Biomass potential in Africa and African Experiences

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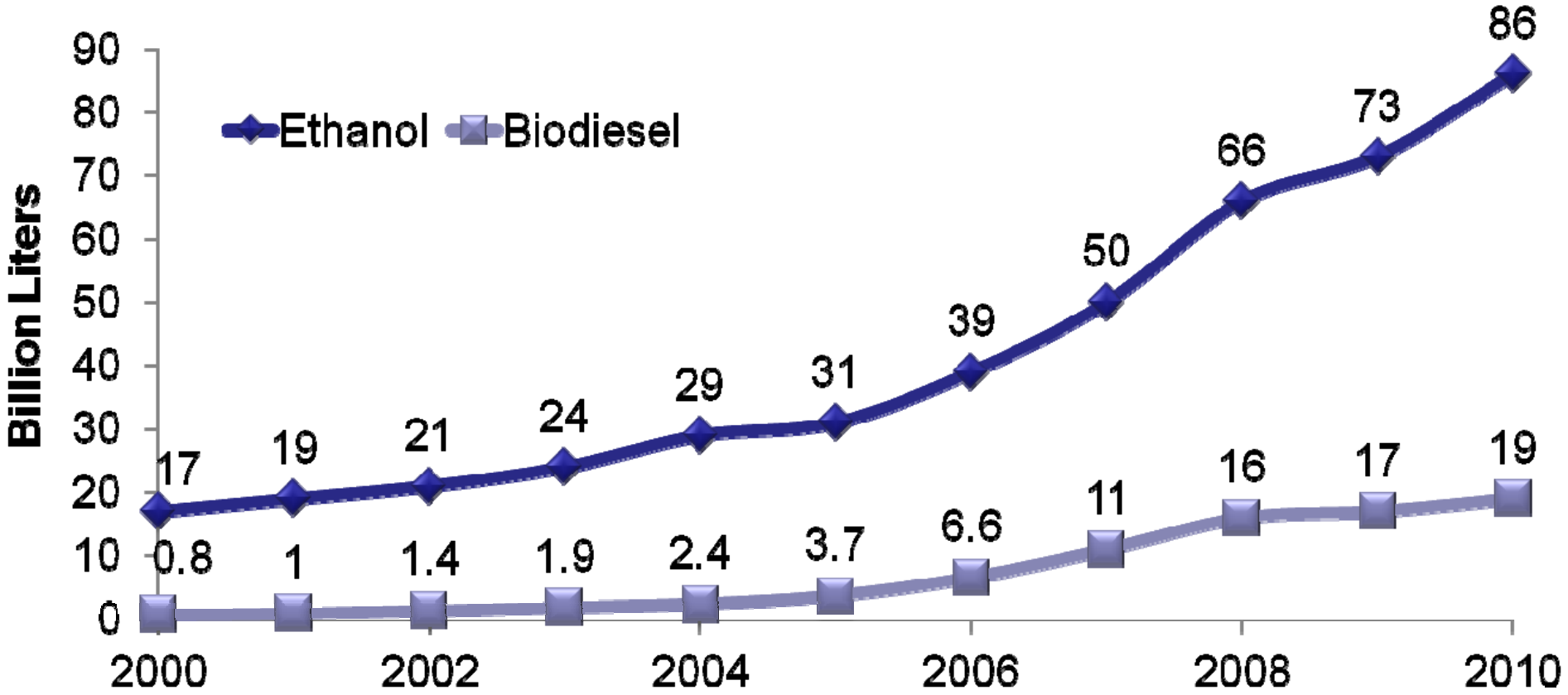
B20 BIODIESEL
Bio Diesel

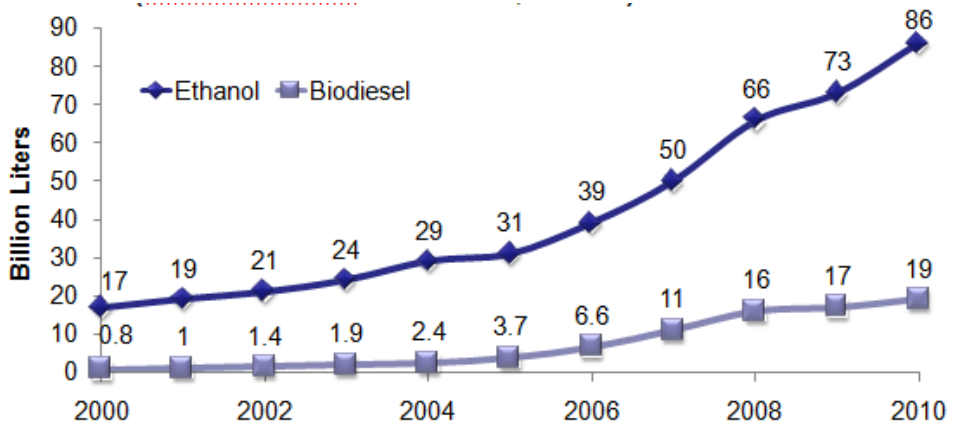
Introduction

- Global biofuels production rose from about 18 billion litres in 2000 to a phenomenal 105 billion litres in 2010 (Worldwatch Institute, 2011; REN21, 2011).



Introduction

- Biofuels provided 2.7% of all global fuel for road transportation in 2010 – an increase from 2% in 2009.



- Supply is dominated by bioethanol, which accounted for approximately 82% of total biofuels production in 2010.

Introduction

- Together, Brazil and the US contributed to about 90% of global ethanol production.
- The European Union contributed about 53% of all biodiesel in 2010.
- Africa has huge potentials but little has been done till date. Large investments into feedstock production, little by way of actual fuel production.

Introduction

- Demand for biofuels is projected to increase to about 183.8 billion litres by 2015 with ethanol said to contribute about 80% of the total (HART/GBC, 2009).
- Several countries have adopted policies to promote liquid biofuel development led by the US, the EU and Brazil.
- A growing number of developing countries, including a few African countries have also started to introduce similar policies.

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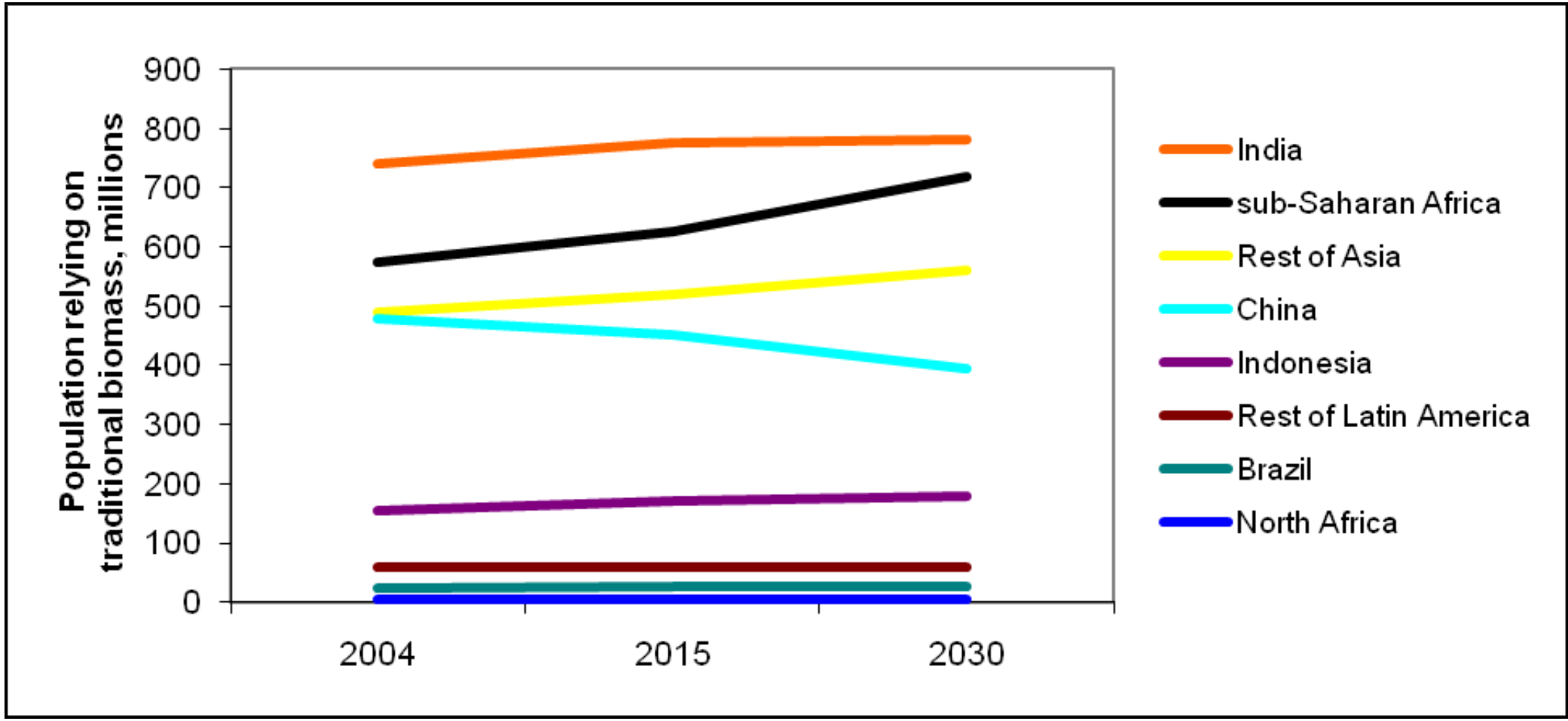
BIOMASS POTENTIALS IN AFRICA

The promise and the threats

- Per capita consumption of electricity in sub-Saharan Africa averages just 457 KWh annually, with the average falling to 124 KWh if South Africa is excluded (World Bank, 2008).
- By contrast, the annual average per capita consumption in the developing world is 1,155 KWh and 10,198 kWh in high-income countries.

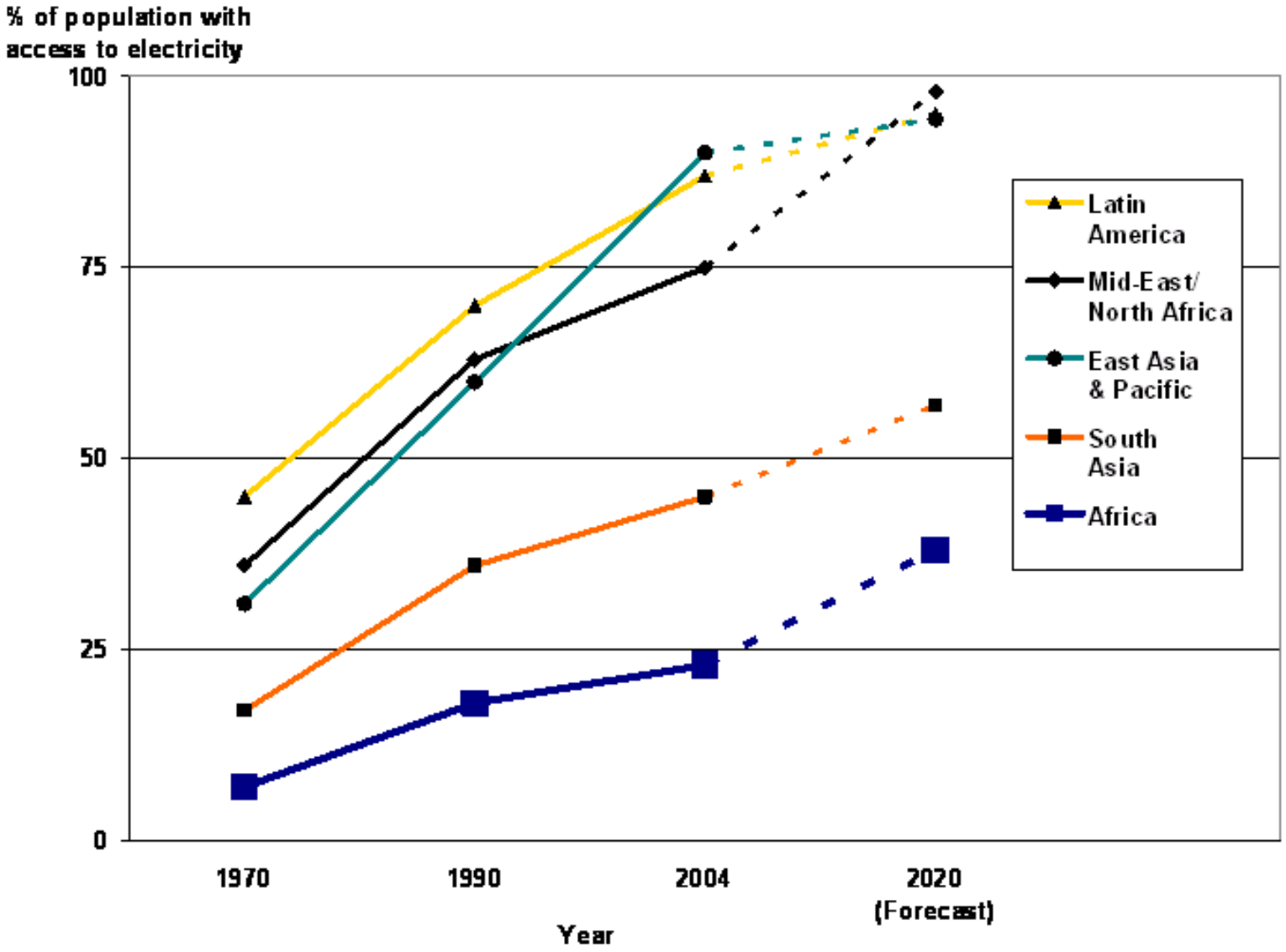
The Fuel situation is Bleak



Source: Data from IEA (2006)

