Milão

June 2, 2015

Professor José Goldemberg

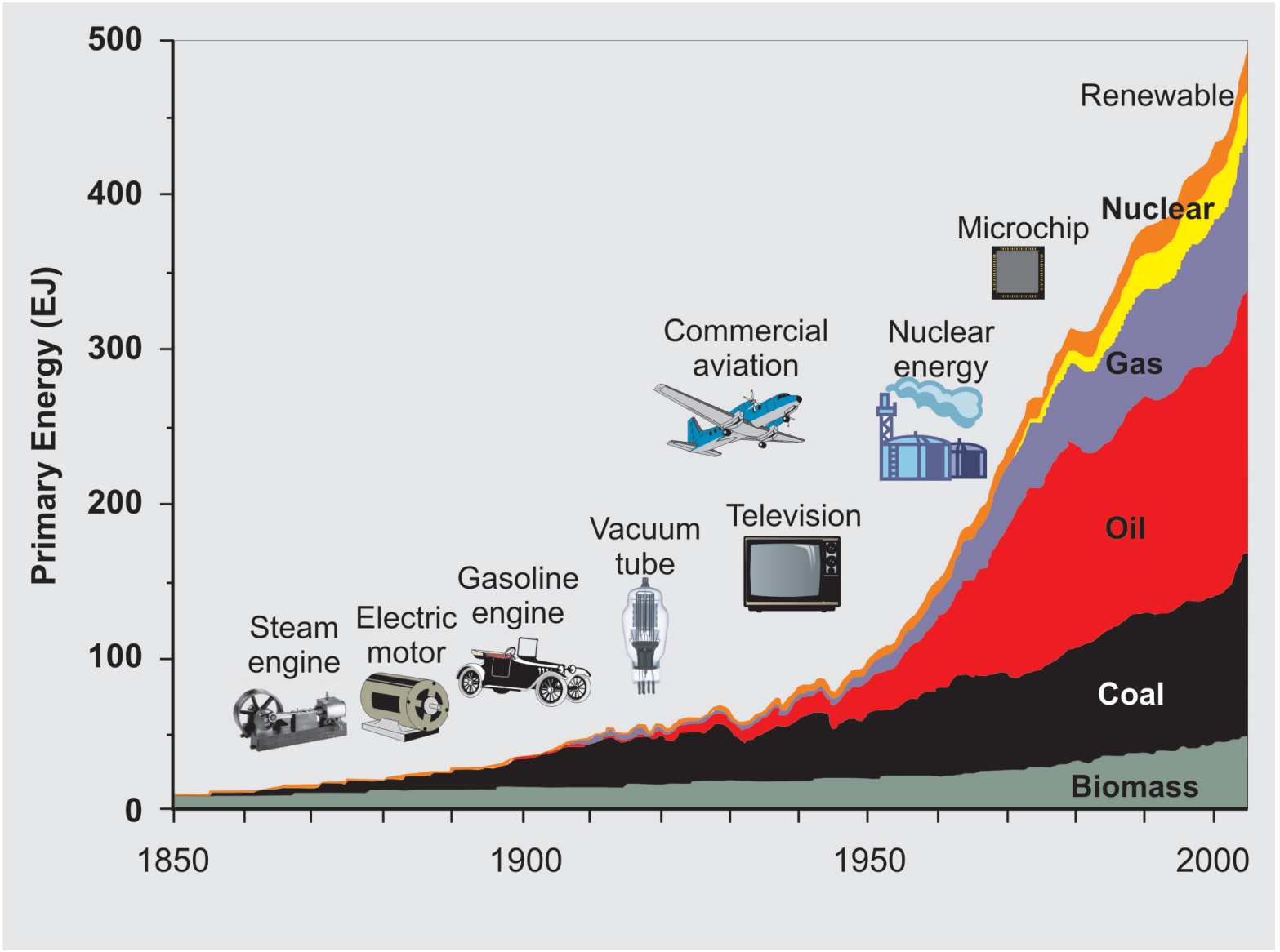
Sustainable development: the role of bioenergy

- What is sustainable development
- A future based on fossil fuels is not sustainable
- Transportation is one of the basic components of development
- The role of biofuels in sustainable development
- Challenges of biofuels as a sustainable development solution

What is sustainable development ("development durable")

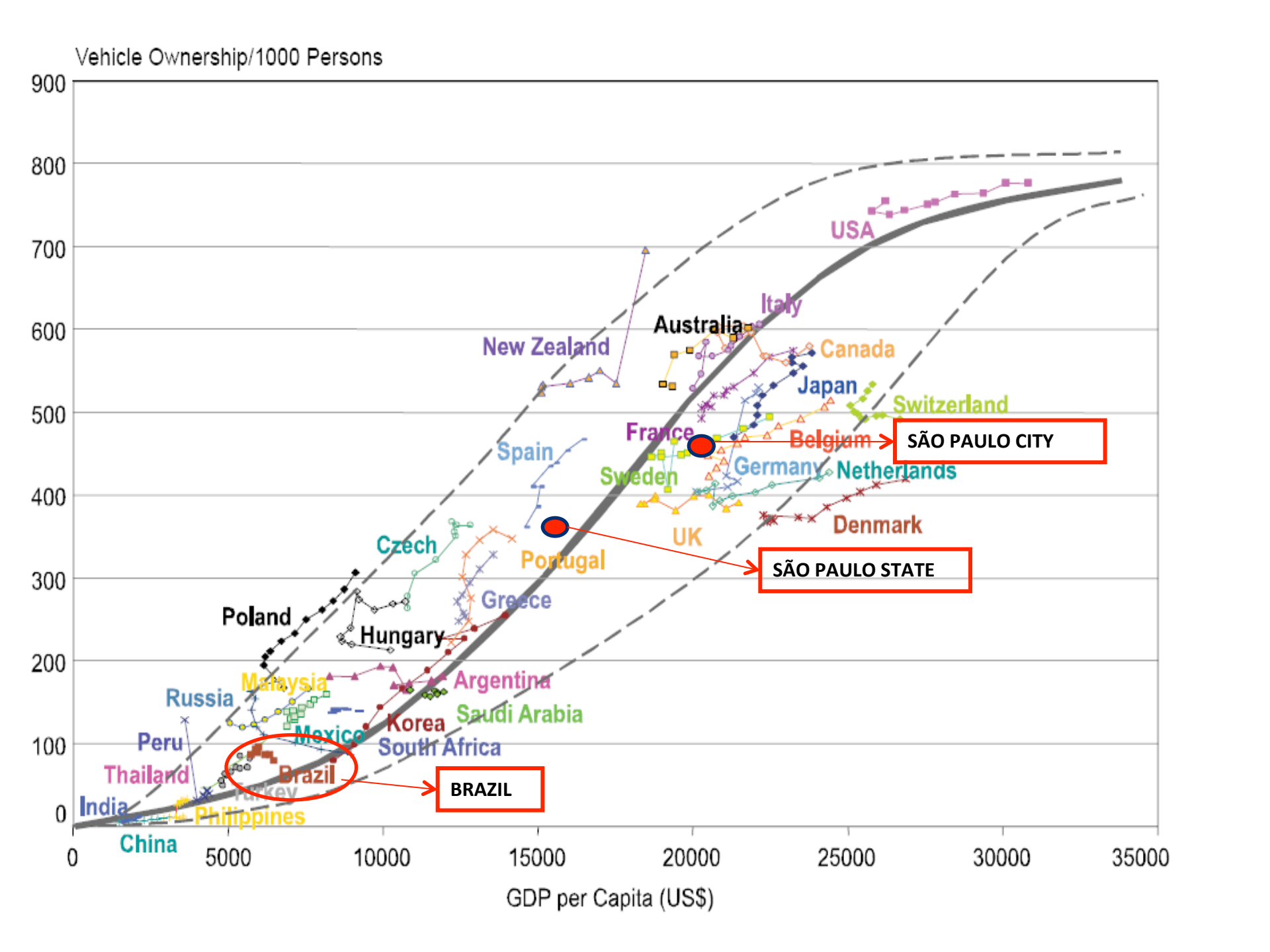
Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- *the concept of "needs," in particular the essential needs of the world's poor, to which overriding priority should be given; and*
- *the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.*

