Land resources for agriculture - competing demands and major trends

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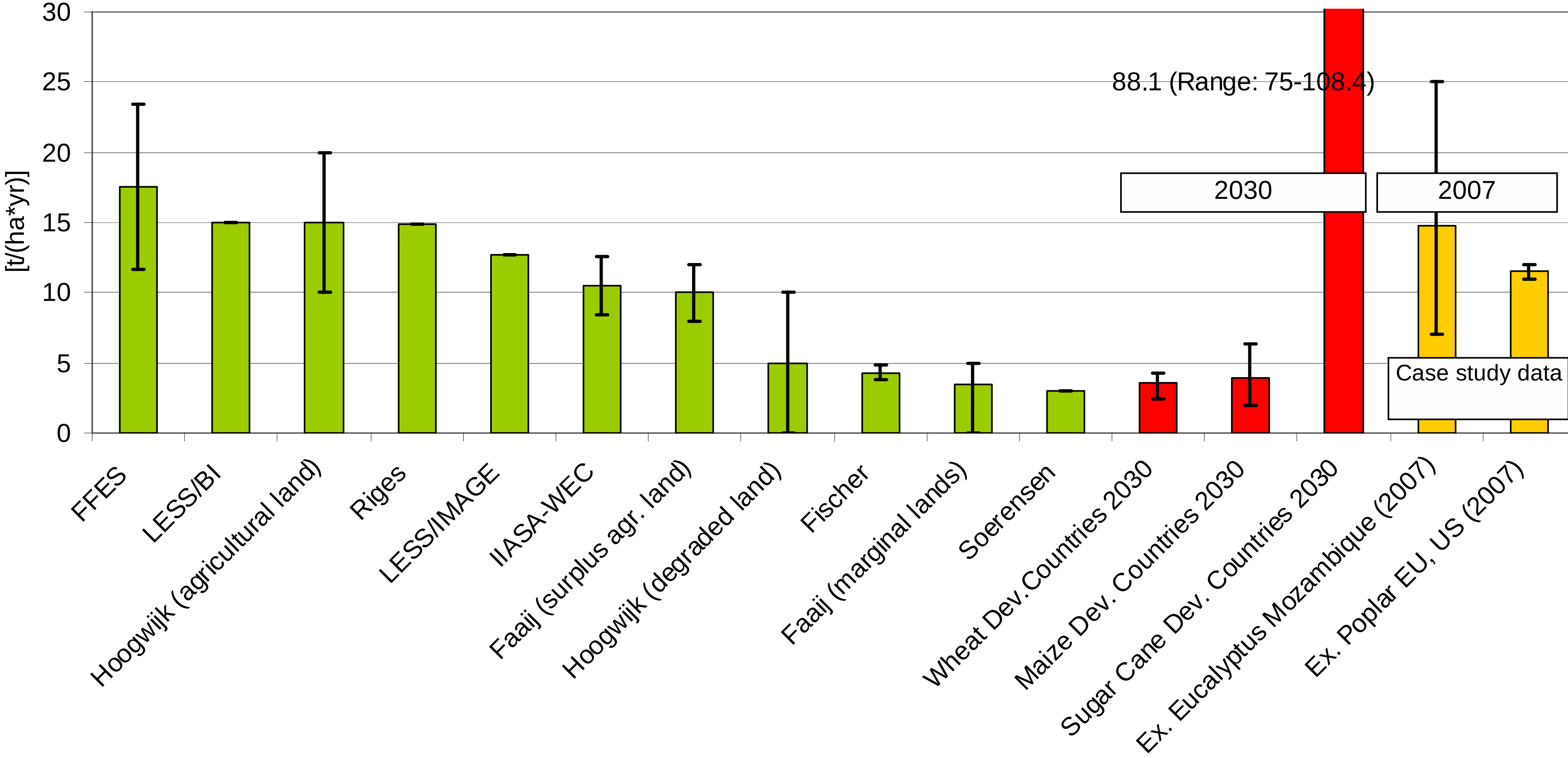
Data requirements

