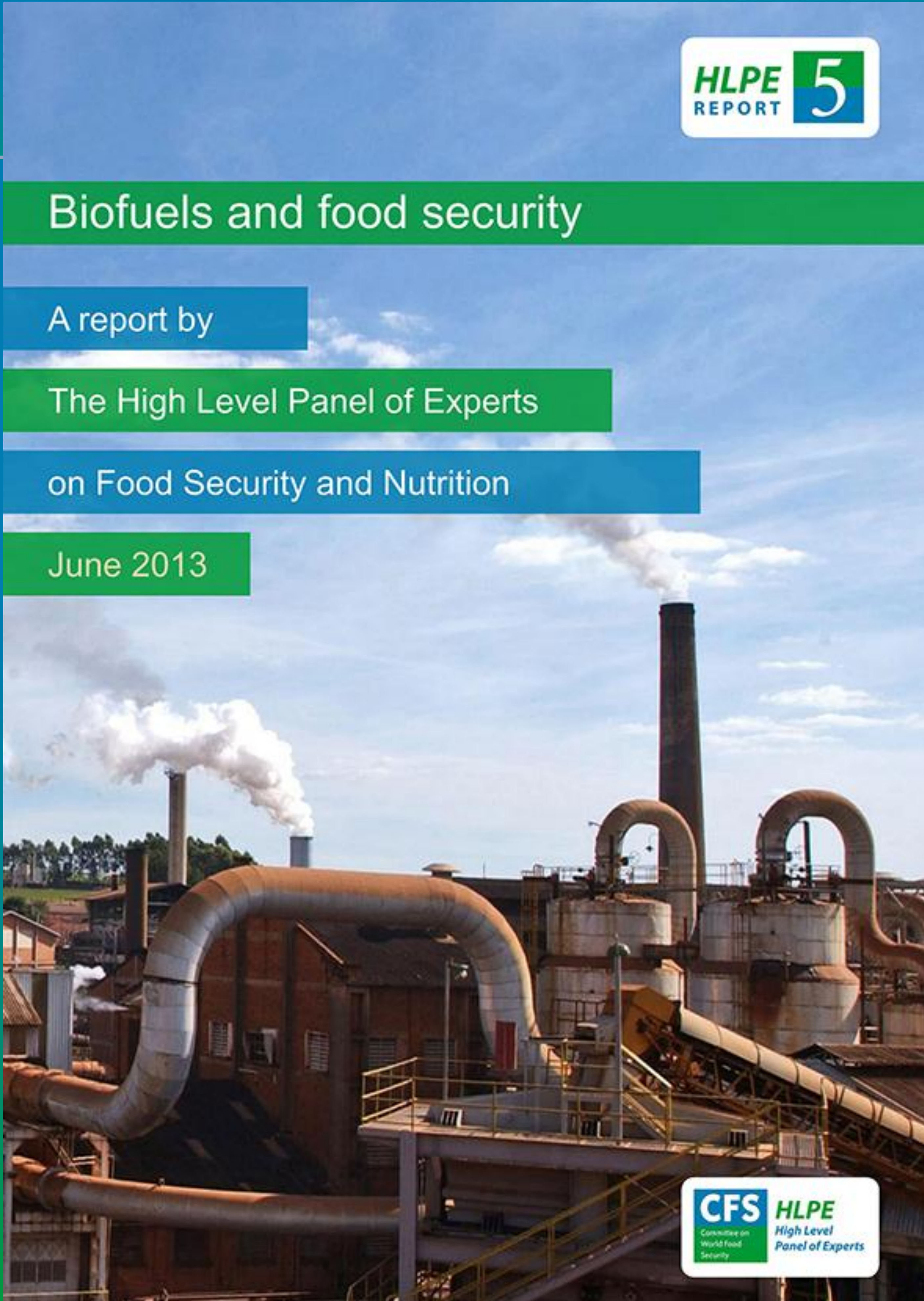


HLPE REPORT

BIOFUELS AND FOOD SECURITY

John Wilkinson
HLPE Project Team Leader

Wednesday 26th June, 2013, FAO, Rome

TERMS OF REFERENCE

In October 2011, the UN Committee on World Food Security (CFS) recommended a "*review of biofuels policies – where applicable and if necessary – according to balanced science-based assessments of the opportunities and challenges that they may represent for food security so that biofuels can be produced where it is socially, economically and environmentally feasible to do so*". In line with this, the CFS requested the HLPE to "*conduct a science-based comparative literature analysis taking into consideration the work produced by the FAO and Global Bioenergy Partnership (GBEP) of the positive and negative effects of biofuels on food security*".

STRUCTURE OF THE REPORT

* Introduction

* Biofuel Policies

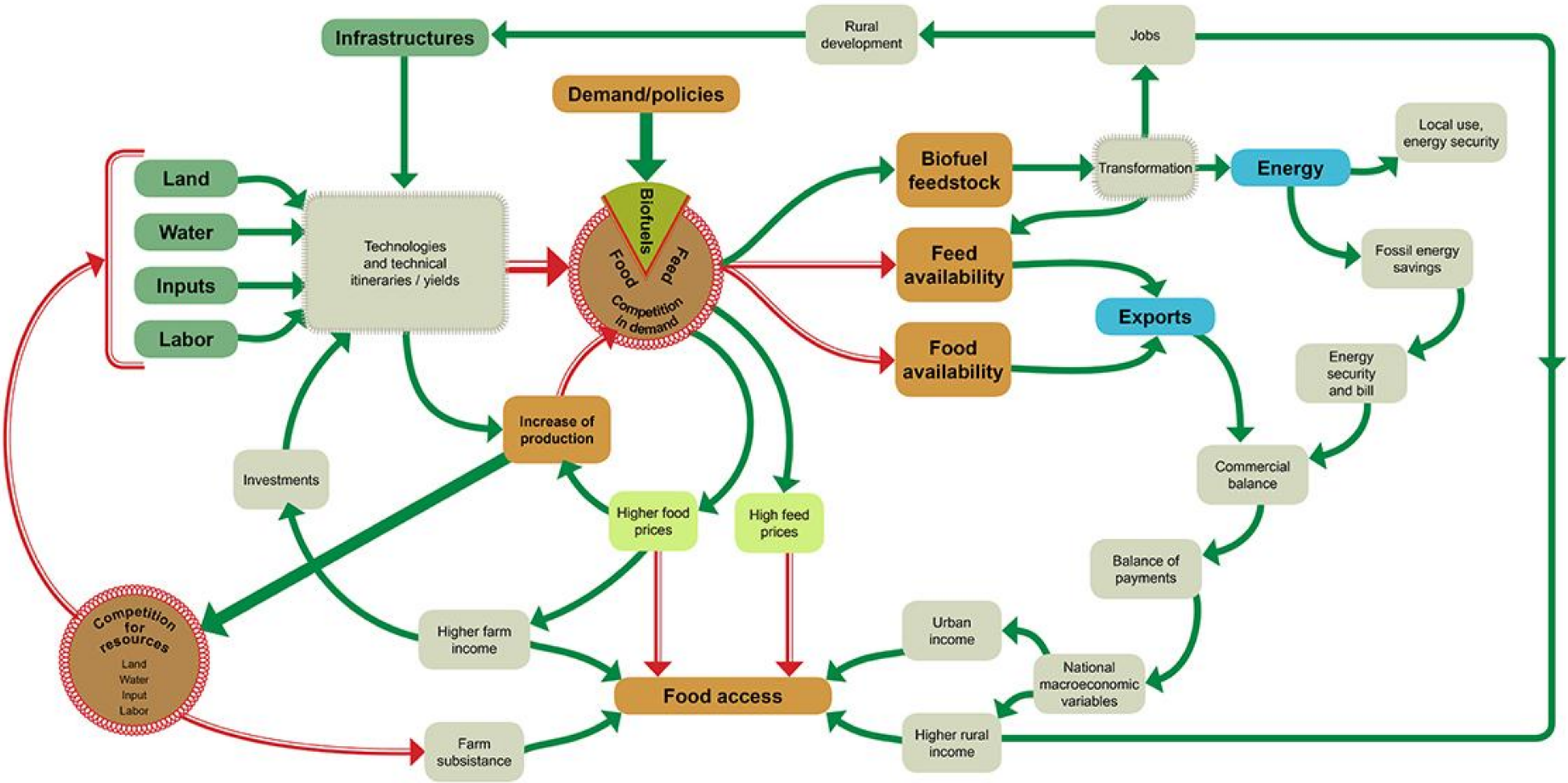
* Biofuels: first and second generation options