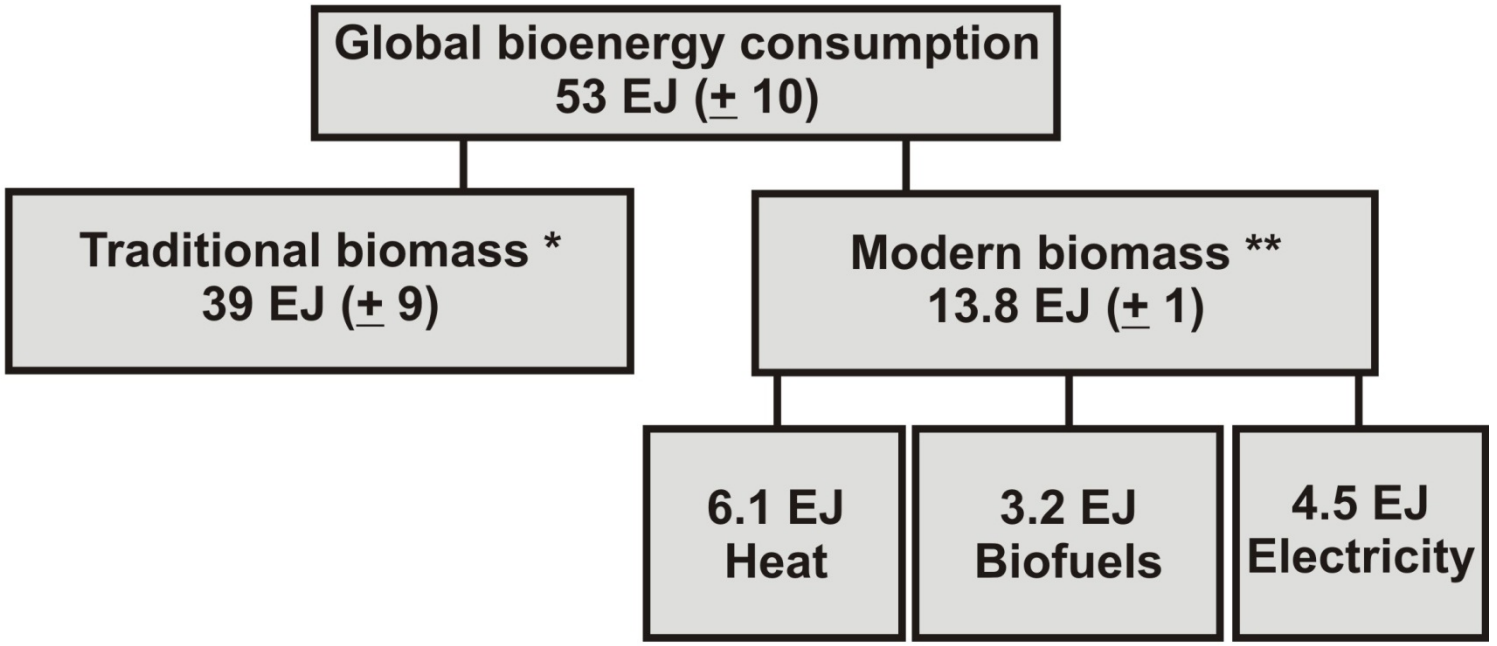

Primary Energy (EJ)
500
400
300
200
100
0
1850
1900
1950
2000
Renewable
Nuclear
Gas
Oil
Coal
Biomass
Microchip
Commercial aviation
Nuclear energy
Television
Vacuum tube
Gasoline engine
Electric motor
Steam engine

PROBLEMS FACED TODAY BY THE WORLD'S ENERGY SYSTEM

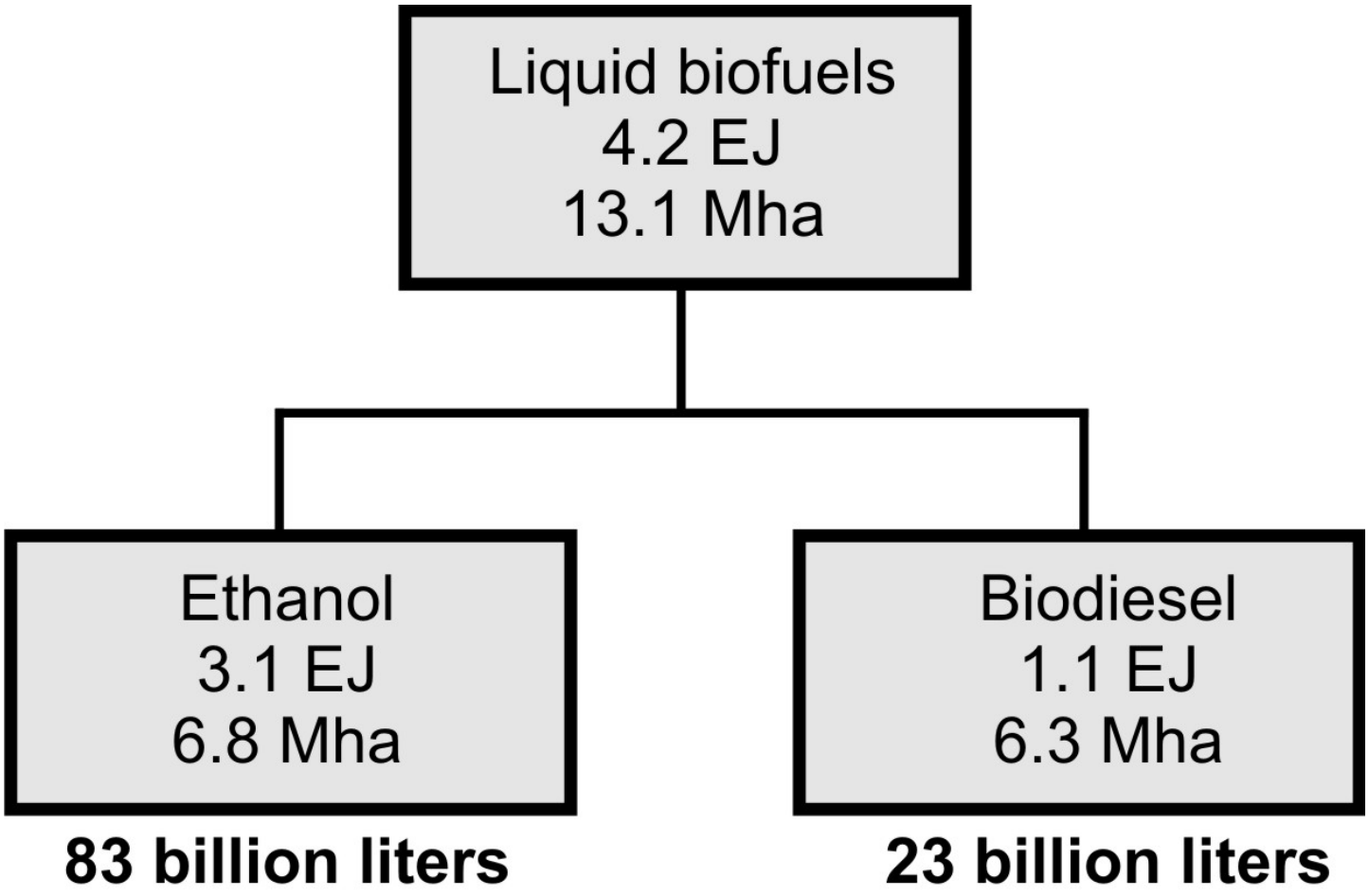
- Exhaustion of easily accessible physical resources,
- Security of access to fuels,
- Degradation of health and environmental conditions.
- Universal access to clean energy services is vital for the poor,


Vehicle Ownership/1000 Persons
900
800
700
600
500
400
300
200
100
0
0
5000
10000
15000
20000
25000
30000
35000
GDP per Capita (US$)
USA
Italy
Australia
New Zealand
Canada
Japan
Switzerland
France
Belgium
SÃO PAULO CITY
Spain
Germany
Netherlands
Sweden
Denmark
UK
Czech
Portugal
SÃO PAULO STATE
Greece
Poland
Hungary
Malaysia
Argentina
Russia
Saudi Arabia
Korea
Mexico
South Africa
Peru
Thailand
Brazil
BRAZIL
India
Philippines
China

BIOENERGY (2010)



