

# ***Opportunities and threats related to global biofuels expansion***



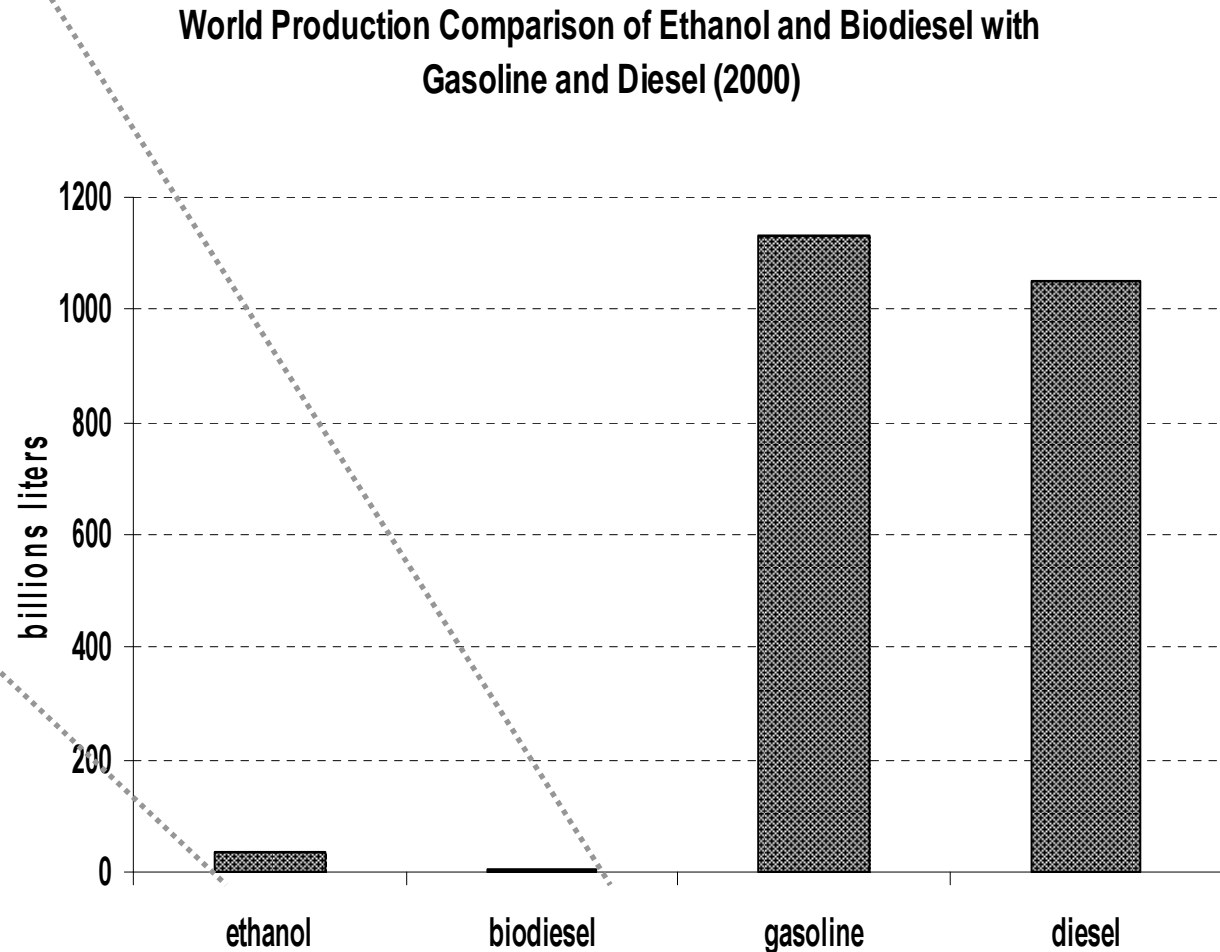
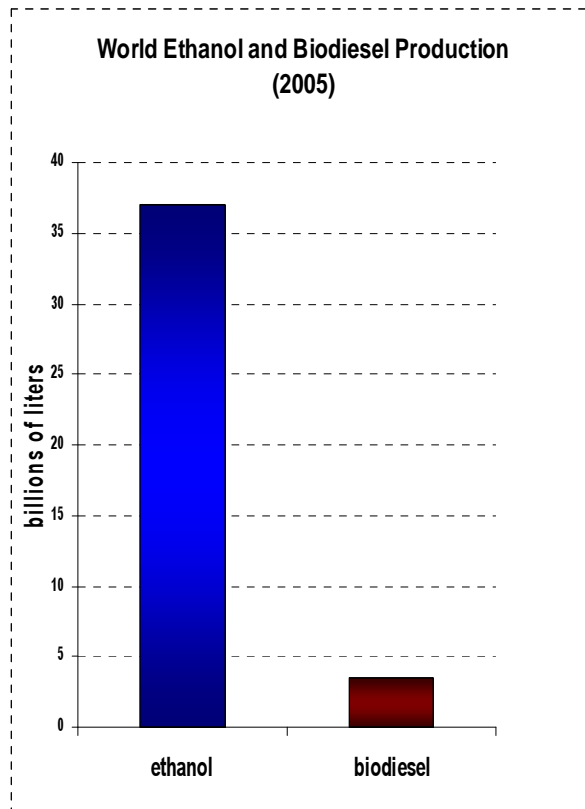
**SOY (left), SUGARCANE (middle), OIL PALM (right)**



**HYBRID POPLAR (left), WILLOW (middle), EUCALYPTUS (right)**

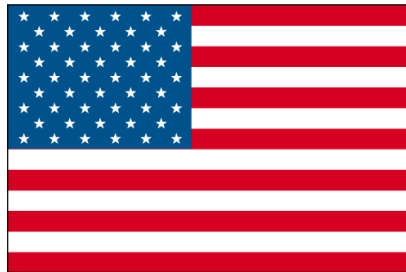
**Michael Totten & John Buchanan  
March 27, 2007**

# Biofuels Today...



... a tiny fraction of the 2.2+ trillion liters of gasoline and diesel produced annually.