* Biofuel demand, food prices, hunger and poverty

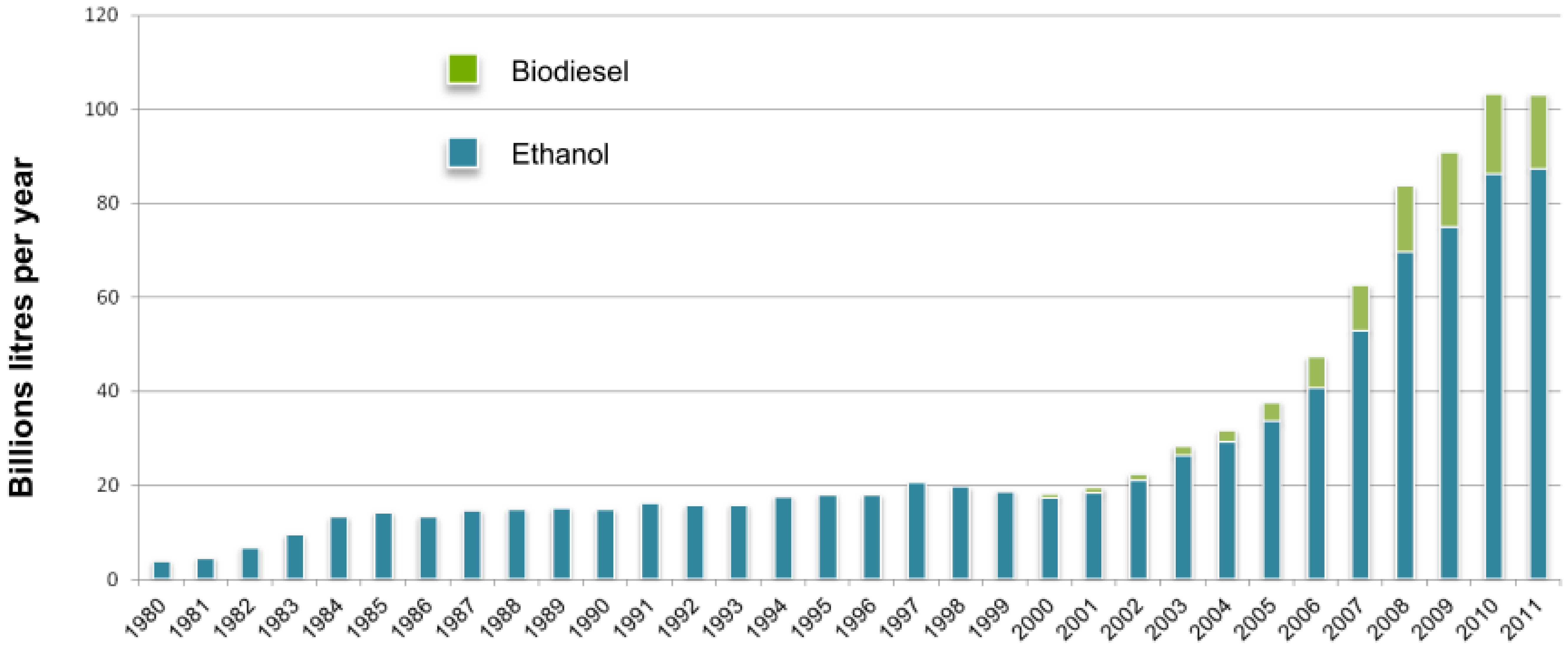
* Biofuels and land

* Biofuels and bionergy: socio-economic impacts and development perspectives

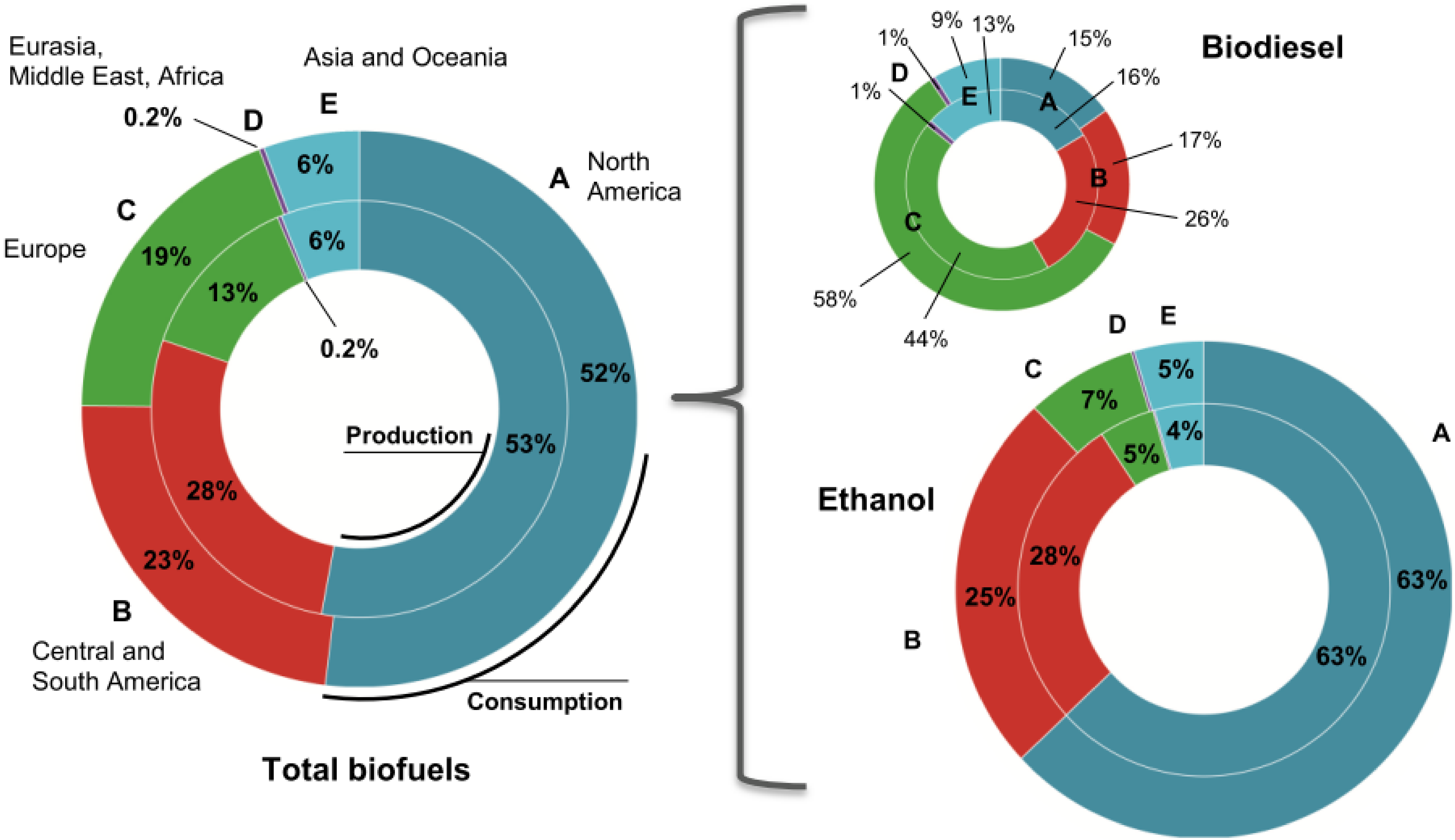
Impacts and feedbacks



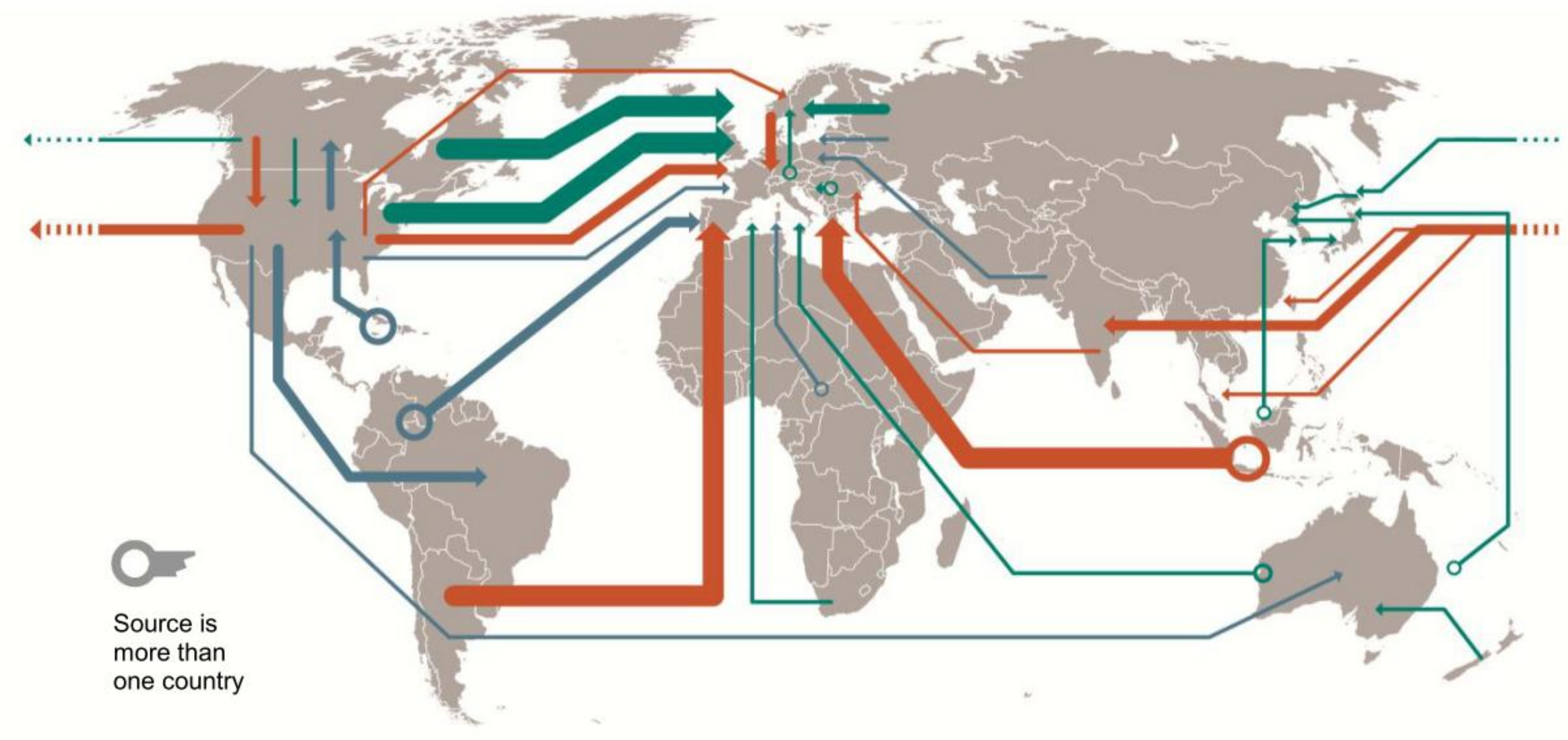
Biofuel production, 1980–2011



Regional production and consumption of biofuels, ethanol and biodiesel in 2011



Net trade streams of wood pellets, biodiesel and ethanol, 2011



Bioethanol	Biodiesel	Pellets	Energy content
> 1 000 Ml/yr	> 600 Ml/yr	> 1 000 kt/yr	> 20 PJ/yr
501-1 000 Ml/yr	301-600 Ml/yr	501-1 000 kt/yr	10-20 PJ/yr
101-500 Ml/yr	61-300 Ml/yr	101-500 kt/yr	2-10 PJ/yr
10-100 Ml/yr	6-60 Ml/yr	10-100 kt/yr	0.2-2 PJ/yr

MAIN FINDINGS

CHAPTER ONE:BIOFUEL POLICIES

*Central role of public policies

*Brazil and the U.S. – sugarcane and corn ethanol

*EU – biodiesel and globalized demand as from 2000s