* Primary energy
** Final Energy



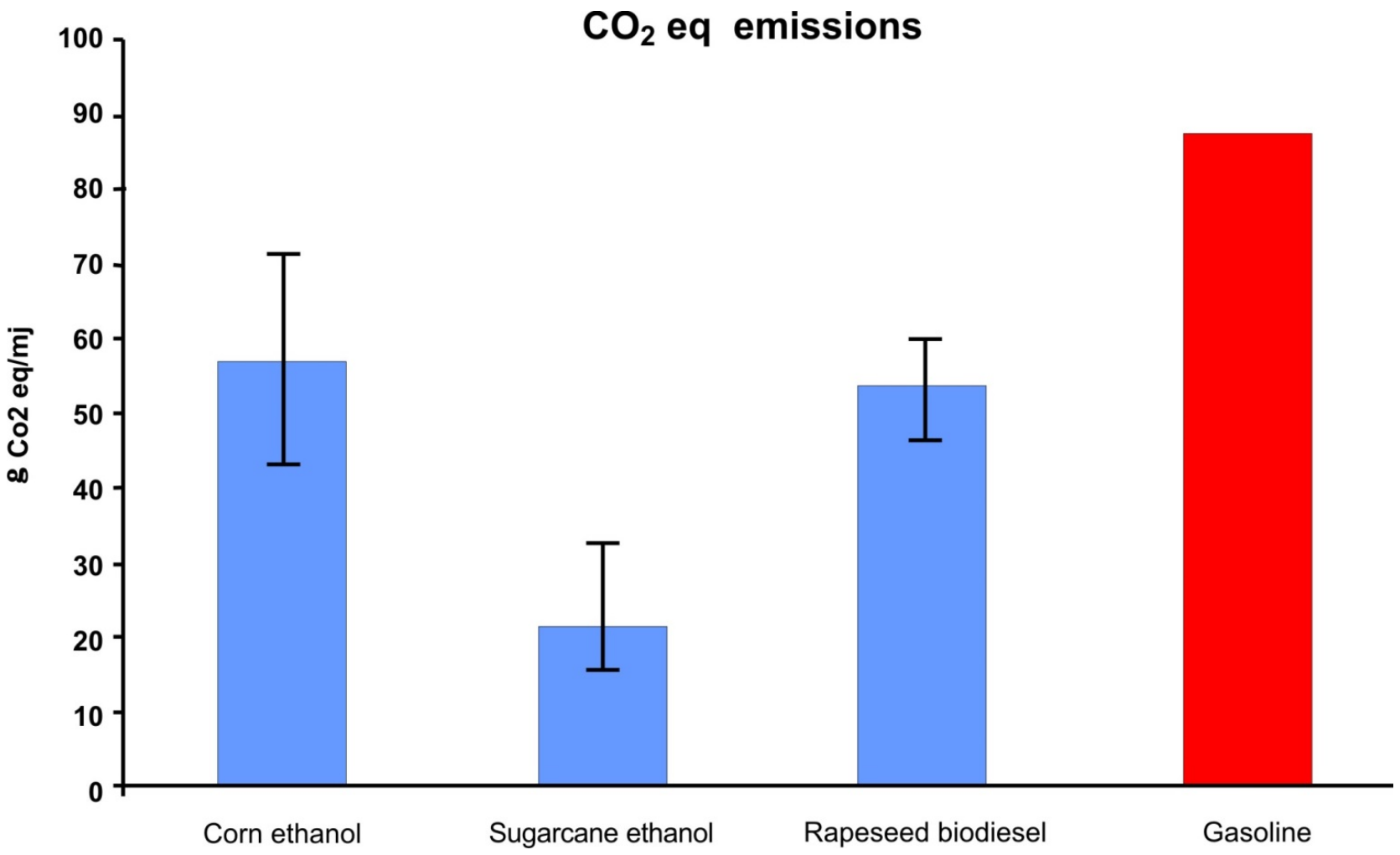
Total Land required: 13.1 million hectares

Biofuel contribution to the use of fuels

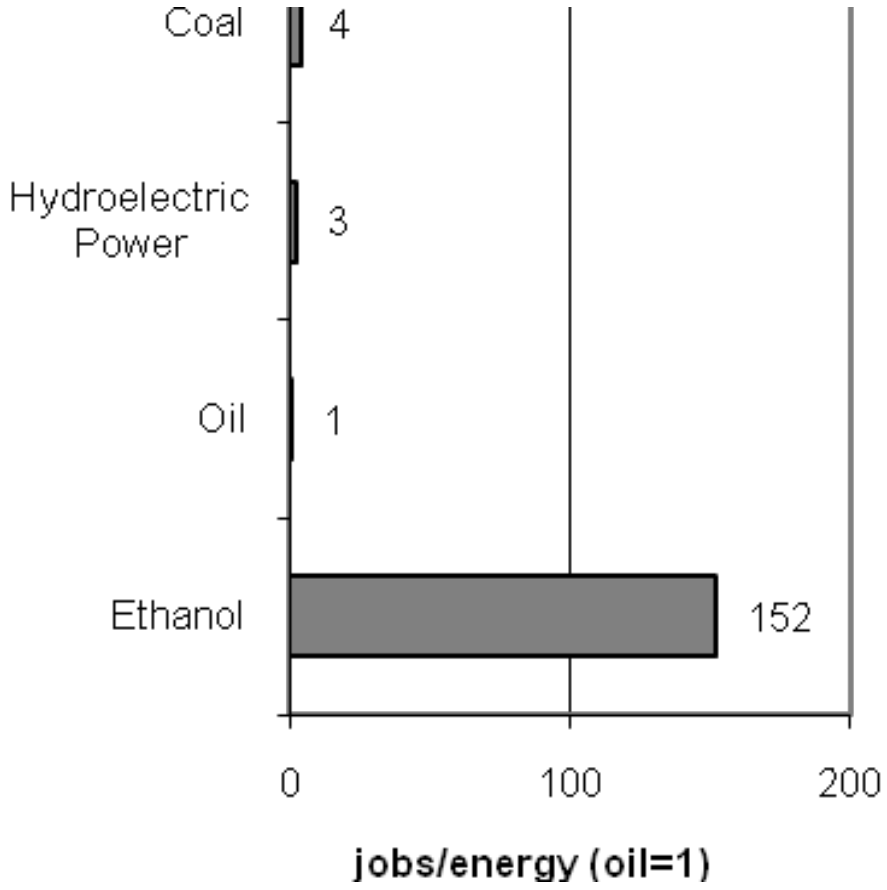
A Ethanol $x10^9$	B Gasoline $x10^9$	A/B
87	1286	6.7%
Biodiesel	Diesel oil	
26	897	2.9%

Ethanol as a sustainable development solution

- Reduces greenhouse gas (GHG) emissions
- Promotes rural development
- Increase security of supply
- Economically competitive


CO_2 eq emissions
g Co2 eq/mj
100
90
80
70
60
50
40
30
20
10
0
Corn ethanol
Sugarcane ethanol
Rapeseed biodiesel
Gasoline

Employment numbers from Proalcool
Jobs per unit of energy produced



Perspectives for the Replication of Brazilian Ethanol Program in Other Developing Countries

