Carbon balance and sequestration in no-till soils under intensive cropping systems in tropical agroecozones

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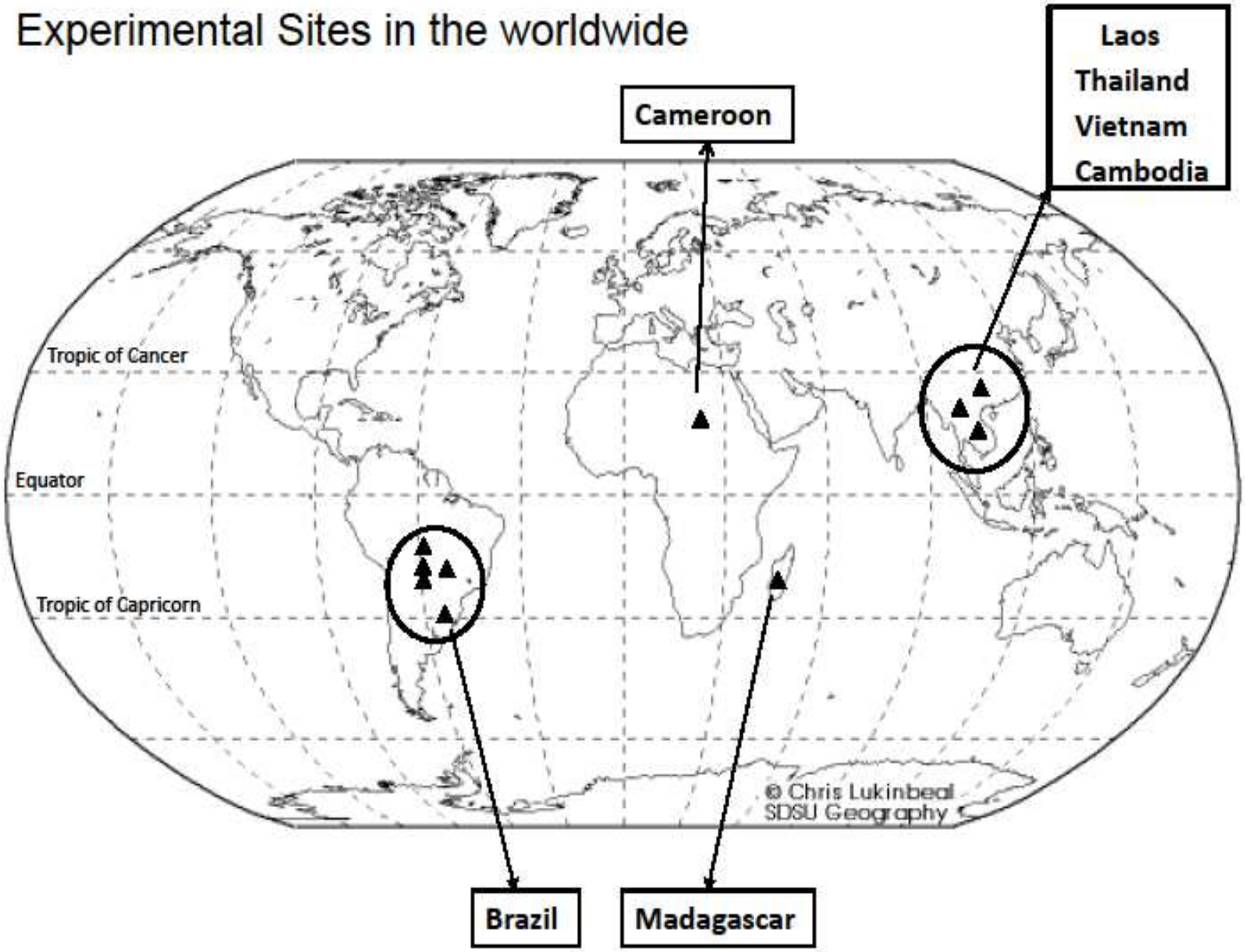
Experimental Sites in the worldwide



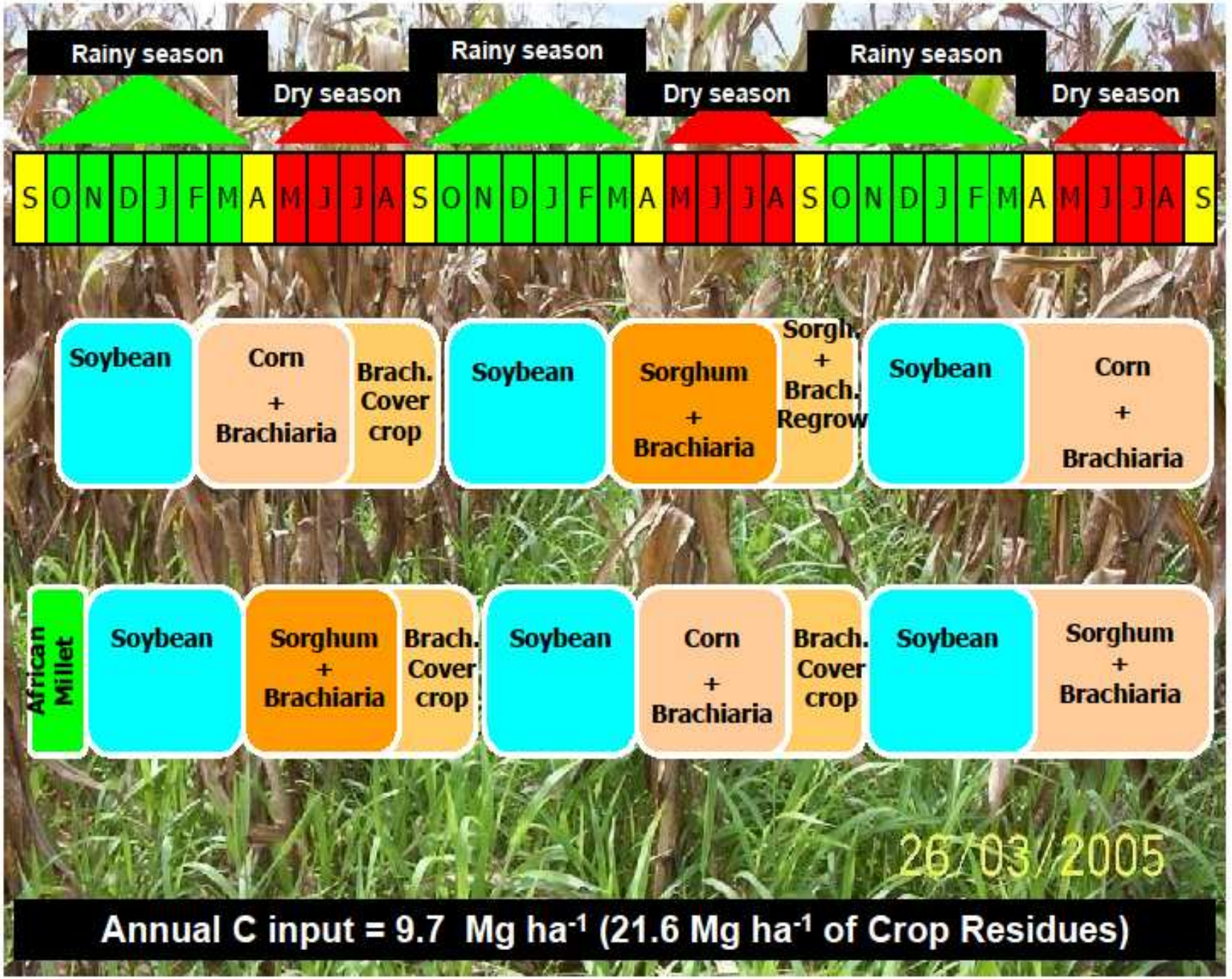

Methodology
No plowing, no tillage
Soil protected all year round
As high as possible production of biomass
Association/rotation of plants to bring…
Complementary functions for soil health

Concept of intensive cropping system

The meaning of the intensive cropping system comprise in to *"close the window"* between the rainy season (wet summer) and the dry season (dry winter) using cover crops associated with cash crops to maintain the soil surface permanent covered.