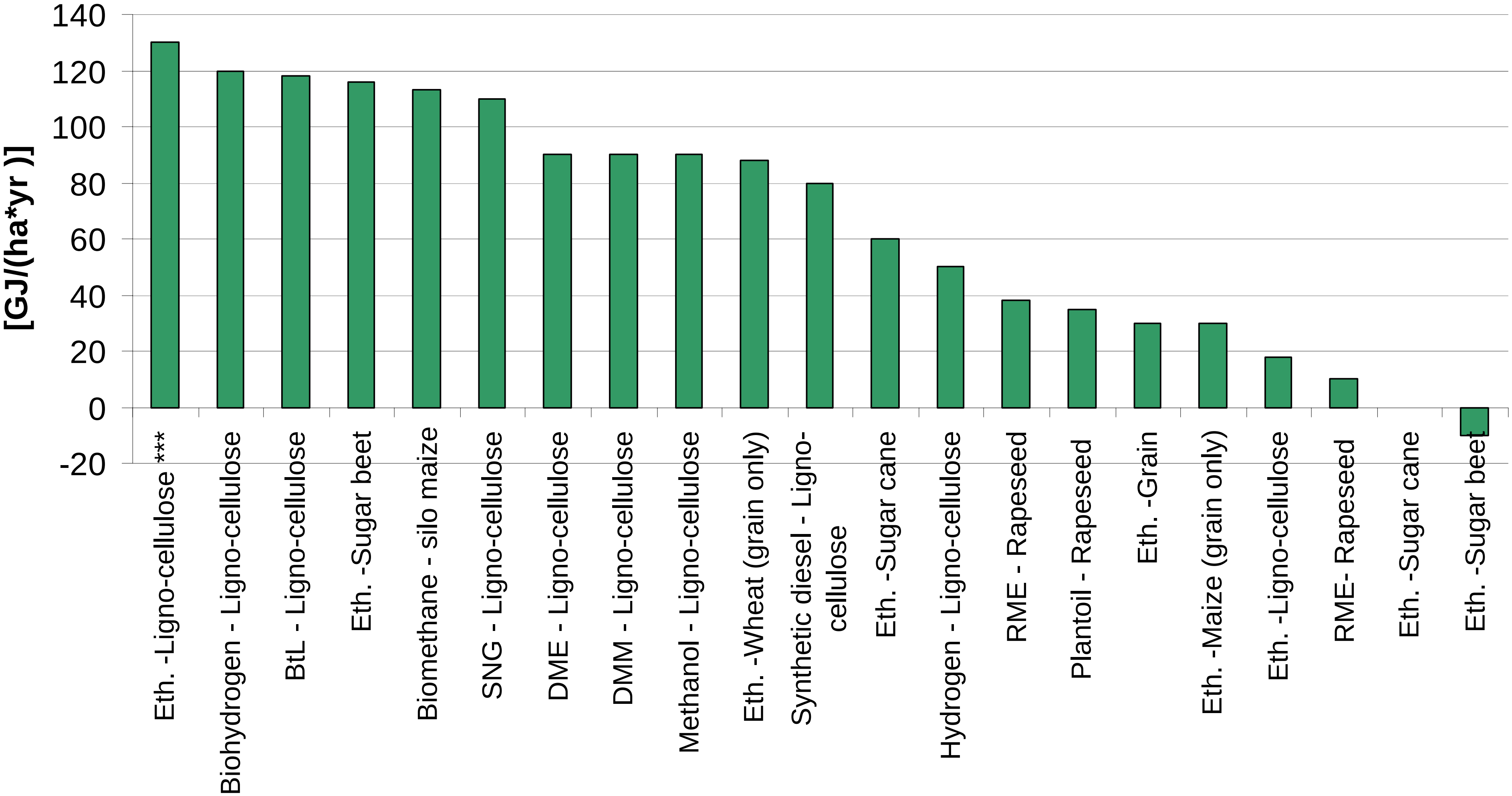
	Required Data	Depends on (development of)...			
1	Yields (t/ha)				
2	Energy Content (GJ/t)				
3	Energy Yield (GJ/ha)				
4	Extent of Biofuels Prod.				
5	Extent of Land Use				
6	Location of Production				
7	Effects on SD				

Average bioenergy crop yields in 2050 [t/(ha*yr)] compared to yields for Wheat, Maize, Sugar Cane in developing countries and Eucalyptus and Poplar in Europe/US



Sources: Berndes et al 2003; FAO 2006; FNR 2004; Kwesha and Matarira 2004; own calculations

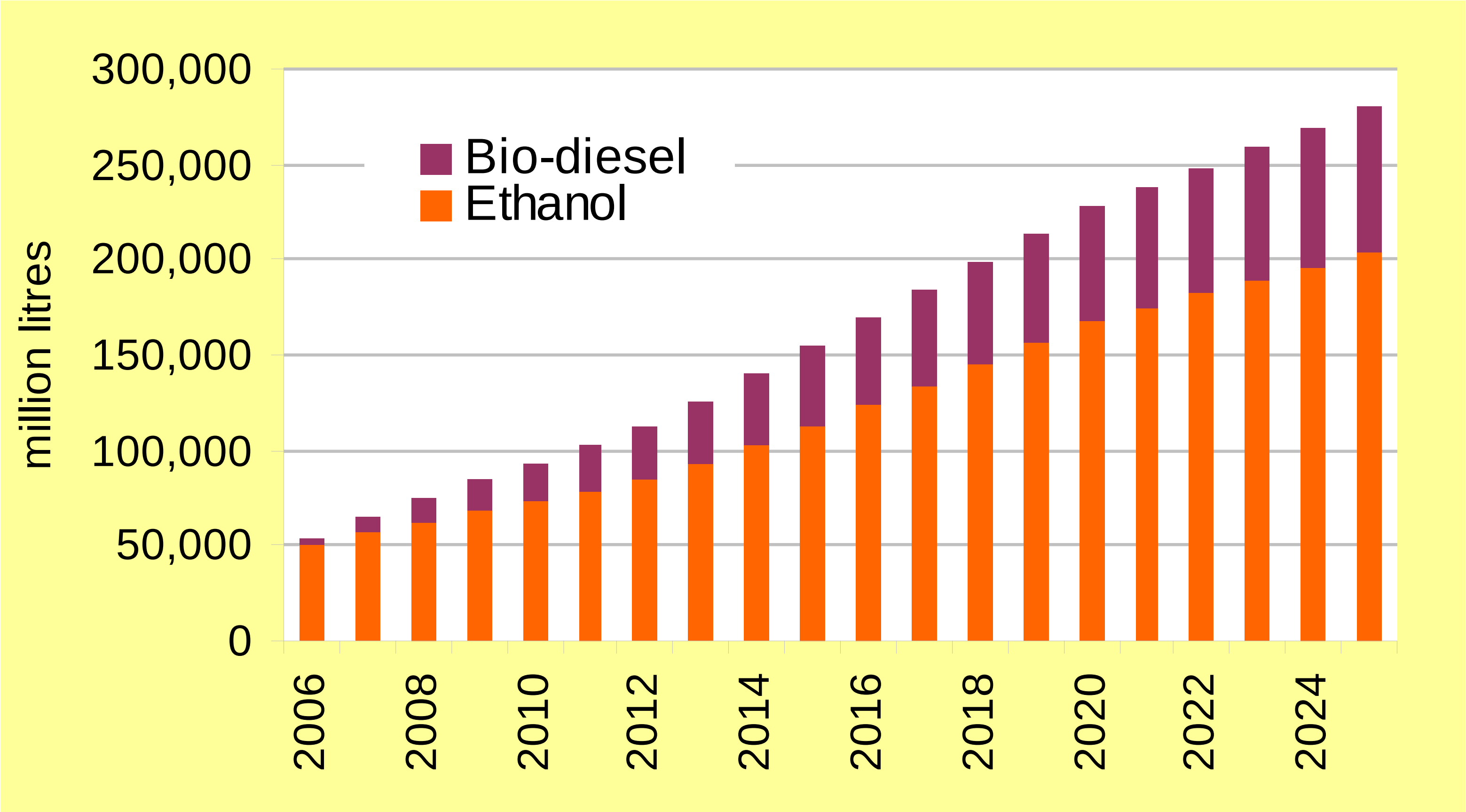
Net energy yield for different biofuels and crops [GJ/(ha*yr)]