# Biofuel Targets



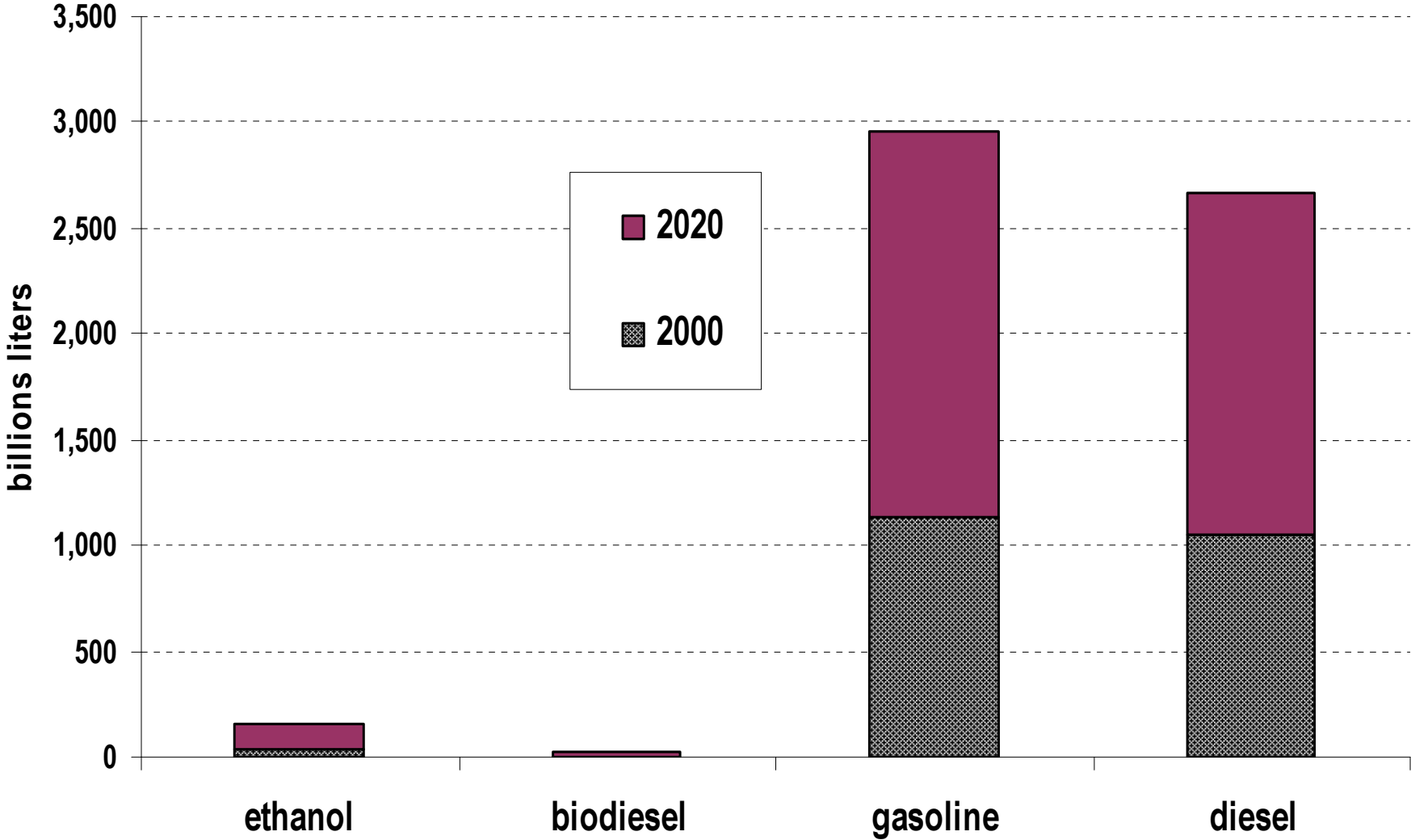
**2017** USA target year under proposal by President Bush for achieving use of 140 billion liters of alternative fuels within the United States.

**2030** Target year set by the U.S. Department of Energy to displace 30 percent of gasoline demand (from 2004 levels) in the USA with biofuels, primarily ethanol.

EU Member States Biofuel Targets

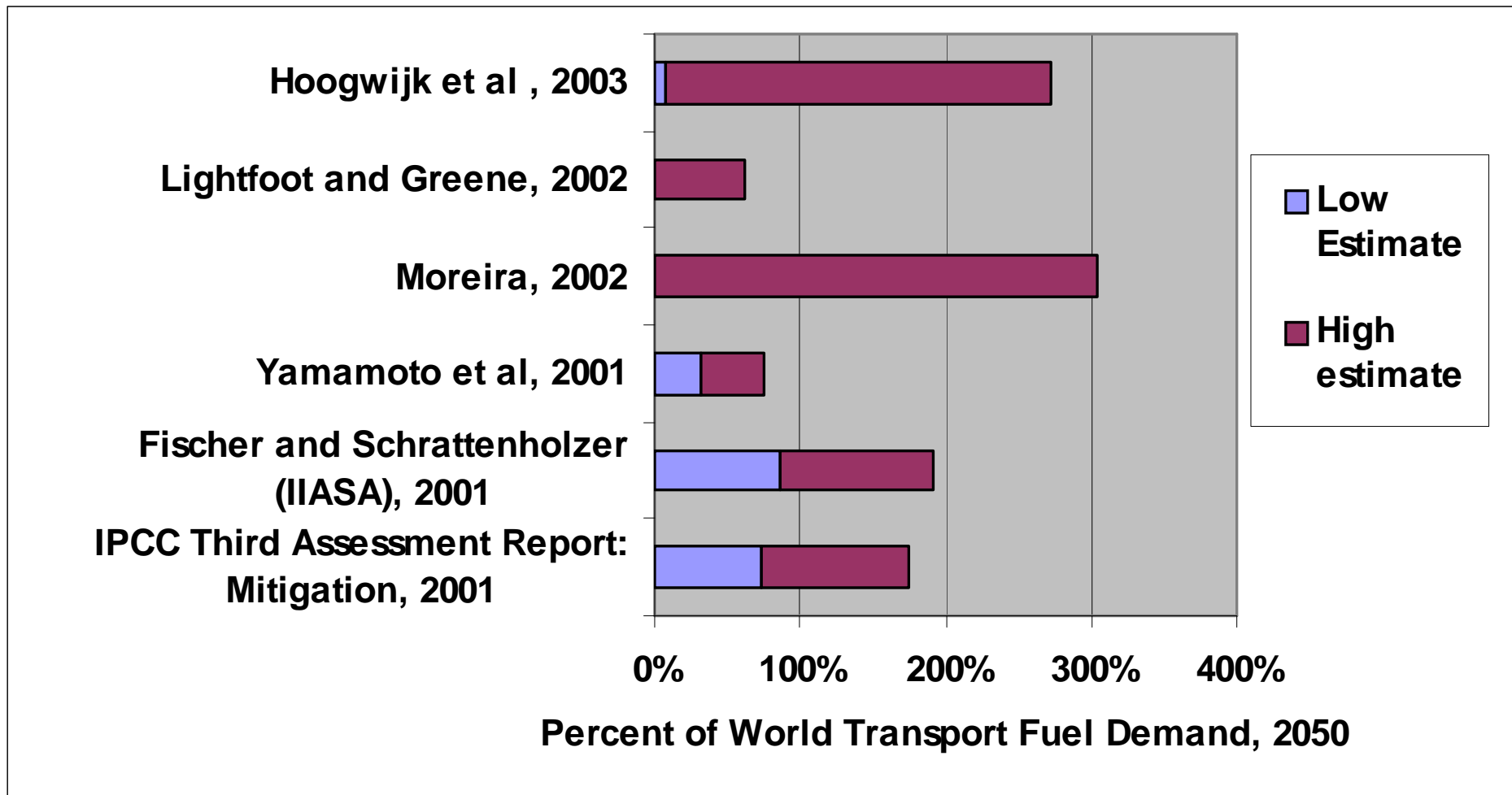
Country	2005 Target (%)	2010 Target (%)
EU Target	2	5.75
Austria	2.5	5.75
Cyprus	1	5.75
Czech Republic	3.7 (2006)	5.55
Denmark	0	Not Available
Estonia	2	Not Available
Finland	0.1	Not Available
France	5.75 (2008)	7
Germany:Ethanol	1.2 mandate (2007)	3.6 mandate
Germany: Biodiesel	4.4 mandate(2006)	6.17 mandate
Greece	0.7	5.75
Hungary	0.4-0.6	Not Available
Ireland	0.6	Not Available
Italy	1	2.5
Latvia	2	5.75
Lithuania	2	5.75
Luxembourg	Not Available	5.75
Malta	0.3	Not Available
Netherlands	2 mandate (2007)	5.75 mandate
Poland	0.5	5.75
Portugal	2	Not Available
Slovakia	2	5.75
Slovenia	0.65	5
Spain	2	Not Available
Sweden	3	5.75
United Kingdom	0.3	3.5

