SIMPOSIO DE BIOECONOMIA EN AMERICA TROPICAL
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The sustainable production of bio-energy in tropical environments

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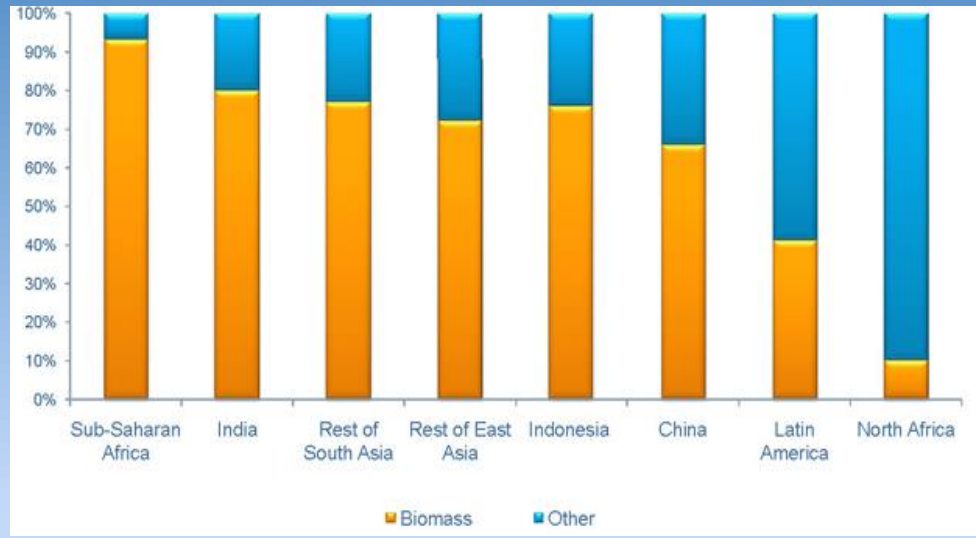
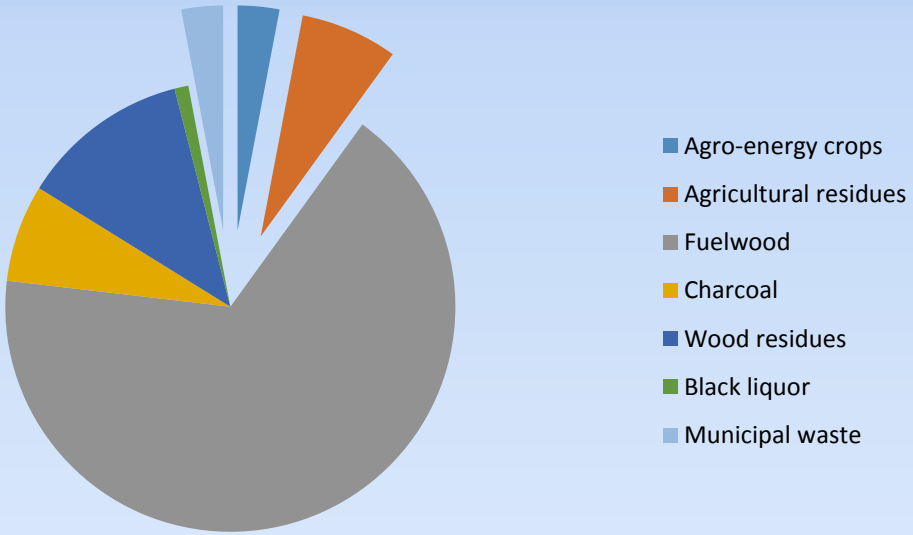
Biomass energy, present use, energy issues and potential for the future

- Biomass = 11% of primary energy demand (50 EJ - 2009)

Region	World	OECD	Non-OECD	**Africa**	**Latin America**	Asia
Primary energy	423.3	222.6	200.7	**20.7**	**18.7**	94.7
Biomass (%)	11%	3%	19%	**50%**	**18%**	25%





74% woodfuel (firewood and charcoal)
12% wood residues
3% = biofuels

Biomass energy, present use, energy issues and potential for the future

- Business as usual projections until 2030 (IEA 2009)
  - Global primary energy demand is projected to increase by 1.5% per year
  - 90% of the increase should come mainly from Asia, Middle-East, Africa and South America.
  - Fossil fuels should remain the dominant source,

  Biomass should grow by 1.5 %/year for residential use, power generation, biofuels

- World is entering a new energy era :
  1. Facing the increasing demand mainly from emerging countries, **energy production has to increase**;
  2. Facing the depletion of fossil fuel resources and the increase in their prices, **alternative sources of energy had to be developed**
  3. Facing climate change, **greenhouse gas emissions have to be reduced**.
  4. Facing the lack of rural energy development in developing countries**, new rural energy sources have to be found**

  In this context, bioenergy and alternatives energy should play a major role

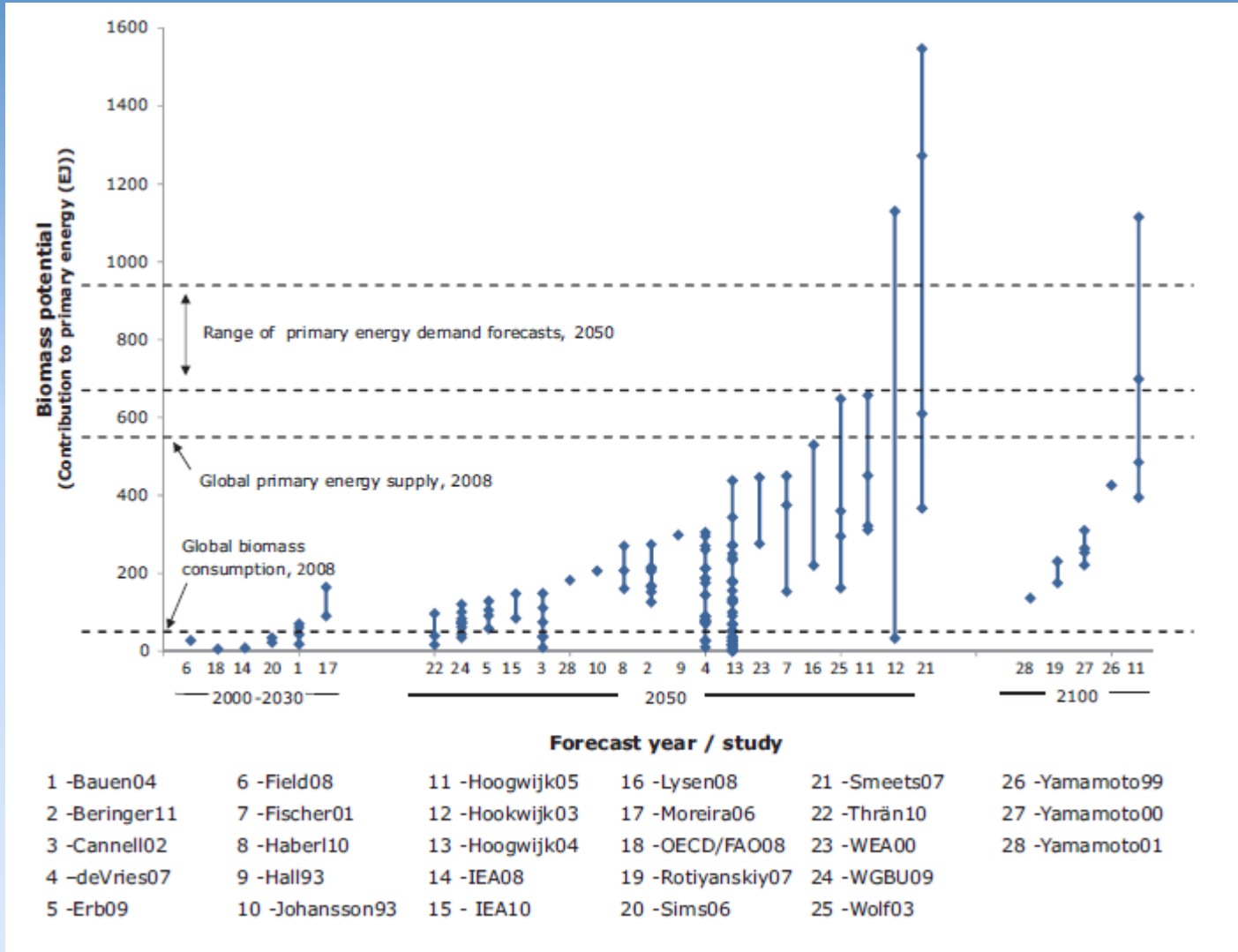
Biomass energy, present use, energy issues and potential for the future

