DESAFIOS DA AGRICULTURA BRASILEIRA NO CENÁRIO DE SEGURANÇA ALIMENTAR GLOBAL

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UNIVERSIDADE FEDERAL DE LAVRAS

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World Food Day • 16 October 2016

http://www.fao.org/3/a-i5758e.pdf

Lima-Paris Action Agenda on Agriculture

Paris Agreement

Recognizing the fundamental priority of safeguarding food security and ending hunger, and the particular vulnerabilities of food production systems to the adverse impacts of climate change,

Article 2

1. This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:

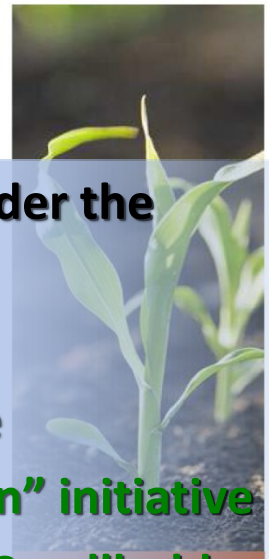
(a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;

(b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production; and

(c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.

unfccc.int/files/meetings/paris_nov_2015/application/pdf/paris_agreement_english_.pdf

LPAA FOCUS ON AGRICULTURE



Initiatives presented under the Agriculture Focus:

- **The 4/1000 initiative**
- **The "Life Beef Carbon" initiative**
- **The "Adaptation for Smallholder Agriculture Programme" ASAP**
- **The Promotion of agro-ecology transition in West Africa**
- **The Blue Growth Initiative**
- **The "Global Initiative on Food Loss and Waste Reduction – SAVE FOOD"**

newsroom.unfccc.int/lpaa/agriculture/press-release-lpaa-focus-agriculture-at-cop21/#downloads

The challenge: how to feed 9.7 billion people in 2050?

HOW TO FEED THE WORLD 2050

HIGH-LEVEL EXPERT FORUM

Rome 12-13 October 2009

HOW TO FEED THE WORLD 2050

HIGH-LEVEL EXPERT FORUM

Rome 12–13 October 2009

Global agriculture towards 2050

THE CHALLENGE

Agriculture in the 21st century faces multiple challenges: it has to produce more food and fibre to feed a growing population with a smaller rural labour force, more feedstocks for a potentially huge bioenergy market, contribute to overall development in the many agriculture-dependent developing countries, adopt more efficient and sustainable production methods and adapt to climate change.

FOOD DEMAND AND PRODUCTION

World population is expected to grow by over a third, or 2.3 billion people, between 2009 and 2050. This is a much slower rate of growth than the one seen in the past four decades during which it grew by 3.3 billion people, or more than 90 percent. Nearly all of this growth is forecast to take place in the developing countries. Among the latter group, sub-Saharan Africa's population would grow the fastest (+114 percent) and East and Southeast Asia's the slowest (+13 percent). Urbanization is foreseen to continue at an accelerating pace with urban areas to account for 70 percent of world population in 2050 (up from 49 percent at present) and rural population, after peaking sometime in the next decade, actually declining.

At the same time, per capita incomes in 2050 are projected to be a multiple of today's levels. There is a consensus among analysts that recent trends whereby the economies of developing countries have been growing significantly faster that the developed ones is likely to continue in the future. Relative inequality in per capita incomes would be reduced considerably by 2050. However, absolute differences would remain pronounced and could even increase further, given the current huge gaps in absolute per capita incomes. Moreover, inter-country and inter-regional inequalities within the present-day developing world would tend to become more pronounced.

The projected global economic growth of about 2.9 percent annually would lead to a significant reduction or even near elimination of absolute "economic" poverty in the developing countries (persons living on less than US$1.25/day in 2005 prices). Nevertheless, even in 2050 the world will still be far from solving the problem of economic deprivation and malnutrition of significant parts of the population: the US$1.25/day poverty line is simply too low. On less stringent criteria, deprivation and undernutrition will remain widespread, though significantly less than today.

These trends mean that market demand for food would continue to grow. Demand for cereals, for both food and animal feed uses is projected to reach some 3 billion tonnes by 2050, up from today's nearly 2.1 billion tonnes. The advent of biofuels

Population growth

NEWS FEATURE FOOD

NATURE|Vol 466|29 July 2010

Brazil is an IMPORTANT part of the solution

Nature, 446:554-556, July 29, 2010

THE GLOBAL FARM

With its plentiful sun, water and land, Brazil is quickly surpassing other countries in food production and exports. But can it continue to make agricultural gains without destroying the Amazon? **Jeff Tollefson** reports from Brazil.

Source: www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Global_Agriculture.pdf

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Outline

- An Overview of Brazil and Its Agriculture
- Brazilian Developments in Farming and Nutrient Management
- Challenges *(and Opportunities)* for a Sustainable Agriculture in Brazil
- Final Remarks

An Overview of Brazil and Its Agriculture

Economic importance of agriculture in Brazil

Brazil: the land of the 4Fs...




Plant the plains, save the forests

"Norman Borlaug, who is often called the father of the Green Revolution, said the best way to save the world's imperilled ecosystems would be to grow so much food elsewhere that nobody would need to touch the natural wonders. Brazil shows that can be done…

…The world is facing a slow-motion food crisis now. It should learn from Brazil."

(The Economist, Aug 26th 2010)

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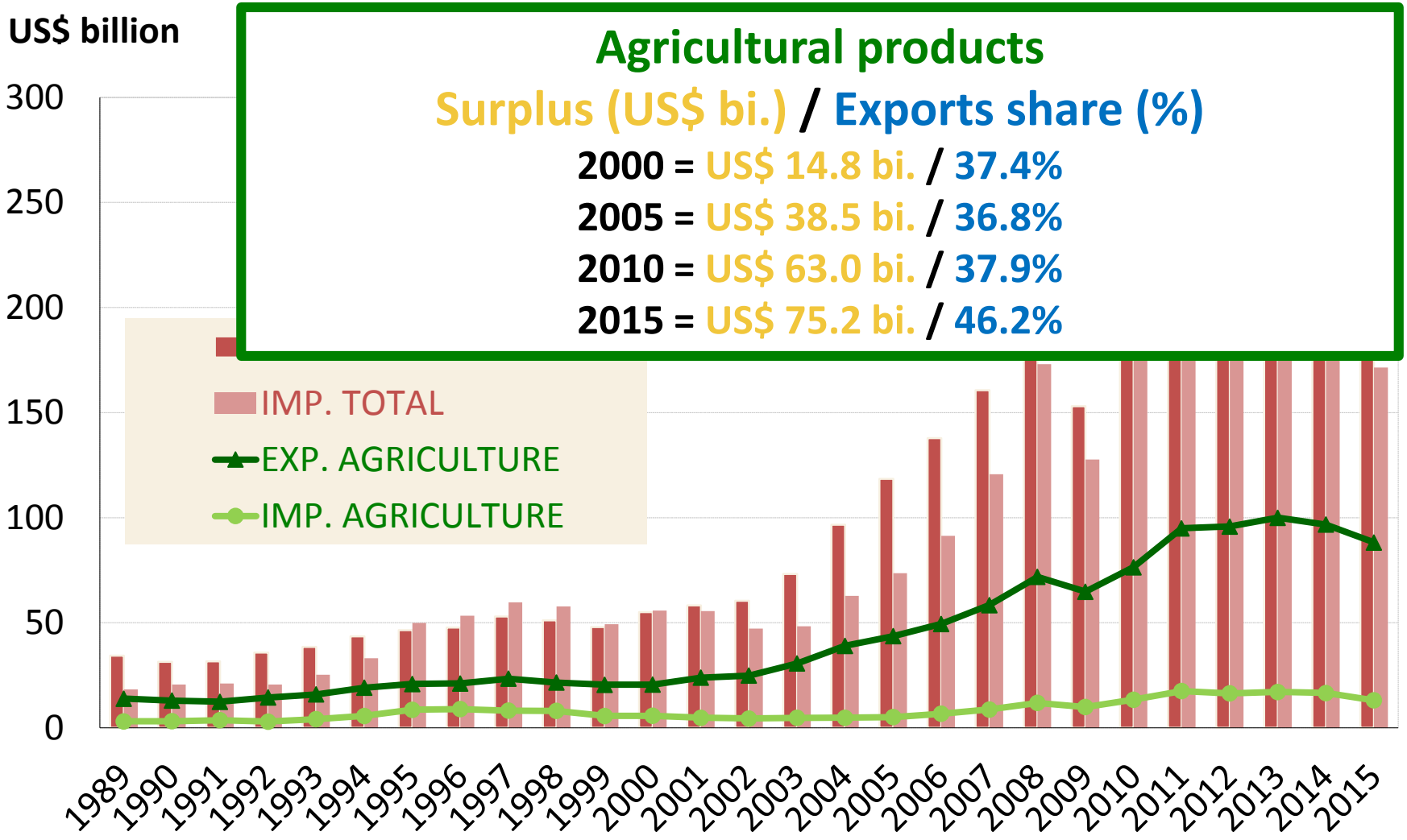
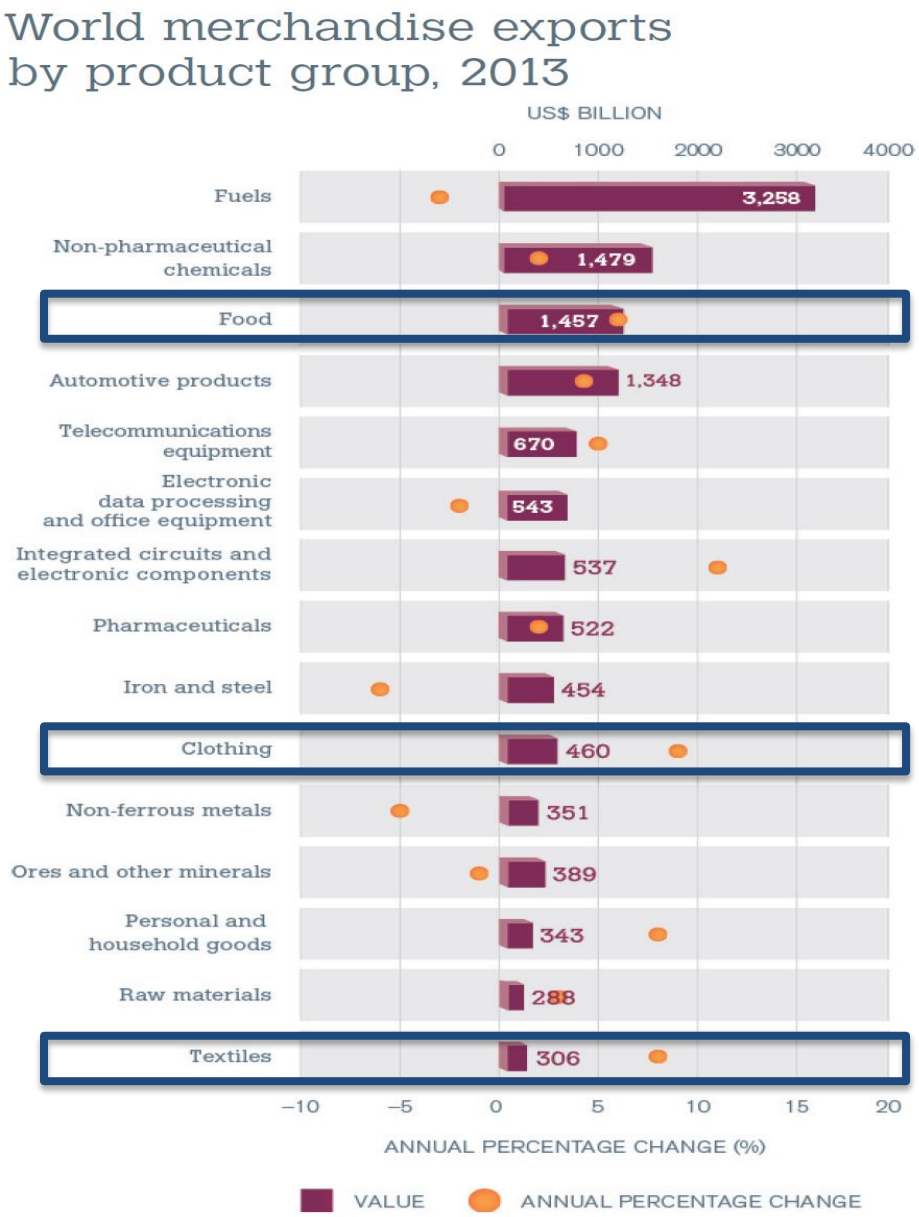
Brazilian Trade Balance: 1989-2015

