Nutrient Management Challenges in Brazil and Latin America

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Outline

- An Overview of Latin America and Brazil
  - Nutrient Balance in Agriculture
  - Sanitation Issues
- An Overview of the Fertilizer Market
  - World *vs* Latin America & Brazil
- Developments in Farming and Nutrient Management
  - Focus on the Success Story of the Brazilian Cerrado
- Final Remarks

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Latin America and Caribbean

Anguilla, Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bolivia, Brazil, British Virgin Islands, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands (Malvinas), French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jama e, Mexico, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Kitts an Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, United Sta ands, Uruguay, Venezuela

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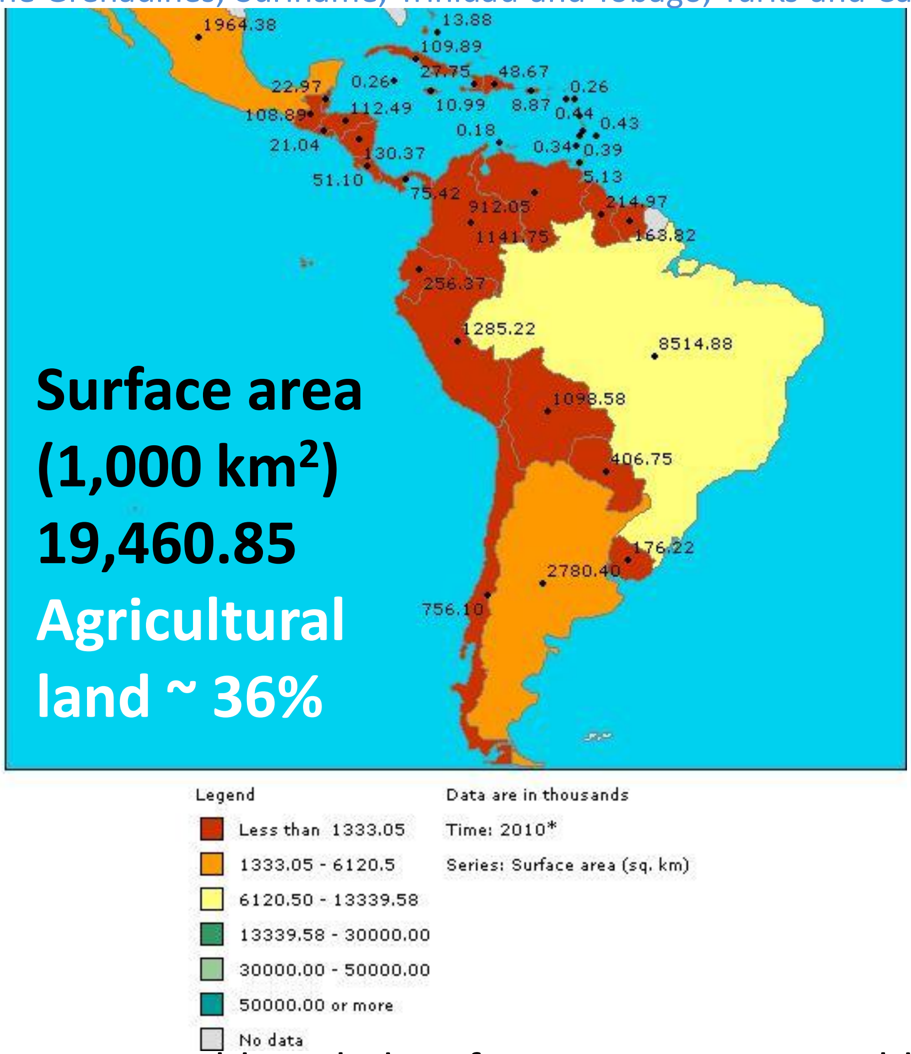

Source: World Bank data from 2010. www.worldbank.org/lac

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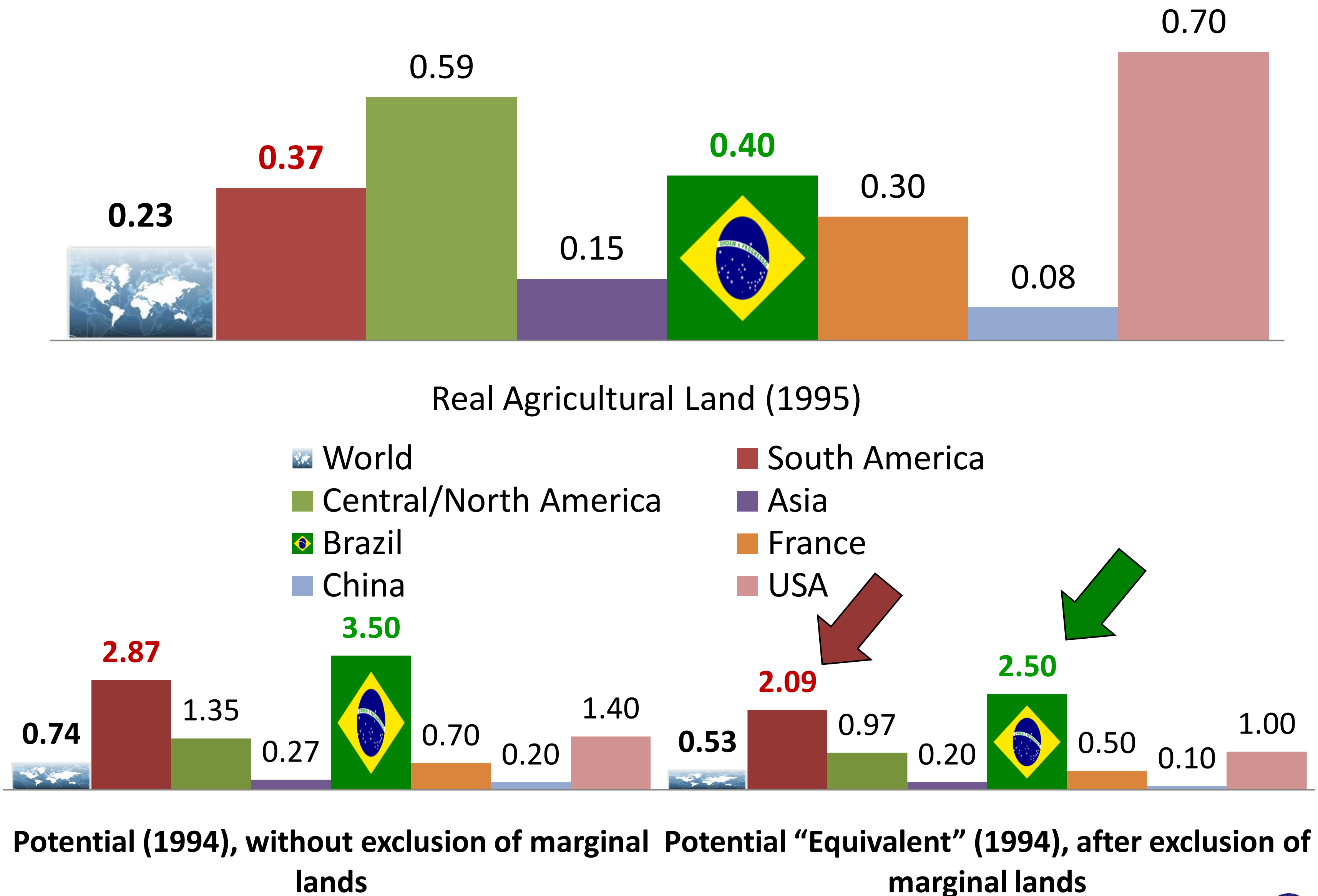
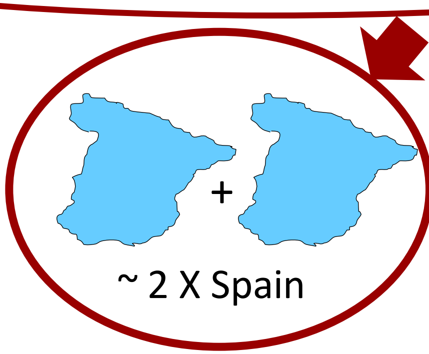
South American & Brazilian Ag. Lands are Extensive (hectares per capita)



Source: Bot et al. (2000)

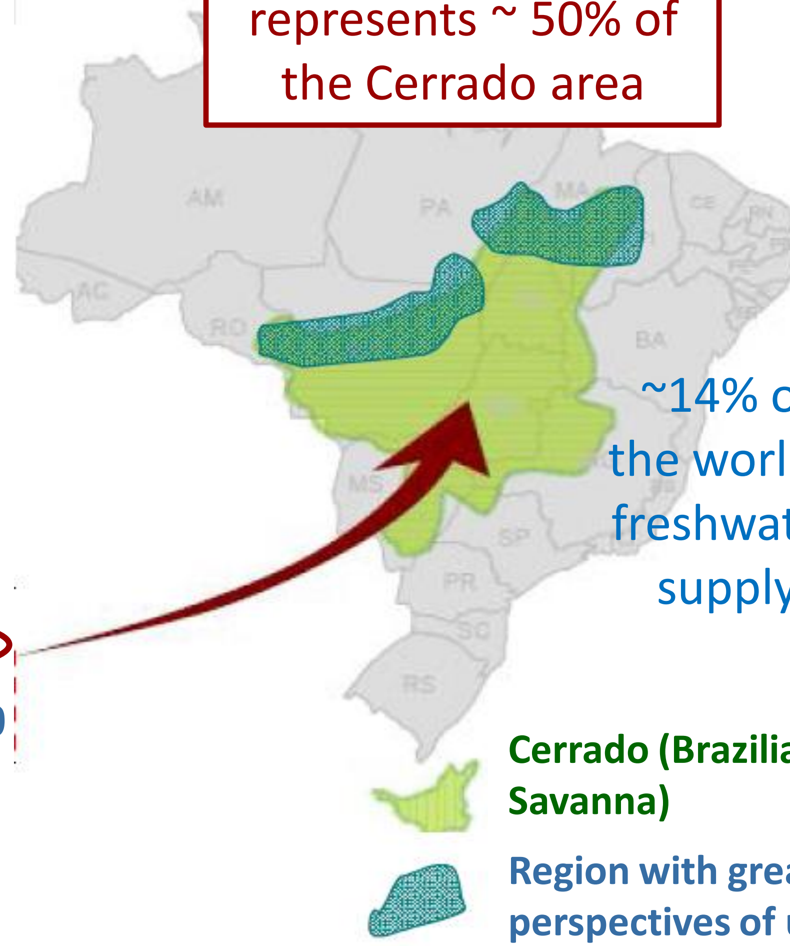
Estimated Land Use in Brazil

Land Use	Million ha	%
Tropical Forest	345	41
Pastures	220	26
Legal Reserves	55	6
Annual Crops	47	5
Permanent Crops	15	2
Cities, Roads, Lakes, Rivers & Swamps	20	2
Reforestation	5	1
Subtotal	707	83
Other Uses	38	4
Area Still Available for Agribusiness	106	13
Total	**851**	**100**