*Explosive growth in U.S. (MTBE) and Brazil (flexfuel cars) as from 2003

*EU and U.S reaching target/blending limits

*U.S. at certain level of oil price now market competitive

*Brazil increasingly market driven

*More than 50 countries now have targets and/or mandates

*Emerging and developing countries adopt targets/mandate: centrality of food security (marginal lands, non-food crops)

POLICIES AT A TURNING POINT

MAIN FINDINGS

CHAPTER ONE:BIOFUEL POLICIES 2

*China: car fleet (100 m), energy (dep:50%); renewable energy target 10% (2010) ethanol 10 b. liters by 2020 ; shift to non-food crops and marginal lands

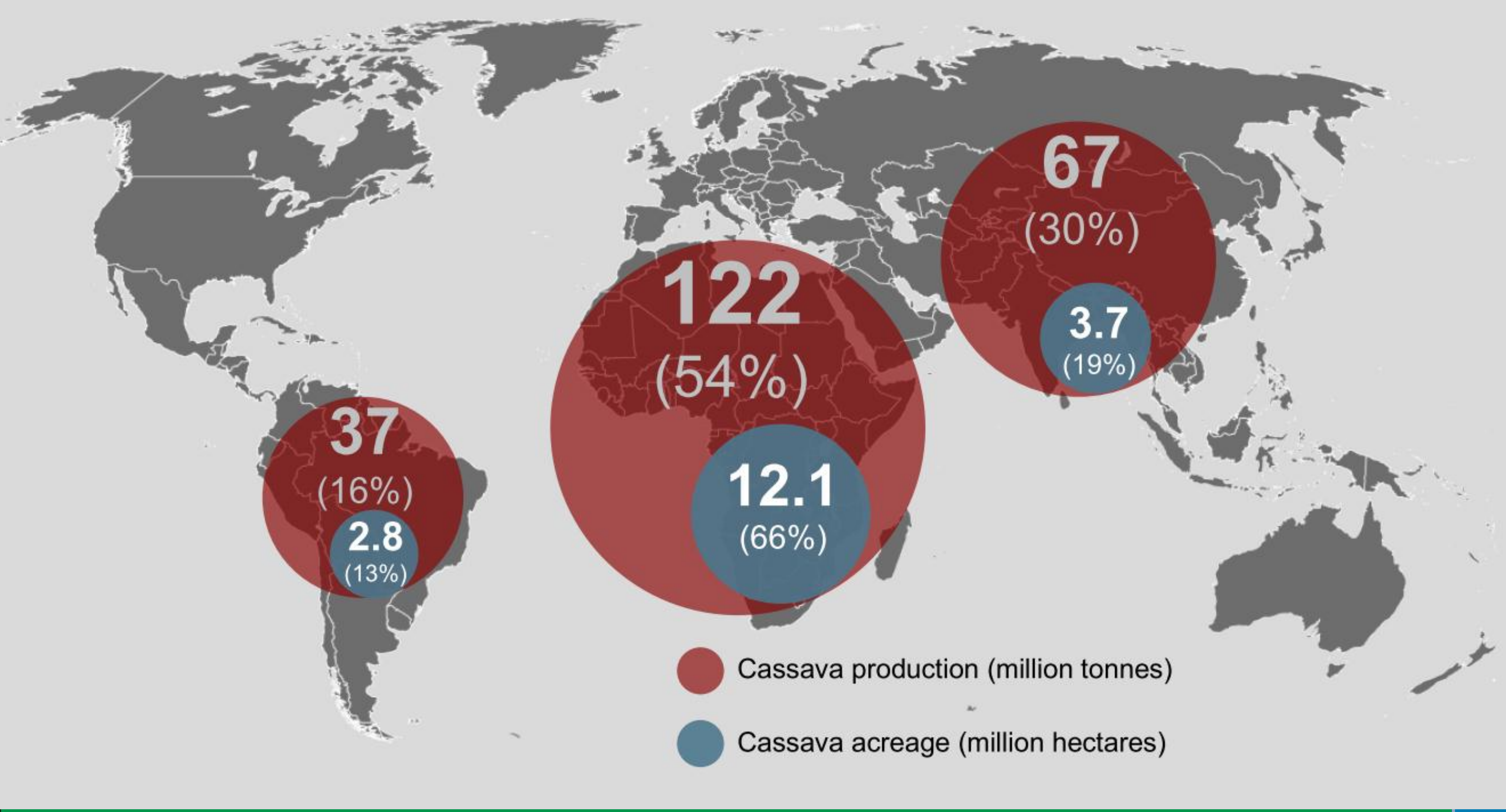
*India: similar to China – large vehicle fleet & energy dependence; 2003: 5% target then 10% and 20% all biofuels by 2017 – marginal land + jatrpoha.
Objs: energy needs of rural pop; emissions reduction; non-edible feedstock; indig. biomass & second generation promotion