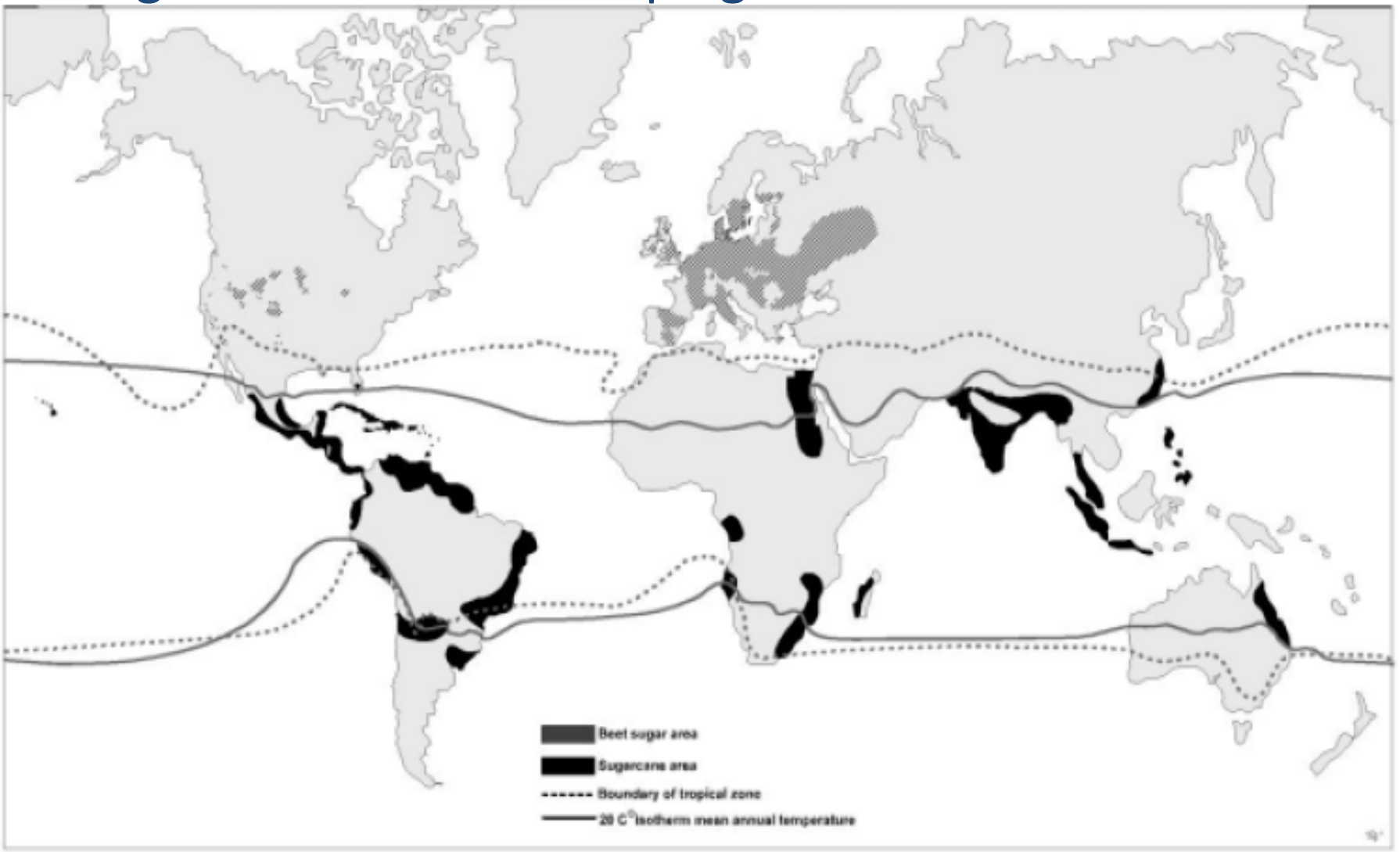
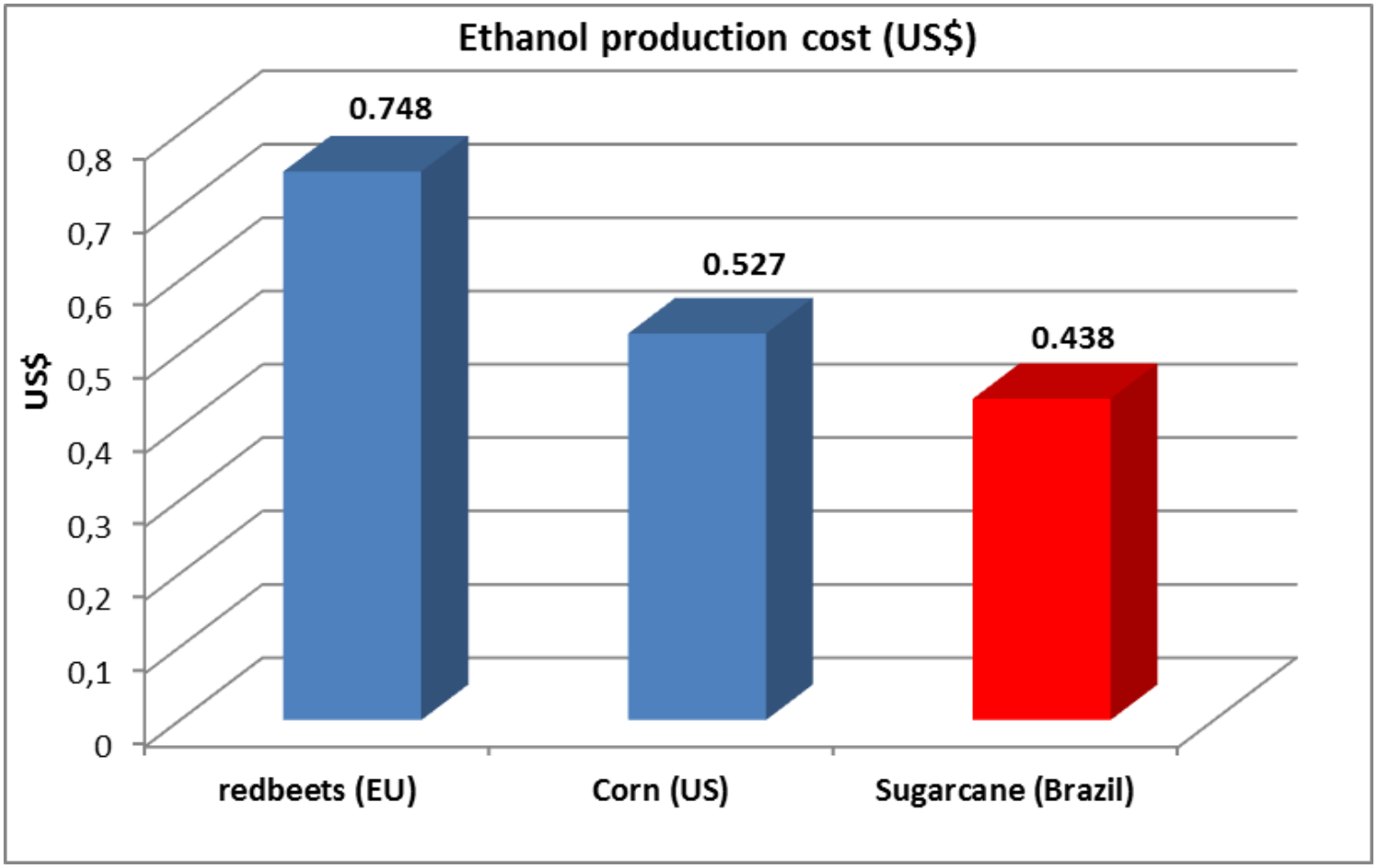
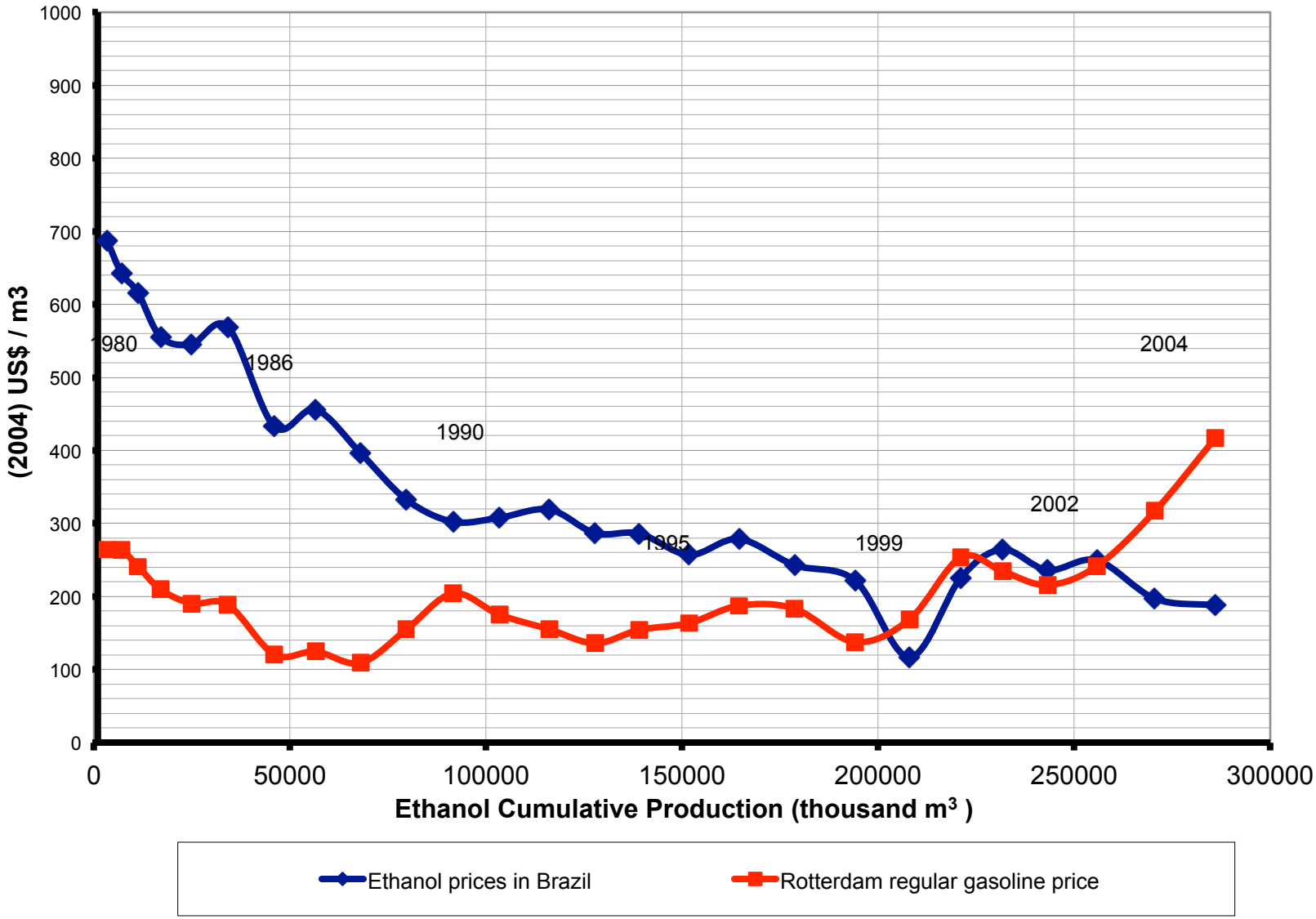


