Potential of Carbon Sequestration in Brazilian No-till

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Manhattan – KS
June 25, 2008

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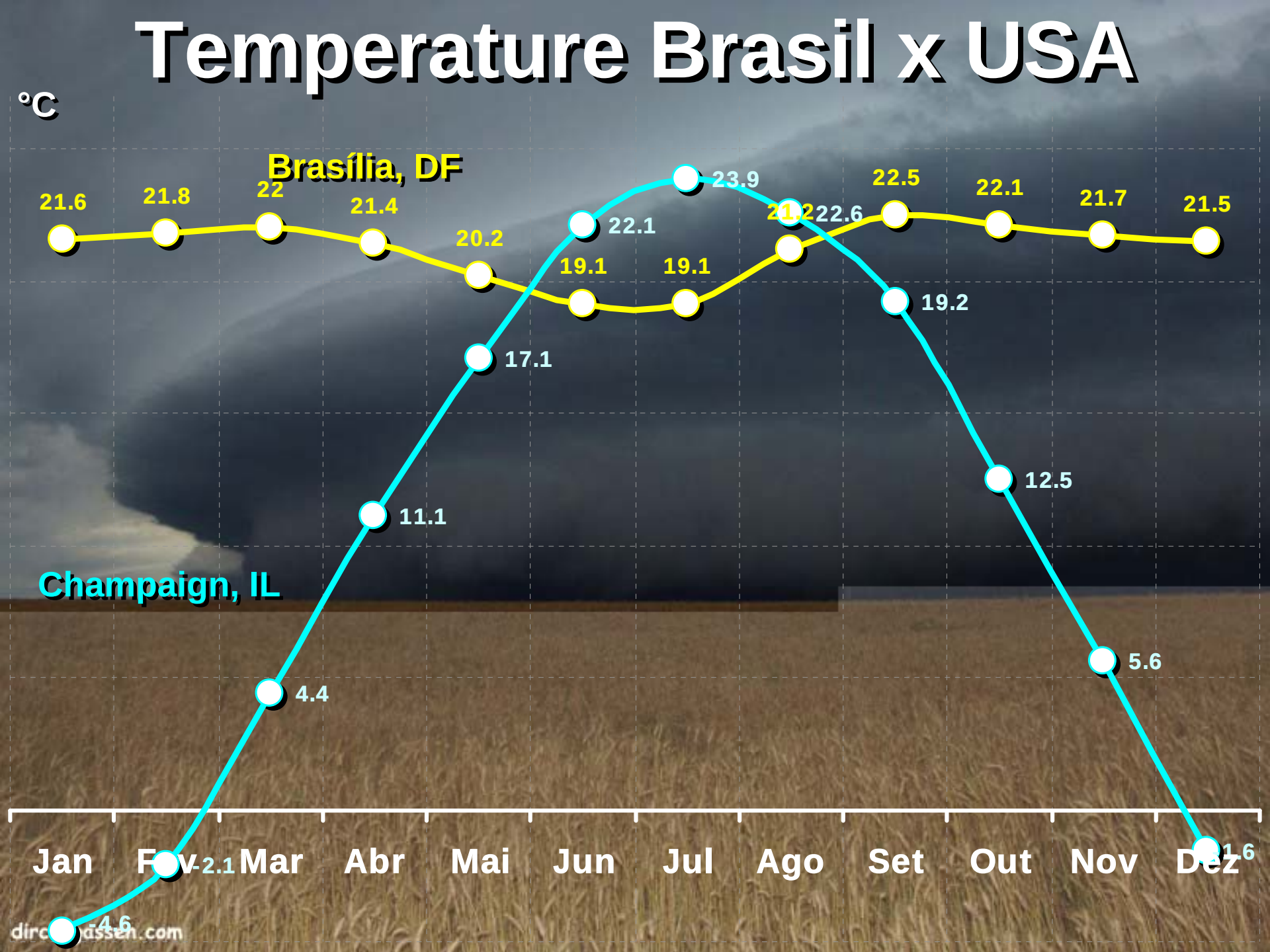
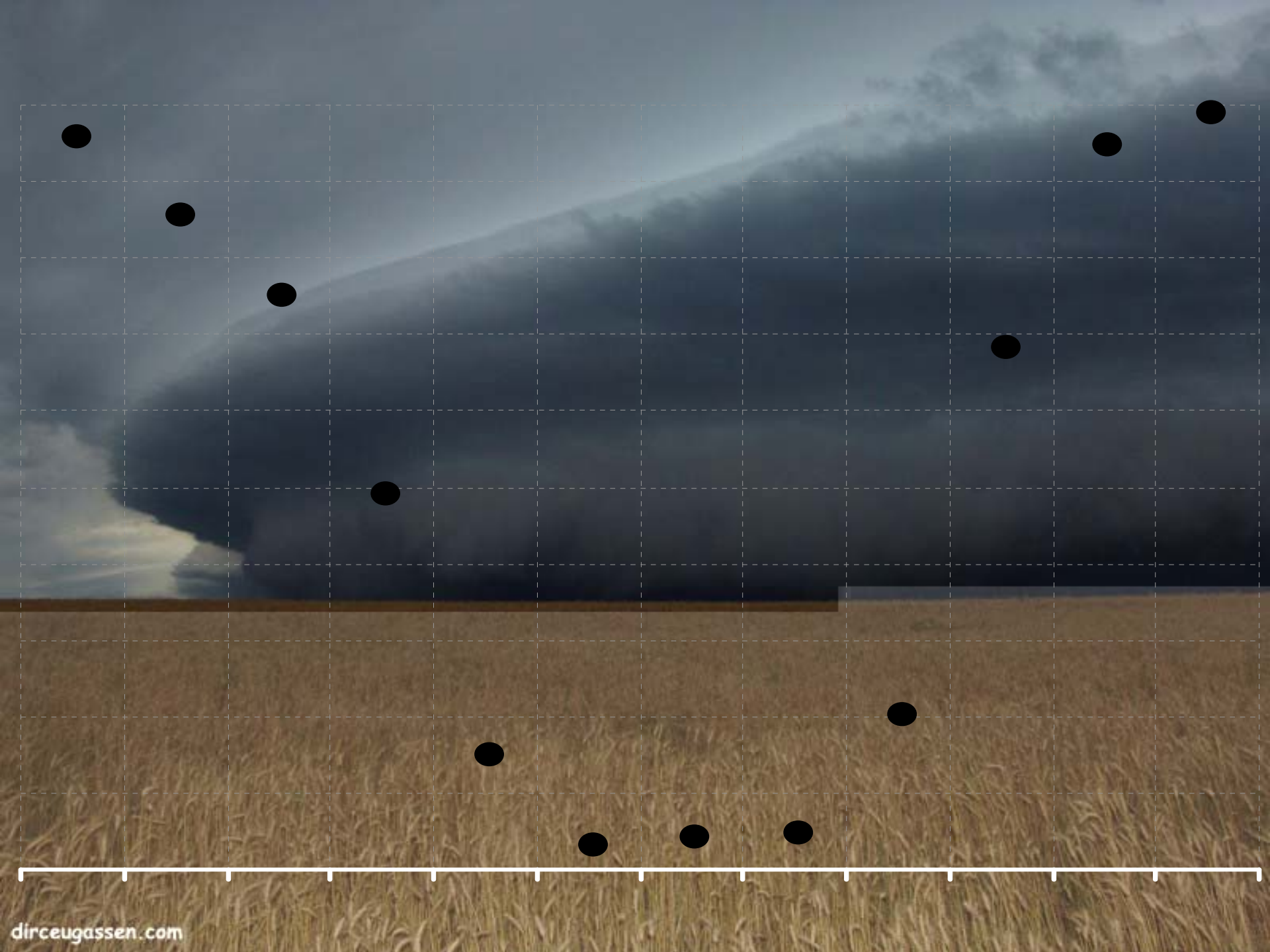
Temperature Brasil x USA

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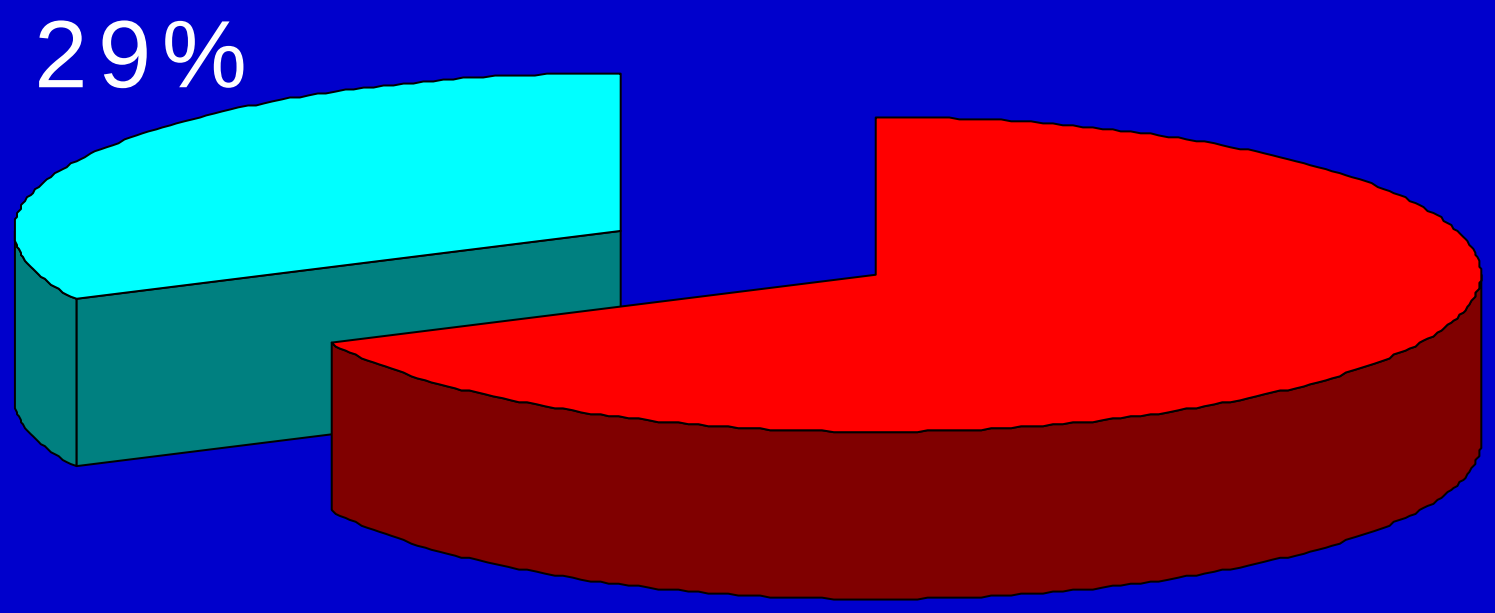
Brazilian agribusiness
General overview