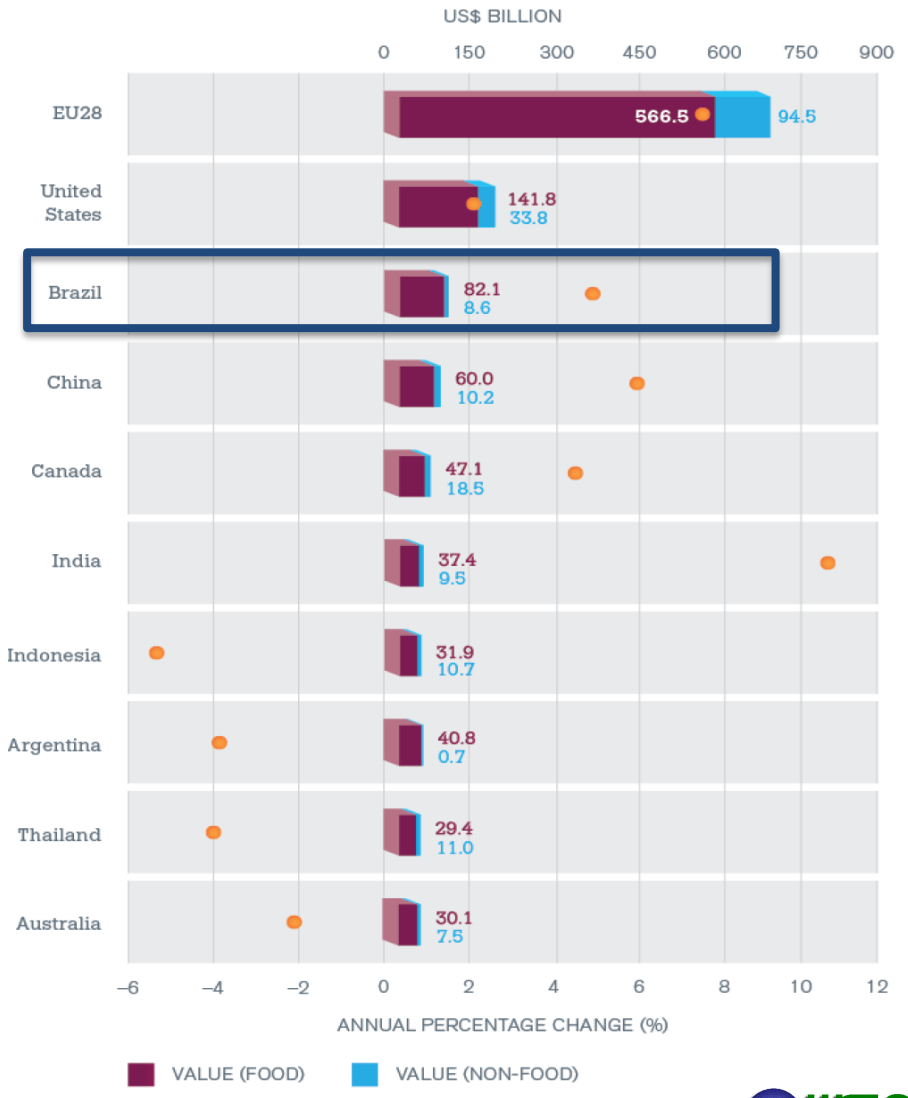
Total & Agricultural Products



Sources: AgroStat Brasil, with data from CEX/MDIC. Prepared by CGOE/ DPI/ SRI/ MAPA
www.agricultura.gov.br/arq_editor/file/Internacional/estatistica/BCA-RESUMIDA-1989-2015.xls

International Trade Value - 2014

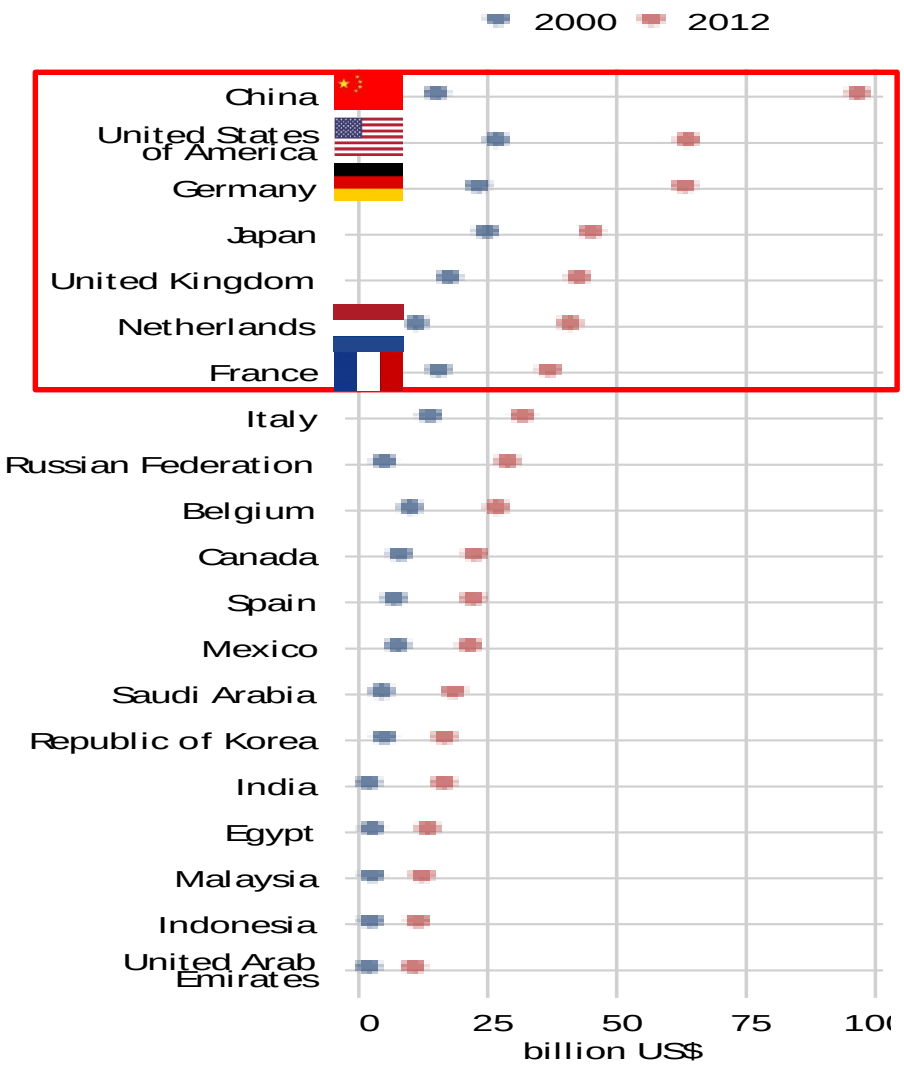




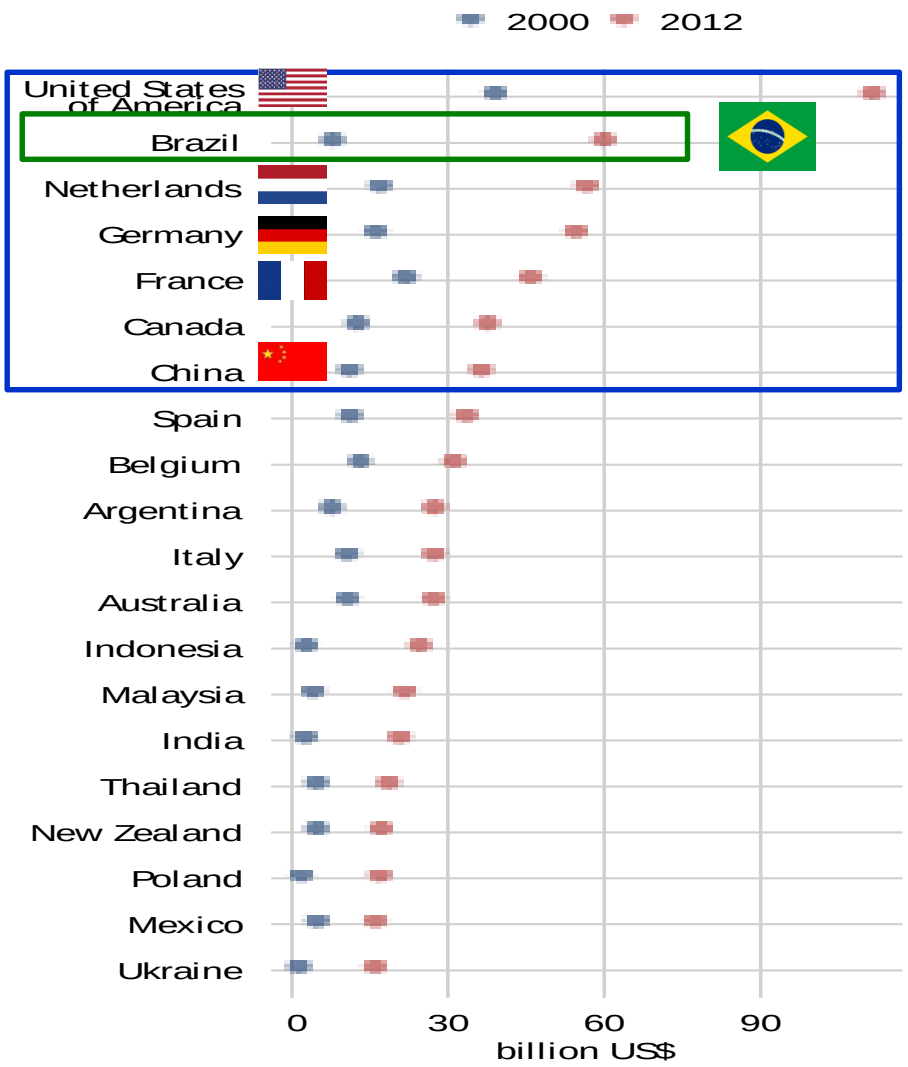
www.wto.org/english/res_e/statis_e/its2014_e/its2014_e.pdf

Top "Food Countries": 2000 & 2012

Top Importing Countries



Top Exporting Countries



Source: FAO Statistical Yearbook 2015. http://www.fao.org/3/a-i4691e.pdf

Brazil: Gross Value of Agricultural Production (evolution 2000-2016)

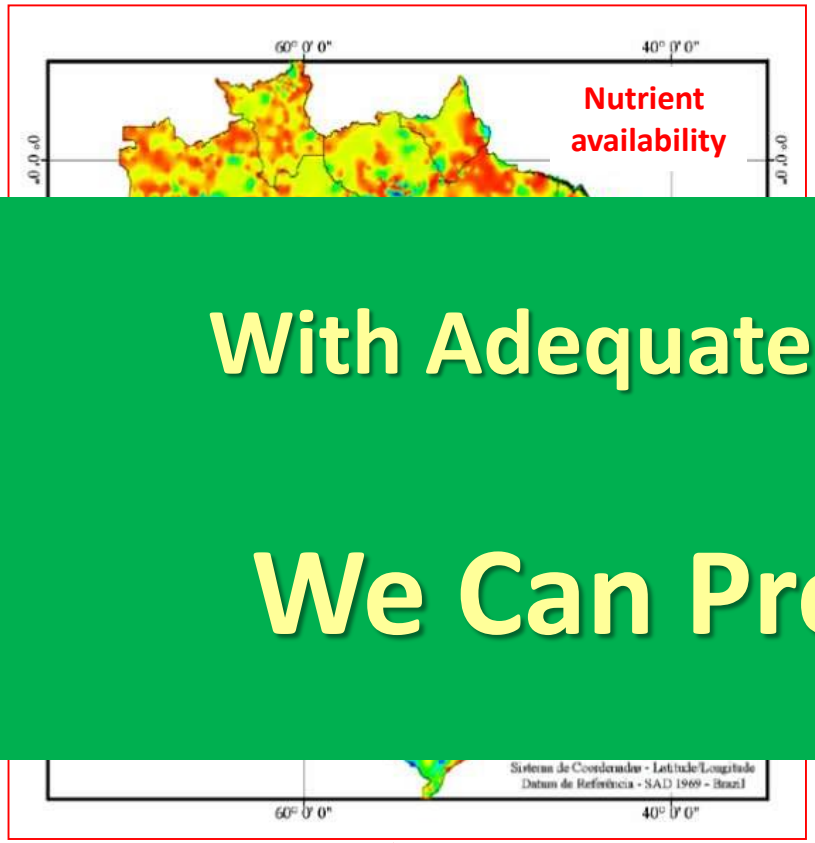
Average increase ~5.1% per year in the last 16 years!!!

Source: http://www.agricultura.gov.br/arq_editor/file/acs/2016/VBP-Produtos-Agropecuarios.pdf (data from October 2016)

Brazil

- Area: 8,514,204.86 km^2 (851.4 million ha)
- Population: ~206 million inhabitants
- Tropical Country (weathered soils)

… Good edaphic conditions overall



With Adequate Ag Management

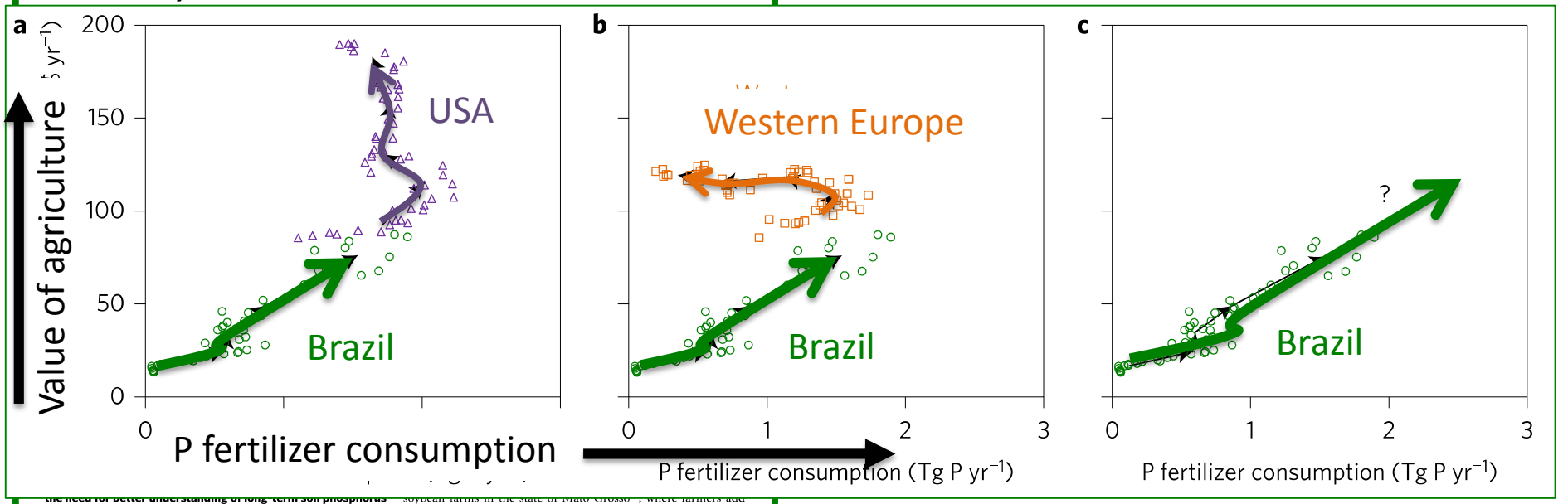
We Can Produce a Lot!