- **Traditional biomass use** is projected to increase in sub-Saharan Africa

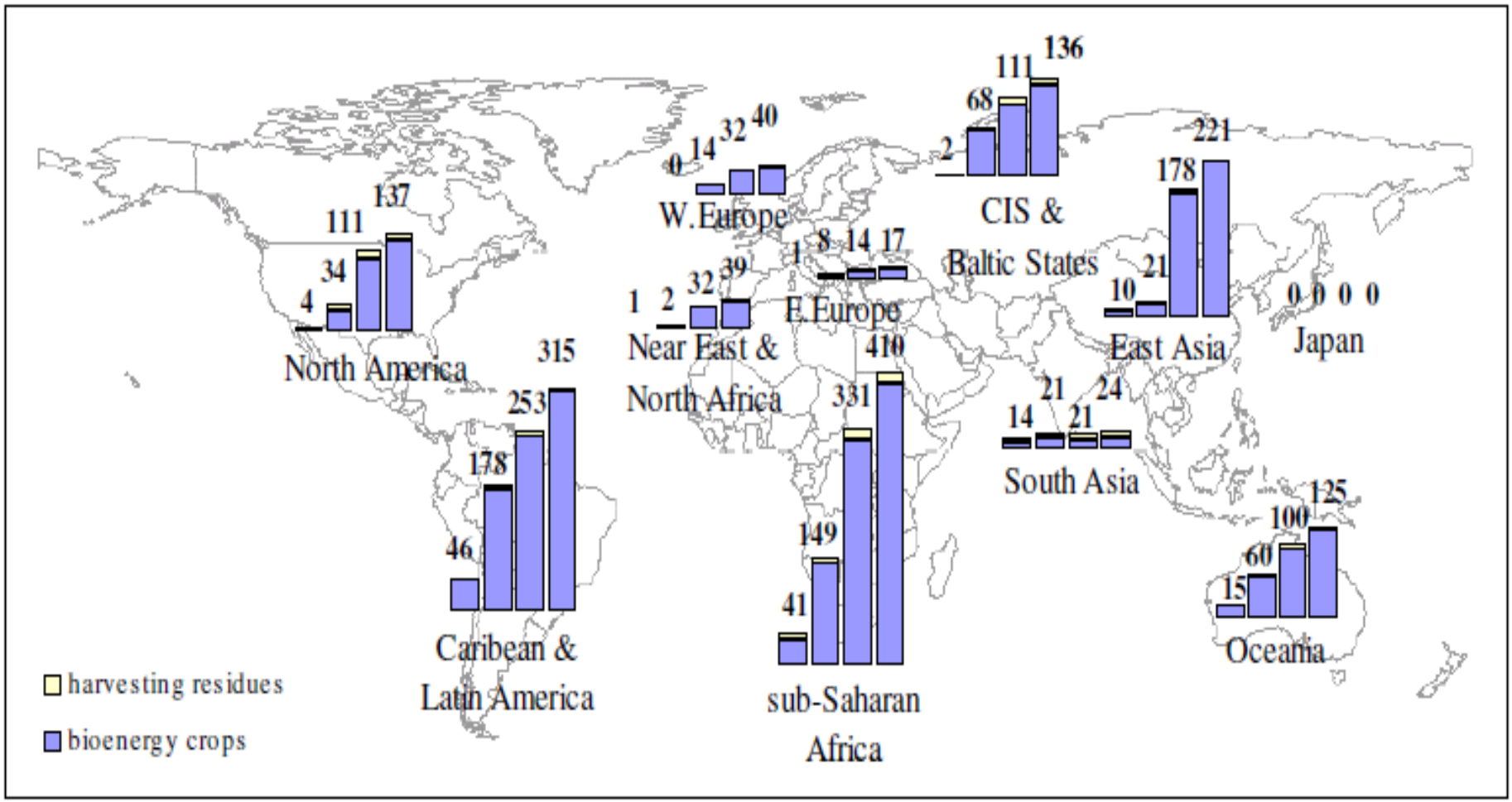
Forecast for electricity access not good either



Biomass opportunities

- Africa is endowed with biomass resources which can be used sustainably to produce fuels to solve some of its energy problems.
- Fuel from biomass biofuels represent a unique opportunity for Africa to address problems linked to rural poverty, lack of access to electricity and the negative impacts of fossil oil imports.

Africa has highest bioenergy potential



Source: Smeets et al. (2008)

Africa has many biofuels options

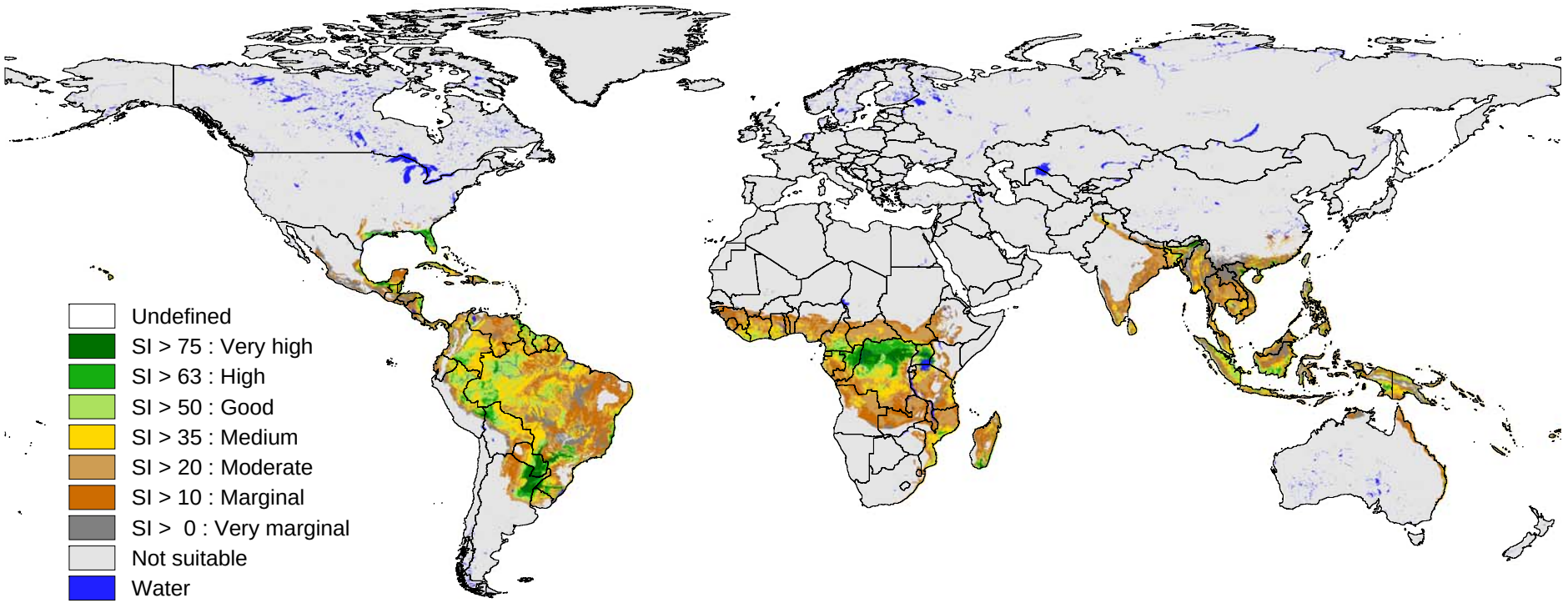
Feedstock	Conditions for best performance	Yield per hectare	Principal producing countries
Bioethanol			
Sugarcane	Up to 1600m above sea level	5800 l/ha in Brazil, 4000 l/ha for Africa	South Africa, Sudan, Kenya, Swaziland, Zimbabwe, Mauritius
Corn	Grows everywhere but often needs irrigation	3000 l/ha, 700 l/ha for Africa due to poor yields	South Africa, Nigeria, Ethiopia, Kenya, Tanzania
Sweet sorghum	Dryer tropics and temperate regions up to 2500m altitude	3000 – 6000 l/ha	Nigeria, Ethiopia, Sudan, Burkina Faso
Cassava	Tropical climates up to 1000m	5400 l/ha, 1750 l/ha in Africa due to low efficiency in current production methods	Nigeria, DR Congo, Mozambique, Ghana, Angola
Biodiesel			
Oil Palm	Humid tropic areas up to 700m altitude	6000 l/ha in Malaysia, Africa plantations average less than half	Nigeria, Cote d'Ivoire, DR Congo, Ghana
Jatropha	Tropical & semi arid regions at altitudes up to 500. Rainfall from as low as 300mm	400 – 2200 l/ha of pure plant oil	Ghana, Mali, Tanzania, Mozambique, Senegal, several other countries

Compiled from Sielhorst *et al.* (2008)

High crop yields are critical

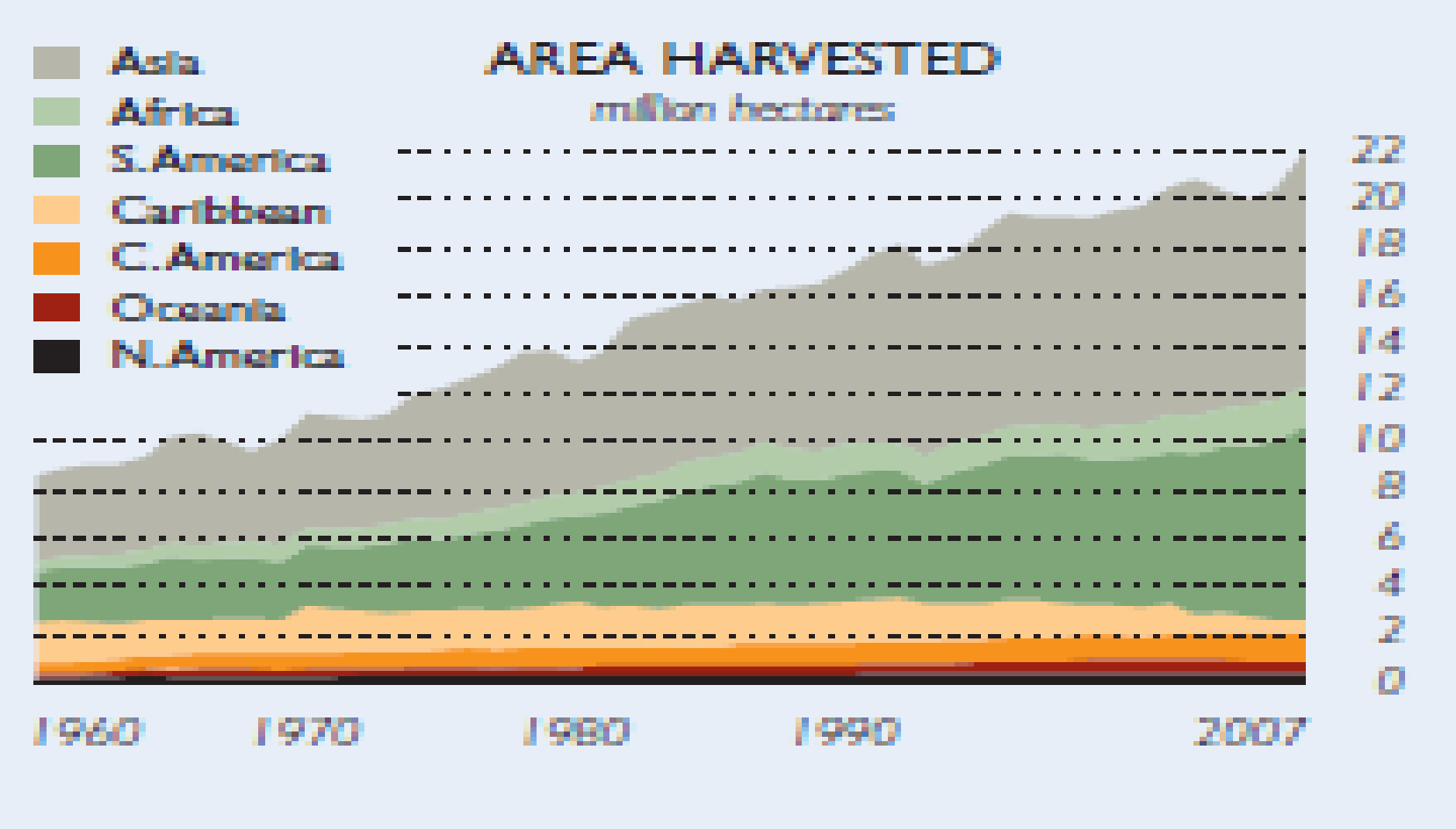
- Develop agronomical systems in Africa
  - Advanced biotechnology and crop-breeding improvements could help feed the population with less land than is used today and therefore free up land for energy crop production.
  - Plant breeders developing highly productive energy crops that grow on marginal lands could yield vast new quantities of biomass resources.