Top 5 biggest world grain producers

Itens	Countries				
	China	USA	Brazil	Russian	Canadian
Total Surface (millions km²)	9,536	9,372	8,547	17,075	9,970
Population (millions)	1,300	278	175	147	31
Crop Area (ha – millions)	78	90	42	40	22
Grain production (ha – millions)	450	420	115	88	88

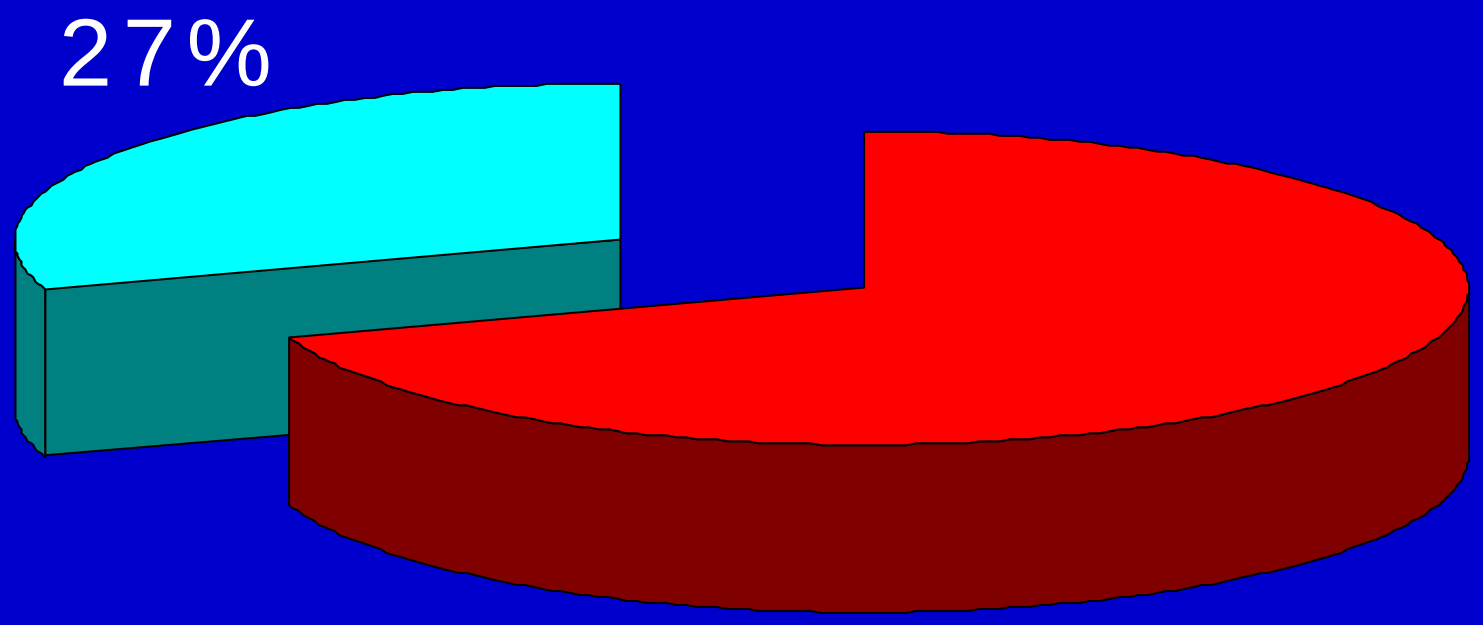
Source: Grolli, D., 2003 (Grãos Brasil, v. 10, p.12)