Unexploited area represents ~ 50% of the Cerrado area

~14% of the world's freshwater supply

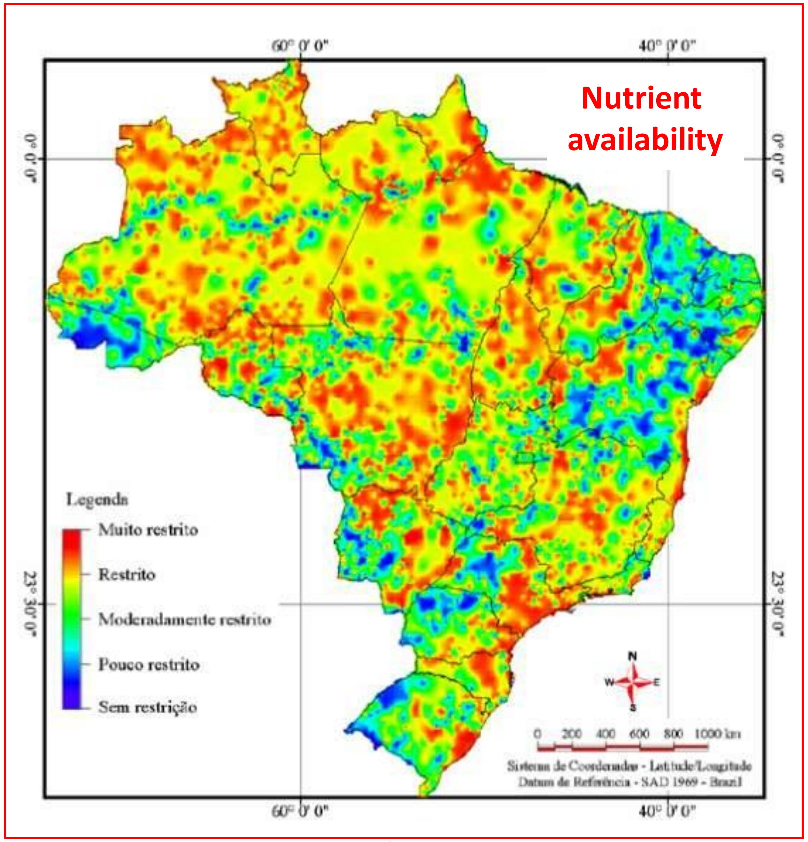


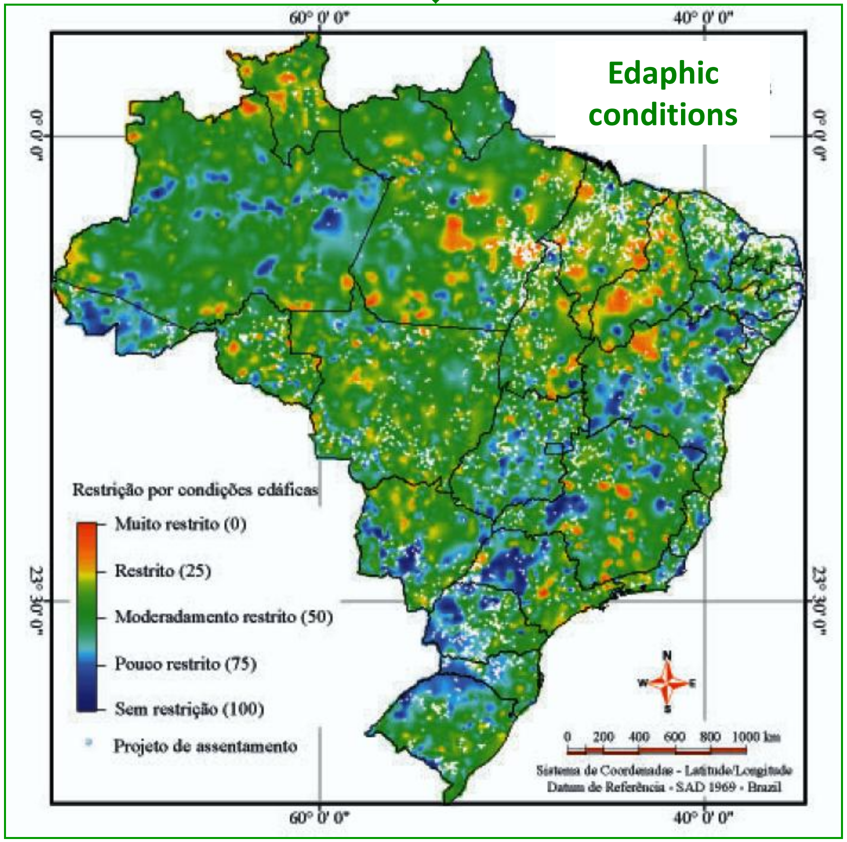
Source: Adapted from I Congresso Brasileiro de Fertilizantes 07/2011

Brazil

- Area: 8,514,204.86 km^2 (851.4 million ha)
- Population: ~200 million inhabitants
- Tropical Country (weathered soils)
- 7.367 km of coastline along the Atlantic Ocean

... Good edaphic conditions overall





Many soil fertility constraints, but...

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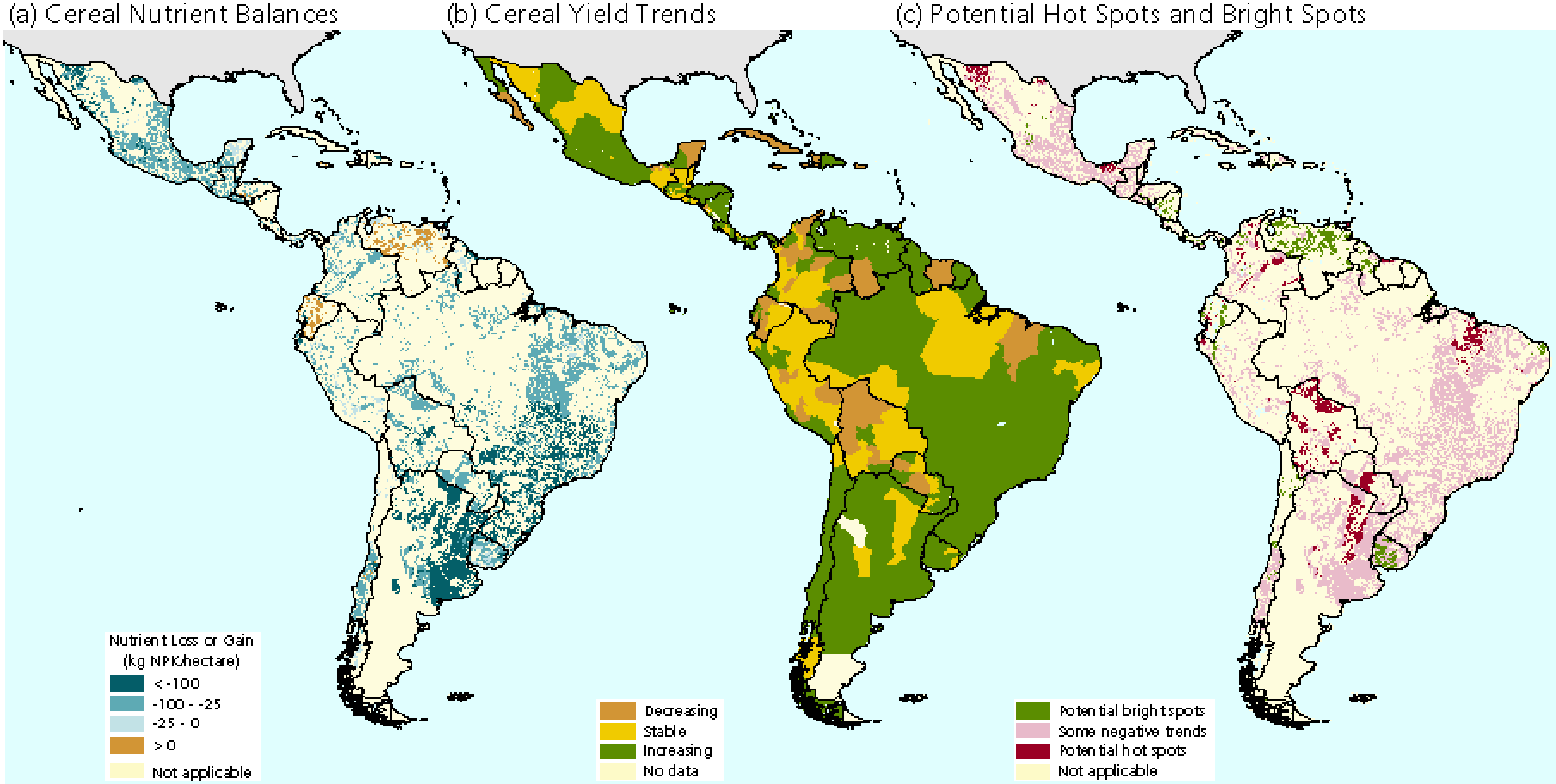
Hot Spots and Bright Spots in Latin American Agroecosystems (2000-2001)



"In fact, most Latin American agricultural soils show a negative "nutrient balance," meaning that more nutrients are lost through plant growth and harvest than are replaced through additions of fertilizer, manure, or legume cover crops."

Source: http://pdf.wri.org/world_resources_2000-2001_people_and_ecosystems.pdf

Nutrient Balance Trends in LA (1981-1999)

Table 12.3. Total Nutrient Balance in Latin America and in Central America and the Caribbean (Henao 2002)

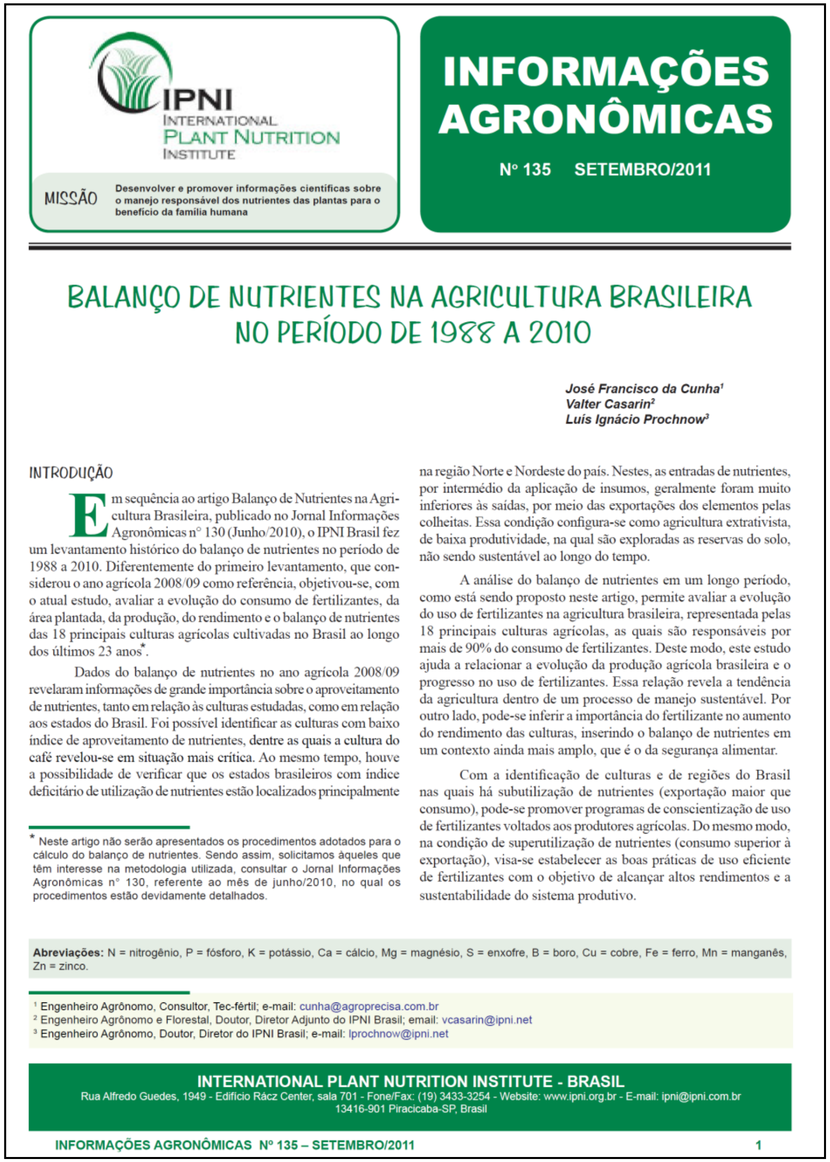
Country	Year (Average)			
	1981–85	1986–90	1991–95	1996–99
	(NPK–kg/ha)			
Argentina	–109.1	–108.8	–105.4	–98.9
Belize	–189.6	–106.3	–125.5	–143.7
Bolivia	–97.4	–105.1	–132.7	–142.9
Brazil	–67.7	–72.3	–79.7	–79.5
Chile	–54.7	–21.1	24.5	101.7
Colombia	–87.7	–55.3	–68.3	–66.0
Costa Rica	–50.4	–22.7	–18.8	63.2
Dominican Rep	–133.6	–85.8	–83.6	–70.0
Ecuador	–68.5	–76.4	–85.4	–63.1
El Salvador	–80.5	–63.9	–83.5	–78.6
French Guiana	109.6	–24.8	–86.6	–69.4
Guatemala	–91.7	–77.8	–88.5	–96.1
Guyana	–150.0	–108.4	–137.9	–132.0
Honduras	–133.7	–132.1	–136.8	–72.9
Jamaica	–120.2	–76.5	–91.2	–90.7
Mexico	–33.2	–27.2	–47.1	–47.4
Nicaragua	–105.5	–76.8	–93.9	–92.8
Panama	–118.6	–74.1	–89.1	–67.5
Paraguay	–88.7	–98.9	–116.2	–117.1
Peru	–97.3	–59.2	–80.2	–63.8
Suriname	–97.2	–121.7	–151.9	–83.5
Trinidad & Tobago	–110.9	–163.0	–131.8	–98.5
Uruguay	–35.9	–33.9	–35.8	–2.6
Venezuela	12.1	113.3	6.3	–29.2

"In general, the nutrient balances in the industrial world are positive, especially for N, as crops use less than half of the applied fertilizer, leading to the eutrophication problem just described. ***In large areas of South America (Wood et al. 2000) and Africa (Smaling et al. 1997; Sanchez 2002), on the other hand, the nutrient balance is negative, leading to declining soil fertility. In the case of South America, the magnitude of the imbalance appears to be decreasing as incomes rise and farmers can afford more fertilizer.****"*

Source: www.unep.org/maweb/documents/document.281.aspx.pdf

Ecosystems and Human Well-being: Current State and Trends, V. 1 (2005) – Ch. 12. Nutrient Cycling

Nutrient Balance in Brazilian Agriculture (1988-2010)



IPNI INTERNATIONAL PLANT NUTRITION INSTITUTE

MISSÃO Desenvolver e promover informações científicas sobre o manejo responsável dos nutrientes das plantas para o benefício da família humana

INFORMAÇÕES AGRONÔMICAS

Nº 135 SETEMBRO/2011

BALANÇO DE NUTRIENTES NA AGRICULTURA BRASILEIRA NO PERÍODO DE 1988 A 2010

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INTRODUÇÃO

Em sequência ao artigo Balanço de Nutrientes na Agricultura Brasileira, publicado no Jornal Informações Agronômicas n° 130 (Junho/2010), o IPNI Brasil fez um levantamento histórico do balanço de nutrientes no período de 1988 a 2010. Diferentemente do primeiro levantamento, que considerou o ano agrícola 2008/09 como referência, objetivou-se, com o atual estudo, avaliar a evolução do consumo de fertilizantes, da área plantada, da produção, do rendimento e o balanço de nutrientes das 18 principais culturas agrícolas cultivadas no Brasil ao longo dos últimos 23 anos*.