Global suitability for rain-fed sugarcane (IIASA, 2009)



- Africa has about same potential as Latin America. Thirty seven SSA countries produce sugarcane

Global sugar cane production 1960-2007



- Inspite of sugarcane potential and land availability, very little production in Africa

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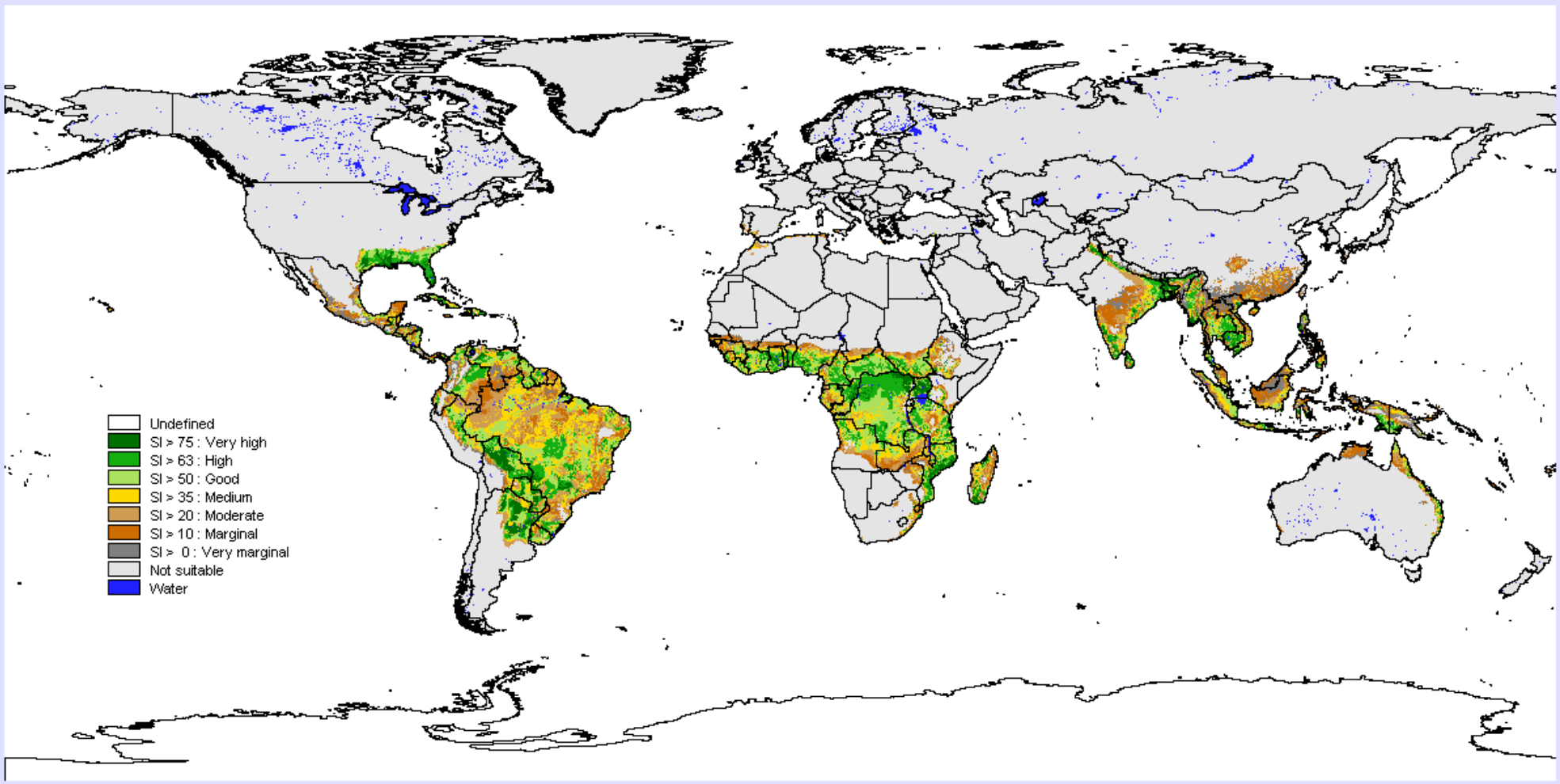
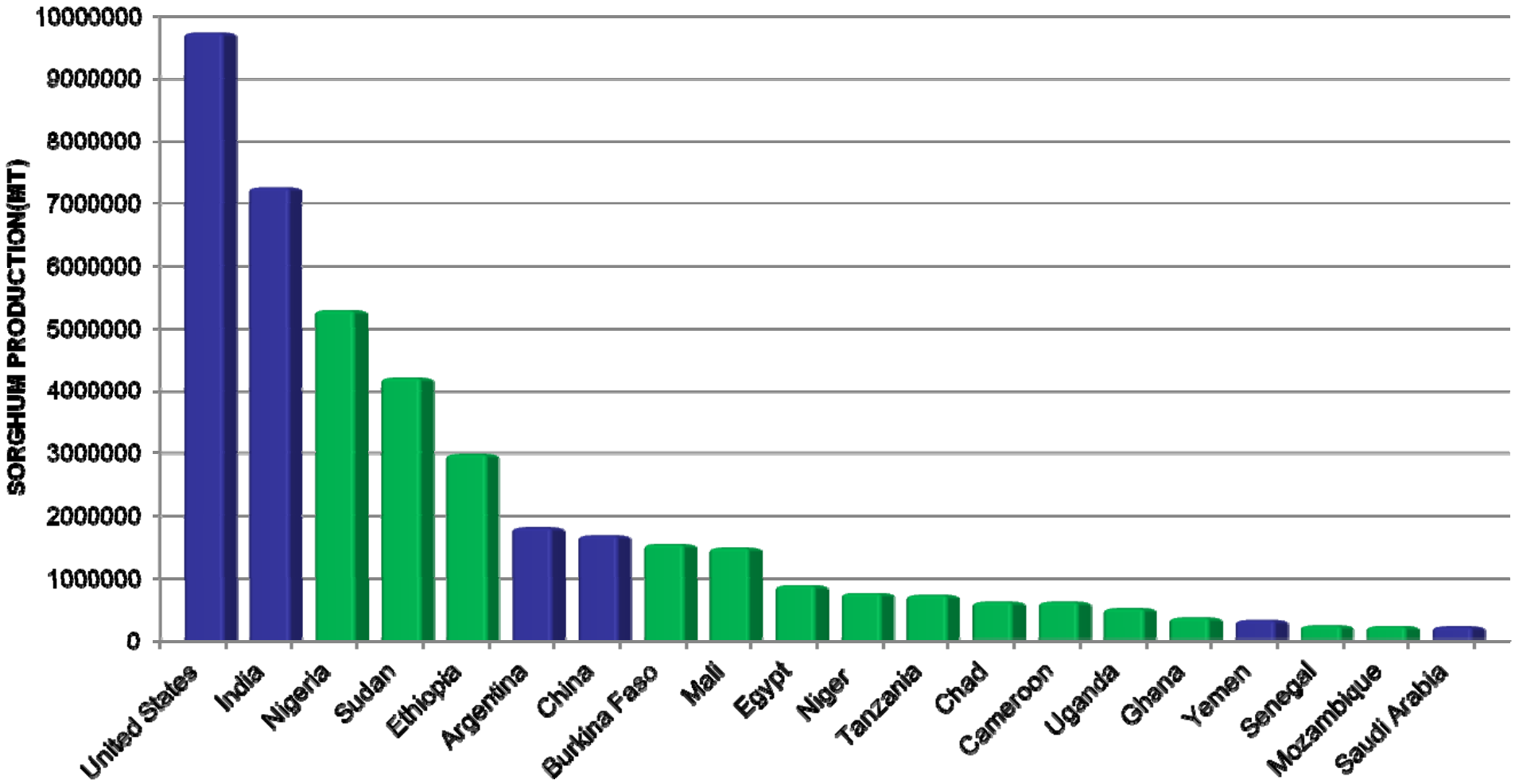
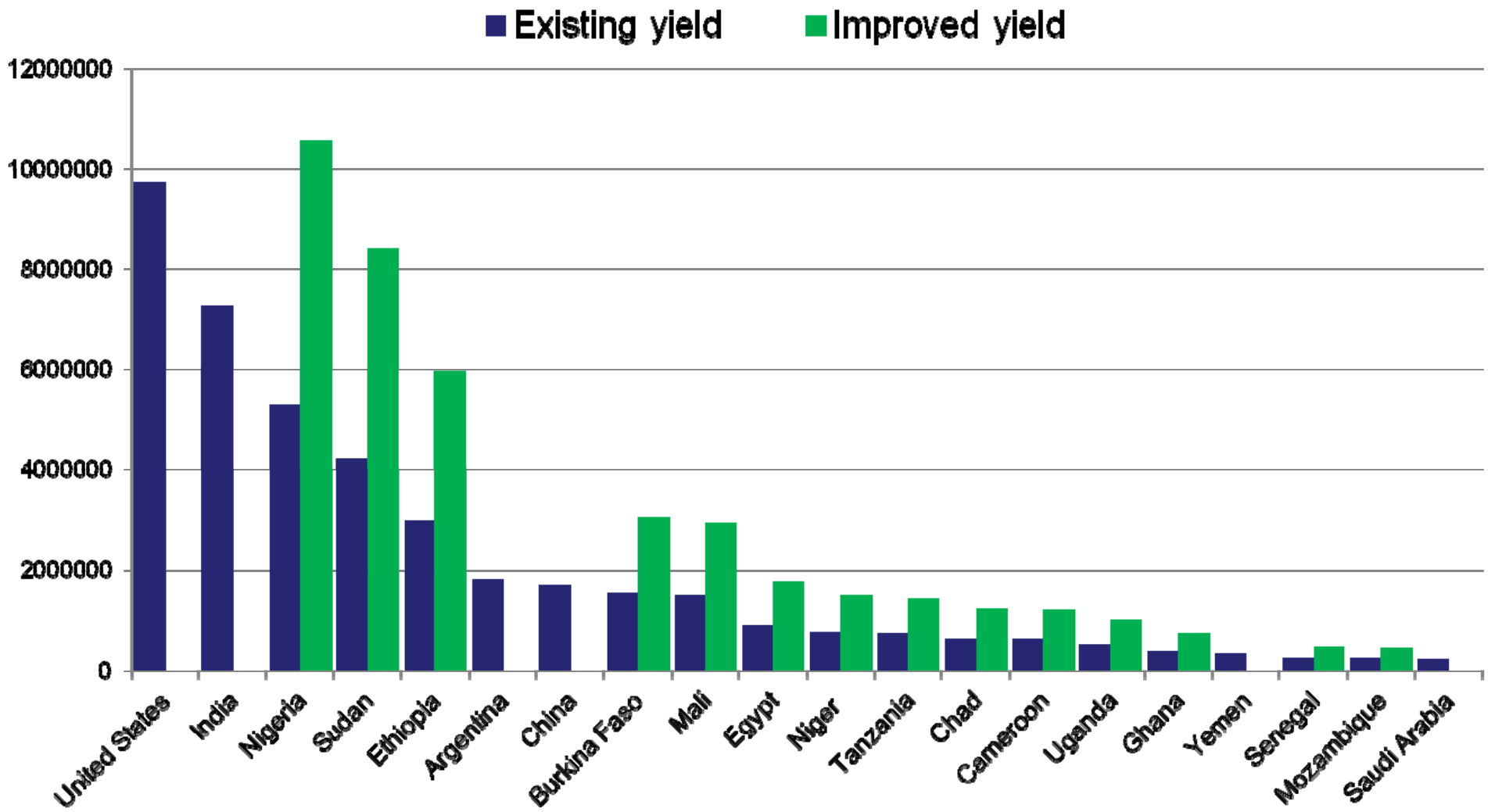
Suitability for rain-fed jatropha (IIASA, 2009)