Many soil fertility constraints (e.g., high P fixation capacity), but…

Cost of Producing in High-P Fixing Soils

nature plants
LETTERS
PUBLISHED: 18 APRIL 2016 | ARTICLE NUMBER: 16043 | DOI: 10.1038/NPLANTS.2016.43

The phosphorus cost of agricultural intensification in the tropics



*"A **great deal of progress has already been made**. Strategies that make farming on phosphorus-fixing soils possible, for example **liming or organic matter additions** have been successful in the southeastern United States and in Brazil. These need to be coupled with **additional efforts to enhance phosphorus efficiency**…"*

doi: 10.1038/NPLANTS.2016.43

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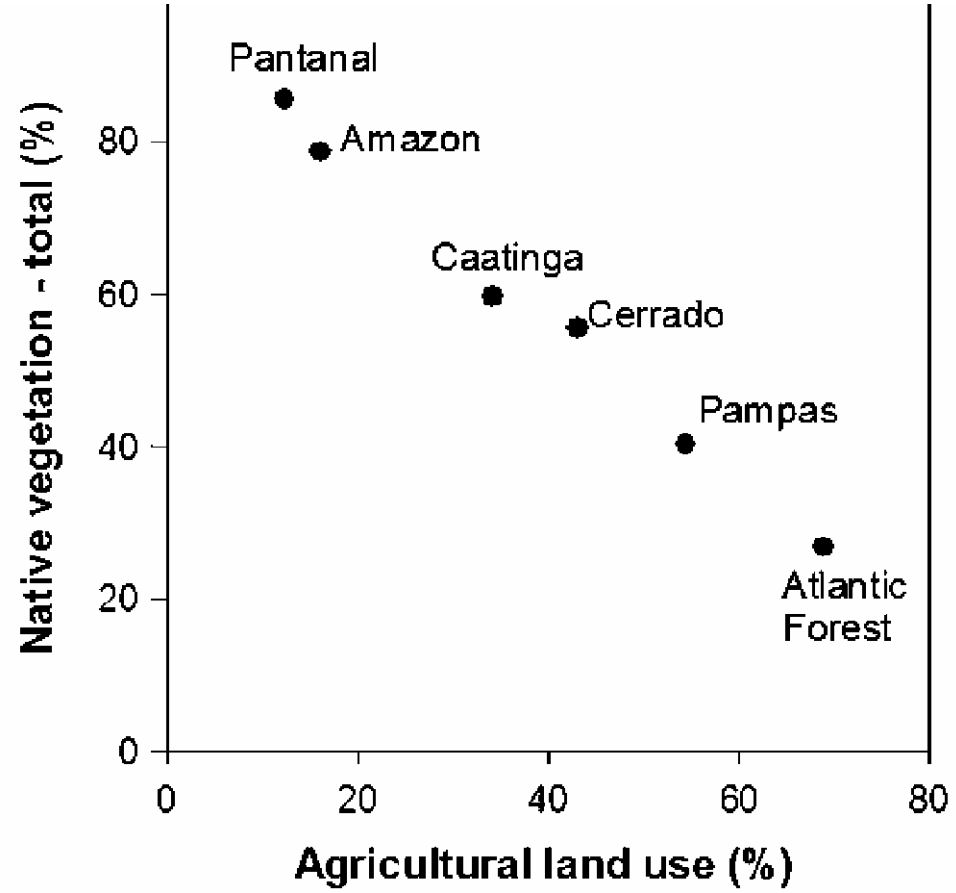
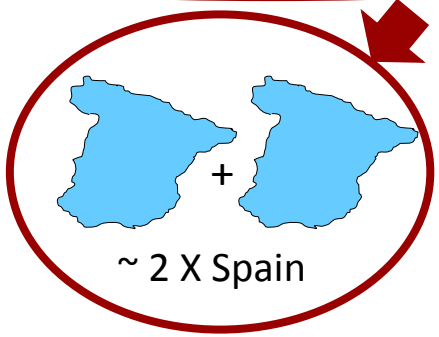
Agricultural Land Use in Brazilian Biomes



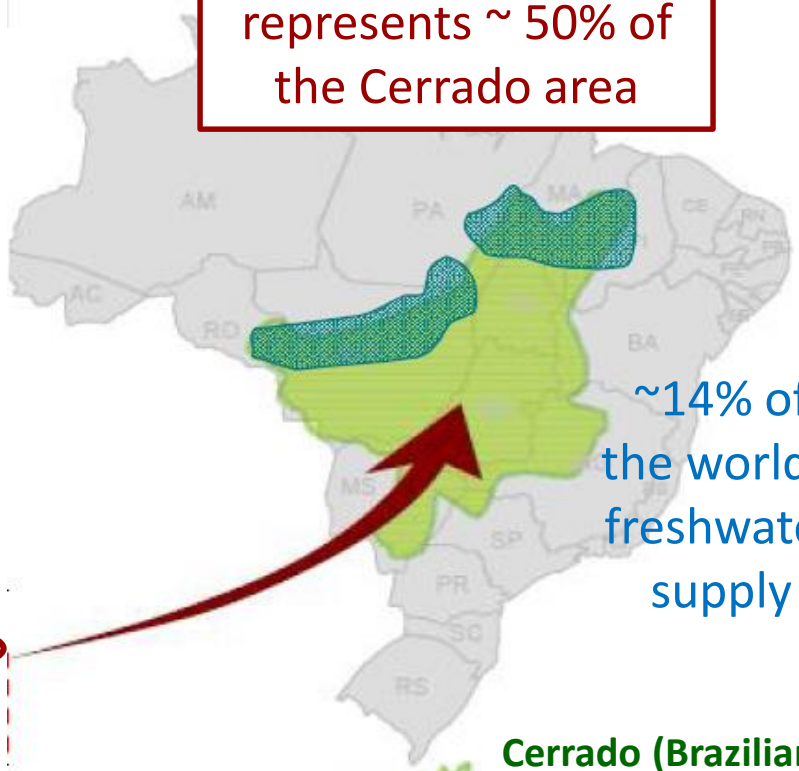
Source: Journal of Applied Ecology, 49:535–541, 2012

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 Agriculture	106	13
Total	**851**	**100**



Unexploited area represents ~ 50% of the Cerrado area



~14% of the world's freshwater supply

Cerrado (Brazilian Savanna)

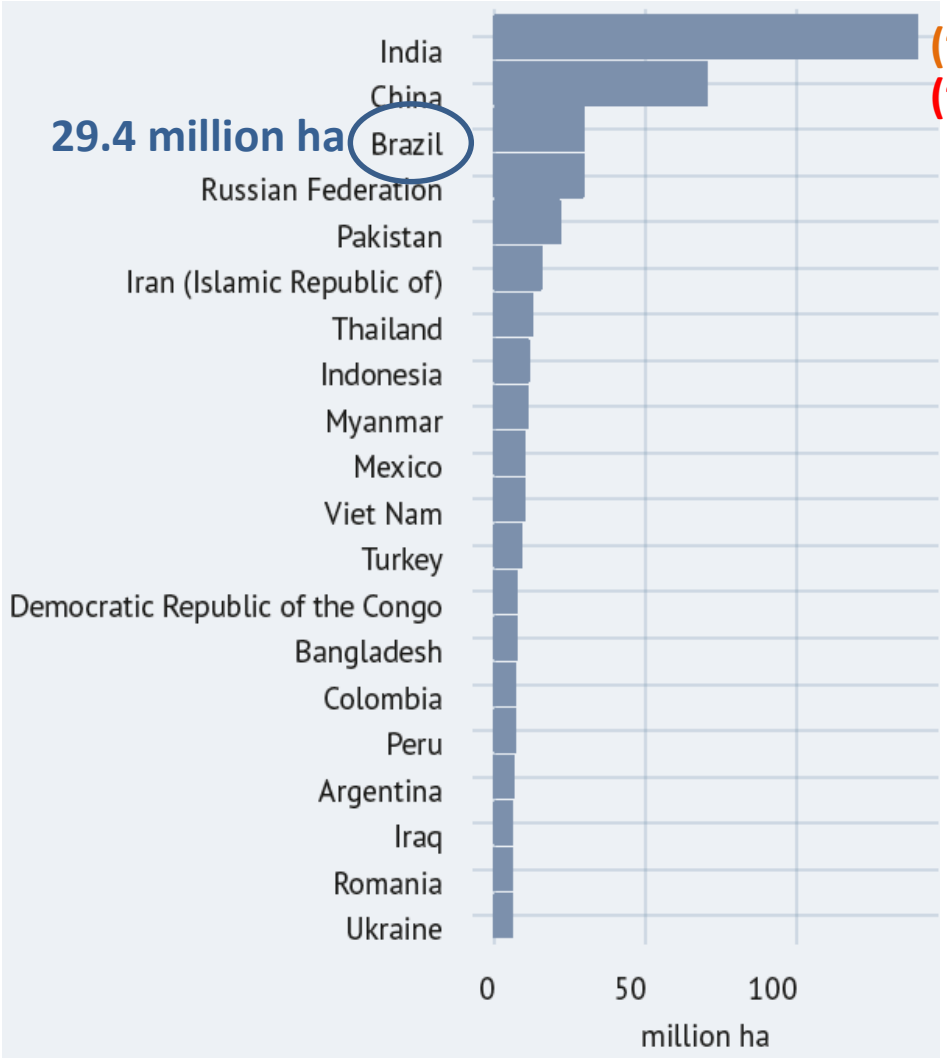
Region with greatest perspectives of use increase

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

Irrigation in Agriculture

Irrigation potential

(top 20 countries - 2012)



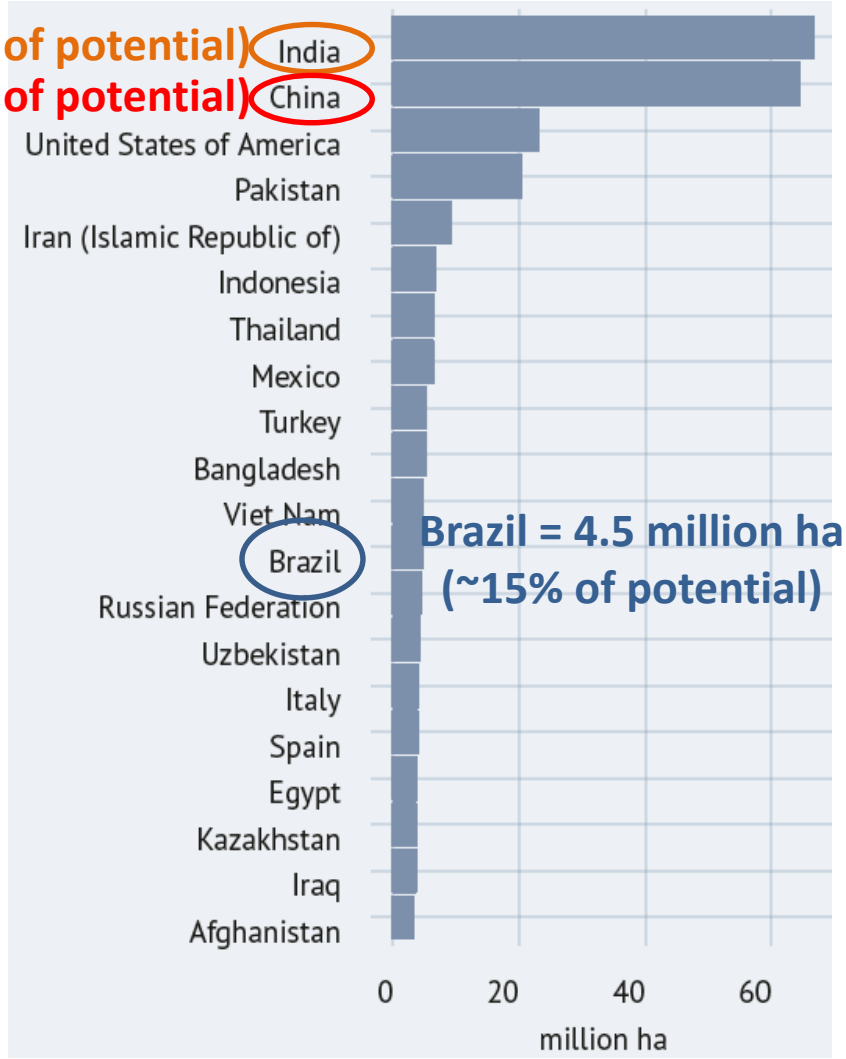
29.4 million ha

(~48% of potential)

(~92% of potential)

Total equipped area

(top 20 countries - 2009)



Brazil = 4.5 million ha
(~15% of potential)

Source: FAO Statistical Yearbook 2013. www.fao.org/docrep/018/i3107e/i3107e.PDF

Average Yields: Brazil vs World

	Average yield 2010/11 (t/ha)			Yield increase 1990/91 to 2010/11 (%)		
	Brazil	EUA	World	Brazil	EUA	World
	3.3	5.3	3.1	108%	25%	21%
	3.0	2.9	2.5	84%	28%	32%
	4.1	9.6	5.1	129%	29%	36%
	3.1	5.1	2.8	93%	14%	19%
	1.5	0.9	0.7	300%	28%	30%

Source: USDA (2011). Prepared by Fiesp-Deagro. www.ocb.org.br/gerenciador/ba/arquivos/cordel_do_agro.pdf.
Grains: barley, corn, cotton, oat, soybean, rice, rye, sorghun, wheat.