Contribution of the agribusiness in the Brazilian GDP



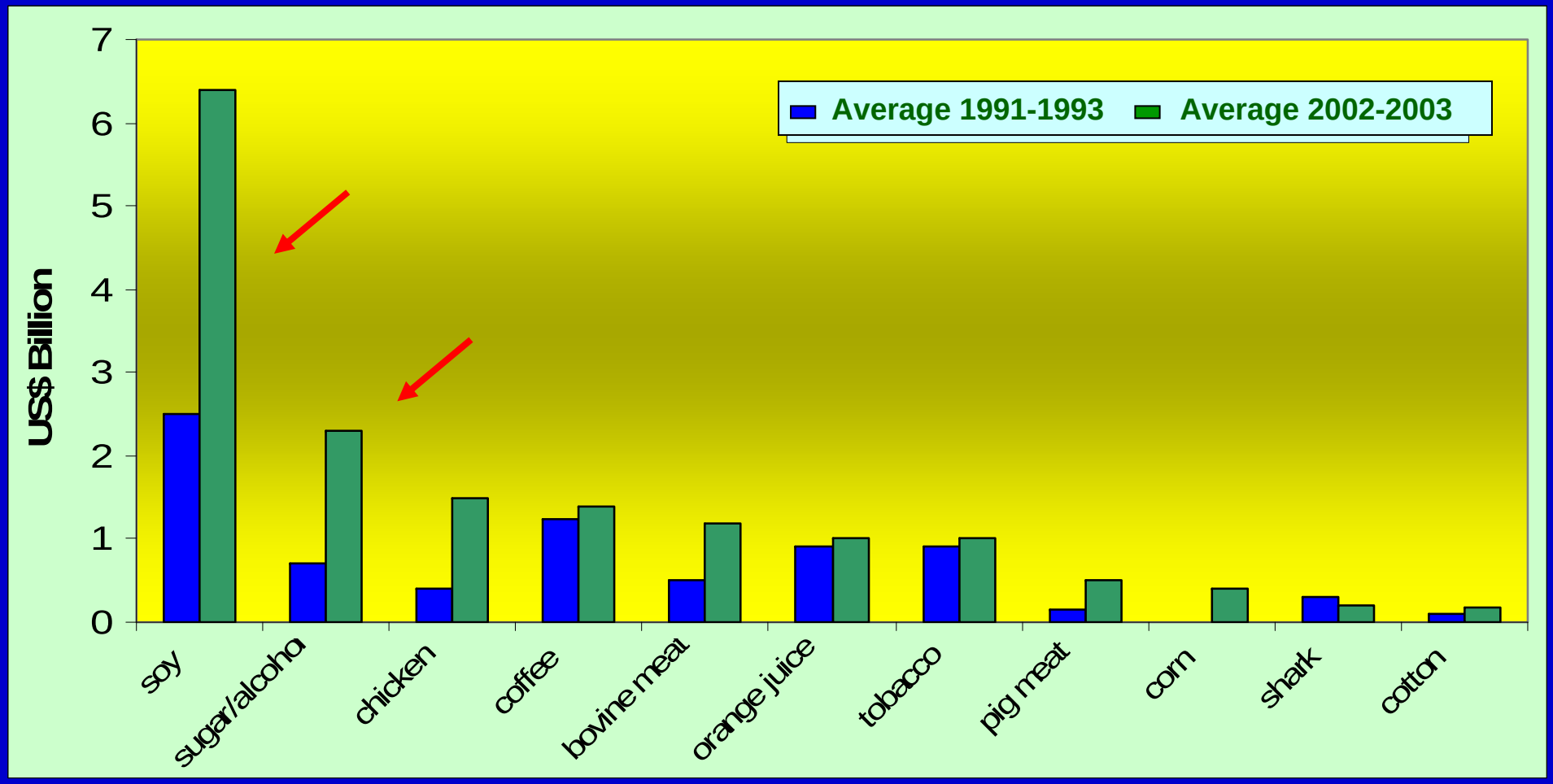
Source: IPEA, 2003

Agriculture contribution to the active economic population

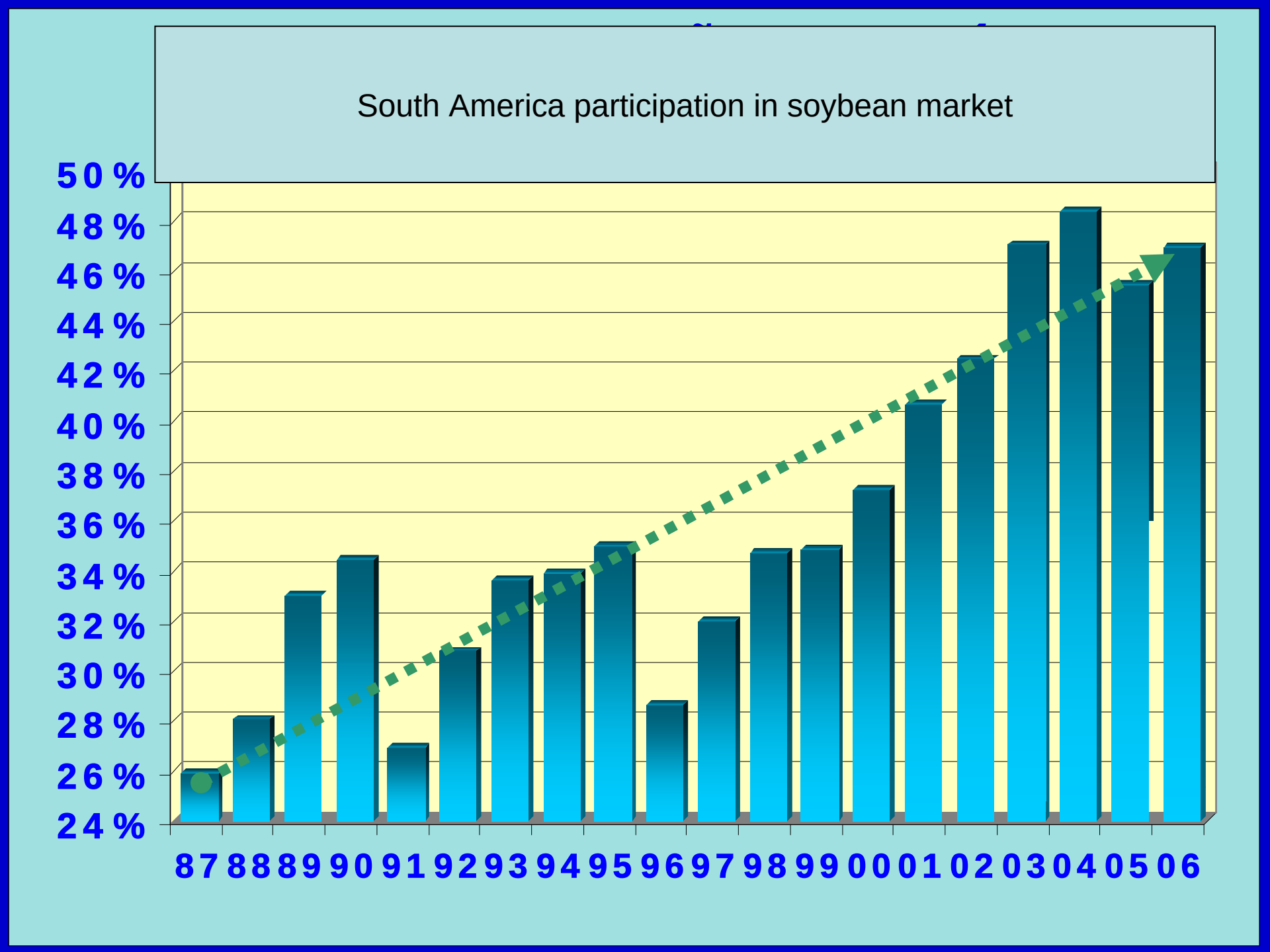


Source: IPEA, 2003

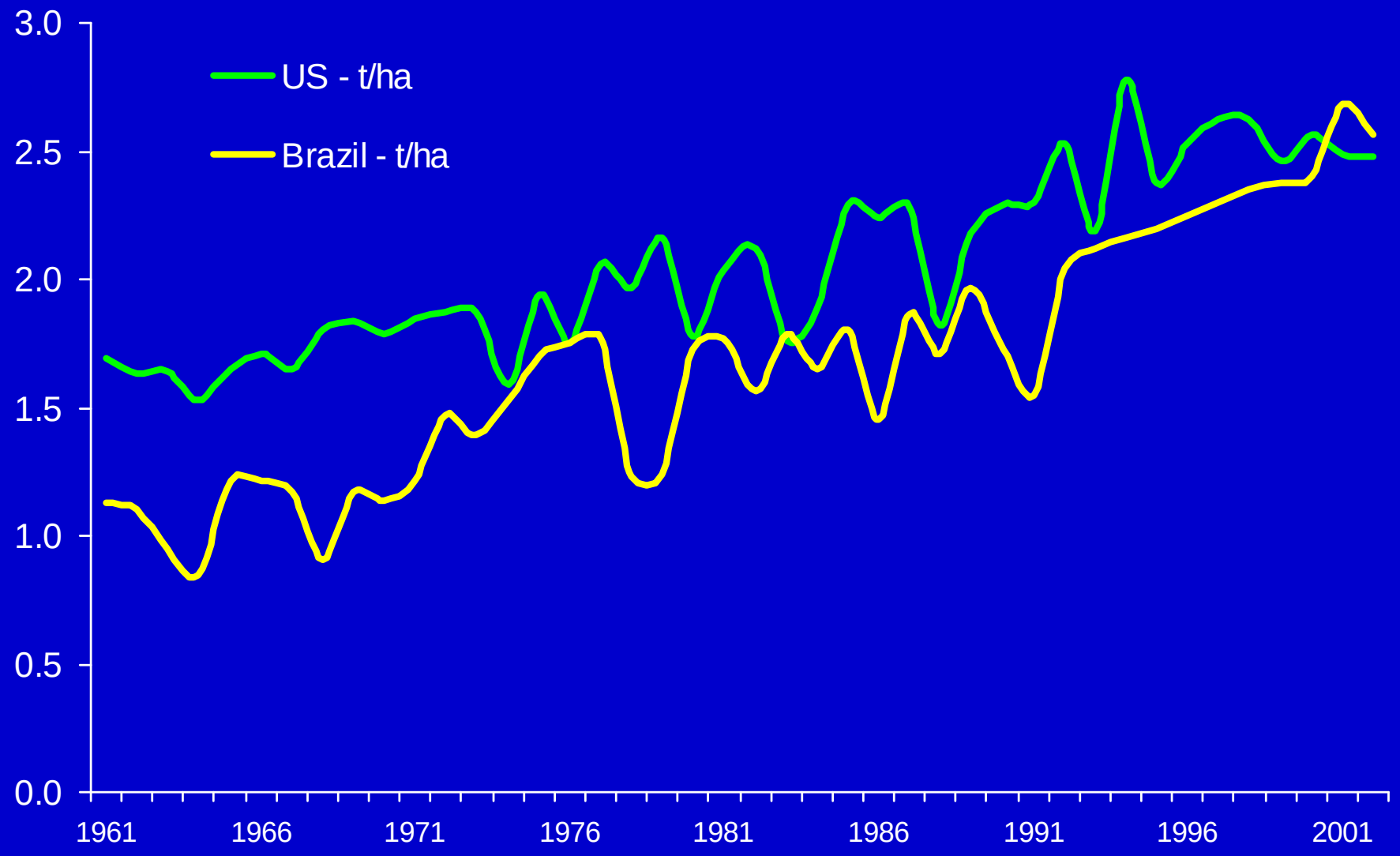
Main agricultural products exported.



Source: Ministry of the development, industry and external trade. MDIC, 2003.


South America participation in soybean market
50%
48%
46%
44%
42%
40%
38%
36%
34%
32%
30%
28%
26%
24%
87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06

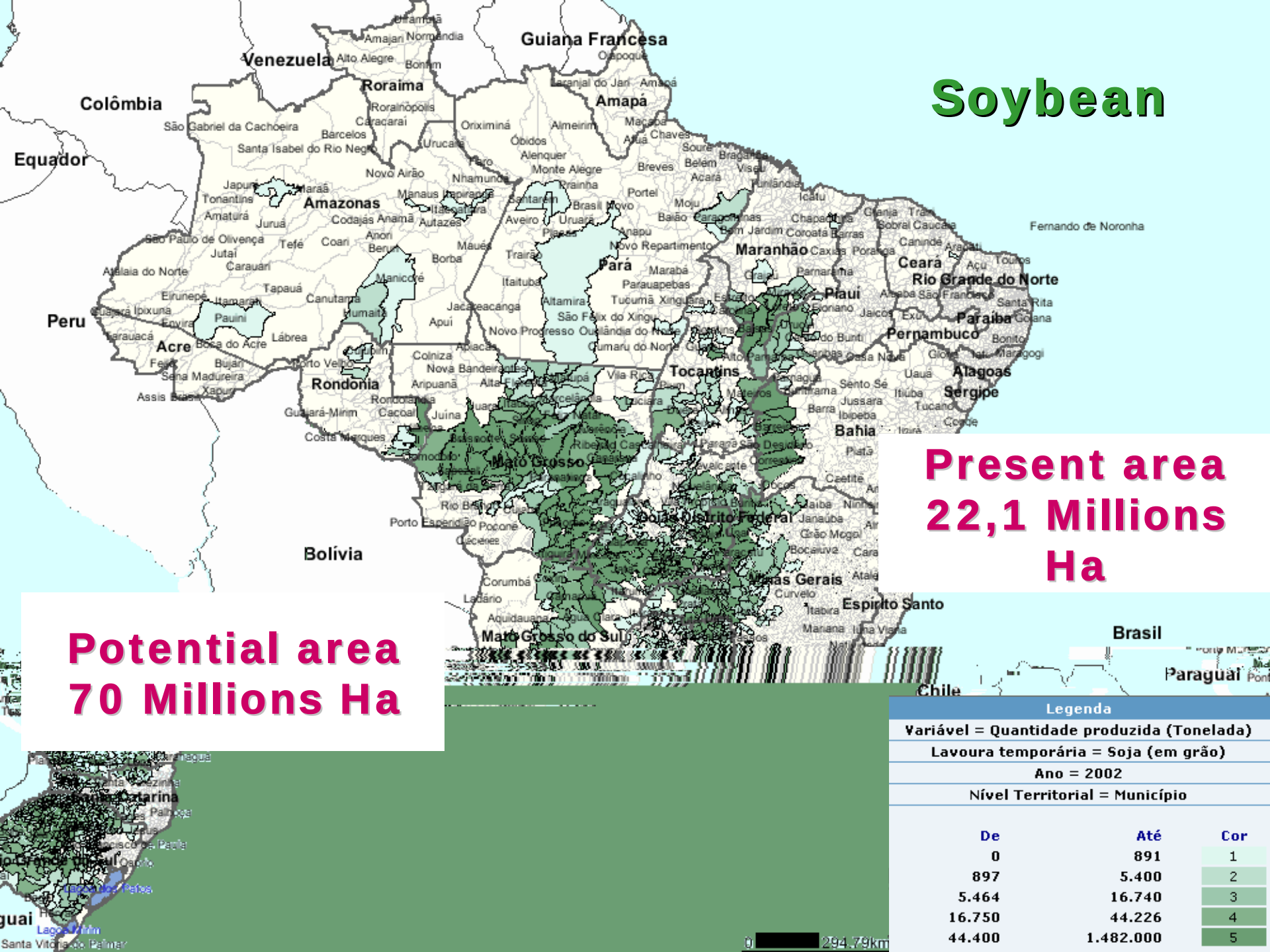
Soybean yields – US/Brazil



AgriStats, NASS

Brazilian agribusiness Future

Soybean



Present area 22,1 Millions Ha

Potential area 70 Millions Ha

Center-West Brazil

BRAZIL: Next decade projections

CROPS	ÁREA HECTARES	ÁREA HECTARES	VARIATION (%)
YEAR	2006/2007	2014/2015	2015/2007
GRAIN *	45.837.100	59.479.305	29.8%
COFFEE	2.309.741	2.656.202	15.0%
SUGAR CANE	6.188.600	9.282.900	50.0%
VEGETABLES AND FRUITS	12.200.000	15.250.000	25.0%
TOTAL UTILIZADO	66.535.441	86.668.408	30.3%
ÁREA AGRICULTÁVEL DISPONÍVEL	388.000.000	388.000.000	
PASTURE	220.000.000	220.000.000	0.0%
COMERCIAL FOREST	6.000.000	12.000.000	100.0%
CROPS	66.535.441	86.668.408	30.3%
TOTAL AVAILABLE	95.464.559	69.331.592	