Sources: FNR 2004; Hamelinck 2004; own calculations

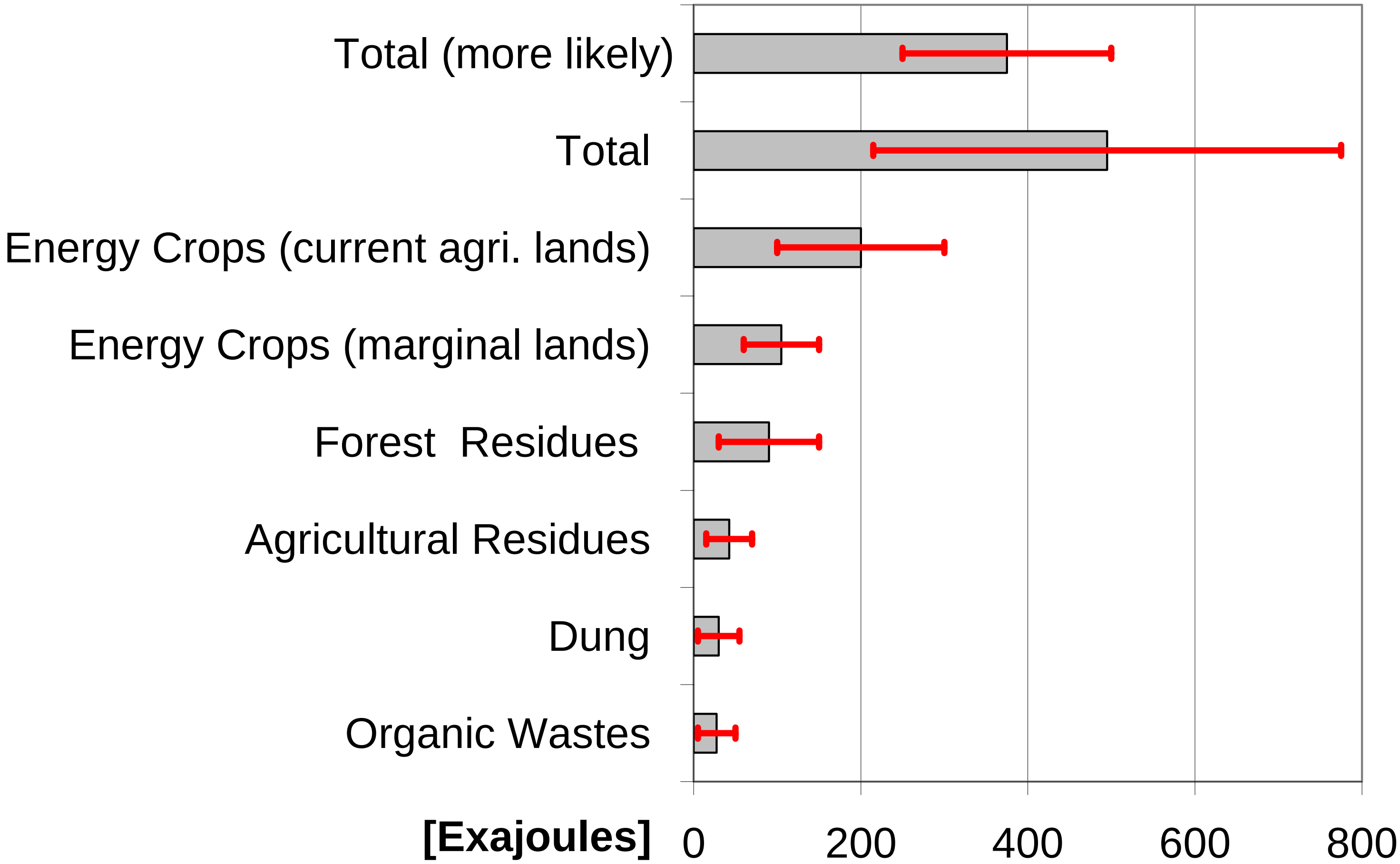
Global bio-fuel production could expand 5-fold by 2025