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Brazilian Developments in Farming and Nutrient Management

The role of fertilizers and organic carbon

Management technologies for low-fertility soils

The case of 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

Advances in Agronomy

Volume 137, 2016, Pages 1–72

Advances in Agronomy

Chapter One – A Career Perspective on Soil Management in the Cerrado Region of Brazil

A.S. Lopes, L.R. Guimarães Guilherme

Universidade Federal de Lavras, Lavras, Minas Gerais, Brazil

Available online 19 March 2016

doi:10.1016/bs.agron.2015.12.004

Cerrado's Share

Brazilian Meat and Ag. Production

Cotton: 89%
Sorghum: 69%
Beef cattle 55%
Soybeans: 53%
Coffee: 48%
Rice: 37%
Corn: 30%
Common beans: 25%
Sugar cane: 13%

5.6 million tons of grain in 1970

"Once regarded as unfit for farming by the father of the Green Revolution and Nobel laureate Dr. Norman Borlaug, today the Cerrado region accounts for a massive 70 percent of Brazil's farm output."

http://www.globalharvestinitiative.org/index.php/2011-gap-report/

Potential for:

252 mi. t of annual crops
90 mi. t of perennial crops
12 mi. t of beef cattle

Source: Macedo,1995

44 million tons of grain in 2003

Growth rate of 6.4% per year in the period (1970-2003)

Source: Roberto Teixeira Alves, Embrapa-Cerrados, 2006

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Nutrient (im)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…

***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.*"**

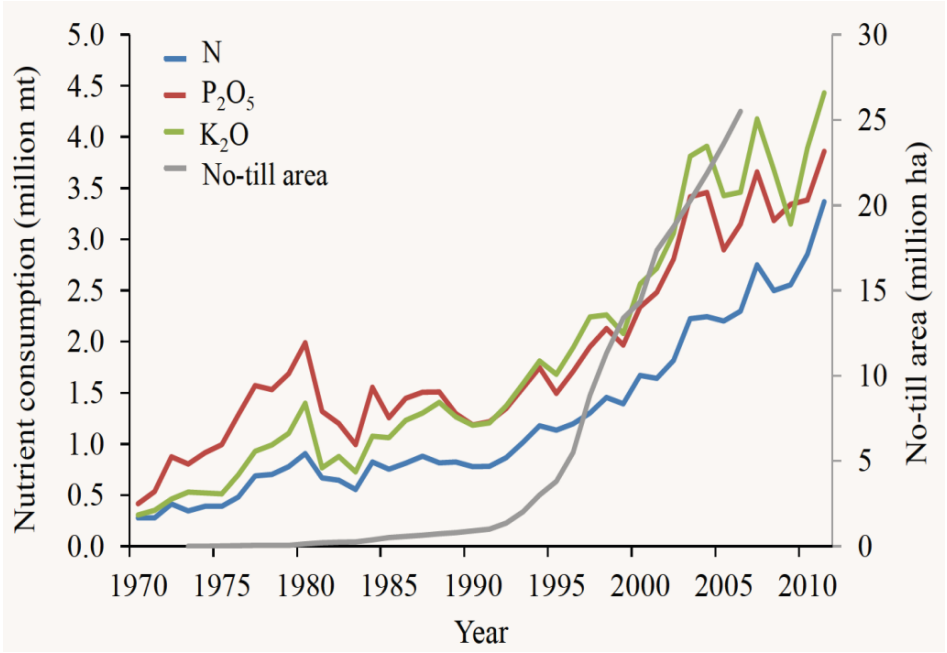
Source: www.unep.org/maweb/documents/document.281.aspx.pdf

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

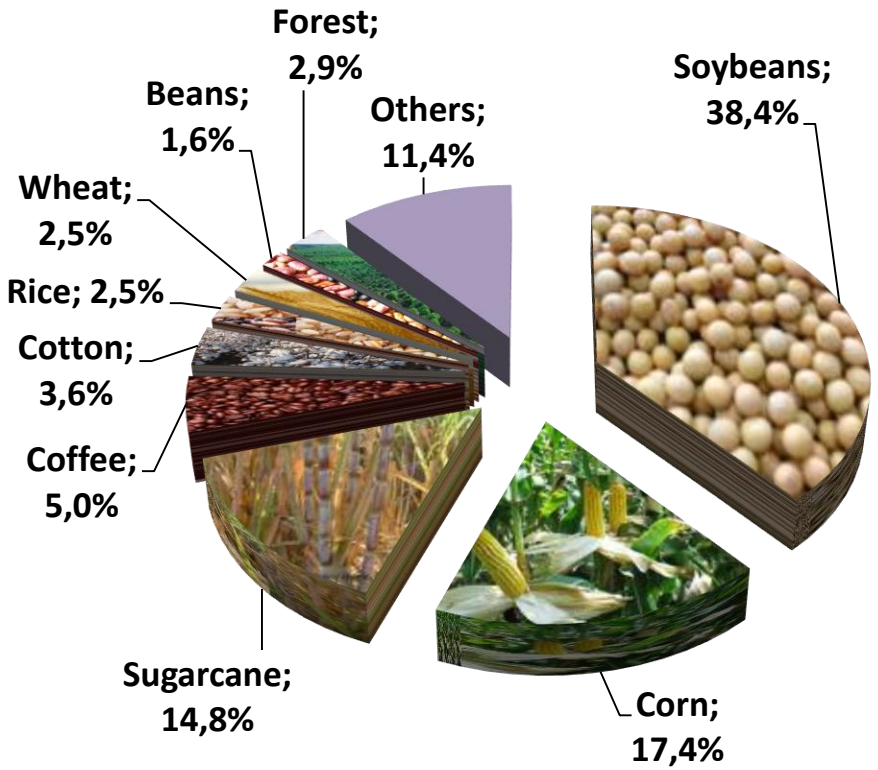
Fertilizer Use in Brazil

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



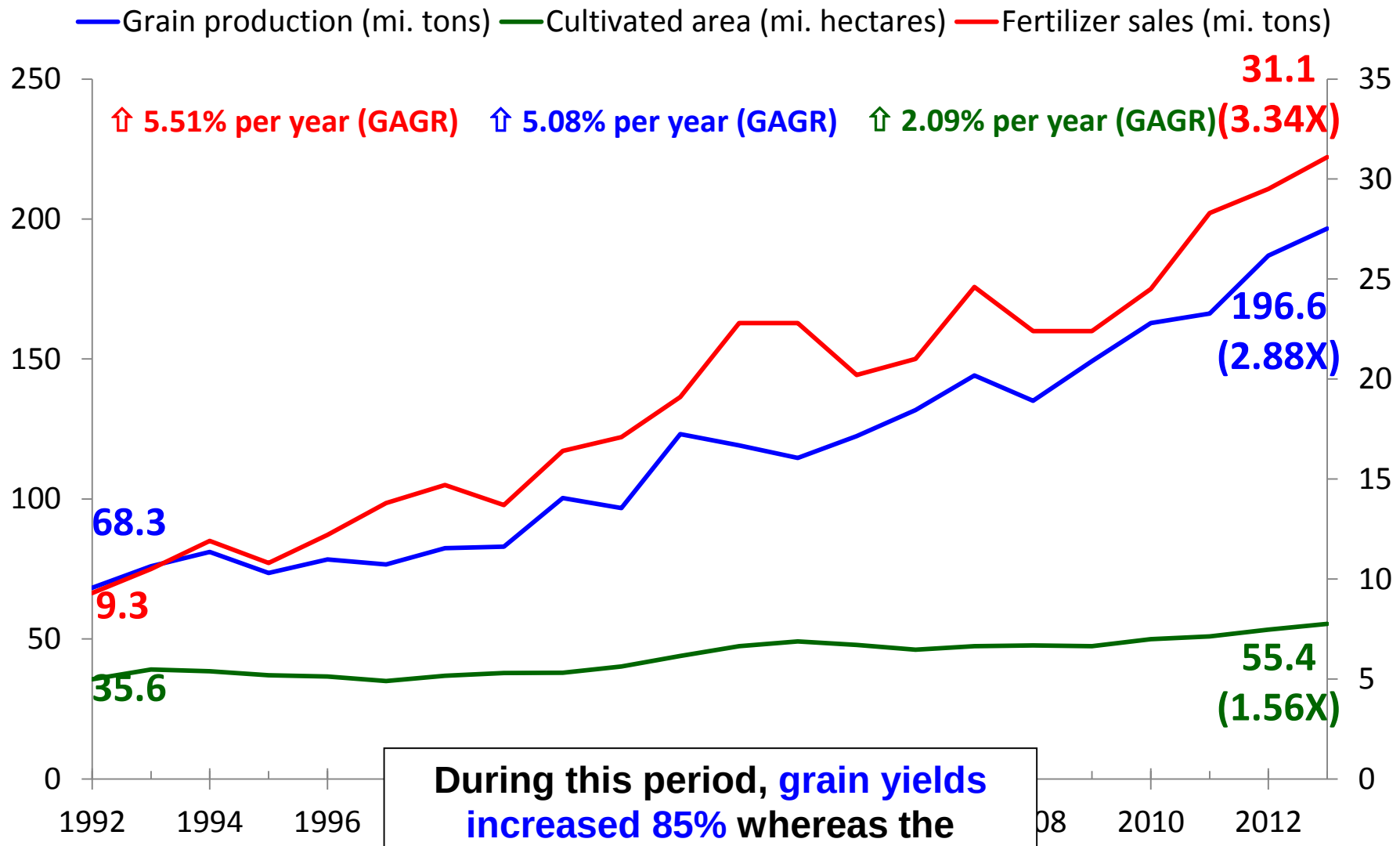
Brazilian fertilizer market share by crop in 2013 (Source: ANDA)



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

Brazil (1992-2013)

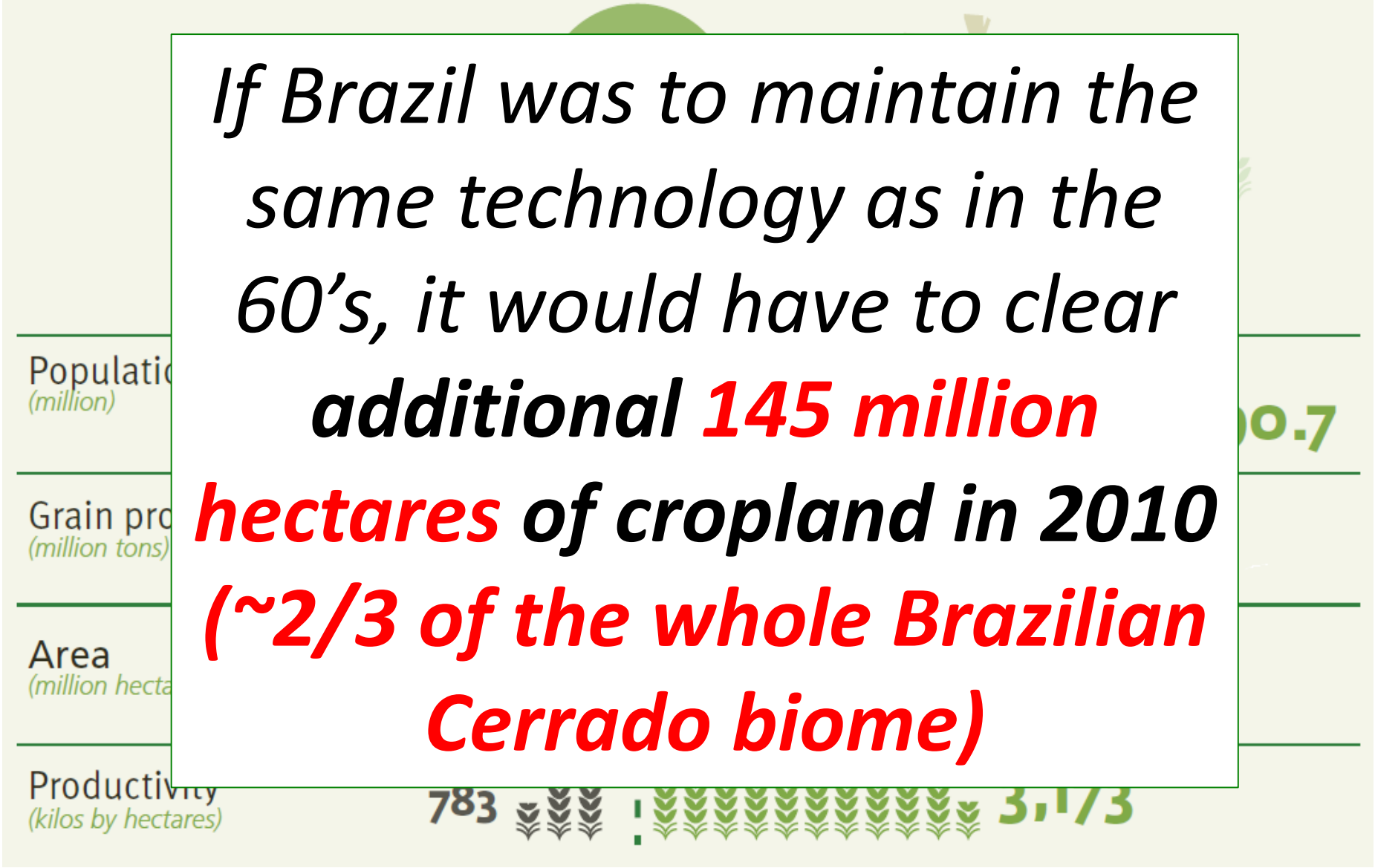
Evolution of Grain Production, Cultivated Area and Fertilizer Sales