# Biofuels 2020 Worldwide Projection



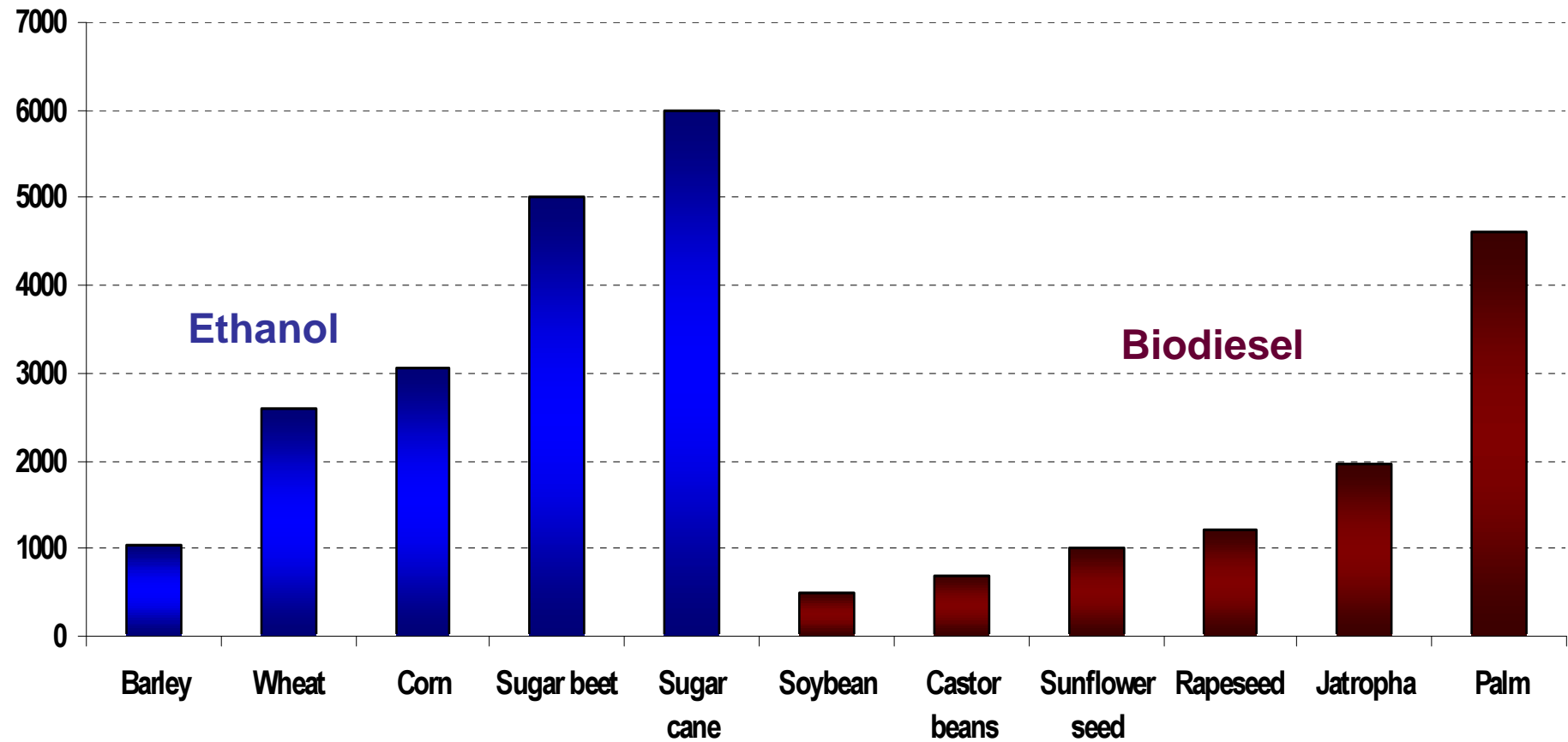
Source: IEA/OECD, 2004, *Biofuels for Transport: An International Perspective*

# Global Technical Potential for Transport Energy Requirements Provided by Biofuels, 2050



## Biofuel Yields of Selected Ethanol & Biodiesel Feedstock (2004)

liters/ha



# View 1

## Biofuels is about Feedstocks

### ⇒ **Largest cost component: feedstock**

- 58-65% of ethanol production cost in Brazil
- At least 70% of cost of biodiesel from Jatropha in India in one preliminary study

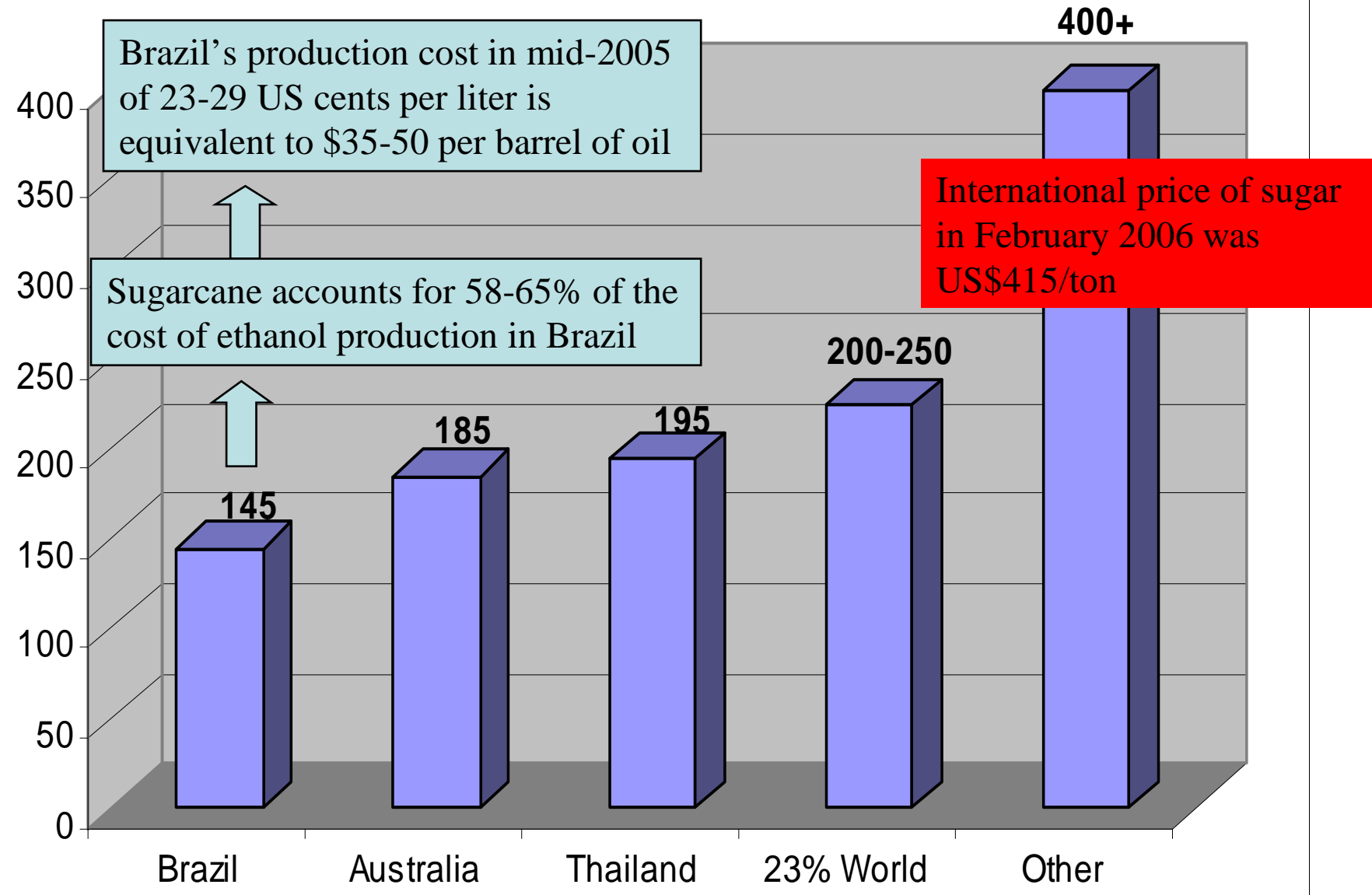
### ⇒ **Biofuel's economics stand or fall with agriculture**

