Universidade Estadual de Londrina

XX RBMCSA

XX Reunião Brasileira de Manejo e Conservação do Solo e da Água

O SOLO SOB AMEAÇA: conexões necessárias ao manejo e conservação do solo e água!

20 a 24 de novembro de 2016
Foz do Iguaçu-PR

CONTRIBUIÇÕES DA MICROBIOLOGIA DO SOLO

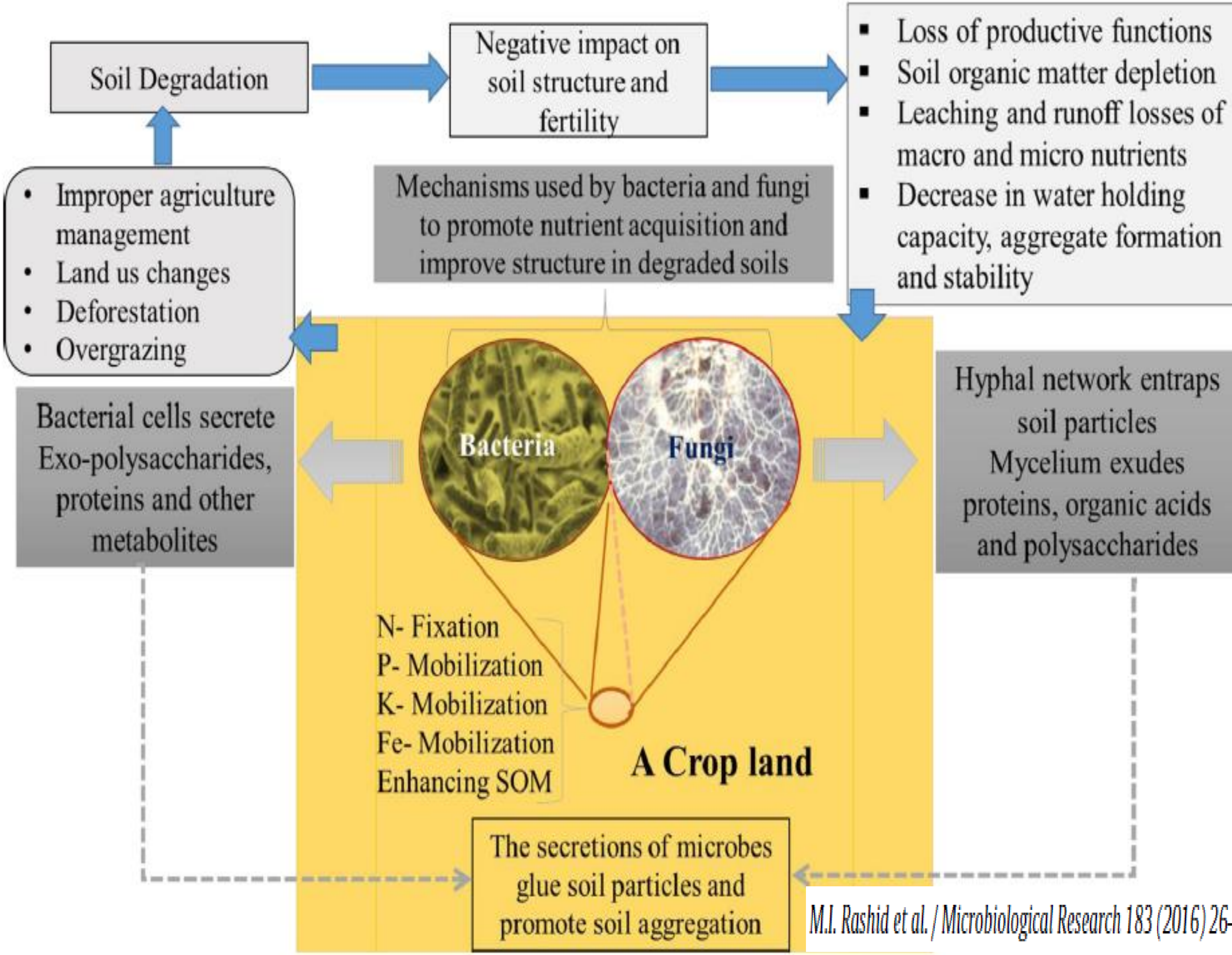
Drª Adriana Pereira

Foz do Iguaçu

2016

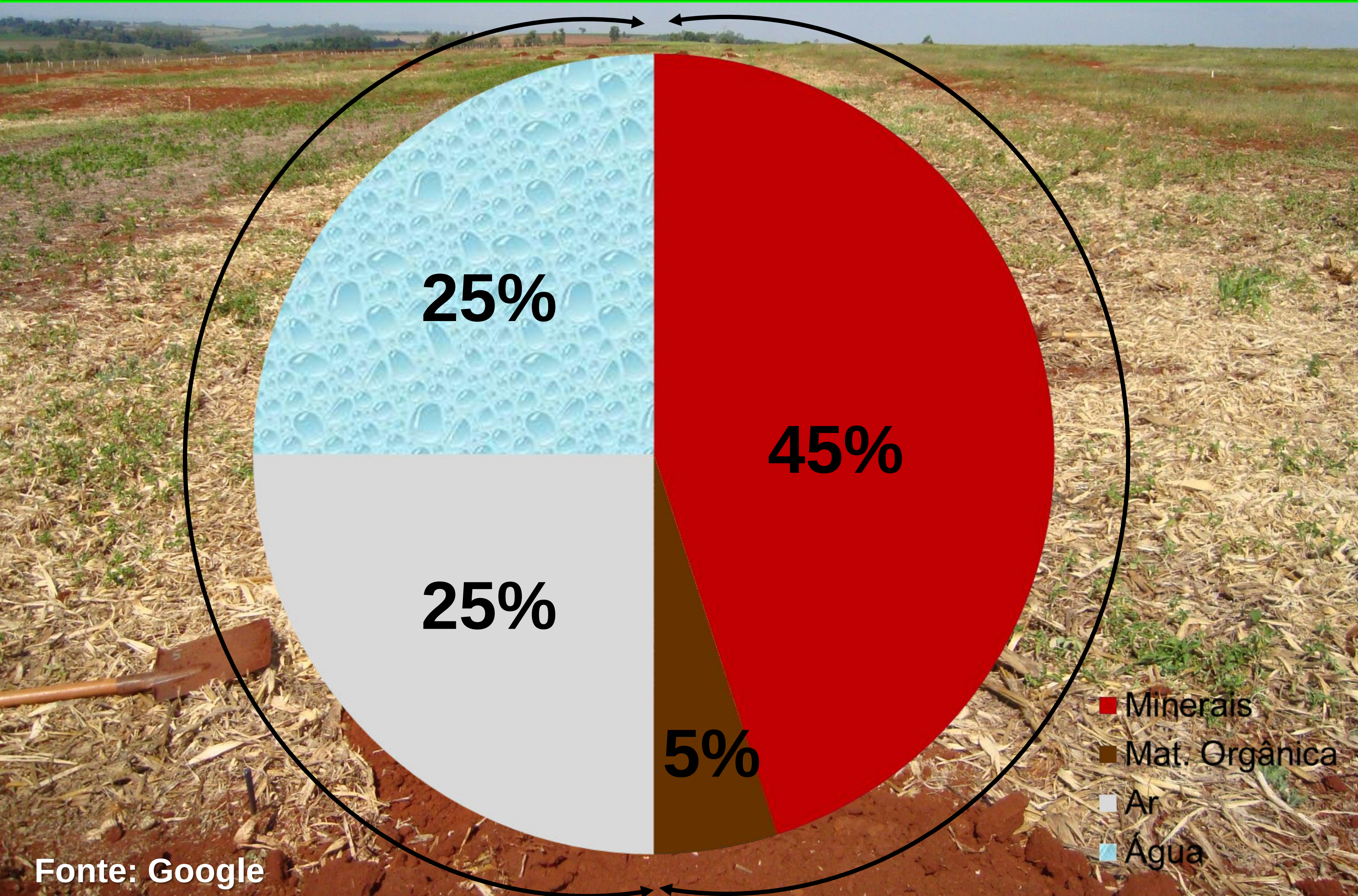
SOLO

Fonte: Google



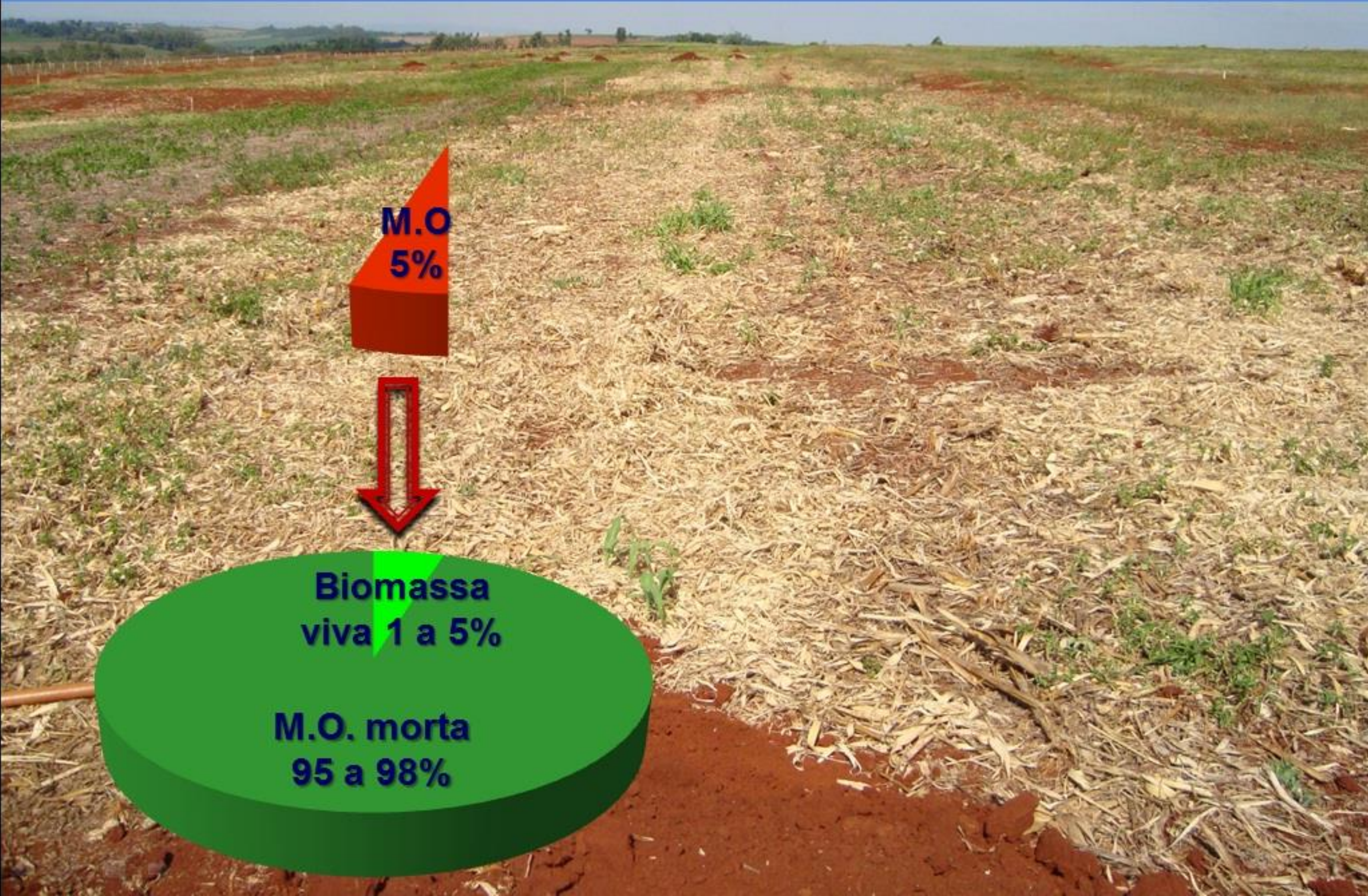
M.I. Rashid et al. / Microbiological Research 183 (2016) 26–41