- Biomass as an opportunity to meet energy challenges
  - has a huge theoretical potential of production especially in tropical areas;
  - can substitute partially for fossil fuels: it is flexible and can produce heat, power and liquid or gas fuels;
  - could offer a light carbon footprint - when carefully managed
  - could be produced and used in rural areas in developing countries
  - expected reservoir of employment (direct and indirect)

- Tropical environments are suitable areas
  - High biomass yields : crops and wood
  - Wide range of candidate plants
  - Theoretical large amount of potentially “available” land (extensive grassland, marginal or degraded lands, deforested areas, forests….)

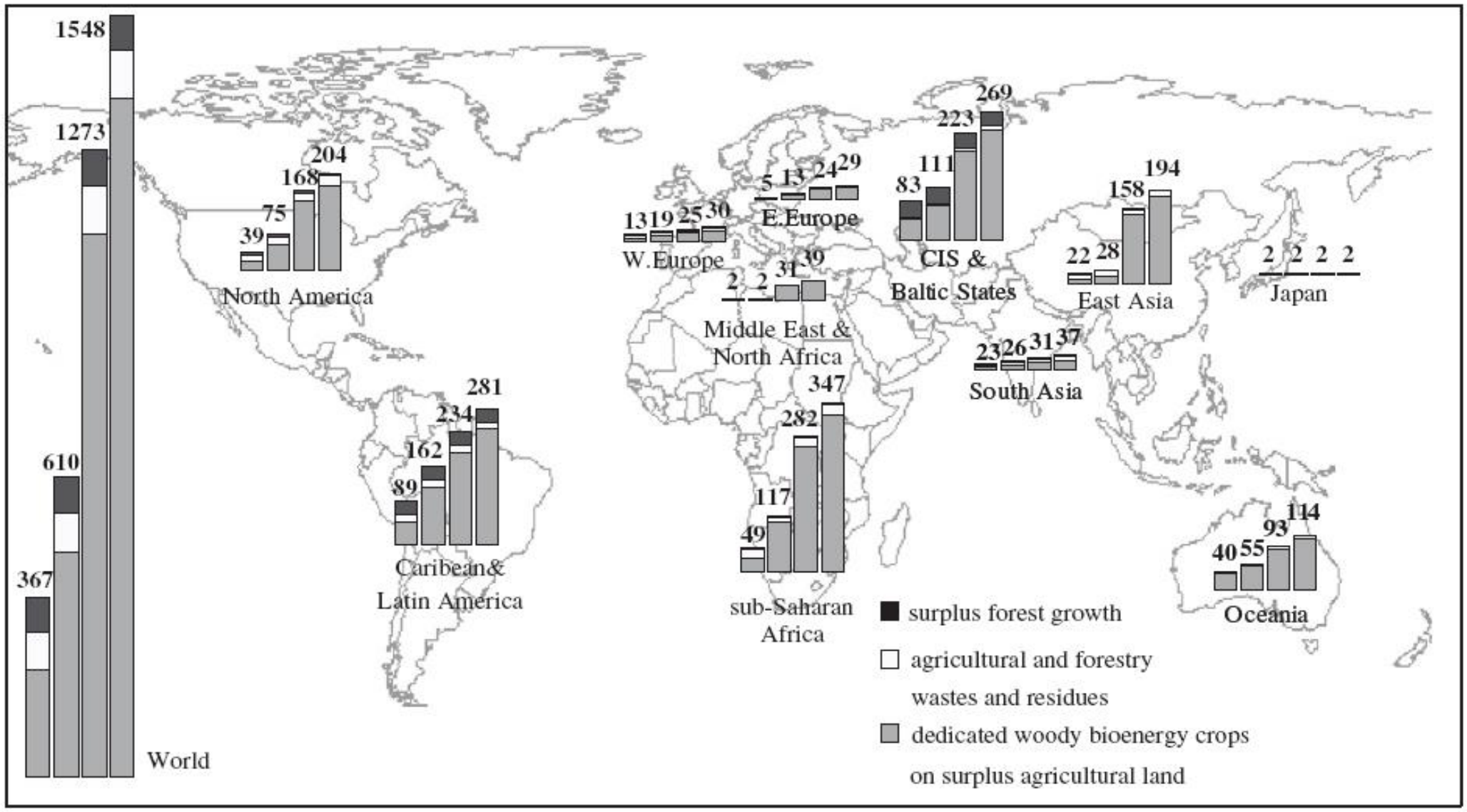
Biomass energy, present use, energy issues and potential for the future

- Biomass = 10 % to 100% of primary energy demand



Source : Slade et al, 2010

Biomass energy, present use, energy issues and potential for the future



Source : Smeets, *et al.*, 2007

In a medium-term scenario, only Africa , South-America and Eastern Europ offer a real potential

Biomass energy, present use, energy issues and potential for the future

- Agriculture and forestry are also entering a new era

they must :

- Meet the growing demand for food and material
- Reduce their impact on water and land resources, on biodiversity losses and on soil degradation
- Reduce their dependency on fossil fuels (fertilizers, fuels)
- Reduce both their contribution to climate change and to the vulnerability of food systems

- Bio-energy represents a massive demand

Producing bio-energy can have an impact on land use, soil degradation, biodiversity, GHG emission, social organization, …

Sustainability is vital for the success of bio-energy value chains

Content

2. the sustainability of bio-energy production chains : definitions, principles, initiatives and issues