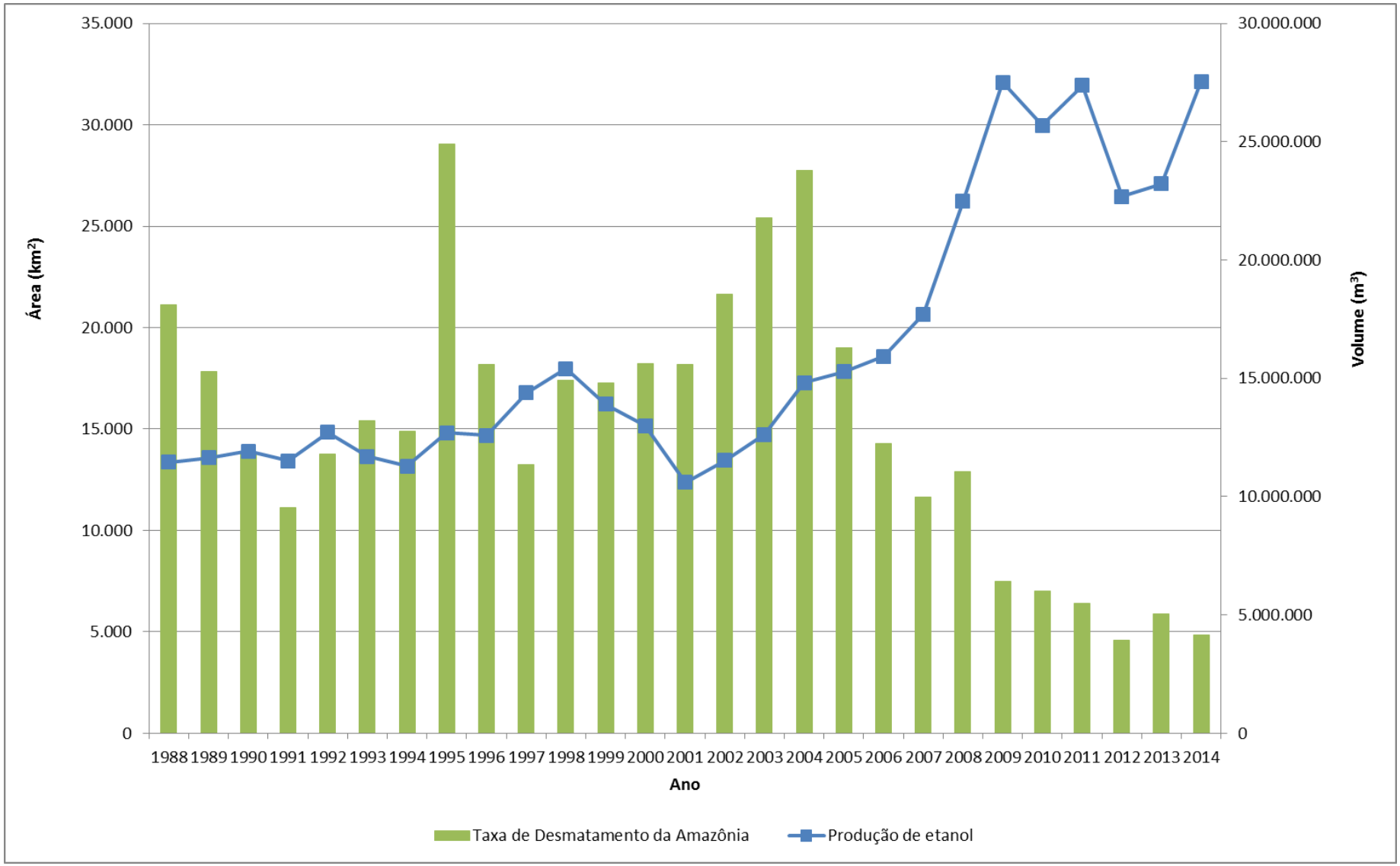
Figure 3.5. Global Distribution of Sugar Beet and Sugarcane Production. Redrawn from Helmut Blume, *Geography of Sugar Cane* (Berlin,1985), 22.


Ethanol production cost (US$)
US$
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
0.748
0.527
0.438
redbeets (EU)
Corn (US)
Sugarcane (Brazil)


1000
900
800
700
600
500
400
300
200
100
0
(2004) US$ / m3
1980
1986
1990
1995
1999
2002
2004
0
50000
100000
150000
200000
250000
300000
Ethanol Cumulative Production (thousand m³)
Ethanol prices in Brazil
Rotterdam regular gasoline price

Challenges of ethanol as a sustainable development solution

- Increased deforestation and loss of biodiversity
- Food x fuel conflict
- “The domino effect” (LUCF) and how to avoid it


35.000
30.000
25.000
20.000
15.000
10.000
5.000
0
Área (km²)
30.000.000
25.000.000
20.000.000
15.000.000
10.000.000
5.000.000
0
Volume (m³)
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Ano
Taxa de Desmatamento da Amazônia
Produção de etanol