During this period, grain yields increased 85% whereas the cultivated area increased 56%

Source: data from ANDA/CONAB/IBGE – Fertilizers, CONAB/IBGE – Area & Production

Evolution in grain production: Brazil 1960 – 2010



If Brazil was to maintain the same technology as in the 60's, it would have to clear ***additional 145 million hectares of cropland in 2010 (~2/3 of the whole Brazilian Cerrado biome)***

Sources: USDA and Brazilian Ministry of Agriculture, Livestock and Food Supply
www.agricultura.gov.br/arq_editor/file/Sala%20de%20Imprensa/Publica%C3%A7%C3%B5es/graficos_ingles.pdf

Livestock: evolution in beef production

Brazil: 1960 – 2010

If Brazil was to maintain the same technology as in the 60's, it would have to clear ***additional***

259 million hectares ***of pastureland in 2010***

(~2/3 of the whole Brazilian Amazon biome)

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Sources: USDA and Brazilian Ministry of Agriculture, Livestock and Food Supply
www.agricultura.gov.br/arq_editor/file/Sala%20de%20Imprensa/Publica%C3%A7%C3%B5es/graficos_ingles.pdf

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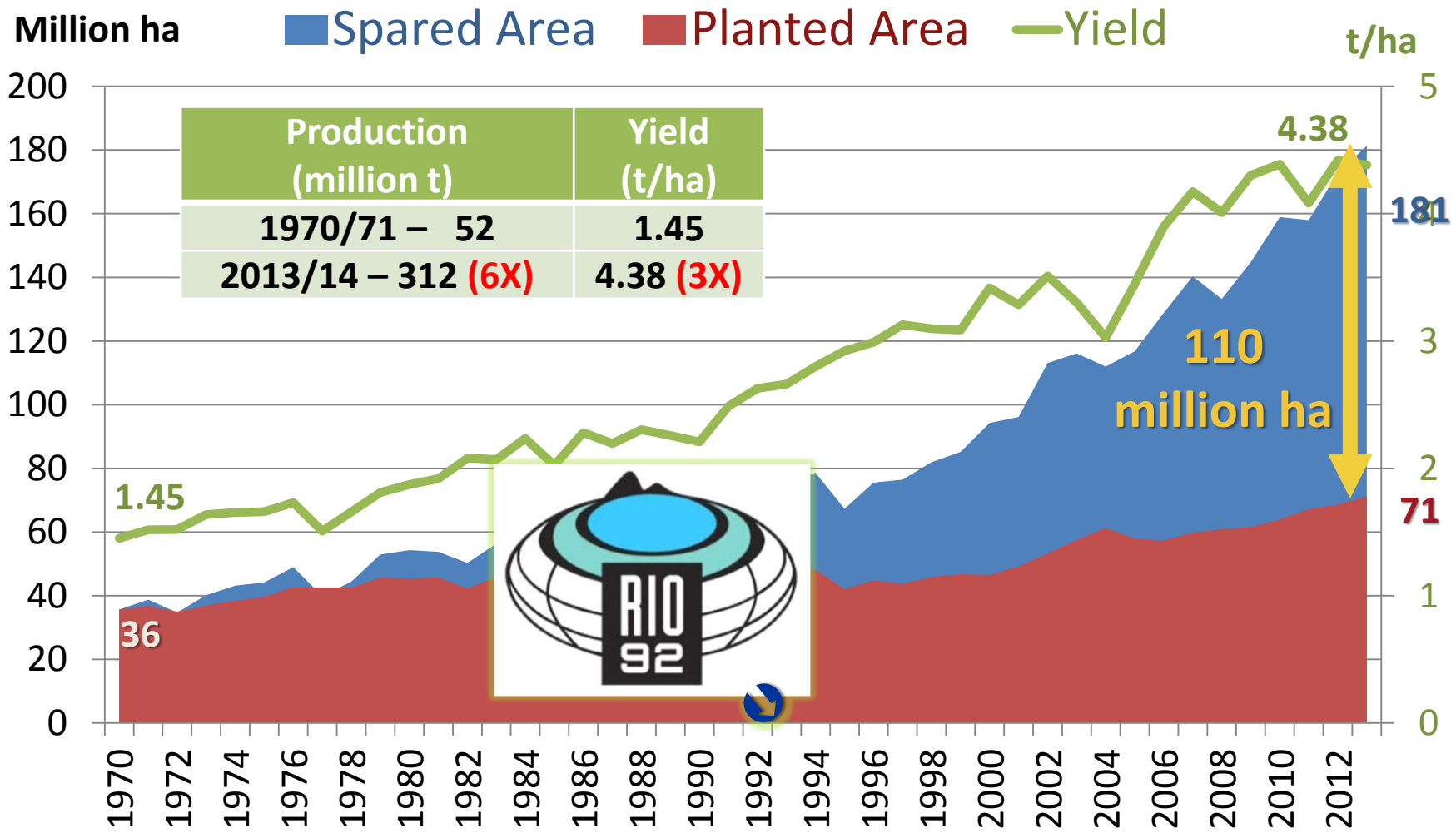
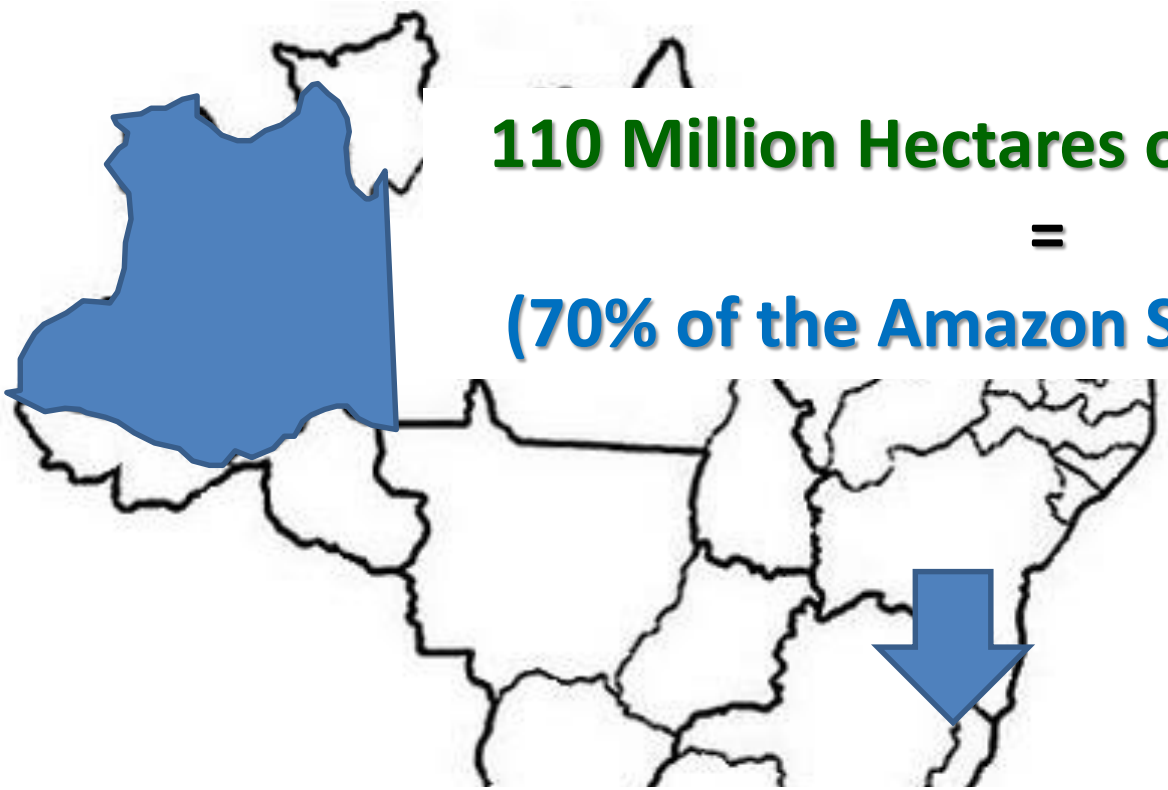
Increasing yields saves land in Brazil

Production (dry weight basis) and **yields** of 16 main crops and **spared area**, 1970/71 to 2013/14



Increasing yields saves land in Brazil



110 Million Hectares of Spared Land

=

(70% of the Amazon State in Brazil)

Environmental Benefits

(Ecological Sustainability)

The Cerrado Region in Brazil is an example that through adequate resource use and soil management we can guarantee the necessary agriculture production to help us ensuring food security at the national and global levels

Our next challenge:

Improve Sustainability and Food Quality

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Challenges *(and Opportunities)* for a Sustainable Agriculture in Brazil

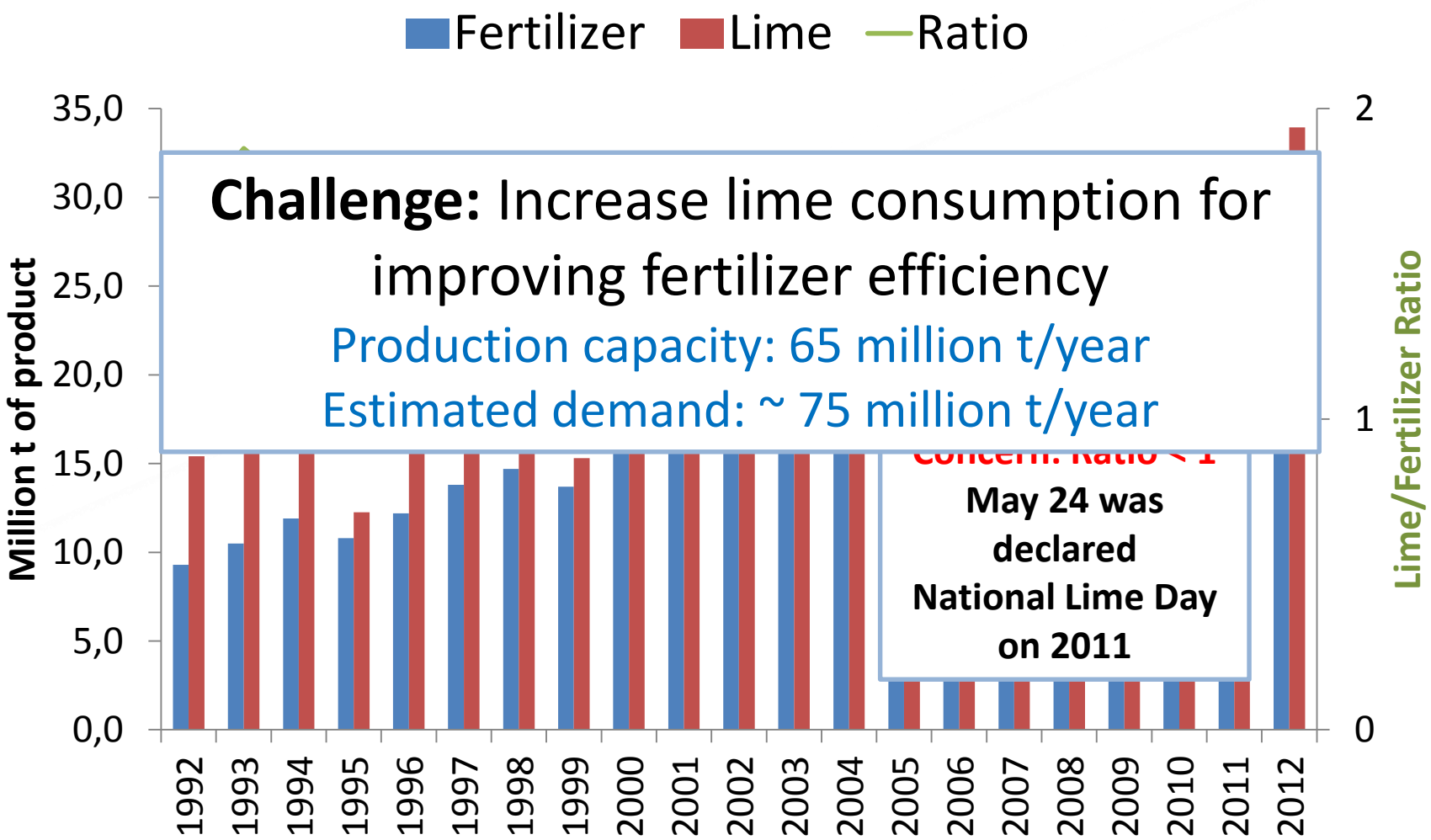
Challenges

☹ Some negative issues

- Technology use/transfer
  - Inconsistent lime consumption
    - ⇩ efficiency of fertilizers
  - Very low use of nitrogen
    - ⇩ potential for efficient use of other nutrients
  - Carbon sequestration in agriculture
- Fertilizer imports
- Food quality
- Logistical and infrastructure deficit