Asia: Japan/Korea imports; Indonesia & Malaysia exports; Thailand. Imp of biogas

South Africa and SAA: small farmer/underutilized (no jatropha);
4 principles: rural dev; energy security; attract inv; sustainable land use

L.A Central America (US), imp transport fuels (17 countries mandates), 320 mill has suitable/available FAO/ECLAC study; IDB policy, Colombia Argentina

Production/harvested areas of cassava in the world (2006)



MAIN FINDINGS

BIOFUELS:FIRST AND SECOND GENERATION OPTIONS

* Definitions: first/second generations;
  conventional/advanced

* Implications of biofuels vary depending on: feedstock , natural resources, eficiencies (emissions, yields, costs, energy) & technology

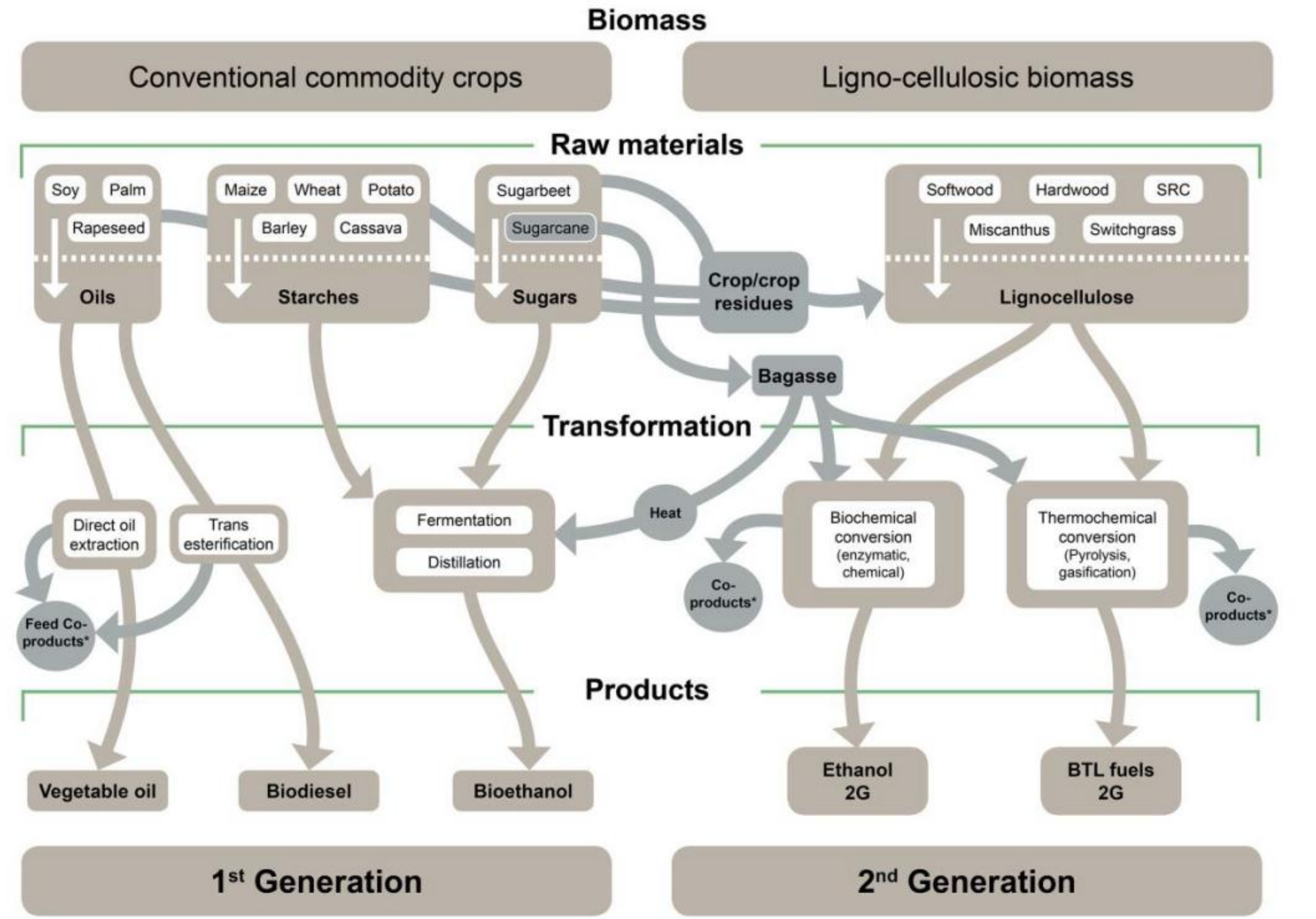
* Importance of co-products

* First generation – 2011 = 99.85% (91.300.000 t)
  - limits and problems

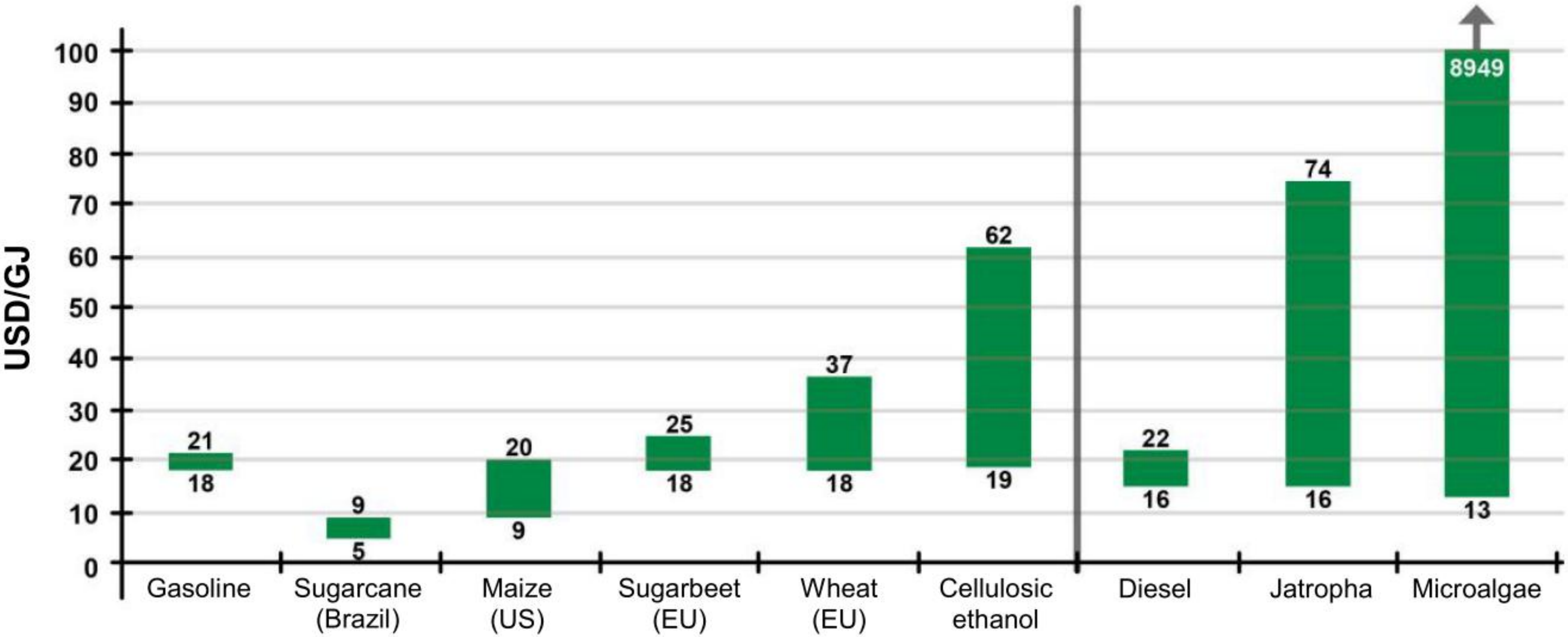
* Second generation – routes, delays and current acceleration
  - characteristics
  - costs

* Jatropha as silver bullet
* What options for developing countries?

Pathways for producing 1st and 2nd generation biofuels



Biofuel production cost from various feedstocks



Land use intensity for selected biofuel crops, global averages

Biofuel	Feedstock	Ha per Mlge*	Main co-product (yield in Kg/L biofuel)	Co-product use
Ethanol	Sugar beet	350	Beet pulp (0.25)	
	Corn	465	Dried distillers grains with solubles (DDGS) (0.3)	Protein for animal feed, solid fuel
	Sugar cane	300	Bagasse (0.25)	Solid fuel for heat/electricity
	Cassava	420		
	Cellulosic	470	Lignin (0.4)	Solid fuel and chemicals
Biodiesel	Rapeseed	670	Glycerine (0.1), Presscake (0.6)	Soy meal
	Soybean	1 310	Soybean meal (0.8)	Soy meal
	Palm	310	Empty fruit bunches (0.25)	Animal feed or solid fuel
	Jatropha	1 540		
	BtL-Short Rotation Coppice (SRC)	320	Low temperature heat; pure CO_2	
Biomethane	Anaerobic digestion (maize)	250	Organic fertiliser	
	bio-SG (SRC)	280	Pure CO_2 (0.6 L)	

*Source: calculated from IEA (2011) and McDonald et al. (2009) * Hectares per million litres of gasoline equivalent*

Estimated costs of production of different cellulosic biofuels using techno-economic analysis

Author	Feedstock	Biofuel	Production cost (USD/litre gasoline equivalent)*
McAloon *et al.* (2000)	Corn stover	Ethanol	0.95
Solomon, Barnes and Halvosen (2007)	Switchgrass or wood	Ethanol	0.95
Sassner, Galbe and Zacchi (2008)	Salix (willow)	Ethanol	0.90–1.09
	Spruce	Ethanol	0.82–0.87
	Corn stover	Ethanol	0.84–1.08
Frederick *et al.* (2008)	Yellow poplar	Ethanol	0.63
	Loblolly pine	Ethanol	0.71–1.03
Wright *et al.* (2010)	Corn stover	Hydrocarbons	0.58
Kazi *et al.* (2010)	Corn stover	Ethanol	1.41–2.38
Swanson *et al.* (2010)	Corn stover	Hydrocarbons	1.10–1.37
Brown *et al.* (2013)	Corn stover	Hydrocarbons	0.68
Haque and Epplin (2012)	Switchgrass	Ethanol	0.66–1.08

Source: Compilation by authors. Data include input costs and industrial/process costs.
** Inflation adjusted to 2012.*

Net energy return on investments for different fuel types

Fuel	EROI	Countries/regions included in the evaluation
Cellulosic ethanol	2–36 (5.4)	United States (switchgrass)
Corn ethanol	0.8–1.7	United States, Colombia, China
Wheat ethanol	1.6–5.8	United Kingdom, Netherlands, Switzerland, Australia
Sugar-beet ethanol	1.2	United Kingdom