3. Biofuel chains sustainability
Existing production chains
Sustainability issues
Which models ?

4. Woodfuel chains sustainability
Existing production chains
Sustainability issues
Which models ?

5. Conclusions

Sustainability, definitions and principles

- No real definition of sustainable bio-energy systems

For FAO, sustainable agriculture is linked to sustainable rural development. It

- provides the basic nutritional requirements while providing a number of other agricultural products.
- Provides durable employment
- Does not disrupt the functioning of basic ecological cycles , does not destroy socio-cultural attributes of rural communities, or does not cause contamination of the environment.
- Reduces the vulnerability of the agricultural sector to adverse natural and socio-economic factors

Global Resource Action Center for the Environment (NGO) has defined a sustainable energy system

- based on renewable resources,
- produces less adverse environmental, economic, health, and social impacts than fossil fuels or nuclear
- ensures that the needs of the present are met without compromising those of future generations

Sustainability, definitions and principles

- The sustainability of bioenergy production chains could be considered as the ability of this sector to :
    1. safeguard or improve food security
    2. ensure the renewal of the resource
    3. contribute to rural development
    4. avoid negative impacts on the environment and on socio-cultural attributes of rural communities

Sustainability, definitions and principles

- Existing standards = certification systems for biomass production

Initiative	RSB	ISCC	BSI Bonsucro	Proterra	RSPO	FSC	PEFC
Product	Bioenergy	Biofuels	Sugarcane	Soybean	Palm oil	Forestry	Forestry

- Some are imposed by importing countries (ISCC)
- Some are labels of good practices (FSC, RSB) driven by consumer expectations
- Some are responses of producers (RSPO, BSI, PEFC) to enter markets or access to fundings

- Example of principles : RSB

Nb	Principle
1 : Legality	Biofuel operations shall follow all applicable laws and regulations.
2 : Planning, Monitoring and Continuous Improvement	Sustainable biofuel operations shall be planned, implemented, and contin improved through an open, transparent, and consultative impact assessment management process and an economic viability analysis
3 : Greenhouse gas emission	Biofuels shall contribute to climate change mitigation by significantly redu GHG emissions as compared to fossil fuels.
4 : Human and labor rigths	Biofuel operations shall not violate human rights or labor rights, and shall decent work and the well-being of workers.
5 : Rural and Social Development	In regions of poverty, biofuel operations shall contribute to the social and development of local, rural and indigenous people and communities.
6 : Local Food Security	Biofuel operations shall ensure the human right to adequate food and imp security in food insecure regions
7 : Conservation	Biofuel operations shall avoid negative impacts on biodiversity, ecosyste conservation values.
8 : Soil	Biofuel operations shall implement practices that seek to reverse soil deg and/or maintain soil health.
9 : Water	Biofuel operations shall maintain or enhance the quality and quantity of s ground water resources, and respect prior formal or customary water rights.
10 : Air	Air pollution from biofuel operations shall be minimized along the supply
11 : Use of Technology, Inputs, and Management of Waste	The use of technologies in biofuel operations shall seek to maximize pro efficiency and social and environmental performance, and minimize the risk o the environment and people.

Sustainability in Biofuel supply/value chains

Biofuel sustainability: the current production situation

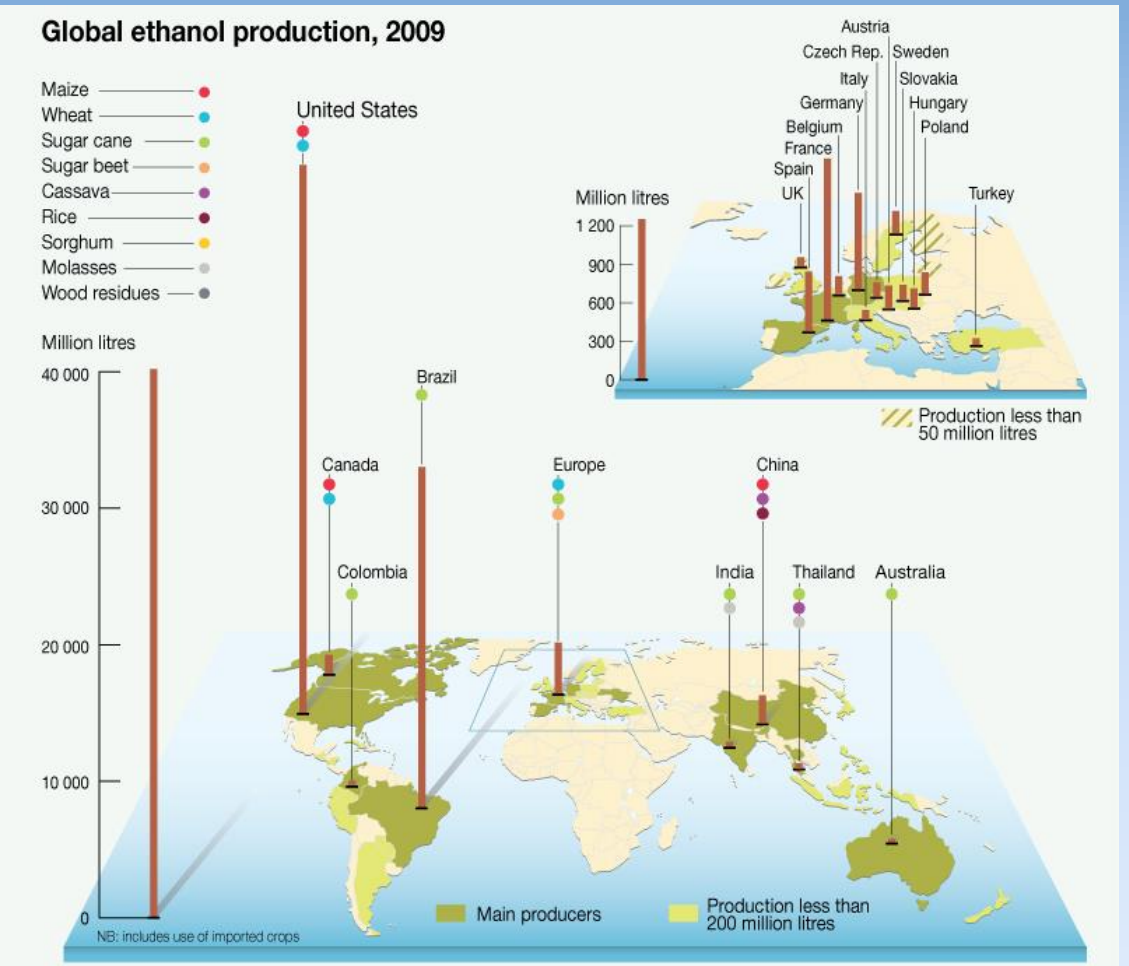
www.eia.gov

Ethanol Production: 87 Gl en 2011

USA (53Gl <- corn); Brazil (23 <- sugarcane)
China (2.3), Canada (1.7), France (1), Germany (0.8)