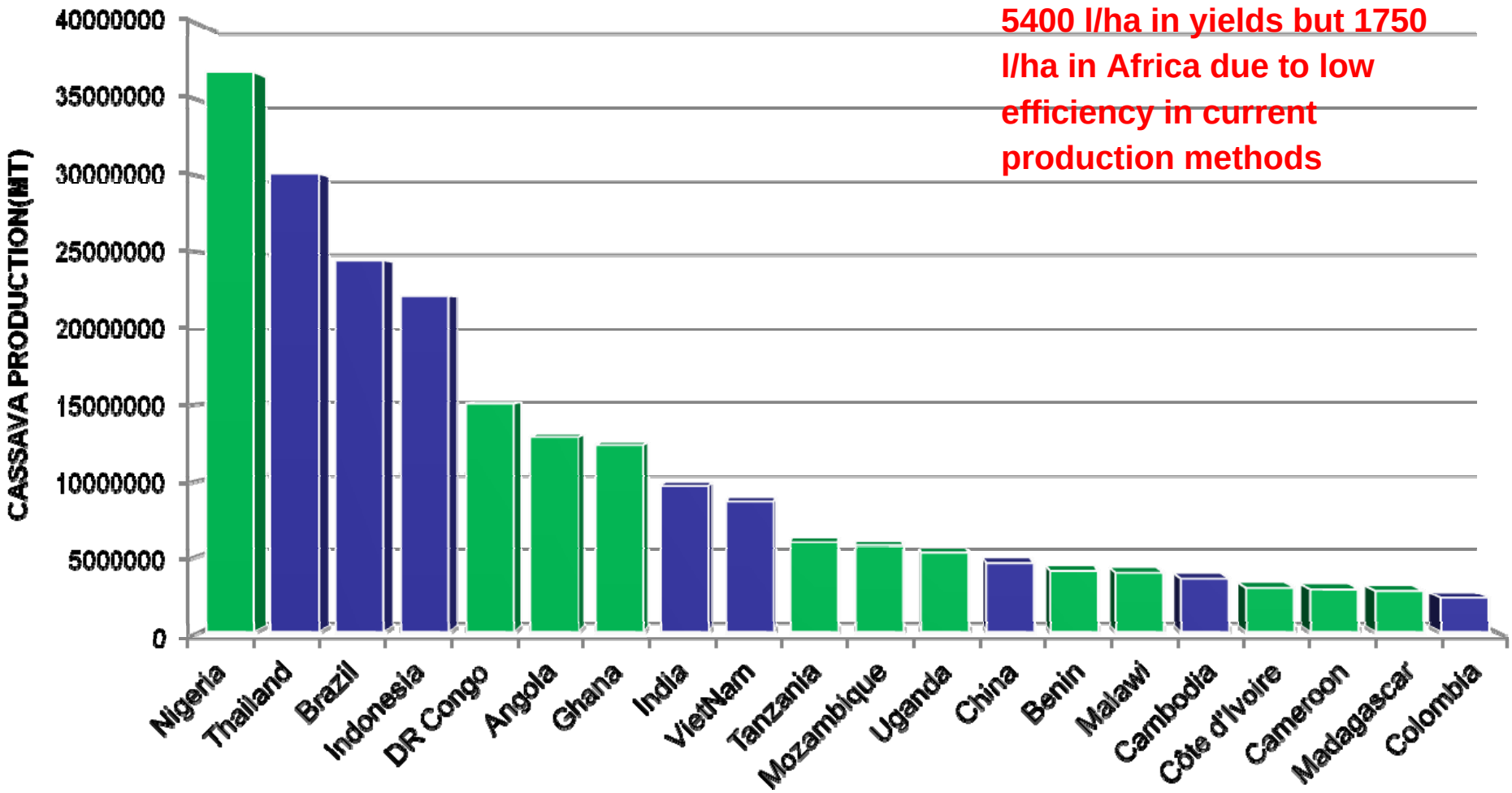
Top 20 Sorghum producers in the world in 2009



If sorghum yields doubled in Africa



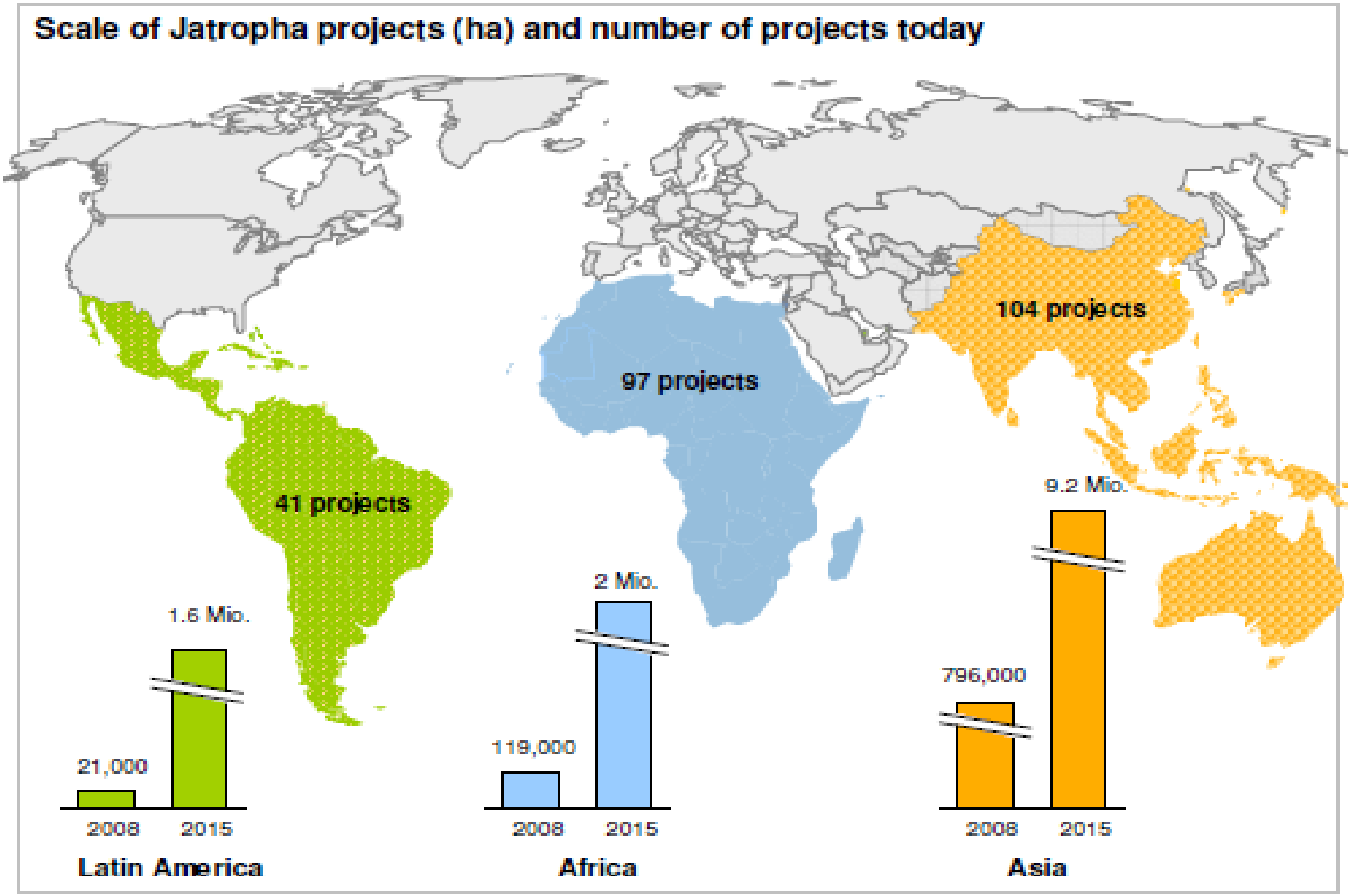
Top 20 cassava producers in the world in 2009



5400 l/ha in yields but 1750 l/ha in Africa due to low efficiency in current production methods

What would a tripling in yields be?

Global distribution of Jatropha Projects



Source: GEXSI, 2008

Large potential, 'ZERO' production

Top 15 Biofuels Producers

	Country	Fuel Ethanol	Biodiesel	Total
		Billion liters		
1	United States	49	1.2	50.2
2	Brazil	28	2.3	30.3
3	Germany	1.5	2.9	4.4
4	France	1.1	2.0	3.1
5	China	2.1	0.2	2.3
6	Argentina	0.1	2.1	2.3
7	Spain	0.6	1.1	1.7
8	Canada	1.4	0.2	1.6
9	Thailand	0.4	0.6	1.0
10	Italy	0.1	0.8	0.9
11	Indonesia	0.1	0.7	0.8
12	Belgium	0.3	0.4	0.7
13	Poland	0.2	0.5	0.7
14	United Kingdom	0.3	0.4	0.7
15	Colombia	0.4	0.3	0.7
World Total		**86**	**19**	**105**

Source: REN 21 (2011)

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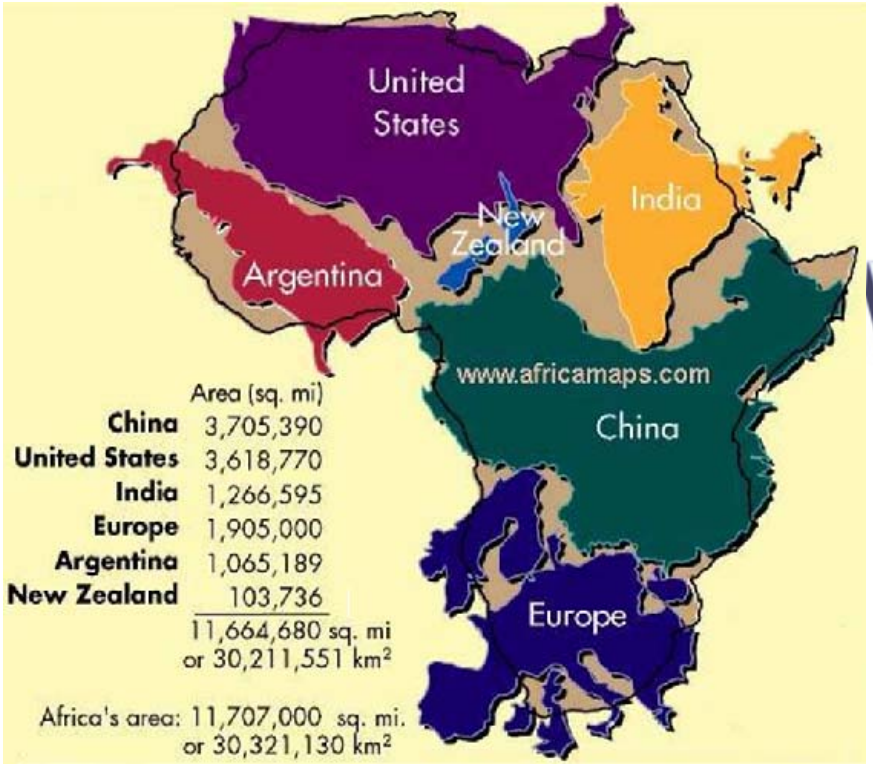
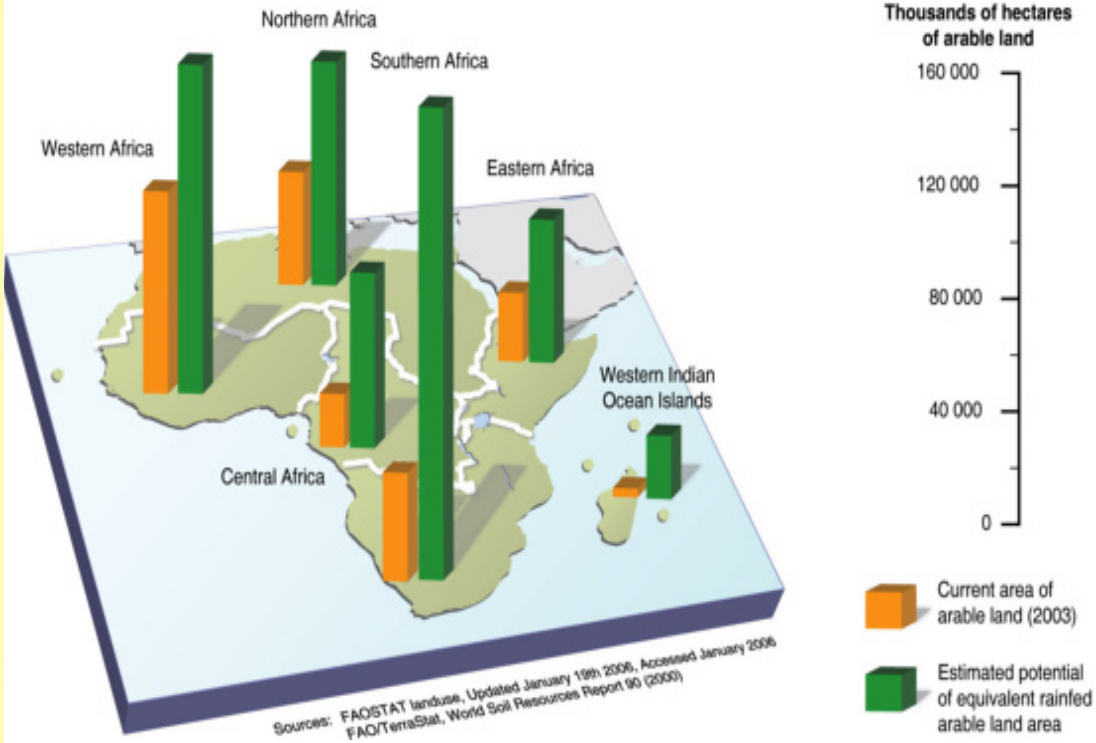
Fortunately, land may not be our biggest problem