Dados do balanço de nutrientes no ano agrícola 2008/09 revelaram informações de grande importância sobre o aproveitamento de nutrientes, tanto em relação às culturas estudadas, como em relação aos estados do Brasil. Foi possível identificar as culturas com baixo índice de aproveitamento de nutrientes, dentre as quais a cultura do café revelou-se em situação mais crítica. Ao mesmo tempo, houve a possibilidade de verificar que os estados brasileiros com índice deficitário de utilização de nutrientes estão localizados principalmente na região Norte e Nordeste do país. Nestes, as entradas de nutrientes, por intermédio da aplicação de insumos, geralmente foram muito inferiores às saídas, por meio das exportações dos elementos pelas colheitas. Essa condição configura-se como agricultura extrativista, de baixa produtividade, na qual são exploradas as reservas do solo, não sendo sustentável ao longo do tempo.

A análise do balanço de nutrientes em um longo período, como está sendo proposto neste artigo, permite avaliar a evolução do uso de fertilizantes na agricultura brasileira, representada pelas 18 principais culturas agrícolas, as quais são responsáveis por mais de 90% do consumo de fertilizantes. Deste modo, este estudo ajuda a relacionar a evolução da produção agrícola brasileira e o progresso no uso de fertilizantes. Essa relação revela a tendência da agricultura dentro de um processo de manejo sustentável. Por outro lado, pode-se inferir a importância do fertilizante no aumento do rendimento das culturas, inserindo o balanço de nutrientes em um contexto ainda mais amplo, que é o da segurança alimentar.

Com a identificação de culturas e de regiões do Brasil nas quais há subutilização de nutrientes (exportação maior que consumo), pode-se promover programas de conscientização de uso de fertilizantes voltados aos produtores agrícolas. Do mesmo modo, na condição de superutilização de nutrientes (consumo superior à exportação), visa-se estabelecer as boas práticas de uso eficiente de fertilizantes com o objetivo de alcançar altos rendimentos e a sustentabilidade do sistema produtivo.

* Neste artigo não serão apresentados os procedimentos adotados para o cálculo do balanço de nutrientes. Sendo assim, solicitamos àqueles que têm interesse na metodologia utilizada, consultar o Jornal Informações Agronômicas n° 130, referente ao mês de junho/2010, no qual os procedimentos estão devidamente detalhados.

Abreviações: N = nitrogênio, P = fósforo, K = potássio, Ca = cálcio, Mg = magnésio, S = enxofre, B = boro, Cu = cobre, Fe = ferro, Mn = manganês, Zn = zinco.

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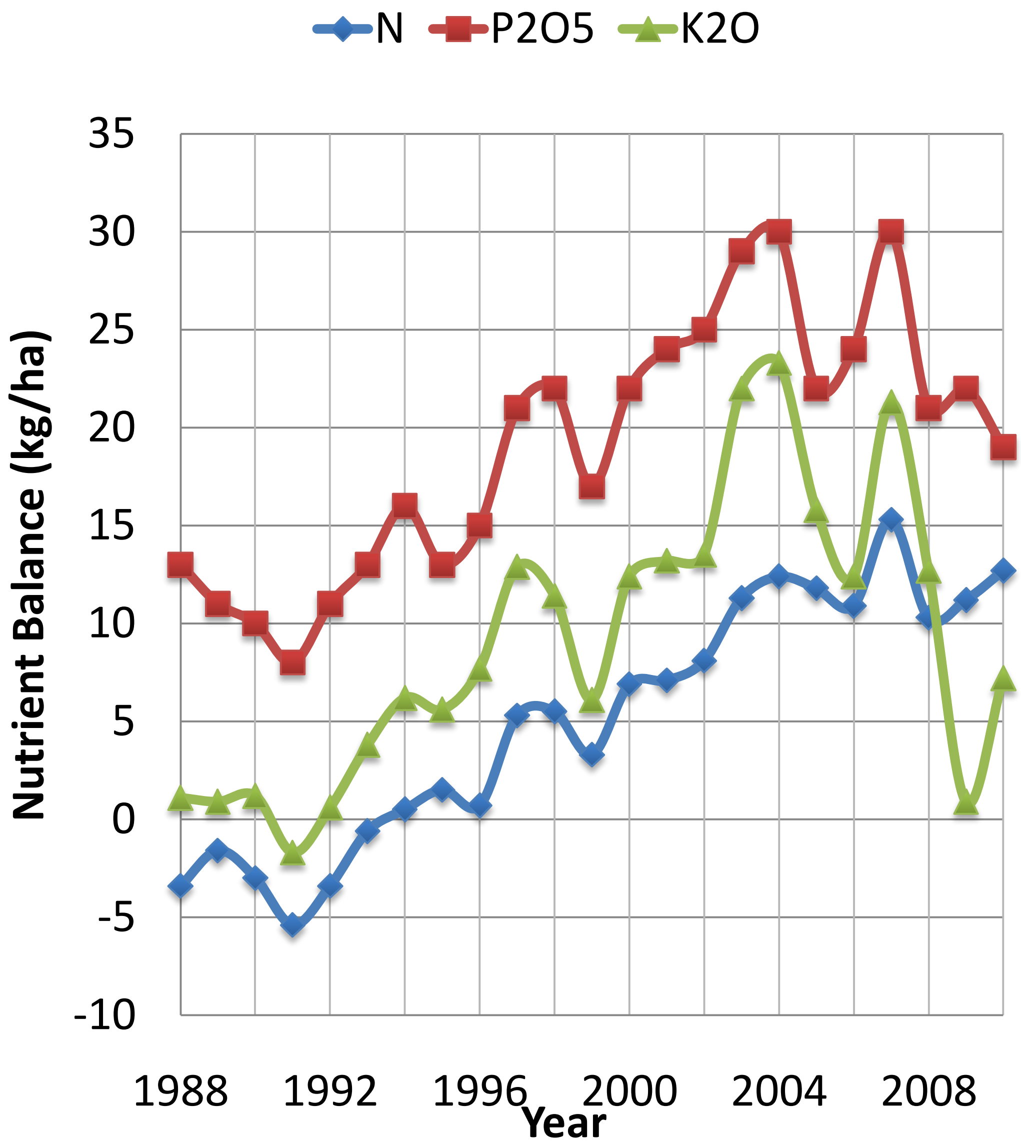

Source: www.ipni.net/publication/ia-brasil.nsf/0/9CA193D11CE9775583257A8F005D3F2C/$FILE/Page1-7-135.pdf

Role of P and N in Ag. Production and Eutrophication

- "… **P often co-limits (with N) plant and animal production on old, highly weathered soils**, such as those that dominate tropical Africa, **South America**, and Australia. Since **NH_4^+ and NO_3^- are both more readily leached out of soils than phosphate**, freshwater and some coastal ecosystems are typically more responsive to increases of P than of N, **making P the principal driver of eutrophication in lakes and estuaries.**
- **The main mechanism by which the P leaves the land and enters freshwater ecosystems is soil erosion. Agricultural P is the principal driver of eutrophication. P concentrated in sewage effluents and animal and industrial wastes, including P-containing detergents, makes a relatively small global contribution (Bennett et al. 2001), although it may be important locally.**"

Source: www.unep.org/maweb/documents/document.281.aspx.pdf
Ecosystems and Human Well-being: Current State and Trends, V. 1 (2005) – Ch. 12. Nutrient Cycling

Latin America's Nitrogen Challenge

POLICYFORUM

- In addition to **N excess from human impact**, mining of natural soil N creates **N deficits in some regions**.
- **Biomass burning** transfers a large amount of reactive N from the land to the atmosphere, which is then redistributed regionally to aquatic and terrestrial ecosystems via wet and dry deposition. By 2050, four of the eight LA biodiversity hotspots are projected to have potentially **harmful levels of N deposition.**
- Because of **lack of basic infrastructure**, especially in low-income areas of megacities, **most domestic sewage is released into water bodies without treatment, causing N and P enrichment**, affecting trophic interactions, and increasing public health risks. Exacerbating the problem is **rural-urban migration**, a result of marginalization and extreme **poverty faced by many small farmers**.
- **Agricultural practices** must **increase functional diversity**, mimicking natural ecosystems. Techniques include **no-till agriculture, cover crops, crop rotation, and enhancement of natural N fixation**. **Intensification must only be encouraged under sustainable practices**, where agroecosystems and neighboring landscapes provide key ecosystem services.

Source: Science 12 April 2013: Vol. 340 no. 6129 p. 149 DOI: 10.1126/science.1231679

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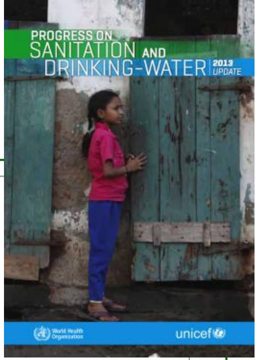
Global Sanitation Trends - 1990–2011



There are 45 countries where sanitation coverage is less than 50 percent

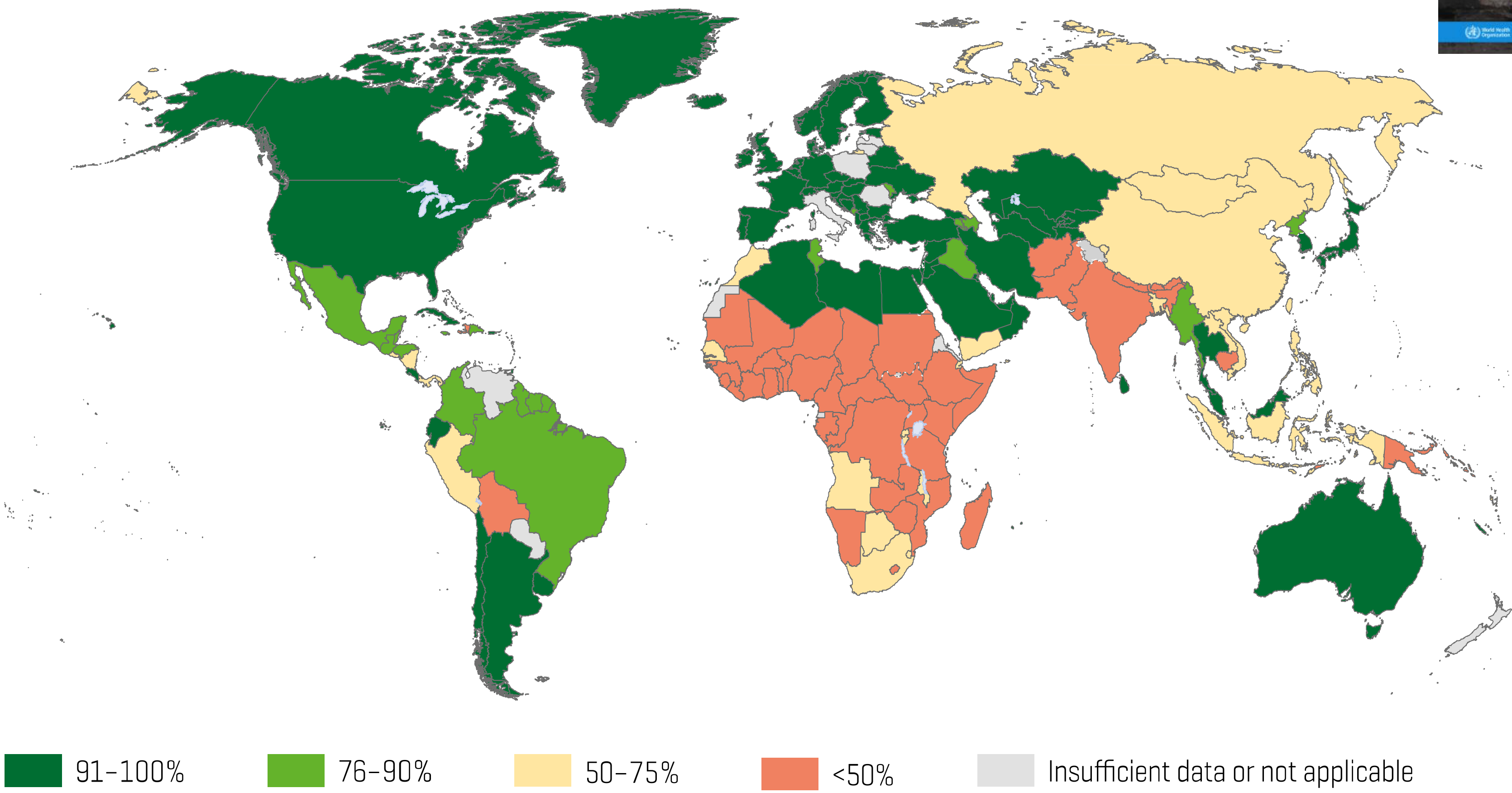


Figure 1. Proportion of the population using improved sanitation in 2011.

Source: Progress on sanitation and drinking-water - 2013 update.
www.who.int/water_sanitation_health/publications/2013/jmp_report/en/

Sewage disposal is still a big challenge in Brazil

Quase metade das casas no Brasil não tem rede de esgoto - Notícias - R7 Brasil 10/1/13 6:35 PM

R7 NOTÍCIAS

27/09/2013 at 10:00 am (Updated 27.09.2013 at 15h26)

Almost half the houses in Brazil have no sewage disposal services

Do R7

Quase 27 milhões de casas ainda não têm rede de coleta de esgoto Valter Campanato/22.03.2008/ABr

Apesar da ascensão da classe C e do aumento do poder aquisitivo dos brasileiros, quase metade dos domicílios particulares brasileiros ainda carece de rede coletora de esgoto, de acordo com a Pnad (Pesquisa Nacional por Amostra de Domicílios) 2012, divulgada nesta sexta-feira (27) pelo IBGE (Instituto Brasileiro de Geografia e Estatística).