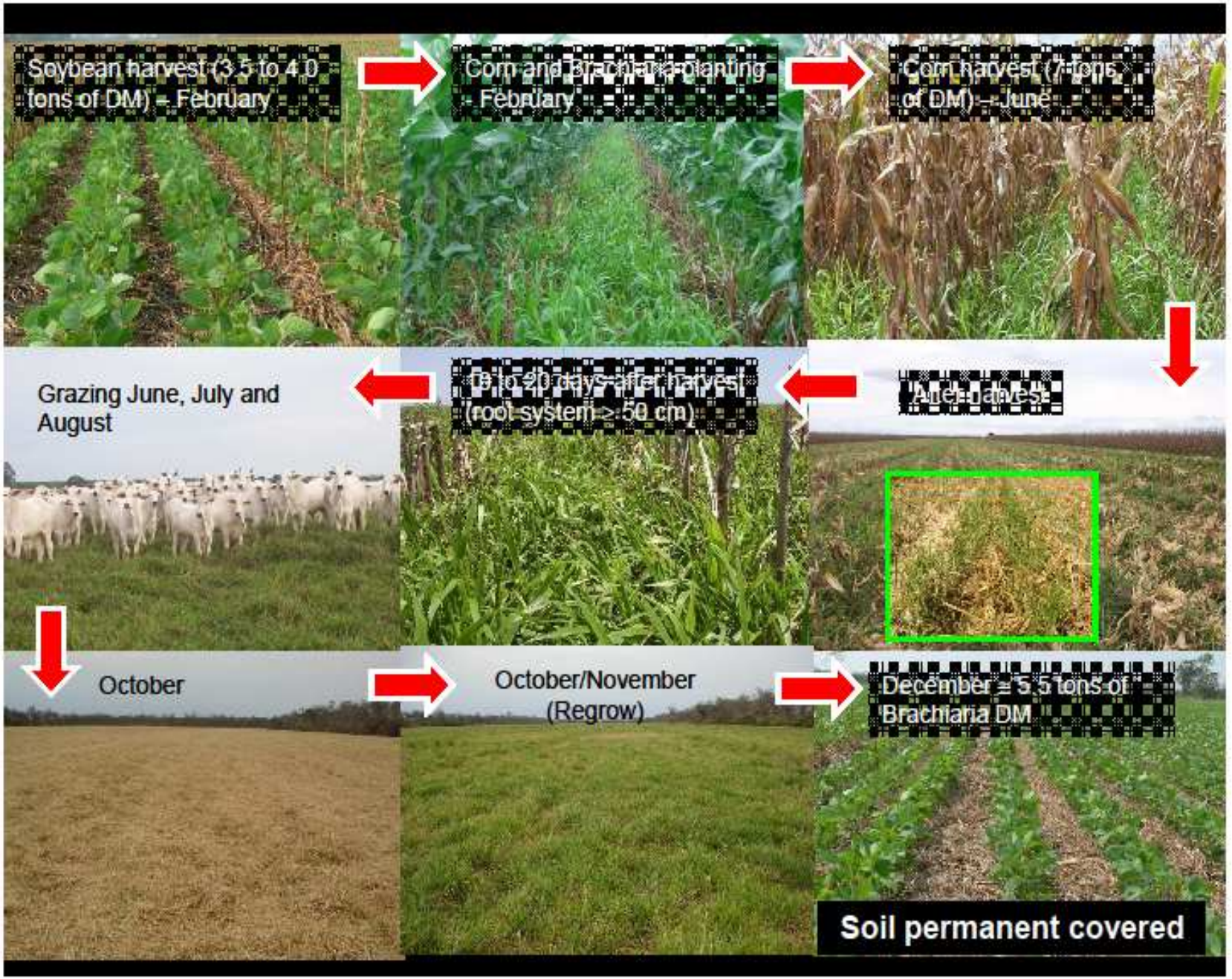

"The challenge in the tropics is the management of the crop residues decomposition rate to maintain the soil covered all year long"