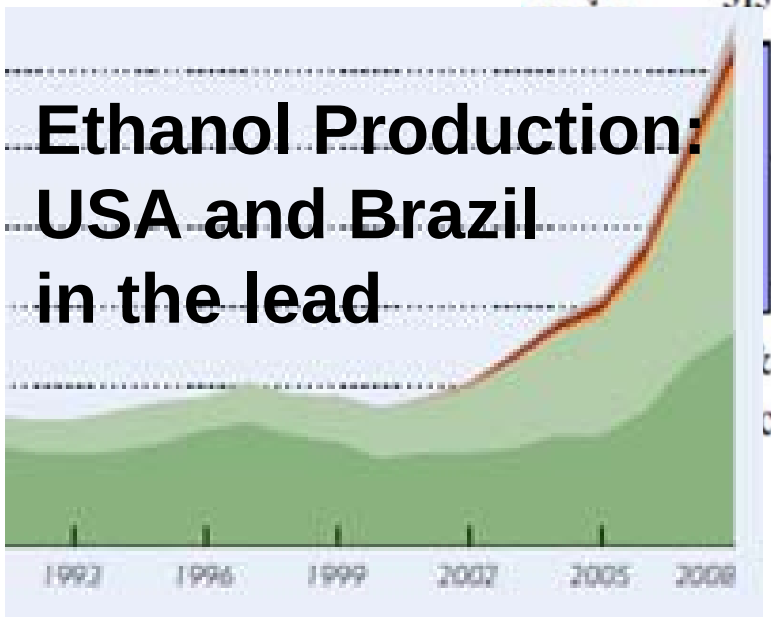


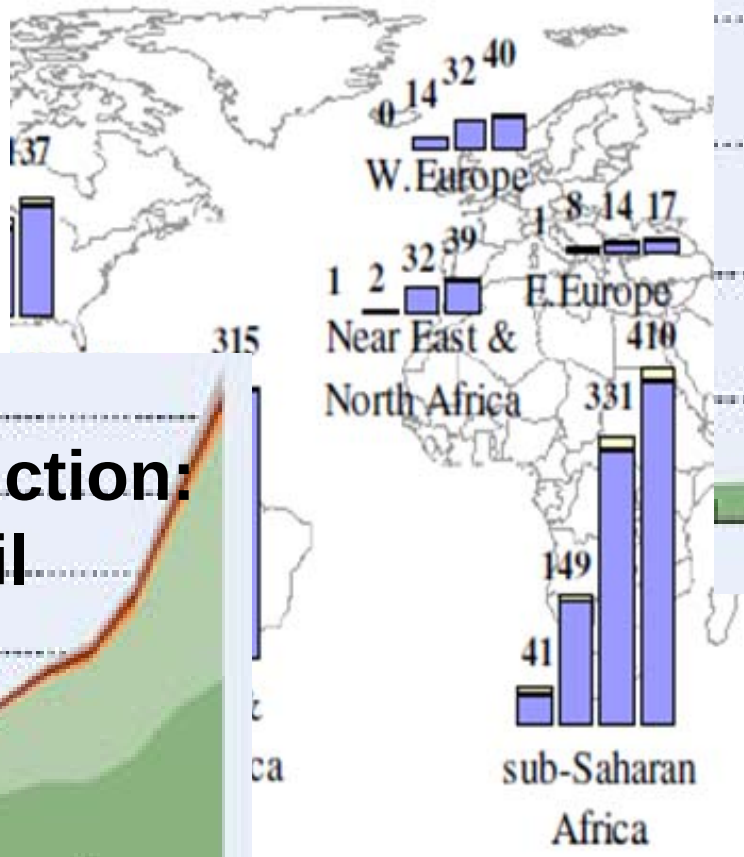


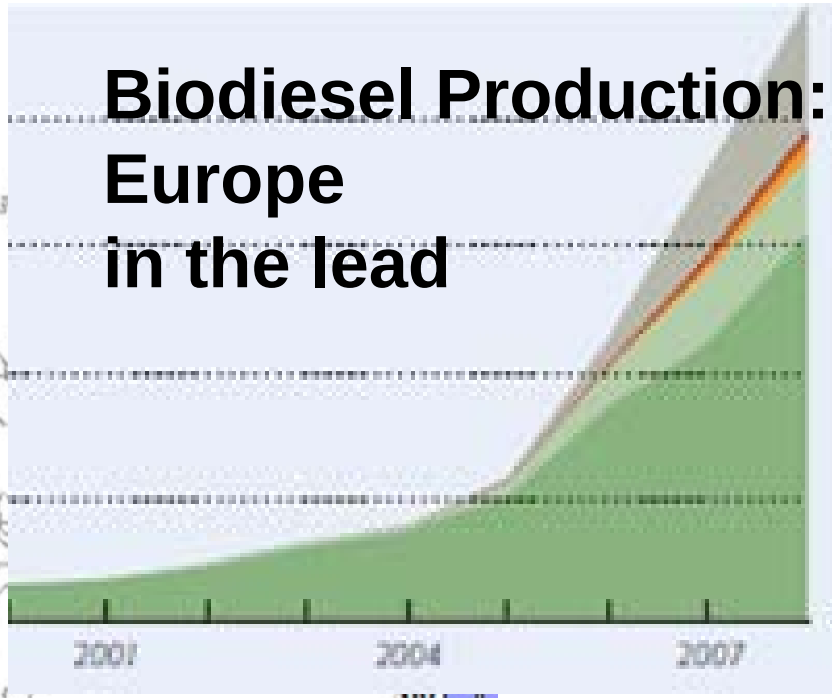
FAO has estimated that the **potential additional land** area available for cultivation in Africa amounts to more than 700 million ha (FAO, 2009)

Approximately how much land did Brazil use for its ethanol in 2010?

Many more countries can and Africa should do better!







Technological options are within reach

- Presently First Generation biofuel technologies are matured
  - Their promotion is based on non-technical issues such as policies and cost-effectiveness
  - They can be used at both large and small-scale level and therefore good for village level energy access
- Electricity production from biomass is not our biggest challenge (large scale in Mauritius; small scale in MFPs in Mali, Senegal, Burkina Faso, etc.)

Electricity production potential

- Technically, bagasse from sugarcane and sweet sorghum can be used as feedstock for electricity in central and decentralised plants
- Jatropha oil in modified engines for rural level electrification is technically feasible in Africa
- Integrated systems (biomass combined with other RE options for power generation) are feasible and in practice

Integrated small power system – Ghana Case


PlanET
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RENEWABLE ENERGY
GHANA/NRW GERMANY
Jatropha and Sunenergy
POWERHOUSE BUSUNU

Biomass for large-scale electricity

- Ghana major power producer in talks to use sunflower oil from local company for power production.
- Company initial activities supported by GEF small grants programme.
- Support from similar agencies (within and outside region) critical to realise potential.

Cooking fuels

- Gel fuel as modern cooking fuel is feasible and in use in Southern Africa.
- Jatropha oil stoves being researched and developed.

Cooking fuels

- Good old woodfuel (firewood and charcoal)
  - practically all biomass: forest residues, agricultural residues, purposely grown agro-forestry trees, residues from timber processing
- Briquettes – practically everything for woodfuel, processed further

Why! How!! What!!!

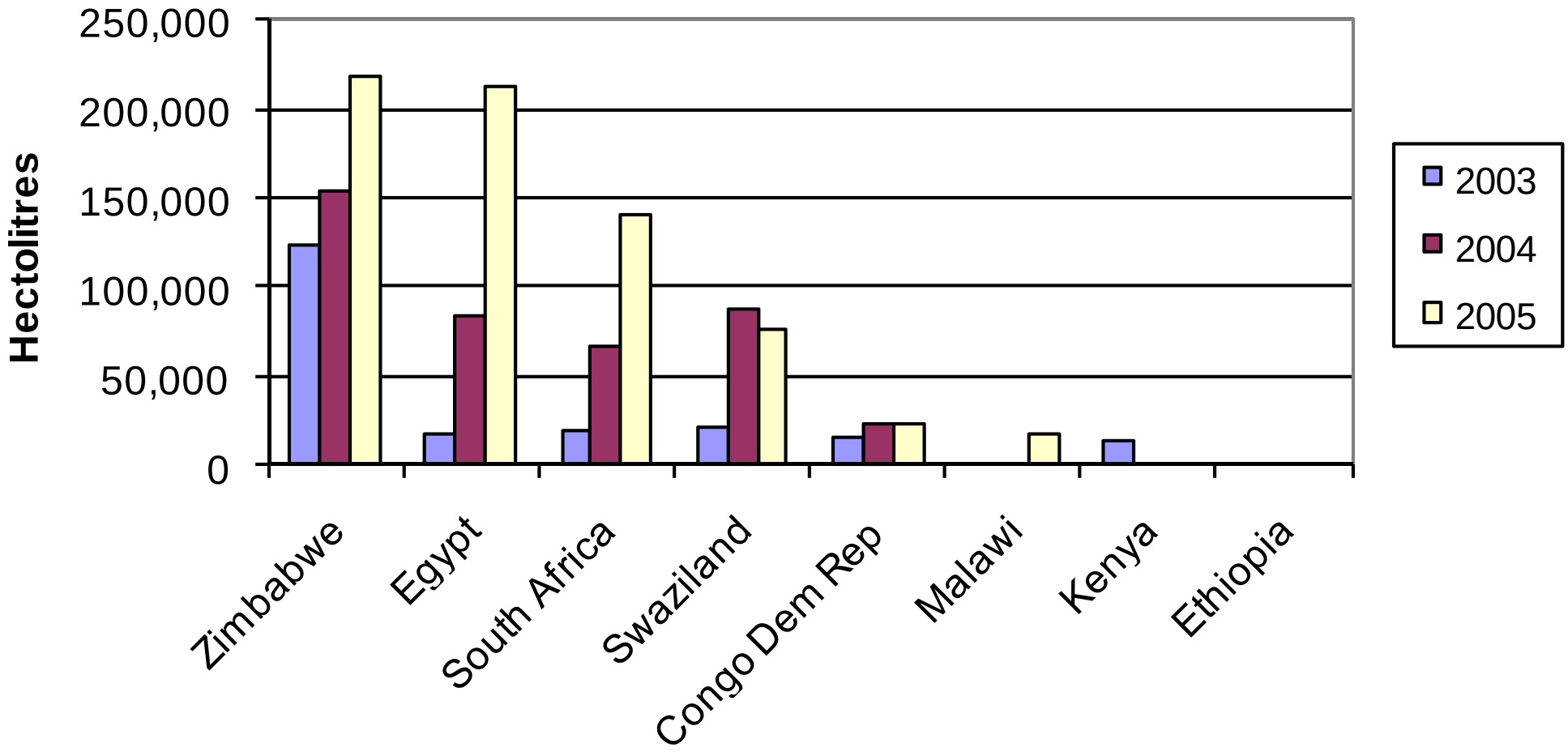
- With all the potentials, why are production levels in Africa very low?
- What are the challenges and barriers?
  - Technology, costs or policy challenges, etc.?
- How can we overcome the challenges and barriers?
- What lessons are there to learn from Brazil, etc.?