- Liberalization of global agricultural trade could increase world feedstock prices
  - 30-40% increase for sugar
  - Slight increase for maize
  - Virtually no effect on soybeans

# View 1- Biodiesel: comparison with vegetable oil prices

- Soybean oil
  - \$500/ton = \$0.46 per liter
- Palm oil
  - \$400/ton = \$0.37 per liter
- Coconut oil
  - \$560/ton = \$0.52 per liter
- Add \$0.10-\$0.15 per liter for converting vegetable oil into biodiesel

# Sugar Production Costs (US\$/ton), mid-2005



Source: ESMAP, *Potential for Biofuels for Transport in Developing Countries*, 10/05, [www.worldbank.org/](http://www.worldbank.org/).

## View 2

# Economics is about Processing, not Feedstocks

*The cost of processing, not feedstock, is the key factor impeding cost-competitiveness*

<u>Feedstock</u>	<u>Representative Price</u>	<u>\$/GigaJoule(GJ)</u>
Low-Cost Cellulosic Residues	0 to \$30/dd ton	0 to 1.7
Cellulosic Energy Crops	\$35 to \$50/dd ton	2 to 2.9
Crude Oil	\$35 to \$70/bbl	6.1 to 12.2
Corn (kernels)	\$2.50/bu	5.0

*Whether accomplished by enzymatic hydrolysis, acid hydrolysis, gasification, or pyrolysis, conversion of cellulosic biomass to reactive intermediates:*

- Represents the largest cost among process steps
- Is the least technologically mature
- Has the greatest potential for R&D-driven improvement

# Different Plant Feedstocks are Responsive to Different Objectives

Feedstock	Potential Scale of Fuel Production		Rural Economic Development		Petroleum Displacement (Security)		Fossil Fuel Displacement/ GHG Reductions		Improved Soil Fertility & Ag. Ecology	Low Fuel Cost (feedstock & conversion)	
	Per unit	Total	Near term	Long term	Per unit	Total	Per unit	Total		Near term	Long term
<b>Cellulosic</b>	+++++	+++++	+	+++++	+++++	+++++	+++++	+++++	+++++	++	+++++
<b>Starch-rich</b>	+++	++	++++ +	+++	+++++	+++	++	++	++	+++	+++
<b>Sugar-rich</b>	+++	+++	++++ +	+++	+++++	+++++	+++++	+++++	+++++	+++	+++
<b>Oil seed</b>	+	+	+++++	++	+++++	+	+++++	+	+++	++	++

## Ratings:

+++++	excellent
++++	very good
+++	good
++	fair
+	poor

This is a work in Progress and still being revised.  
One major objective in need of inclusion  
is biodiversity protection.

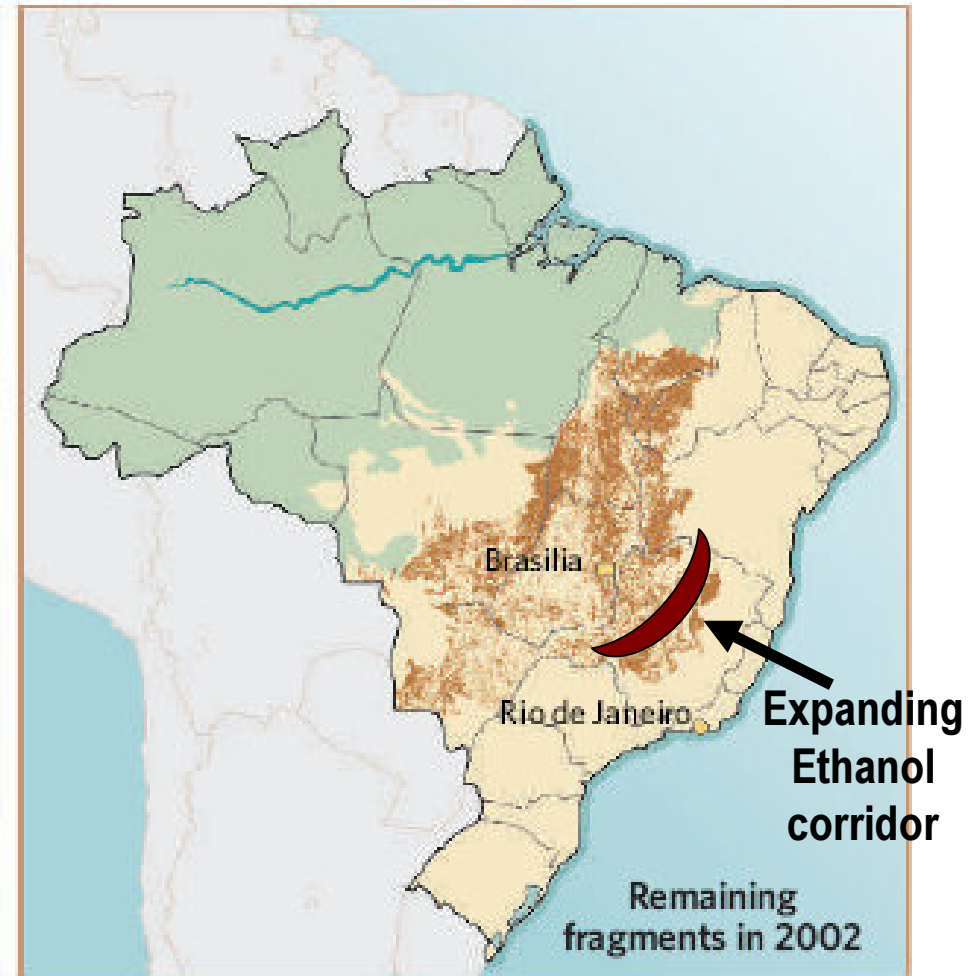
# ***First Principle – Do No Harm*** **Agricultural Expansion in the Cerrado Biodiversity Hotspot**



**Erosion in Brazil after 10 years  
of production in the Cerrado**



**Erosion in Brazil after 20 years  
of production in the Cerrado**



**55% of the 2 million km<sup>2</sup> Brazilian Cerrado – richest tropical savanna in world – converted to agricultural purposes (i.e., ranching, soy, cotton, corn).**

**Deforestation rate is ~1.5% or 3 million hectares (7.4 million acres) per year.**

**Higher rate of clearing than in the Amazon, and if current rates continue, natural Cerrado habitat will be gone by 2030.**