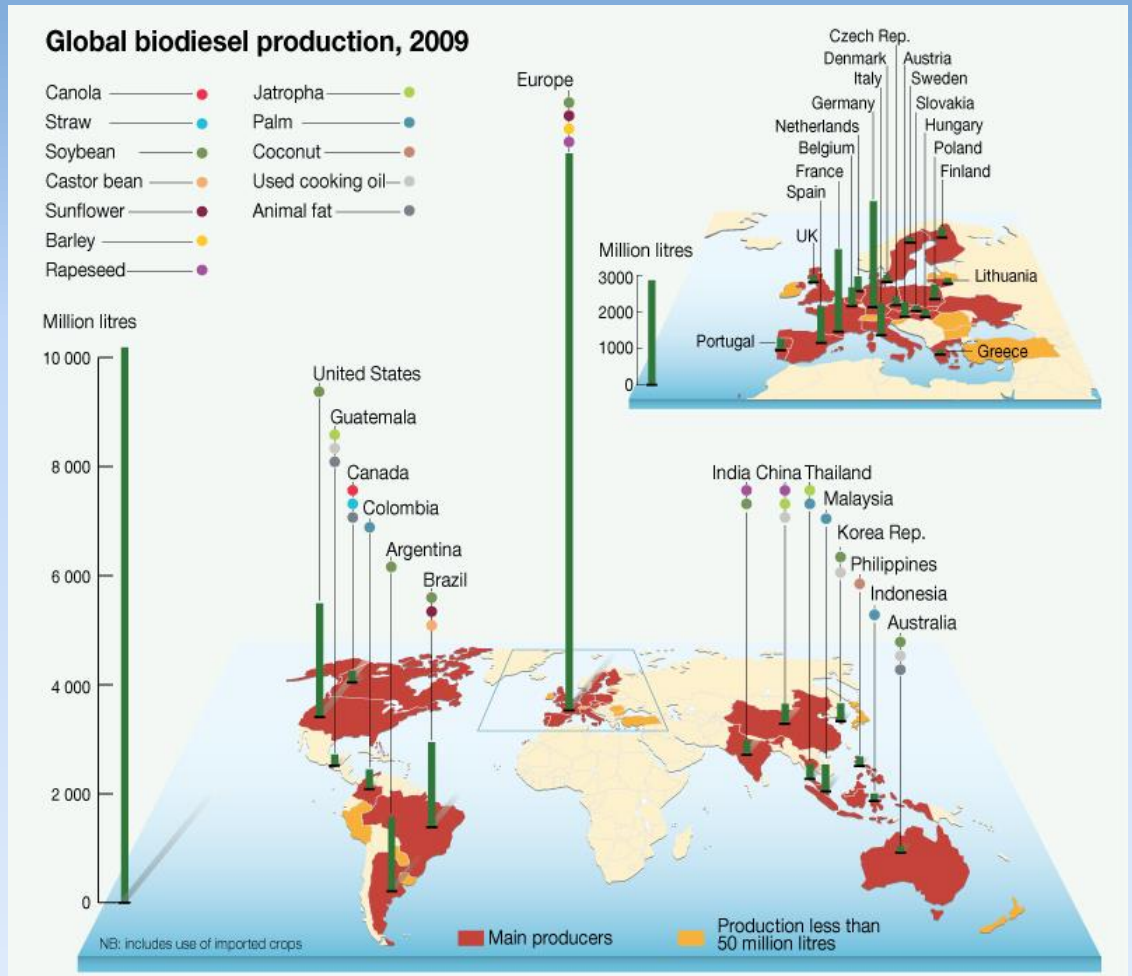
Biodiesel production: 23 Gl en 2011

USA (3.7Gl); Germany (3); Argentina (2.8 <- soy);
Brazil (2.7) France (2), Indonesia (1.2)



Sources: Biofuels Platform, *Geographic distribution of bioethanol and biodiesel production in the world in 2008*; IEA, *Biofuels for transport*, 2004; UNCTAD, *The emerging biofuels market*, 2006; International Food & Agricultural Trade Policy Council, *WTO disciplines and biofuels*, 2006.