- Sustained high prices of crude oil projected provide an additional incentive to expand bio-fuel output – beyond the levels stipulated by policy – as long as retail excise tax relief for bio-fuels remains



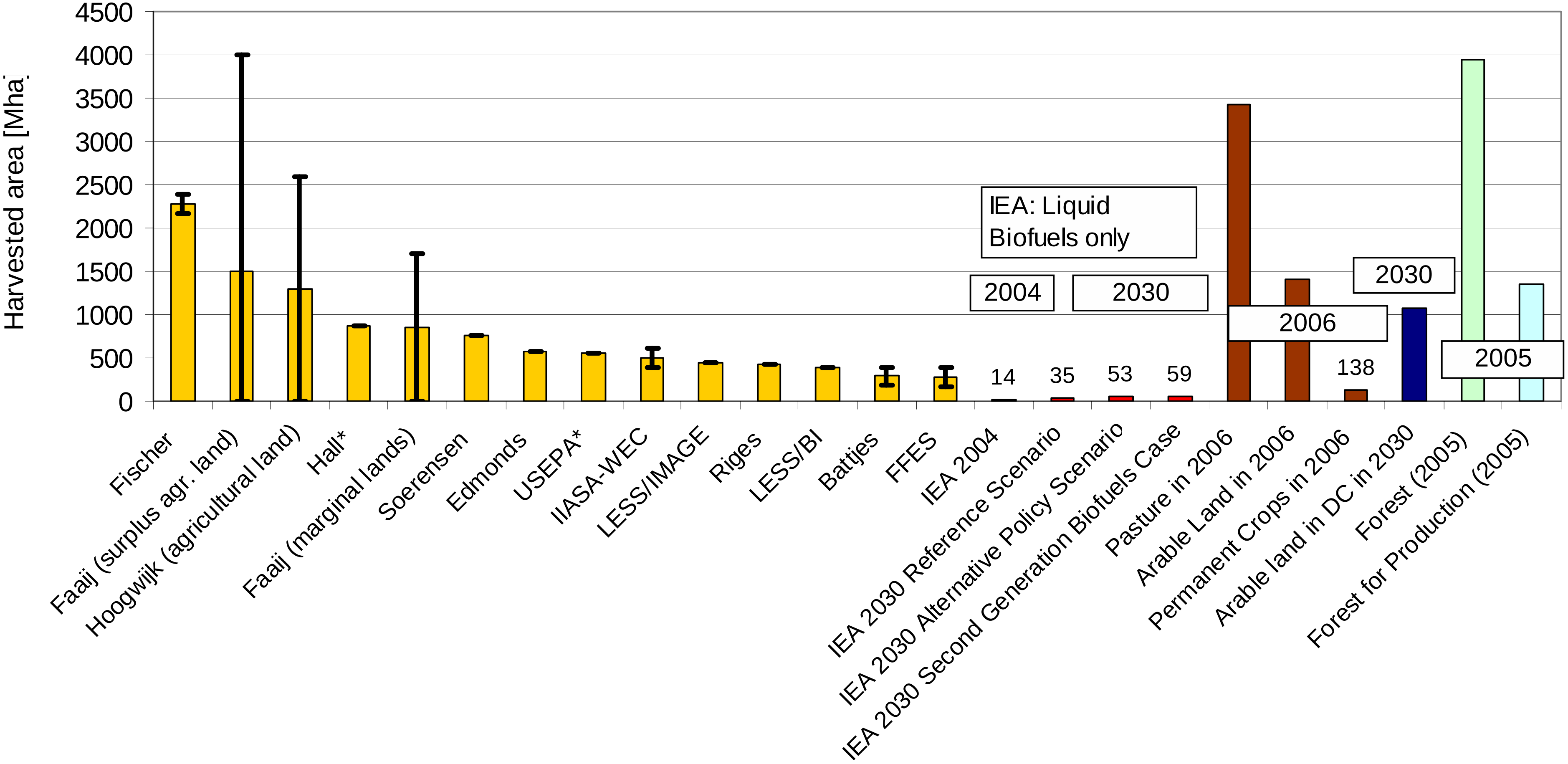
Source: Adam Prakash (EST-FAO) 2007

Bioenergy potential per type of biomass: **different scenarios, year 2050 Exajoules/yr**



