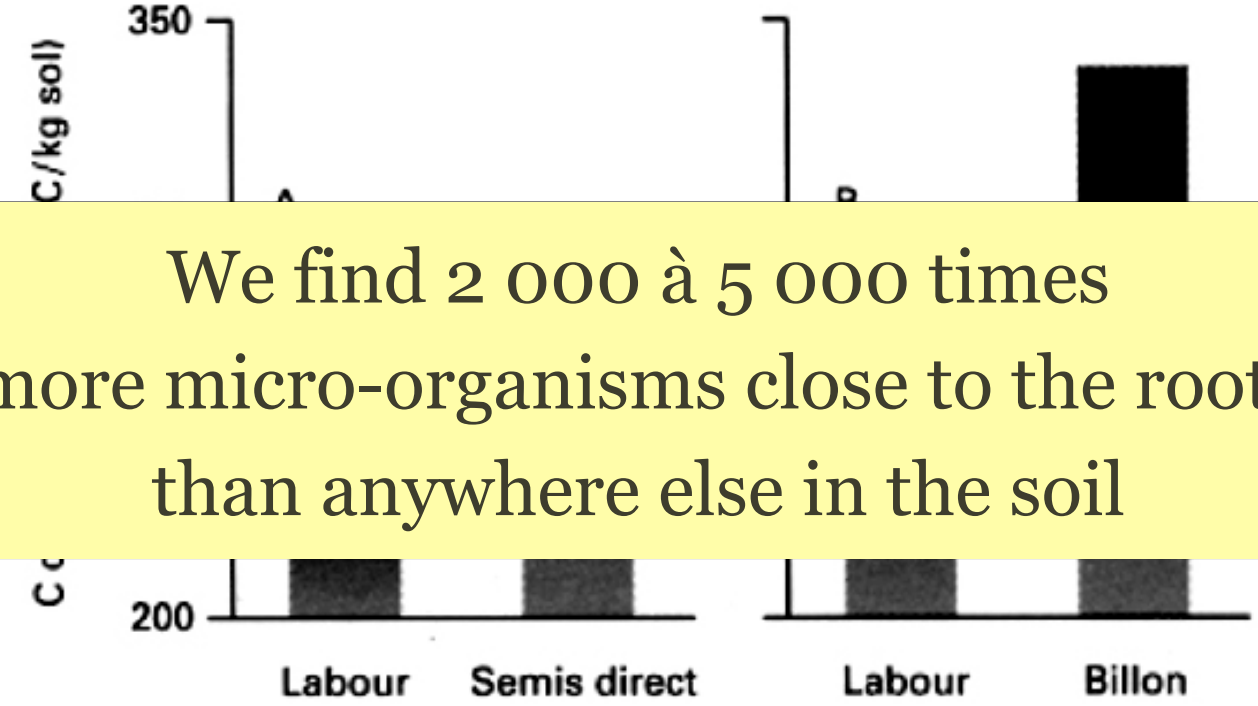
Plowing system

- Dominated by bacterias
- Carbon management efficiency : 20-30%
  Prefer aerobic conditions



No-till fields

- Dominated by fungies
- Carbon management efficiency 40 – 55%
- Aérobic and heterotrophe



We find 2 000 à 5 000 times
more micro-organisms close to the roots
than anywhere else in the soil

Soil microbial biomass (0-3 inches)