O Brasil tem cerca de 62,8 milhões de domicílios particulares permanentes — entre casas, indústrias, comércios etc. Deste total, segundo o IBGE, apenas 35,8 milhões têm esgoto, número que representa 57,1% do total. Já o restante, cerca de 27 milhões de endereços, não tem esgoto.

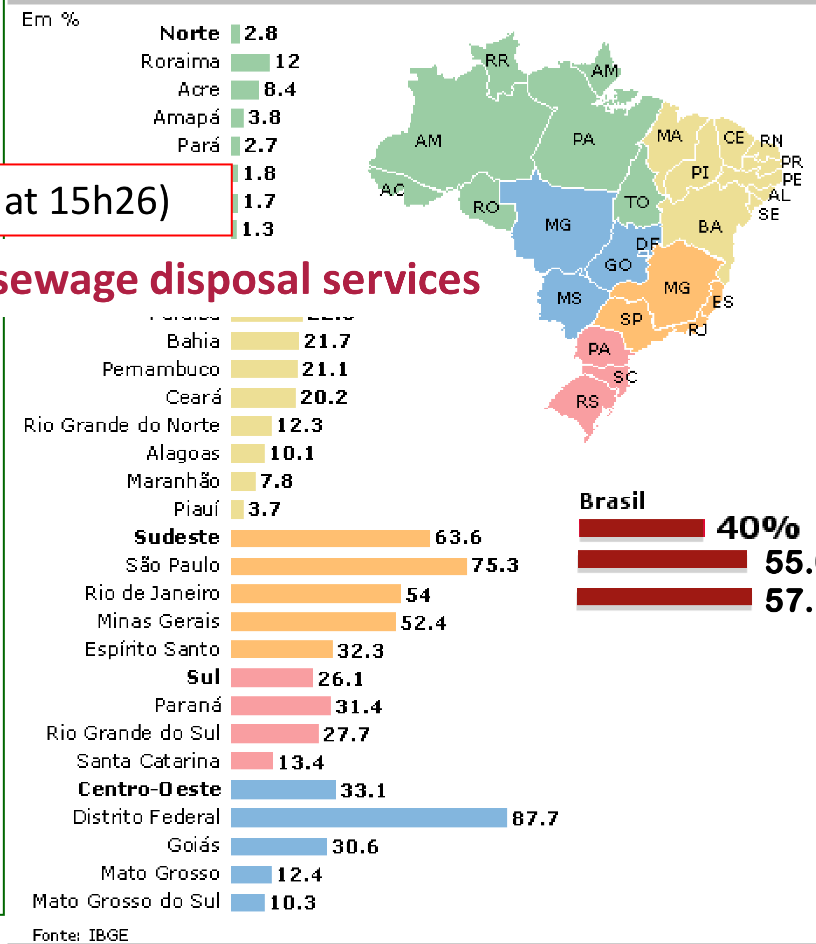
Apesar do número alarmante, houve um crescimento na participação das casas que dispunham dos serviços de esgoto entre 2011 e 2012. Houve um aumento de 2,1 pontos percentuais. Regionalmente, o IBGE destaca a região Sul, onde a participação passou de 35,7% para 42,3% nesse período, e a Norte que se manteve estável em relação a 2011 (13%).

Leia mais notícias de Brasil e Política

Por outro lado, o País tem muito a comemorar quanto a outros serviços, como a rede de abastecimento de água, que chegou a 85,4% do total de casas em 2012. Hoje, 53,6 milhões de domicílios têm água encanada. A Pnad destaca a evolução da região Norte, com um aumento de 2,4 pontos percentuais na proporção de domicílios com rede geral de água em relação ao ano anterior (de 55,9% para 58,3%).
No caso da coleta de lixo, passou de 54,4 milhões para 55,8 milhões o número de domicílios brasileiros que têm o serviço. Agora, 88,8% do total de endereços fixos tem coleta de lixo — mesma participação apurada em 2011. Na região Sudeste, a coleta de lixo beneficia a 96% das residências pesquisadas e no Centro-Oeste, a 91,3%. Nas regiões Norte, Nordeste e Sul, esse serviço é ofertado a 77,3%, 76,6% e 93% dos domicílios, respectivamente.

http://noticias.r7.com/brasil/quase-metade-das-casas-no-brasil-nao-tem-rede-de-esgoto-27092013 Page 1 of 2

Houses (%) with sewage disposal services in 2004



Source: Data from the *National Household Sample Survey / National Survey of Basic Sanitation*
The Brazilian Institute of Geography and Statistics (IBGE) - www.ibge.gov.br

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Sewage (wastewater) treatment is still a big challenge in Brazil

A ***2008 National Household Sample Survey*** revealed that **only 28.5% of Brazilian municipalities had wastewater treatment systems**

Source: The Brazilian Institute of Geography and Statistics (IBGE) - www.ibge.gov.br

Brazil: wastewater treatment systems coverage *vs* use of lime and mineral N fertilizers (2006) by farmers

- **71.5% of the municipalities did not have a wastewater treatment system (2008)**
- **84.1% of the farmers did not use lime and 74.4% did not use mineral N fertilizer (2006)**

Source: Data from the 2006 Agricultural Census and the 2008 National Survey of Basic Sanitation, The Brazilian Institute of Geography and Statistics (IBGE) - www.ibge.gov.br

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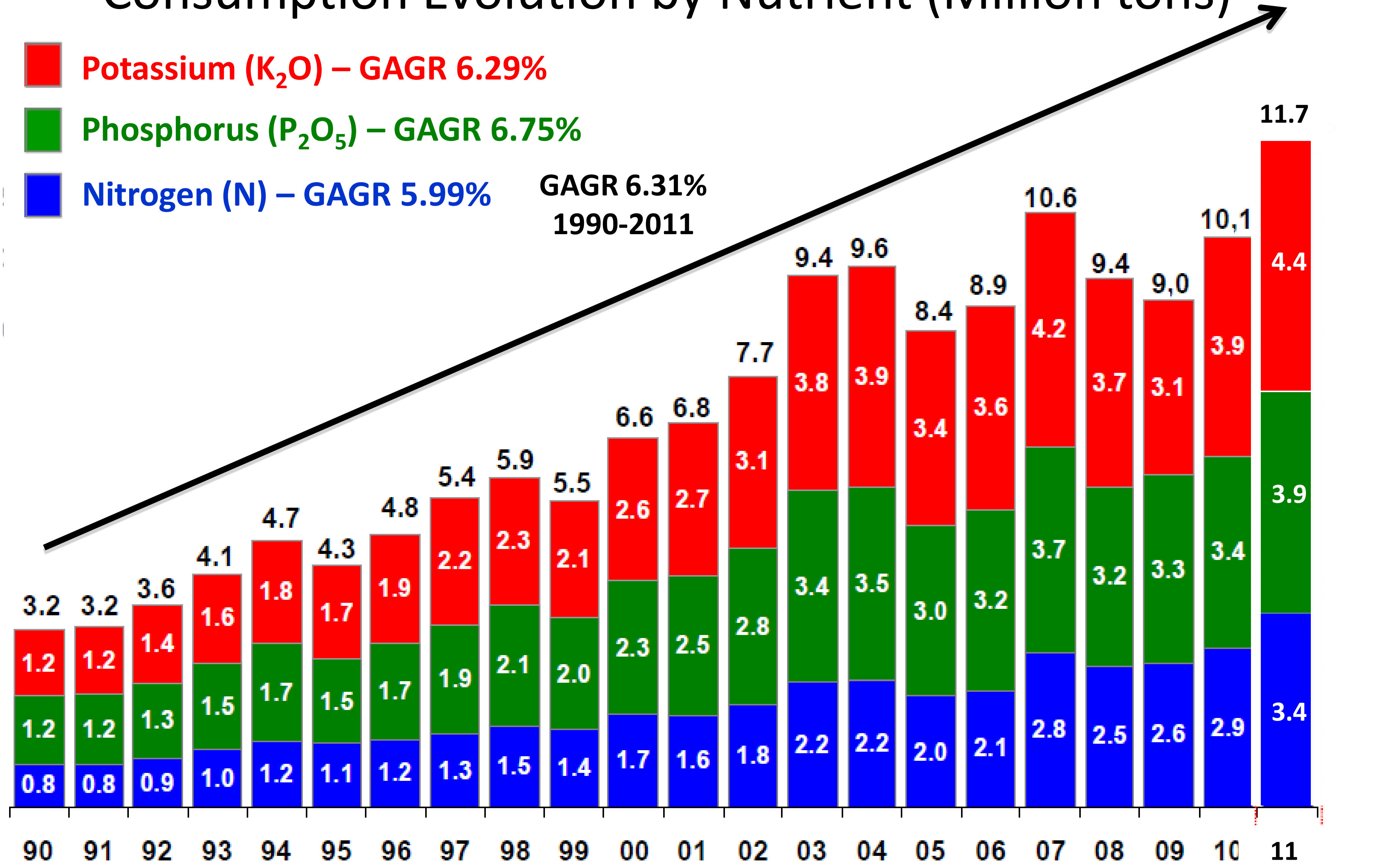
Brazilian Fertilizer Market: 1990 – 2011

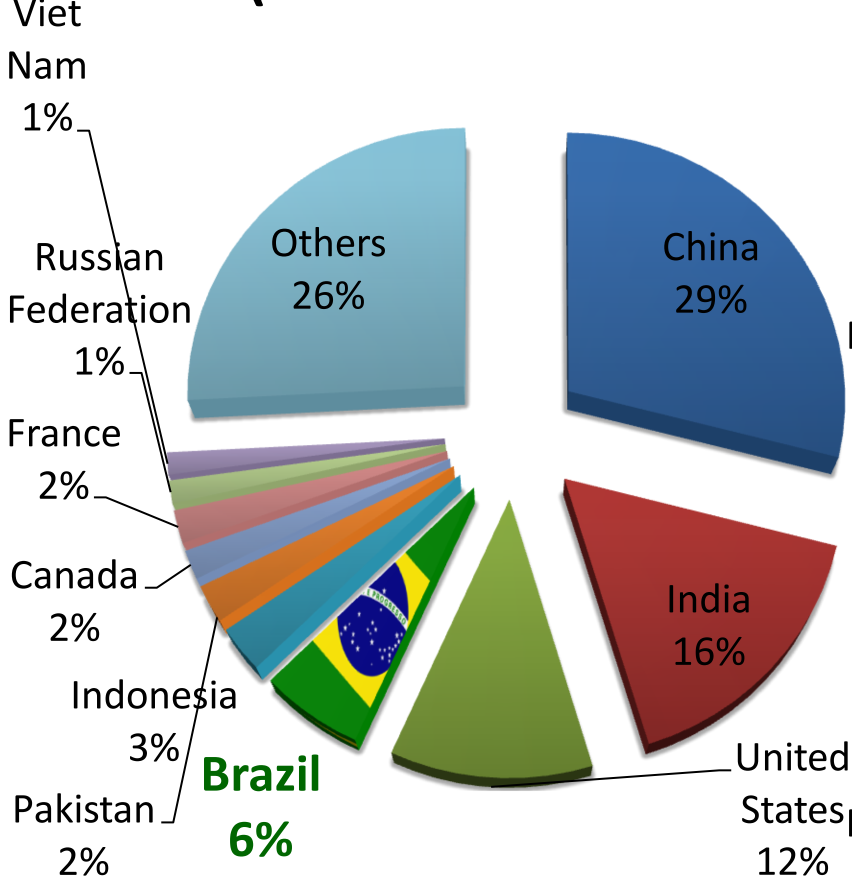
Consumption Evolution by Nutrient (Million tons)