Soybeans biodiesel	1.0–3.2	United States, Argentina, Brazil, China, South Africa
Sugar-cane ethanol	3.1–9.3	Brazil, Mexico, Southern Africa
Molasses	0.6–0.8	Thailand, Nepal
Cassava	1.3–1.9	China, Thailand
Sweet sorghum	0.7–1.0	China
Rapeseed biodiesel (Europe)	2.3	United Kingdom
Waste vegetable oil biodiesel	5–6	
Palm oil biodiesel	2.4–2.6	Southeast Asia, Thailand
Jatropha	1.4–4.7	China, India, Thailand, Africa
Algae	0.01–7.01	

Source: Compilation by authors, based on WWI (2006); Pimentel and Patzek (2005); Shapouri et al. (2004); Quintero et al. (2008); Kim and Dale (2008); Hill et al. (2006); Royal Society (2008); Grant et al. (2008).

GHG emission reductions of select biofuels compared with gasoline and diesel excluding land-use change impacts

Biofuel	Emission reductions (%)*	Biofuel	Emission reductions (%)*
Sugar-cane ethanol	65–105	Palm oil biodiesel	30–75
Wheat ethanol	-5–90	Jatropha biodiesel	40–100
Corn ethanol	-20–55	Soybean biodiesel	52–70
Sugar-beet ethanol	30–60	Lignocellulose diesel	5–120
Rapeseed biodiesel	20–80	Lignocellulose ethanol	45–112[a]

*Source: Compilation by authors based on OECD (2008); WWI (2007); Wang, Wu and Huo (2007); Borrion, McManus and Hammond 2012); Kumar et al. (2012); Hou et al. (2011); Ndong et al. (2009); Stratton, Wong and Hileman (2010); Whitaker and Heath (2009); O'Connor (2011). * Negative numbers mean net increases in GHG emissions. a Includes forest residues, energy crops (such as short tree rotations (e.g. poplar), and switchgrass) and crop residues (e.g. corn stover)*

Cellulosic biofuels volumes (in million gallons) anticipated under the Energy Independence and Security Act (EISA) of 2007, revised, and actual production*

	2010	2011	2012	2013
Originally mandated (2007)	100	250	500	1 000
Revised by EPA	5	6.6	8.65	14
Actual production	0	0	0.02	>5?[a]

Source: Elaborated based on Schnepf and Yacobucci (2013) and EPA data available at: http://www.epa.gov/otaq/fuels/rfsdata/2012emts.htm.
** 1 gallon = 3.785 litres a Energy Information Administration (2013).*

US 2011 biofuel consumption and US 2022 projections

Subsector	2011 (billion gallons* in ethanol equivalence)	2022 (billion gallons in ethanol equivalence)
Biodiesel	1.2	6.0
Biobutanol	0	9.9
Renewable diesel	0	2.6
Cellulosic ethanol	0.006	6.7
Other crop diesels	0	2.6
Imported sugarcane ethanol	0.17	1.0
Subtotal advanced biofuels	1.35	28.5
Corn ethanol	12.6	7.5
RFS totals	13.95	36.0 (RFS2 target)

Source: 2011 data calculated from the US Energy Information Administration (EIA, 2012), 2022 projection reproduced from Biofuels Digest (2012).
** 1 gallon = 3.785 litres*

MAIN FINDINGS

BIOFUELS DEMAND:FOOD PRICES HUNGER AND POVERTY 1

*** Fivefold abrupt increase in biofuels in less than 10 yrs (US, Brazil, EU). Steepest rise coincided with food price spikes – extent of biofuels` impact and role in volatility**

*** Why debate and controversy continue:**

- separation of drivers & impacts;
- many actors; short-term/long-term;
- one among many factors;
- price and consumption impacts

*** Key focus: impact of additional demand for biofuels (also as amplifier)**

*** Chapter maps debates around 3 questi0ns:**

i) what mechanisms explain the incremental impact;
ii) what was share of biofuel in price increases ?,
iii) what could happen in the future?