# Oil Palm and Forest Cover in Borneo



Forest Cover 1950



Forest Cover 1985



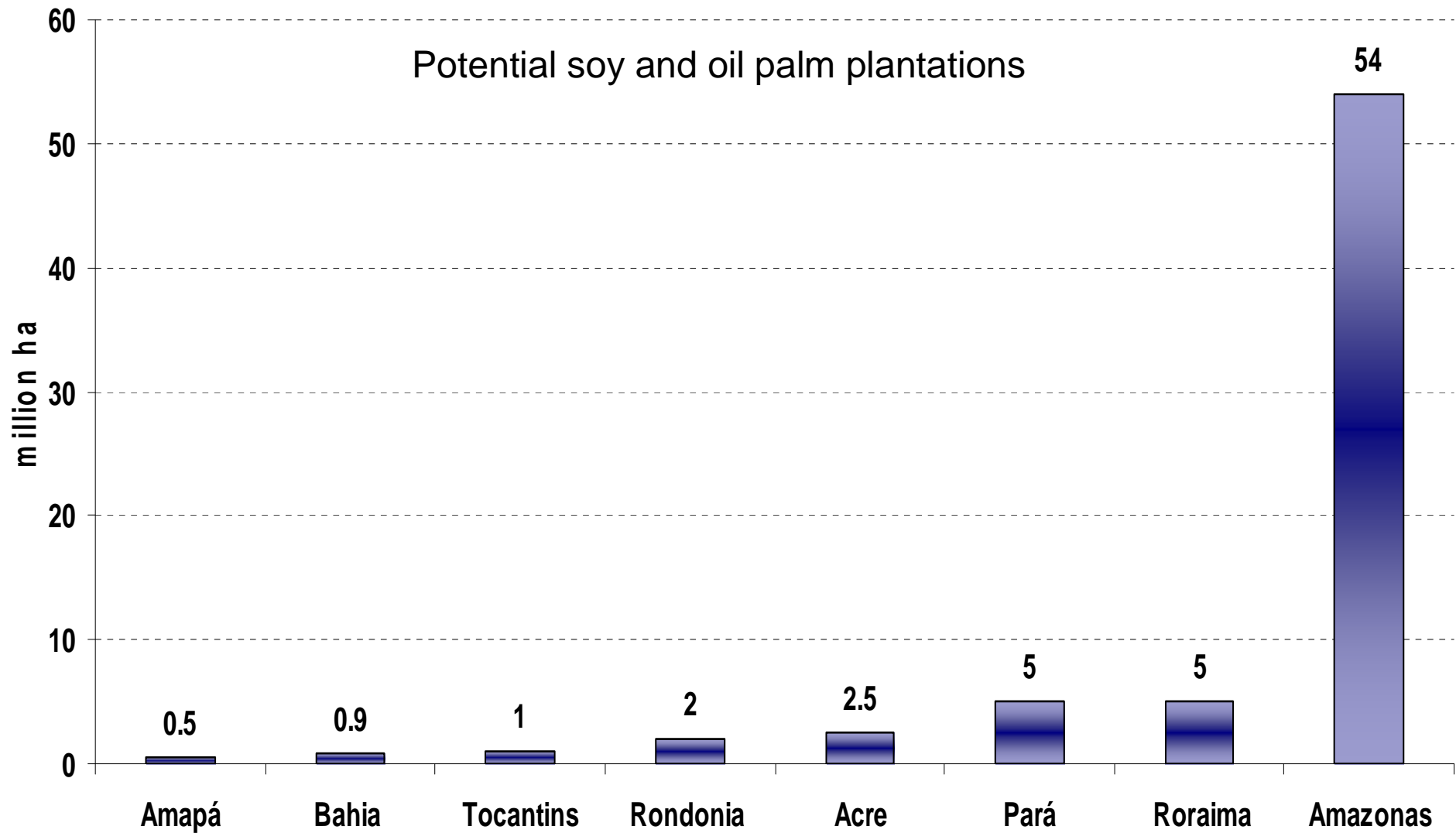
Approximate Forest Cover 2010



Approximate Forest Cover 2020

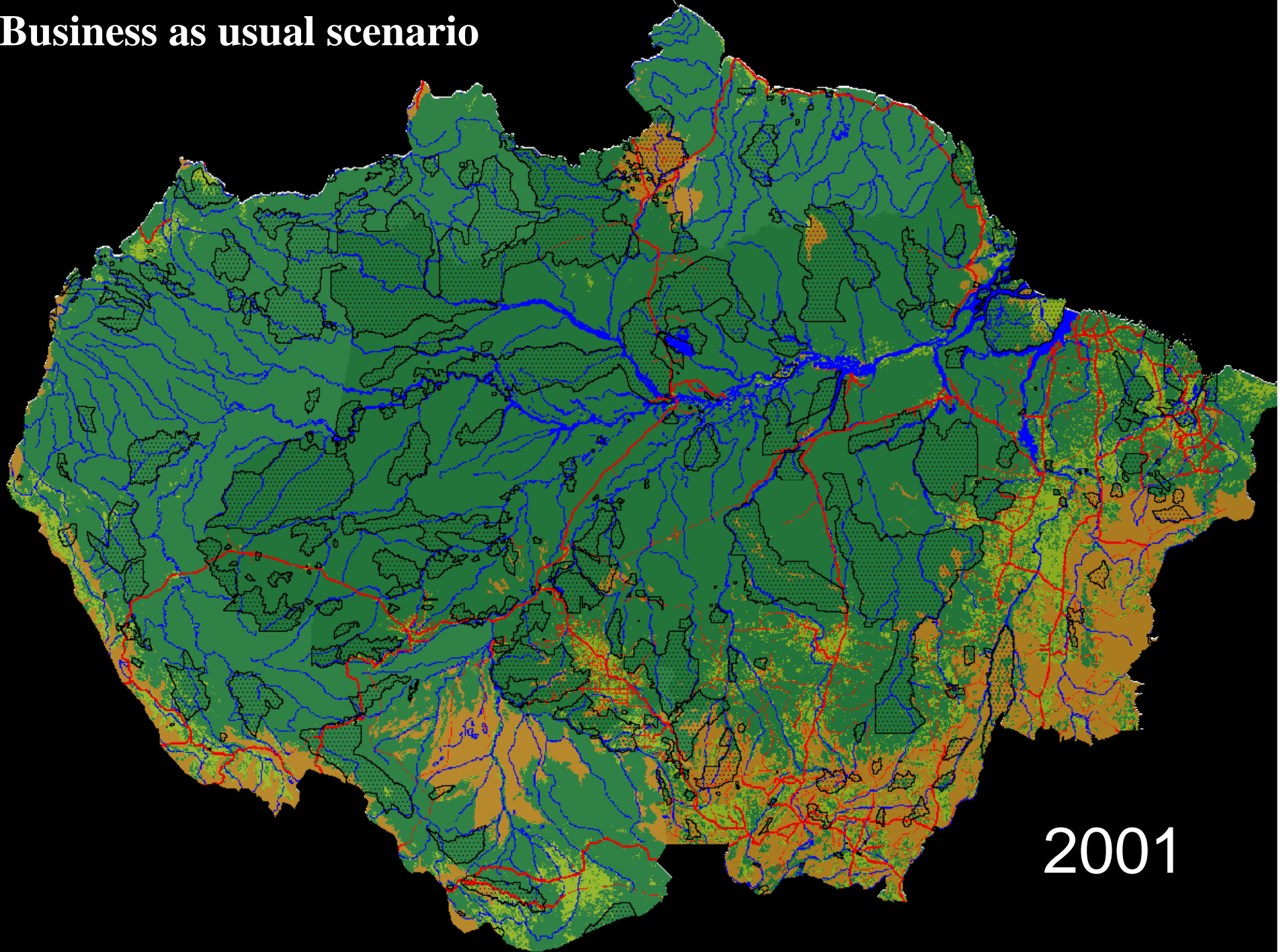
Source: WWF

## Brazil States - Identified lands for biodiesel feedstocks (no environmental constraints)



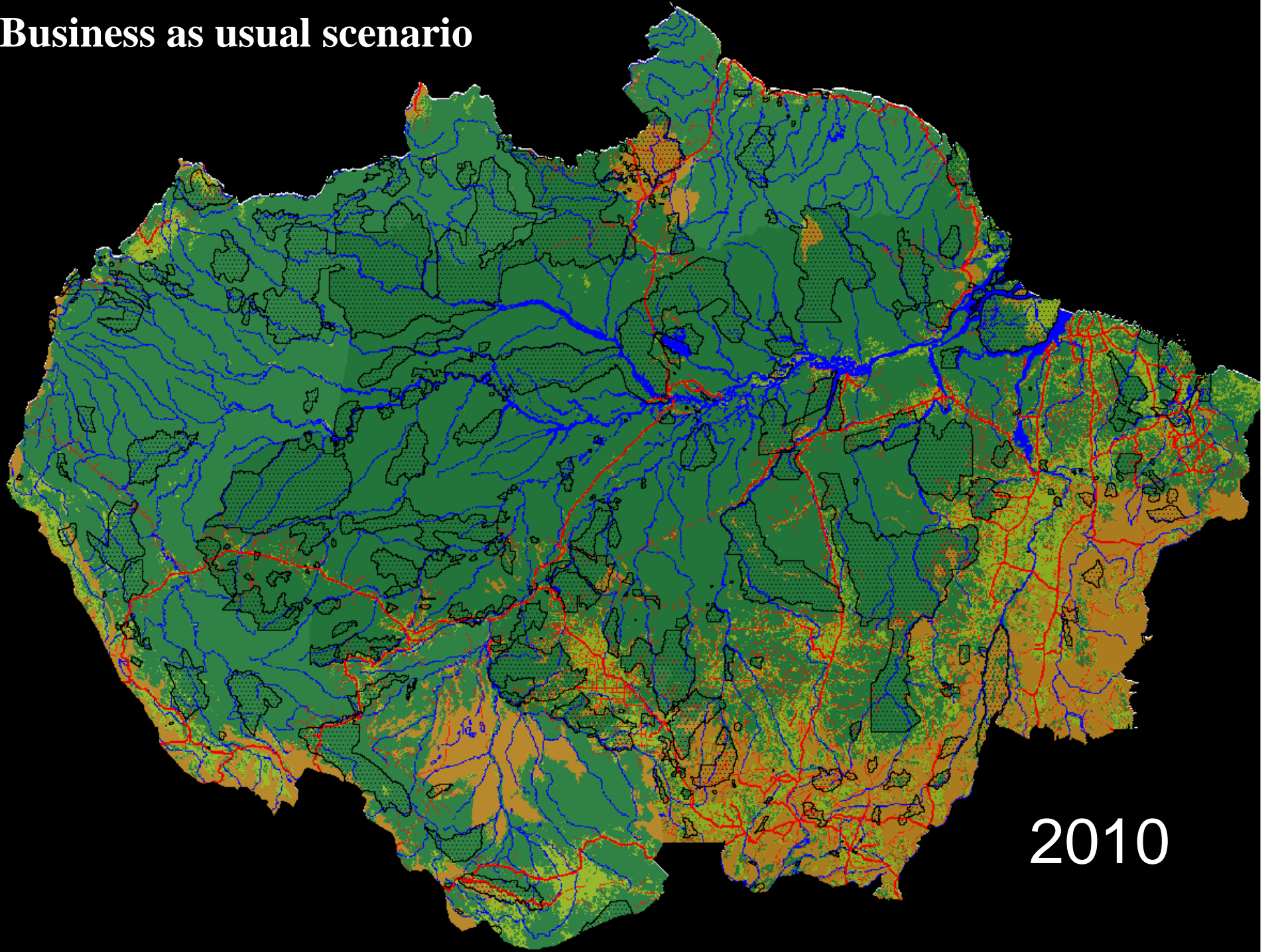
Kaltner, Franz J. et al, 2005, with Gil Floro P. Azevedo, Ivonice A. Campos, and Agenor O. F. Mundim, Liquid Biofuels for Transportation in Brazil, Potential and Implications for Sustainable Agriculture and Energy in the 21st Century, November 2005, 130 pp., <http://www.fbds.org.br/IMG/pdf/doc-116.pdf>.