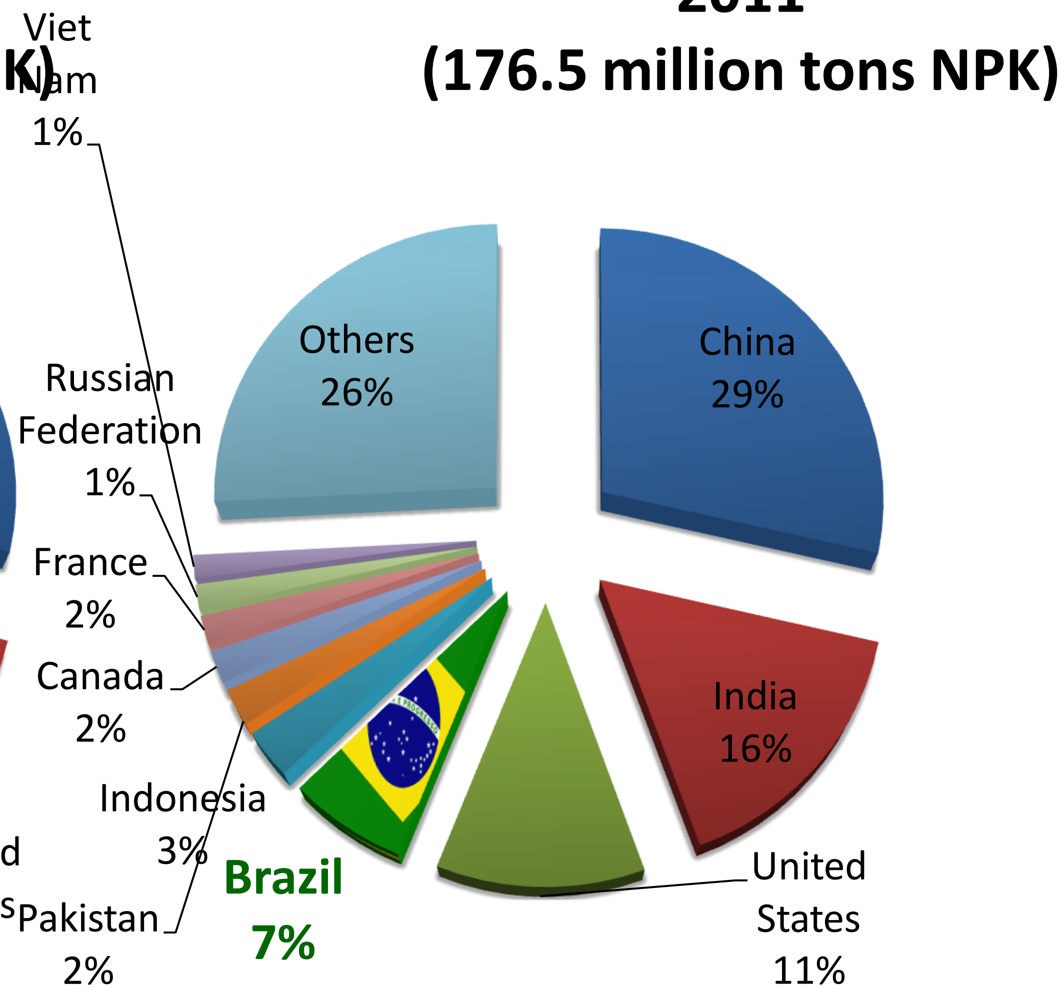
Source: ANDA

Fertilizers: World Consumption by Country

2010
(172.2 million tons NPK)



2011
(176.5 million tons NPK)

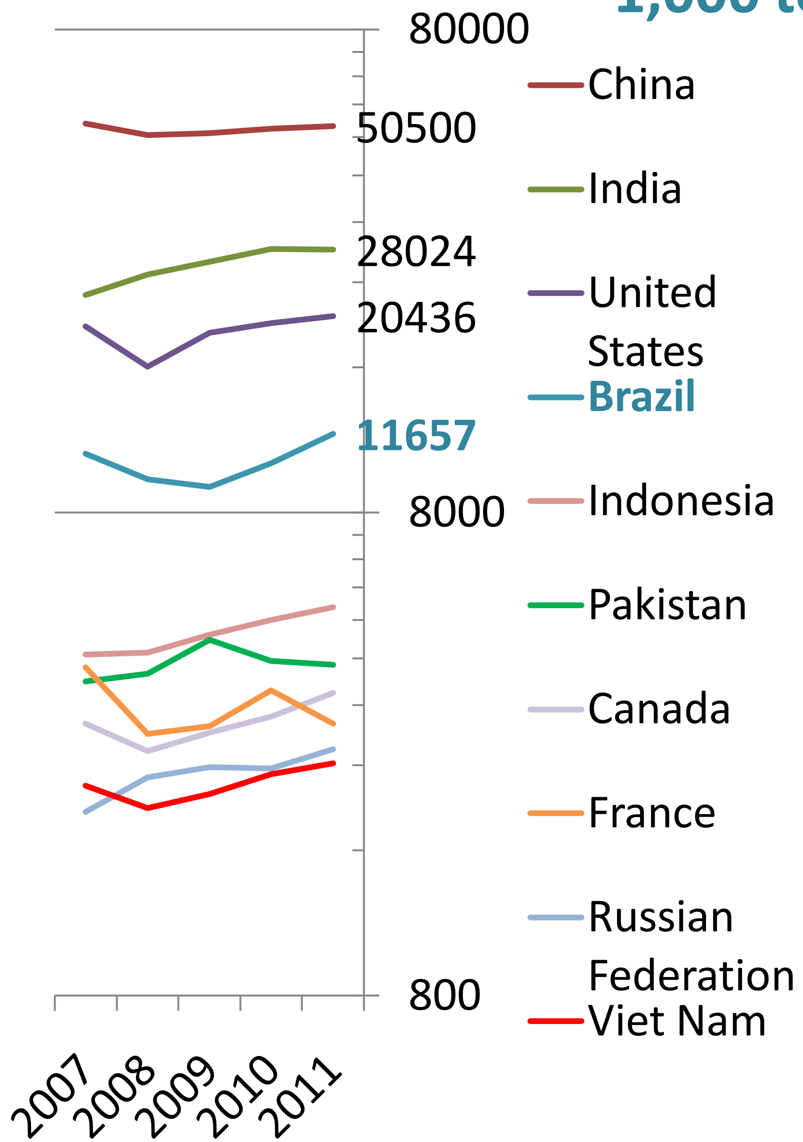


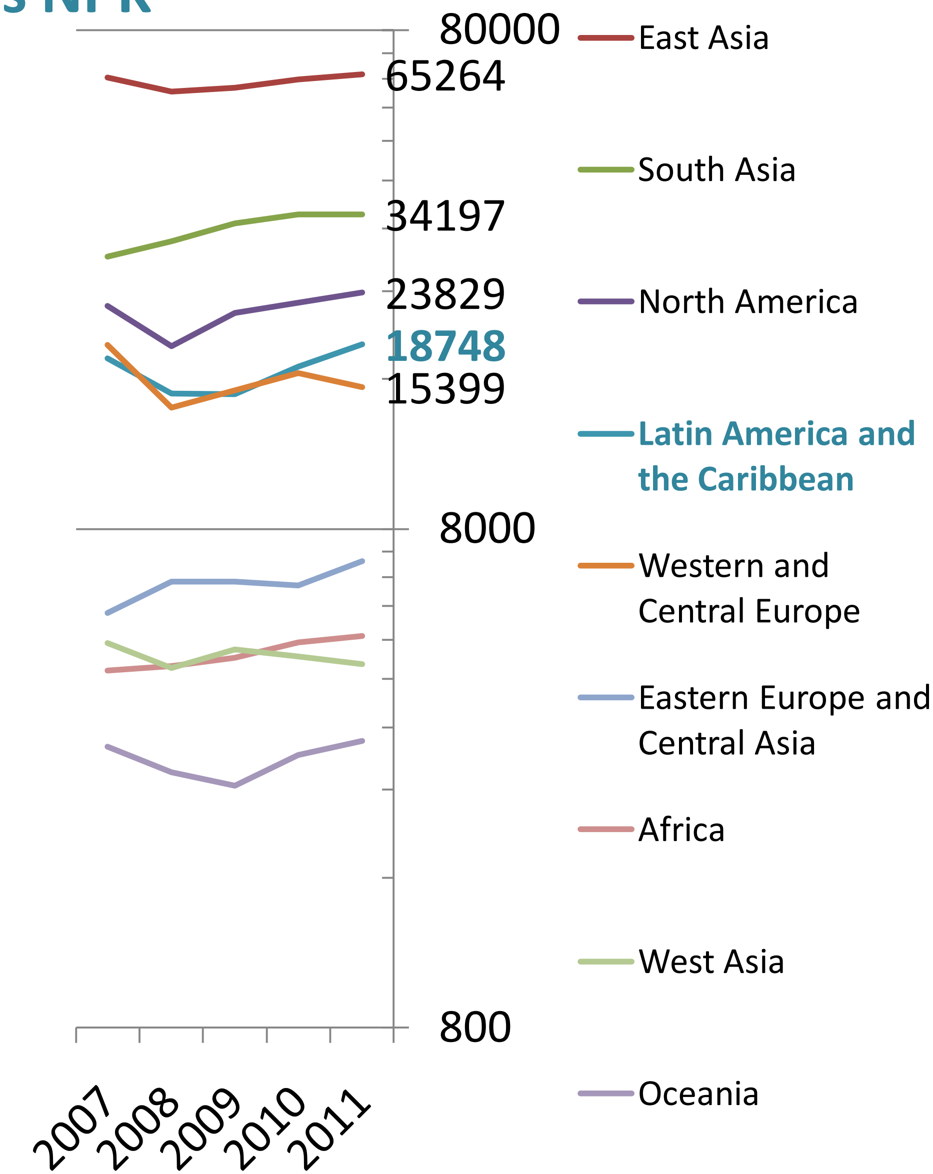
Brazil: world´s 4º largest market; ~ 70-75% of South America´s Market

Source: IFA http://www.fertilizer.org/ifa/ifadata/search

Fertilizers: World Consumption Trend (2007-2011)