Composição do Solo

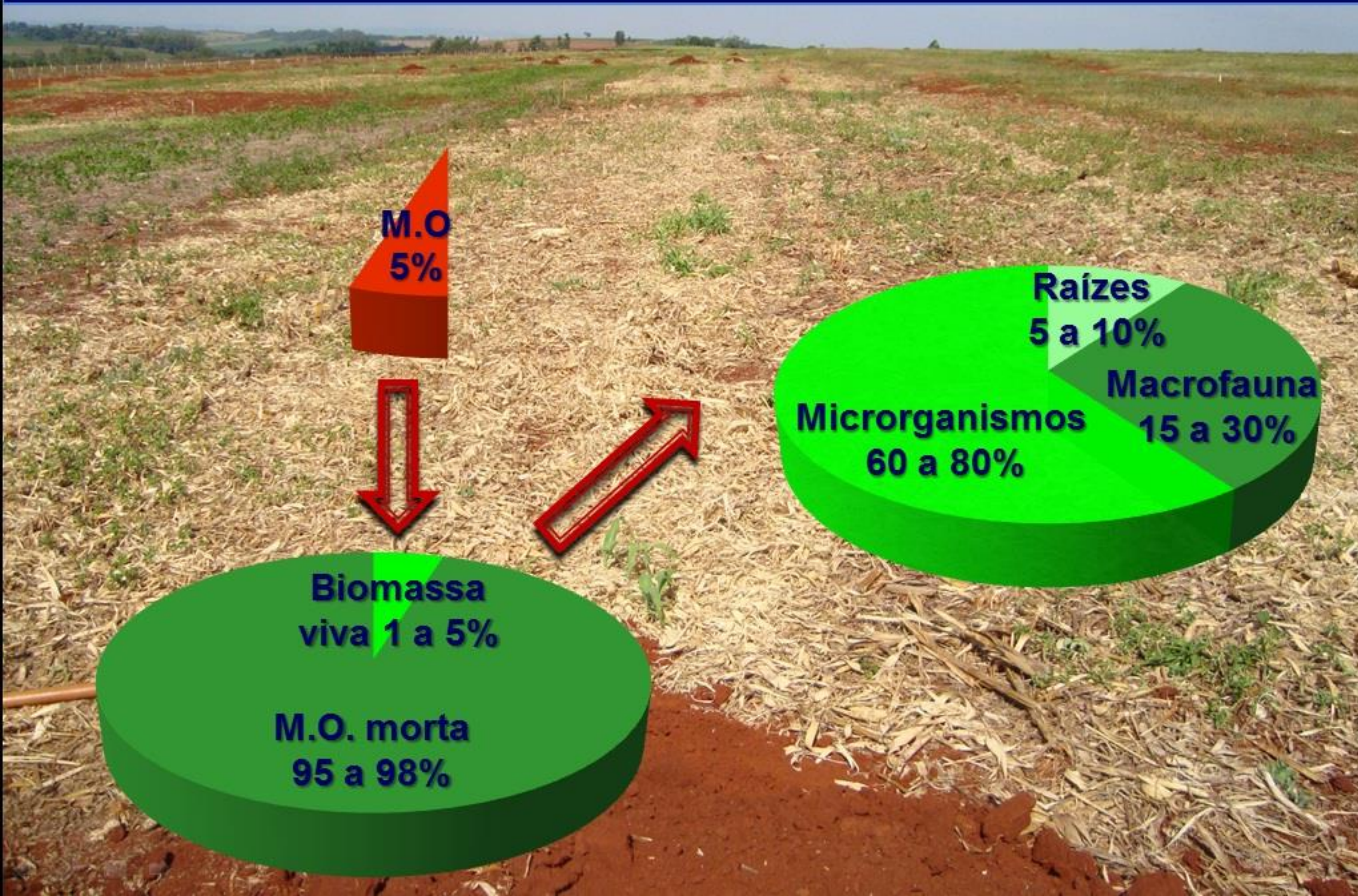


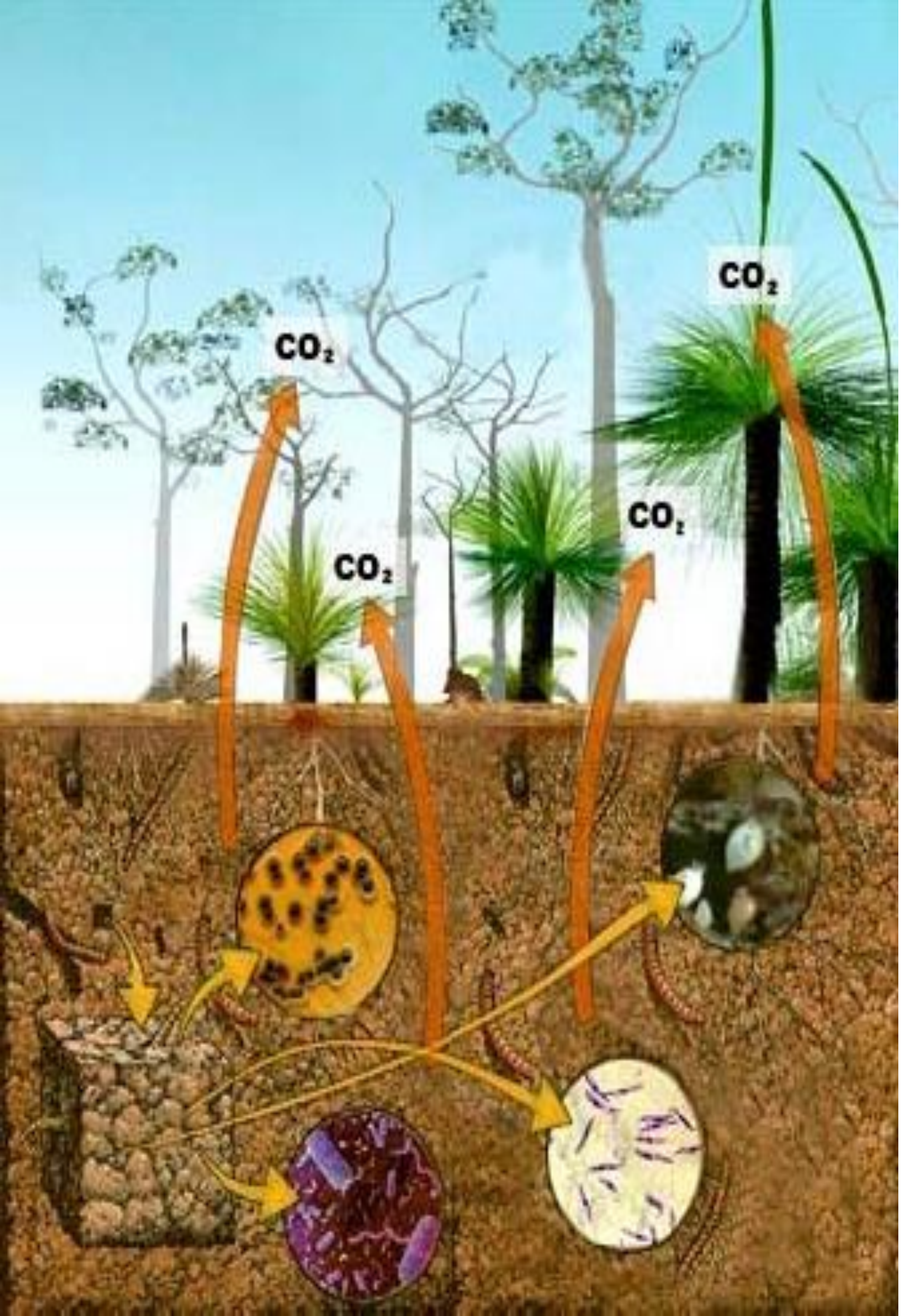
Fonte: Google

Matéria Orgânica do Solo



Matéria Orgânica do Solo





Microbiota do Solo

Fonte: Google

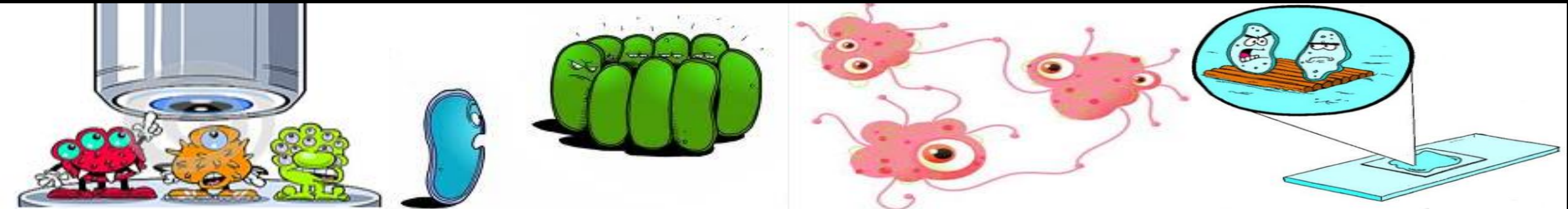
SANIDADE, CONTROLE BIOLÓGICO, BIOFERTILIZAÇÃO E ESTABILIDADE

FERTILIDADE DO SOLO E QUALIDADE AMBIENTAL

Siqueira e Trannin, 2003

“A importância dos infinitamente pequenos é infinitamente grande.”

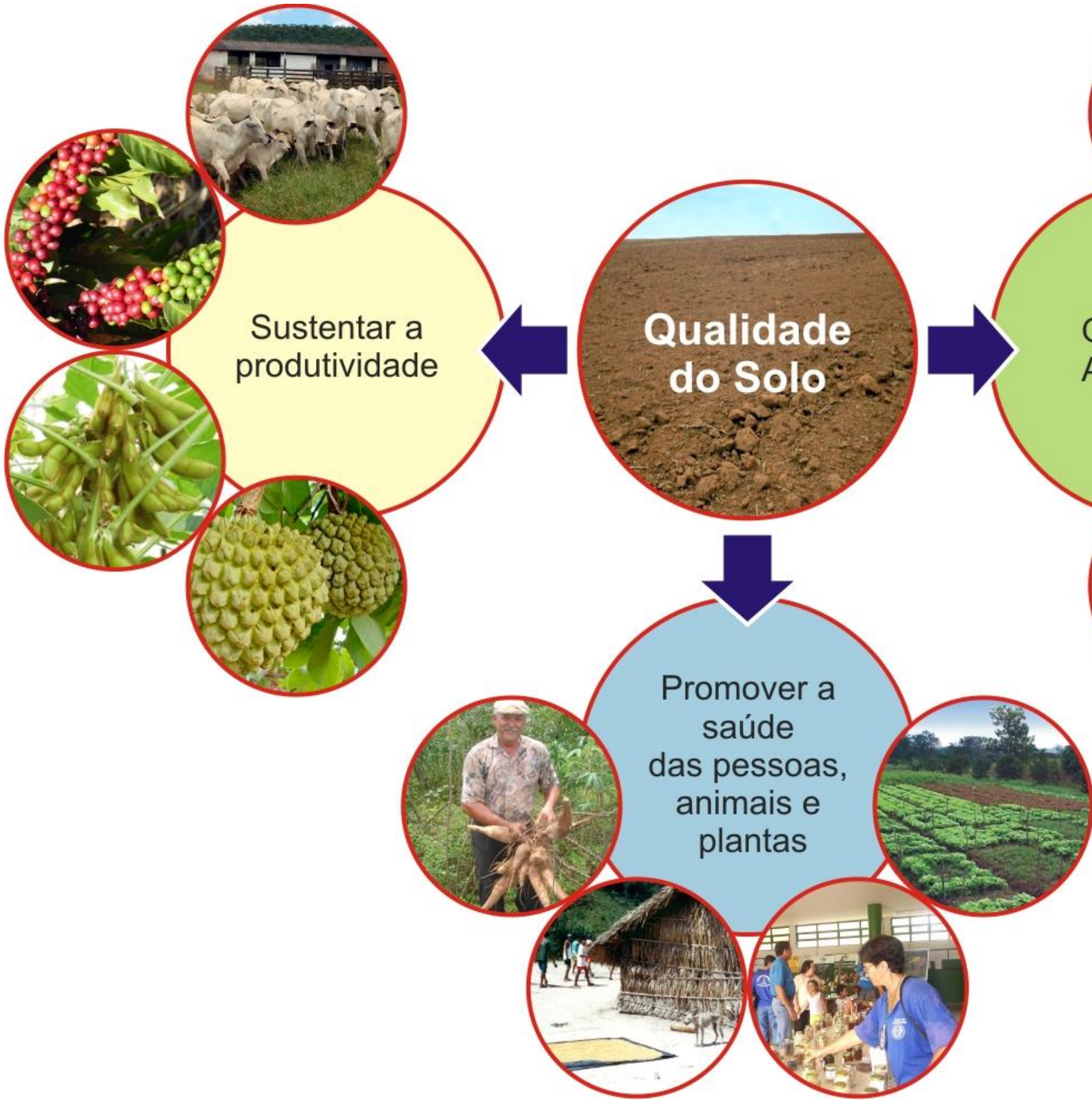
Louis Pasteur



QUALIDADE DO SOLO

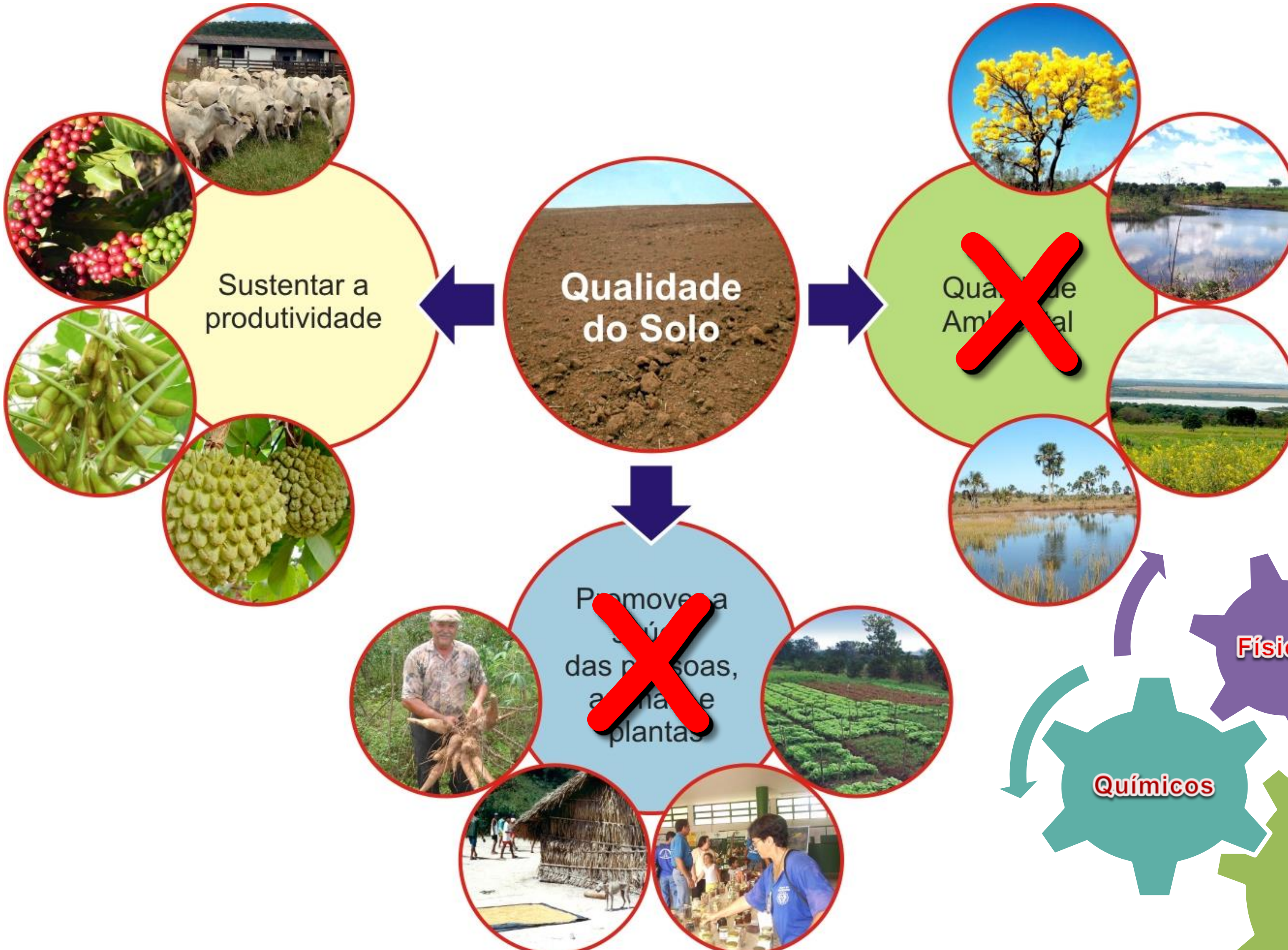
Fonte: Ieda Mendes. Embrapa Cerrados.

QUALIDADE DO SOLO



Fonte: Ieda Mendes. Embrapa Cerrados.

QUALIDADE DO SOLO



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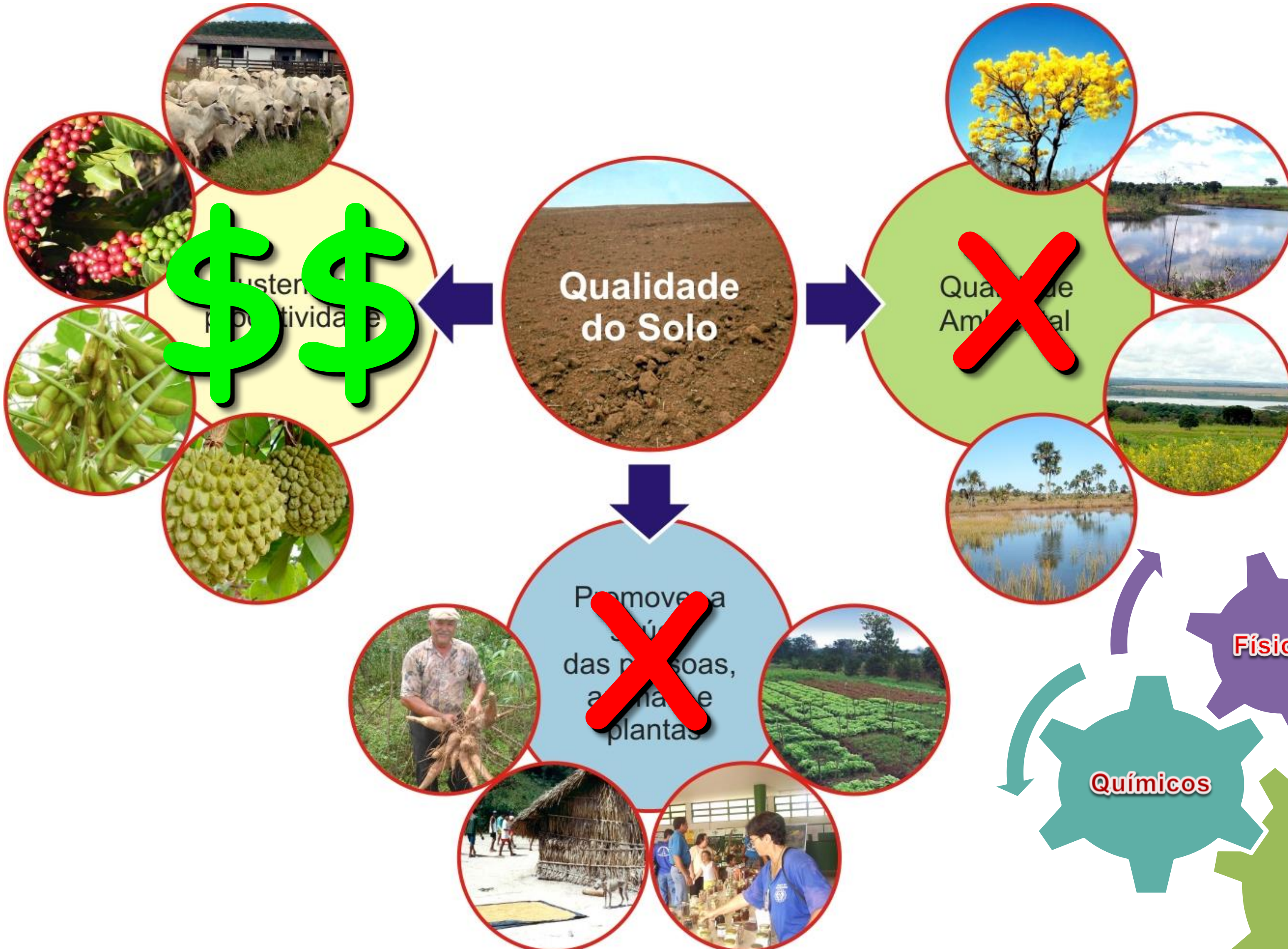
QUALIDADE DO SOLO



Fonte: Ieda Mendes. Embrapa Cerrados.

TIPOS DE INDICADORES

VISUAIS

FÍSICOS

QUÍMICOS

BIOLÓGICOS

Fonte: Google

INDICADOR MICROBIOLÓGICO X QUÍMICO X FÍSICO

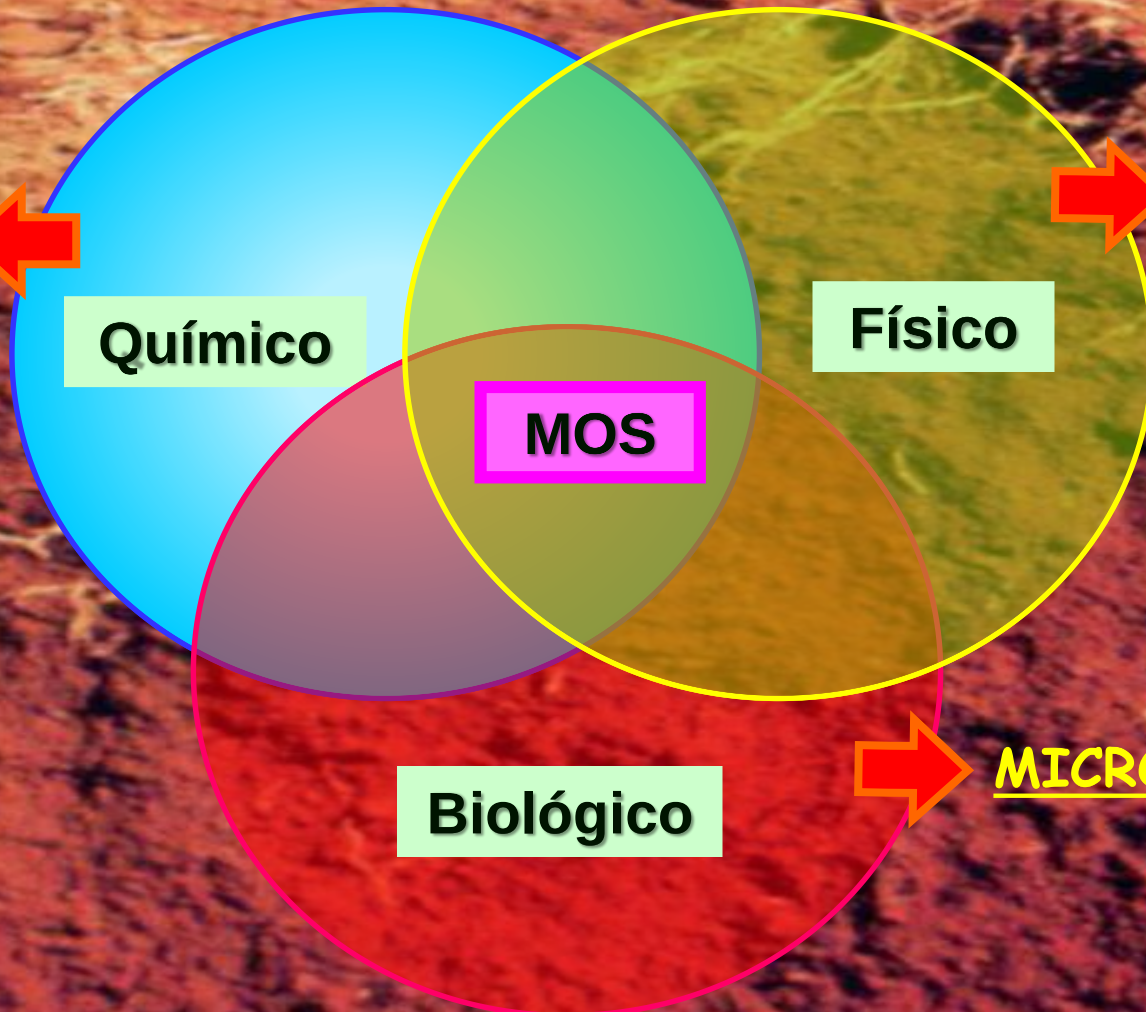
Figura 2. Tempo necessário para detectar variações positivas no solo pela mudança do sistema de plantio convencional para o plantio direto na Estação Experimental da Embrapa Soja, em Londrina, Paraná.