Example: Campo Verde – MT, Brazil
Oxisol, Red Dark Latosol, Sand-Clay
26/03/2005

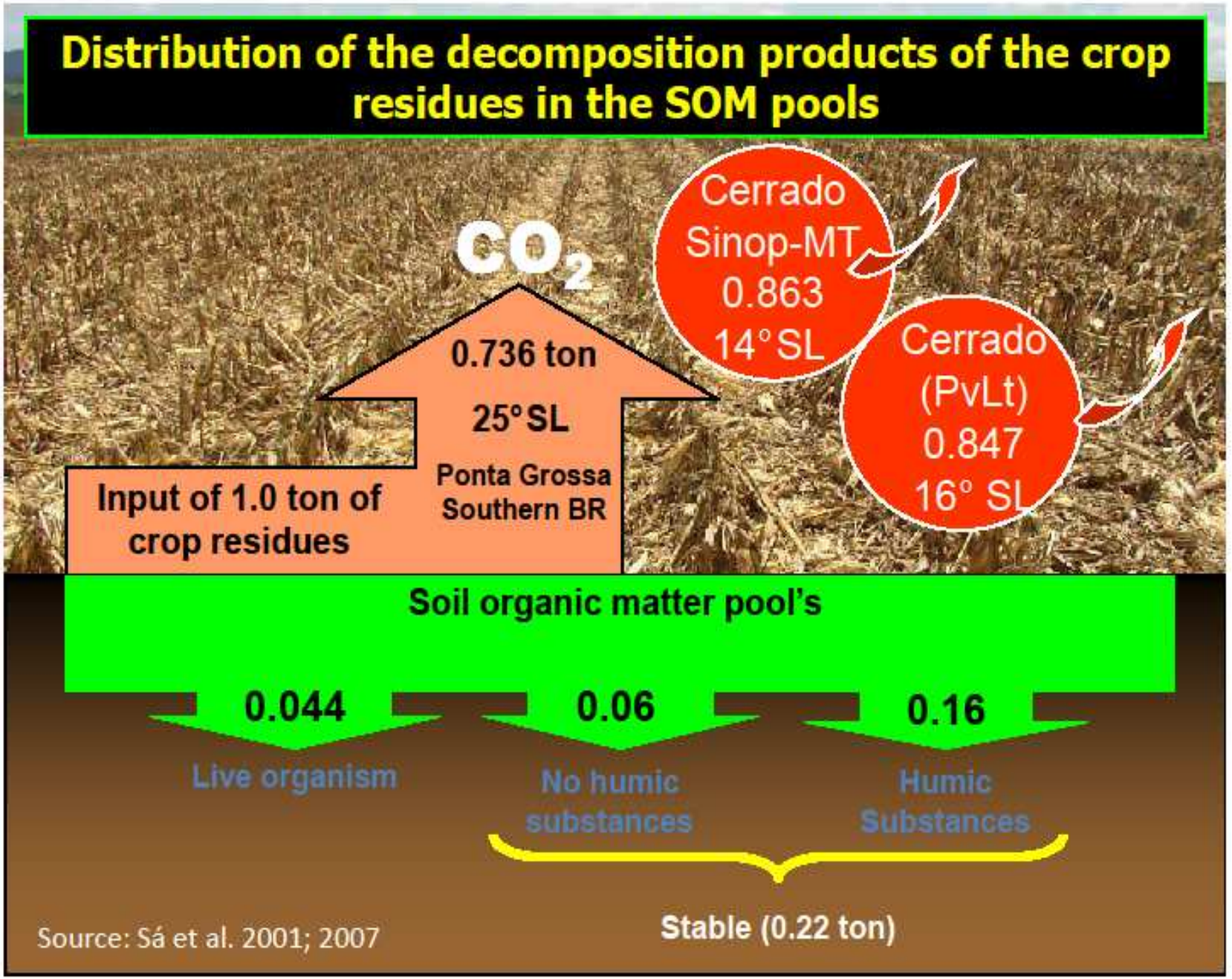

Rainy season
Dry season
Rainy season
Dry season
Rainy season
Dry season
S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S
Soybean
Corn + Brachiaria
Brach. Cover crop
Soybean
Sorghum + Brachiaria
Sorgh. + Brach. Regrow
Soybean
Corn + Brachiaria
African Millet
Soybean
Sorghum + Brachiaria
Brach. Cover crop
Soybean
Corn + Brachiaria
Brach. Cover crop
Soybean
Sorghum + Brachiaria
26/03/2005
Annual C input = 9.7 Mg ha-1 (21.6 Mg ha-1 of Crop Residues)


Soybean harvest 73.5 to 4.0 tons of DM) – February
Corn and Brachiaria planting – February
Corn harvest 7.6 to 7 tons of DM) – June
After harvest
10 to 20 days after harvest (root system > 50 cm)
October – Before soybean planting ≅ 11-12 tons of Brachiaria DM
November – 12 days after soybean planting
November ≅ 9.5 tons of Brachiaria DM
December ≅ 7.0 tons of Brachiaria DM
Soil permanent covered

Example of Soybean/Corn + Brachiaria + beef cattle rotation

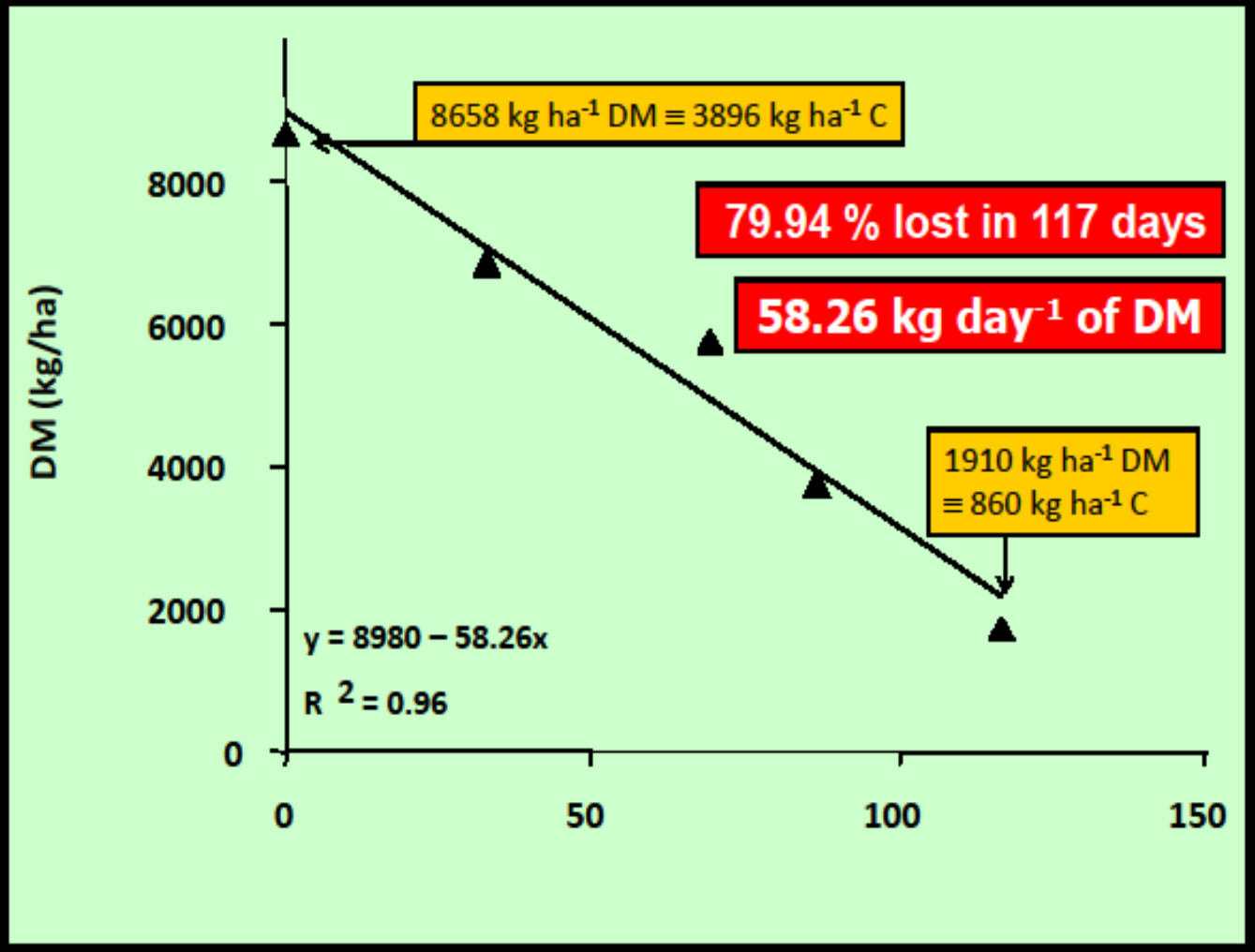

Soybean harvest (3.5 to 4.0 tons of DM) – February
Corn and Brachiaria planting – February
Corn harvest (7 tons of DM) – June
After harvest
0 to 20 days after harvest (root system ≥ 50 cm)
Grazing June, July and August
October
October/November (Regrow)
December = 5.5 tons of Brachiaria DM
Soil permanent covered


"In tropical areas the challenge with cropping systems is to adjust cash crops and cover crops that can be profitable and compensate the high decompositon rates of the crop residues"