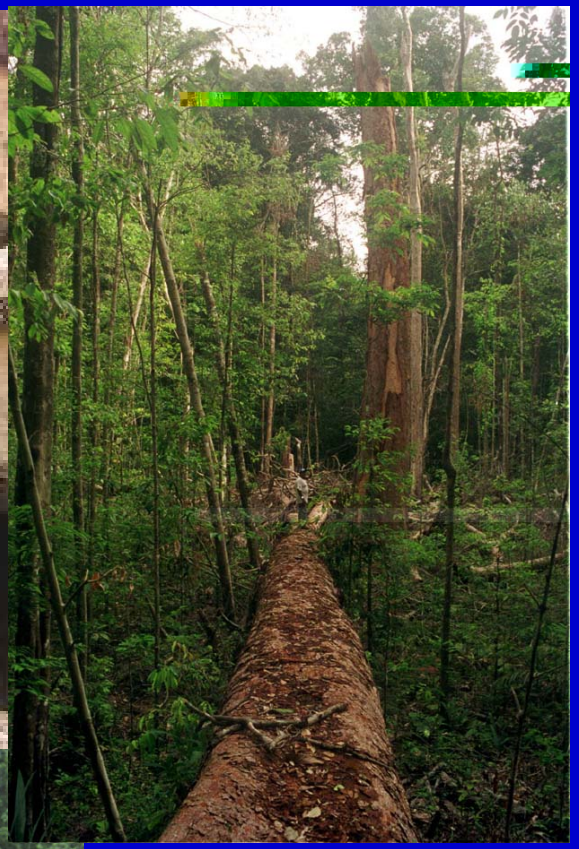
* INCLUSO ALGODÃO CAROÇO

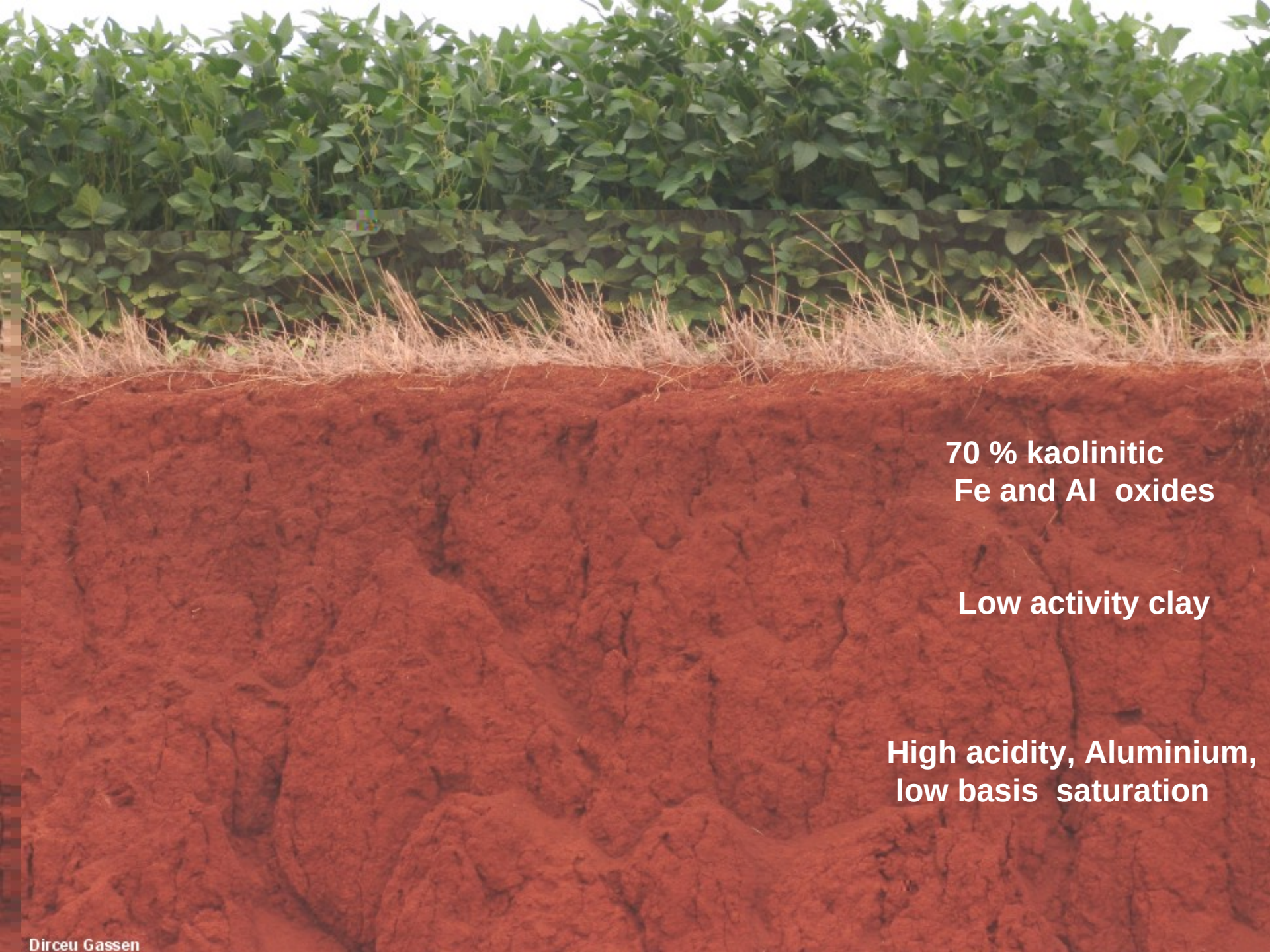
Elaboração e Projeções: Carlos Cogo Consultoria Agroeconômica

The rain forest...

Fire...

Selective logging...




70 % kaolinitic
Fe and Al oxides
Low activity clay
High acidity, Aluminium,
low basis saturation
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EROSION

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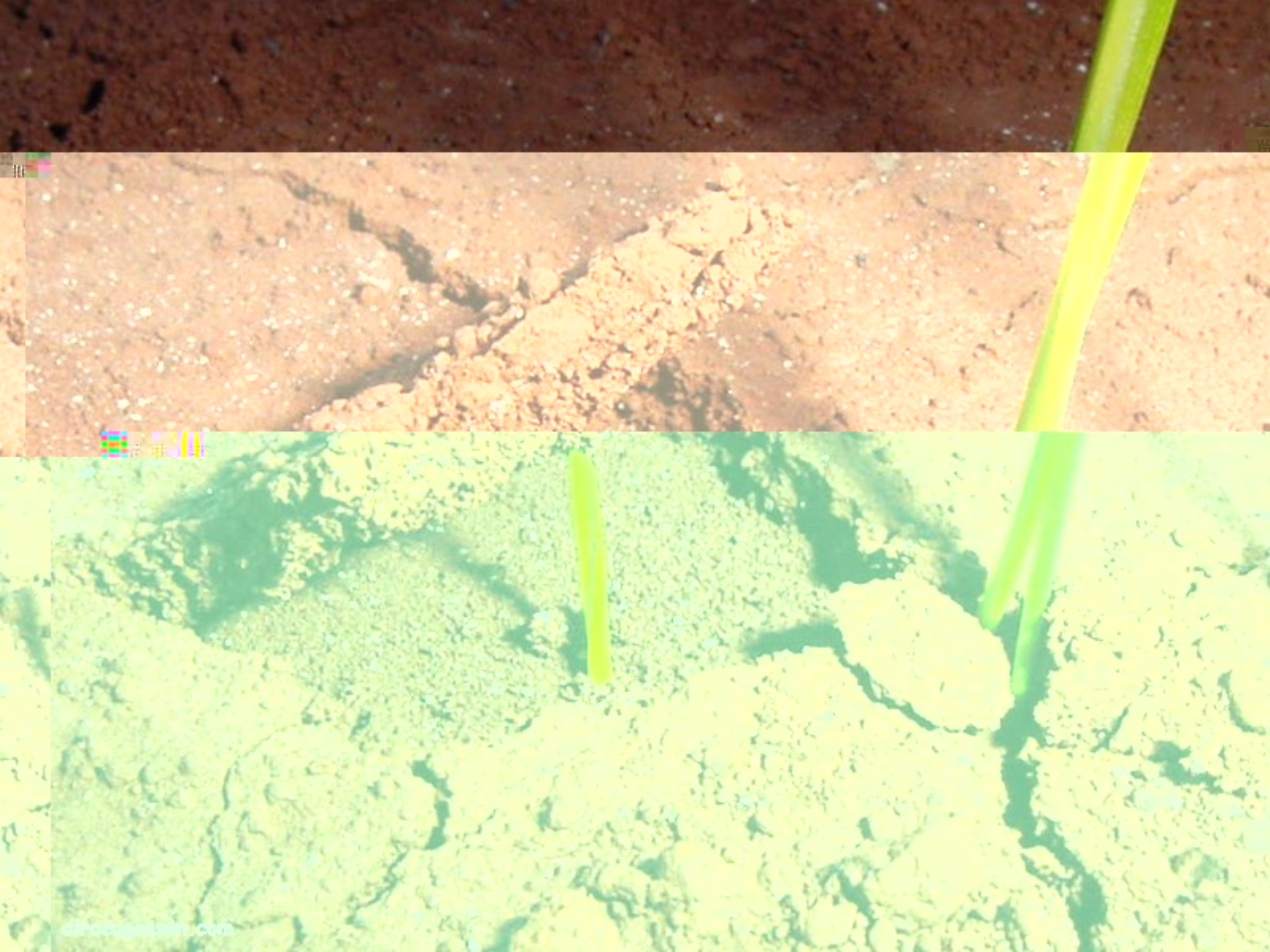

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Fonte: Moryja, 2005

16 1 2003

Erosion: 24 t/ha/year

Yield: 2.3 t/ha/year

1 t grain = 10 t soil

Werner Wünsche
Embrapa Trigo

NO-TILL

1962

Brazil NT area

Animal traction No-till

No-till animal traction

Fonte: Moryja, 2005

Fonte: Moryja, 2005

Fonte: Moryja, 2005

No-till smallholders

Country	Área (ha)	N° Farmers
Brazil	173.000	38.000
India	130.000	26.000
Pakistan	80.000	5.500
Ghana	45.000	100.000
Bangladesh	10.000	30.000
Paraguai	6.500	2.300

(Wall, P., 2002)