Hungria, M.; Nogueira, M.A.; Mercante, F.M.; Silva, A.P., 2013.

Indicadores de Qualidade do Solo

pH, Al, Ca^{+}
Mg, P, K...

Textura
Densidade
Cap. ret. H_2O



MICRORGANISMOS

MANEJO DO SOLO

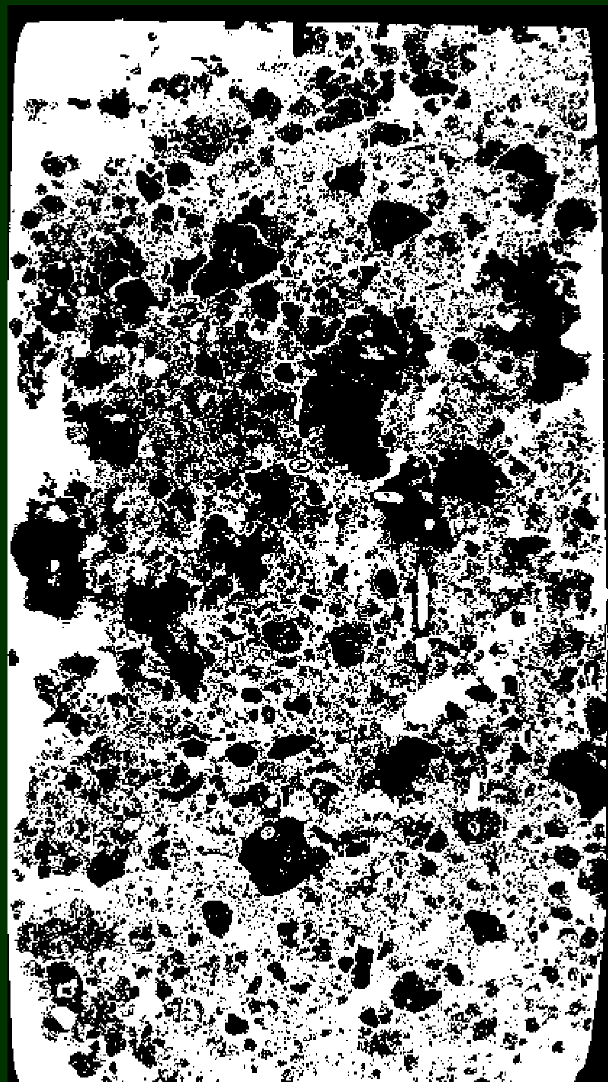
Fonte: Google

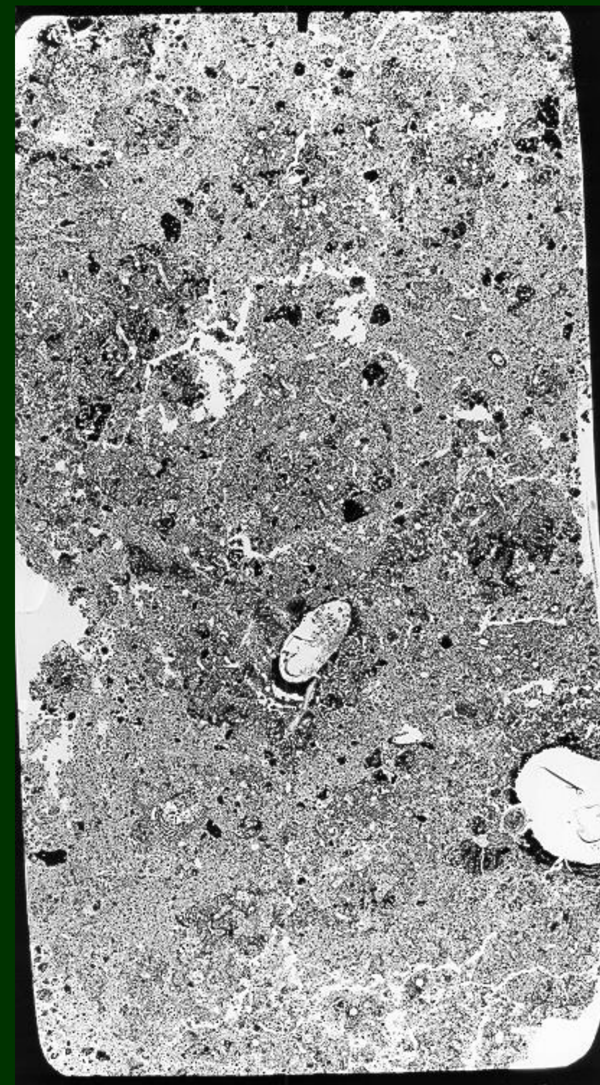
Amostras de lâmina delgada solo sob mata

0

0,1

0,2 m





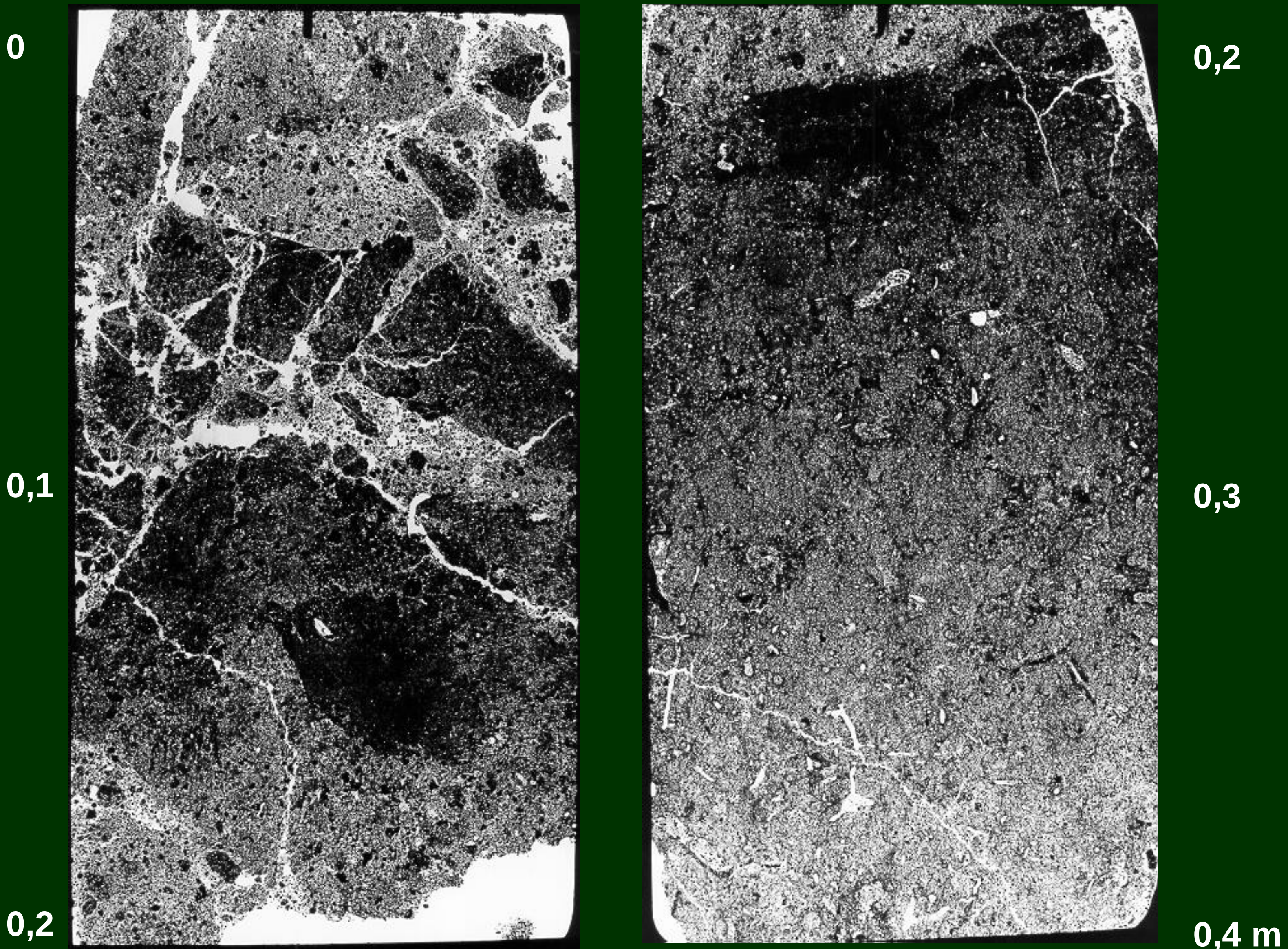
0,2

0,3

0,4 m

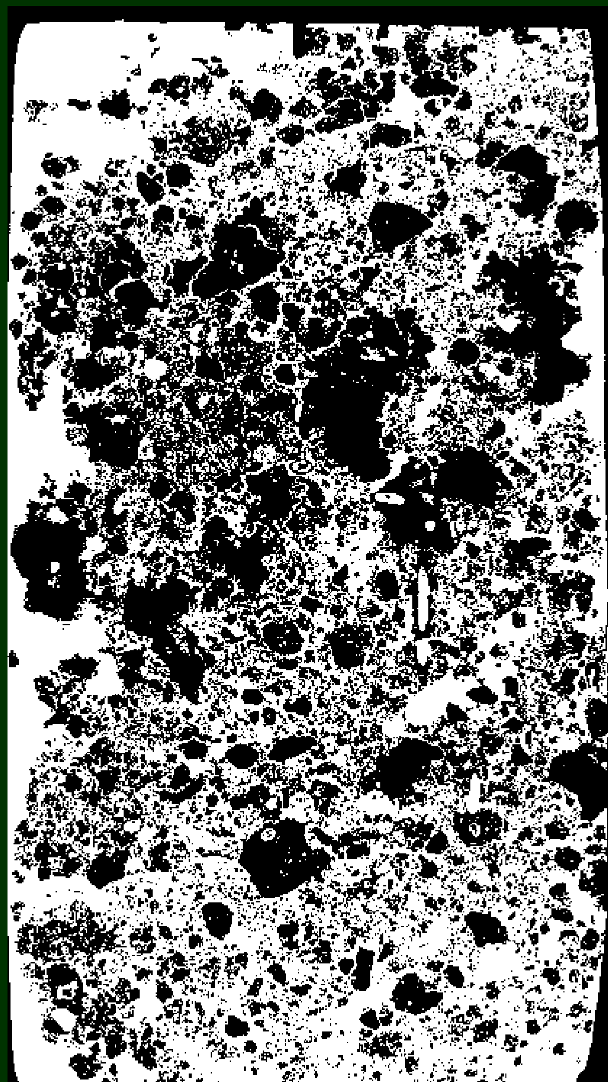
Fonte: Maria de Fátima Guimarães. UEL.

Amostras de lâmina delgada solo sob cultivo

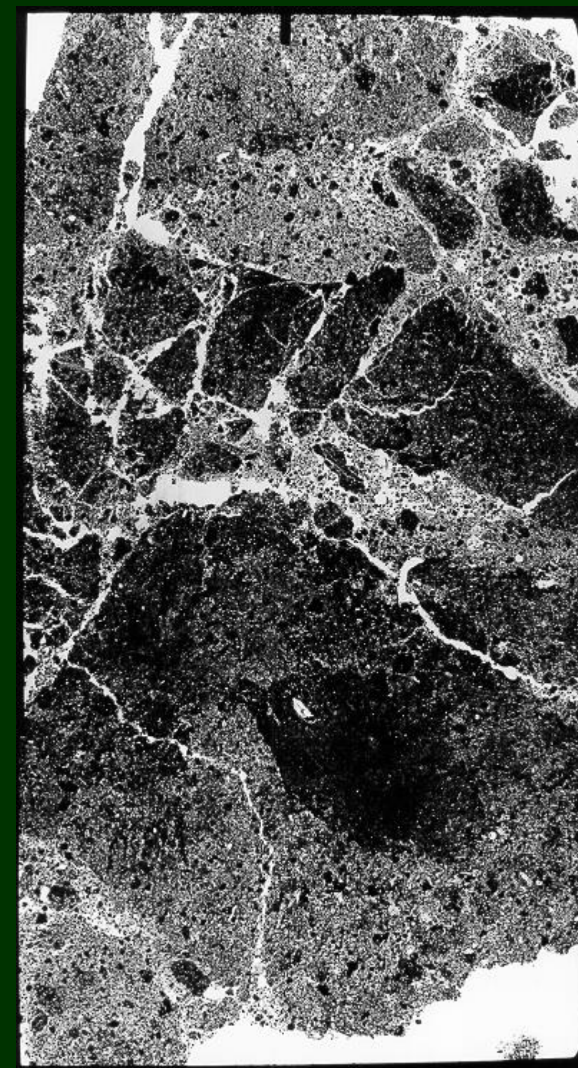


Fonte: Maria de Fátima Guimarães. UEL.

Mata



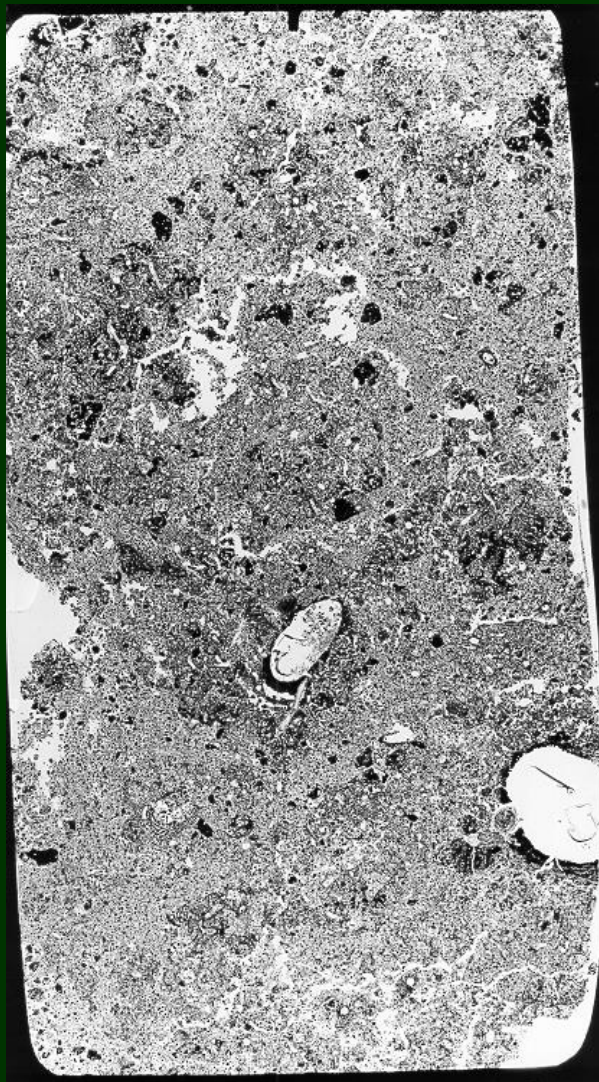
Cultivo



Fonte: Maria de Fátima Guimarães. UEL.

Mata

0,2

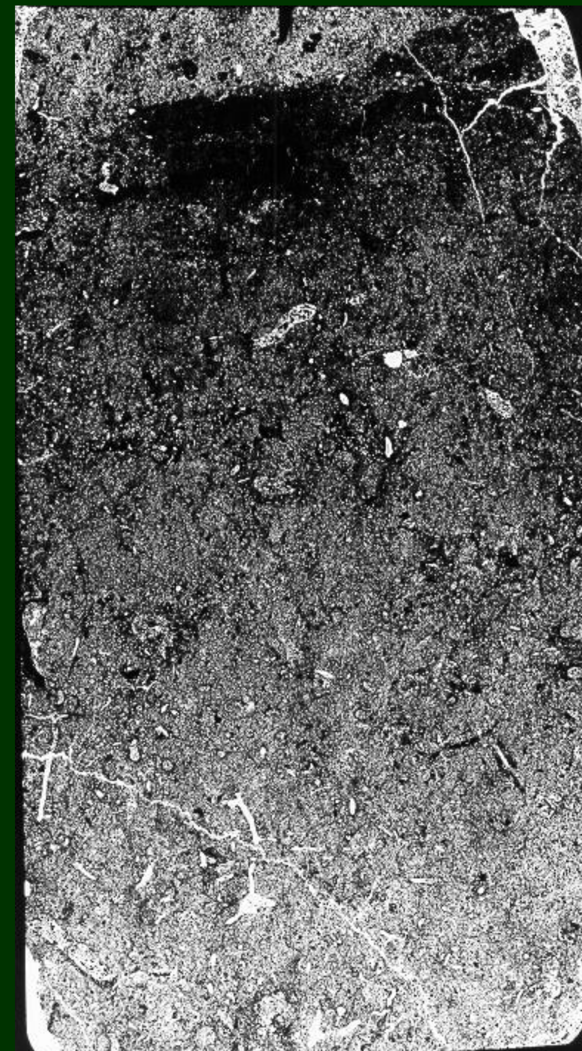


0,3

0,4 m

Cultivo

0,2



0,3

0,4 m

Fonte: Maria de Fátima Guimarães. UEL.