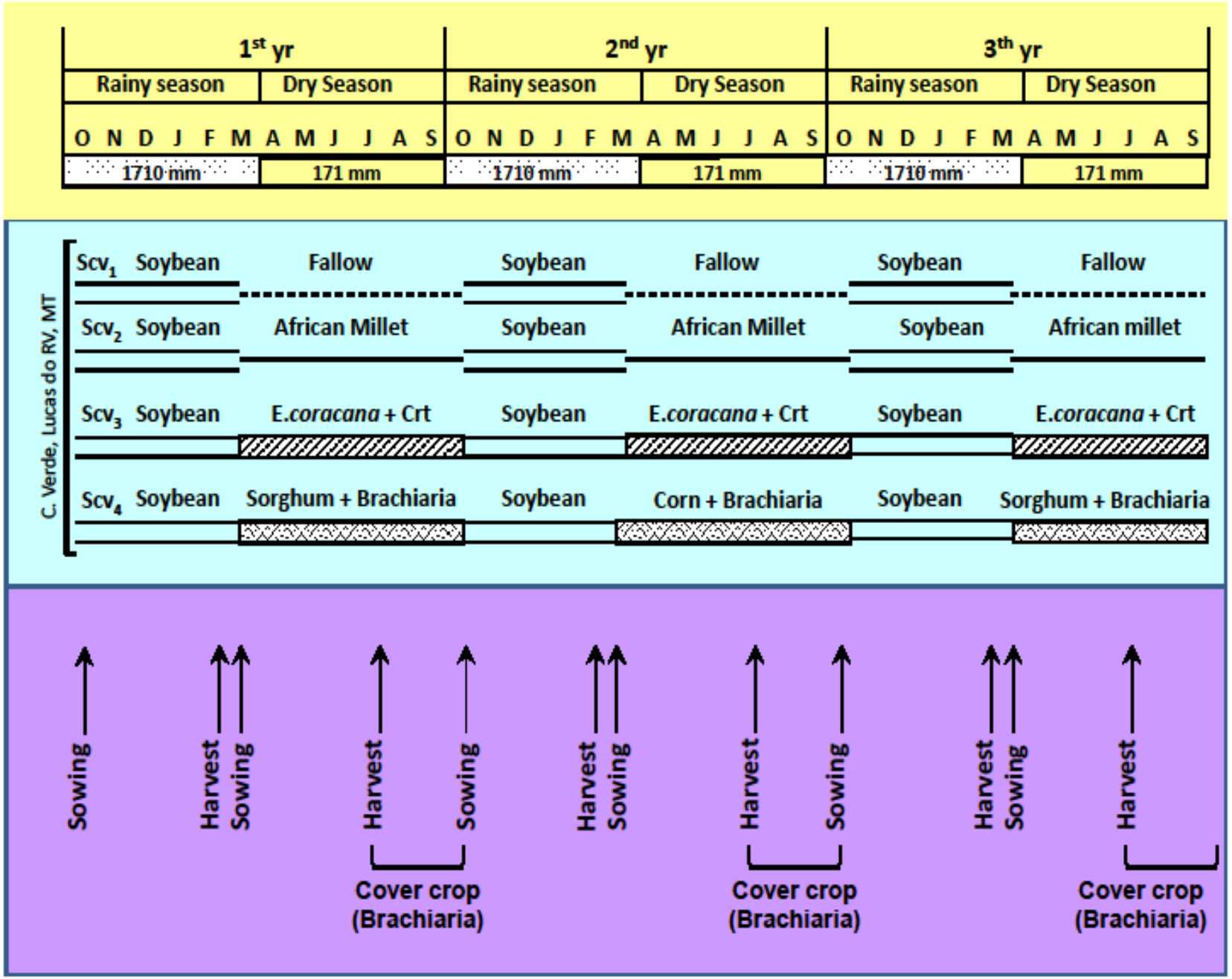

Distribution of the decomposition products of the crop residues in the SOM pools
CO_2
Cerrado
Sinop-MT
0.863
14° SL
Cerrado
(PvLt)
0.847
16° SL
0.736 ton
25° SL
Ponta Grossa
Southern BR
Input of 1.0 ton of crop residues
Soil organic matter pool's
0.044
0.06
0.16
Live organism
No humic substances
Humic Substances
Stable (0.22 ton)
Source: Sá et al. 2001; 2007

Crop residues (Brachiaria *decumbens*) decomposition during the **corn** development

Rio Verde, 880 m ASL, Latitude ≅ 16° S, 2003-04, Oxisol (65% of clay)