The problem of low consumption of lime

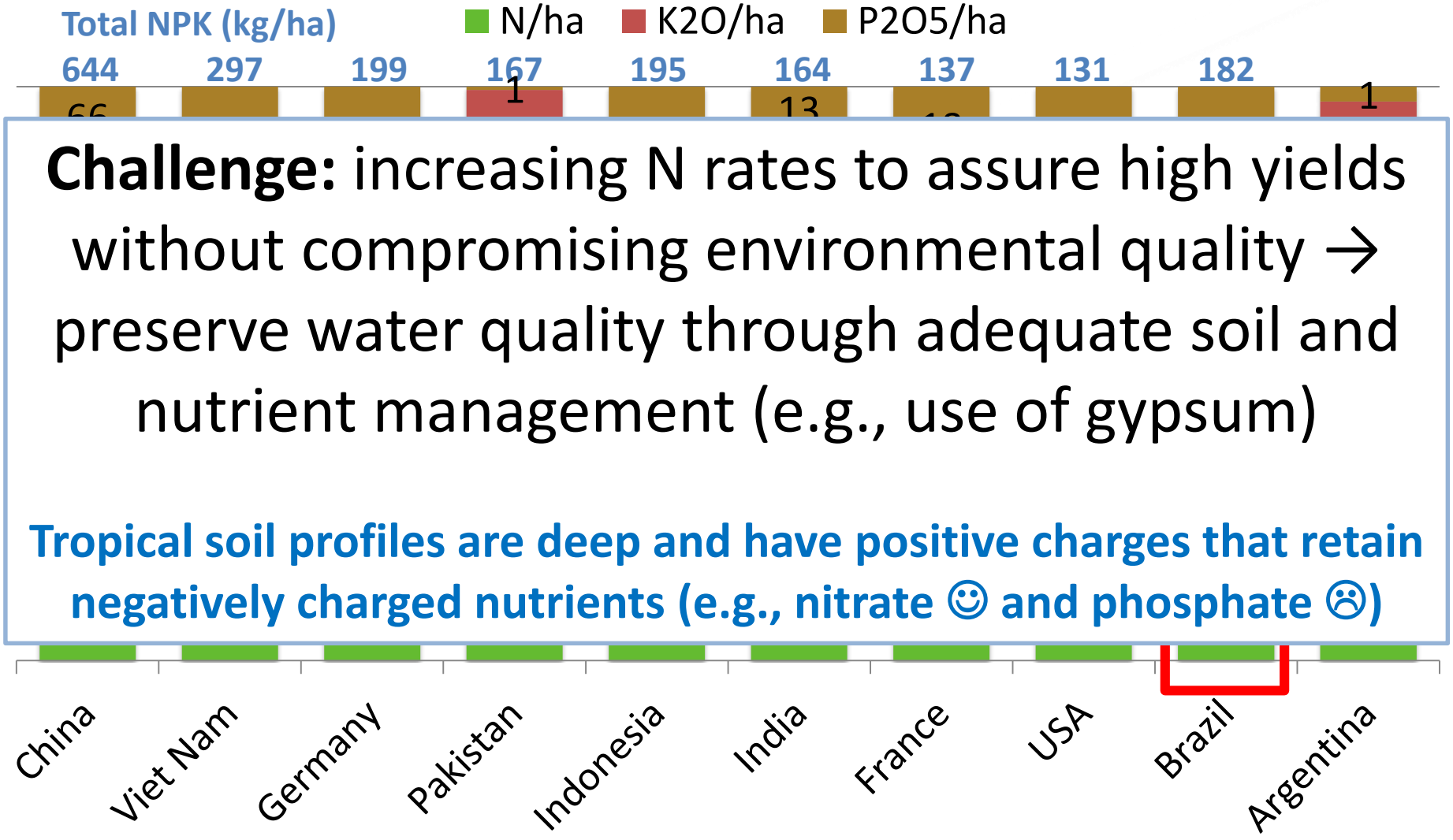
Fertilizer and Lime Consumption - Brazil (1992-2012)



Source: ABRACAL and ANDA (personal communication) and DNPM (https://sistemas.dnpm.gov.br/publicacao/mostra_imagem.asp?IDBancoArquivoArquivo=8971)

The problem of low N consumption in Brazil

Nutrient Consumption by Country - 2014 (kg/ha)



Challenge: increasing N rates to assure high yields without compromising environmental quality → preserve water quality through adequate soil and nutrient management (e.g., use of gypsum)

Tropical soil profiles are deep and have positive charges that retain negatively charged nutrients (e.g., nitrate ☺ and phosphate ☹)

Source: FAO Statistical Yearbook 2015. http://www.fao.org/3/a-i4691e.pdf

Brazil: 2006 Agricultural Census

Use of lime and mineral N fertilizers by farmers

- 84.1% of the farmers did not use lime
- 74.4% did not use mineral N fertilizer

- 78% of the farms (54% of the land) did not receive any agronomic or technical assistance. The average area of assisted group is 228 ha, while the unattended is 42 ha (smallholder farmers).

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

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The Law of Diminishing Returns in Agriculture

P. E. McNall. 1933. J. Ag. Research 47(3):167-178

"the first application (or first unit available for plant growth) of any single fertilizing element or factor of production causes a greater relative growth than any subsequent application of a like unit"

Thus, simulating smallholder farmers to use fertilizer is key to assure greater returns and nutrient use efficiency in Northeast and North Brazil

Also… ***"Smallholder farmers are among the best possible clients for climate finance. Such investments can increase agricultural productivity while at the same time restoring and maintaining a resilient natural resource base and reducing agriculture's carbon footprint."***

http://newsroom.unfccc.int/lpaa/agriculture/small-farms-big-impacts-adaptation-for-smallholder-agriculture-programme/

Soils for Food Security and Climate

- One priority: agricultural soils to ensure food security
- One Vision: The "4‰ Initiative : soils for food security and climate"
- **Why 4‰?**

  A "4‰" annual growth rate of the soil carbon stock would make it possible to stop the present increase in atmospheric CO_2…

  … is crucial to improve soil fertility and agricultural production …

  …complement the necessary efforts to comprehensively reduce global greenhouse gas emissions.

http://newsroom.unfccc.int/media/408539/4-per-1000-initiative.pdf

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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

Nitrogen 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)**.

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 a
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

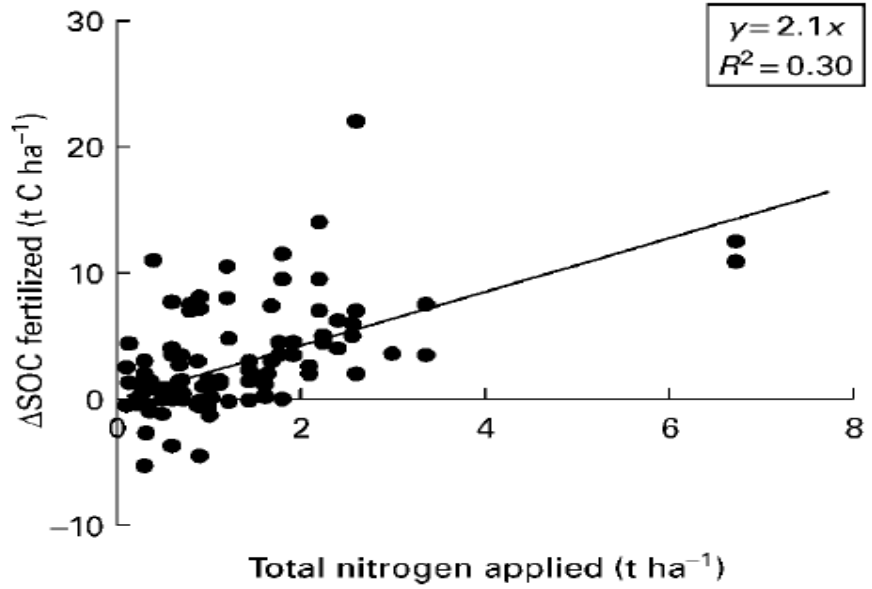

Figure 1. Relationship between carbon content differences of fertilized and control treatments (ΔSOC fertilized) and the total nitrogen applied in experiments with crop residues retained.

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Challenge: conserving organic matter in tropical agricultural systems

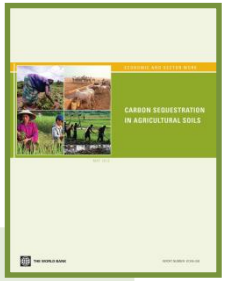
Nutrient Management

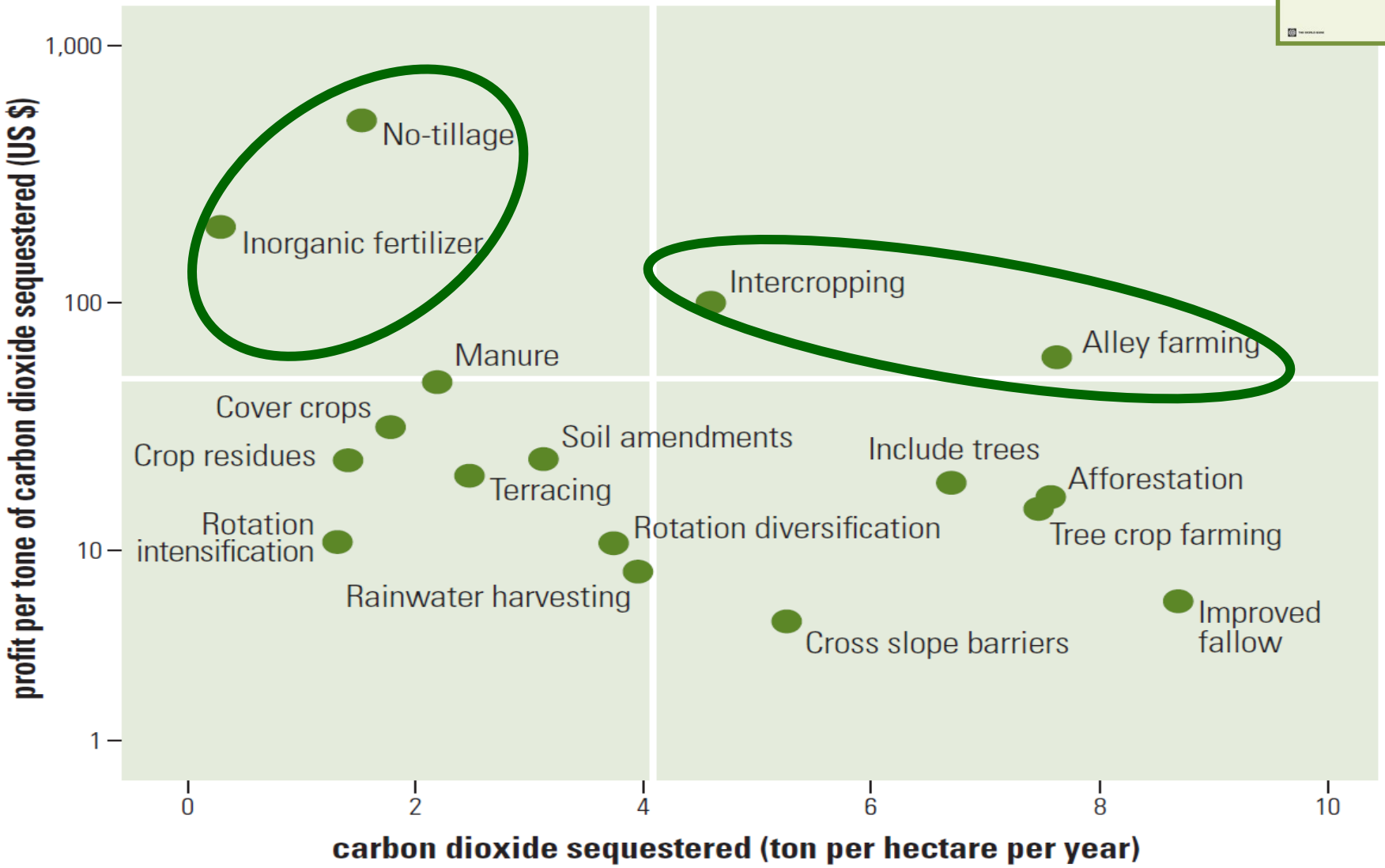
Fertilizer use sequesters carbon by stimulating biomass production. Judicious fertilizer application also counters nutrient depletion, reduces deforestation and expansion of cultivation to marginal areas, and increases crop yields.

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

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Challenge: Towards Food Security at National and Global Level

The Five Dimensions of Food Security and Proposed Indicators

(1) food sufficiency (quantity)

- Undernourishment indicator

(2) nutrient ad

- To be develo … alue of food balance shee

(3) cultural acc

- National agg … ptability sub-scale

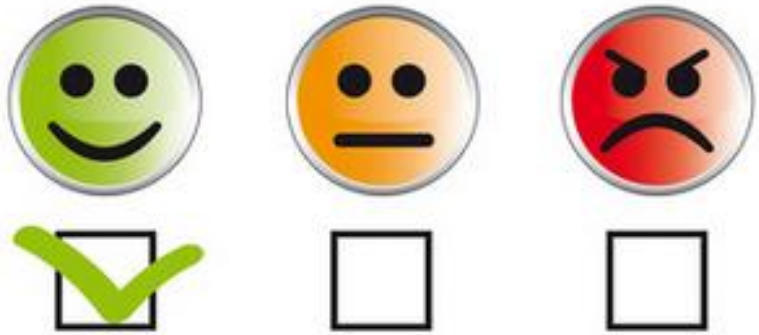
(4) safety

- To be determined

(5) certainty and stability

- Coefficient of variation(CV) of calorie adequacy and of other priority nutrients
- CV of food prices

How good we are?



Source: Global Food Security 2:188-194, 2013

Food security: why food quality is important?