~ 300 milhões de ha

(MAPA, 2015)

Fonte: Google

Field Crops Research 119 (2010) 20–26

Contents lists available at ScienceDirect

Field Crops Research

journal homepage: www.elsevier.com/locate/fcr

Microbial biomass under various soil- and crop-management systems in short- and long-term experiments in Brazil

Adriana Pereira Silva[a,b], Letícia Carlos Babujia[a,b], Julio Cezar Franchini[a], Rosinei Aparecida Souza[a], Mariangela Hungria[a,b,*]

[a] *Embrapa Soja, Cx. Postal 231, 86001-970, Londrina, PR, Brazil*
[b] *Universidade Estadual de Londrina, Depto. Biotecnologia, Londrina, PR, Brazil*

Table 2

Microbial biomass MB-C and MB-N (μg C or N g^{-1} dry soil) in soils (0–10 cm) in two experiments: the first with 26 years and four types of soil management and the second with 21 years and on crop succession and seven different crop rotation systems under the no-tillage system. *Experiments 1 and 2*.

	Summer		Winter	
	MB-C	MB-N	MB-C	MB-N
Soil management[a]				
Conventional tillage	343[b] AB	37 C	264 C	30 C
Heavy-disc harrow	332 B	33 C	329 B	43 B
Field cultivator	365 AB	51 B	310 B	43 B
No-tillage	410 A	66 A	451 A	57 A

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A.P. Silva et al. / Field Crops Research 119 (2010) 20–26

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↑20% ↑78%

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↑20% ↑78% ↑71% ↑90%

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No-tillage	410 A	66 A	451 A	57 A

Nitrogênio → encontra-se quase totalmente complexado na forma orgânica (98%).

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Table 3

Microbial biomass MB-C and MB-N (μg C or N g^{-1} dry soil) in soils (0–10 cm) after the 14th year in a field experiment under different soil[a] and crop[b] management systems. *Experiment 3*.

Soil management[a]	Summer											Winter										
	CR 1[b]			CR 2			CS			Mean		CR 1			CR 2			CS			Mean	
MB-C																						
Conventional tillage	157[c]	B	a	172	B	a	168	B	a	166	B	365	C	a	322	C	b	383	C	a	357	C
New no-tillage	160	B	a	169	B	a	190	B	a	173	B	477	B	a	454	B	a	447	B	a	459	B
Old no-tillage	220	A	c	421	A	a	270	A	b	304	A	612	A	a	635	A	a	551	A	b	599	A
Mean	179		c	254		a	209		b			485		a	470		ab	460		b		
MB-N																						
Conventional tillage	27	C	a	26	B	a	27	C	a	27	C	34	C	a	36	C	a	32	C	b	34	C
New no-tillage	57	B	b	68	A	a	54	B	b	60	B	41	B	c	46	B	b	50	B	a	46	B
Old no-tillage	75	A	a	66	A	b	62	A	b	68	A	61	A	b	70	A	a	56	A	c	62	A
Mean	53		a	53		a	48		b			45		b	51		a	46		b		

[a] New no-tillage, 4 years old; old no-tillage, 14 years old.

[b] Crop rotations (CRs) and crop succession (CS) as described in Table 1.

[c] Means of four replicates followed by the same capital letters within each column and by the same small letters within each line, for each parameter and sampling time are not statistically different ($P \leq 0.05$, Duncan's test). The same applies for the comparison of the mean values (12 replicates each) of the three soil and three cropping managements.

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	CR 1[b]			CR 2			CS			Mean		CR 1			CR 2			CS			Mean	
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Conventional tillage	157[c]	B	a	172	B	a	168	B	a	166	B	365	C	a	322	C	b	383	C	a	357	C
New no-tillage	160	B	a	169	B	a	190	B	a	173	B	477	B	a	454	B	a	447	B	a	459	B
Old no-tillage	220	A	c	421	A	a	270	A	b	304	A	612	A	a	635	A	a	551	A	b	599	A
Mean	179		c	254		a	209		b			485		a	470		ab	460		b		
MB-N																						
Conventional tillage	27	C	a	26	B	a	27	C	a	27	C	34	C	a	36	C	a	32	C	b	34	C
New no-tillage	57	B	b	68	A	a	54	B	b	60	B	41	B	c	46	B	b	50	B	a	46	B
Old no-tillage	75	A	a	66	A	b	62	A	b	68	A	61	A	b	70	A	a	56	A	c	62	A
Mean	53		a	53		a	48		b			45		b	51		a	46		b		

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Microbial biomass MB-C and MB-N (μg C or N g^{-1} dry soil) in soils (0–10 cm) after the 14th year in a field experiment under different soil[a] and crop[b] management systems. *Experiment 3.*

CBM

Soil management[a]	Summer											Winter										
	CR 1[b]			CR 2			CS			Mean		CR 1			CR 2			CS			Mean	
MB-C																						
Conventional tillage	157[c]	B	a	172	B	a	168	B	a	166	B	365	C	a	322	C	b	383	C	a	357	C
New no-tillage	160	B	a	169	B	a	190	B	a	173	B	477	B	a	454	B	a	447	B	a	459	B
Old no-tillage	220	A	c	421	A	a	270	A	b	304	A	612	A	a	635	A	a	551	A	b	599	A
Mean	179		c	254		a	209		b			485		a	470		ab	460		b		
MB-N																						
Conventional tillage	27	C	a	26	B	a	27	C	a	27	C	34	C	a	36	C	a	32	C	b	34	C
New no-tillage	57	B	b	68	A	a	54	B	b	60	B	41	B	c	46	B	b	50	B	a	46	B
Old no-tillage	75	A	a	66	A	b	62	A	b	68	A	61	A	b	70	A	a	56	A	c	62	A
Mean	53		a	53		a	48		b			45		b	51		a	46		b		

[a] New no-tillage, 4 years old; old no-tillage, 14 years old.

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CBM

Soil management[a]	Summer				Winter			
	CR 1[b]	CR 2	CS	Mean	CR 1	CR 2	CS	Mean
MB-C								
Conventional tillage	157[c] B a	172 B a	168 B a	166 B	365 C a	322 C b	383 C a	357 C
New no-tillage	160 B a	169 B a	190 B a	173 B	477 B a	454 B a	447 B a	459 B
Old no-tillage	220 A c	421 A a	270 A b	304 A	612 A a	635 A a	551 A b	599 A
Mean	179 c	254 a	209 b		485 a	470 ab	460 b	
MB-N								
Conventional tillage	27 C a	26 B a	27 C a	27 C	34 C a	36 C a	32 C b	34 C
New no-tillage	57 B b	68 A a	54 B b	60 B	41 B c	46 B b	50 B a	46 B
Old no-tillage	75 A a	66 A b	62 A b	68 A	61 A b	70 A a	56 A c	62 A
Mean	53 a	53 a	48 b		45 b	51 a	46 b	

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New no-tillage	160	B	a	169	B	a	190	B	a	173	B	477	B	a	454	B	a	447	B	a	459	B
Old no-tillage	220	A	c	421	A	a	270	A	b	304	A	612	A	a	635	A	a	551	A	b	599	A
Mean	179		c	254		a	209		b			485		a	470		ab	460		b		
MB-N **NBM**																						
Conventional tillage	27	C	a	26	B	a	27	C	a	27	C	34	C	a	36	C	a	32	C	b	34	C
New no-tillage	57	B	b	68	A	a	54	B	b	60	B	41	B	c	46	B	b	50	B	a	46	B
Old no-tillage	75	A	a	66	A	b	62	A	b	68	A	61	A	b	70	A	a	56	A	c	62	A
Mean	53		a	53		a	48		b			45		b	51		a	46		b		

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Table 3

Microbial biomass MB-C and MB-N (μg C or N g^{-1} dry soil) in soils (0–10 cm) after the 14th year in a field experiment under different soil[a] and crop[b] management systems. *Experiment 3*.

Soil management[a]	Summer											Winter										
	CR 1[b]			CR 2			CS			Mean		CR 1			CR 2			CS			Mean	
MB-C																						
Conventional tillage	157[c]	B	a	172	B	a	168	B	a	166	B	365	C	a	322	C	b	383	C	a	357	C
New no-tillage	160	B	a	169	B	a	190	B	a	173	B	477	B	a	454	B	a	447	B	a	459	B
Old no-tillage	220	A	c	421	A	a	270	A	b	304	A	612	A	a	635	A	a	551	A	b	599	A
Mean	179		c	254		a	209		b			485		a	470		ab	460		b		
MB-N **NBM**																						
Conventional tillage	27	C	a	26	B	a	27	C	a	27	C	34	C	a	36	C	a	32	C	b	34	C
New no-tillage	57	B	b	68	A	a	54	B	b	60	B	41	B	c	46	B	b	50	B	a	46	B
Old no-tillage	75	A	a	66	A	b	62	A	b	68	A	61	A	b	70	A	a	56	A	c	62	A
Mean	53		a	53		a	48		b			45		b	51		a	46		b		

[a] New no-tillage, 4 years old; old no-tillage, 14 years old.

[b] Crop rotations (CRs) and crop succession (CS) as described in Table 1.

[c] Means of four replicates followed by the same capital letters within each column and by the same small letters within each line, for each parameter and sampling time are not statistically different ($P \leq 0.05$, Duncan's test). The same applies for the comparison of the mean values (12 replicates each) of the three soil and three cropping managements.

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Table 3

Microbial biomass MB-C and MB-N (μg C or N g^{-1} dry soil) in soils (0–10 cm) after the 14th year in a field experiment under different soil[a] and crop[b] management systems. *Experiment 3.*

Soil management[a]	Summer											Winter										
	CR 1[b]			CR 2			CS			Mean		CR 1			CR 2			CS			Mean	
MB-C																						
Conventional tillage	157[c]	B	a	172	B	a	168	B	a	166	B	365	C	a	322	C	b	383	C	a	357	C
New no-tillage	160	B	a	169	B	a	190	B	a	173	B	477	B	a	454	B	a	447	B	a	459	B
Old no-tillage	220	A	c	421	A	a	270	A	b	304	A	612	A	a	635	A	a	551	A	b	599	A
Mean	179		c	254		a	209		b			485		a	470		ab	460		b		
MB-N NBM																						
Conventional tillage	27	C	a	26	B	a	27	C	a	27	C	34	C	a	36	C	a	32	C	b	34	C
New no-tillage	57	B	b	68	A	a	54	B	b	60	B	41	B	c	46	B	b	50	B	a	46	B
Old no-tillage	75	A	a	66	A	b	62	A	b	68	A	61	A	b	70	A	a	56	A	c	62	A
Mean	53		a	53		a	48		b			45		b	51		a	46		b		

[a] New no-tillage, 4 years old; old no-tillage, 14 years old.

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Table 5
Effects of conventional tillage (CT) and no-tillage (NT) on microbial biomass carbon and nitrogen (MB-C and MB-N), ratio MB-C/MB-N and grain yield in field experiments with different times of establishment. For MB, values represent the means of evaluations performed in the summer and in the winter.

Time (years)	MB-C (µg C/N g^{-1} dry soil)		MB-N (µg C/N g^{-1} dry soil)		MB-C/MB-N		Yield[a] (kg ha^{-1})	
	Soil management							
	CT	NT	CT	NT	CT	NT	CT	NT
4	261[b] B	316 A	30 B	53 A	8.7 A	6.0 B	2988 A	3173 A
10	299 B	431 A	36 B	72 A	8.3 A	6.0 B	6985 B	7628 A
14	261 B	451 A	30 B	65 A	8.7 A	6.9 B	2988 B	3399 A
26	303 B	430 A	33 B	61 A	9.2 A	7.0 B	2058 B	3472 A

CT, conventional tillage; NT, no-tillage.
[a] Soybean at the 4-, 14- and 26-year-old experiments and maize at the 10-year-old experiment.
[b] Comparison of means for each parameter and year (24 replicates for the 4-, 10- and 14-year-old experiments, eight replicates for the 26-year-old experiment), and values followed by the same letter are not statistically different ($P \leq 0.05$, Duncan's test).

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Time (years)	MB-C (μg C/N g^{-1} dry soil)		MB-N (μg C/N g^{-1} dry soil)		MB-C/MB-N		Yield[a] (kg ha^{-1})	
	Soil management							
	CT	NT	CT	NT	CT	NT	CT	NT
4	261[b] B	316 A	30 B	53 A	8.7 A	6.0 B	2988 A	3173 A
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Soja

↑ **14% após 14 anos**

↑ **69% após 26 anos**

Milho

↑ **14% após 14 anos**

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40 The Open Agriculture Journal, 2013, 7, (Suppl 1-M6) 40-47

Bacterial Diversity Under Different Tillage and Crop Rotation Systems in an Oxisol of Southern Brazil

A.P. Silva[a,b], L.C. Babujia[a,c], L.S. Matsumoto[a,d], M.F. Guimarães[b] and M. Hungria[a,*]

PRINCÍPIO DA TÉCNICA DE DGGE

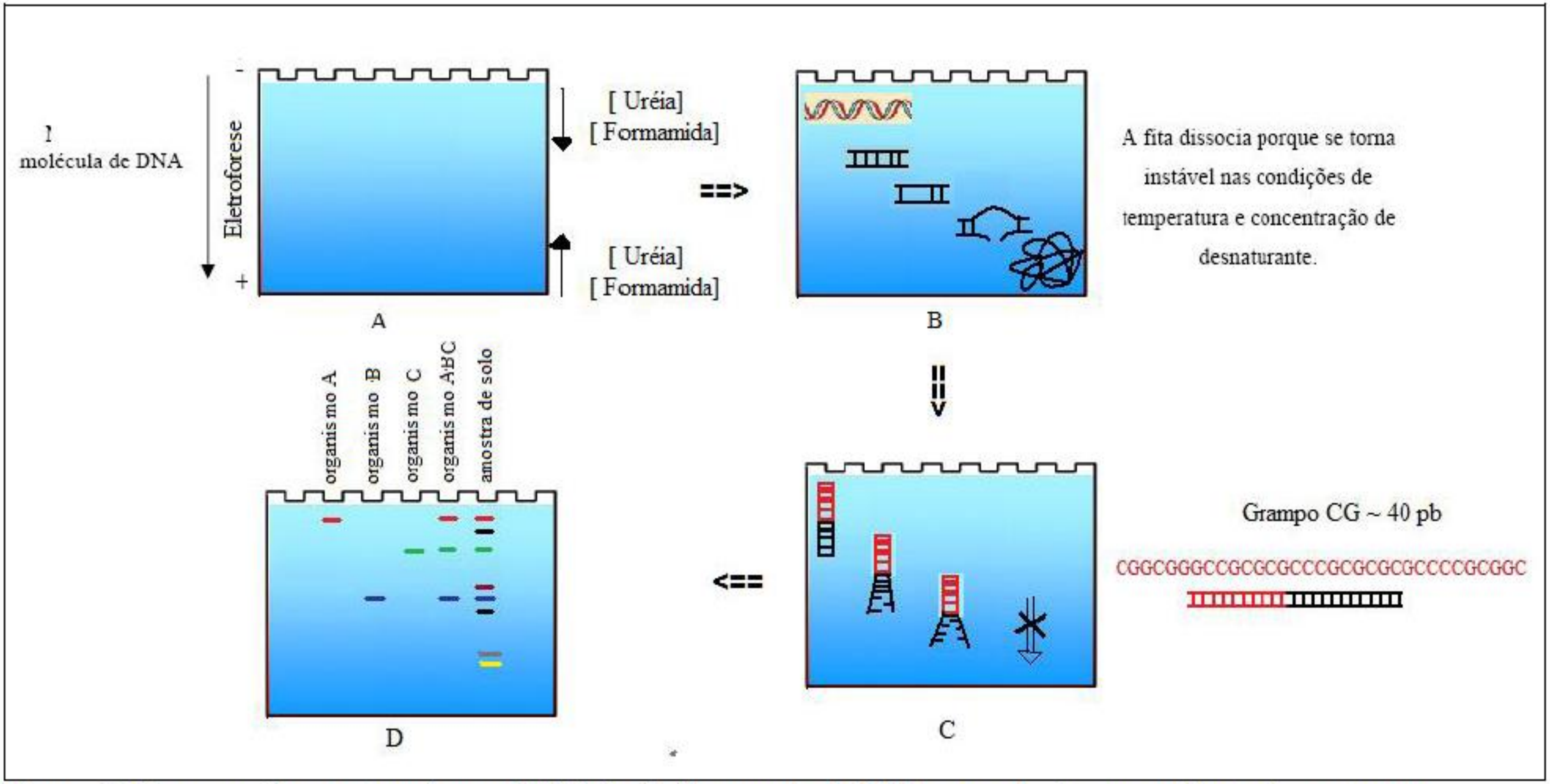
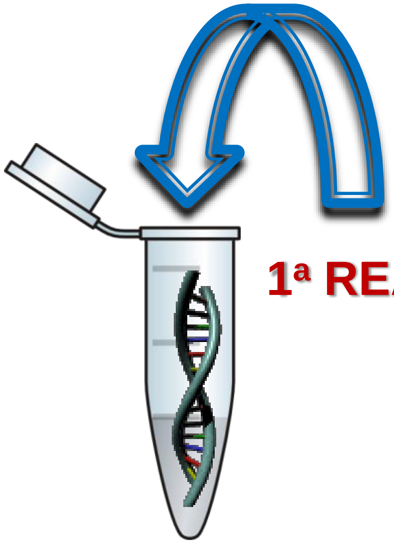


Figura 2: Esquema demonstrando a mobilidade do fragmento de DNA em relação ao gradiente desnaturante.