Ag Soil Carbon Sequestration

Sá, 2004

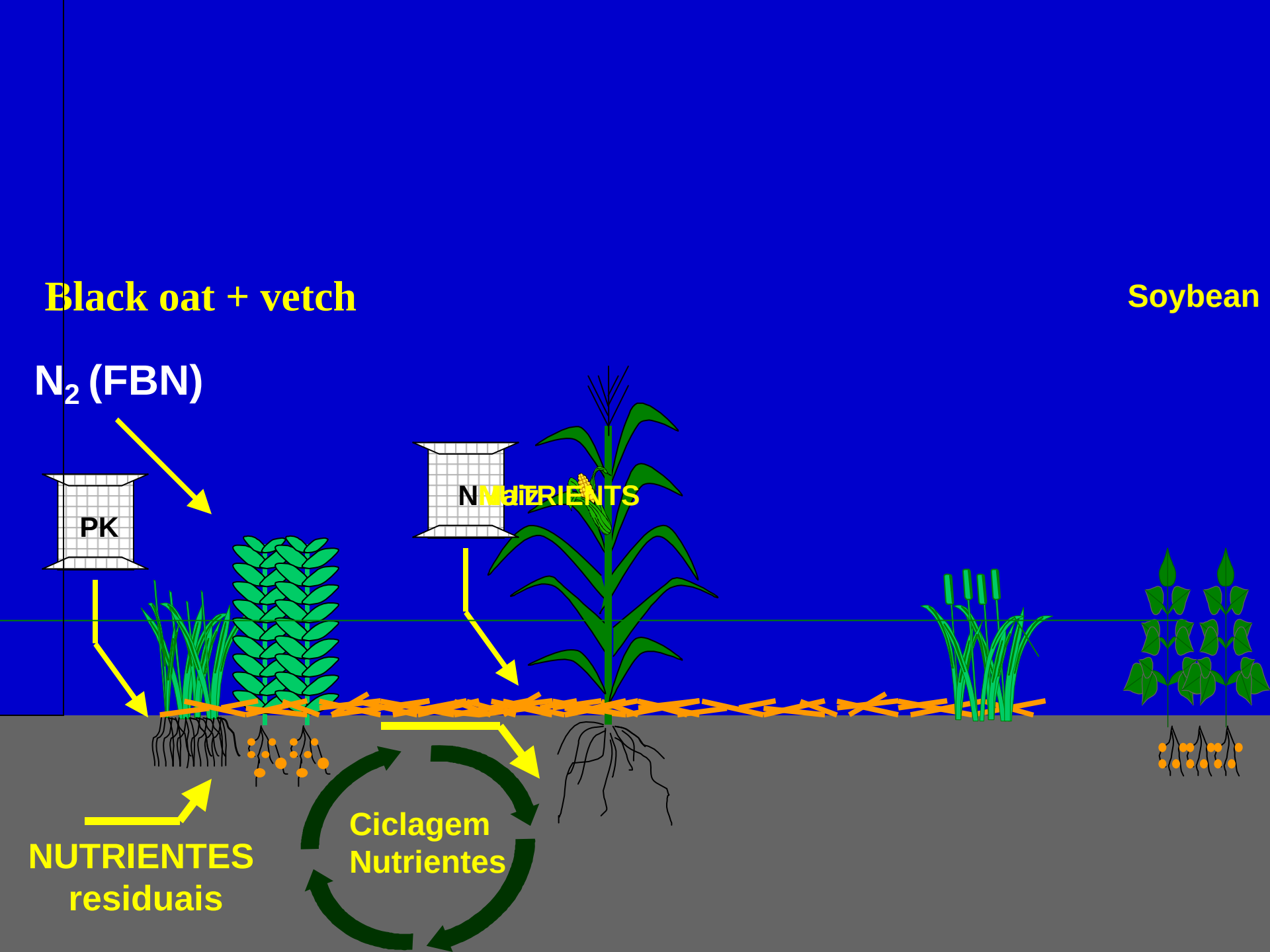
Some soil carbon sequestration rates

Brazil

Region		Rate
		Mg ha^{-1} yr^{-1}
Tropical (West-Central BR)	Range	0.04 – 0.63
	Mean	0.39
Subtropical (Southern BR)	Range	0.04-0.97
	Mean	0.58
Temperate (USA)	Range	0.1-0.5
	Mean	0.34
GLOBAL	Mean	0.57

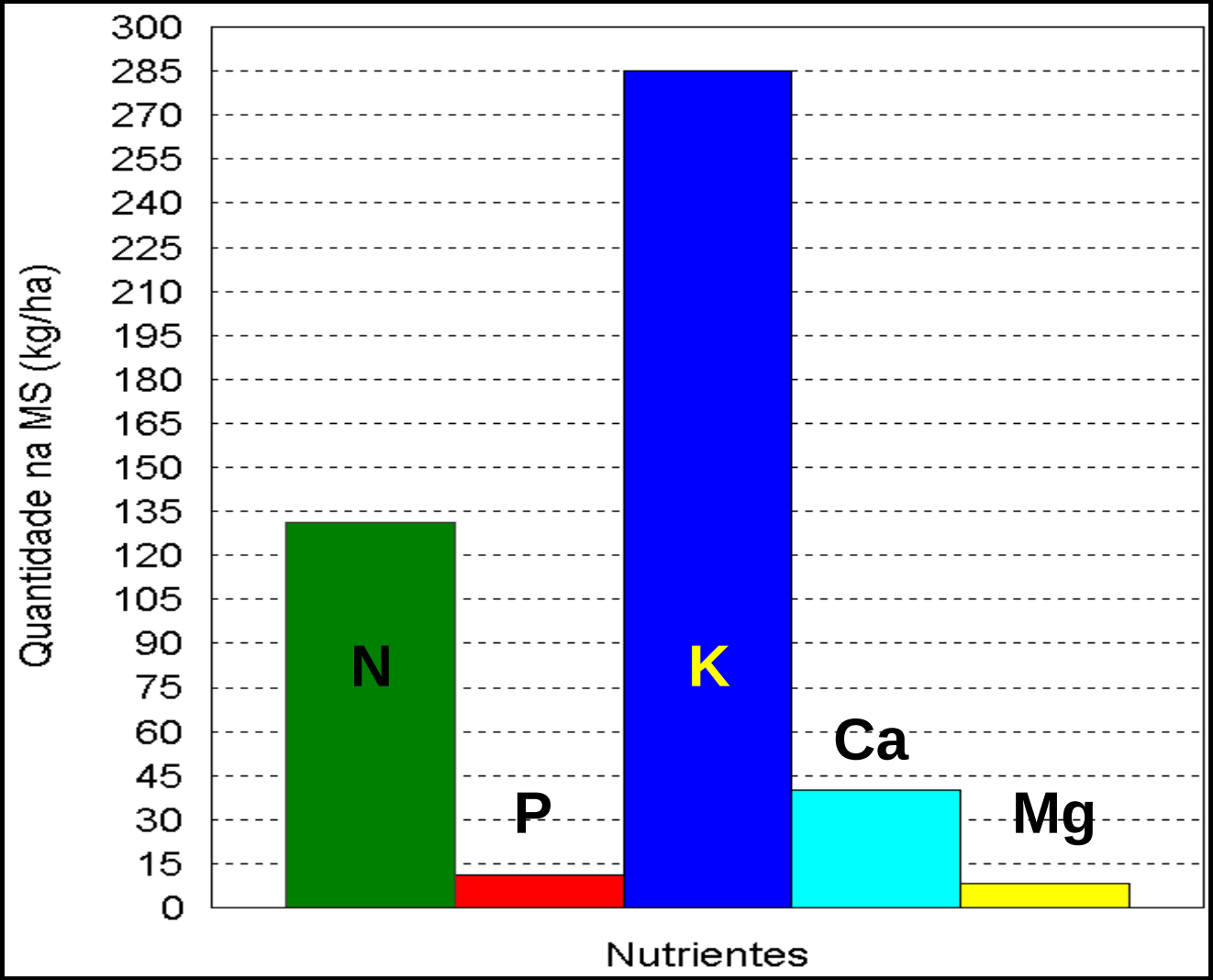
Tropical: Corazza et al. (1999), Silva et al. (2001), Leite et al. (2001)
Subtropical: Bayer et al. (2000a,b), Lovato (2001), Amado et al. (2001), Freixo et al. (2002)
Temperate: Lal et al. (1999); West & Marland (2002)
Global: West & Post (2002)

Bayer, 2007

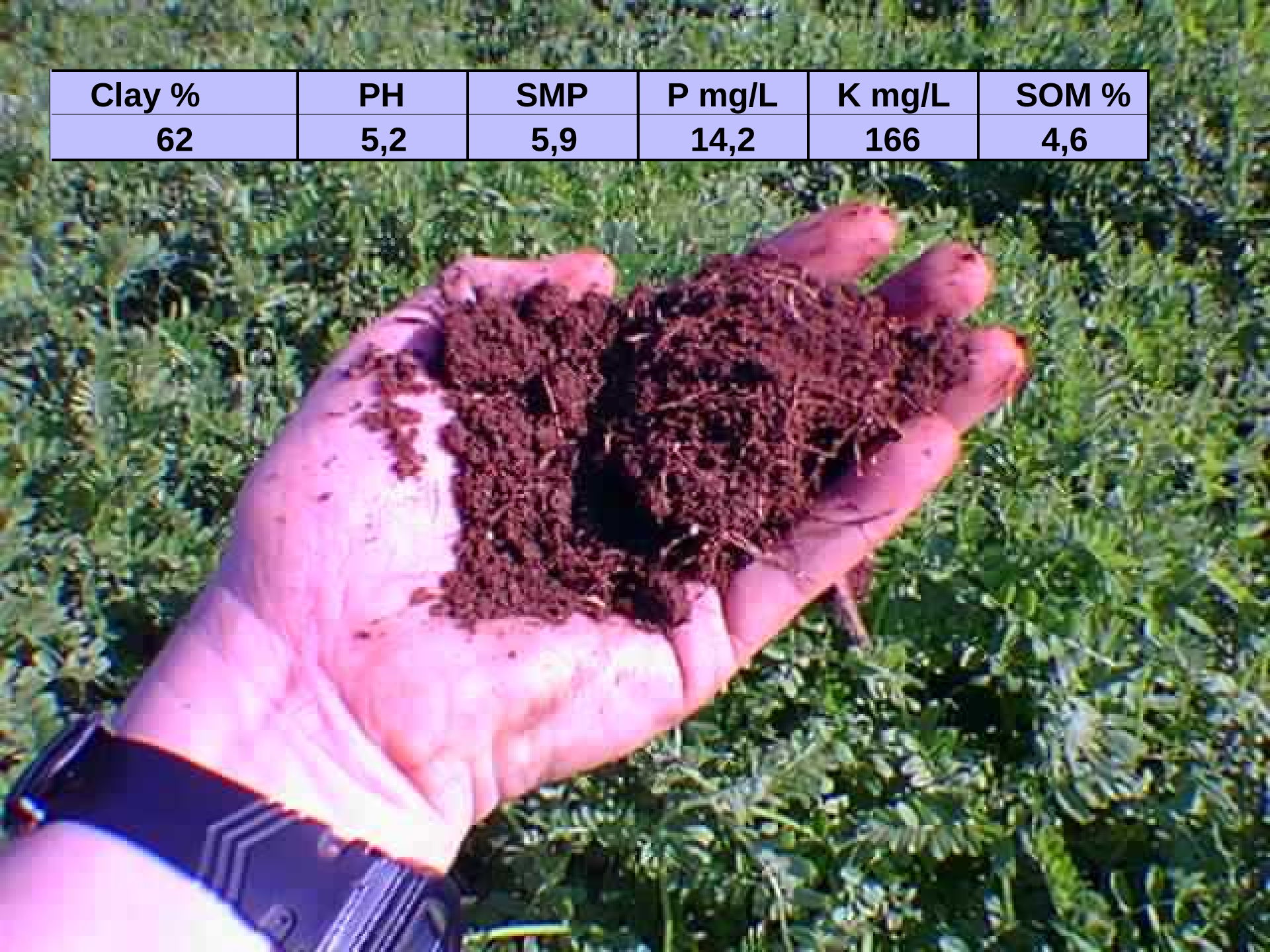

Black oat + vetch
Soybean
N2 (FBN)
PK
N
NUTRIENTS
NUTRIENTES residuais
Ciclagem Nutrientes