LETT

Increasi

Samuel S. Myers[1,2],
Lee H. Dietterich[7], C
Victor Raboy[13], Hide

Dietary deficiencies c
health problem. An e
ciencies[1], causing a lo
these people depend
dietary source of zinc
legumes have lower c
under field condition
tion predicted for th
legumes also have lo
crops seem to be less
single crop suggest th
spheric CO_2 concentration could partly address these new challenges to global health.

*"Here we report that **C3 grains and legumes have lower concentrations of zinc and iron when grown under field conditions at the elevated atmospheric CO_2 concentration predicted for the middle of this century**. C3 crops other than legumes also have lower concentrations of protein, whereas C4 crops seem to be less affected. **Differences between cultivars of a single crop suggest that breeding for decreased sensitivity to atmospheric CO_2 concentration could partly address these new challenges to global health.**"*

We found that elevated [CO_2] was associated with significant decreases in the concentrations of zinc and iron in all C_3 grasses and le-

Source: *Nature* (2014) doi:10.1038/nature13179. Published online 07 May 2014

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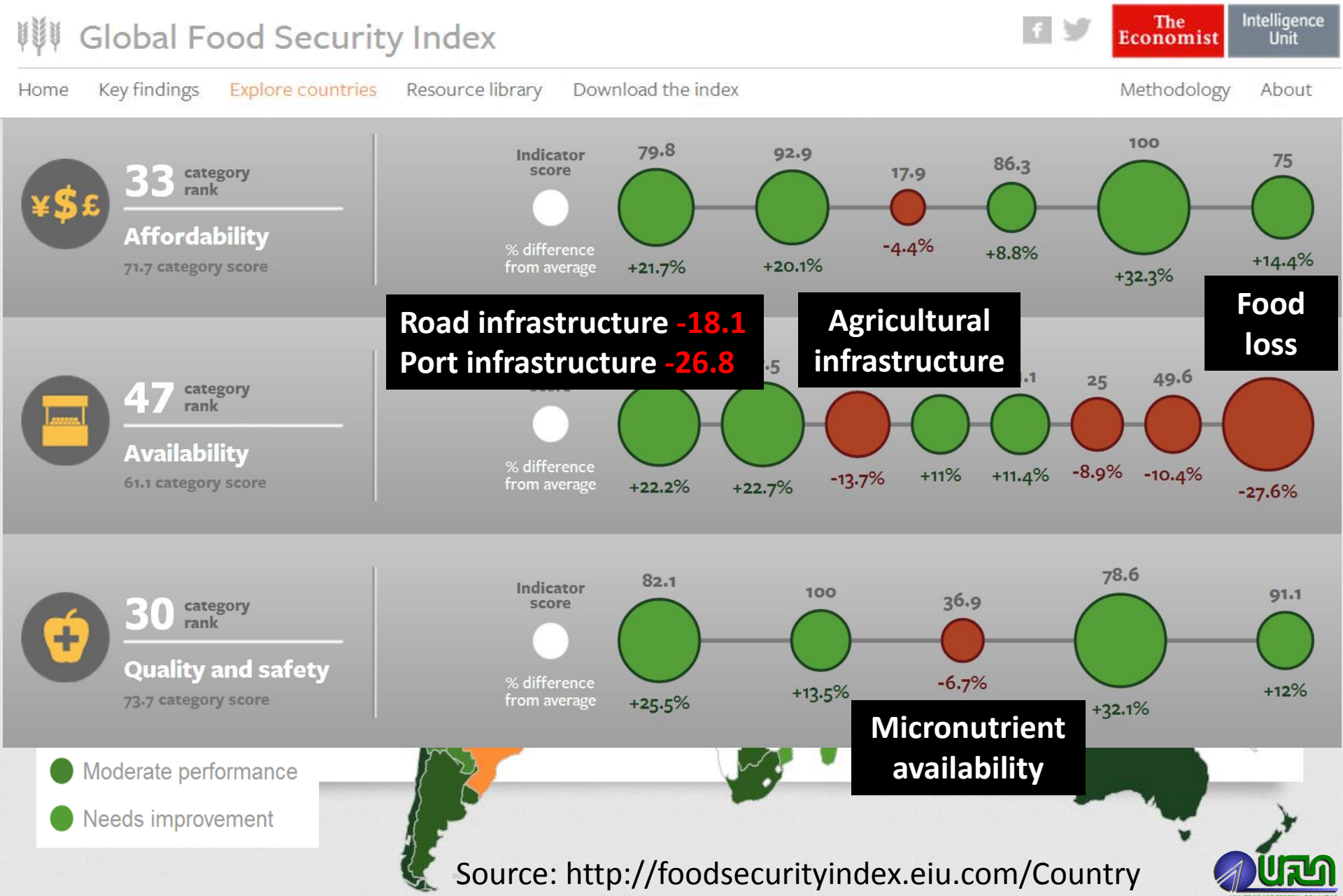
Global food security index: Brazil (2015)



Source: http://foodsecurityindex.eiu.com/Country

Challenges: Logistical and infrastructure deficit

- The Ministry of Agriculture, Livestock and Supply (MAPA) estimates **losses from 10% to 15%** of what is produced due to poor infrastructure
- From the farm gate inside the Brazilian agriculture is improving. But there **is a long way after the harvest…**
- The National Plan of Logistics and Transport (PNLT) estimates that around 150-200 US$ billion are needed by 2025 to address the **bottlenecks in Brazilian infrastructure**

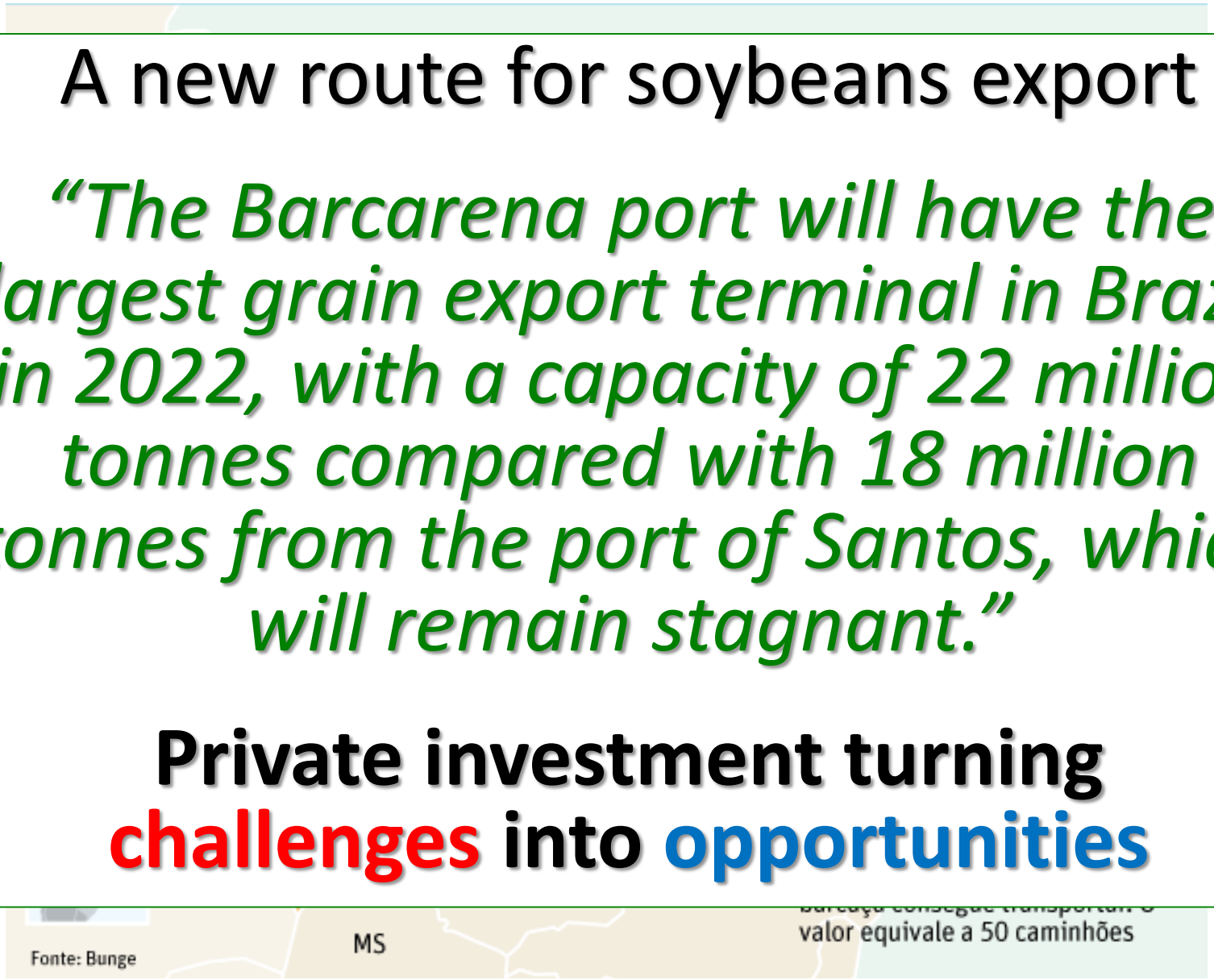
Source: Associação Nacional dos Exportadores de Cereais (Anec)
http://souagro.com.br/infraestrutura-logistica-deficiente-custa-caro-para-a-populacao/

Port Logistics: turning challenges into opportunities

A new route for soybeans export

"The Barcarena port will have the largest grain export terminal in Brazil in 2022, with a capacity of 22 million tonnes compared with 18 million tonnes from the port of Santos, which will remain stagnant."

Private investment turning challenges into opportunities



Source: Folha de Sao Paulo (Brazilian newspaper) – April 25, 2014.

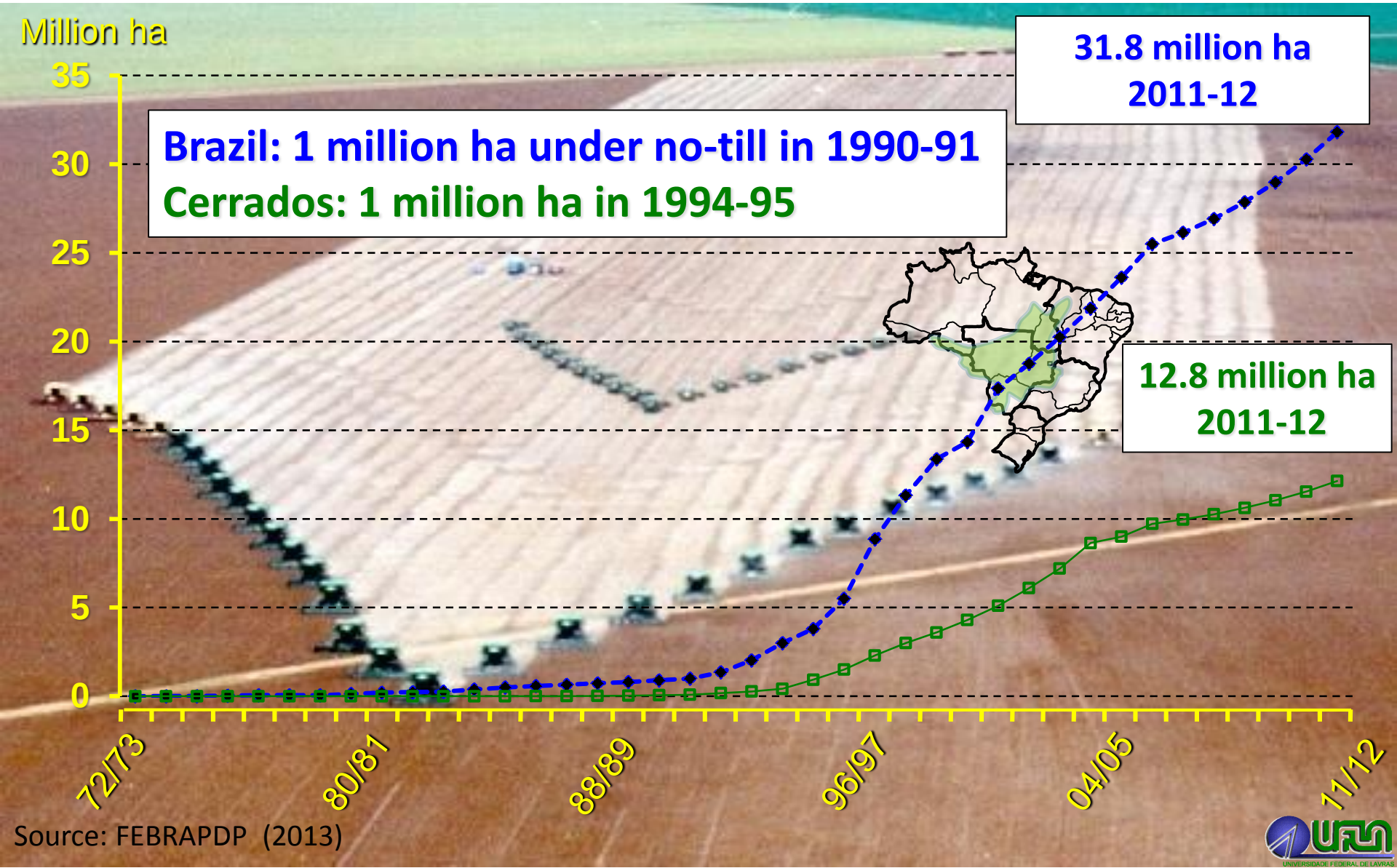
Opportunities

☺ Some positive issues

- Diversity of products and markets
- Technology development for low-carbon agriculture: no till, crop/livestook/forestry integration
- Agroenergy know-how: ethanol experience (70's)