Fonte: Google

Reações de PCR



1ª REAÇÃO

PRIMERS: fD1 e rD1 (~1.500 pares de bases)

fD1(5'-AGAGTTTGATCCTGGCTCAG-3') e rD1(5'-AAGGAGGTGATCCAGCC-3')

Weisburg et al. (1991)

2ª REAÇÃO

F- 968- GC (5´-CGCCCGGGGCGCGCCCCGGGCGGGGCGGGGGACGGGGAACGCGAAGAACCTTAC-3´)

R- 1401 (5´-GCGTGTGTACAAGACCC-3´)

Nubel et al. (1996)

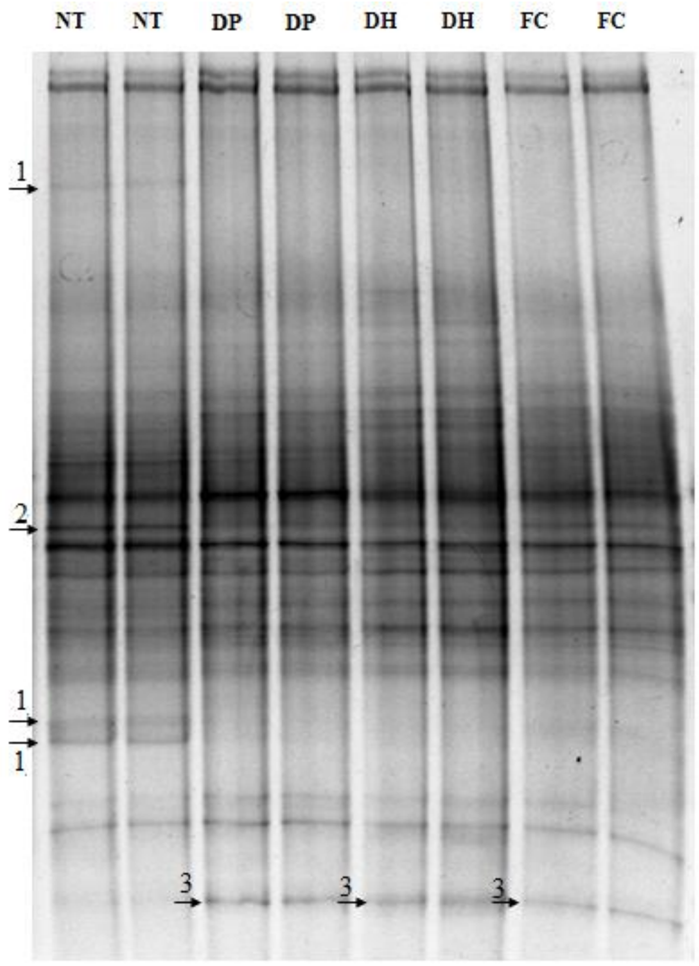
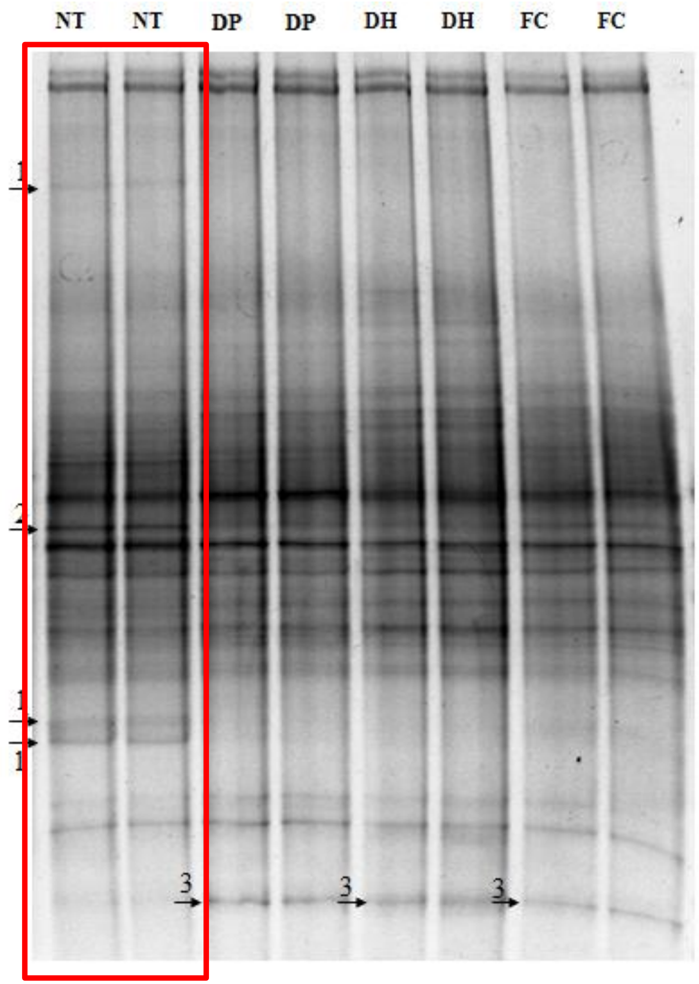


Fig. 1. Representative DGGE profiles of 16S rDNA of soil samples (0-10 cm depth) under different soil tillage systems. NT- no tillage; CT- conventional tillage; DH- disc harrow; FC- field cultivation. *Experiment — 26-year trial*.



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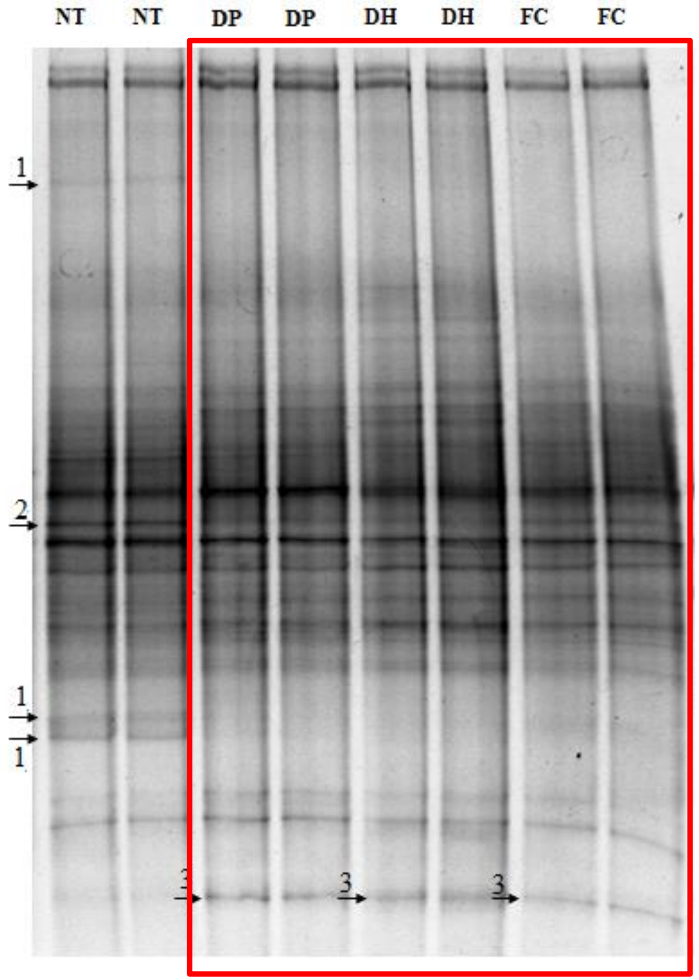

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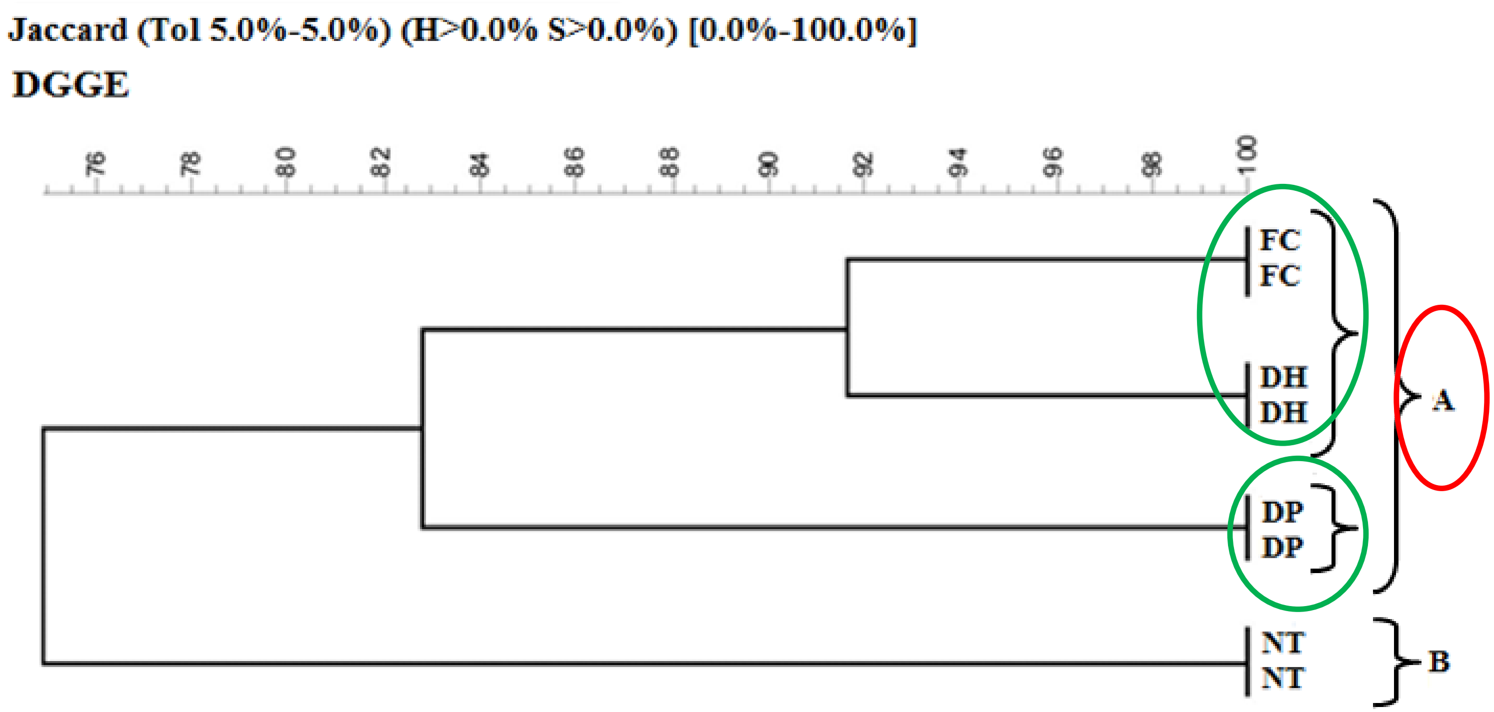

Fig. 2. Similarity dendrogram (0 to 10 cm depth) using the Jaccard coefficient with tolerance established at 5% and unweighted pair-group method with arithmetic averages (UPGMA) for DGGE profiles of bacterial 16S rDNA communities. Soil tillage: NT- no tillage; CT- conventional tillage; DH- disc harrow; FC- field cultivation. Crop succession with soybean on summer and wheat on winter. *Experiment — 26-year trial*.

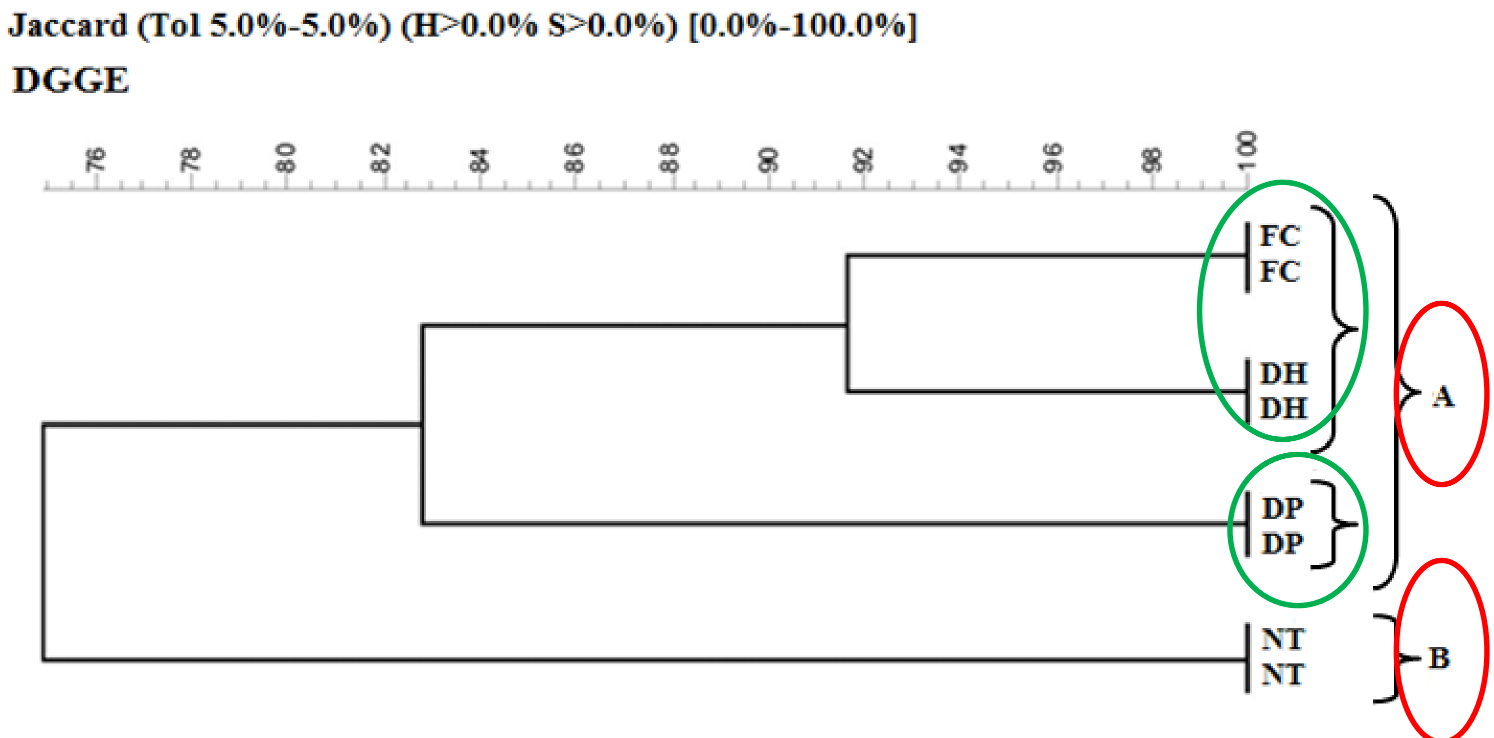

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Table 2 Diversity indice[1] of bacterial community on different soil tillage managements and crop rotations systems.

Greater diversity — GRADIENT OF SOIL DISTURBANCE → Lower diversity

Bacterial diversity	*Experiment 1— 26-year trial*			
	No-tillage (NT)	Field cultivation (FC)	Disc harrow (DH)	Disc Plough (DP)
Shannon index (H)	3.341 ± 0. 077	3.180 ± 0.083	3.099 ± 0.086	3.026 ± 0.089
Shannon modified	4.565 ± 0.436	4.038 ± 0.308	3.908 ± 0.299	3.923 ± 0.344
Richness index (ACE)	155.9 ± 79.1	77.6 ± 30.7	66.6 ± 26.0	67.6 ± 29.3
Total bands	31	27	25	23
Evenness (E)	0.979	0.964	0.962	0.965

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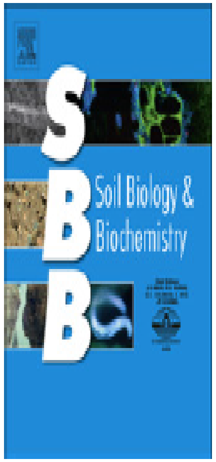

Microbial biomass and activity at various soil depths in a Brazilian oxisol after two decades of no-tillage and conventional tillage

L.C. Babujia [a,b], M. Hungria [a,b,*], J.C. Franchini [a], P.C. Brookes [c]

[a] Embrapa Soja, Caixa Postal 231, 86001-970 Londrina, PR, Brazil

[b] Universidade Estadual de Londrina, Dept. Biotechnology, Caixa Postal 6001, 86055-990 Londrina, PR, Brazil

[c] Soil Science Department, Rothamsted Research, Harpenden, Herts AL5 2JQ, UK

Table 2
Total soil organic carbon (TSOC) and total soil-N (TSN) in an oxisol after 20 years under no-till (NT) and conventional tillage (CT) systems with the soybean (summer)/wheat (winter) crop succession. Means of four field replicates for each soil depth.