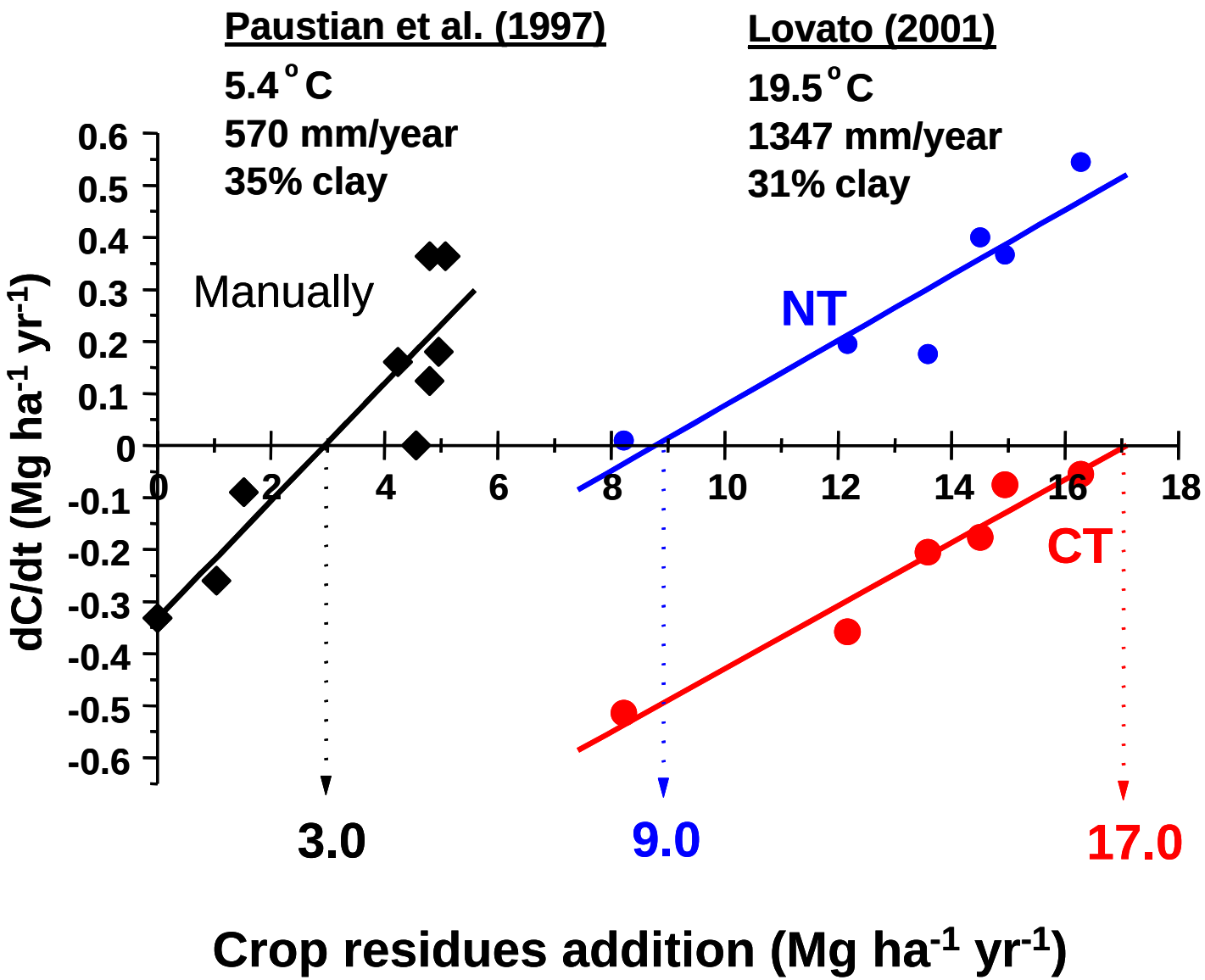
> 5 Mg MS ha^{-1}

5 Mg MS ha^{-1}


Quantidade na MS (kg/ha)
300
285
270
255
240
225
210
195
180
165
150
135
120
105
90
75
60
45
30
15
0
N
P
K
Ca
Mg
Nutrientes

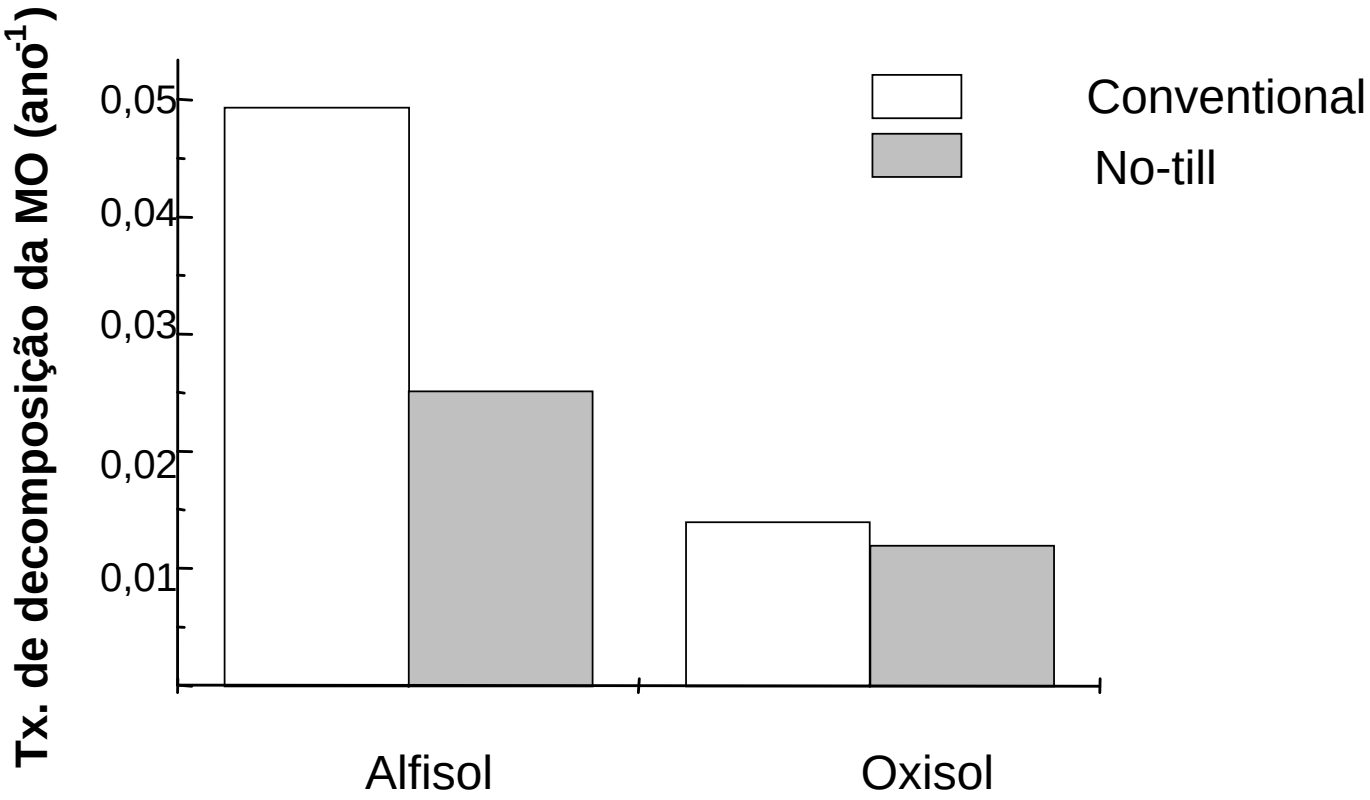
Clay %	PH	SMP	P mg/L	K mg/L	SOM %
62	5,2	5,9	14,2	166	4,6




Paustian et al. (1997)
5.4 °C
570 mm/year
35% clay
Lovato (2001)
19.5 °C
1347 mm/year
31% clay
Manually
NT
CT
dC/dt (Mg ha-1 yr-1)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
0
2
4
6
8
10
12
14
16
18
3.0
9.0
17.0
Crop residues addition (Mg ha-1 yr-1)

Alfisol

Rate of SOM mineralization x Soil Type



Temperatura (ºC)	**19,4**	**21,2**
Precipitação (mm/ano)	**1550**	**1620**
Argila (g kg^{-1})	**220**	**620**
Fe_2O_3 (g kg^{-1})	**103**	**211**

C accumulation in subsoil layers of mature no-till

Soil	Reference System	C sequestration		Paper
		0-20	0-100	
		---- Mg ha^{-1} ano^{-1} ----		
No-till				
Alfisol	PC	0,65	1,05	*Zanatta et al. (2005)*
Alfisol	PC	1,22	1,95	*Dieckow et al. (2005)*
Oxisol	PC	0,52 *	0,98	*Sisti et al. (2004)*
Oxisol	PC	0,20	0,27	*Conceição et al. (2006)*
Oxisol	PC	0,82	1,36	*Jantalia et al. (2007)*
Oxisol	PC	0,83	2,28	*Corazza et al. (1999)*
Oxisol	PC	0,21 *	0,52	*Jantalia et al. (ñ pub)*
Pasture				
Alfisol	PC	0,91 **	3,23	*Omonode et al. (2006)*
Oxisol	PC	0,76 **	3,13	*Omonode et al. (2006)*
Oxisol	PC	0,43	1,92	*Corazza et al. (1999)*
Oxisol	Cerrado	1,14	2,53	*Silva et al. (2004)*

* 0-30 cm ** 0-15 cm

Mechanisms of C stabilization in no-tillage soils

-**Molecular recalcitrance**
-**Chemical protection**
-**Physical protection**

→ Very important in variable charge soils

Chemical and physical protection

Very important mechanisms in variable charge soils

Soil Quality Indicator

SOM fraction	Tillage Systems		Δ%	Δ Mg ha^{-1}
	CT	NT		
Particulate SOM	5.19	7.06	36	1.87
Mineral-associate SOM	25.22	30.90	23	5.68