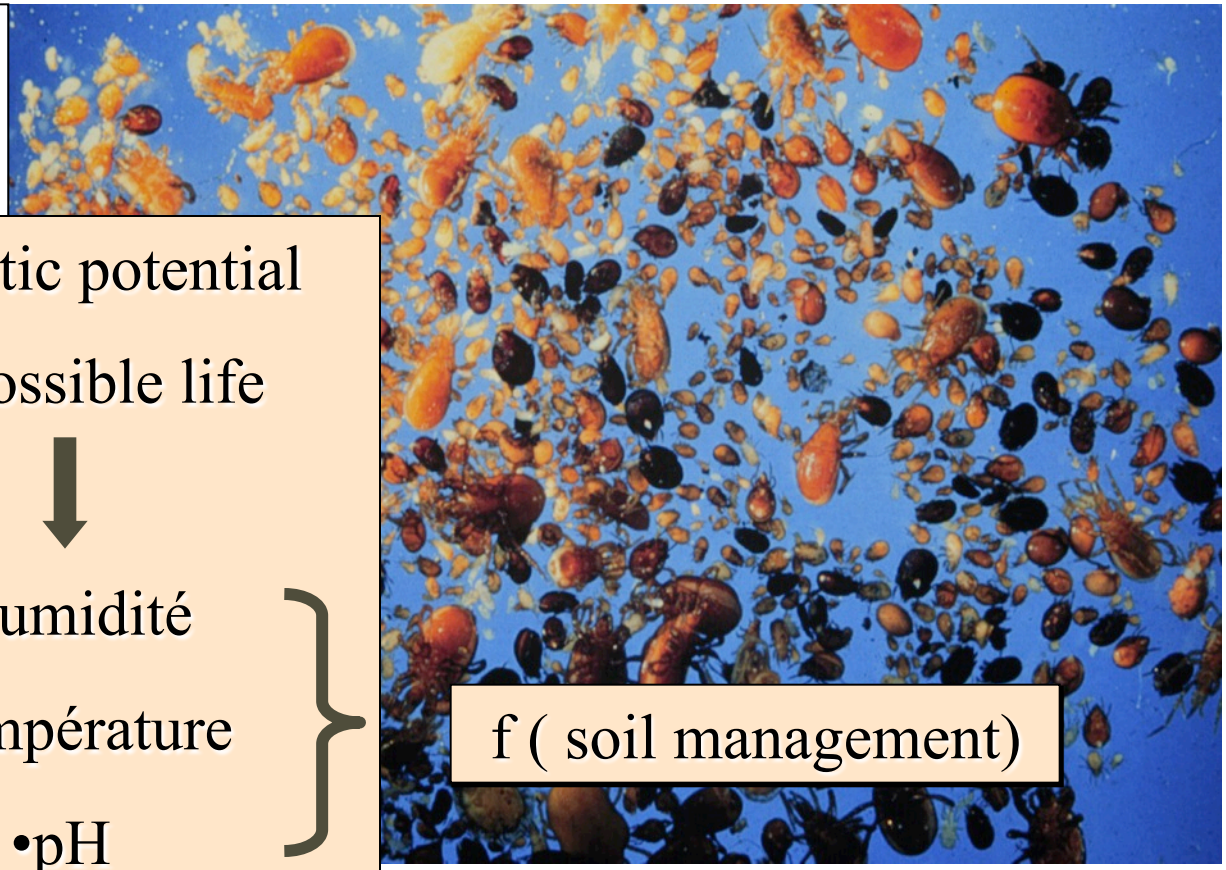
A. **Plowed and no-till fields** (D. Angers et S. Thibaudeau, not published)
B. **Plowed and ridge till fields** (D. Angers, G.Tremblay et L. Robert, not published)

What does it do in the soils

Soil structure	Earthworms, fungies, mycorhizia, roots
Hydrology	Earthworms, arthropodes, roots
Échanges gazeux et GES	Micro-org. roots
Depollution	Micro-org.
Pests and diseases	Mycorhizia, bacteria, earthworms
Food	Roots, insects, earthworms
Symbiotic relationship	Mycorhizia and other micro-org.
Plant growth	Roots, mycorhizia and other micro-org.