Depth (cm)	TSOC						TSN					
	(kg C m^{-3} soil)											
	NT			CT			NT			CT		
0–5	25.74	a[a]	A[a]	18.23	a	B	2.54	a	A	1.68	b	B
5–10	25.53	a	A	18.87	a	B	2.41	a	A	1.72	ab	B
10–20	27.92	a	A	19.38	a	B	2.65	a	A	1.90	a	B
20–30	17.01	b	A	16.68	ab	A	1.48	b	A	1.56	b	A
30–40	12.61	bc	A	13.49	bc	A	1.24	bc	A	1.32	c	A
40–50	11.78	c	A	11.40	c	A	1.11	c	A	1.10	d	A
50–60	10.19	c	A	9.68	c	A	1.00	c	A	1.03	d	A
P tillage	0.062						0.030					
CV_t (%)	5.97						5.89					
P depth	≤0.001						≤0.001					
P tillage × depth	≤0.001						≤0.001					
CV_{txd} (%)	3.90						3.82					

[a] Means followed by different lower case letters indicate differences (ANOVA) at $P \leq 0.05$ between depths and differences in upper case letters indicate difference between tillage systems. CV indicates coefficient of variation.

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COT

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20–30	17.01	b	A	16.68	ab	A	1.48	b	A	1.56	b	A
30–40	12.61	bc	A	13.49	bc	A	1.24	bc	A	1.32	c	A
40–50	11.78	c	A	11.40	c	A	1.11	c	A	1.10	d	A
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PD ⬆ 18% COT

PD ⬆ 16% NT

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Depth (cm)	MB-C CBM						MB-N						*q*Mic					
	(g C m^{-3} soil)												%					
	NT			CT			NT			CT			NT			CT		
0–5	1090	a[a]	A[a]	582	a	B	66.54	a	A	36.48	a	B	4.23	a	A	3.19	a	B
5–10	800	b	A	570	ab	B	43.64	b	A	33.62	ab	A	3.13	b	A	3.02	ab	A
10–20	638	bc	A	390	bc	B	37.66	bc	A	31.28	ab	A	2.28	c	A	2.01	e	A
20–30	500	cd	A	327	c	B	34.53	bc	A	25.76	ab	A	2.94	b	A	1.96	e	B
30–40	382	de	A	336	c	A	22.72	cd	A	20.06	abc	A	3.03	b	A	2.49	d	B
40–50	270	e	A	296	c	A	10.96	de	A	16.80	bc	A	2.29	c	A	2.60	cd	A
50–60	221	e	A	272	c	A	0.01	e	A	5.25	c	A	2.17	c	A	2.81	bc	A
P tillage	0.003						0.026						0.033					
CV_t (%)	5.50						8.30						8.43					
P depth	≤0.001						≤0.001						≤0.001					
P tillage × depth	≤0.001						≤0.001						0.004					
CV_{txd} (%)	17.60						28.85						26.60					

[a] Means followed by different lower case letters indicate differences (ANOVA) at $P \leq 0.05$ between depths and differences in upper case letters indicate difference between tillage systems. CV indicates coefficient of variation.

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40–50	270	e	A	296	c	A	10.96	de	A	16.80	bc	A	2.29	c	A	2.60	cd	A
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5–10	800	b	A	570	ab	B	43.64	b	A	33.62	ab	A	3.13	b	A	3.02	ab	A
10–20	638	bc	A	390	bc	B	37.66	bc	A	31.28	ab	A	2.28	c	A	2.01	e	A
20–30	500	cd	A	327	c	B	34.53	bc	A	25.76	ab	A	2.94	b	A	1.96	e	B
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CBM

PD (0-5 cm) 82%

PD (0-30 cm) [70%]

Depth (cm)	MB-C ($g C m^{-3}$ soil)						MB-N						*q*Mic %					
	NT			CT			NT			CT			NT			CT		
0–5	1000	a[a]	A[a]	582	a	B	66.54	a	A	36.48	a	B	4.23	a	A	3.19	a	B
5–1	[illegible]			[illegible]			[illegible]	b	A	33.62	ab	A	3.13	b	A	3.02	ab	A
10–	[illegible]			[illegible]			[illegible]	bc	A	31.28	ab	A	2.28	c	A	2.01	e	A
20–	[illegible]			[illegible]			[illegible]	bc	A	25.76	ab	A	2.94	b	A	1.96	e	B
30–	[illegible]			[illegible]			[illegible]	cd	A	20.06	abc	A	3.03	b	A	2.49	d	B
40–	[illegible]			[illegible]			[illegible]	de	A	16.80	bc	A	2.29	c	A	2.60	cd	A
50–	[illegible]			[illegible]			[illegible]	e	A	5.25	c	A	2.17	c	A	2.81	bc	A
P tillage	0.003						0.026						0.033					
CV_t (%)	5.50						8.30						8.43					
P depth	≤0.001						≤0.001						≤0.001					
P tillage × depth	≤0.001						≤0.001						0.004					
CV_{txd} (%)	17.60						28.85						26.60					

[a] Means followed by different lower case letters indicate differences (ANOVA) at $P \leq 0.05$ between depths and differences in upper case letters indicate difference between tillage systems. CV indicates coefficient of variation.

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Depth (cm)	MB-C CBM						MB-N NBM						*q*Mic					
	($g C m^{-3}$ soil)												%					
	NT			CT			NT			CT			NT			CT		
0–5	1090	a[a]	A[a]	582	a	B	66.54	a	A	36.48	a	B	4.23	a	A	3.19	a	B
5–10	800	b	A	570	ab	B	43.64	b	A	33.62	ab	A	3.13	b	A	3.02	ab	A
10–20	638	bc	A	390	bc	B	37.66	bc	A	31.28	ab	A	2.28	c	A	2.01	e	A
20–30	500	cd	A	327	c	B	34.53	bc	A	25.76	ab	A	2.94	b	A	1.96	e	B
30–40	382	de	A	336	c	A	22.72	cd	A	20.06	abc	A	3.03	b	A	2.49	d	B
40–50	270	e	A	296	c	A	10.96	de	A	16.80	bc	A	2.29	c	A	2.60	cd	A
50–60	221	e	A	272	c	A	0.01	e	A	5.25	c	A	2.17	c	A	2.81	bc	A
P tillage	0.003						0.026						0.033					
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P depth	≤0.001						≤0.001						≤0.001					
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Depth (cm)	MB-C CBM		MB-N NBM		*q*Mic	
	($g\ C\ m^{-3}$ soil)				%	
	NT	CT	NT	CT	NT	CT
0–5	1090 a[a] A[a]	582 a B	66.54 a A	36.48 a B	4.23 a A	3.19 a B
5–10	800 b A	570 ab B	43.64 b A	33.62 ab A	3.13 b A	3.02 ab A
10–20	638 bc A	390 bc B	37.66 bc A	31.28 ab A	2.28 c A	2.01 e A
20–30	500 cd A	327 c B	34.53 bc A	25.76 ab A	2.94 b A	1.96 e B
30–40	382 de A	336 c A	22.72 cd A	20.06 abc A	3.03 b A	2.49 d B
40–50	270 e A	296 c A	10.96 de A	16.80 bc A	2.29 c A	2.60 cd A
50–60	221 e A	272 c A	0.01 e A	5.25 c A	2.17 c A	2.81 bc A
P tillage	0.003		0.026		0.033	
CV_t (%)	5.50		8.30		8.43	
P depth	≤0.001		≤0.001		≤0.001	
P tillage × depth	≤0.001		≤0.001		0.004	
CV_{txd} (%)	17.60		28.85		26.60	

[a] Means followed by different lower case letters indicate differences (ANOVA) at $P \leq 0.05$ between depths and differences in upper case letters indicate difference between tillage systems. CV indicates coefficient of variation.

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CBM

NBM

Depth (cm)	MB-C						MB-N						*q*Mic					
	($g C m^{-3}$ soil)												%					
	NT			CT			NT			CT			NT			CT		
0–5	1090	a[a]	A[a]	582	a	B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.19	a	B
5–10	800	b	A	570	ab	B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.02	ab	A
10–20	638	bc	A	390	bc	B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.01	e	A
20–30	500	cd	A	327	c	B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.96	e	B
30–40	382	de	A	336	c	A	22.72	cd	A	20.06	abc	A	3.03	b	A	2.49	d	B
40–50	270	e	A	296	c	A	10.96	de	A	16.80	bc	A	2.29	c	A	2.60	cd	A
50–60	221	e	A	272	c	A	0.01	e	A	5.25	c	A	2.17	c	A	2.81	bc	A
P tillage	0.003						0.026						0.033					
CV_t (%)	5.50						8.30						8.43					
P depth	≤0.001						≤0.001						≤0.001					
P tillage × depth	≤0.001						≤0.001						0.004					
CV_{txd} (%)	17.60						28.85						26.60					

PD (0-5 cm)

46%

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	($g C m^{-3}$ soil)												%					
	NT			CT			NT			CT			NT			CT		
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CBM **NBM** ***q*MIC**

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5–10	800	b	A	570	ab	B	43.64	b	A	33.62	ab	A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10–20	638	bc	A	390	bc	B	37.66	bc	A	31.28	ab	A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20–30	500	cd	A	327	c	B	34.53	bc	A	25.76	ab	A	2.94	b	A	1.90	c	B
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P tillage	0.003						0.026						[illegible]					
CV_t (%)	5.50						8.30						[illegible]					
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Ciclagem de nutrientes

PD (0-5 cm) 33%

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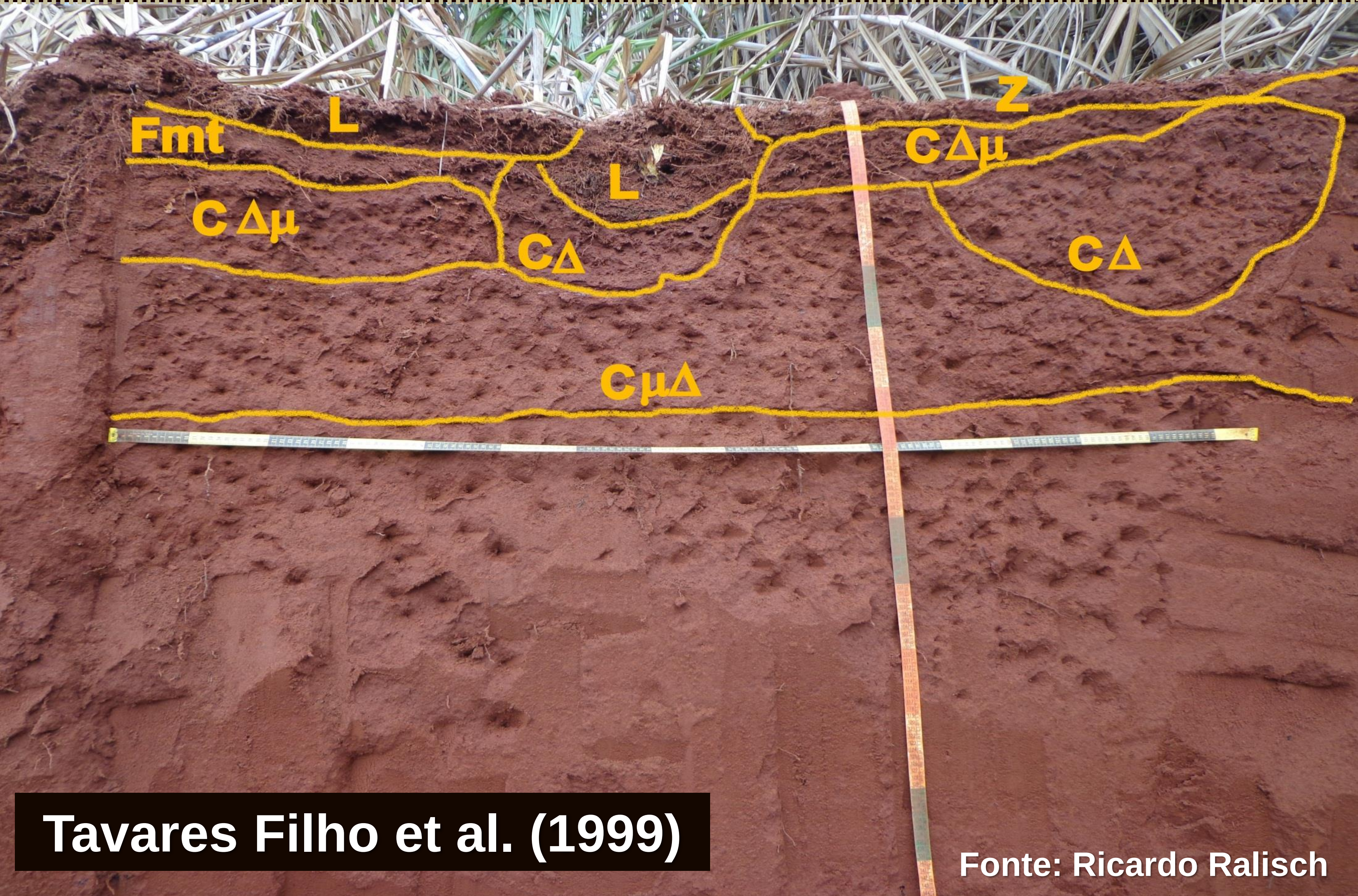
journal homepage: www.elsevier.com/locate/still

Soil structure and its influence on microbial biomass in different soil and crop management systems

Adriana Pereira da Silva [a], Letícia Carlos Babujia [a], Julio Cezar Franchini [a], Ricardo Ralisch [b], Mariangela Hungria [a], Maria de Fátima Guimarães [b,*]

[a] EMBRAPA Soja, Cx. Postal 231, 86001-970 Londrina, PR, Brazil
[b] Universidade Estadual de Londrina, Department of Agronomy, Caixa Postal 10011, 86057-970 Londrina, PR, Brazil

PERFIL CULTURAL



Tavares Filho et al. (1999)

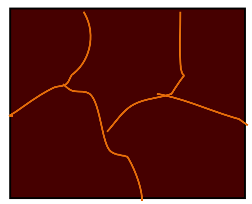
Fonte: Ricardo Ralisch

Critérios Morfológicos para a Caracterização do Estado Estrutural

Modo de Organização Espacial dos Torrões

Contínuo

Fissurado



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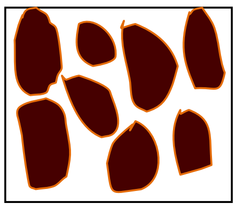


Estado Interno dos Torrões

μ

Porosidade forte

estado microagregado natural

Δ

Porosidade fraca

até

nula estado compactado

μΔ/μΔ

Estados intermediários entre

Δ e μ

Descrição da Área de Estudo

- **Início verão de 1988/1989 (22 anos)**
- **Blocos ao acaso em esquema fatorial, com três manejos de solo:**

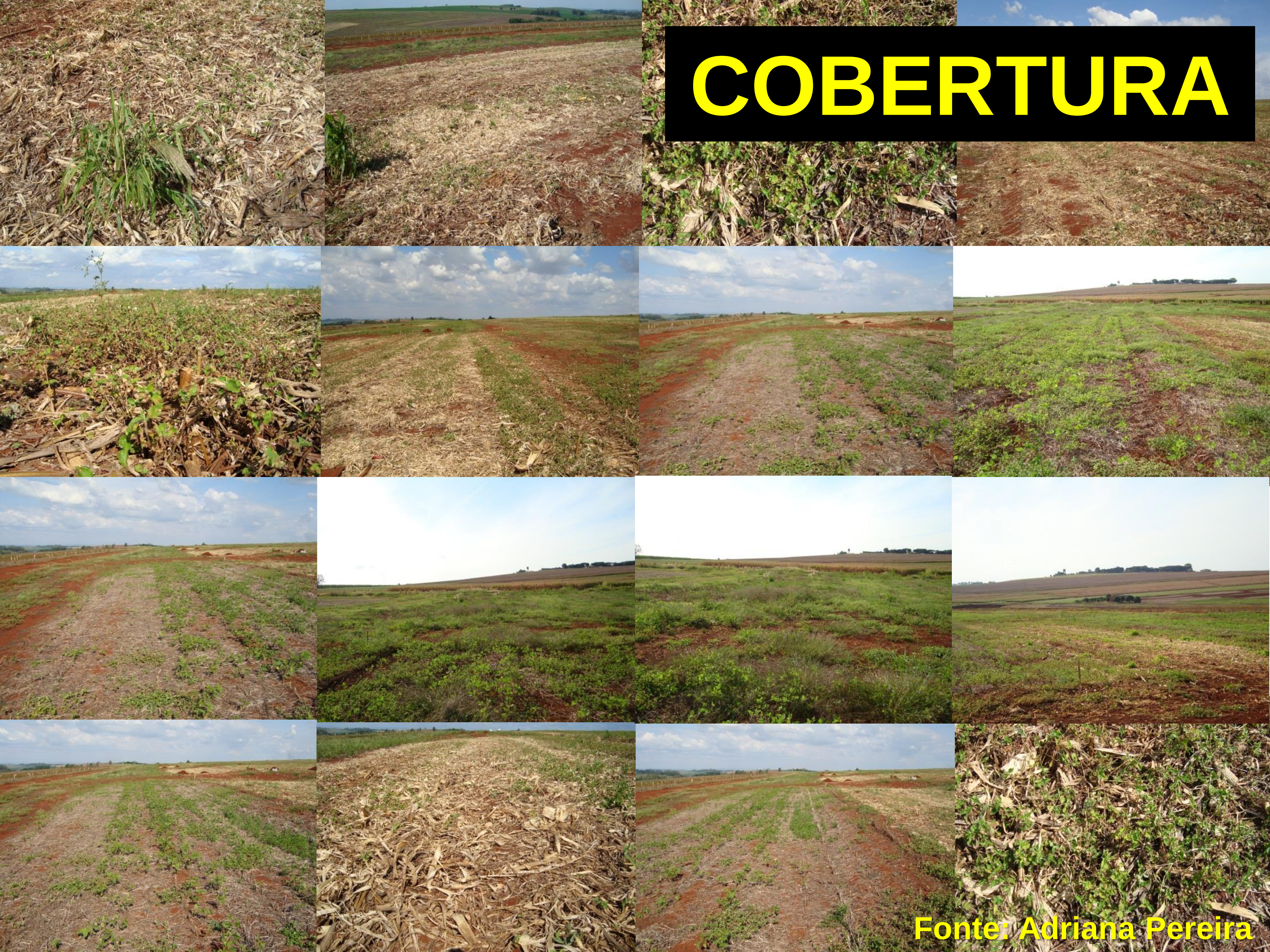
  1) **Plantio direto (PD)**
  2) **Plantio direto escarificado (PDE)**
  3) **Plantio convencional (PC)**