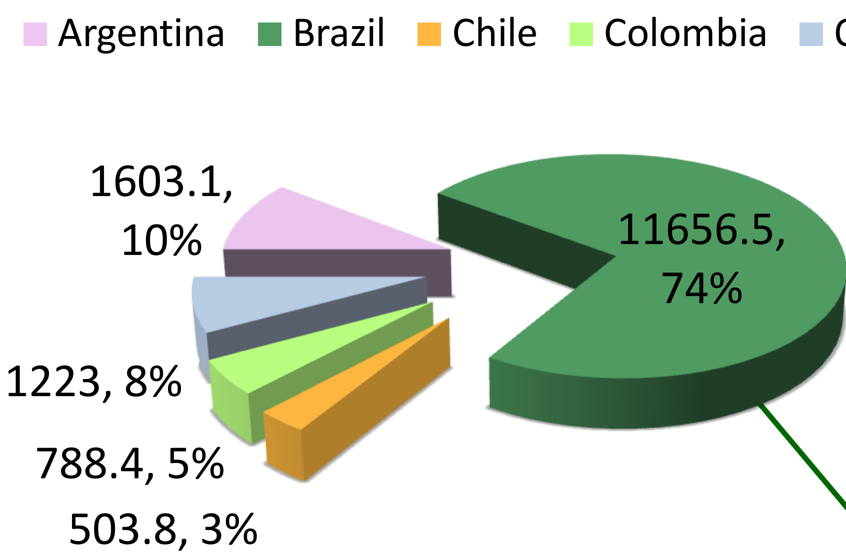
1,000 tons NPK



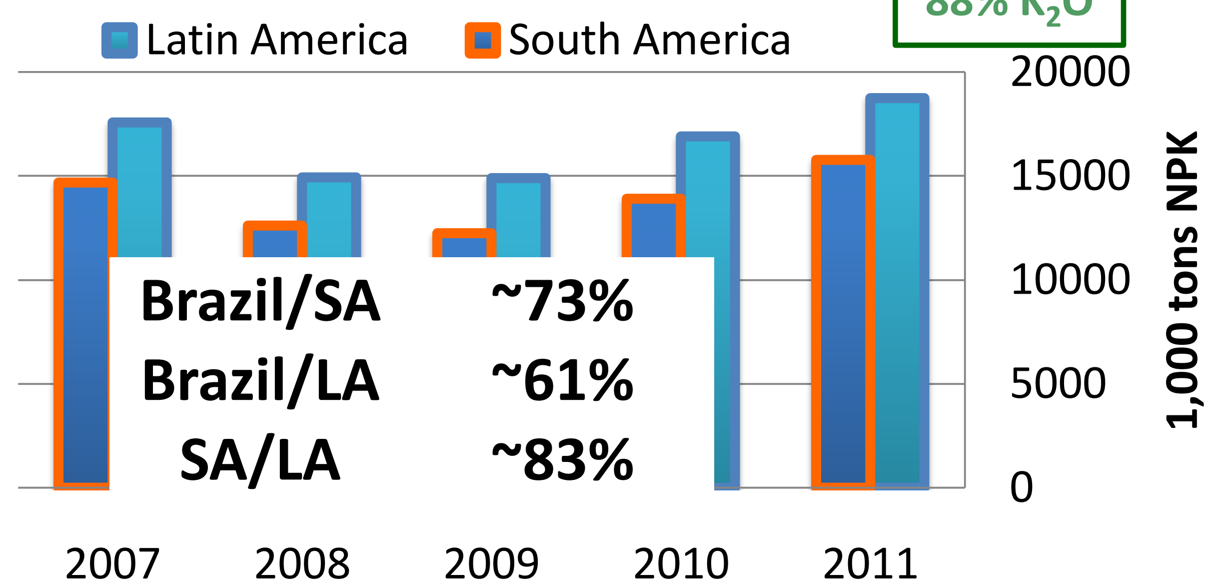


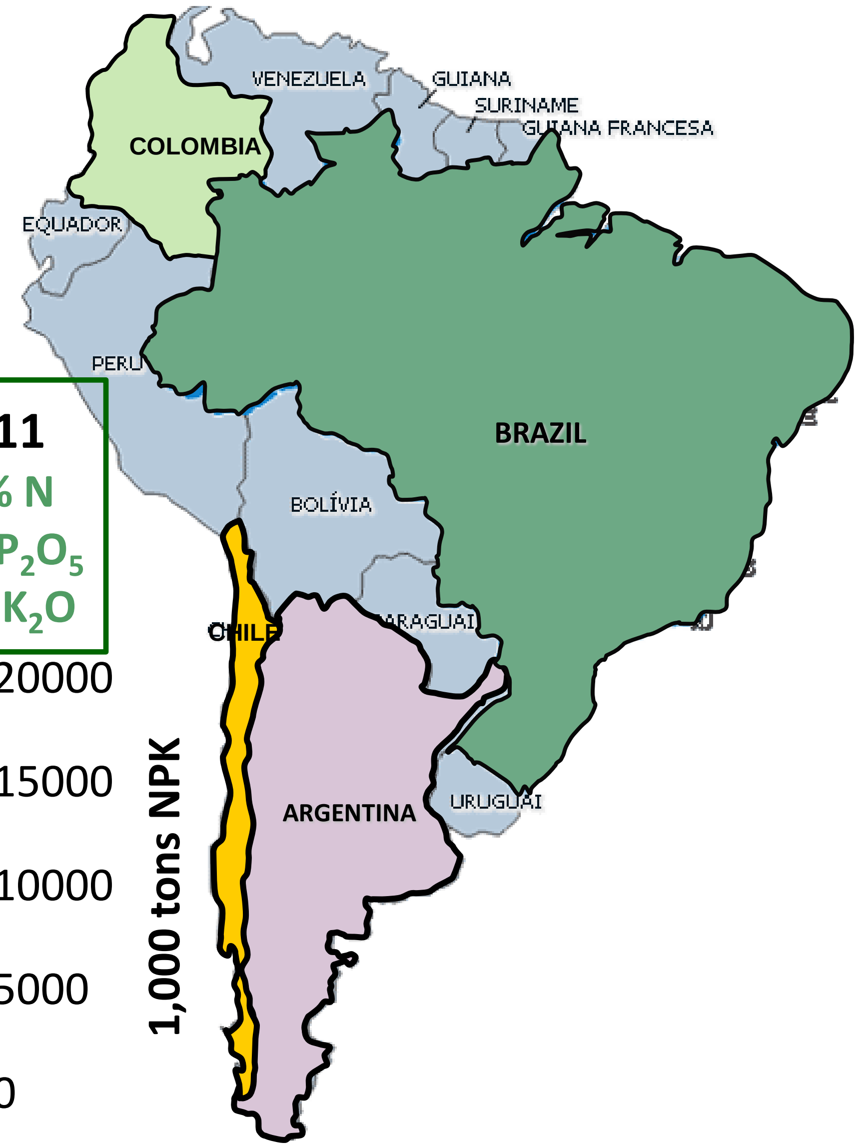
Source: IFA http://www.fertilizer.org/ifa/ifadata/search

Fertilizer Market Share: Brazil *vs* SA and LA



2011
61% N
74% P_2O_5
88% K_2O



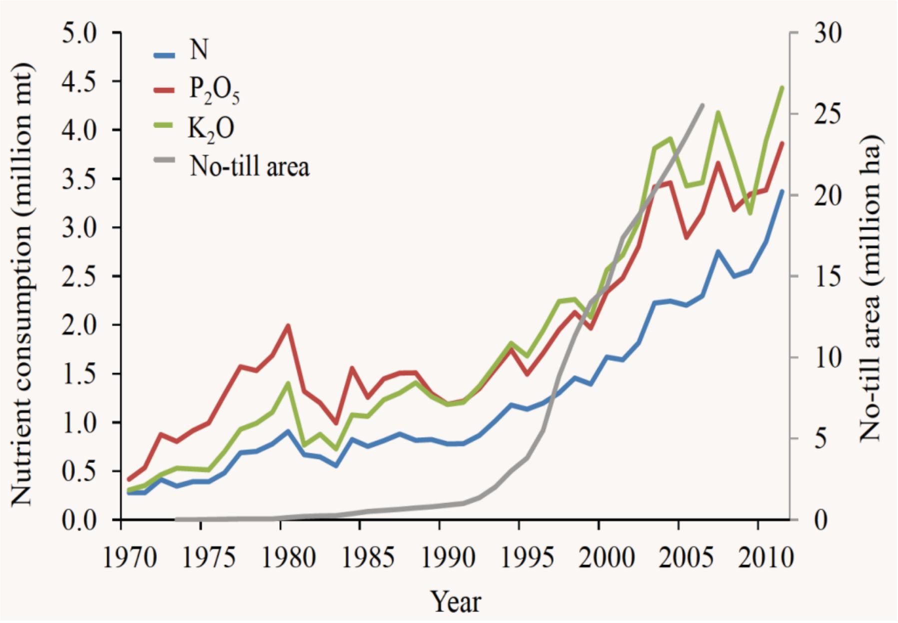


Source: IFA http://www.fertilizer.org/ifa/ifadata/search

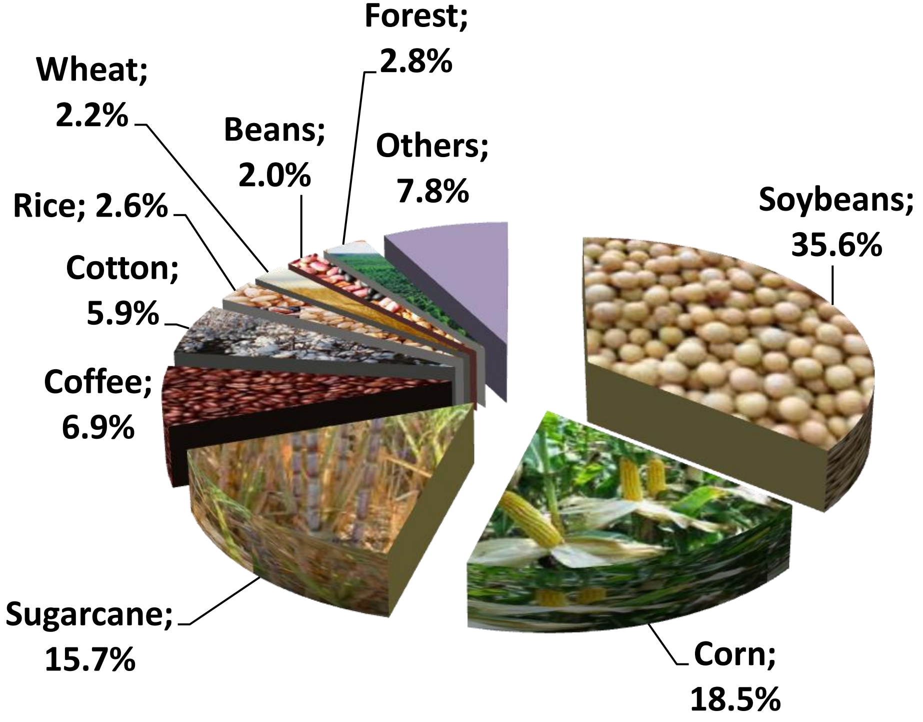
Fertilizer Use in Brazil

Evolution & Share by Crop

N, P_2O_5 and K_2O consumption in Brazilian agriculture from 1970 to 2011, and expansion of the no-till area in Brazil from 1973 to 2006



Brazilian fertilizer market share by crop in 2011 (Source: ANDA)

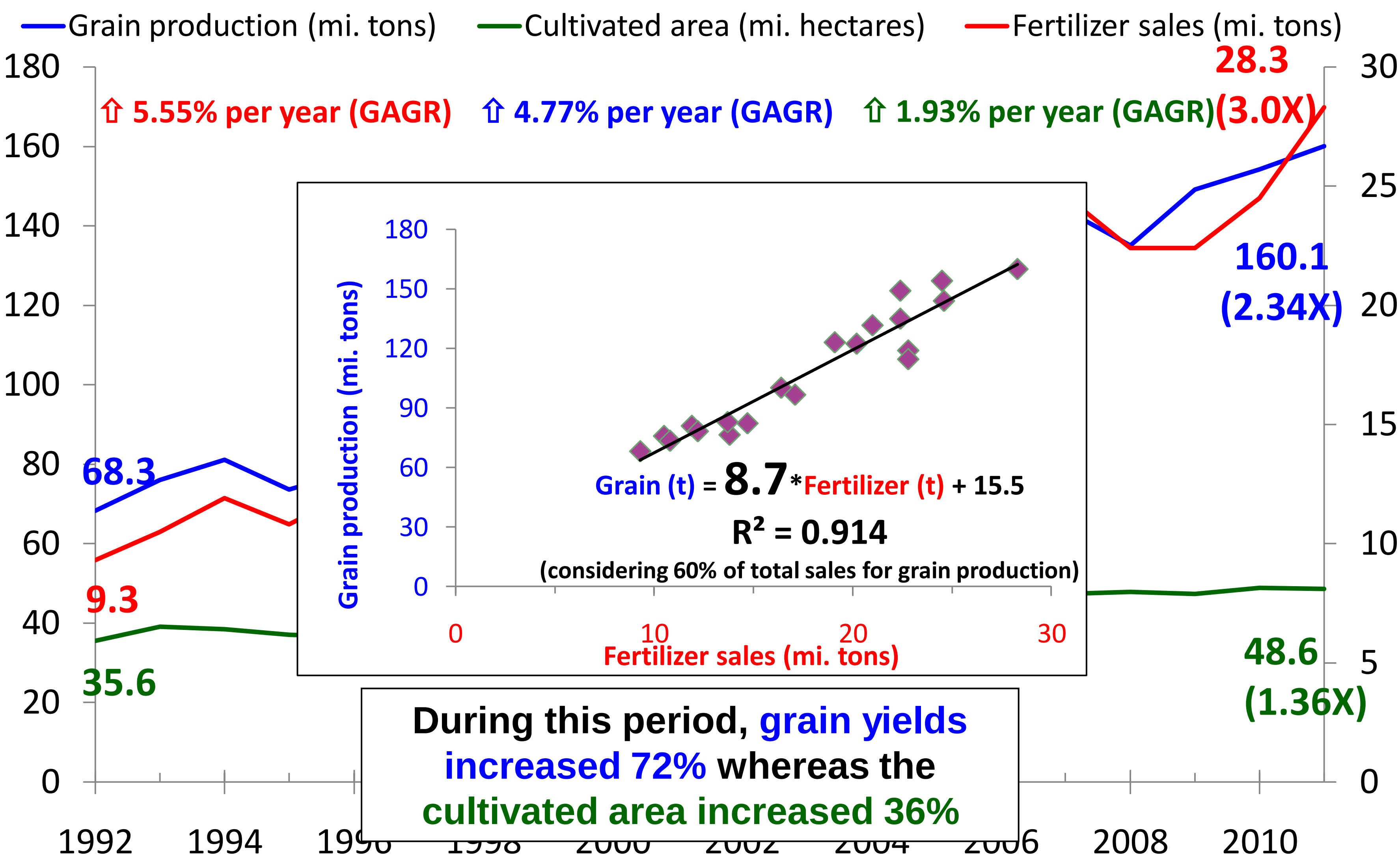


Source: Lopes, Guilherme & Ramos (2012)

www.ipipotash.org/udocs/e-ifc_no_32_november_2012_hr.pdf

Brazil (1992-2011)

Evolution of Grain Production, Cultivated Area and Fertilizer Sales



During this period, grain yields increased 72% whereas the cultivated area increased 36%

Source: data from ANDA/CONAB/IBGE, * 2012 estimates by RC Consultants – Fertilizers, CONAB/IBGE – Area & Production

Growth in Land and Labor Productivity (1961-2001)

"Globally, 78% of the increase in crop output between 1961 and 1999 was attributable to yield increases and 22% to expansion of harvested area… …While the pattern of yield increases outpacing harvested area increases was true for most regions, the proportions varied. ***For example, only 55% of total output growth was derived from yield increases in Latin American and the Caribbean compared with 80% in South Asia****. In contrast, only 34% of increased output was derived from yield increases in sub-Saharan Africa and 66% from harvested area expansion."*

Source: www.unep.org/maweb/documents/document.295.aspx.pdf

Ecosystems and Human Well-being: Current State and Trends, V. 1 (2005) – Ch. 26. Cultivated Systems

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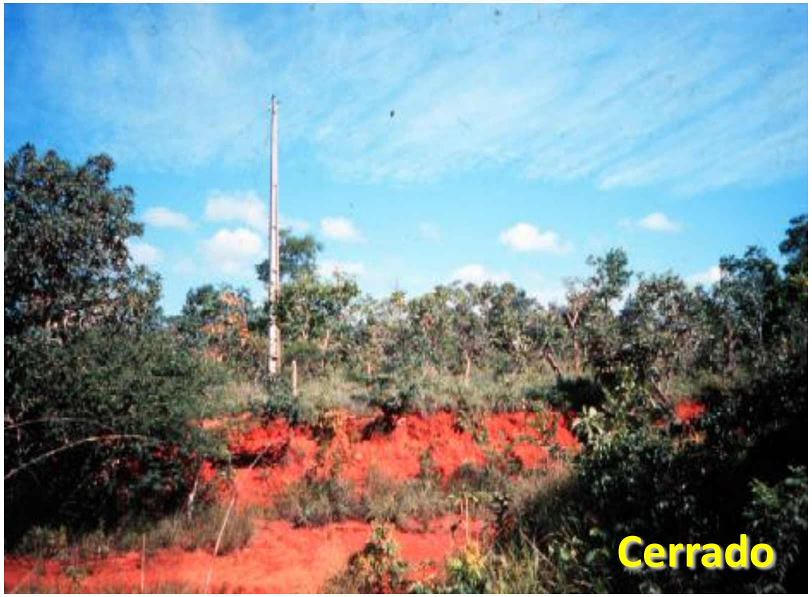
“Cerrado” Vegetation