Source: Juergens and Mueller *forthcoming 2007*, based on data from Faaij 2006

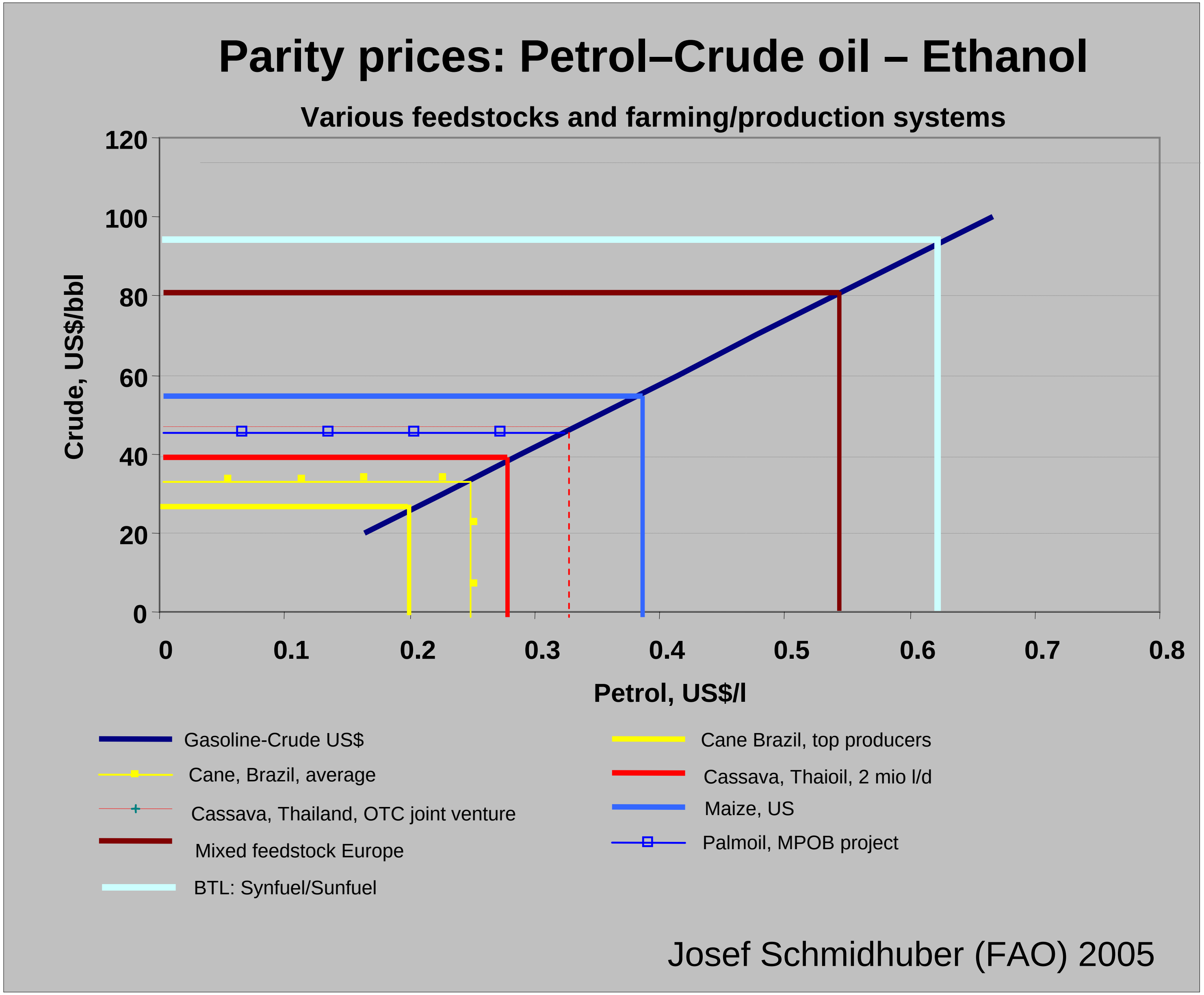
Land Area for Bioenergy crops in 2050 – compared to land area for: Liquid biofuels in 2004 and 2030; other major land use categories