The ecology of soil

10



Energetic potential

All possible life

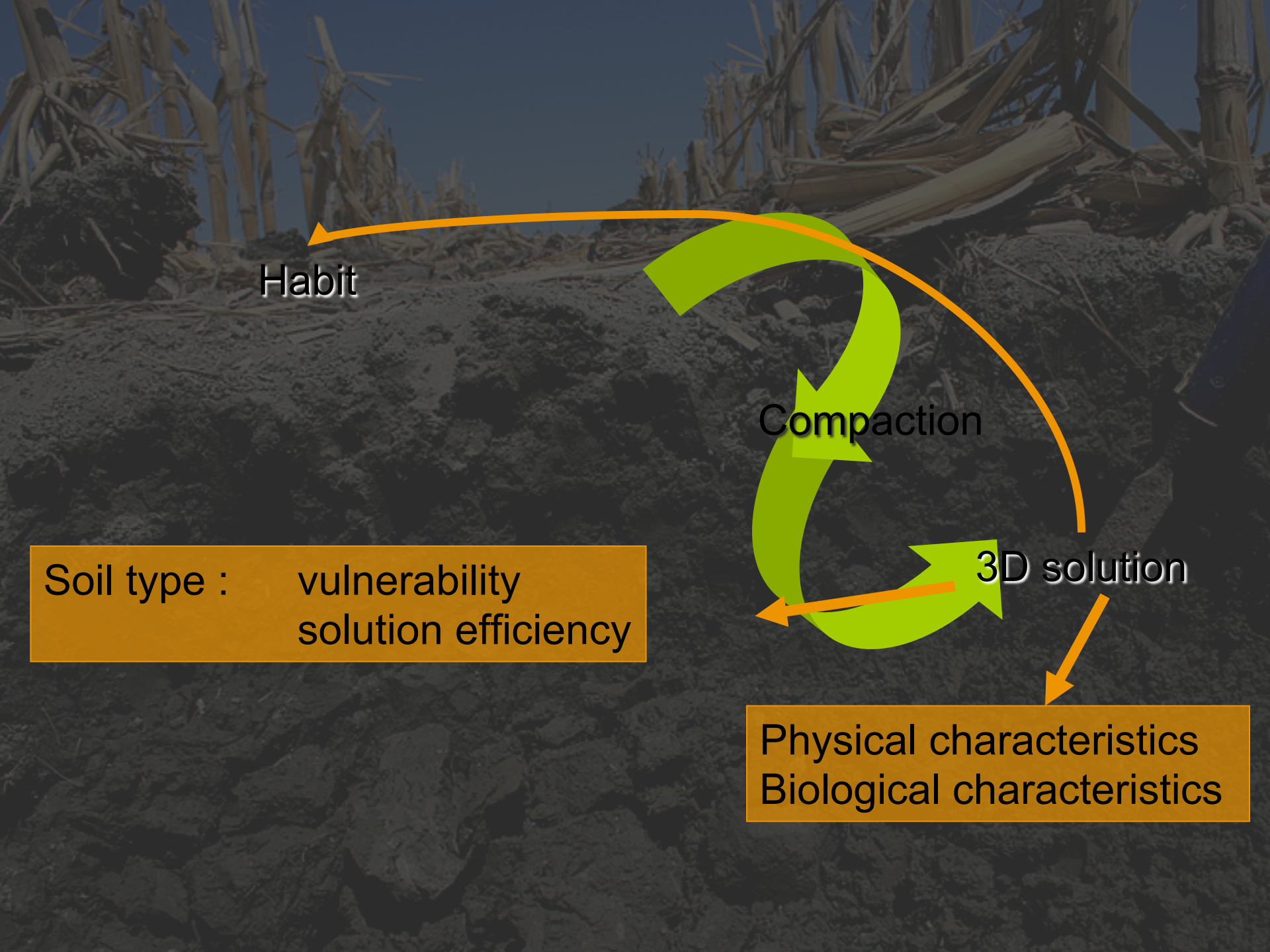
- Humidité
- Température
- pH

f (soil management)

Soil degradation

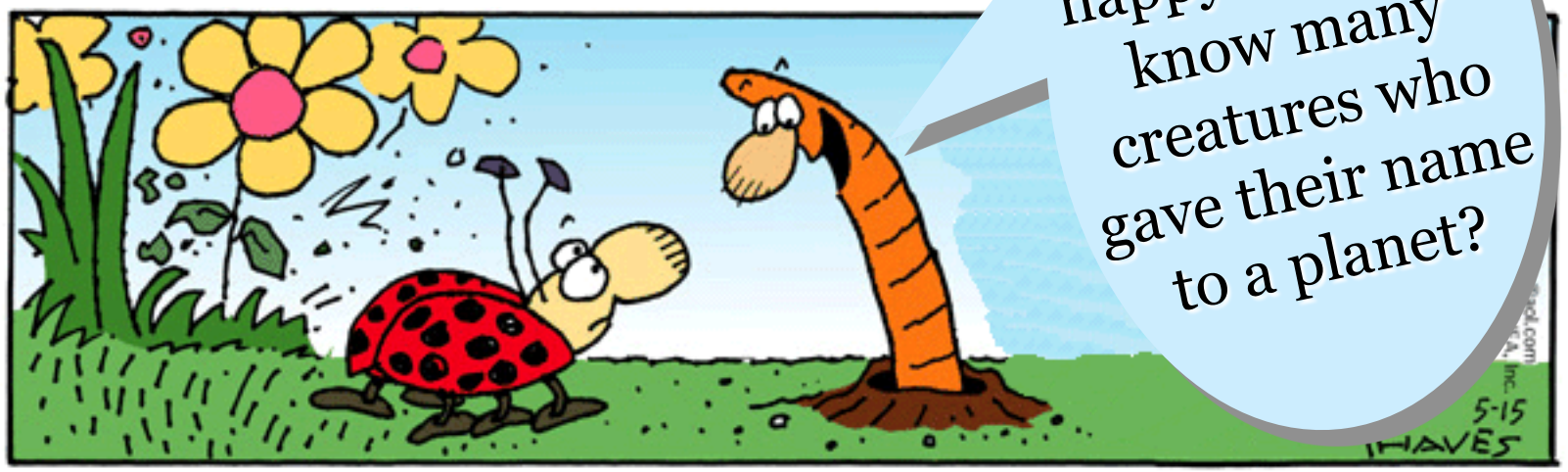
Soil type : vulnerability
solution efficiency

? Broken structure
? Loss of organic matter
? Surface compaction
? Sub-soil compaction



Soil type : vulnerability
solution efficiency

Physical characteristics
Biological characteristics



Merci beaucoup