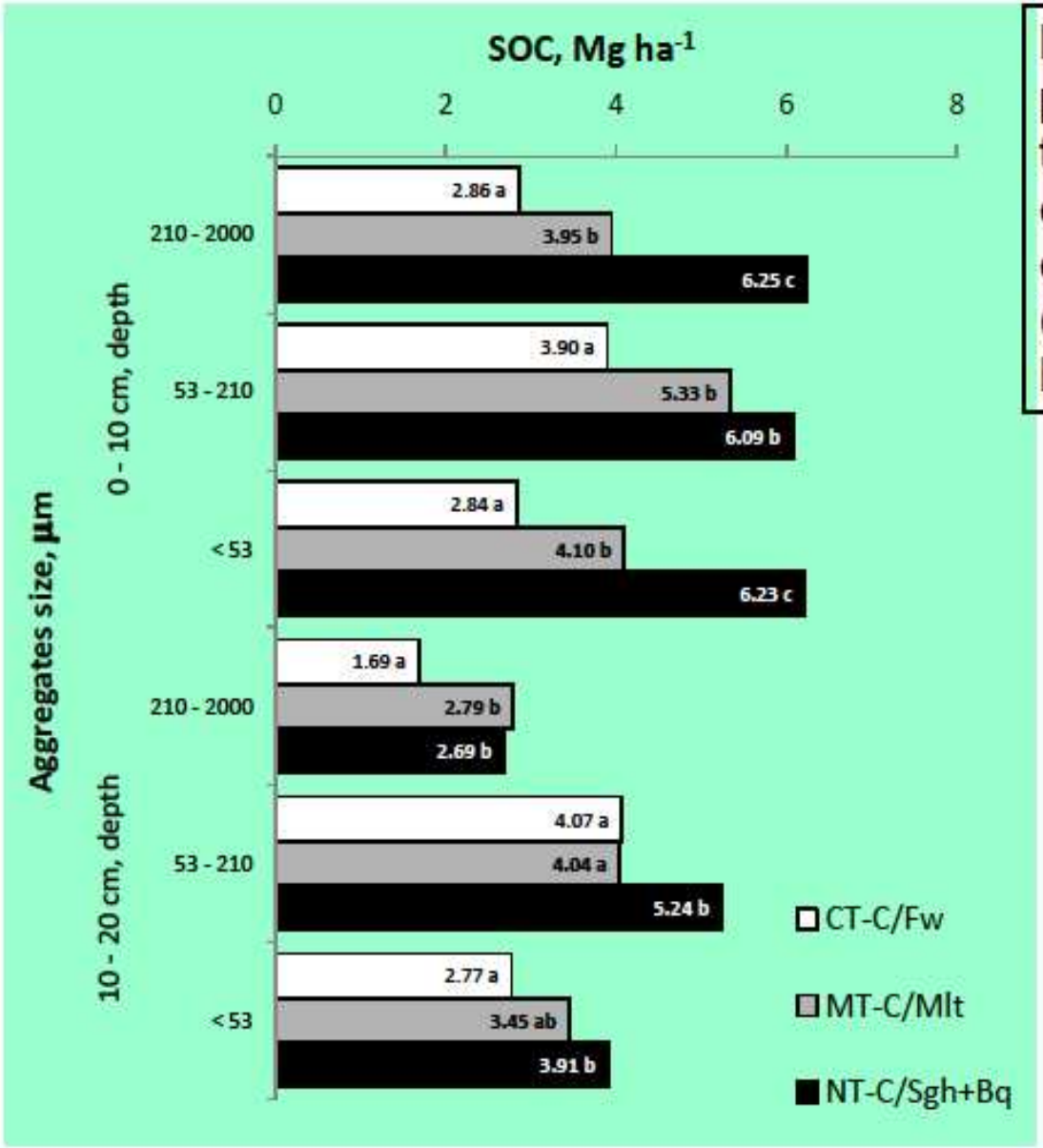


Source: Sá, et al, 2004


1st yr
2nd yr
3th yr
Rainy season
Dry Season
O N D J F M A M J J A S
1710 mm
171 mm
C. Verde, Lucas do RV, MT
Scv1 Soybean Fallow Soybean Fallow Soybean Fallow
Scv2 Soybean African Millet Soybean African Millet Soybean African millet
Scv3 Soybean E.coracana + Crt Soybean E.coracana + Crt Soybean E.coracana + Crt
Scv4 Soybean Sorghum + Brachiaria Soybean Corn + Brachiaria Soybean Sorghum + Brachiaria
Sowing
Harvest
Sowing
Harvest
Sowing
Cover crop
(Brachiaria)
Harvest
Sowing
Harvest
Sowing
Cover crop
(Brachiaria)
Harvest
Sowing
Harvest
Cover crop
(Brachiaria)

SOC balance for 0- to 20-cm depth for experimental sites

Site	Cropping System/Till.	SOC Measured		C input		SOC Sequestration rates
		t_1	t_2	Cumulative	Annual	
		---------- Mg ha^{-1} ----------				Mg ha^{-1} yr^{-1}
CV	CT-S	18.12	17.04	2.29	1.15	-0.54
	MT-S/Mlt	23.66	20.41	7.62	3.81	-1.63
	NT-S/Els+Crt	28.47	32.05	18.78	9.39	1.79
	NT-S/Sgh+Brq	30.66	35.03	19.38	9.69	2.18
LRV	CT-S	48.30	43.70	4.87	0.97	-0.93
	NT-S/Els+Crt	55.80	65.10	37.12	7.42	1.86
	NT-S/Sgh+Brq	58.30	68.80	39.54	7.91	2.10
Snp	CT-S	48.68	43.70	3.67	0.92	-1.25
	NT-S/Els+Crt	40.30	47.20	40.12	10.03	1.73
	NT-S/Tifton	43.02	53.40	51.26	12.82	2.60
Adrom.	Fallow	47.37	41.40	1.08	0.12	-0.66
Madag.	NT-M/S	47.37	56.38	16.05	1.78	1.00
	NT-M+SD	47.37	52.69	25.08	2.79	0.59
	NT-S/GB+KK	47.37	56.81	35.50	3.94	1.05



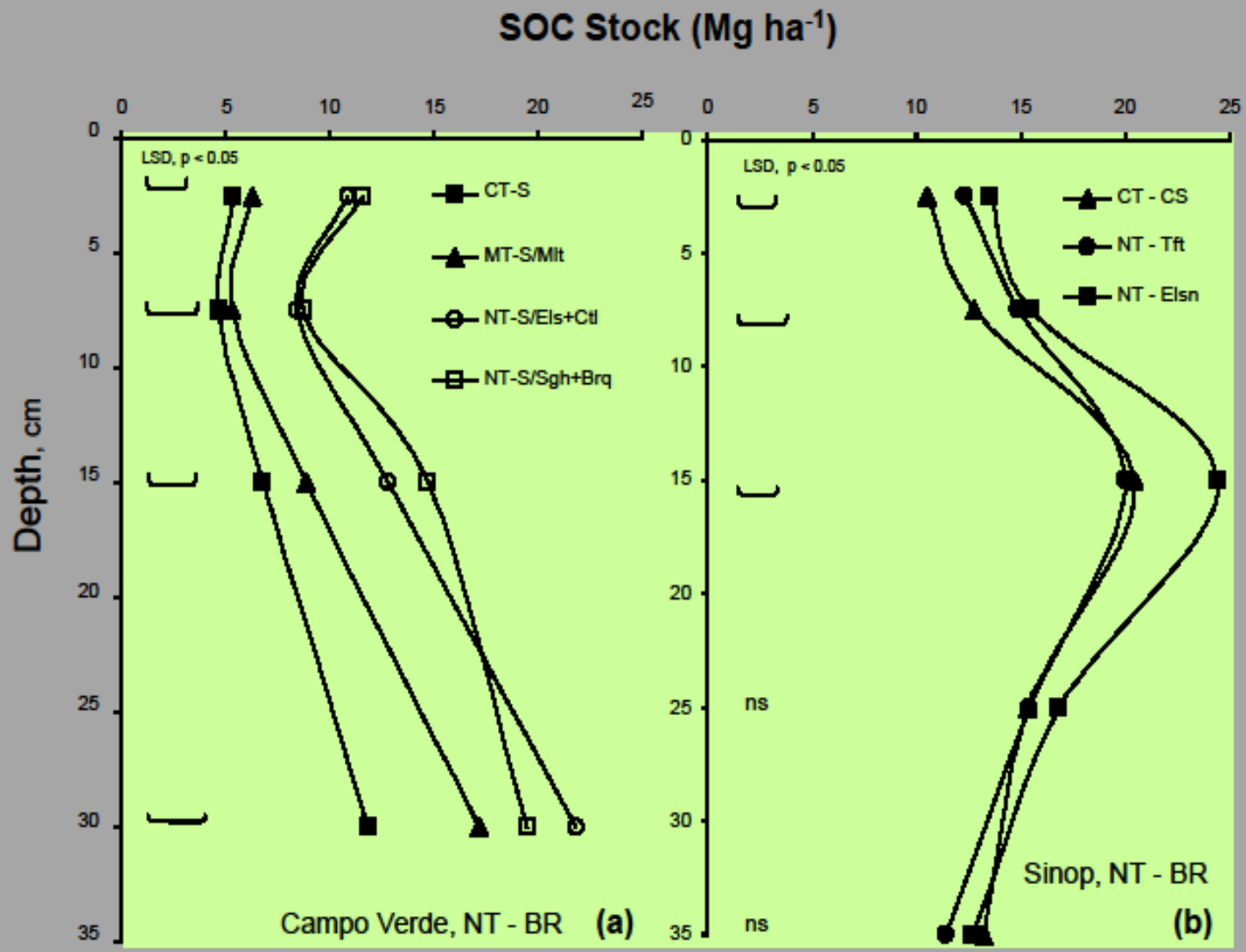
Distribution of C in the particle size fraction in the profile under three crop rotations with cotton as the main crop (Campo Verde-MT, Brazil, 16° SL)