75% of the total soil C sequestration

Bayer et al. (2003)

Brazil:

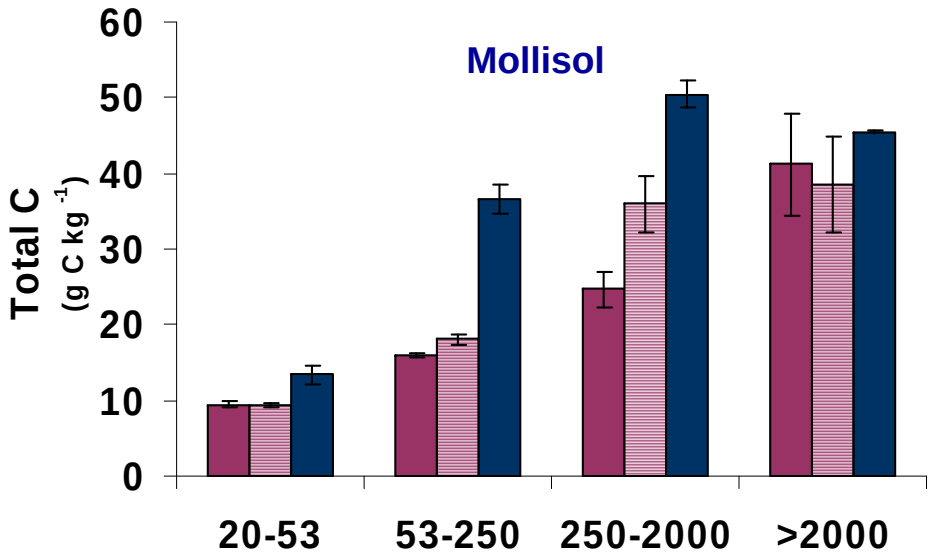
Soil: clay Rhodic Hapludox (Oxisol).

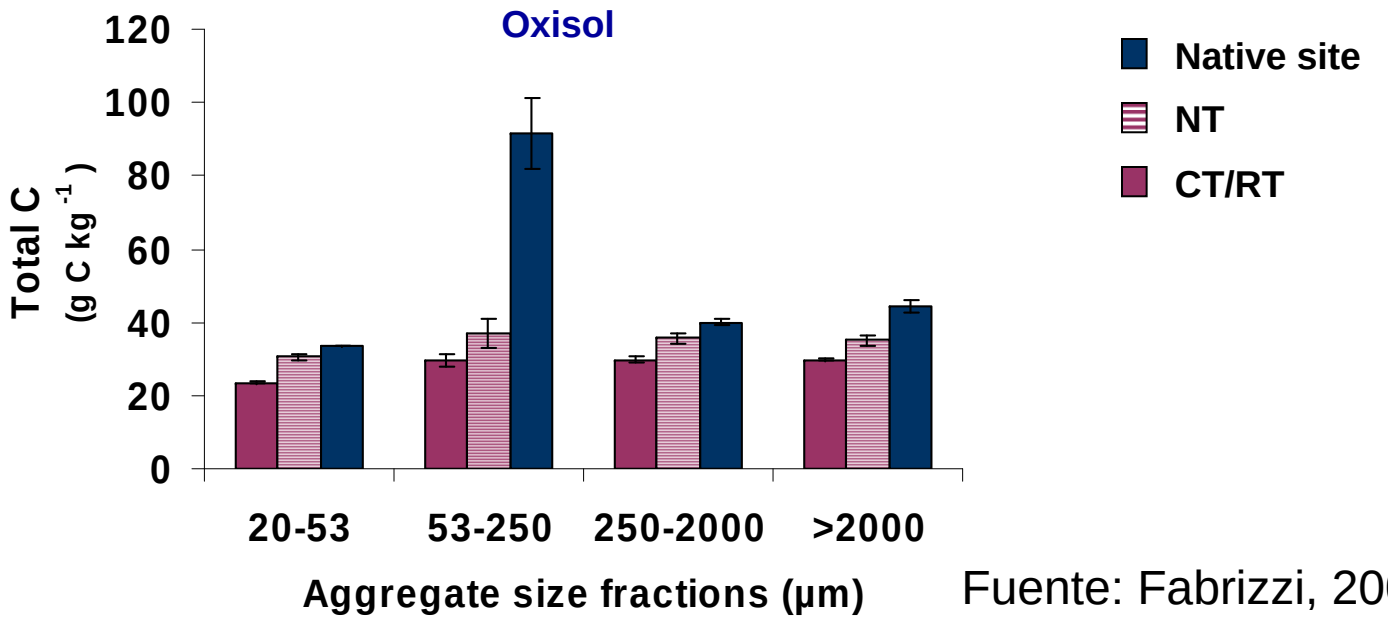
The treatments selected were:

1) Intensive crop system under CT and NT

Rotation: Black oat/soybean/black oa
+ vetch/maize/radish oil (*Raphanus sativus L.*)/wheat/soybean

Aggregate-associated C





Fuente: Fabrizzi, 2006

Soybean Ecosystem C Balance

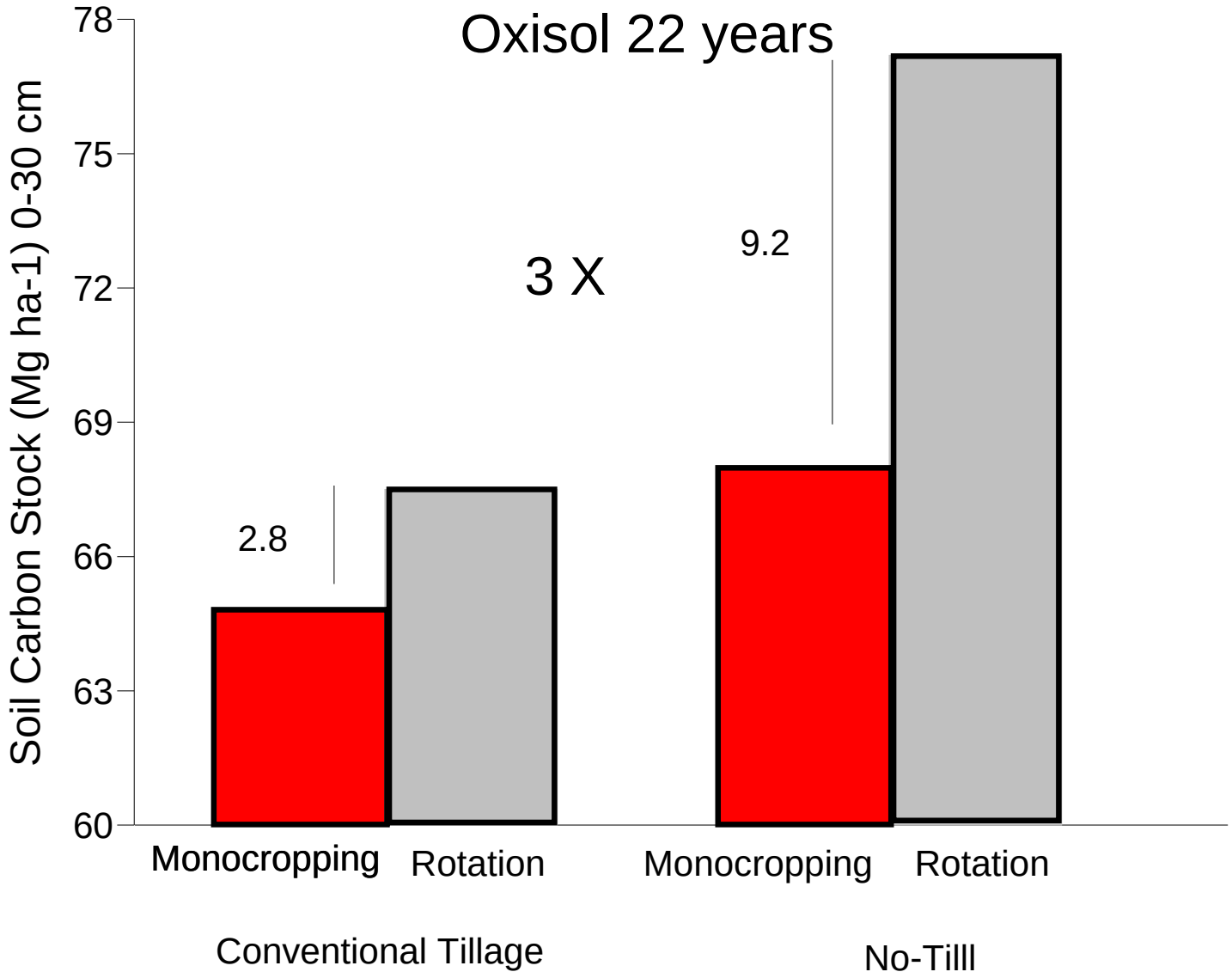
Soybean	Yield	C grain	CO2 Flux	CO2 flux-C grain
	---------- g m^{-2} ----------			
2006/07	321.3	150,95	-158.05	-7.10