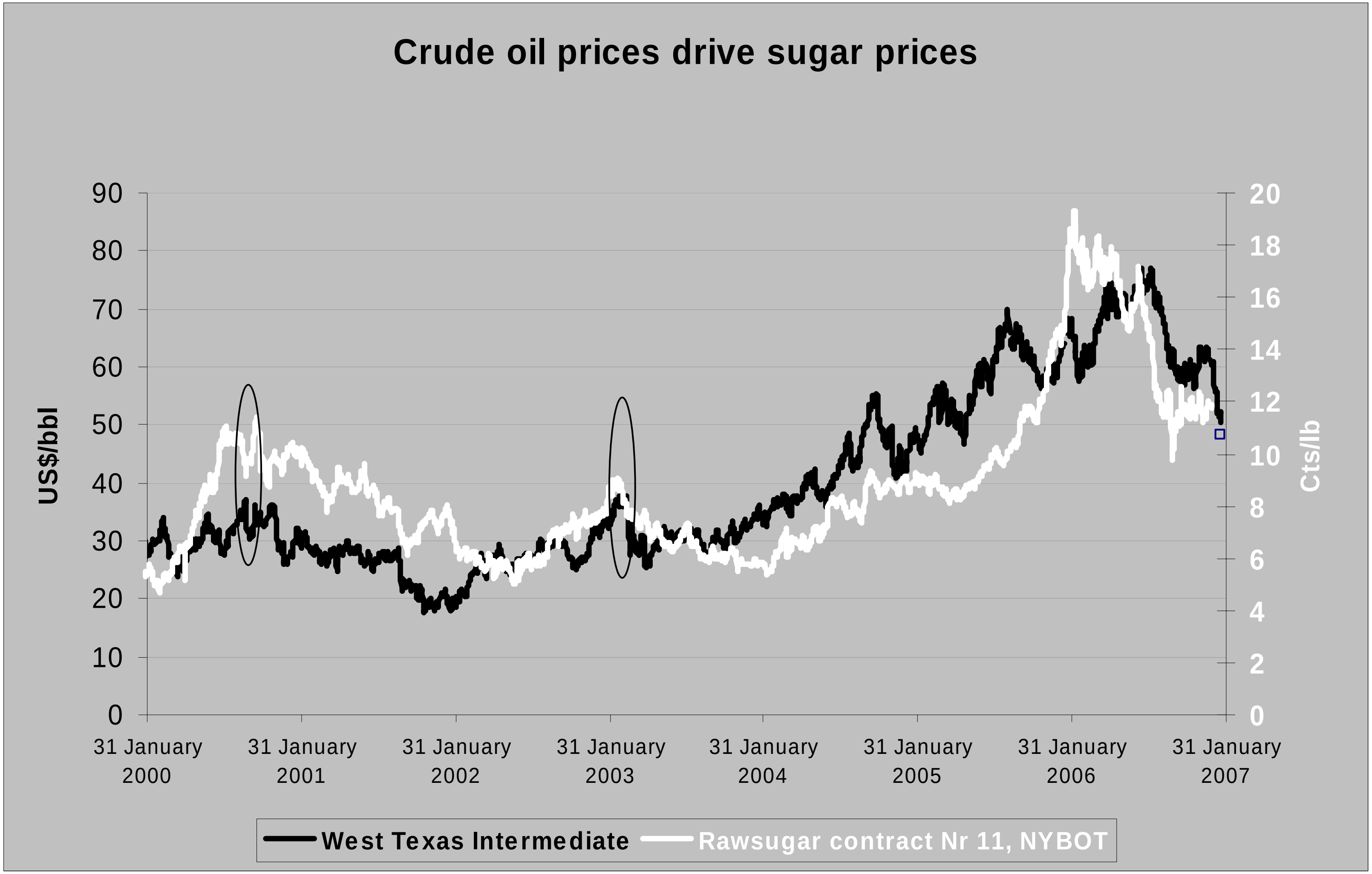
Sources: Berndes et al 2003; FAO 2005, 2006, 2007; Hoogwijk et al 2005; WWI/Faaij 2006; own calculations

Notes: studies marked with *: no specific projection year

Which farming systems and crops and where represent a competitive feedstock?



Floor and ceiling price effect in the sugar markets



Source: J. Schmidhuber (FAO) 2007;
Data: Nymex and EIA,

Data requirements – some ideas

	Required Data	Depends on (development of)...			
1	Yields (t/ha)	Crop	Location, AEZ	Management level; scale	Tech. Progress/ implementation
2	Energy Content (GJ/t)	Crop		Type of Biofuel and conversion	Tech. Progress/ implementation
3	Energy Yield (GJ/ha)	1 and 2		Type of Biofuel and conversion	Tech. Progress/ implementation
4	Extent of Biofuels Prod.	Prod. cost	Energy Prices	Policies; Carbon Prices	Sustainability of biofuels prod.
5	Extent of Land Use	1-4, 6,7			Sustainability of biofuels prod.
6	Location of Production	1, 3; Prod. cost	opportunity costs (SD)	Policies, tariffs; market outlet	mature indus.; refining tech.
7	Effects on SD	Price premium	Demand for sust. biofuels	Size of biofuels market	Certification/ standards

Land Use

Land use: the sequence of operations carried out with the purpose to obtain goods and services from the land, characterized by the actual goods and services obtained as well as by the particular management interventions undertaken by the land users.

Land use is generally determined by **socio-economic** market forces and the **biophysical** constraints and potentials imposed by the land resource.