Review of price impacts (based on existing reviews) CHAPTER 3 and Annex A1

Source	Coverage and key assumptions	Effects
Roberts and Schlenker (2010)	US biofuel policy + 5% of world harvest for biofuel; no policy.	30% increase in food price (20% if a third of feedstock is used for livestock).
Carter and Smith (2011)	2001–2007; US biofuel policy *vs.* no policy.	20–25% contribution (corn price rise) 7–8% contribution (soybean price rise).
National Research Council (2011)	2007–2009; US biofuel policy; using a review of several studies.	20-40% on food commodity prices.
Banse *et al*. (2008)	2001–2010; Reference scenario without mandatory biofuel blending, 5.75% mandatory blending scenario (in EU member states), 11.5% mandatory blending scenario (in EU member states).	Price change under reference scenario, 5.75% blending, and 11.5% blending, respectively: Cereals: -4.5%, -1.75%, +2.5% Oilseeds: -1.5%, +2%, +8.5% Sugar: -4%, -1.5%, +5.75%
Baier *et al*. (2009)	24 months ending June 2008; historical crop price elasticities from academic literature; bivariate regression estimates of indirect effects.	Global biofuel production growth responsible for 17%, 14% and 100% of the rises in corn, soybean and sugar prices, respectively, and 12 % of the rise in the IMF's food price index.
Lazear (2008)	12 months ending March 2008.	US ethanol production increase accounted for 20% of the rise in corn prices. US corn-grain ethanol production increased global food prices by 3%.
IMF (2008)	Estimated range covers the plausible values for the price elasticity of demand.	Range of 25-45% for the share of the rise in corn prices attributable to ethanol production increase in the US.
Collins (2008)	2006/07–2008/09; Two scenarios considered: (1) normal and (2) restricted, with price inelastic market demand and supply.	Under the normal scenario, the increase in ethanol production accounted for 30% of the rise in corn price; Under the restricted scenario, ethanol could account for 60% of the expected increase in corn prices.
Glauber (2008)	12 months ending April 2008.	Increase in US biofuels accounted for about 25% of the rise in corn prices; US biofuels production accounts for about 10% of the rise in global food prices IMF global food commodity price index.
Lipsky (2008) and Johnson (2008)	2005–2007	Increased demand for world biofuels accounts for 70% of the increase in corn prices.
Mitchell (2008)	2002-mid-2008; ad hoc methodology: impact of movement in dollar and energy prices on food prices estimated, residual allocated to the effect of biofuels.	70-75% of the increase in food commodities prices was due to world biofuels and the related consequences of low grain stocks, large land use shifts, speculative activity and export bans.

MAIN FINDINGS

BIOFUELS DEMAND:FOOD PRICES HUNGER AND POVERTY 2

1) introduction of rigid sharp biofuels demand affects food commodity prices;

2) key role in recent food price increases – difficulty of supply response; biofuels translate oil prices to food;

3) different biofuels provoke different impacts: exs: EU & Brazil

4) biofuels as link between energy and food markets

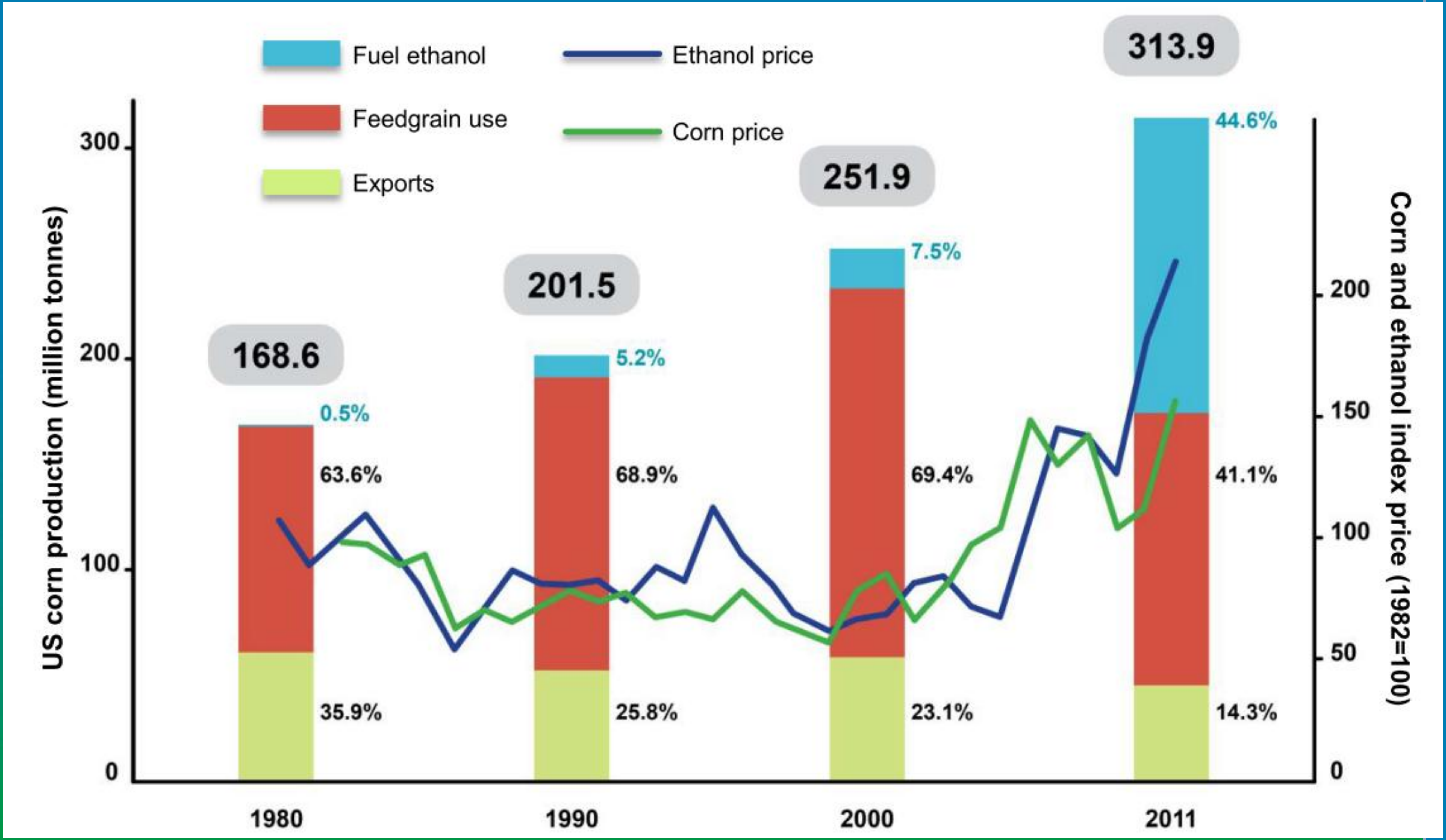
Policy Implications:

1) Need to respond to rapidly changing contexts

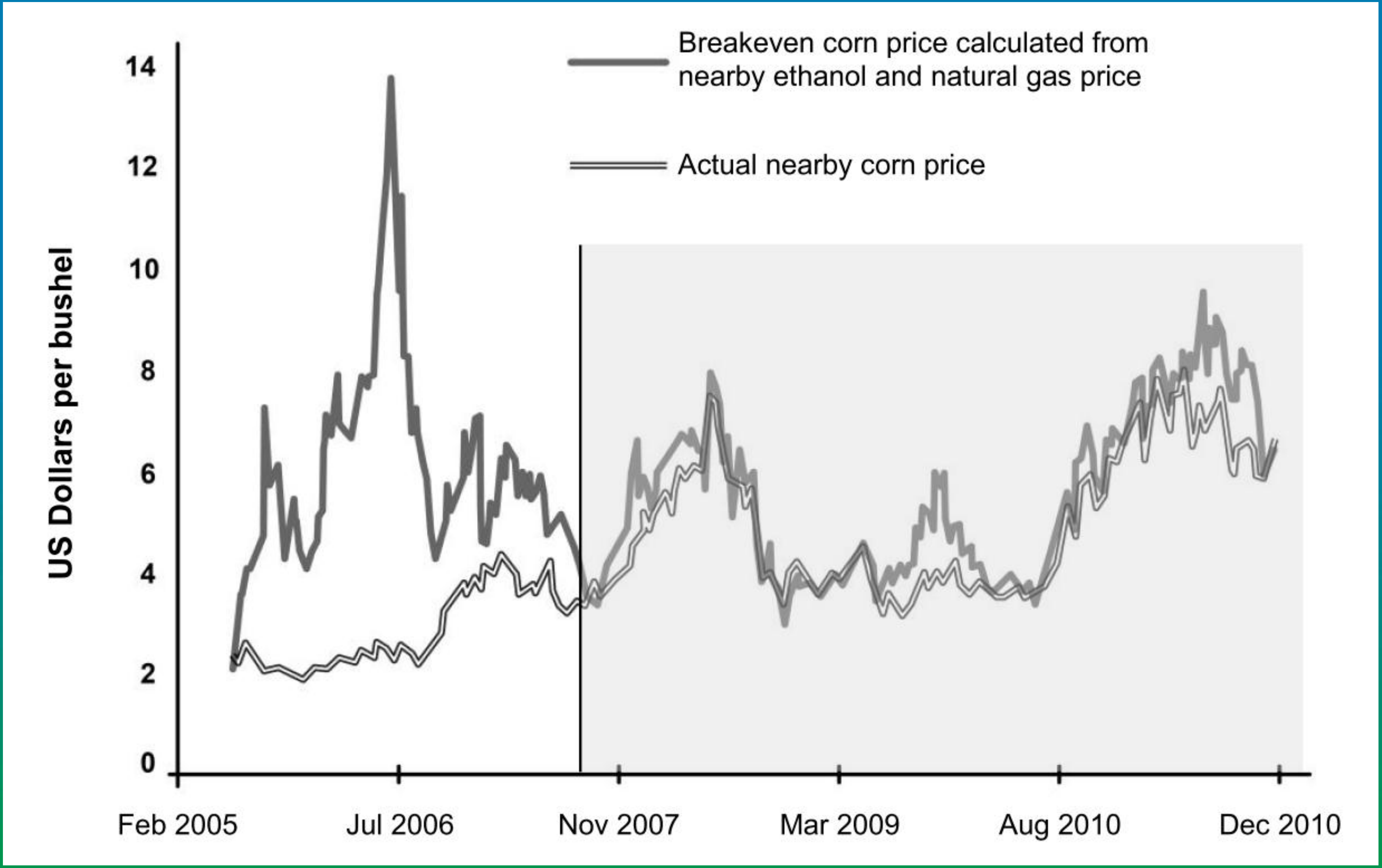
2) U.S. & EU – mandates becoming caps

3) Biofuels markets competitive with oil

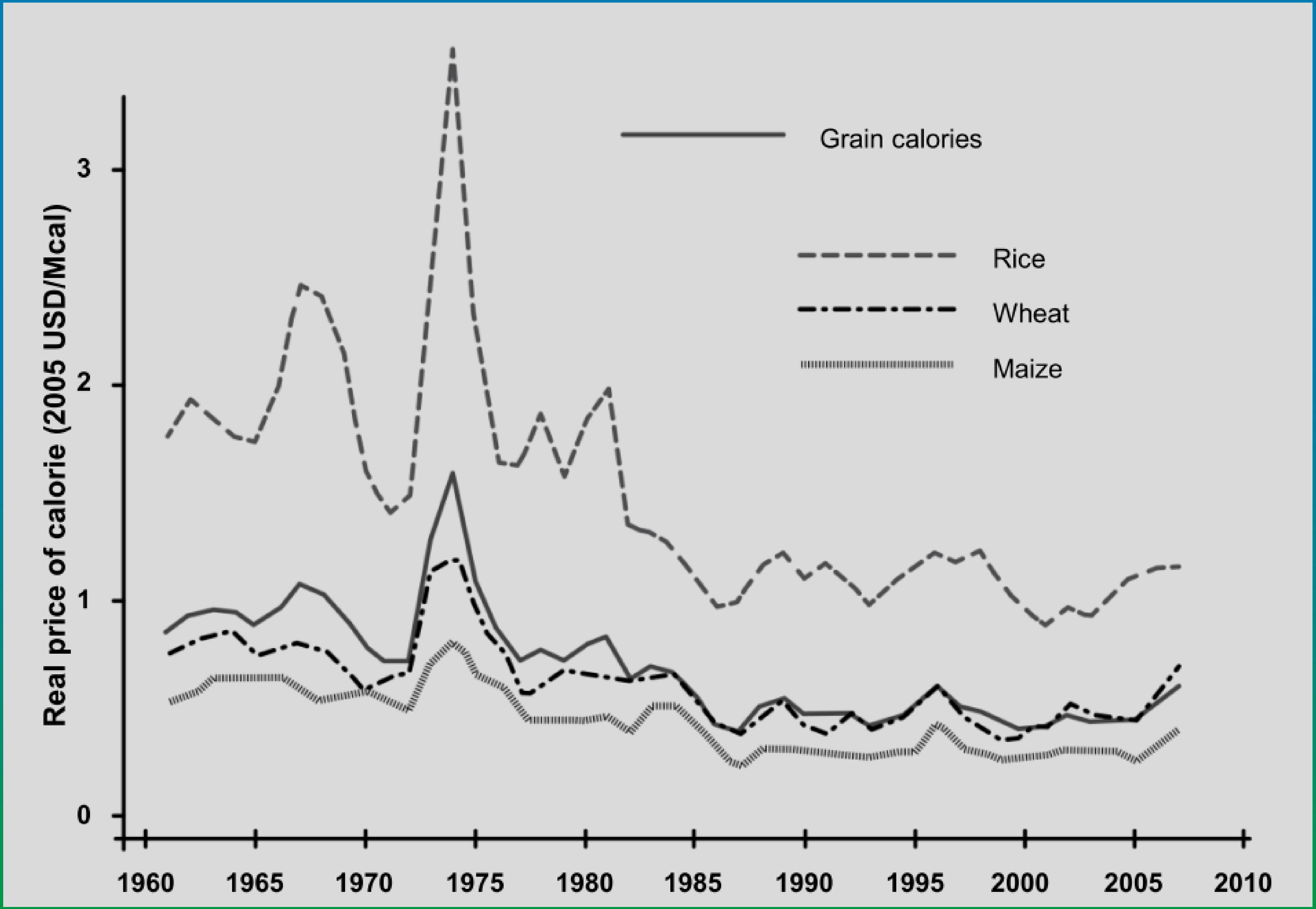
Ethanol and corn prices, and US corn production for fuel, feed and exports