www.grida.no



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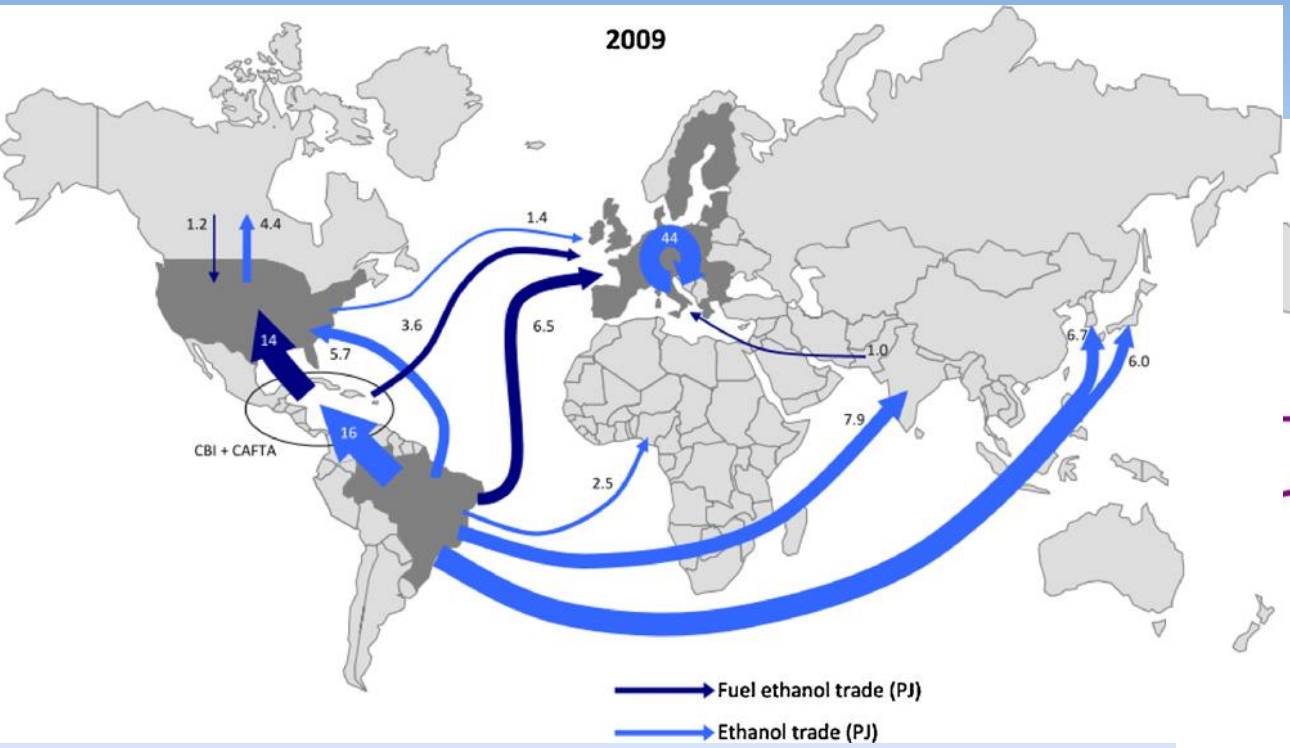
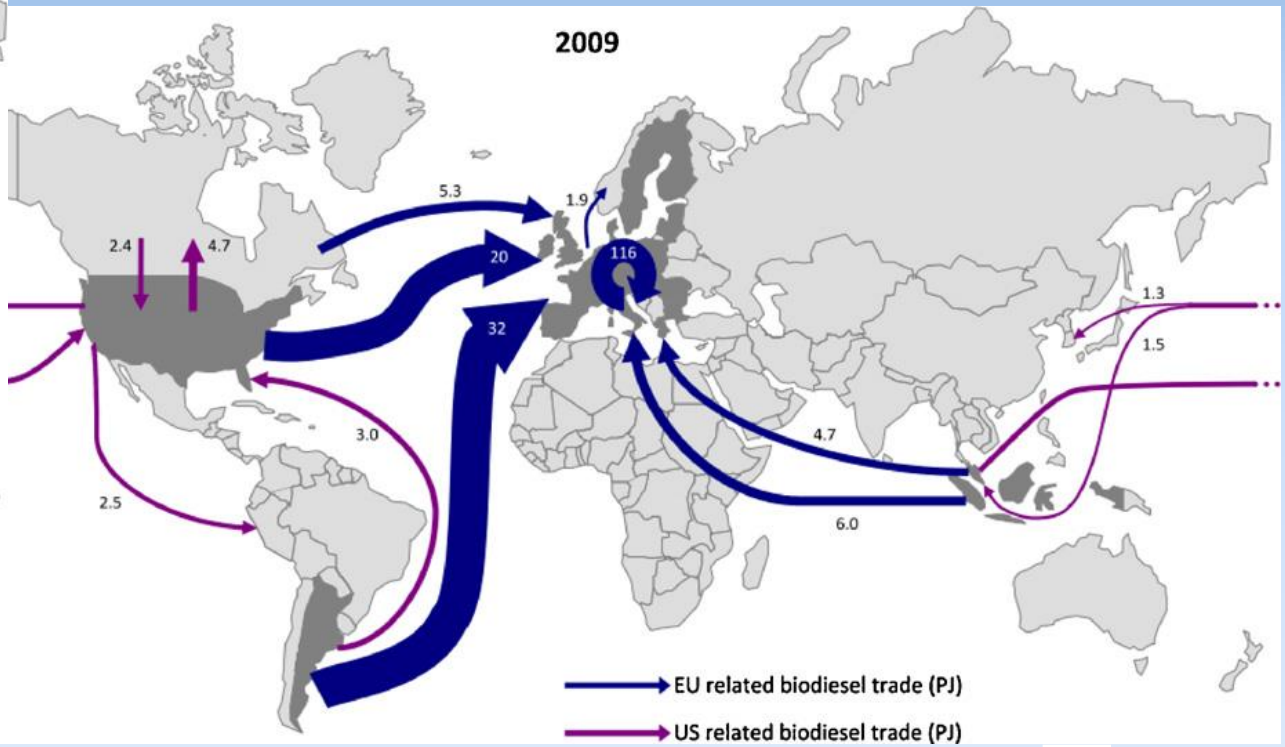
Biofuel sustainability: the current export situation

[Lamers et al. 2011]

Ethanol exports from Brazil mainly, sometimes through intermediate country where dehydration (CR, ES, JM, TT)



Biodiesel export from Argentina mainly



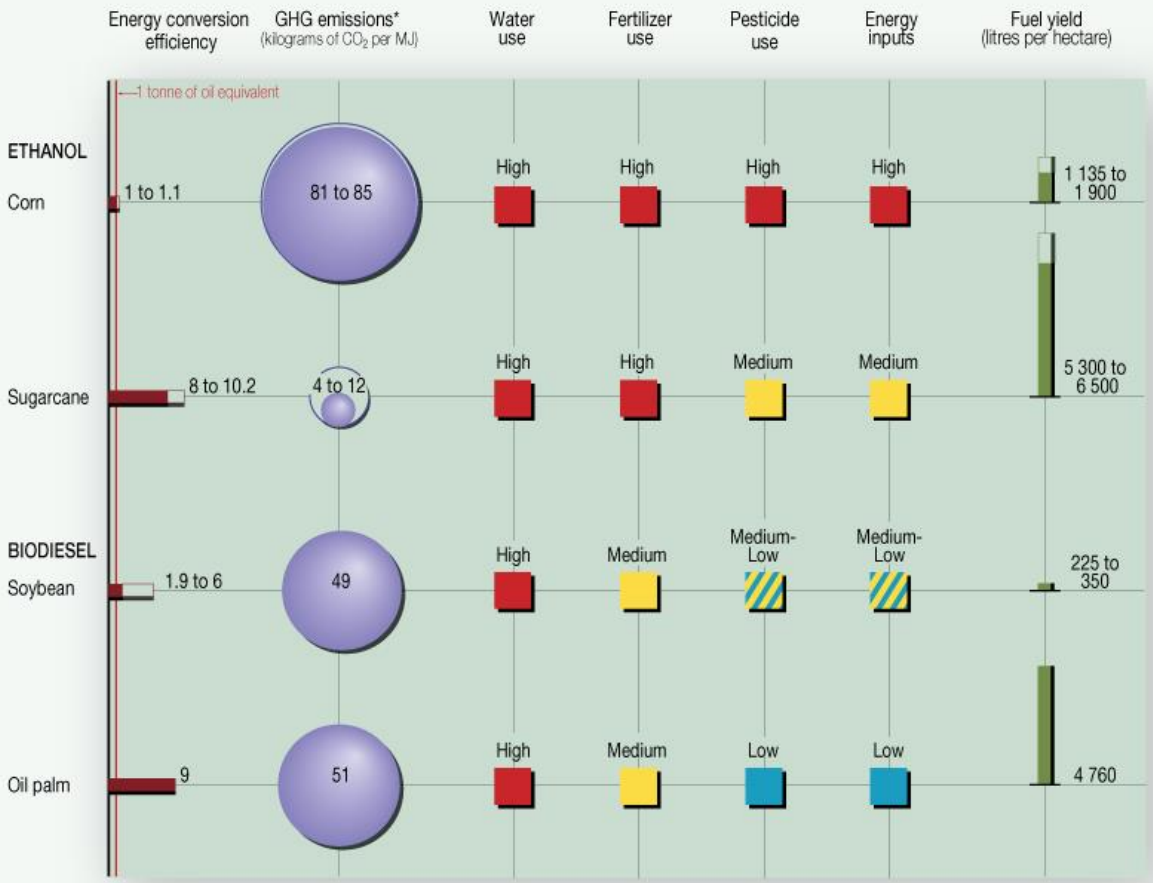
=> Importance of tropical environments

Biofuel sustainability: some orders of magnitude

www.irena.org

- Biofuel production meets 3% of transport fuel demand. IEA scenarios: 9.3% in 2030, 27% by 2050
- Biofuel crops cover 2-3% of arable land with diverse yields

Estimated feedstock efficiency and environmental impacts



Note : *Greenhouse gas emissions over biofuel life cycle (gasoline = 94 kgCO_2/MJ fuels; diesel =83 kgCO_2/MJ fuels).