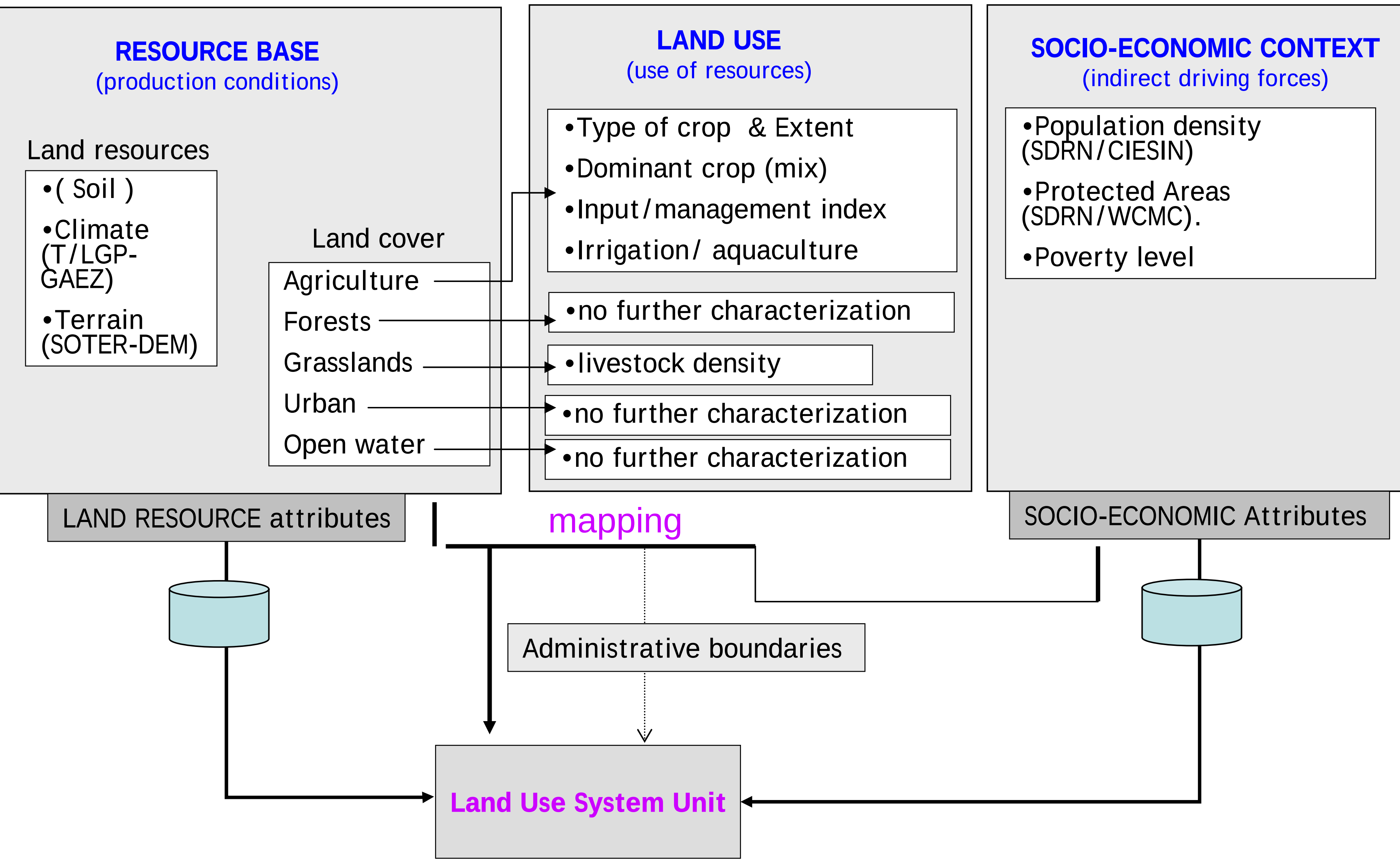
Information on the land use can be indirectly derived from agricultural census data, land cover information and from maps of the biophysical resource.

Few global databases are available that allow the characterization of the land management interventions themselves (fertilizer use, mechanization are only available as national statistics). The purpose for which the goods are produced is sometimes difficult to detect (Crops grown for bio-fuel being a particular good example).

Global and Regional Land Use information

- **Previous efforts to characterize land use globally were incomplete or fragmented**.
  - The farming system maps produced by Dixon et al. (FAO/World Bank 2001) covered the developing world only and were too generalized to be of practical use within countries. The farming system scheme developed however appears to be a valid scheme to define global and regional land use classes.
  - The Global land cover dataset (GLC-2000, JRC), although providing global coverage at much higher resolution than the farming systems map, recognizes only the land cover aspect and did not attempt to further characterize land use in terms of goods and services or management interventions.
  - Other efforts have attempted to distribute national agricultural statistics in a rational way based on bio-physical conditions and the actual land cover (FAO-IIASA, 2007 and IFPRI - You and Wood, 2006).

GLOBAL LAND USE SYSTEMS
Characterization



Land Use System Approach

- The descriptions of the farming systems as given by Dixon etal. (2001) is taken as a guideline to define LUS.
- Dixon's empirical/expert driven mapping rules to determine where specific land use system occurred was applied rigorously using global databases and a decision tree of rules to arrive at the most likely land use system in a given area.
- In addition a number of additional Land Use System classes were created to cover systems that were ignored under the farming systems. Protected Areas was considered a specific LUS class which identified the Serengeti not as a farming system where root crops are dominant (Dixon). A natural vegetation class was created which did not exist in the Dixon approach giving the impression that all area was farmed or used for pastoral activities.

Data Quality

- Data quality is and remains a major concern. Putting together by simple overlay global data layers of variable quality and resolution is a risky exercise that is bound to result in erroneous conclusions on the land use system practiced. Major problems with the individual databases used are well known, the main ones are discussed below:

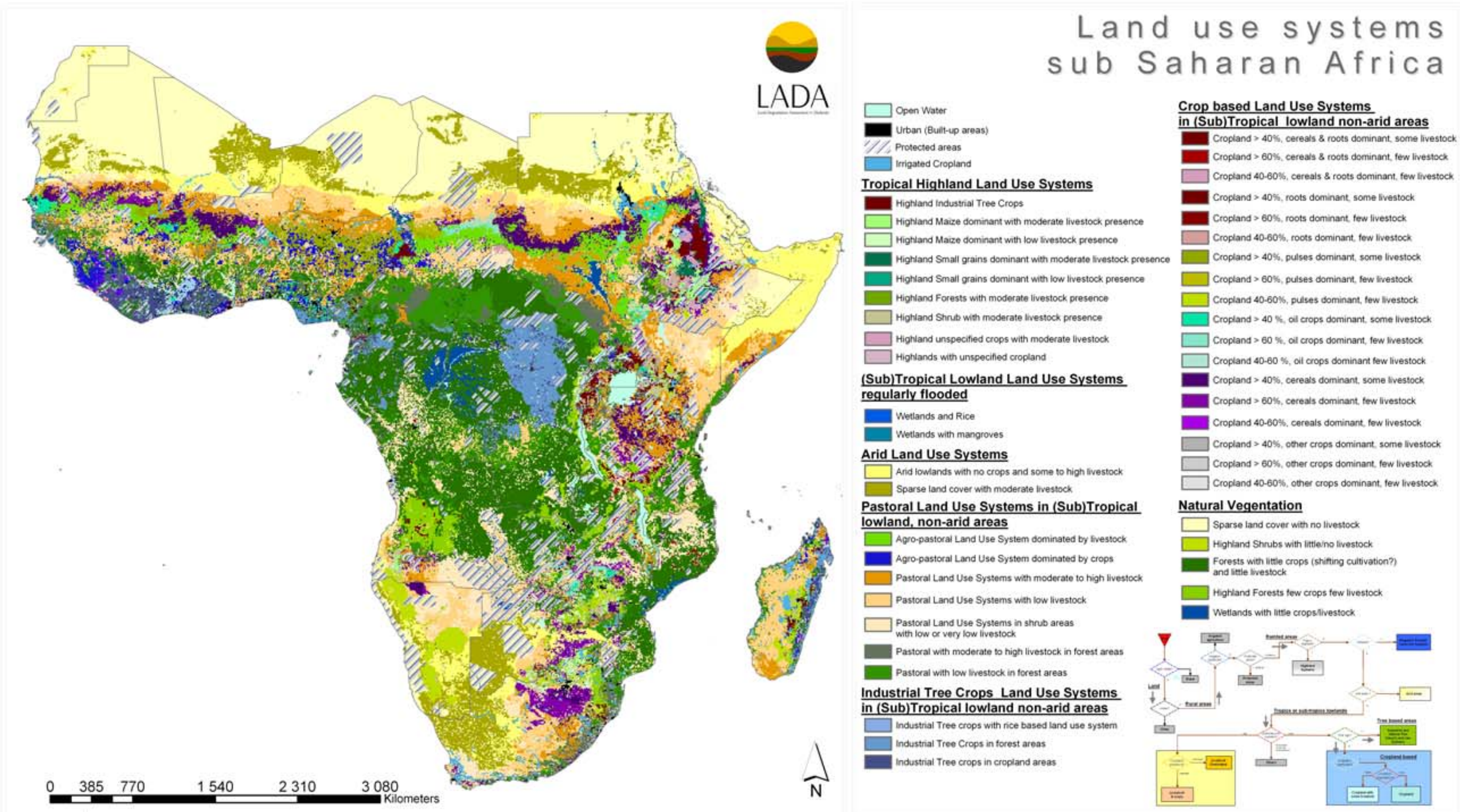
- **GLC-2000**: the global land cover dataset is an essential layer in that it distinguishes at the highest level if land use systems are forest, crop or livestock based. Any error here will result in errors in the end-product. Resolution used for all databases is 5 arc minutes while this database is of higher resolution. At world scale this results in errors being created for LUS.

- **Agro-Maps**: crop dominance and cropping patterns are derived from this database which is incomplete (Some countries have no information at all) and shows annoying gaps (no information on coffee in Uganda no sugar cane in Cuba no maize in Nigeria, to name but a few.). In general perennial crop information is very scarce. Moreover as administrative units are used as units this results in a variable resolution of information (Compare Ethiopia -very detailed- with other countries in Africa).

- **Livestock data**: the livestock data are available at a relatively high resolution (3 arc minutes grid) but much of it has been obtained by modelling rather than actual inventories. The reliability of the modelling exercise and its variation is unknown.

- **The resource base**: although the individual resource base layers are relatively uniform in resolution some of the underlying data were obtained from less detailed databases (for instance climate), while others like terrain were difficult to use to distinguish land use systems.

Land use Systems in Sub-Saharan Africa



Conclusions

- **Demand side**
  - Energy Prices and Carbon Prices
  - Sustainability of biomass production – certification schemes under development
  - Biomass energy - Alternative energy sources for different sectors: heating, electricity, transport energy
  - Alternative energy sources (transport sector the exception?)

- **Supply side:**
  - Technological progress: different energy yields between technologies, fuels, crops
  - Technological Implementation and rural investment
  - Support measures (policies), SD concerns

- **Large uncertainties for different data**

- **Translation of price signals into land-use change!?**

- **Land Use**
  - Actual land use has been getting insufficient attention compared to land cover in the scientific community.
  - There is an urgent need to agree on a land use system classification and make a serious start of mapping actual land uses.

Thank you!

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- International Bioenergy Platform (IBEP) http://www.fao.org/sd/en2_en.htm
- Global Bioenergy Partnership – GBEP-Secretariat@fao.org and coming soon: www.globalbioenergy.org
- Get in touch with us about additional contact information, publications and ongoing bioenergy initiatives or go online at www.fao.org