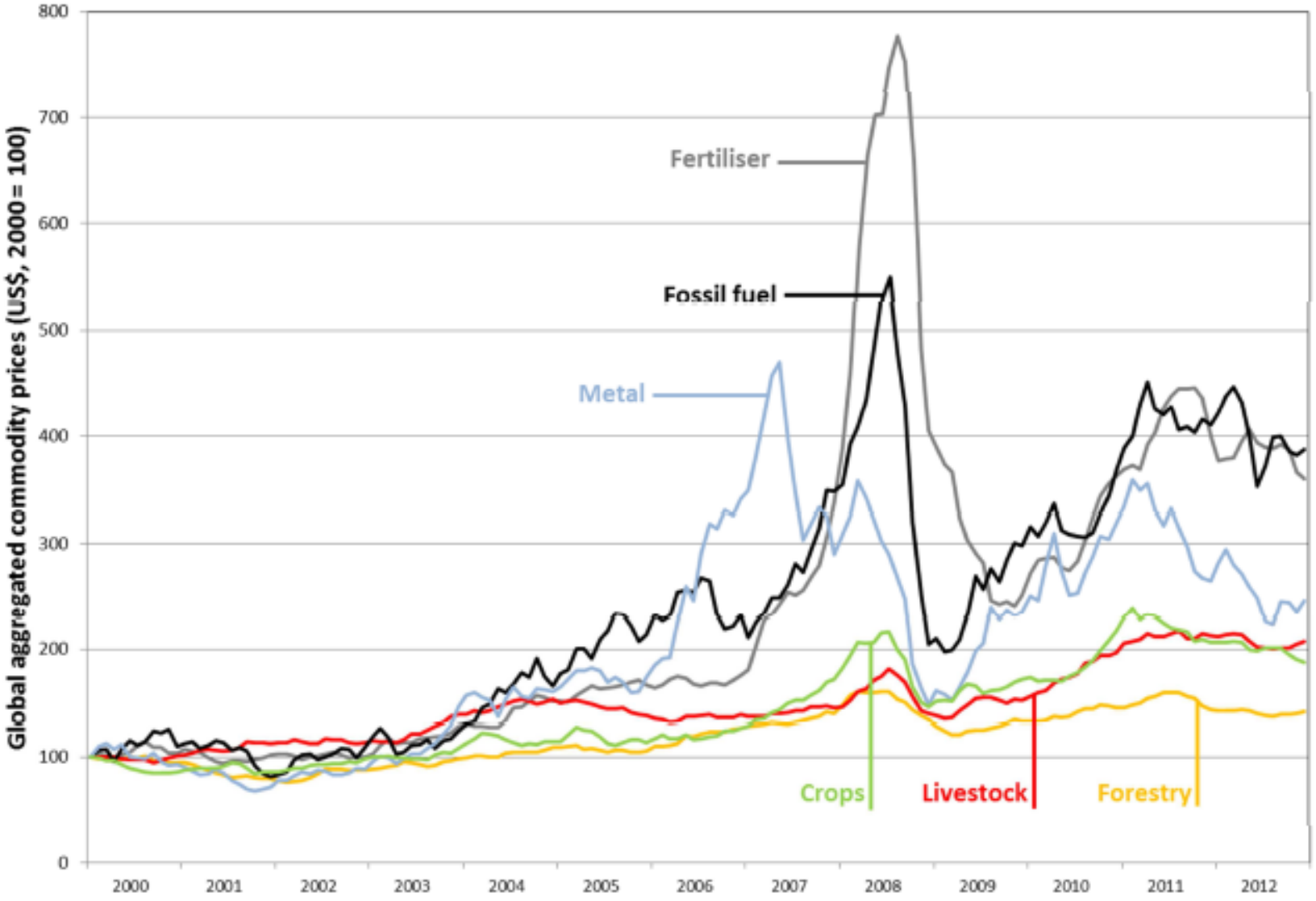


Figure 3. Global aggregated commodity prices, normalised.

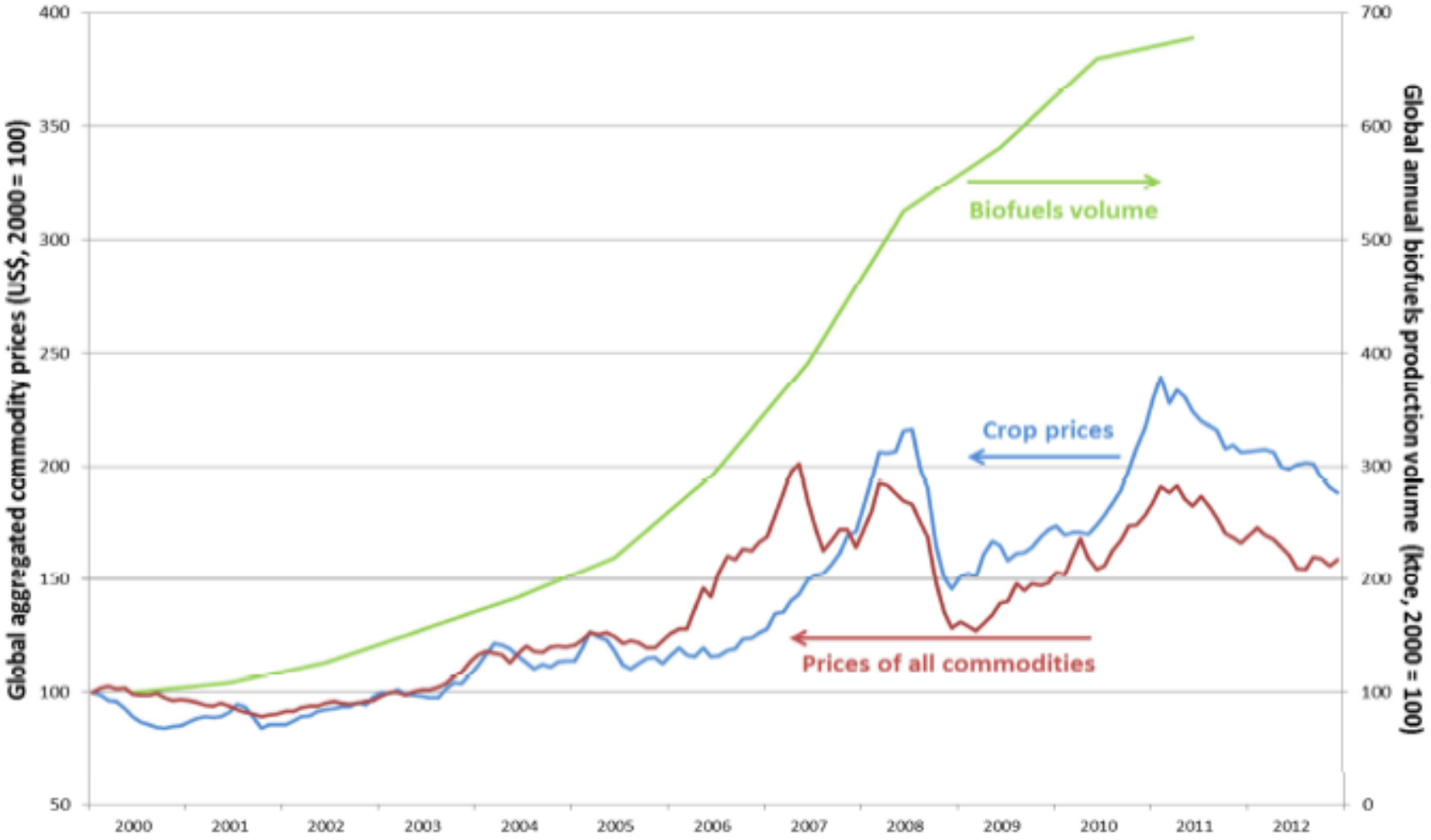
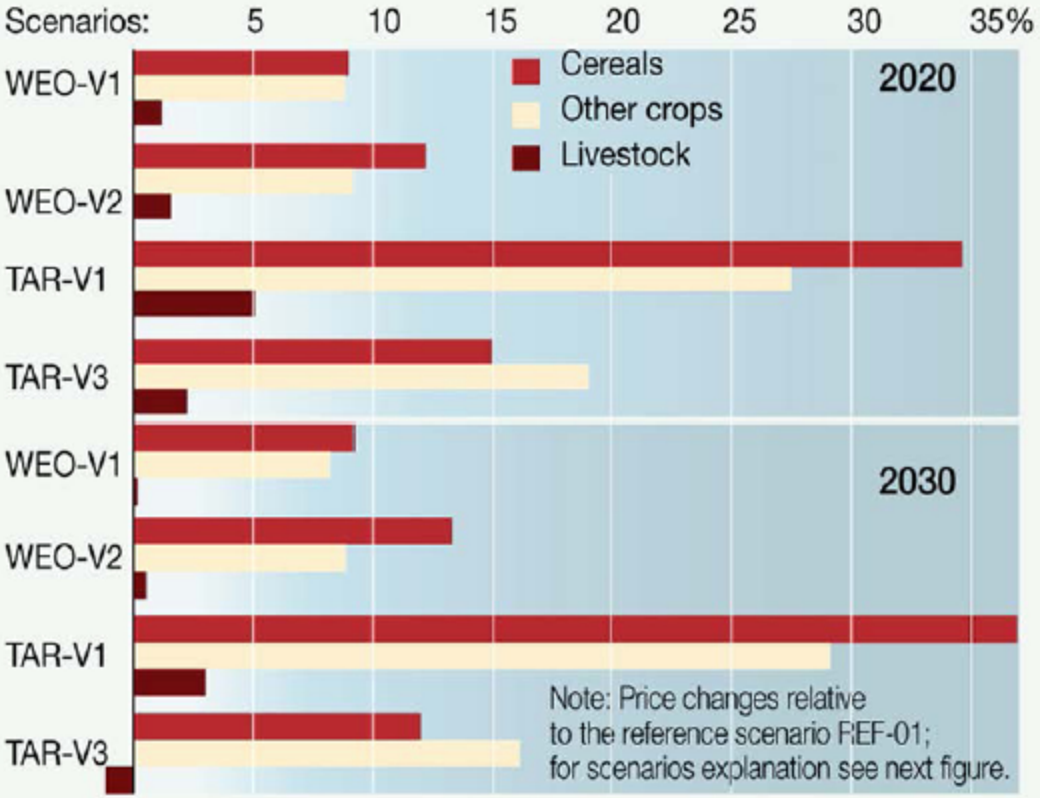


Figure 1. Global crop commodity prices and the aggregated price of all commodities[14], versus global biofuels production volume[15], both normalised.

Impacts of first-generation biofuels on agricultural prices



Source: OFID, *Biofuels and Food Security*, 2009.