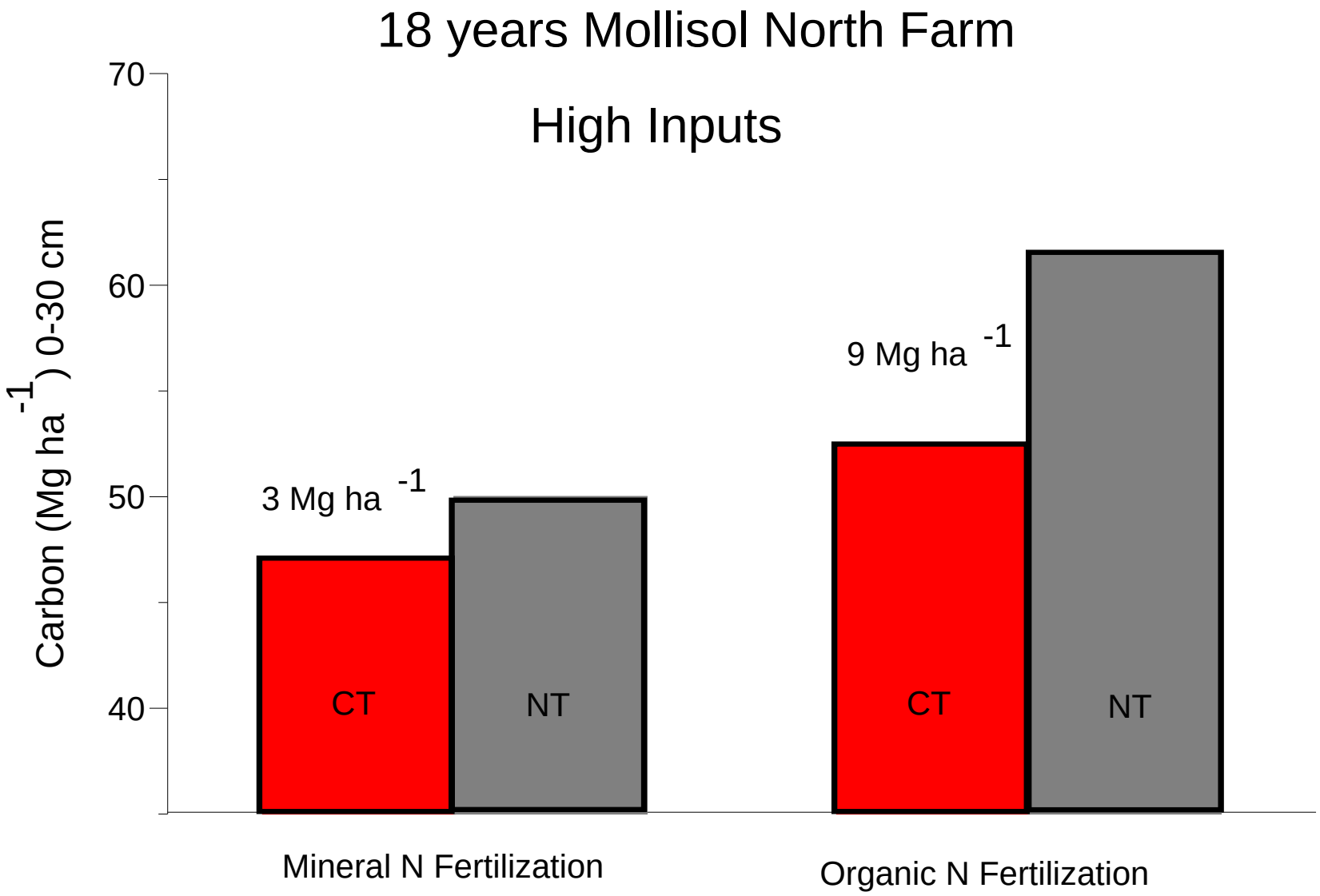
Verma et al. (2005) +/- 45 g C m^{-2}

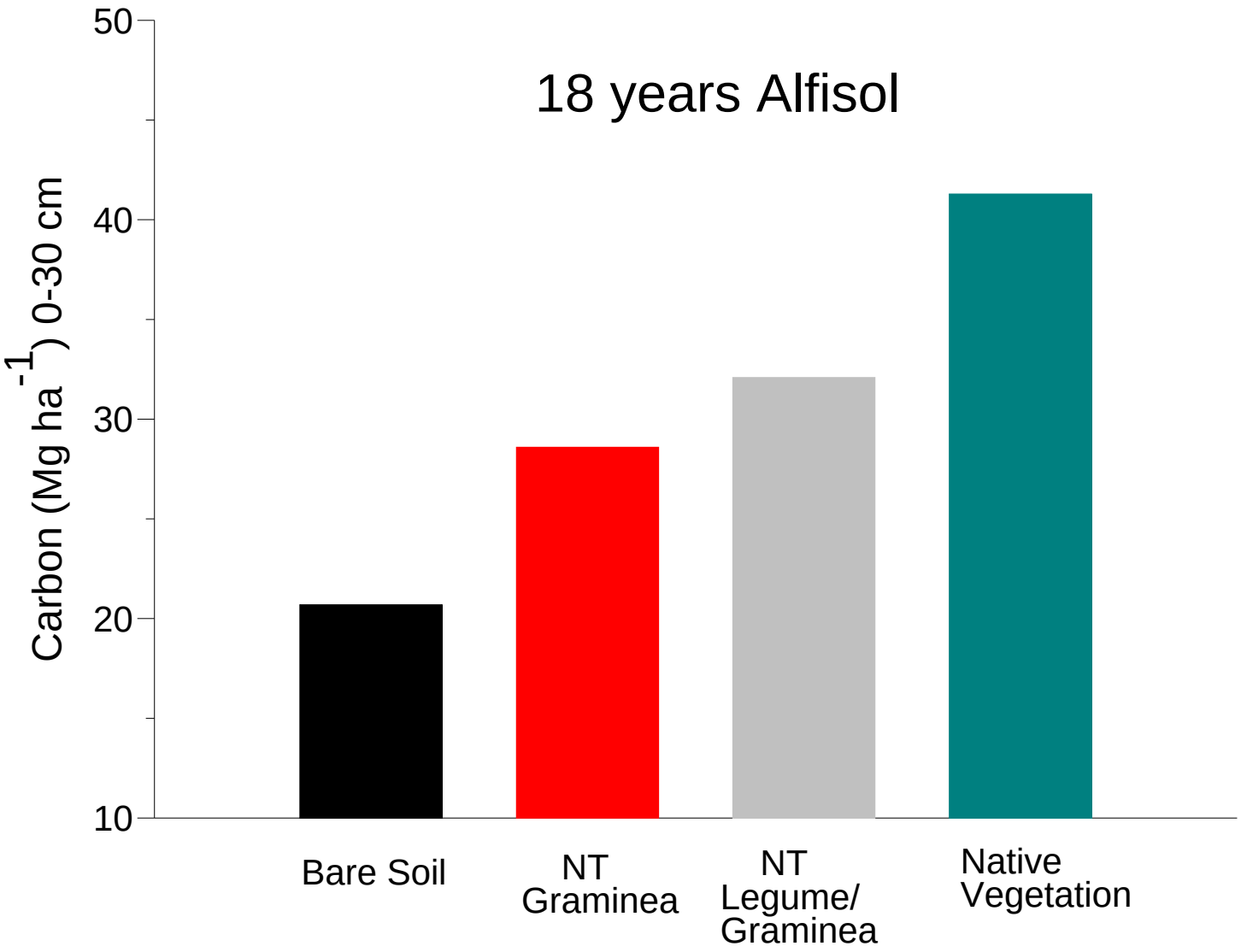
Conclusion: Carbon sequestration? Not with soybean

NT soybean neutral balance

Escobar, 2007

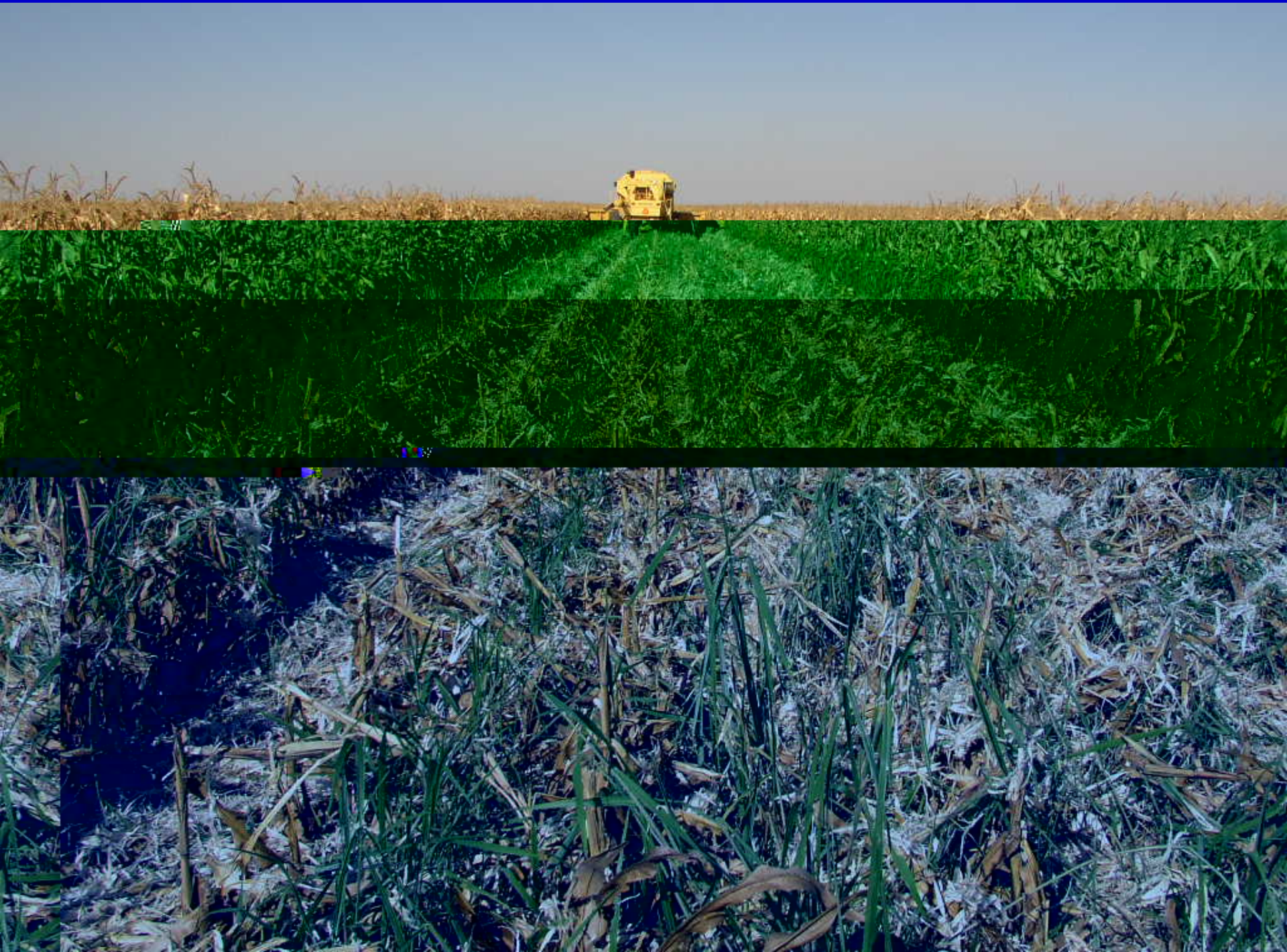

Oxisol 22 years
Soil Carbon Stock (Mg ha-1) 0-30 cm
78
75
72
69
66
63
60
3 X
9.2
2.8
Monocropping
Rotation
Monocropping
Rotation
Conventional Tillage
No-Tilll


18 years Mollisol North Farm
High Inputs
Carbon (Mg ha-1) 0-30 cm
70
60
50
40
3 Mg ha -1
9 Mg ha -1
CT
NT
CT
NT
Mineral N Fertilization
Organic N Fertilization


18 years Alfisol
Carbon (Mg ha-1) 0-30 cm
50
40
30
20
10
Bare Soil
NT Graminea
NT Legume/ Graminea
Native Vegetation

Innovate cropping systems

COMO PLANTAR O S



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