Source: M. Groom et al., Biofuels and Biodiversity: *Principles for Creating Better Policies for Biofuel Production*, Conservation Biology, 2008; CIA, *The World Factbook*, 2010.

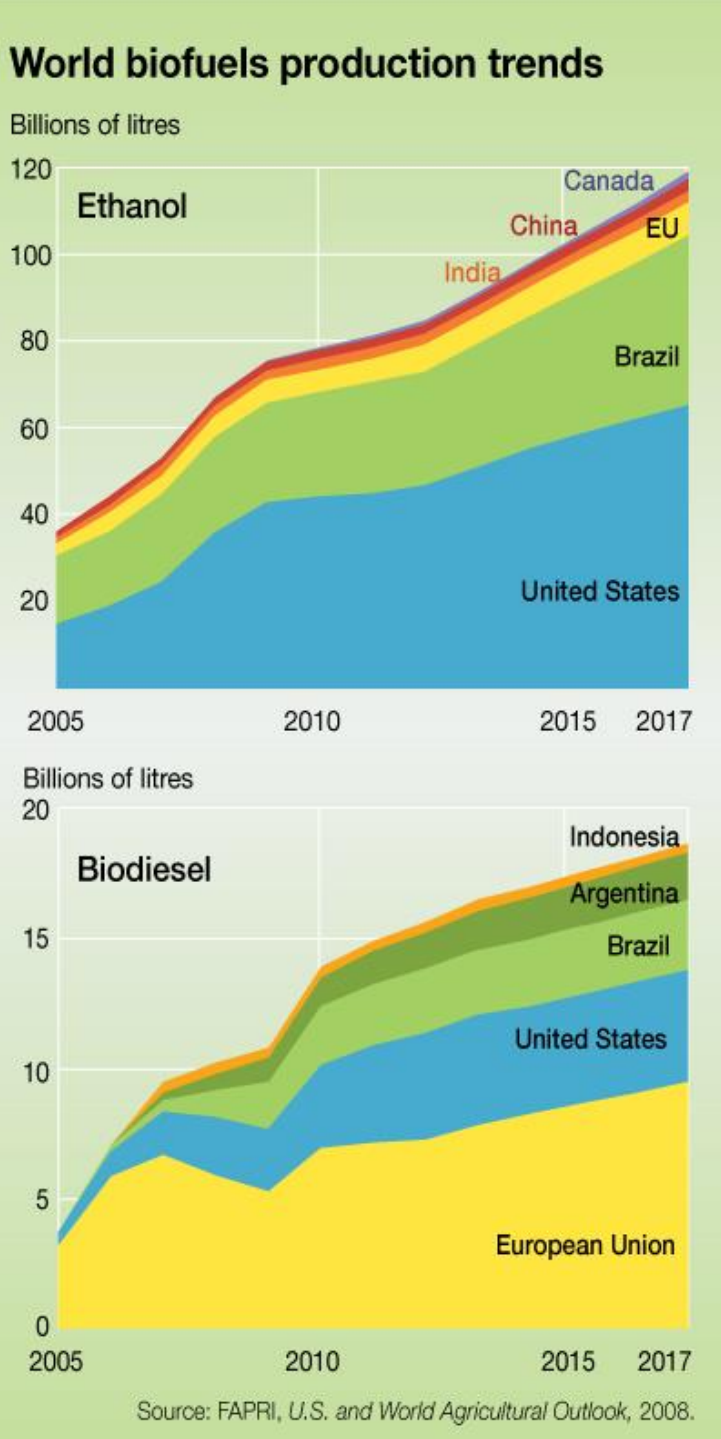
Best yields in tropical environments

Feedstock/Biofuel	Yield 2010 (2050) (lde-lge/ha)[5]	Co-products (kg/l biofuel)	CO_2 reduction vs. fossil fuels %
Sugarbeet Ethanol	2800 (3700)	0.25 Beet pulp	25 to 65
Corn (maize) Ethanol	1800 (2400)	0.3 DDGS	-20 to 60
Sugarcane Ethanol	3900 (4800)	2.5 Bagasse	70 to 105
Cellulosic Ethanol/SRC	2200 (3700)	0.4 Lignin	50 to 110
Rapeseed Diesel	1500 (2100)	0.1 Glycerine 0.6 Presscake	15 to 85
Soy seed Diesel	600 (900)	0.1 Glycerine 0.8 Bean meal	na
Palmseed Diesel/FAME	3200 (4800)	0.1 Glycerine, 0.25 Bunches	25 to 80
BTL Diesel/SRC	3100 (5200)	Low-temp heat, Pure CO_2	55 to 120
HVO Diesel	2000 (3400)	0.1 Glycerine	15 to 84
Algae Diesel	Na	Several	-50 to 65

Projections on biofuels

- For ethanol to reach 10% of global oil consumption in transport sector
  200 Mha wheat (= actual wheat area)
  or 85 Mha corn
  or 33 Mha sugarcane (current area reaching 26 Mha in 2012)
- EU objective: 10% in transport sector by 2020 ⇔ additional 5 to 7 Mha
- Projections on biodiesel difficult to translate in additional vegetable oil demand given that it is rising for many purposes

  - Ambitious targets but recent slowdown
  - Potentially available land for biofuel expansion: depend on the type of production chain considered



Biofuel sustainability with agro industrial models in tropical envir.

Sugarcane-to-ethanol

- In Brazil principally , but also Colombia, Guatemala, …
- High yielding sugarcane varieties
- Controlled maturation and mechanical harvesting at optimal moment
- Flexibility to produce sugar & molasses instead of ethanol
- Optimized use of bagasse generating electricity that can be exported to the grid
- Minimized generation of vinasse which is then carefully handled and used where soil need it
- Crop rotation with nitrogen fixing species

Oil palm-to-biodiesel

- Indonesia and Malaysia; Thailand Colombia Congo Basin, Honduras…
- High yielding low size varieties
- Optimized logistics to process the fruit bunches right after harvest
- Energy generations out of empty fruit bunches (process heat) and wastes (biogaz)
- Dynamic international oil market that do not differentiate final uses
- Biodiesel produced in Europe mainly
- Glycerin of controlled quality sold to the chemical/cosmetic industry

=> Important infrastructure requirements, many scale effects leading to the supremacy of large scale producers

Biofuel sustainability issues for further biomass production

- Extension of cultivated areas affecting environment and development patterns
  - On which land?
    - Carbon balance reduced by land preparation (savannas) and soil degradation (pastures)
    - Biodiversity affected by single crop farming (mechanization)
    - Water required for biomass production & transformation and possibly polluted by waste products
  - Which biomass?
    - Several crops are still looking for adequate technical packages: sweet sorgho, Jatropha…
  - Whose land?
    - Cases of land grabbing, use of reserved land, access to specific funds
    - Subcontracting and the unbalance in negotiation power
    - Migrations, unclear balance on employment
- Risky business
  - Costly investments without reliable policy decisions, given lack of energy-agriculture convergence
  - Fluctuating yields versus the industrial logic of the energy sector
  - Unsettled issues of food versus fuel: how to handle crisis?
- Open canal between food and energy international markets -> more price instability => regulation?