(Cotton / Fallow)

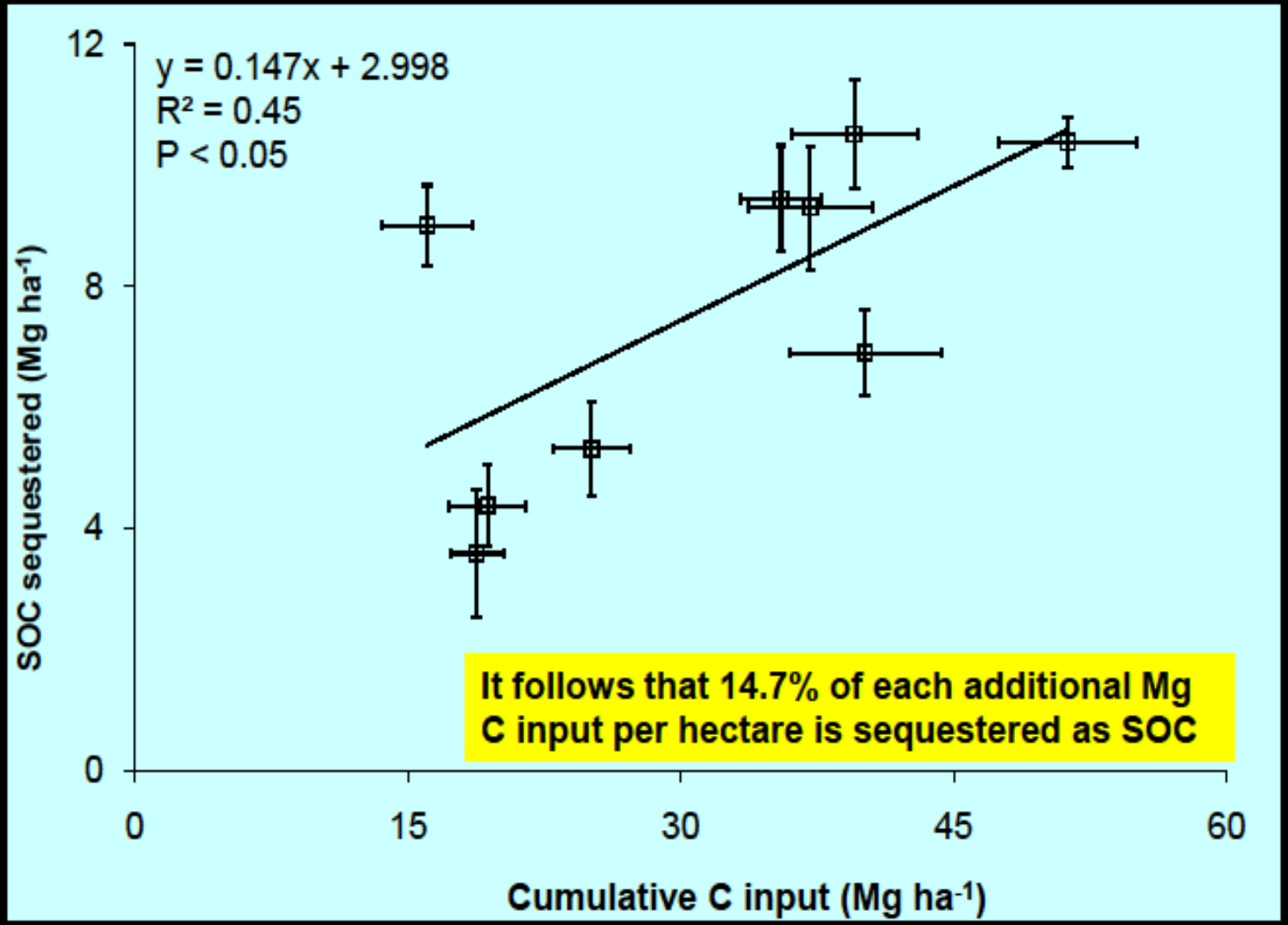
(Cotton / African millet)

(Cotton / Shorghum + Brachiaria)

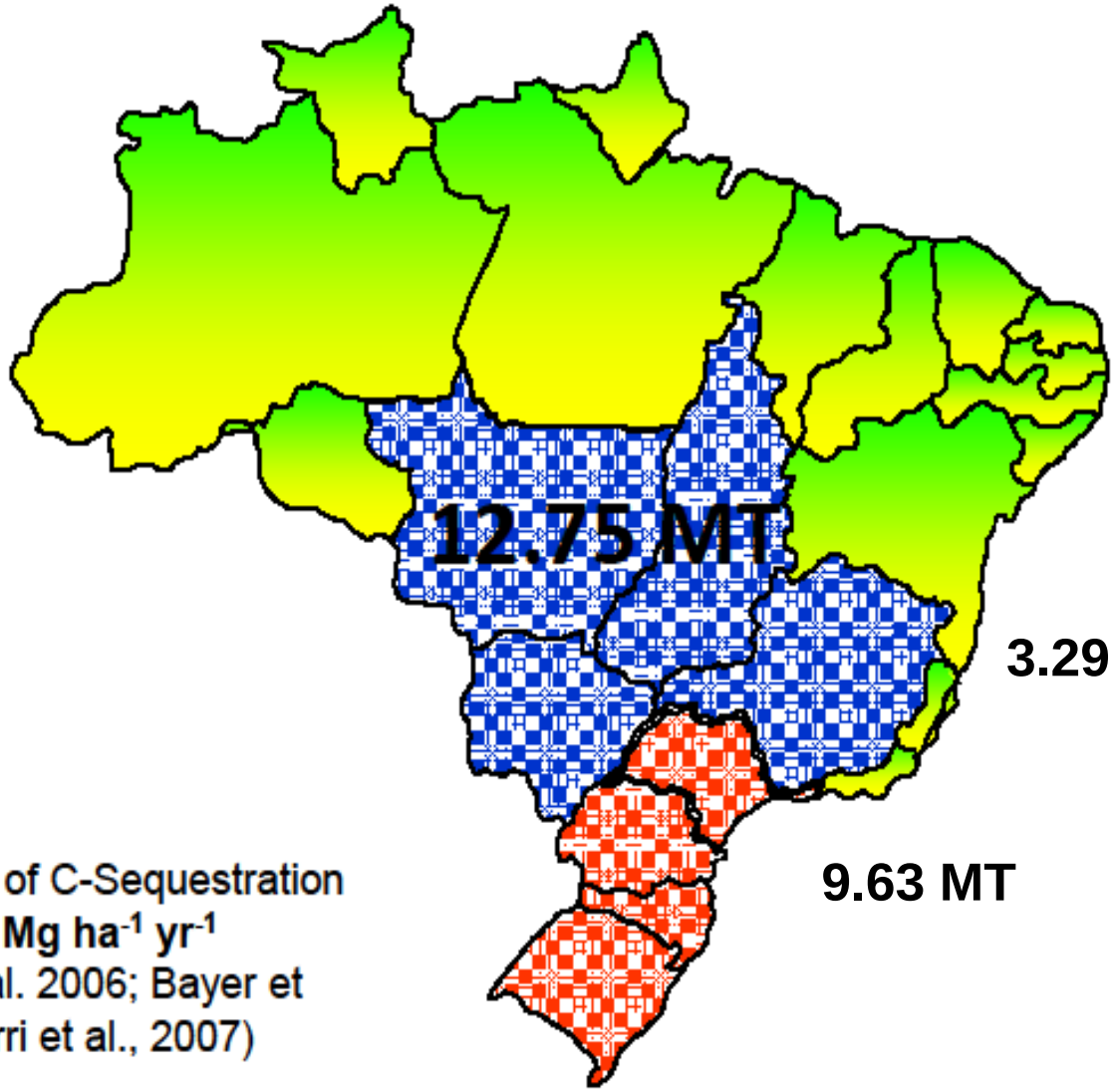
SOC stock affected by tillage and associated with cropping system