Management Technologies for the "Cerrado" region in Brazil

50 years of research-teaching-extension efforts

a) Liming

b) Amelioration of subsoil acidity (gypsum)

c) "Build-up" phosphate fertilization

d) "Build-up" potash fertilization

e) "Build-up" micronutrient fertilization

f) Organic matter management

g) Maintenance fertilization

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Organic Matter Management

Some Technologies

Crop rotation

Cover crops

Crop sequences

No-till

Minimum tillage

Integration: grain crops/cattle

Green manure

Weed management

Mulching (small farmers)

Manure (small farmers)

Fertilizers

Conserving organic matter – a challenge in tropical agricultural systems

Nutrient Management

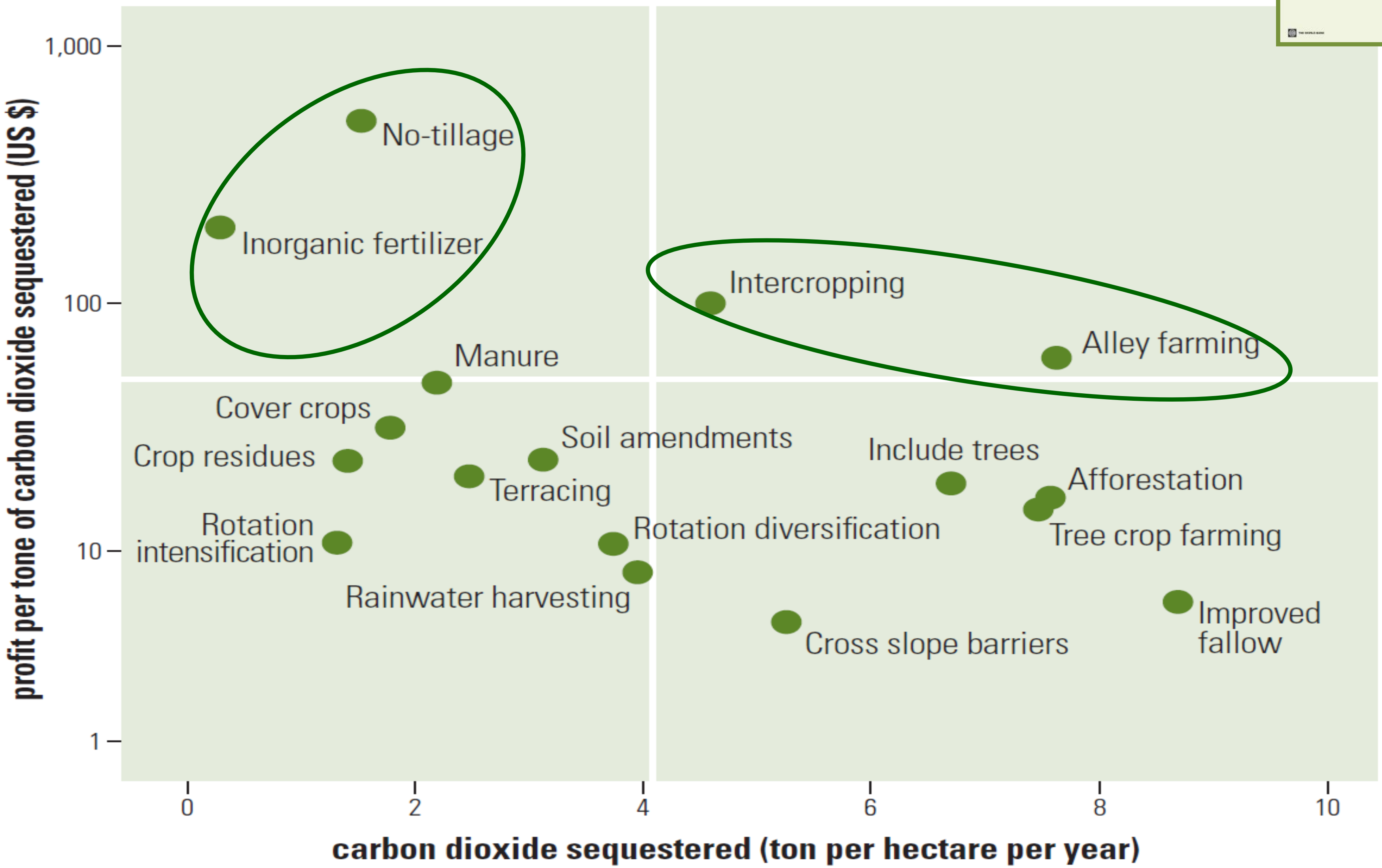
Fertilizer use sequesters carbon by stimulating biomass production. Judicious fertilizer application also counters nutrient depletion, reduces deforestation and expansion of cultivation to marginal areas, and increases crop yields. **Strategies to promote nutrient use efficiency include the following:**

- **Adjusting application rates based on assessment of crop needs;**
- **Minimizing losses by synchronizing the application of nutrients with plant uptake;**
- **Correcting placement to make the nutrients more accessible to crop roots (microfertilization and microdosing);**
- **Using controlled-release forms of fertilizer that delay its availability for plant uptake and use after application;**
- **Using nitrification inhibitors that hold-up microbial processes leading to nitrous oxide formation;**

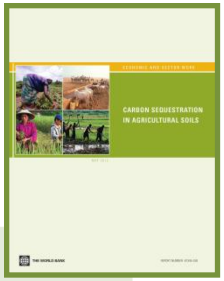
The average effect size of applying fertilizer was an additional **124 kg C ha^{-1} yr^{-1} sequestered for Latin America**, **222 kg C ha^{-1} yr^{-1} for Asia, and 264 kg C ha^{-1} yr^{-1} for Africa.**

Source: Carbon Sequestration in Agricultural Soils (2012)
http://hdl.handle.net/10986/11868

Capitalizing on Synergies and Managing Trade-Offs in Soil Carbon Sequestration



Source: Carbon Sequestration in Agricultural Soils (2012)
http://hdl.handle.net/10986/11868



Conserving organic matter – a challenge in tropical agricultural systems

N fertilizer increases C storage when crop residues are retained in the soil

As more nitrogen was applied to the system, the differences in SOC storage between fertilized treatments and controls tended to increase by approximately **2 t soil C ha^{-1} for each 1 t N fertilizer ha^{-1} (P = 0.001)**.

Soil Use and Management (2005) **21**, 38–52

A review of nitrogen fertilizer and conservati
effects on soil organic carbon storag

R. Alvarez

Abstract. The effects of nitrogen fertilizer and tillag
been tested in many field experiments worldwide. Th
for evaluation of the impact of management practices
with varying nitrogen rates and 161 sites with contras
increased SOC but only when crop residues were retu
for just over half the variance ($R^2 = 0.56$, $P = 0.001$).
lative nitrogen fertilizer rate; rainfall; temperature; soi
a combination of the number of crops per year and pe
increased as more nitrogen was applied to the system,
with higher mean temperatures and also in fine texture
bon costs of production, transportation and application
tion predicted by the model, it appears that nitrogen f
carbon sequestration, whereas in temperate climates,
differences in SOC were found between reduced till (c
tional tillage (mouldboard plough, disc plough) was
under conservation tillage (reduced and no till) was
steady state after 25–30 years, but this relationship o
SOC differences in all the experiments under conserv
ploughing. However, when only those cases that had ap
vs. conventional tillage comparisons from temperat
12 t C ha^{-1}. This estimate is larger than others previou
tillage was not significantly related to climate, soil textu

Keywords: Soil carbon storage, nitrogen fertilizer, tilla

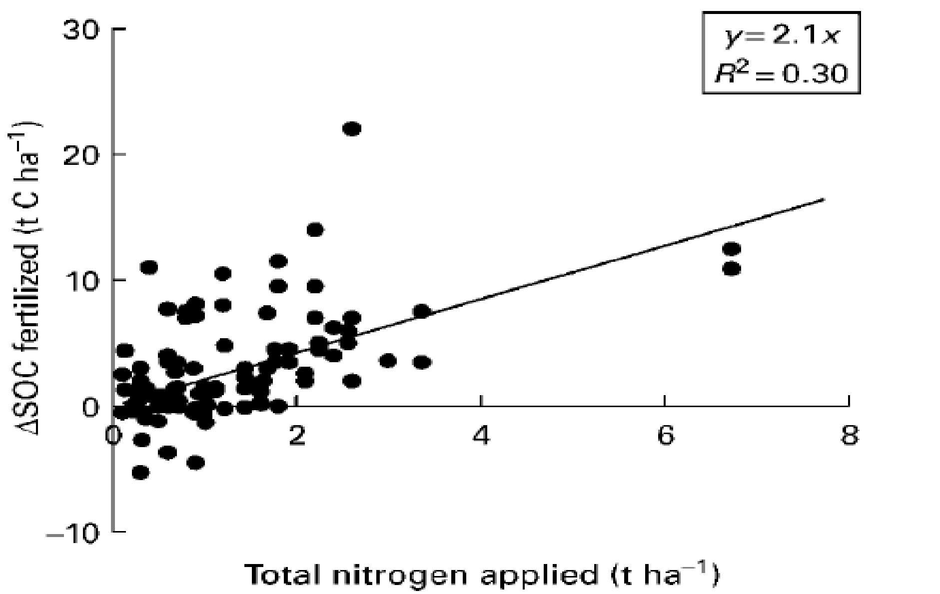


Figure 1. Relationship between carbon content differences of fertilized and control treatments (ΔSOC fertilized) and the total nitrogen applied in experiments with crop residues retained.

Nitrogen sources and loss of N

Nutrient Cycling in Agroecosystems **67:** 215–223, 2003.

Fruit yield of Valencia sweet orange fertilized with diffe
and the loss of applied N

H. Cantarella[1,*], D. Mattos Jr.[2], J.A. Quaggio[1] and A.T. Rigolin[3]
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Citricultura Sylvio Moreira – IAC, CP 6, Cordeirópolis, SP 13490-970, Brazil; [3]*C*
CP 120, Matão, SP 15990-000, Brazil; [*]*Author for correspondence (e-mail: cantar*

Received 29 January 2002; accepted in revised form 25 February 2003

Attention to the
4 R's of fertilizer application

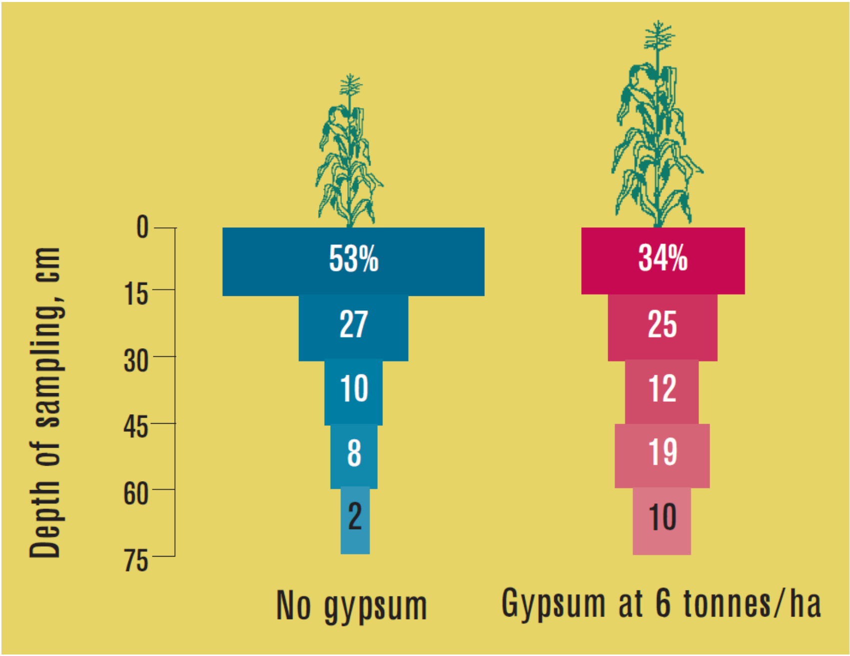
N content in the 20-60 cm soil depth

	(kg ha^{-1} N)	April 1997	October 1998	April 1999	August 2000	Mean
		kg ha^{-1} $(NH_4^+ + NO_3^-)$-N				
Urea	20	26a[2]	24a	23	35	27a
	100	18a	22a	18	32	23a
	180	32a	34a	24	59	37a
	260	32a	32a	24	50	35a
Ammonium nitrate	20	20a	26a	21	32	25a
	100	30a	37a	22	56	36b
	180	79b	40a	20	83	55b
	260	59b	79b	22	63	56b

Rainfall in the season preceding soil sampling[3] (mm)			
Oct 96–Apr 97	May 98–Sep 98	Oct 98–Apr 99	May 00–Aug 00
1071	292	1483	107

Better Root Development… Better Nutrient Uptake… Less Nutrient Leaching

Relative distribution of a corn root system with and without gypsum in a clayey Oxisol in central Brazil

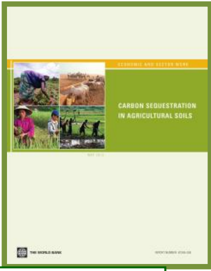


Source: Sousa & Ritchey (1986)

Cotton root development in depth without (left) and with (right) application of 3 t/ha of gypsum. Each square is 15 cm by 15 cm.