Sustainable biofuel, what are the alternatives?

Ethanol production

- Cassava, sweet sorghum, sweet residues…
- 2nd generation biofuel slowly integrated for the use of residues
- Small scale has an additional cost
  => Financing lower yields and productivities?
- …

Biodiesel production

- Jatropha, castor oil…
- Straight vegetable oil direct use
- Esterification process with ethanol
- Special program for family agriculture (PNPB-BR)
- …

Many issues require clarification / systematic records of experiences and achievements

- Detailed yields and associated conditions
- Alternative coordination modes: financing issues of cooperatives
- Local markets: quality and social acceptability issues (added value of local products)

No simple answer to differentiate sustainable production chain from unsustainable ones
=> constant need to innovate and look for more sustainability

Uncertainties on "new" biomass and associated crop technical package
=> experimental stages must clearly be identified as such, for more realistic expectations

Sustainability in Woodfuel supply/value chains

Woodfuel supply/value chains

- In rural areas: woodfuel is free, through individual collection of wood by households
  Wood is collected around villages by rural people, in forests, savannas, cerrados, fallows, and outside of forest (fields)

- In urban areas : commercial but informal supply chains
  Dominant chains = individual rural producers (woodcutters, charcoal processors) / urban transporters, wholesalers and retailers

- Emergence of "modern" value chains to supply increasing demand for power, heat and steel
  Many projects of fast growing plantations to produce wood pellets, chips and charcoal
  Short rotation coppices are under development

2.4 billion people rely mainly on woody biomass for cooking and heating

Woodfuel supply/value chains

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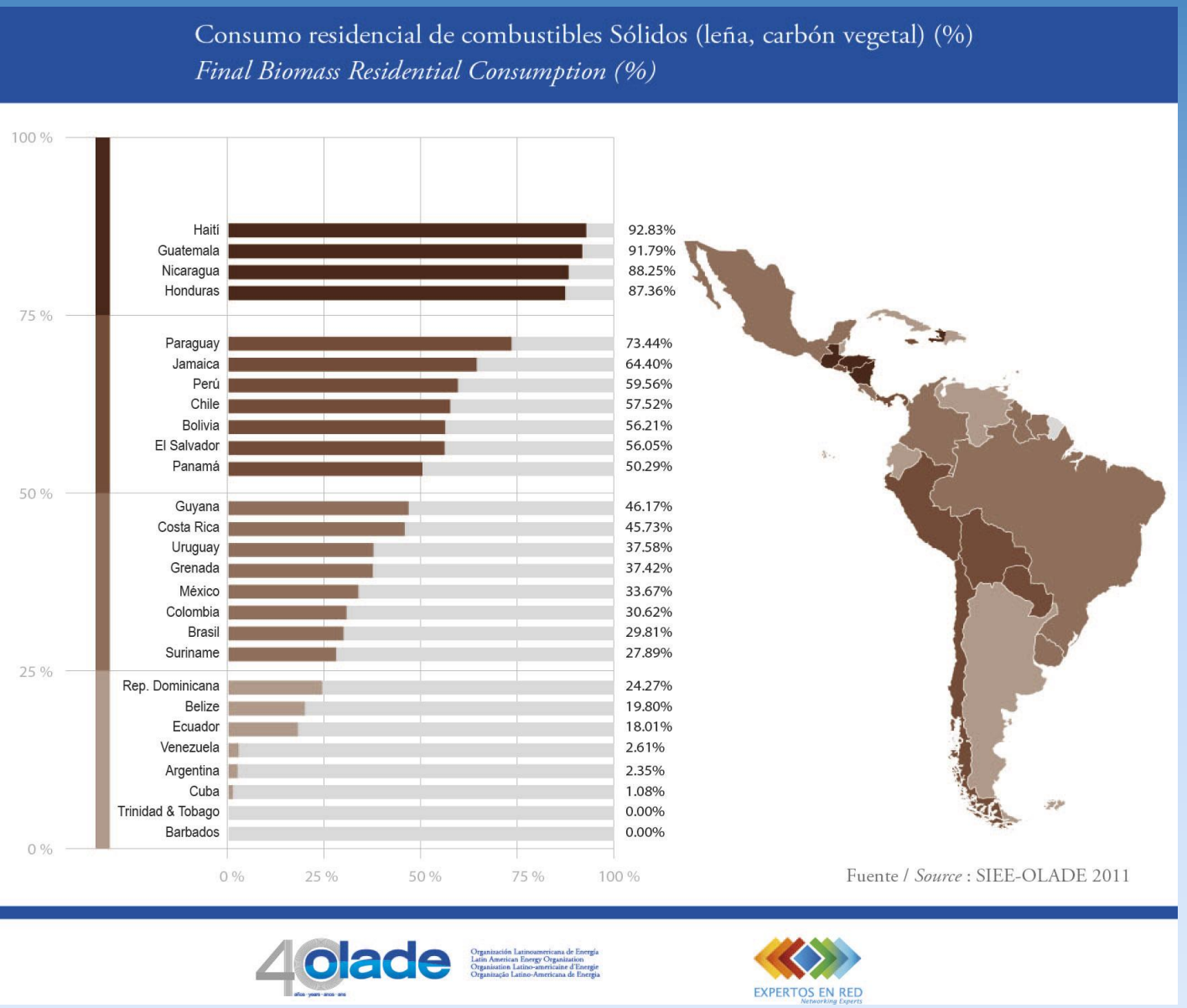