# Business as usual scenario



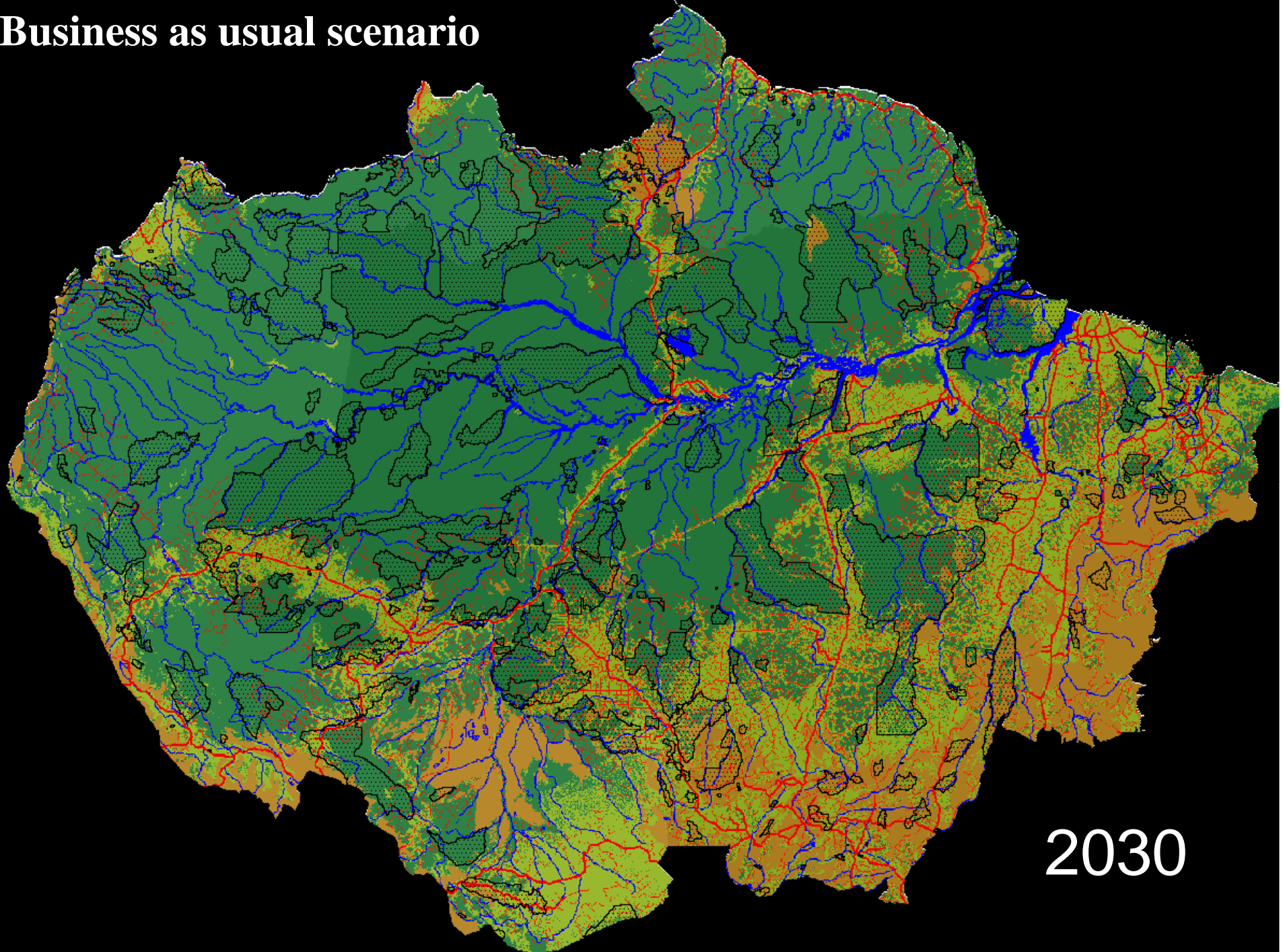
2001

# Business as usual scenario



2010

# Business as usual scenario



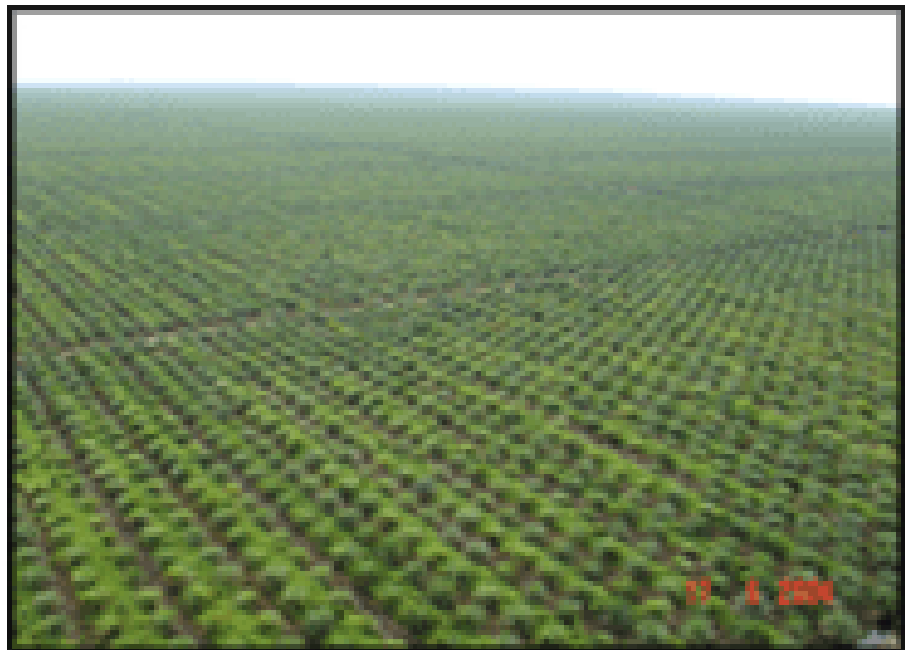
2030



## Food, Fuel, Species Tradeoffs?

By 2100, an additional 1700 million ha of land may be required for agriculture.

When combined with the 800 million ha of additional land needed to support the medium growth bioenergy scenarios, this will greatly increase threats to intact ecosystems and biodiversity-rich habitats.



# Biofuel Guidelines & Standards Initiatives Under Development

- **German government** (coordinated by Environment Ministry) is just starting to look into developing biofuel sustainability standards, and hopes to draft something in ~5 months. Next month, they will be meeting with the coordinators of the Dutch and British (LCVP) standards initiatives.
- **WWF Germany**, which has assembled a dozen or so NGOs and companies to define biofuel standards and hopes to release the first draft in a few weeks
- **Dutch government** Sustainable Production of Biomass Project Group, produced draft report, *Criteria for Sustainable Biomass Production* (although not as developed as others such as LowCVP)
- **Swiss government**
- **National Wildlife Federation** – would like to convene all standards stakeholders and establish (over many years!) a new FSC like body to manage the governance of biofuels standards and create regionally adapted standards.
- **UK Low Carbon Vehicle Partnership** (LowCVP), [www.lowcvp.org.uk](http://www.lowcvp.org.uk) – this appears to be the most advanced in terms of defining sustainability criteria (incl. for biodiversity)
- **UN FAO** - Worldwatch Institute is being contracted to inventory what other institutions are doing on the issue
- **Institute for Agriculture & Trade Policy** (IATP), Minnesota, USA, [www.iatp.org](http://www.iatp.org) – although they are focusing on US crop production with emphasis on switch grass, etc. rather than first generation biofuels
- **Roundtable on Sustainable Palm Oil** - [www.sustainable-palmoil.org](http://www.sustainable-palmoil.org)
- **Roundtable on Responsible Soy** - [www.responsiblesoy.org](http://www.responsiblesoy.org)
- **WWF's Better Sugarcane Initiative** - <http://assets.panda.org/downloads/sugarmeetingreport.doc>
- **Standards for Soybean Cultivation (Basel Criteria)** - <http://www.responsiblesoy.org>

Area of concern	Loose set of criteria	Strict set of criteria
<b><i>Sustainability Criteria for Biofuels</i></b>		
Food supply	The production of bioenergy is not allowed to endanger food supply. The theoretical potential to generate surplus agricultural land in 2015 was estimated, following the methodology of Smeets (2004a).	
Deforestation	The production of bioenergy is not allowed to result in deforestation. The theoretical potential to generate surplus agricultural land in 2015 was estimated, following the methodology of Smeets (2004a).	
Soil erosion	Soil erosion rates are not allowed to increase compared to conventional agricultural land use. Soil erosion rates are compared based on crop/vegetation specific management factors and if required additional soil erosion prevention measures (no tillage, ridge ploughing) are implemented.	Soil erosion rates are not allowed to increase compared to conventional agricultural land use and must be decreased compared to the natural soil regeneration capacity. Soil erosion rates under various land cover types (including bioenergy crops) are calculated using the Universal Soil Loss Equation. Additional soil erosion prevention measures are implemented if required. E.g. ridge ploughing, which result in higher labour and machinery costs.
Depletion of fresh water resources	Depletion of fresh water resources is not allowed. The risk of groundwater depletion is estimated by means of a water balance, in which the evapotranspiration is compared with the (effective) rainfall. Irrigation is not allowed, for ecological and economical reasons; yields are based on rain-fed production. No additional costs to reduce the water use are included, due to a lack of data.	
Nutrient losses and soil nutrient depletion	Soil nutrient depletion must be prevented by means of the sufficient application of fertilizers.	Soil nutrient depletion must be prevented by means of the sufficient application of fertilizers. Nutrient leaching must be prevented by increasing the nutrient uptake efficiency as far as reasonably is achievable. E.g. by increasing the fertilizer application rate, which results in higher labour and machinery costs.