Source: Sousa & Rein (2009)
Photo courtesy of D.M.G. Sousa

Tillage, Crop Residue Management, and Soil Carbon Sequestration Rates (kg C ha^{-1} yr^{-1})



PRACTICE	MEAN	LOWER 95 PERCENT CONFIDENCE INTERVAL OF MEAN	UPPER 95 PERCENT CONFIDENCE INTERVAL OF MEAN	NUMBER OF ESTIMATES
Africa				
Crop residues	374	292	457	46
Mulches	377	159	595	6
Cover crops	406	298	515	24
No-tillage	370	322	418	108
Asia				
Crop residues	450	379	521	189
Mulches	565	371	759	53
Cover crops	414	233	594	38
No-tillage	224	97	351	48
Latin America				
Crop residues	948	638	1,258	56
Mulches	748	262	1,108	16
Cover crops	314	108	520	33
No-tillage	535	431	639	249

Source: Carbon Sequestration in Agricultural Soils (2012)
http://hdl.handle.net/10986/11868

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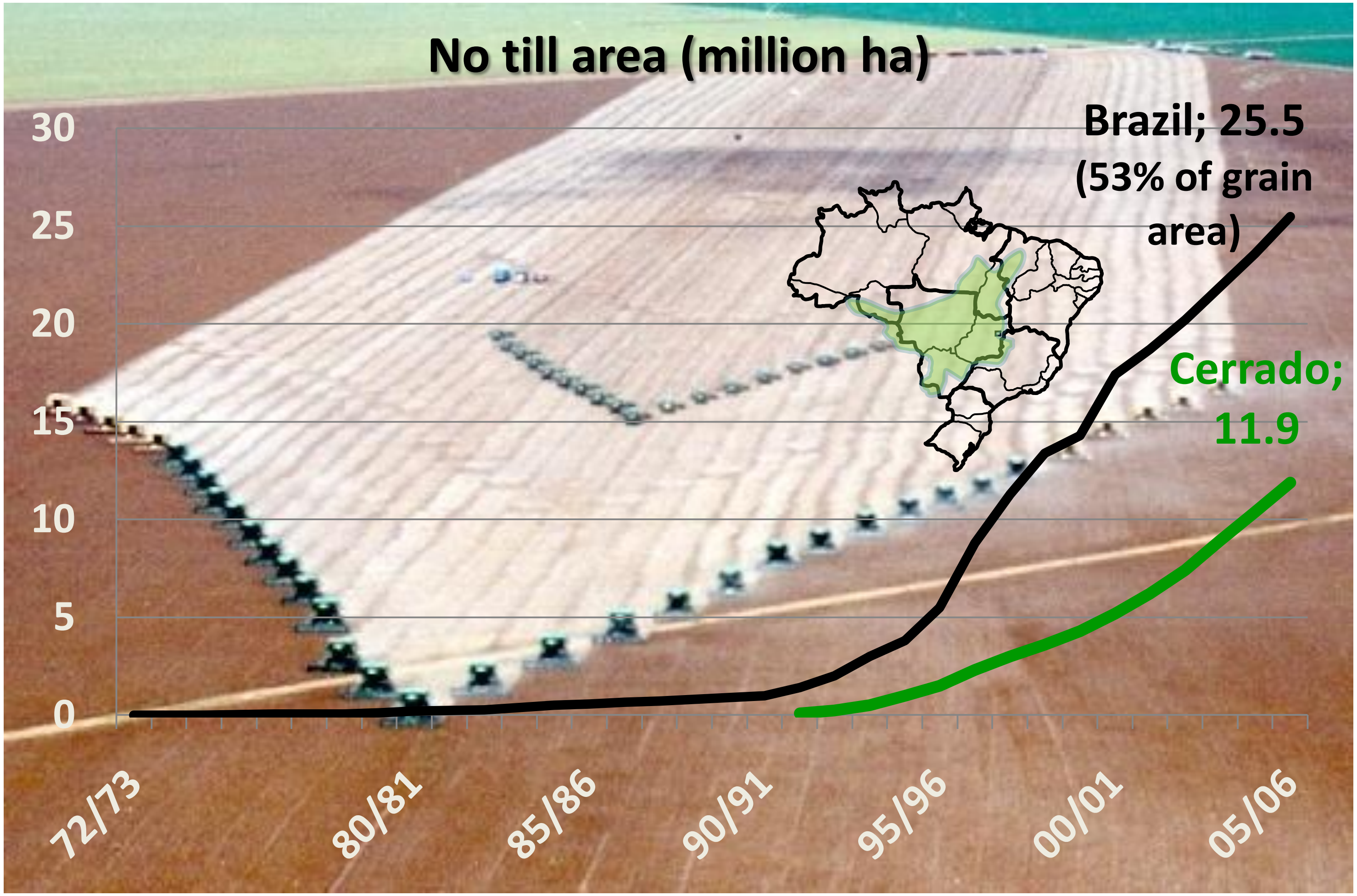
Agri-technology: no-till at Fazenda Filadélfia

State of Mato Grosso (Cerrado)



Source: FEBRAPDP (2007)

Conserving organic matter with no-till

Available online at www.sciencedirect.com

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Soil & Tillage Research 91 (2006) 24

Short communicat

Short-term soil CO_2 emission after c
tillage of a no-till sugar cane ar

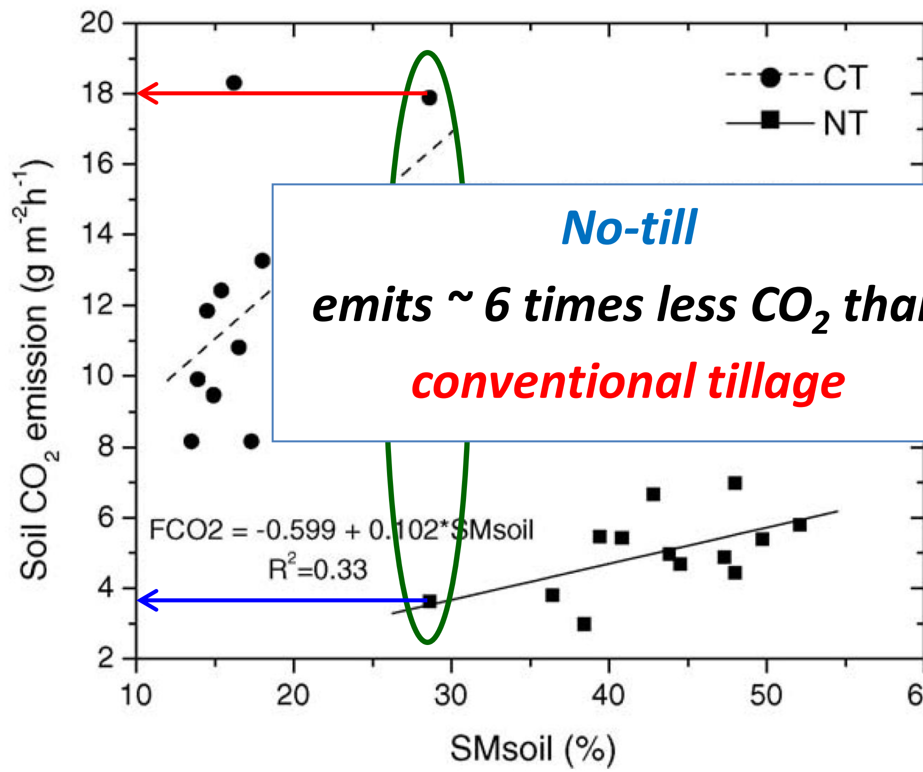
N. La Scala Jr.*, D. Bolonhe

FCAV-UNESP, Via de Acesso Prof. Paulo Donato Castellane

Received 10 January 2005; received in revised form 22 Nove

Abstract

The impact of tillage systems on soil CO_2 emission is a complex issue a
no-till to intensive land preparation. In southern Brazil, the adoption of a ne
tillage as well as no burning of crops residues left on soil surface after ha
practice has helped to restore soil carbon, the tillage impact on soil carbon l
study evaluated the effect of moldboard plowing followed by offset disk har
sugar cane field treated with no-tillage and high crop residues input in the
undisturbed soil CO_2 emissions during a 4-week period by using an
Conventional tillage caused the highest emission during almost the wh
following tillage, when the reduced plot produced the highest peak. The lowest emissions were recorded 7 days after tillage, at the



No-till

emits ~ 6 times less CO_2 than

conventional tillage

"Although it is known that crop residues are important for restoring soil carbon, our result indicates that an amount equivalent to approximately 30% of annual crop carbon residues could be transferred to the atmosphere, in a period of 4 weeks only, when conventional tillage is applied on no-tilled soils."

Keywords: Soil CO_2 emission; Soil respiration; Soil tillage; No-tillage

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Conserving organic matter – avoid burning

Changing from pre-harvest burning to green cane harvesting (GCH) has two main consequences with respect to GHG emissions:

1. The sugarcane harvest after burning emits CH_4 and N_2O, besides polluting the atmosphere with smoke and soot. Although mechanized harvesting increases consumption of fossil fuels, the elimination of burning decreases total GHG emissions that occur at harvest by almost 80%;
2. The maintenance of straw on the ground preserves nutrients, especially N and S, besides maintaining soil moisture and protecting the soil surface from erosion.

Source: www.cnpm.embrapa.br/publica/download/Doc_77.pdf

Conserving organic matter in Jamaica

Sugar Industry Research Institute
Mandeville, Jamaica W. I.

Back

Moving Towards Green Cane Harvesting

Ever since the start of pre-harvest burning there have been periodic debates surrounding its pros and cons compared with the previous system of harvesting "green." The switch to pre-harvest burning however involved more than just the passage of fire through the cane field for trash removal. Fire sweeping through the field would blunt cane spines, drive away pests such as wasps, centipedes, the occasional snake, and reduce the tangle of vines, cow itch or other weeds which create an inhospitable environment for cane cutters. Most of all, it was part and parcel of a new technology, introduced during the sixties, facilitating loading of cane by machines, and which marked the end of manual loading.

Very soon, the disadvantages of pre-harvest burning became apparent, triggering a nostalgic yearning for a return to green cane harvesting (GCH). One estate, Long Pond, succeeded in returning briefly to GCH during the eighties. Since then chopper harvesters have entered the picture. These are sometimes used to harvest cane without burning, but with some loss of quality and, if not carefully managed, at higher cost.

Economics however has always been at the heart of the debate. It is not so much a question of whether green cane harvesting can or should be done, but at what price. Would green cane harvesting result in greater viability, would it assist in reducing cost? - these are some of the questions.

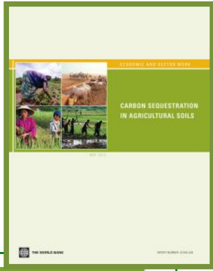
New Challenges

Today the Industry is faced with a new set of challenges. Urban areas are getting closer to and are springing up within traditional cane growing areas. For those citizens, the smoke and soot from pre-harvest burning, although momentary in duration, are an unbearable nuisance. For those with respiratory problems a cane fire may trigger a medical emergency.

The Sugar Industry must therefore take the lead by adopting more enlightened approaches. With tourism playing an ever increasing role in the economy, and as people get more aware of what is good for the environment, the daily burning of cane during crop becomes less and less acceptable. Furthermore, the whole world is moving towards conduct that improves rather than degrades our surroundings in any way. Countries that do not conform may very well find themselves ostracised.

Source: www.jamaicasugar.org/sugarcane/GreenCaneHarvesting.htm

Agroforestry and Soil Carbon Sequestration Rates (kg C ha^{-1} yr^{-1})



PRACTICE	MEAN	LOWER 95 PERCENT CONFIDENCE INTERVAL OF MEAN	UPPER 95 PERCENT CONFIDENCE INTERVAL OF MEAN	NUMBER OF ESTIMATES
Africa				
Include trees in field	1,204	798	1,610	125
Intercropping	629	162	1,421	14
Alley farming	1,458	869	2,047	46
Tree-crop farming	1,359	755	1,964	44
Improved fallow	2,413	1,886	2,941	71
Asia				
Include trees in field	562	220	904	58
Intercropping	803	65	1,541	17
Latin America				
Include trees in field	1,065	270	1,860	43
Diversify trees	1,365	516	2,213	6
Intercropping	1,089	116	2,063	7

Source: Carbon Sequestration in Agricultural Soils (2012)
http://hdl.handle.net/10986/11868

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Examples of a "Green Agriculture" in the Cerrado

one of the most productive regions in Brazil in terms of grain, beef cattle, and agro-energy production, as well as reforestation

Brachiaria as a cover crop in maize field

Crop-livestock-forest production system

Source: Lopes, Guilherme & Ramos (2012). Photos courtesy of R. Trecenti.
www.ipipotash.org/udocs/e-ifc_no_32_november_2012_hr.pdf.

Final Remarks

- Adoption of better agronomic practices (e.g., no-till, cover crops, crop rotation, agroforestry systems, intercropping, avoid burning) is a need to improve nutrient use efficiency and nutrient cycling in LA countries with positive nutrient balance due to fertilizer use
- Yet, in many LA countries, there is still a demand for nutrient replenishment in order to support adequate plant growth and agricultural production
- Issues concerning nutrient release into aquatic environments caused by the uncontrolled discharge of untreated urban wastewater need also to be addressed in most LA countries for improved water quality

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Thank you !!!
Obrigado!!!
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