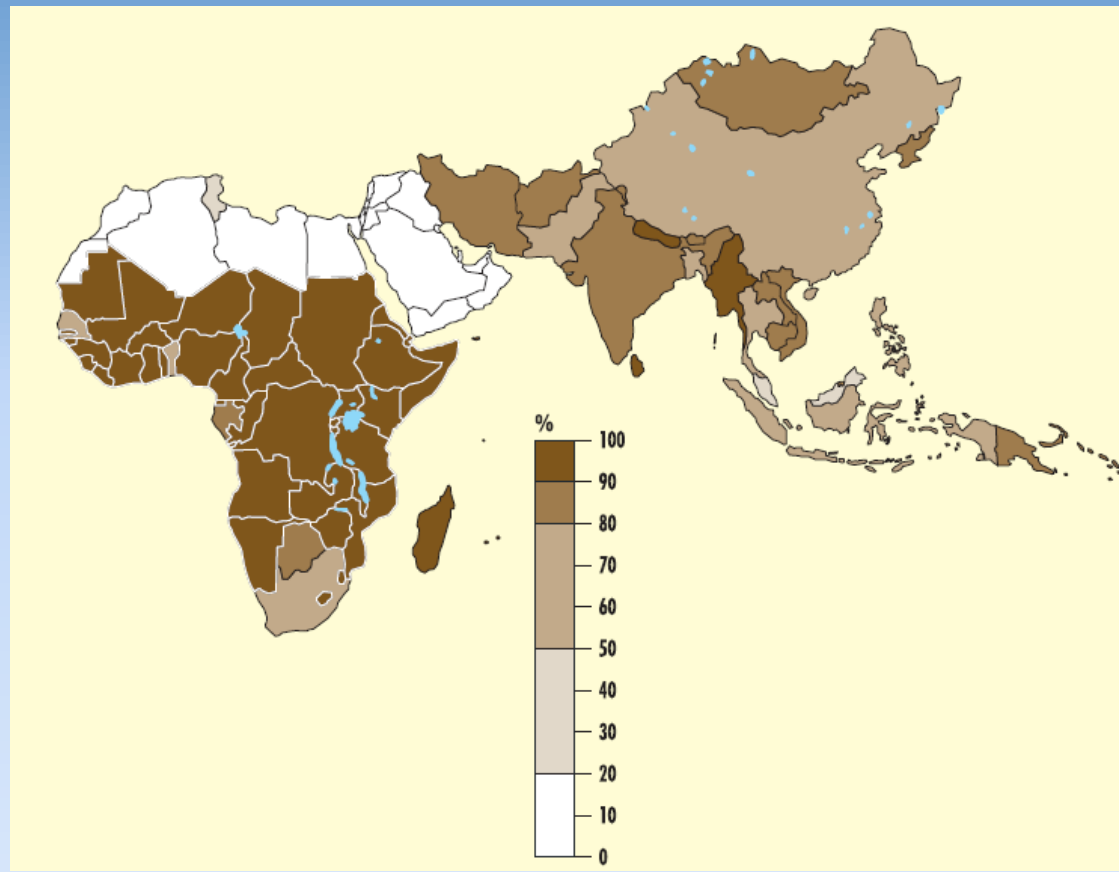

Source IEA 2006

Woodfuel and controversies about sustainability

- Source of forest degradation, deforestation, biodiversity losses
- Source and synonymous with poverty
- Source of serious respiratory diseases and a high mortality rate in developing countries
- Water pump
- Competition with other forest value chains (Timber, pulpwood)
- Negative carbon balance

BUT ……. lack of evidences and observations can show the contrary

Woodfuel and controversies about sustainability

- Source of forest degradation, deforestation, biodiversity losses – What do we know ?

In natural forests

- Deforestation generally occurs when there is a change of land use, not when trees are harvested. In many countries, woodfuel production is the first step before conversion to agriculture.
- Rarely ,if ever, does woodfuel collect leads to deforestation in the tropics as felled trees usually coppice from stems and roots, seeds regenerate and suppressed seedlings and young trees take over.
- Intensification of the harvest (for woodfuel) may have negative impact on biodiversity and soil quality
- There may be a change and reduction of species mix leading to degradation

In traditional plantations

- Plantations can have both positive and negative impacts on biodiversity
- At a landscape level, plantations can enhance biodiversity and for instance provide corridors between isolated areas

In short rotation coppices

- There may be competition for best lands with food crops
- Sustainable management rules yet to be defined

Woodfuel and controversies about sustainability

- Source of poverty – What do we know ?

  - Woodfuel supply chains represent **an unofficial first rate economic sector** (more than fossil fuels and electricity in Africa)
  - Woodfuel supply chains represent **a great wealth of employment**. In Sub-Saharan Africa it is estimated that 13 million people could be employed in the woodfuel sector
  - Woodfuel supply chains require little initial technical skill and capital. They are therefore very easily accessible for the more destitute and constitute a **safety net against extreme poverty**.

Woodfuel and controversies about sustainability

- Source of serious respiratory diseases – What do we know ?
  - Smoke from the fire can and does affect the health of people within its vicinity.
  - Measures of exposition are lacking and there are many other causes of respiratory diseases in developing countries
  - Kitchen without good ventilation and chimney are the main cause of respiratory diseases
  - Technical solutions exist : improved charcoal, improved stoves, chimneys

- Plantations = water pumps – What do we know ?
  - Fast-growing, short-rotation forest plantations use more water than plantations composed of slower-growing species.
  - Plantations are likely to increase water quality compared with agriculture because of its lower agro-chemical requirements
  - For the same amount of biomass, some forest plantations use less water than annual agricultural crops

Woodfuel and controversies about sustainability

- Competition with other value chains – What do we know ?
  - paper industries have lead intense campaigns against woodfuel
  - woodfuel is now perceived by timber producers as an income supplement
  - trials of intensive dual exploitation (timber/woodfuel) are currently being carried out in humid tropical forests

- Source of GHG – What do we know ?

  - In the absence of losses, woodfuel is carbon-neutral
  - Main losses come from land-use change : ex savannahs to plantations
  - The carbon balance is better if wood is used as material (stock)
  - Sustainable management regime are possible
  - impacts of black carbon (soot), a short-lived pollutant that contributes to climate forcing.

Woodfuel, a need for new production models

- Woodfuel is not an unstainable disease BUT current forestry models need to be renewed because not adapted to the demand, neither in quantity, quality, nor costs

Woodfuel must be considered as a noble product and not as a by-product or a energy from the past

- On going developments :
  - New technologies (for power generation, for heating, for cooking)
  - New fuels (pellets)
  - New forestry models adapted to the knowledge and practices of local players
  - Harvest intensification in dense forests
  - Trials of short rotation coppices in tropical areas
    - need to generate data from large-scale field studies
  - Assisted regeneration in natural forests
  - New Agroforestry models integrating woodfuel (ex cassava/acacia

Conclusions

- World is entering new eras
  - New energy era : less fossil fuel dependency
  - New agriculture era : more ecology, sustainable production intensification
  - An energy transition is needed in tropical rural areas – and also in urban areas

- Bio-energy offers opportunities in tropical environments
  - Rural energy services, employment, innovations and new markets for agriculture and forestry

- Biomass production is still a challenge in terms of sustainability
  - Must be massive and carbon neutral
  - Can lead to land use changes and corresponding negative impacts (environmental and social)
  - Is still uncertain in terms of business models (technical packages, scaling, markets and incentive systems)
  - ...

Conclusions

Finally

- Bioenergy future is uncertain, as energy future in general
  - Many countries are in a conservative position towards biofuels
  - Innovations are needed in energy and agriculture sectors

- To make bioenergy sustainable :
  - Need for uninterrupted innovations and improvements
  - Need for clear political messages (VS currently ambiguous)
  - Need for consistency in political actions and synergies between energy, environment, agriculture and industrial sectors
  - Need for new thinking at landscape and territorial levels
  - Need for social consensus and also consistency in our way of life

Thank you