Source: The impact of sustainability criteria on the costs and potentials of bioenergy production An exploration of the impact of the implementation of sustainability criteria on the costs and potential of bioenergy production, applied for case studies in Brazil and Ukraine Edward Smeets, André Faaij and Iris Lewandowsk, Copernicus Institute, University of Utrecht

## ***Sustainability Criteria for Biofuels (cont.)***

Pollution from chemicals	Pollution from agricultural chemicals must be avoided by means of good management as far as reasonably is achievable. No costs are included.	Pollution from agricultural chemicals must be avoided as far as reasonably is achievable by means of substitution of chemicals by manual and mechanical operations, which result in higher labour and machinery costs.
Employment	The production and trade of bioenergy must contribute to employment. By definition, bioenergy crop production contributes to employment. No costs are included.	The production of bioenergy is not allowed to result in a decrease in employment compared to the baseline situation measured economy-wide. No costs are included due to a lack of data and suitable methodologies to calculated overall employment effects.
Wages	Wages must be based on at least the minimum wages and must be above the international poverty line.	Wages must be based on the average wage.
Child labour	Child labour is not allowed. No costs are included.	Child labour is not allowed and parents are compensated for the loss of family income and for the costs of education.
Education	Education is the responsibility of society in general. No costs are included.	Education is (partially) the responsibility of the bioenergy crop producer. The average costs for education for an average family are added up to the hourly labour costs.
Health care	Health care is the responsibility of society in general. No costs are included.	Health care is (partially) the responsibility of the bioenergy crop producer. The average costs for education for an average family are added up to the hourly labour costs.
Biodiversity	Biodiversity must be protected.	

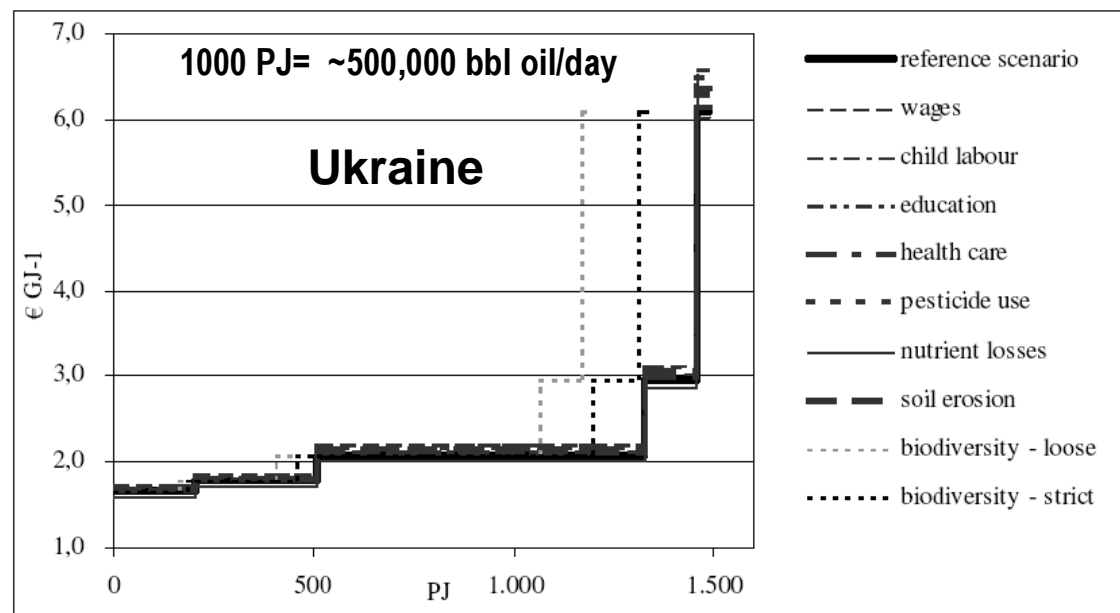
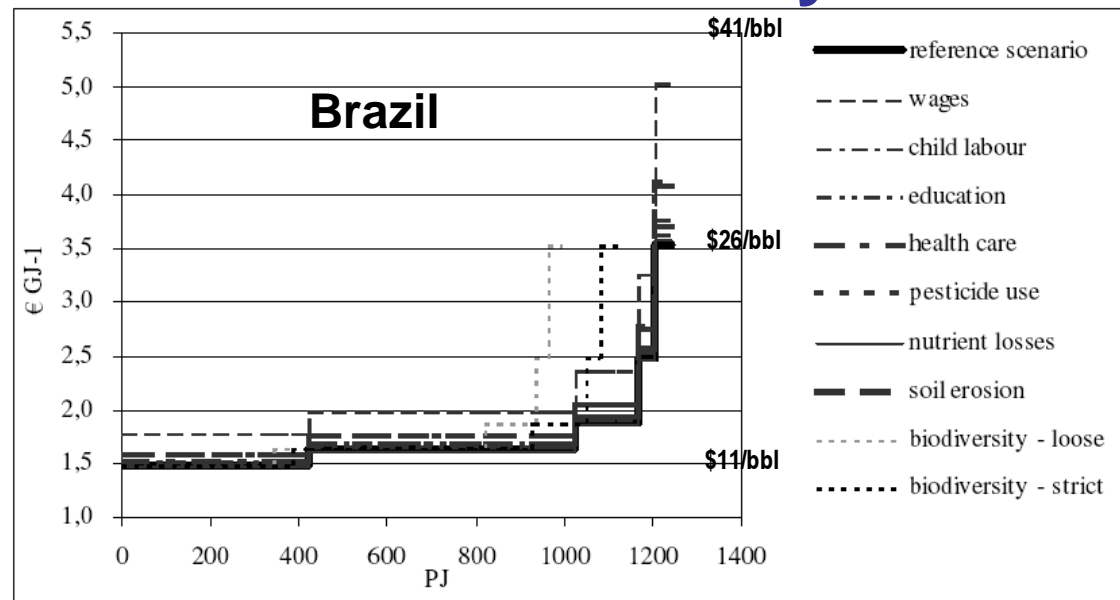
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# Example of Cost Curves with Sustainability Criteria

Cost supply curve for bioenergy crop production in a loose and strict set of criteria in Brazil (Rio Grande do Sul; top figure) and Ukraine (bottom figure) in 2015 (€ per GJ).

**The total costs for bioenergy crop production in Brazil are calculated at 1.5 €/GJ to 3.5 €/GJ (\$11 to \$26 per barrel oil), dependant on the land suitability class (and respective yields), including the impact of basic levels for the various sustainability criteria.**

Total costs for Ukraine 1.7 €/GJ to 6.1 €/GJ (\$13-\$45/bbl oil).



# Conclusions

Whatever standards do emerge, need to foster best practices that avoid adverse impacts and unintended consequences, most notably damage and destruction of key biodiversity areas, but in ensuring other important environmental and social objectives are also sustained.

1. Biofuels could become major global commodity (and climate- and biodiversity-friendly)
2. First Principle -- Do No Harm -- Avoid removal of existing, intact ecosystems (forests, peat lands, grasslands) in developing or procuring any biofeedstocks and fuels
3. Concentrate biofuel crop production on degraded and abandoned lands
4. Require and apply best practices in growing and processing feedstocks
5. Use biodiversity information and planning tools such as web-based landscape mapping resources and IBAT (Industry Biodiversity Assessment Tool)
6. Offset ecological impacts through private or public sector funding for protection of key biodiversity areas
7. Certify practices AND results