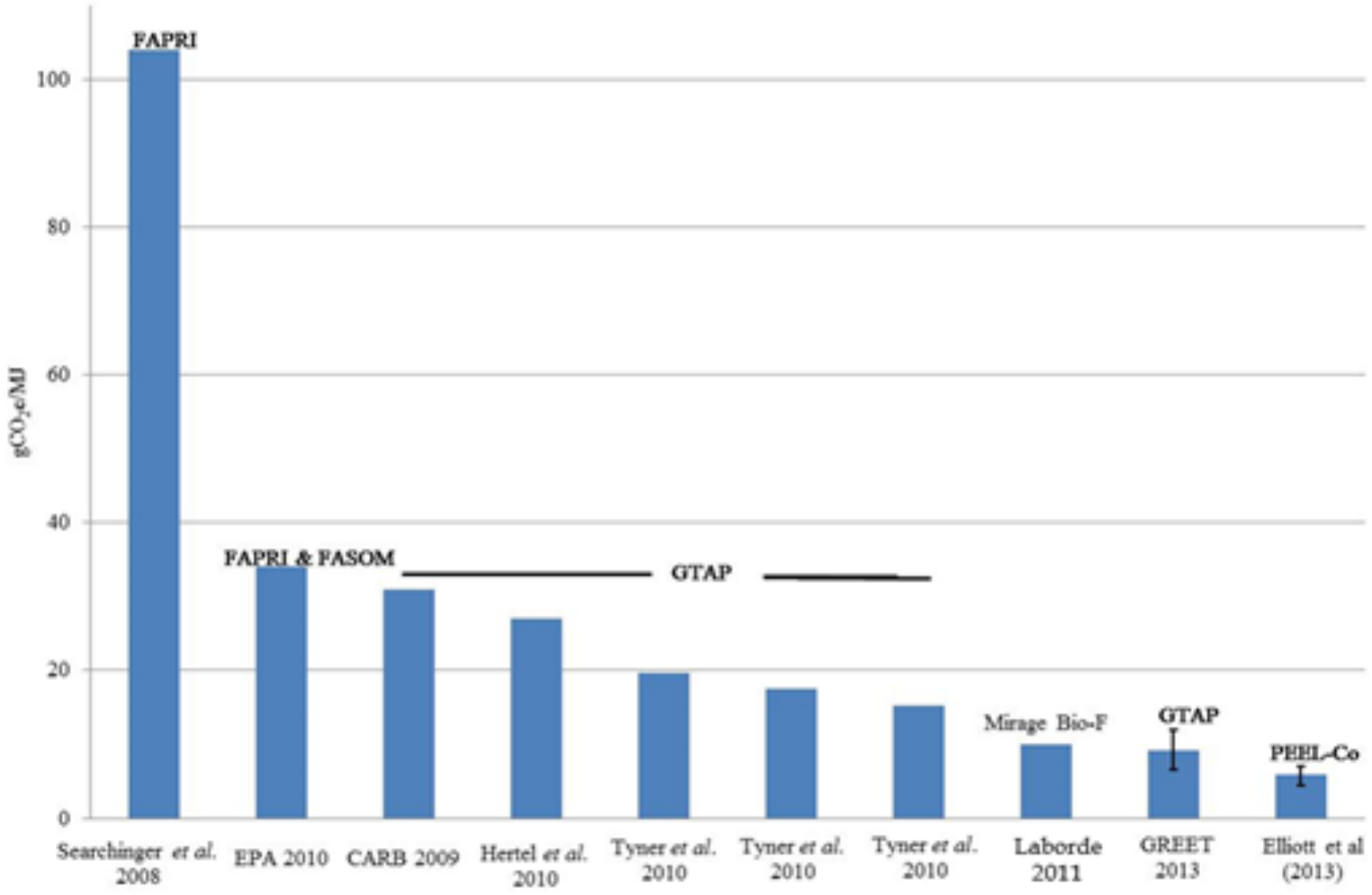
Commodity price effects from Laborde (2011) for selected sectors and world regions (comparison between 2020 reference and 2020 biofuel policy scenario)

	8.4% EU biofuel share in 2020		5.7% EU biofuel share in 2020	
	EU27	World	EU27	World
Wheat	1.48%	1.01%	0.73%	0.48%
Maize	1.09%	0.74%	0.52%	0.33%
Sugarcane/beet	0.01%	0.88%	0.01%	0.41%
Soybeans	2.64%	2.48%	0.94%	0.88%
Sunflower	7.06%	4.82%	2.56%	1.77%
Rapeseed	14.08%	11.34%	5.50%	4.27%
Palm oil	4.43%	4.53%	1.53%	1.55%
Rape oil	16.40%	9.20%	6.52%	3.56%
Soy oil	9.79%	7.30%	3.71%	2.69%

The domino effect

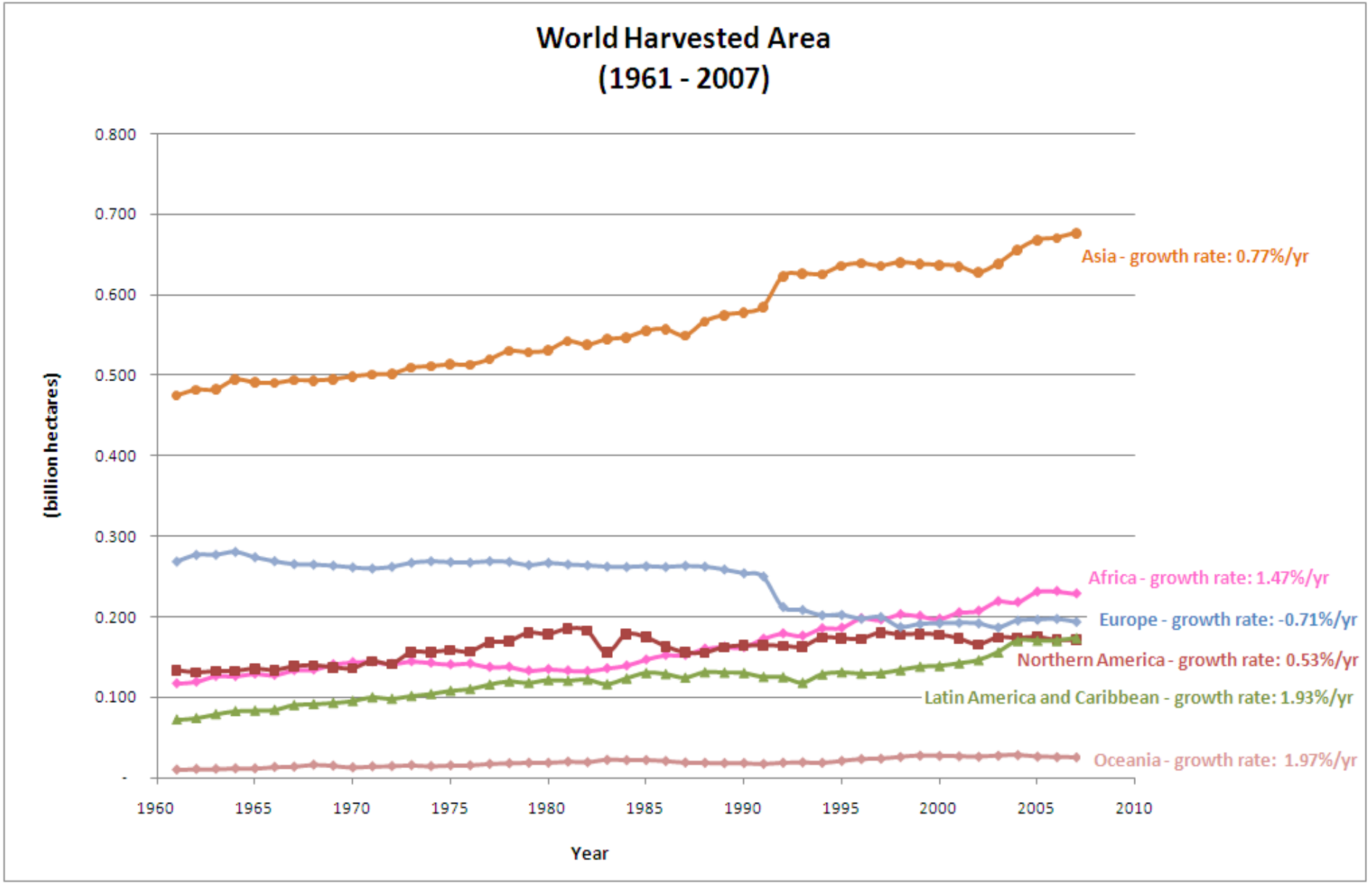
What is the link between biofuels and indirect land use change (ILUC)?