Agri-technology: no-till at Fazenda Filadélfia

State of Mato Grosso (Cerrado)



Source: FEBRAPDP (2013)

Conserving organic matter with no-till

ELSEVIER

Available online at www.sciencedirect.com

ScienceDir

Soil &

Soil & Tillage Research 91 (2006) 24

Short communicat

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

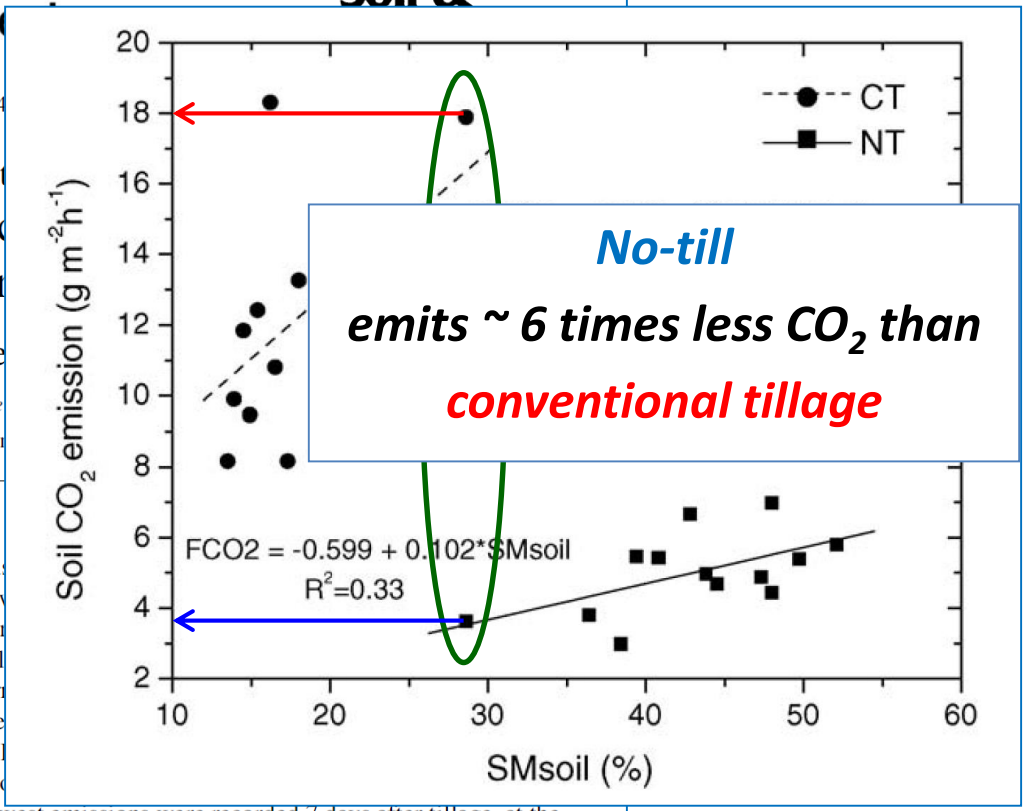
N. La Scala Jr.*, D. Bolonhe

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

Received 10 January 2005; received in revised form 22 Nover

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 harr
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



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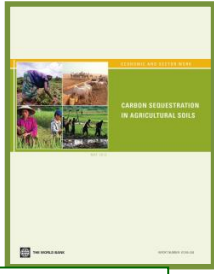
Tillage, Crop Residue Management, and Soil Carbon Sequestration Rates (kg C ha^{-1} yr^{-1})



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

Examples of a "Green Agriculture" in the Cerrado

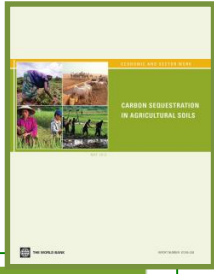
one of the most productive regions in Brazil in terms of grain, beef cattle, and agro-energy production, as well as reforestation

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.

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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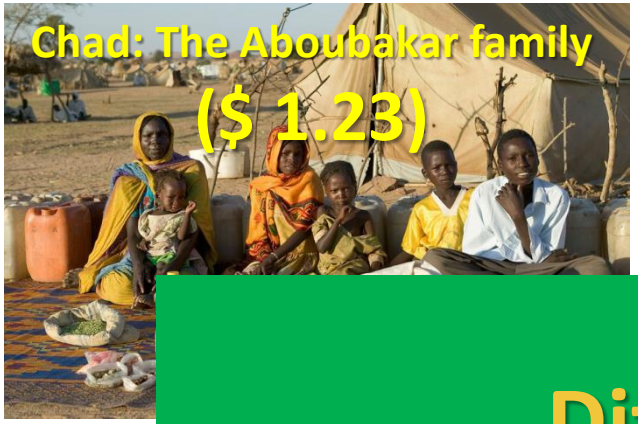
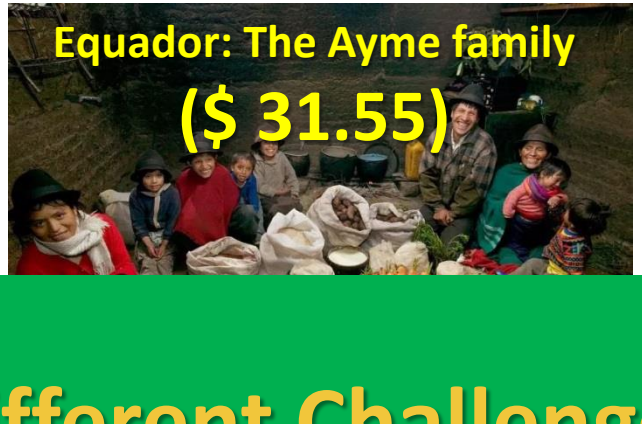
Final Remarks

Hungry Planet: What The World Eats

Food expenditure for one week for families living in different countries (US$)





Different Challenges...

Different Opportunities...

Source: http://time.com/8515/hungry-planet-what-the-world-eats/

Brazil's role in the global bio-economy

- *Throughout history, agriculture and natural resources have been used for the production of food, feed, fibre, fuel, and environmental goods.*
- ***Recent developments have led to a rapidly growing and globally integrated "bio-economy."***

  … includes all industries and economic sectors that produce, manage, and exploit biological resources.
- ***The opportunities and challenges for the global bio-economy are significant… …new developments… …"old problems"… …global hunger and poverty… …sustainable natural resource management…***

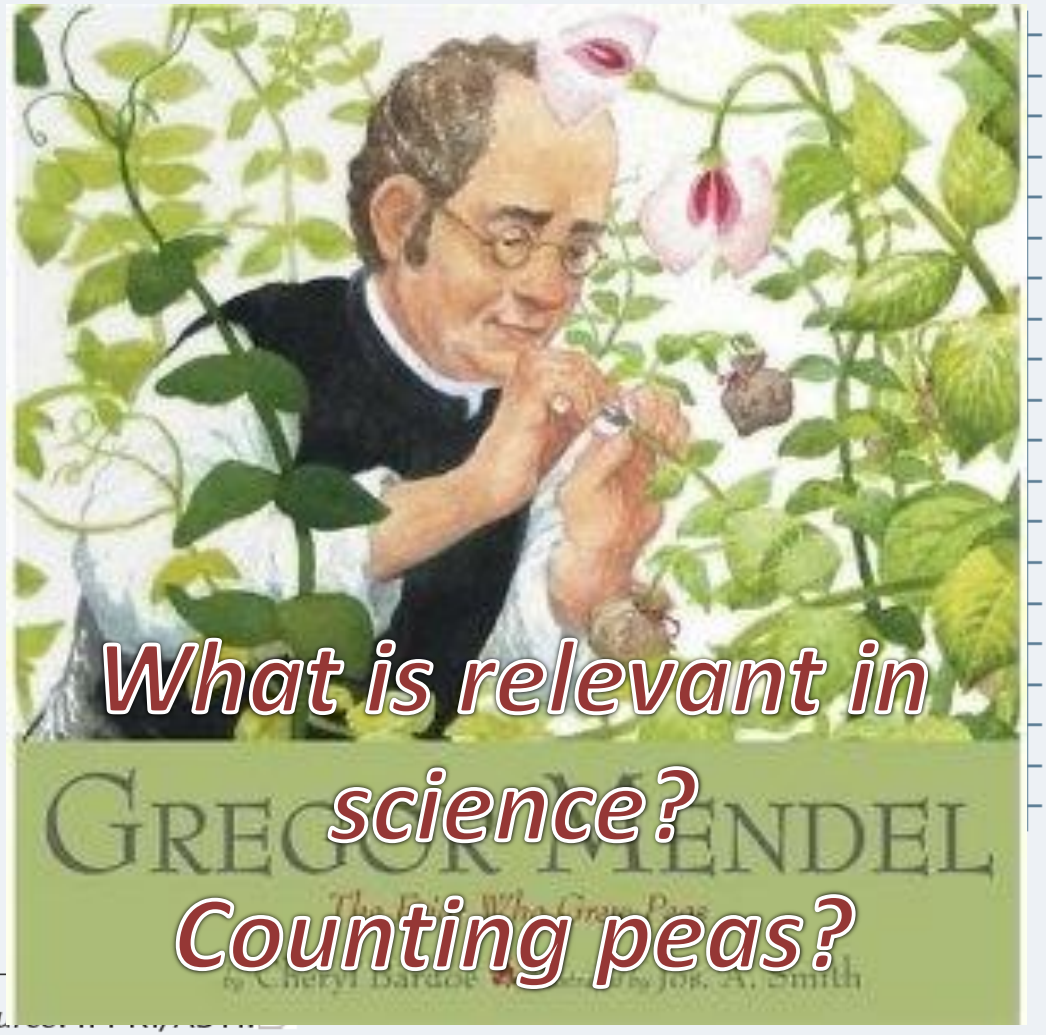
Source: Agricultural Economics 44:supplement 1–5, 2013

Public Ag. Research Expenditure (% of Ag. GDP)

Top 20 countries

CHART 22: **Total public agricultural research expenditure, share of agricultural GDP, top 20 countries (2006-2010*)**

Countries with highest values

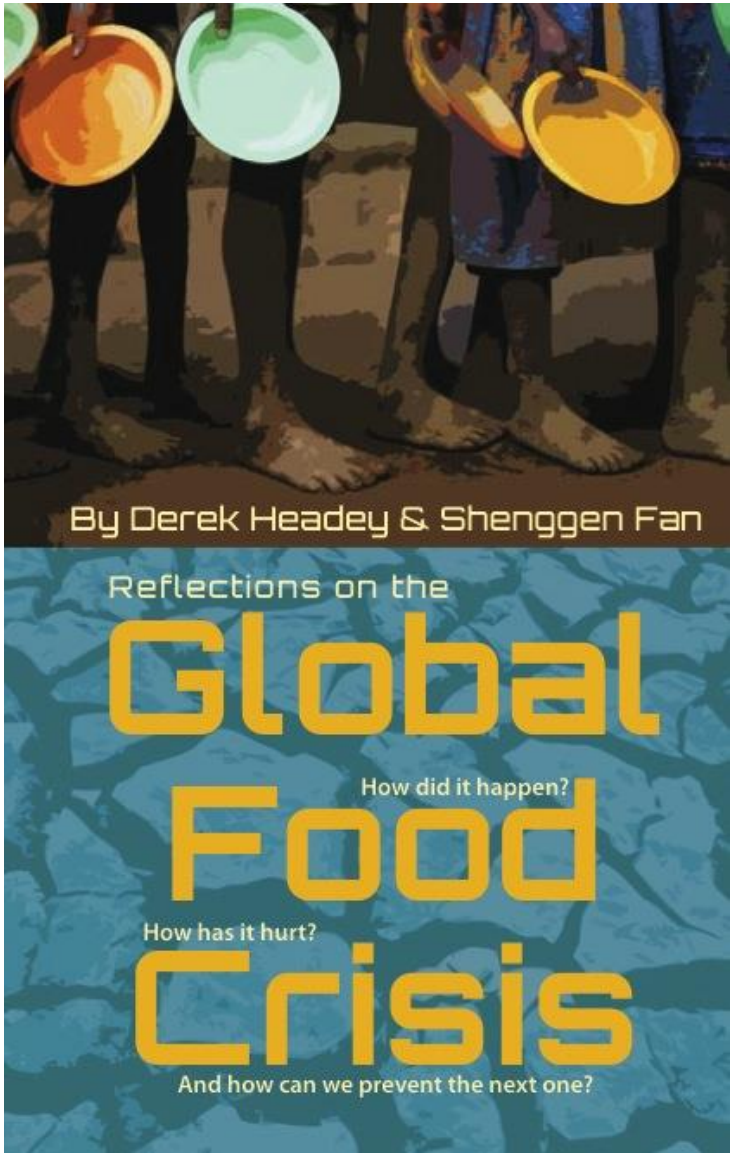


What is relevant in science?

Counting peas?

Source: FAO Statistical Yearbook 2013. www.fao.org/docrep/018/i3107e/i3107e.PDF

Take-home message



- Brazil has a major role on ensuring food security – as well as fibers and renewable fuel – at the global level
- While Ag. technology has developed rapidly in Brazil, lack of adequate infrastructure is Brazilian agriculture Achilles' hell, yet technology transfer is still a vulnerable issue that compromise food security
- Providing 4Fs – food, feed, fiber & fuel – while assuring environmental preservation is our next great challenge

UFLA
UNIVERSIDADE FEDERAL DE LAVRAS

Thank you !!!
Obrigado!!!

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luiz.guilherme@pesquisador.cnpq.br

53-ha Brazilian flag planted with Barley Canola Triticale Lupin