EXPERIENCES

Age old experience in ethanol production

- Ethanol production from sugarcane and molasses in mainly Eastern and Southern Africa.
- Includes Kenya, Malawi, Zimbabwe, South Africa, Ethiopia and Egypt.
- Production fluctuates depending on sugar prices and availability of molasses.
- Experience with ethanol blending in almost all these countries – it is not new at all!

Africa exported 6 Million Hectolitres of Ethanol in 2005



Much of the ethanol experience is on small scale

Jatropha is increasingly being used for Bio-oil / Biodiesel

- Palm Oil (local consumption & industry, uncompetitive)
- Jatropha Oil
  - Farm Machinery and MFPs in Mali (CMDT, Malifolkecenter/ CNESOLER, UNDP/GOM, AMADER)
  - MFP in Ghana (Gbimsi Women/ UNIFEM)
  - AREED/E+Co Enterprises in Zambia
  - Burkina Faso
- Jatropha Biodiesel
  - Scattered small scale production. No reported completed large scale project
- Other Vegetable Oils (coconut, soya / moringa, nim, used oil)

Again, small scale biodiesel systems

Larger scale plants do not have enough feedstock despite the noise we make about large parcels of land under cultivation.

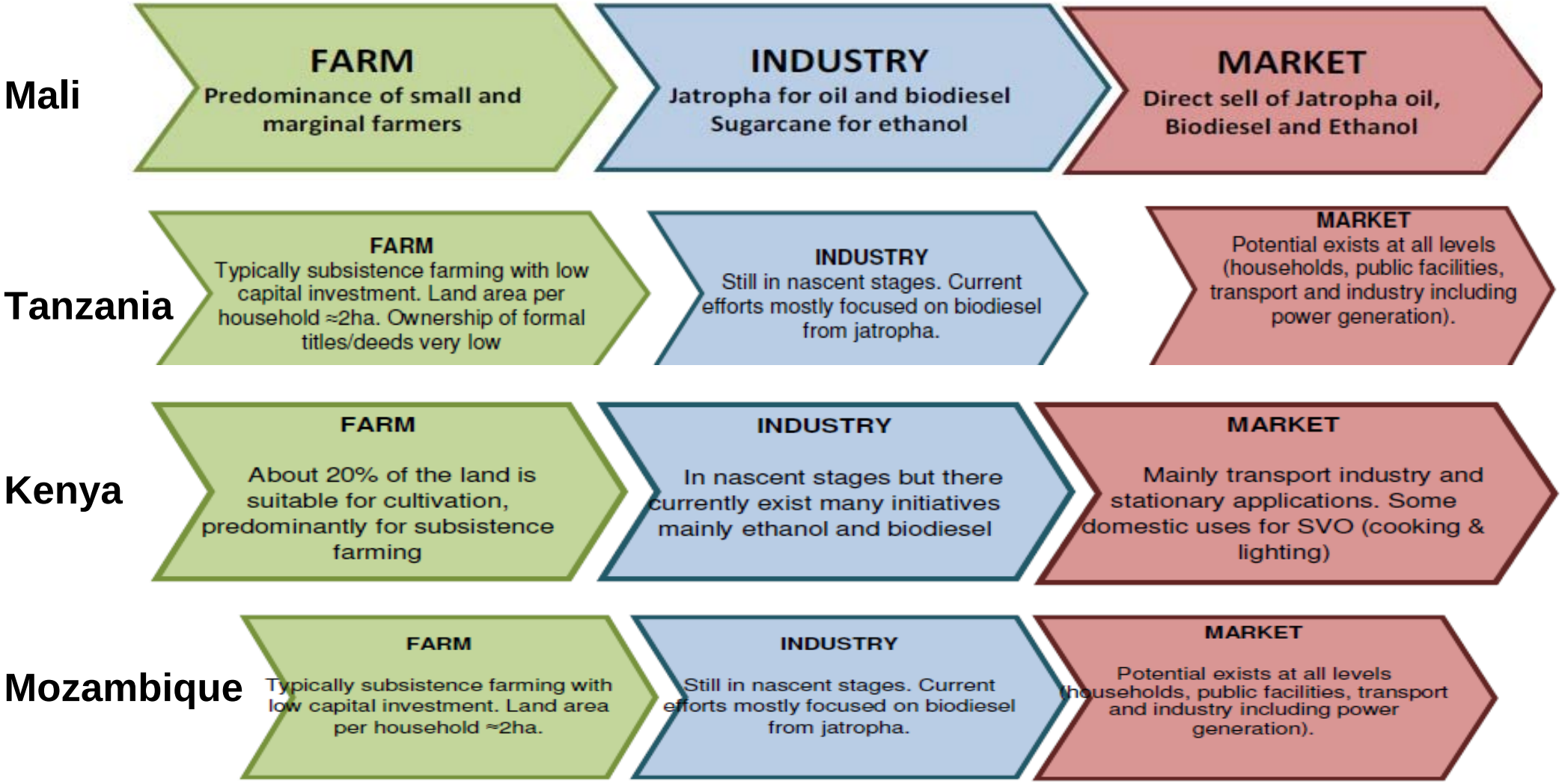
Blending and mandates proposed in Africa

- **Ghana (proposed)**
  - To substitute national petroleum fuels consumption with biofuel by 10% by 2020 and 20% by 2030.
- **Mali (proposed)**
  - Replace 10% of the diesel consumed in the country with biodiesel from jatropha. This is expected to increase to 15% in 2018 and 20% in 2023.
- **Nigeria**
  - Has an E10 ethanol target in place, no mandate.
- **Kenya**
  - Has an E10 mandate in place in Kisumu, the country's third largest city. Regulation for biodiesel approved B5 for Kenyan automobiles in 2009.

Blending and mandates proposed in Africa

- **Malawi**
  - Has an E10 ethanol mandate in place, but depends on availability.
- **South Africa**
  - Backed away from implementing (to date) an E8 ethanol mandate and B2 biodiesel mandate, both approved originally in 2007, for 2013.
- **Mozambique**
  - Phasing in blend mandates over an extended period of time, to blend levels set provisionally at 10% and 5% for gasoline and diesel, respectively.
- **Uganda**
  - Use of modern renewable energy, from the current 4% to 61% of the total energy consumption by the year 2017. A blend of up to 20% biofuel proposed.

Summary of biofuels activities in selected countries



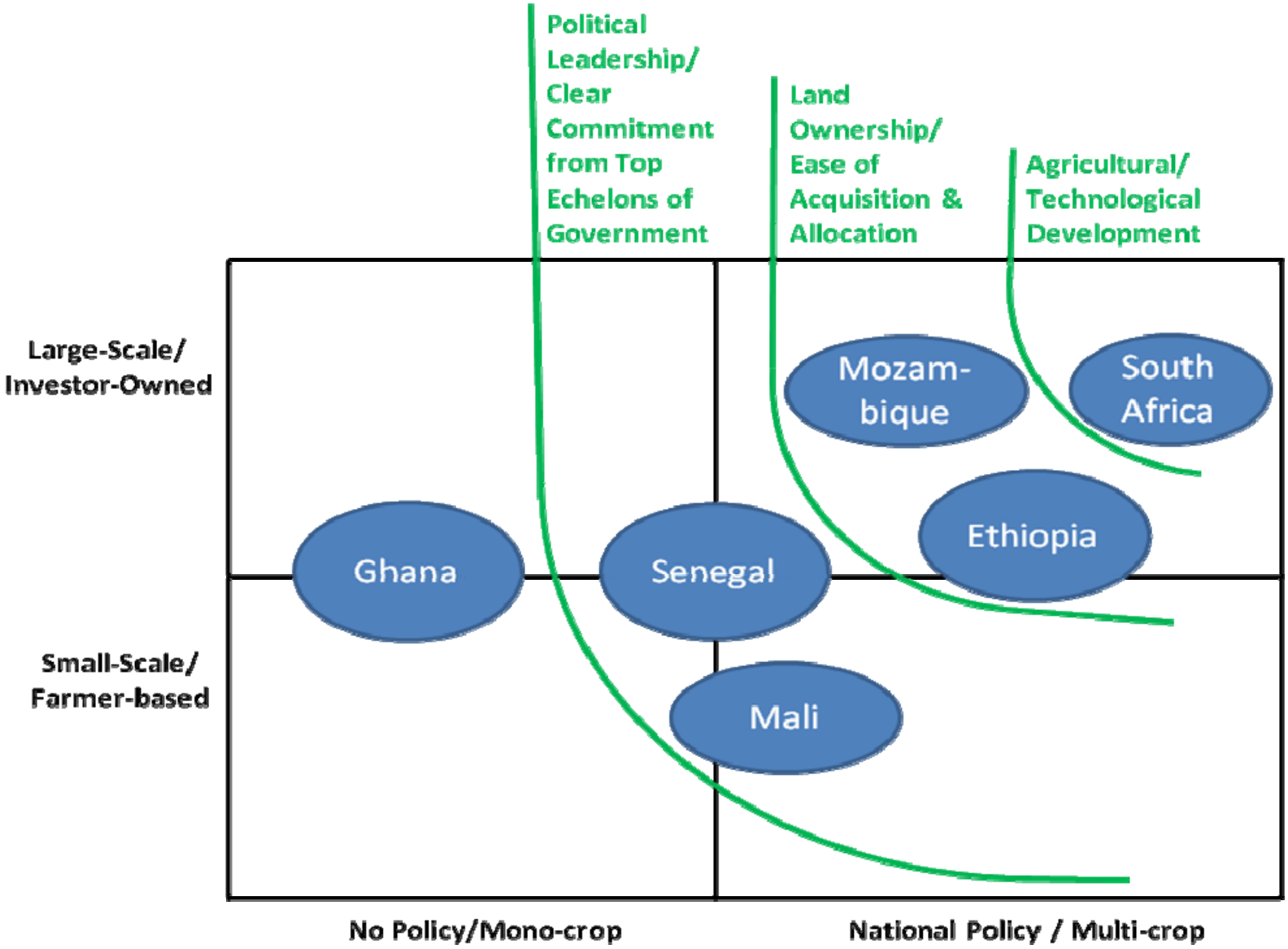
Key elements of policy and institutional frameworks are emerging ...

- National Biofuels Policy Documents
  - Blending ratios and targets (critical to market creation)
  - Financing mechanisms, including incentives for R&D
  - Provisions for development of the needed infrastructure
- Food security measures specifying allowable fuel crops
- Land use maps with clear zones for food/feed and fuel crops
- Establishment of Biofuels Agencies or specific units/ departments to oversee biofuels development programmes

Common country policy objectives

- To remove institutional barriers in order to promote private sector participation in the biofuel industry.
- To create favourable regulatory climate to ensure development of a competitive market, favourable pricing regime and high quality products.
- To improve the efficiency of production technologies and techniques of biofuel with the aim of reducing costs and also raising the quality and efficacy of the product through prioritized research and development programmes.