- **dois manejo de culturas:**

  1) **Rotação (R):** tremoço/milho/aveia preta/soja/trigo/soja/trigo/soja
  2) **Sucessão (S):** soja/trigo


Fonte: Adriana Pereira

COBERTURA



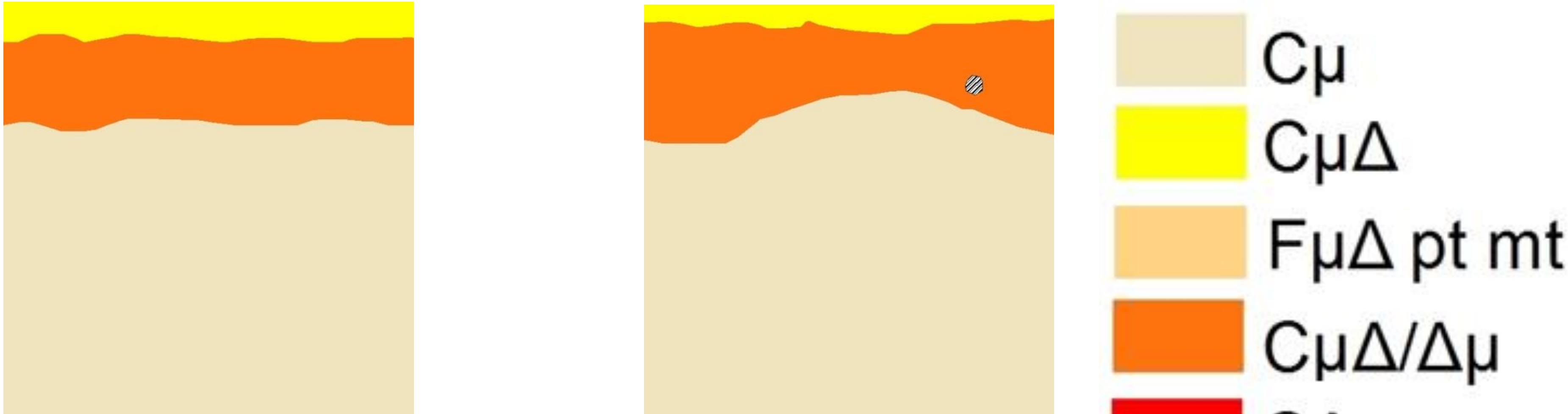
Fonte: Adriana Pereira


MACROFAUNA
Fonte: Adriana Pereira

BIOPOROS

Fonte: Adriana Pereira

PLANTIO DIRETO (PD)- ROTAÇÃO



PD- SUCESSÃO

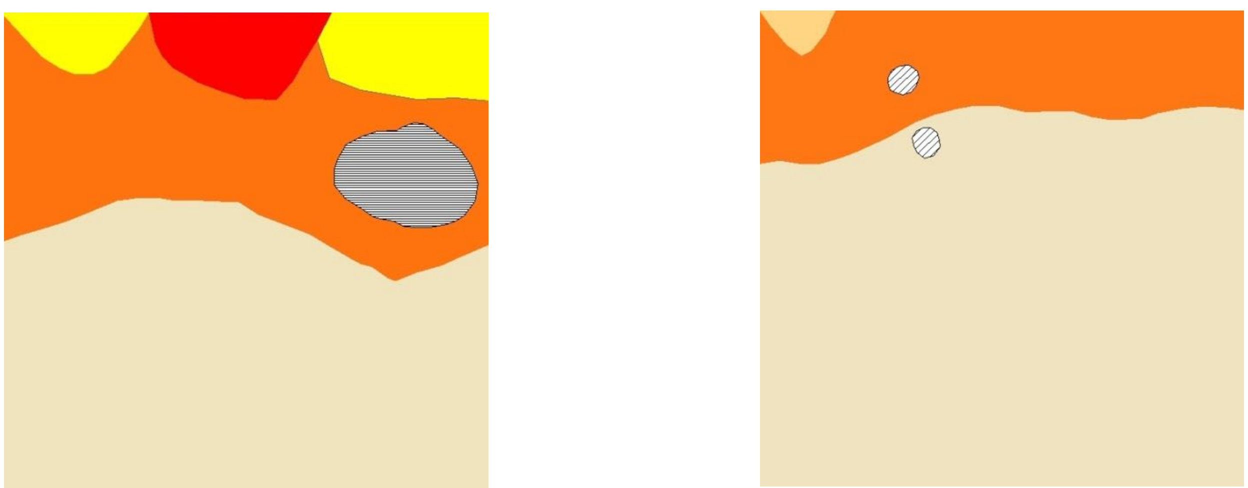


Figura 1.

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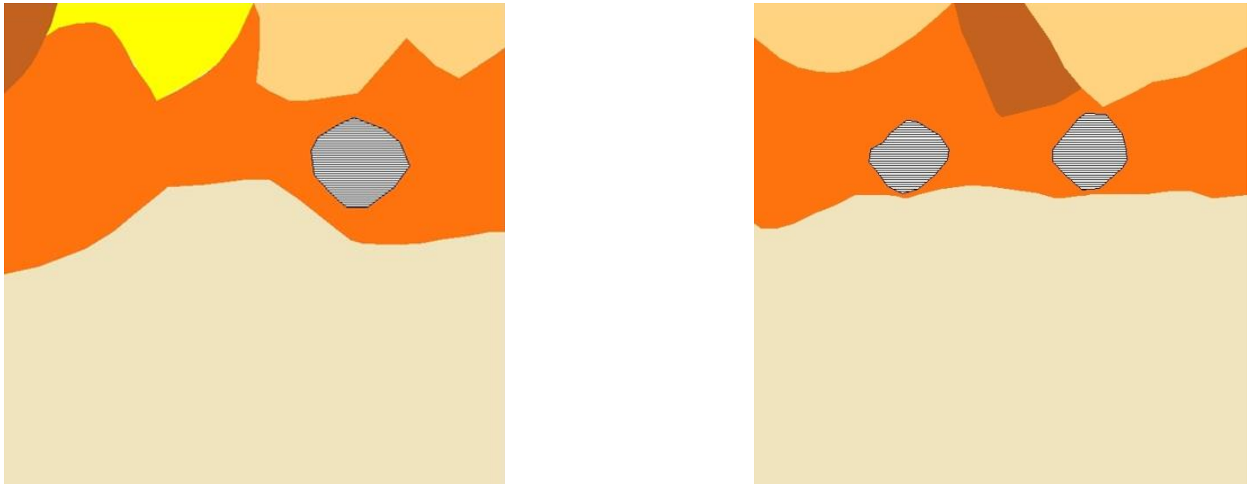
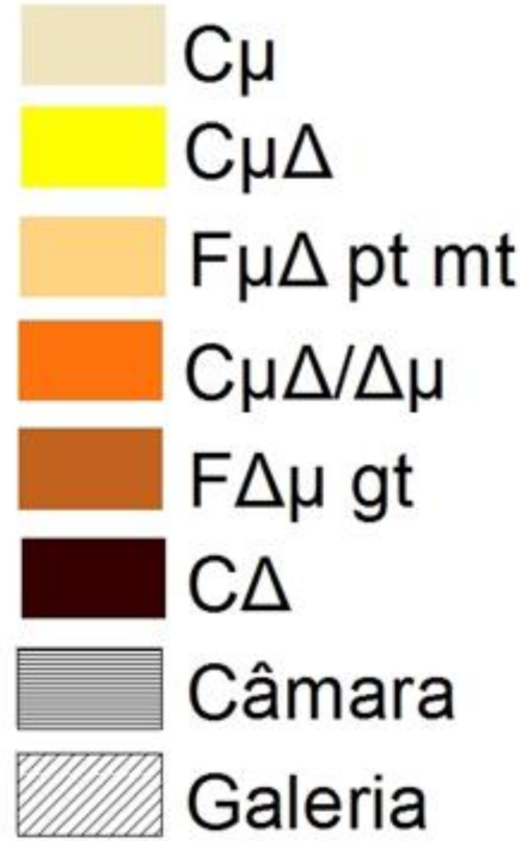
PLANTIO DIRETO ESCARIFICADO (PDE)- ROTAÇÃO





PDE- SUCESSÃO

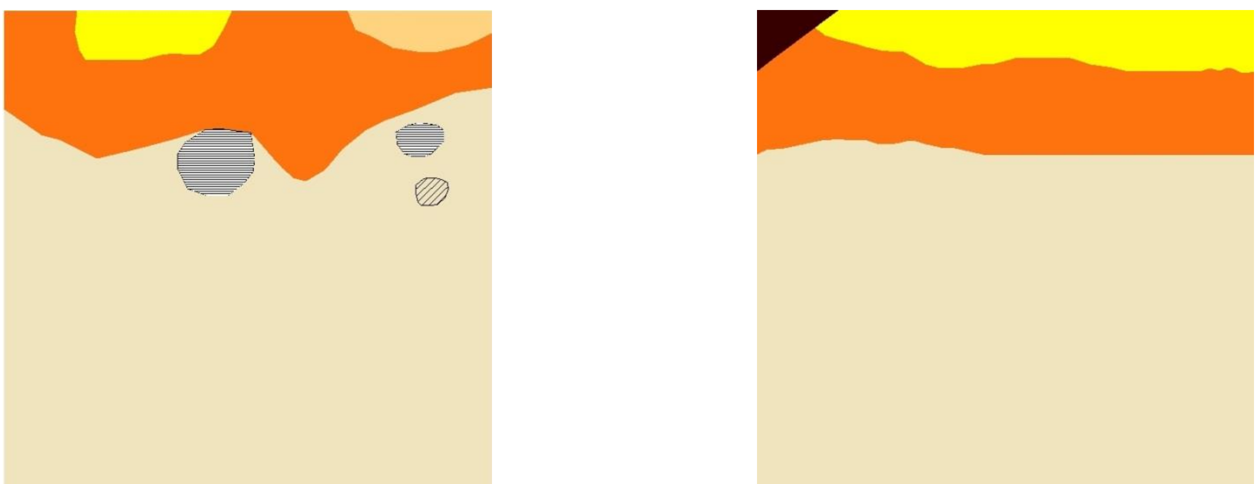


Figura 2.

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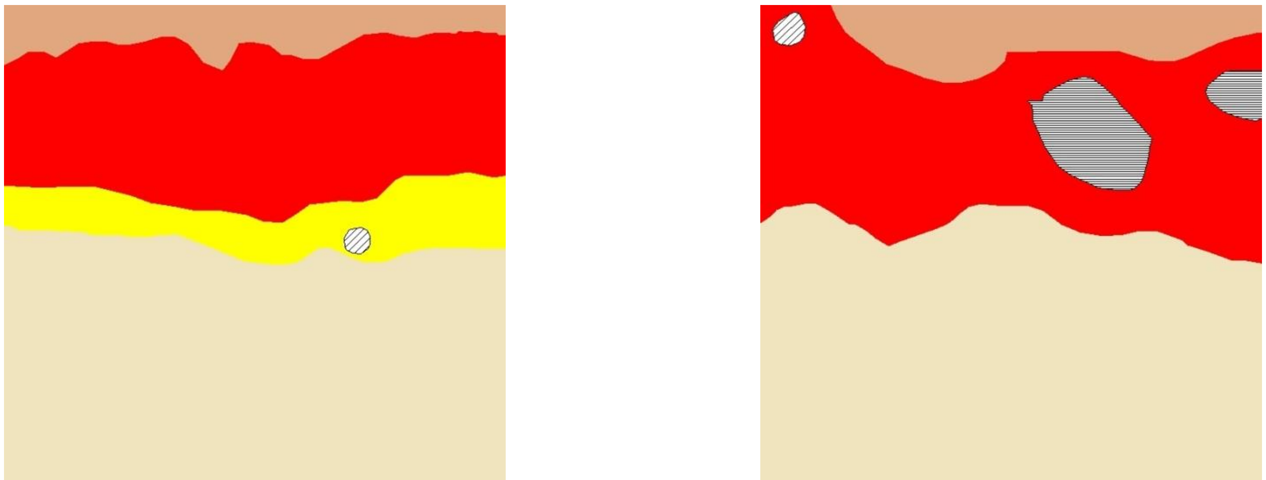
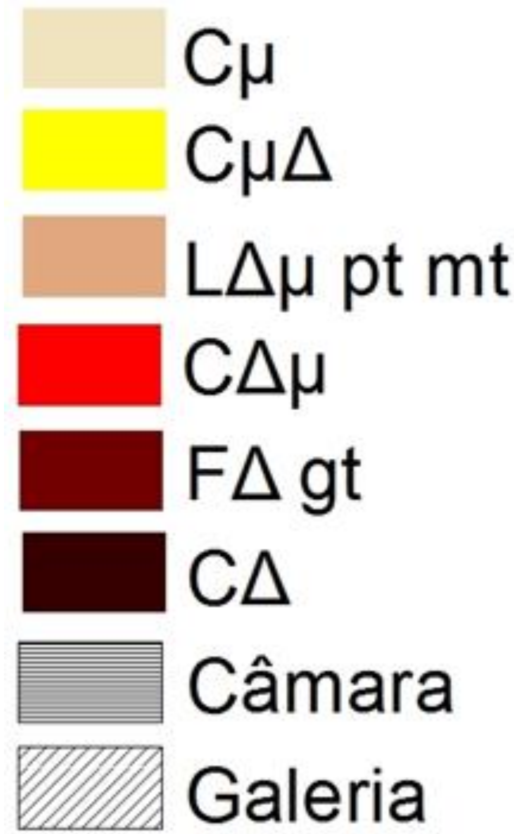
PLANTIO CONVENCIONAL (PC)- ROTAÇÃO





PC- SUCESSÃO

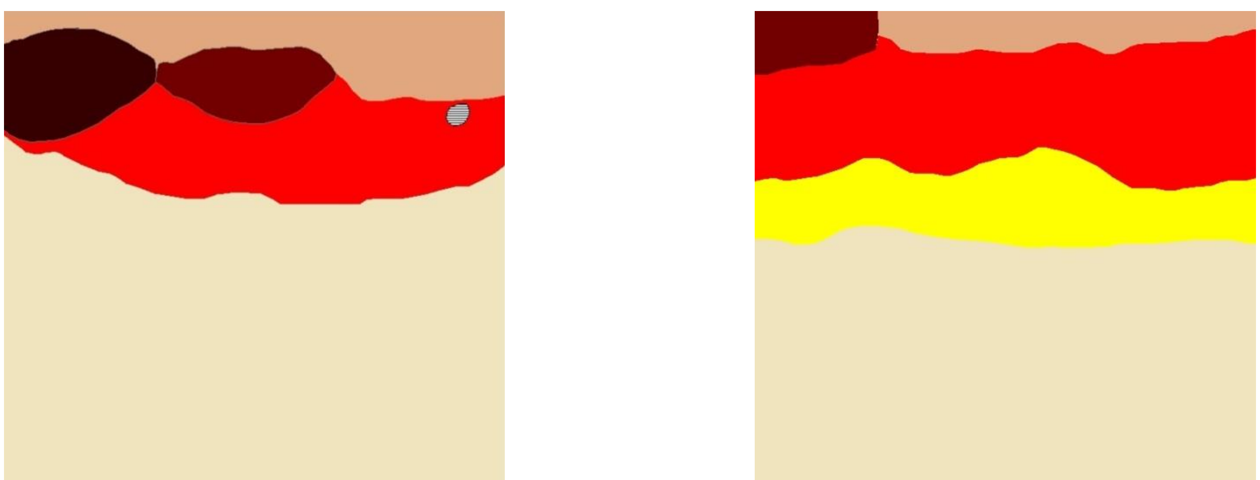


Figura 3.