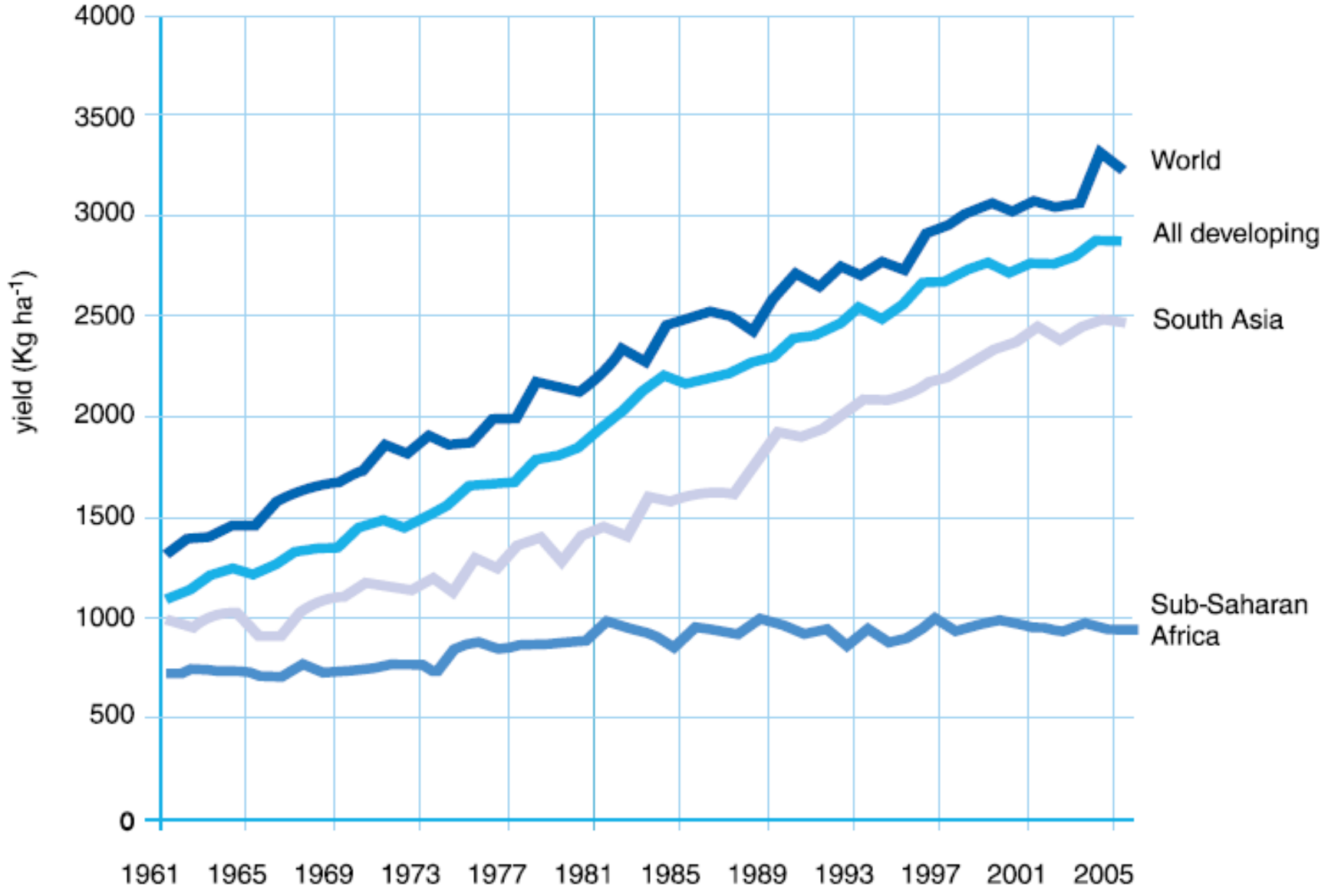
When biofuels are produced on existing agricultural land this can cause a sort of "chain reaction": since there is always a demand for food and feed crops, someone may start producing more food and feed somewhere else, for instance changing forests into agricultural land. This would in turn increase CO2 emissions and therefore counteract the benefits resulting from the use of biofuels.



iLUC Factors for biofuels (Macedo, I.C. and Nassar, A., in press)

Various studies have argued and demonstrated that biofuels were in part responsible for increasing food prices over the past years and that they will cause more price surges in the near future. The extent of their role has been calculated, often by using sophisticated economic models that are difficult to mutually compare. The general conclusion of these studies is that any agricultural demand shock from biofuels in a market that is already restricted in options (low in stocks, nervous and speculative) leads to a quick increase in prices.


World Harvested Area
(1961 - 2007)
(billion hectares)
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
-
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year
Asia - growth rate: 0.77%/yr
Africa - growth rate: 1.47%/yr
Europe - growth rate: -0.71%/yr
Northern America - growth rate: 0.53%/yr
Latin America and Caribbean - growth rate: 1.93%/yr
Oceania - growth rate: 1.97%/yr



Source: Hazel & Wood 2008 (adapted from FAOSTAT 2006)

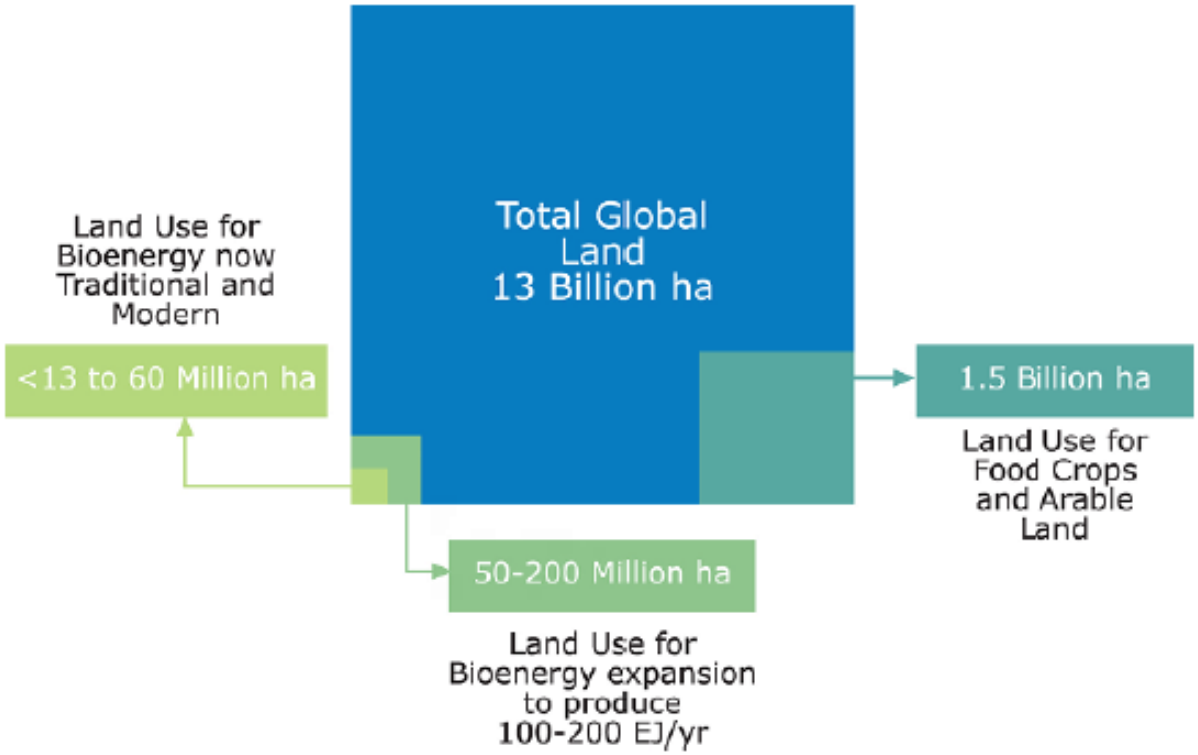


Figure 1.1. Global land use for bioenergy. Approximate numbers.

Sustainability Criteria

1. GHG Balance
2. Competition with food & energy supply, and others
3. Biodiversity
4. Wealth
5. Welfare
    a. Labor conditions
    b. Human rights
    c. Property and use rights
    d. Social conditions of local pollution
    e. Integrity
6. Environment
    a. Waste management
    b. Use of agrochemical (including fertilizers)
    c. Prevention of soil erosion and nutrient depletion
    d. Preservation on surface & ground water
    e. Airbone emissions
    f. Use of GMOs