Issues chart for biofuels in Africa

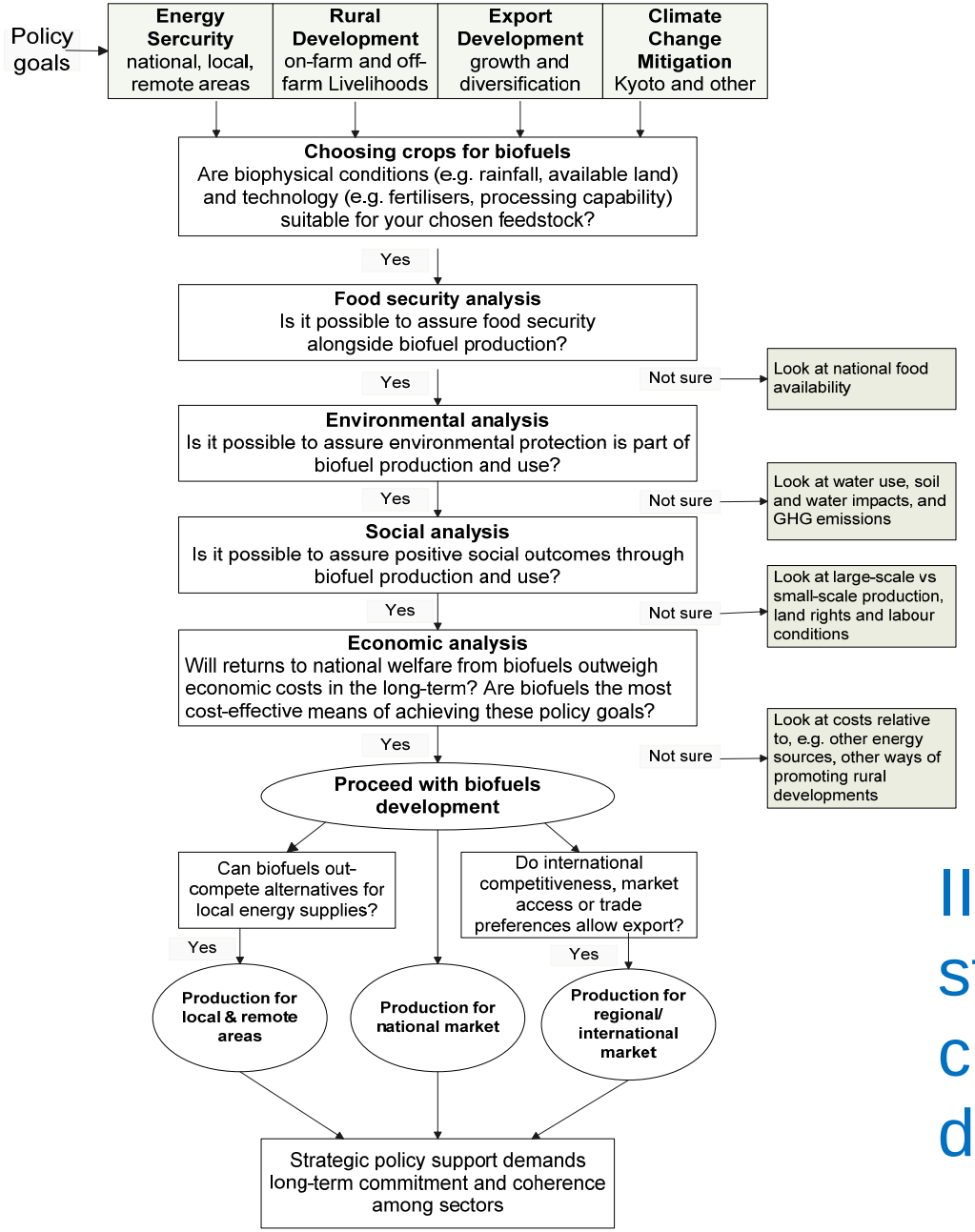


Addressing sustainability issues

- Embracing methodologies for sustainable biofuels development
  - with definitive steps for environmental, social and economic analysis
  - and options for local/ national and regional/ international markets

Ongoing efforts aimed at Sustainability

- Organisations/bodies such as IIED, ESMAP, RSB, COMPETE have made efforts at developing sustainability criteria, some specifically for Africa.
- In the IIED criteria, the decision making process begins with the policy goals of the project and along the chain, addresses pertinent issues like choosing crops for biofuels; food security analysis and environmental, social and economic analysis, which must be favourable before permit is granted to a project.



IIED Decision tree for strategic national choices on biofuel development

COMPETE 'declaration on sustainable bioenergy for Africa

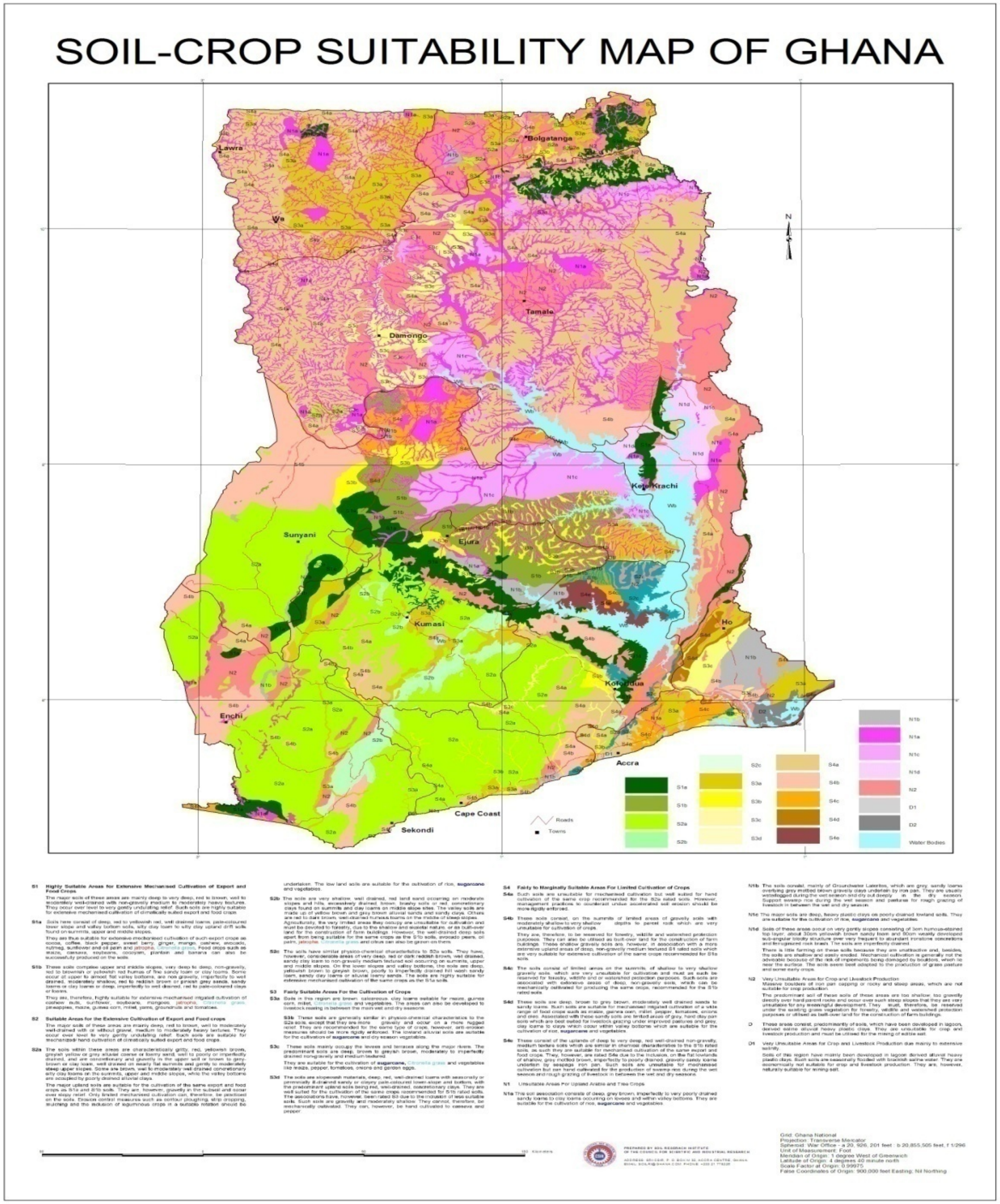
- The Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems - Africa (COMPETE) recently came up with a 'declaration on sustainable bioenergy for Africa'
- Critical inputs came from a cross section of African biofuels practitioners and energy experts, decision makers from several African countries, representatives from the Private Sector, NGOs, the donor community, FAO, UNEP, and other international initiatives.
- Five main areas were seen as critical for the sustainability of the biofuels industry in Africa.

COMPETE critical sustainability areas

- Visions guiding the implementation of policies for bioenergy development in Africa
- Markets (local, national, international) for bioenergy development in Africa
- Development of Land Use Strategies as means to ensure sustainable bioenergy development in Africa
- Appropriate land tenure systems as pre-requisite to ensure sustainable bioenergy development in Africa
- Capacity building and R&D

Land use maps

- A few countries are advanced in preparation of land use maps for energy crops
- South Africa, Mozambique and Uganda are few examples.
- As a continent, very little has been done as the case exist in the EU.