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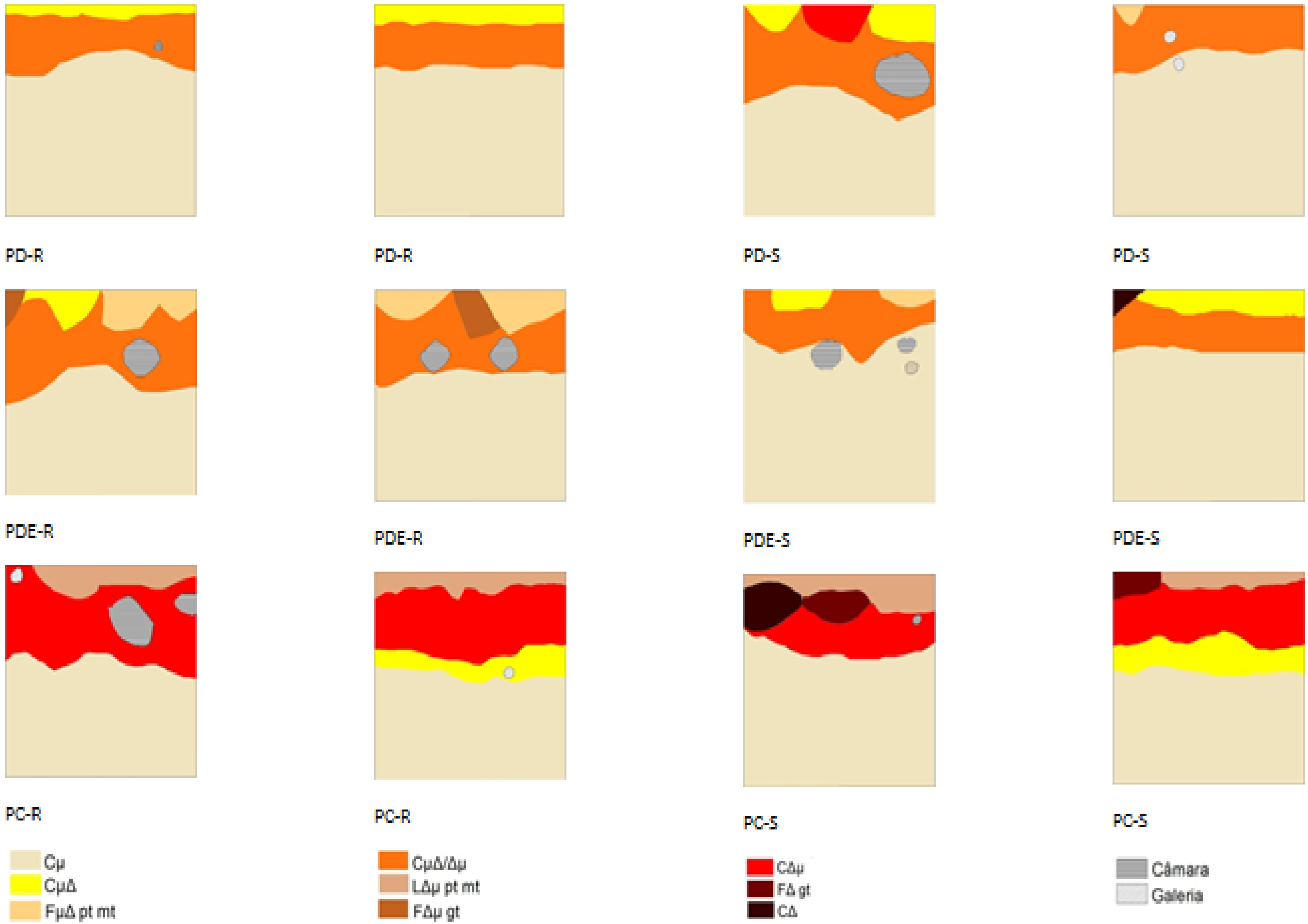
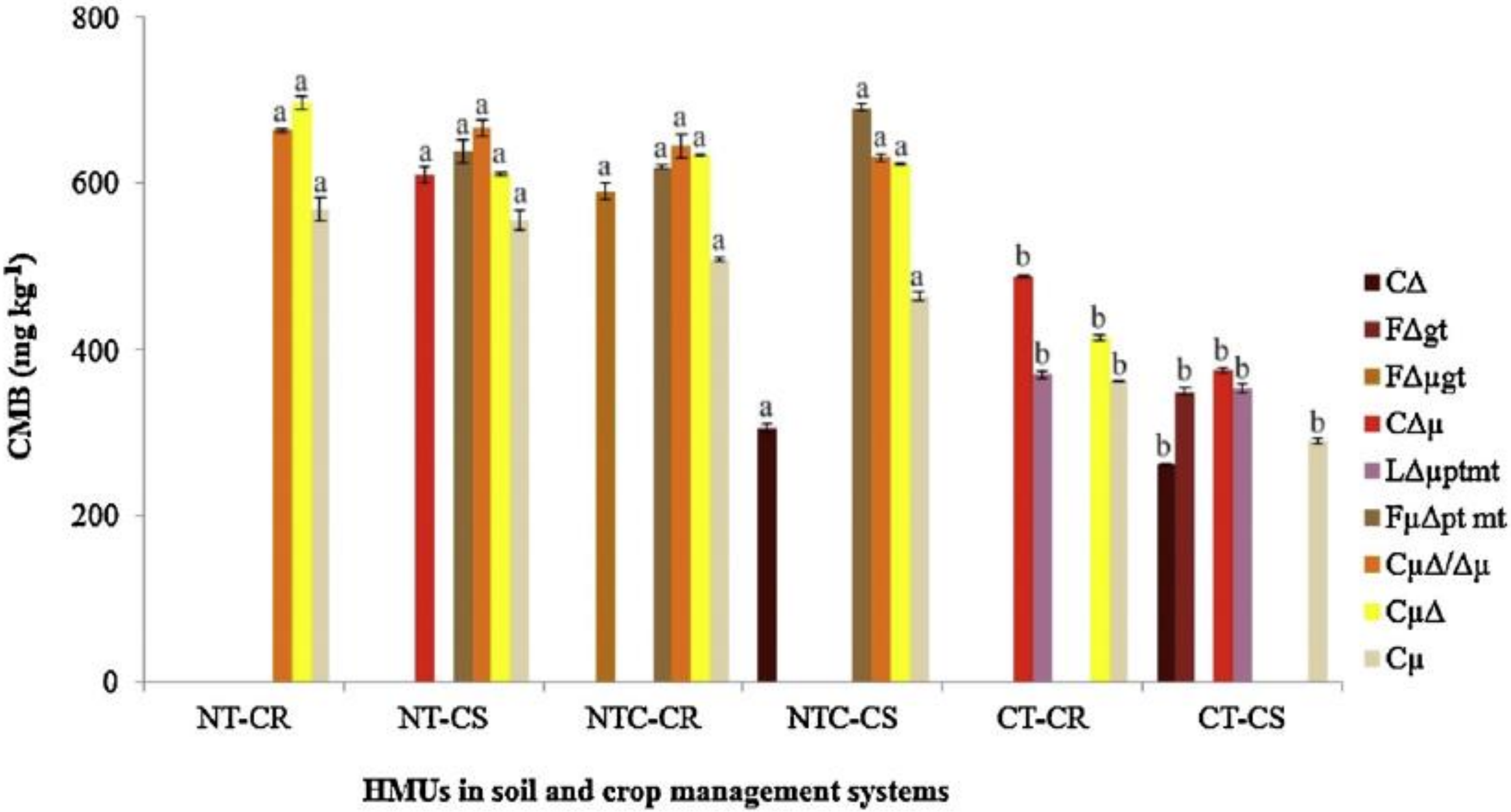


VISÃO GERAL DOS PERFIS SOB PD, PDE E PC EM ROTAÇÃO E SUCESSÃO DE CULTURAS

CARBONO DA BIOMASSA MICROBIANA (CBM)



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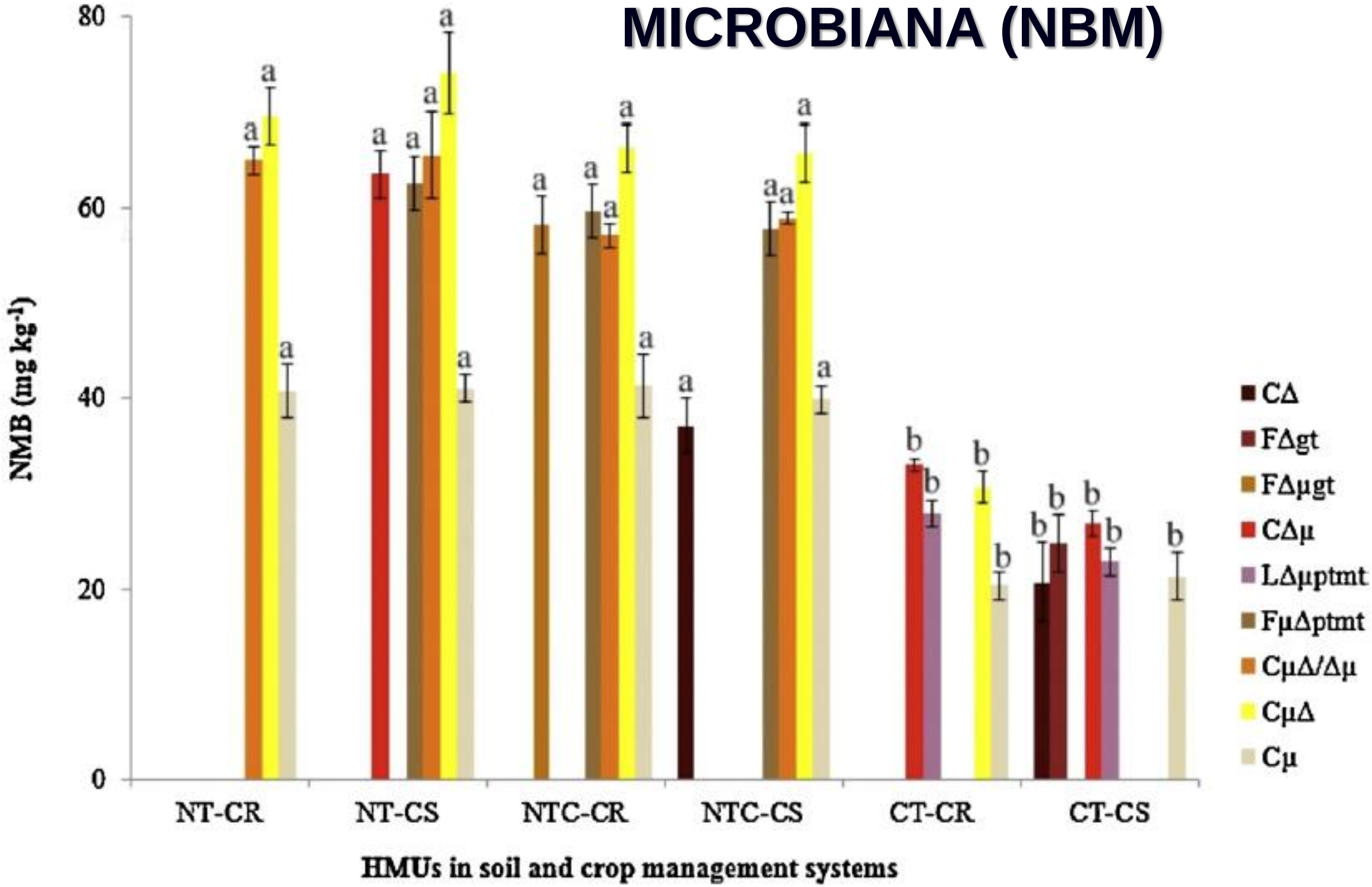
NITROGÊNIO DA BIOMASSA MICROBIANA (NBM)



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CARBONO ORGÂNICO TOTAL E NITROGÊNIO TOTAL

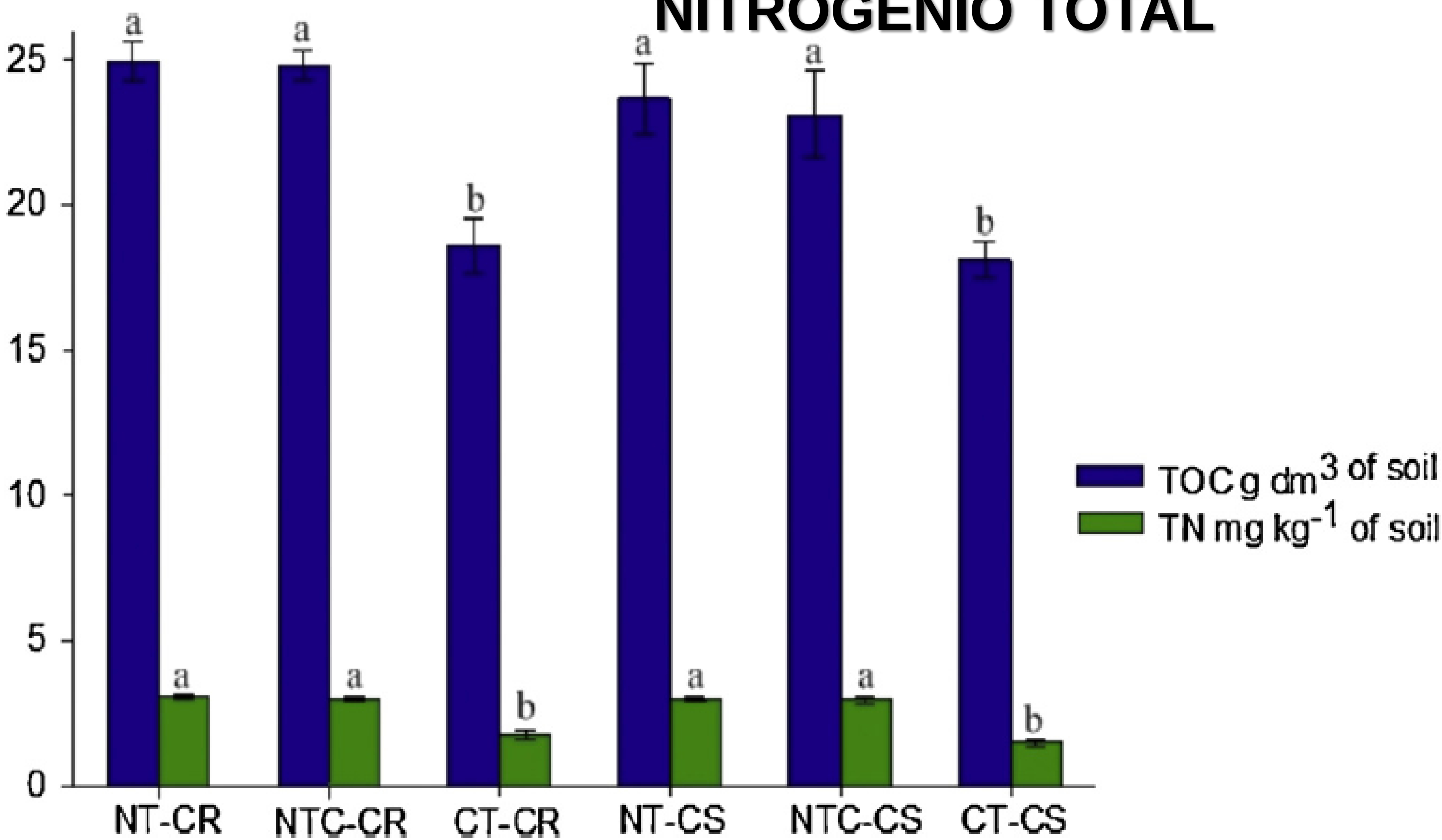

Figura 10.

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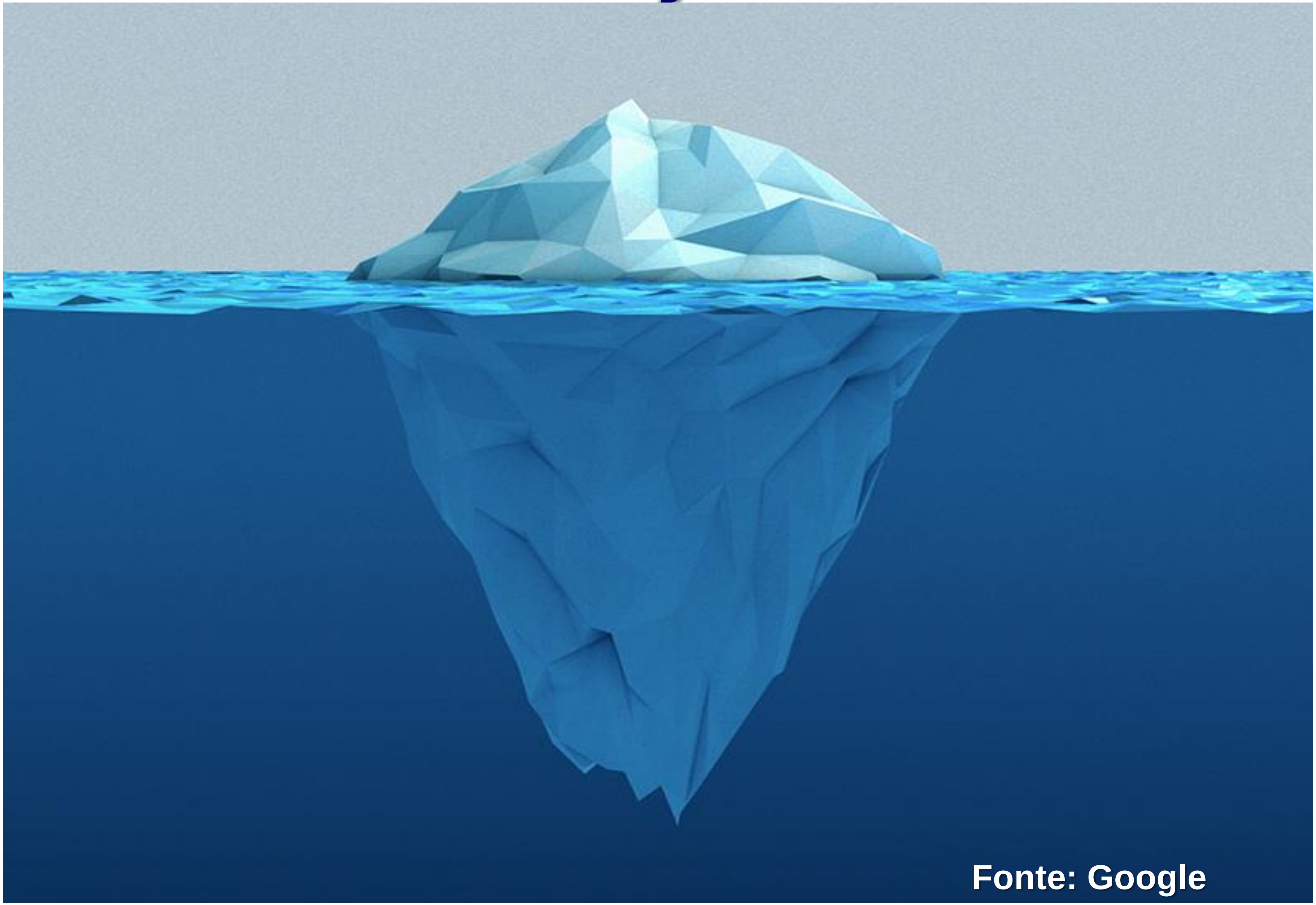
CONSIDERAÇÕES FINAIS




drikapera@yahoo.com.br
OBRIGADA!!