Cumulative C input x SOC sequestered

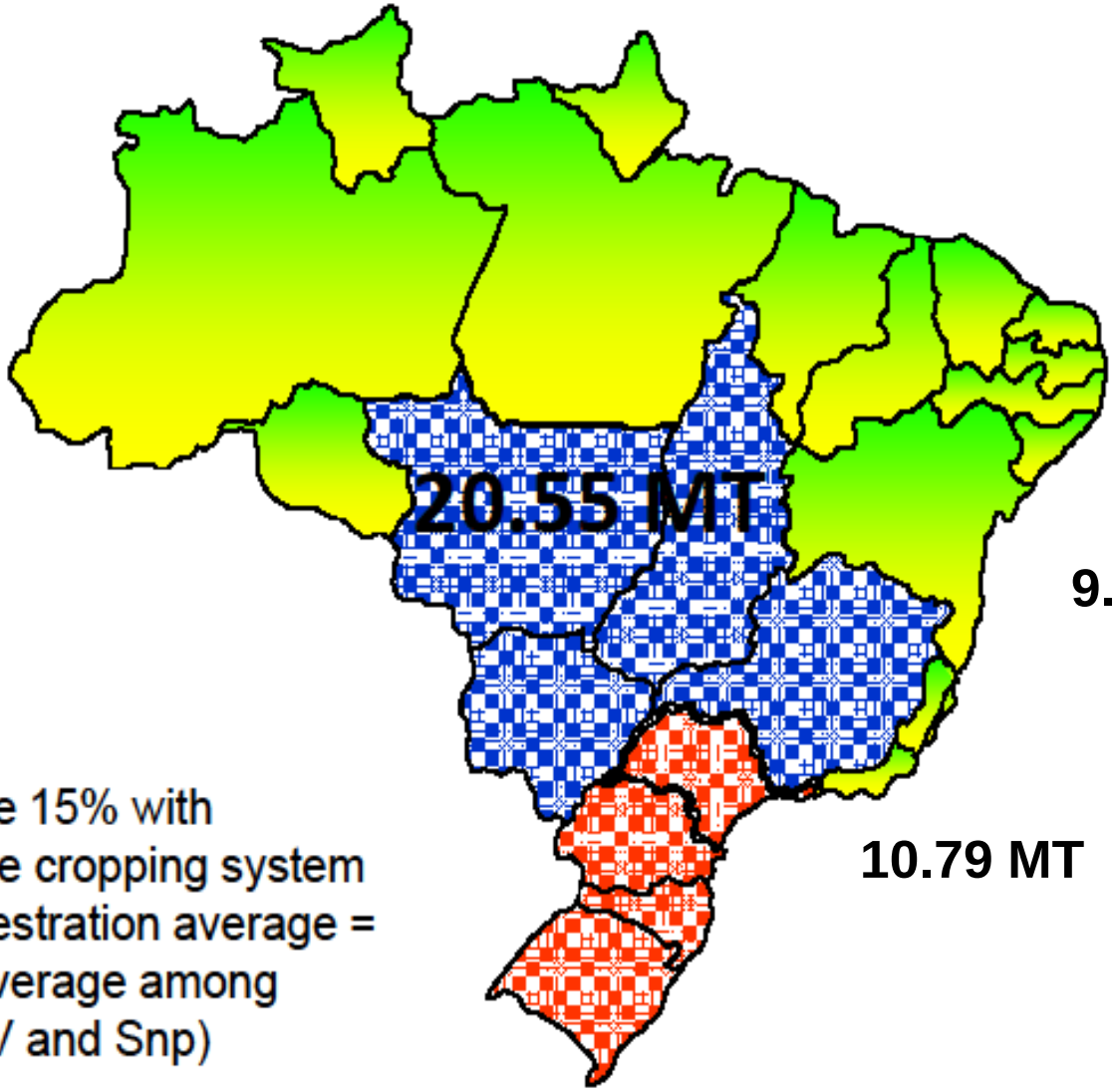


Scenario 1 – Potential of C-sequestration based in average rate



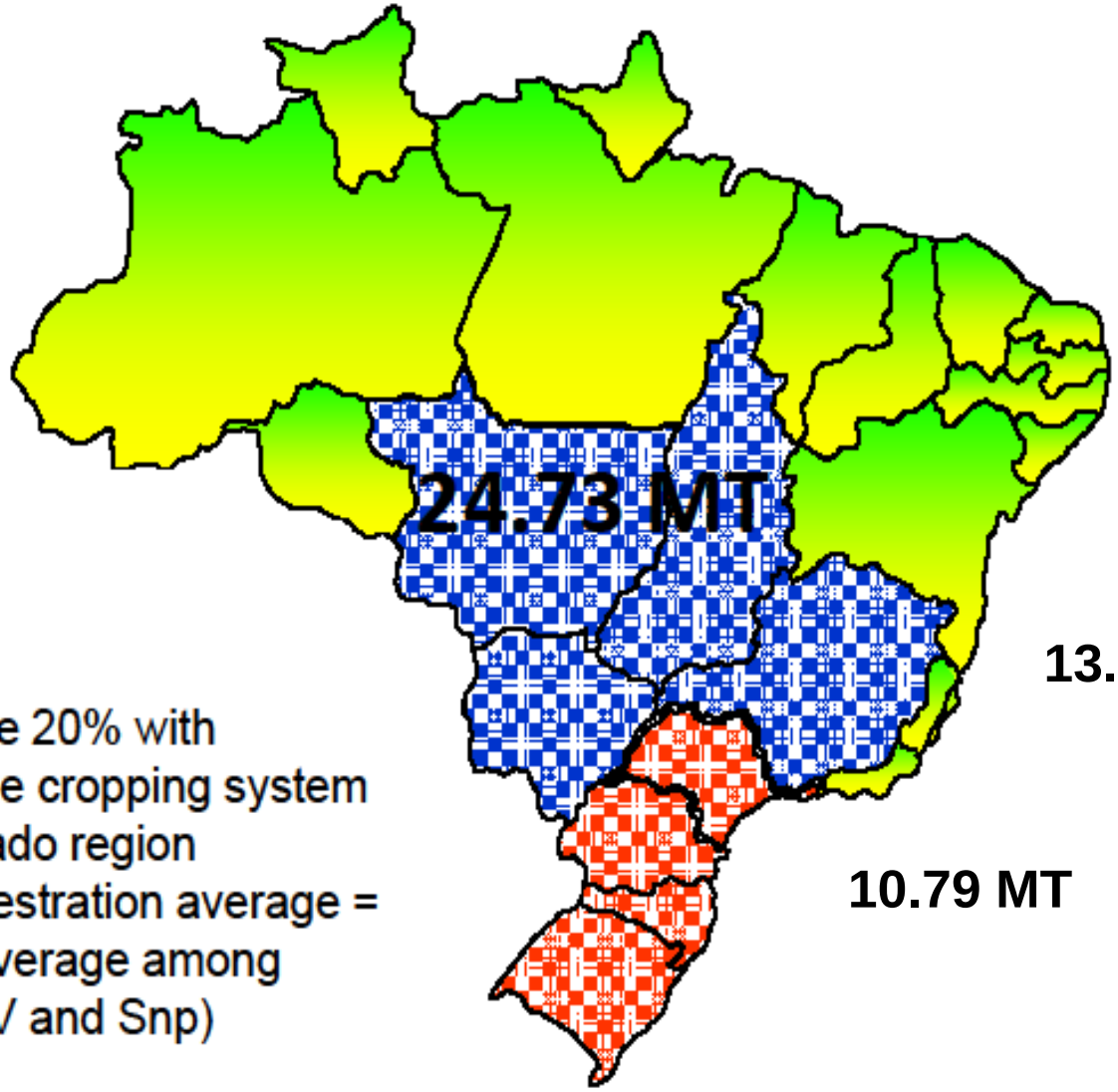
Average rate of C-Sequestration
0.5 Mg ha^{-1} yr^{-1}
(Bernoux et al. 2006; Bayer et al., 2006; Cerri et al., 2007)

Scenario 2



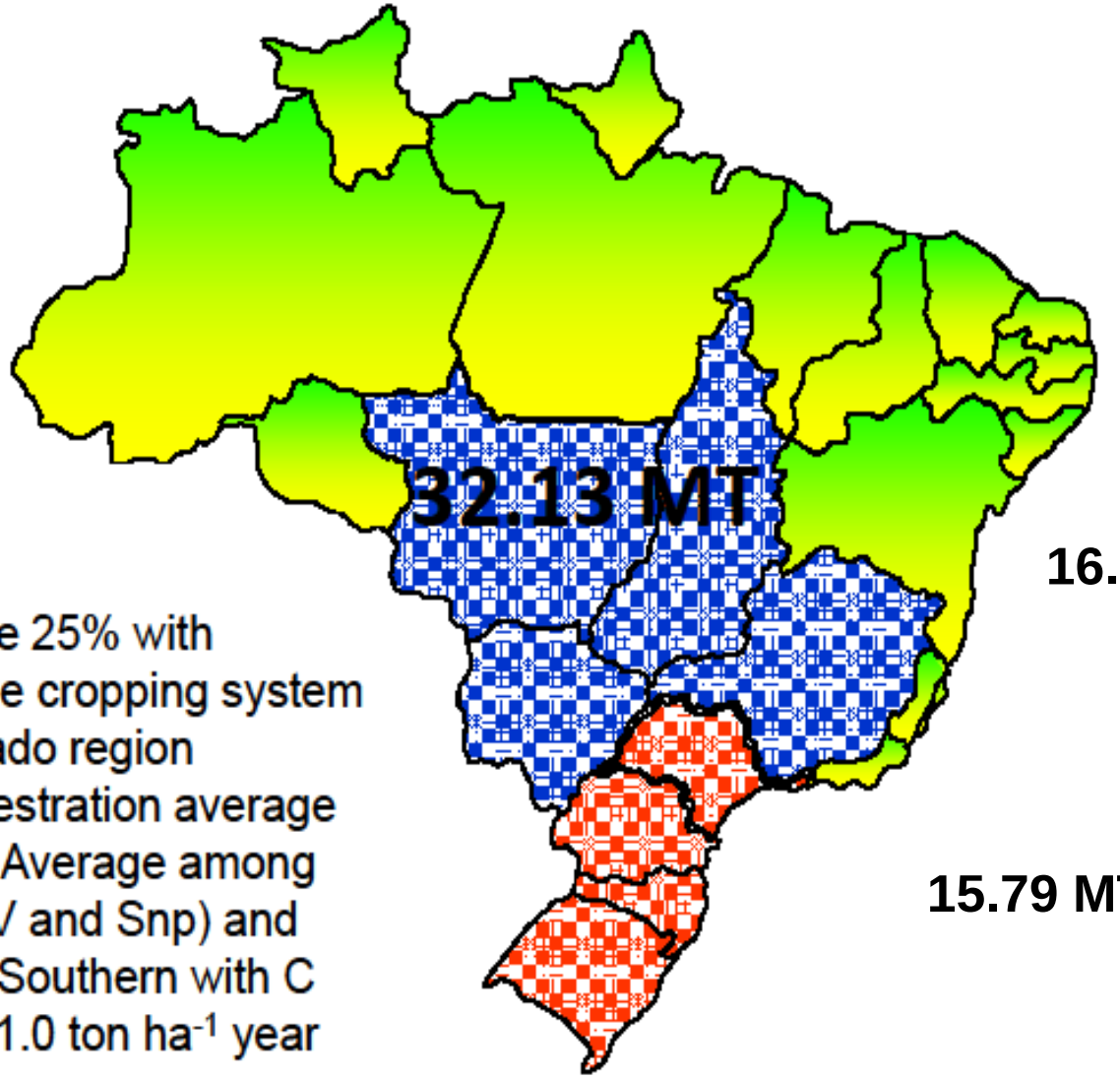
Increase 15% with intensive cropping system C sequestration average = 2.04 (Average among CV, LRV and Snp)

Scenario 3



Increase 20% with intensive cropping system in Cerrado region
C sequestration average = 2.04 (Average among CV, LRV and Snp)

Scenario 4



16.94 MT

15.79 MT

Increase 25% with intensive cropping system in Cerrado region
C sequestration average = 2.04 (Average among CV, LRV and Snp) and 15% in Southern with C seq. at 1.0 ton ha^{-1} year

Conclusions

In tropical areas is essential the management of the soil organic matter through adoption of intensive cropping systems to reach the sustainability of the farm business.

For those areas the C input to reach the equilibrium is close to 7.4 Mg C ha^{-1} yr^{-1} . The farmers have to introduce the systemic approach to choice the cropping system and always try to "close the window" between wet and dry season because it is the way to enhance SOC sequestration and sustainability

Conclusions

The challenge is to convince the farmers to adopt these system in large scale.

Four points to convince the farmers:

1. Reduction of costs
2. Reduction of the risks with weather impact (Drought)
3. Increase the yield of the main cash crop and the profitability of the whole system
4. Making extra money with C-sequestration and giving a good contribution to the environment.