SOIL-CROP SUITABILITY MAP OF GHANA
Lawra
Bolgatanga
Wa
Tamale
Damongo
Kete-Krachi
Sunyani
Ejura
Kumasi
Ho
Koforidua
Enchi
Accra
Cape Coast
Sekondi
S1a
S1b
S2a
S2b
S2c
S3a
S3b
S3c
S3d
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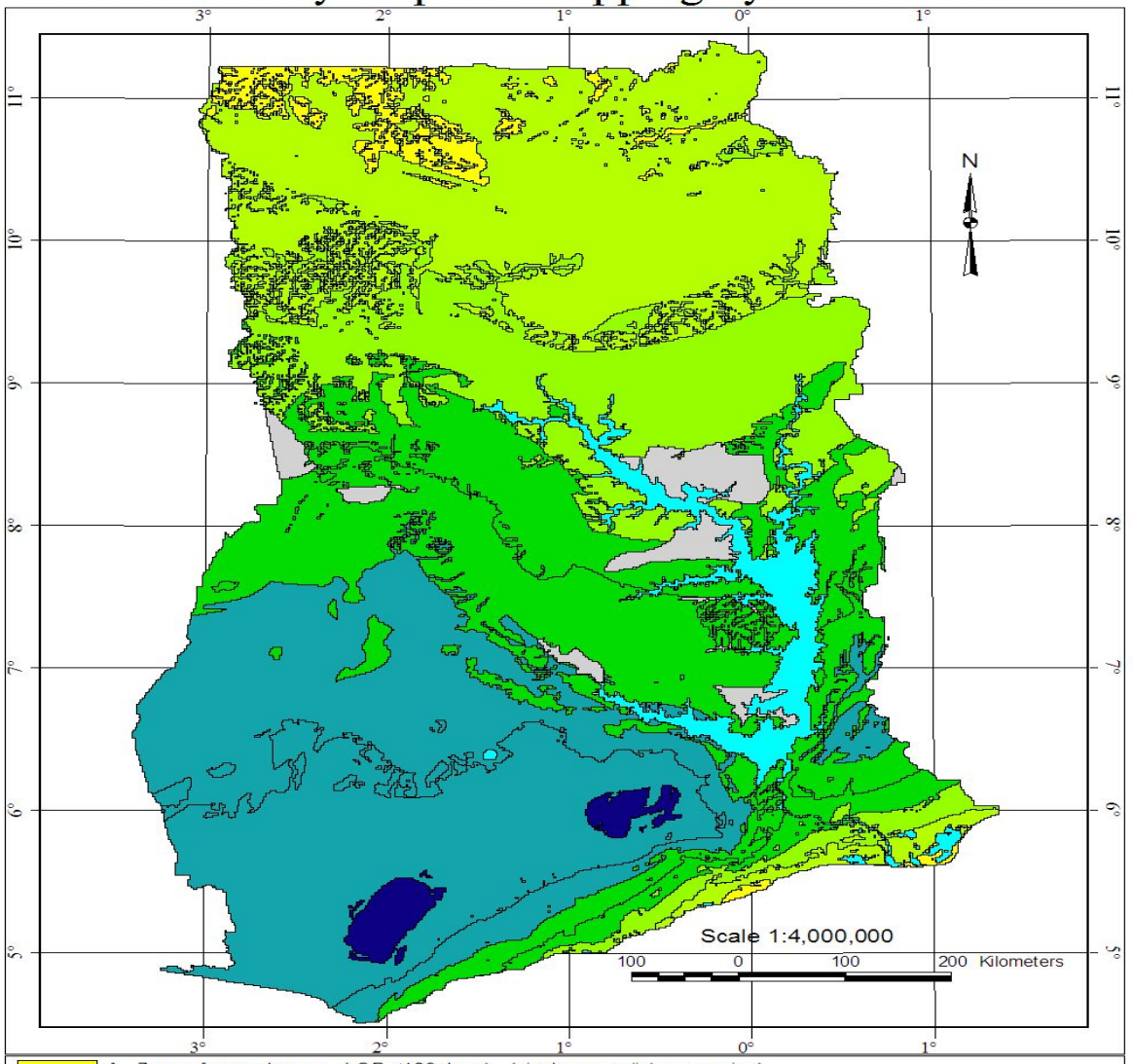
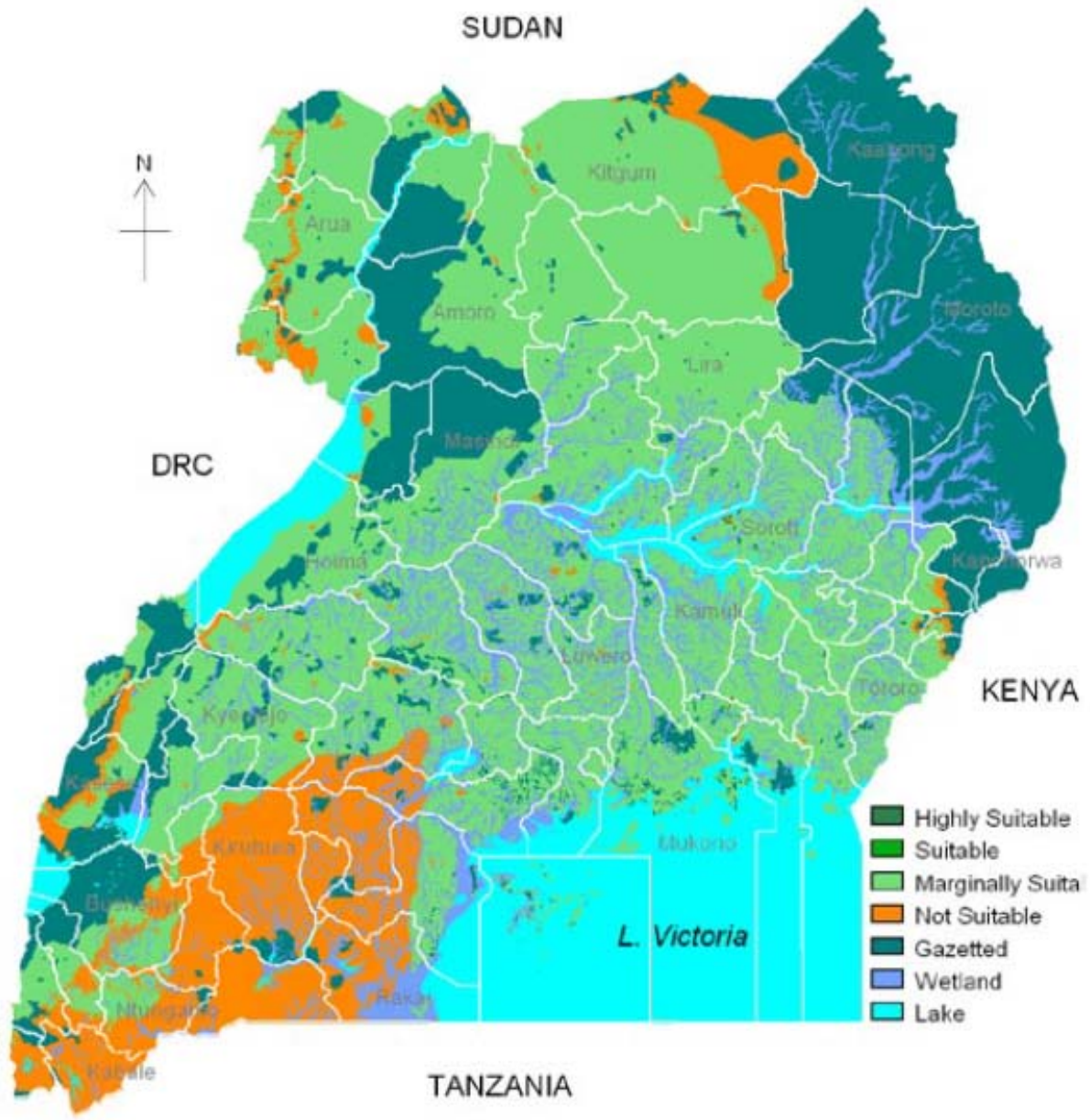
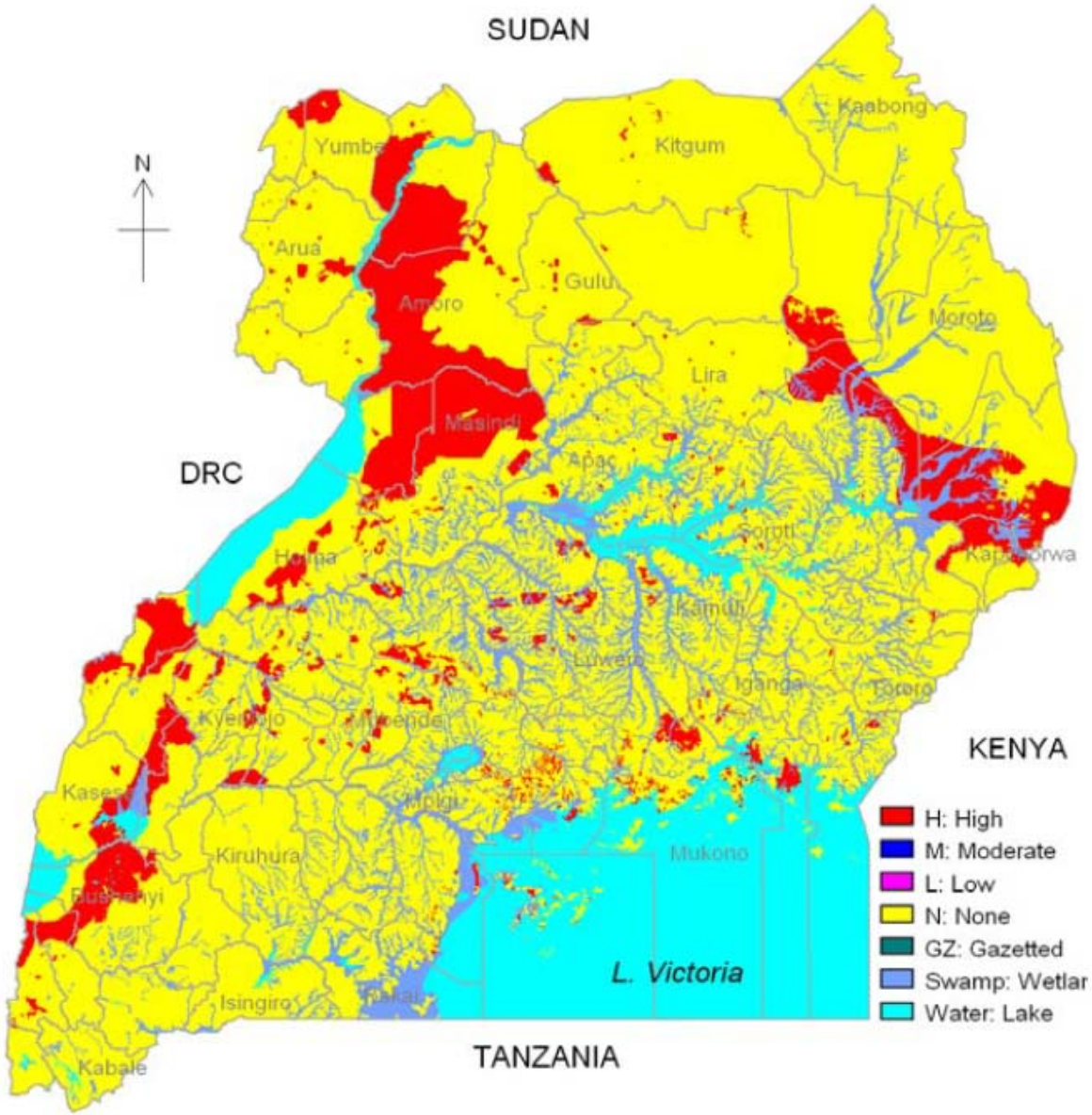
Land Suitability Map for Cropping Systems in Ghana



Sugarcane suitability ratings map for Uganda



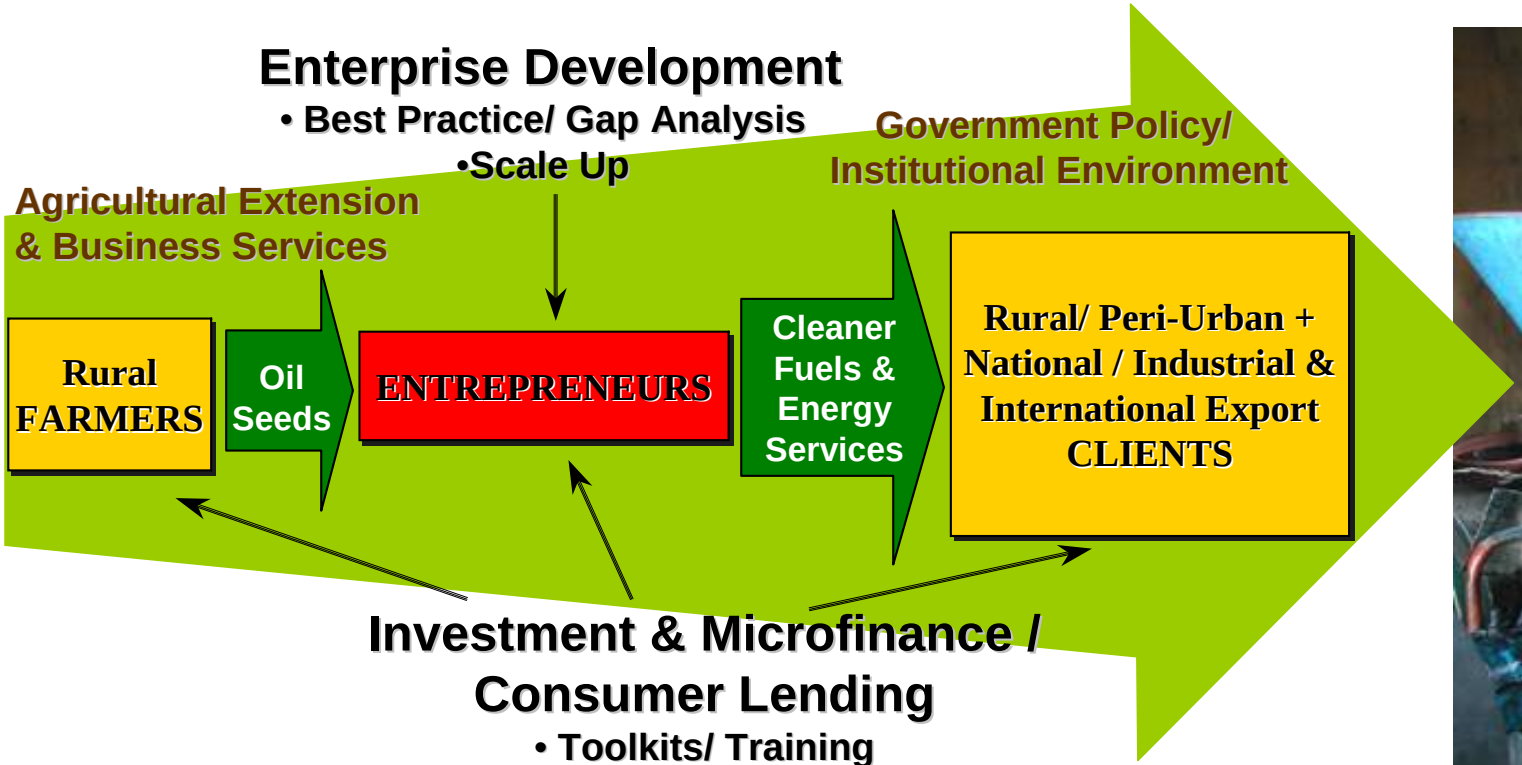
Areas of potential land-use conflict between sugarcane and Gazetted areas



Science and technology challenges

- Capacity exist in most countries for the design and manufacture of small scale equipment for oil extraction and associated processes but not for transesterification.
- Majority of research institutions not well equipped and resourced to undertake specialised engineering research and development.

Important need to pay attention to rural farmers and local private entrepreneurs



The way forward

- Increase efforts at processing biomass for transport, electricity generation and cooking fuel.
- Increase remote rural level electrification using biomass technologies and integrated systems.
- Science and technology research support critical: development of agriculture, increase capacity in technological issues.
- Enforce regulations to avoid exploitation.

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