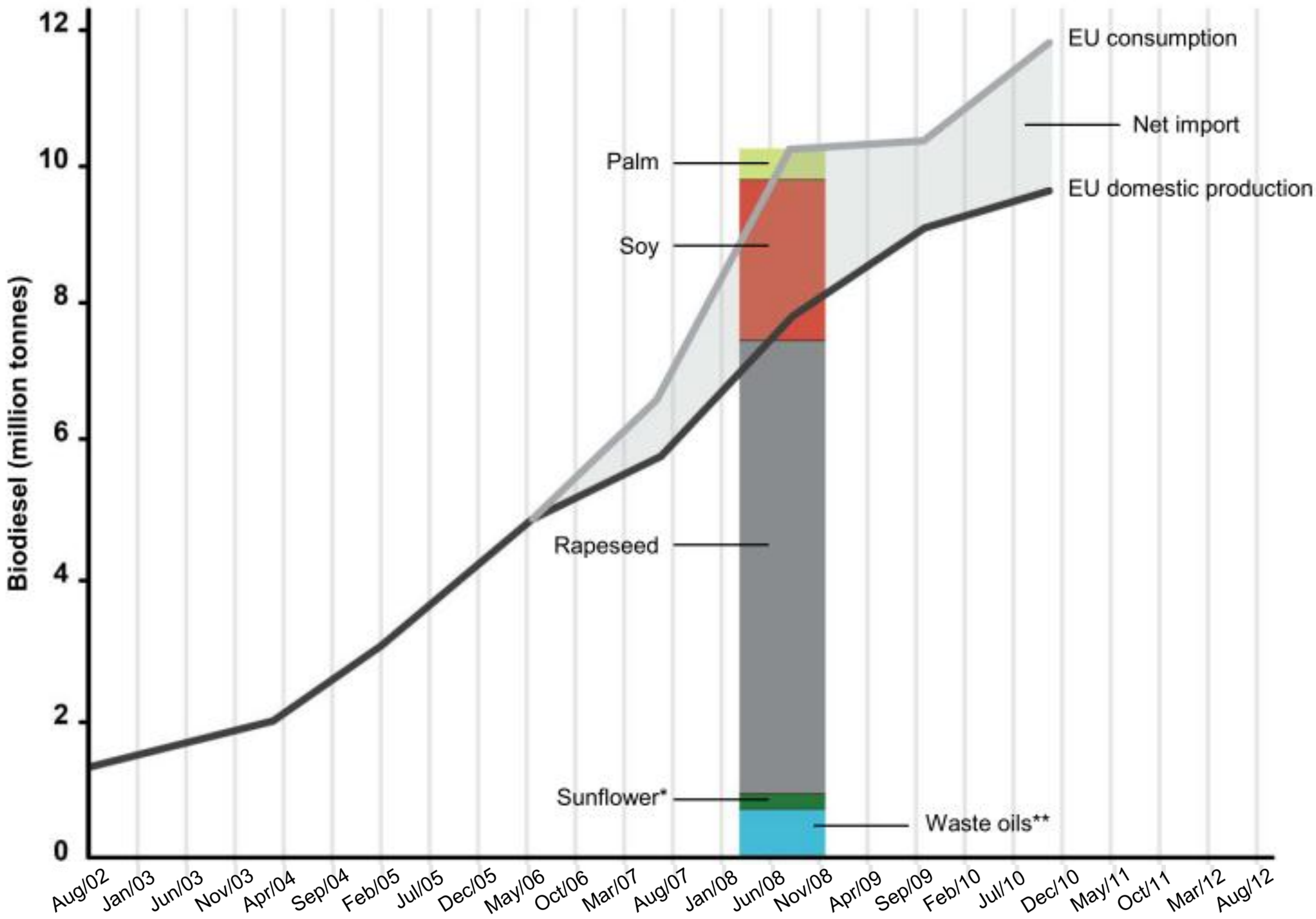
Biofuel production capacities open the door for a close relationship between oil prices and food commodity prices



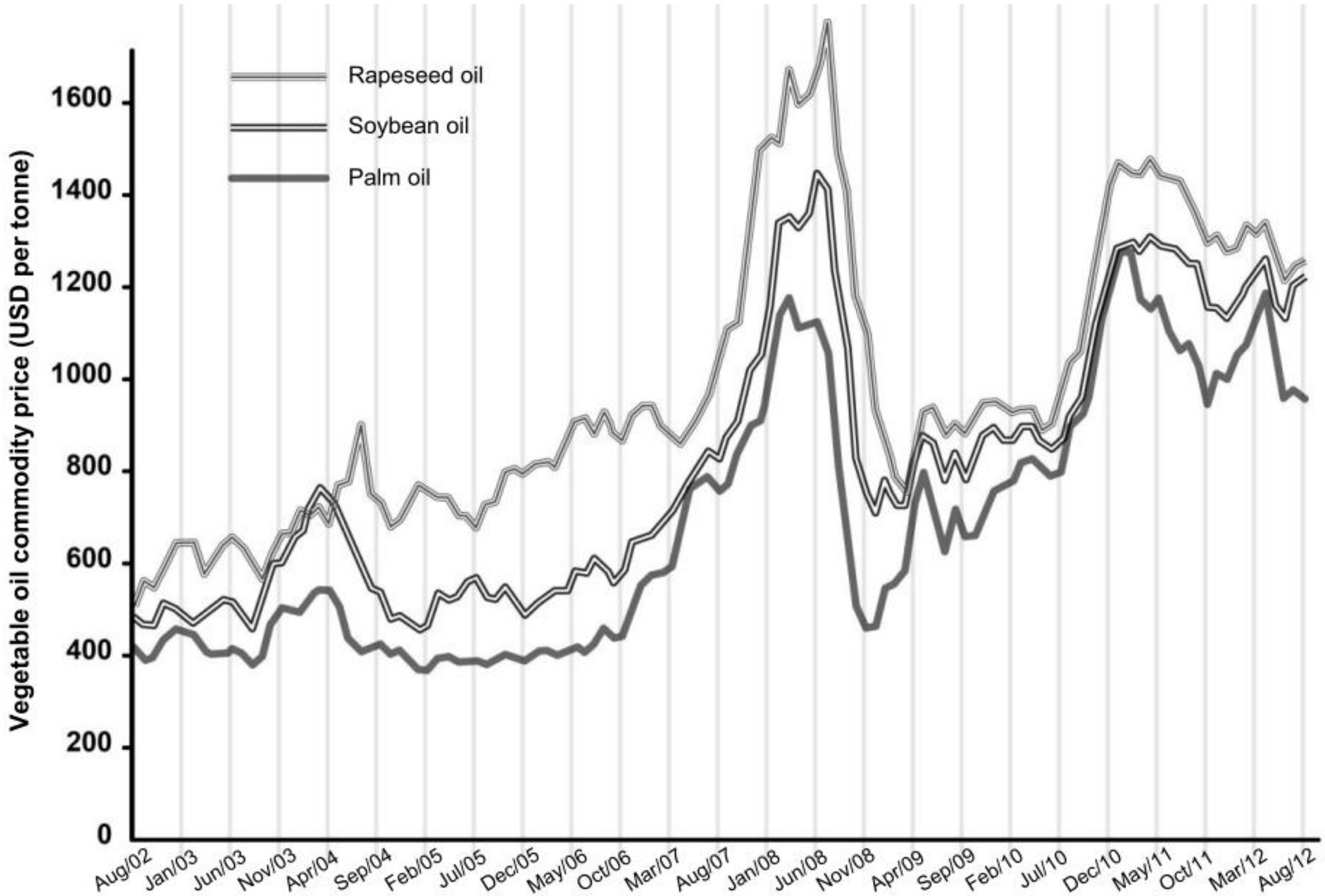
Market linkage between grain wheat, rice and maize (1960–2010)



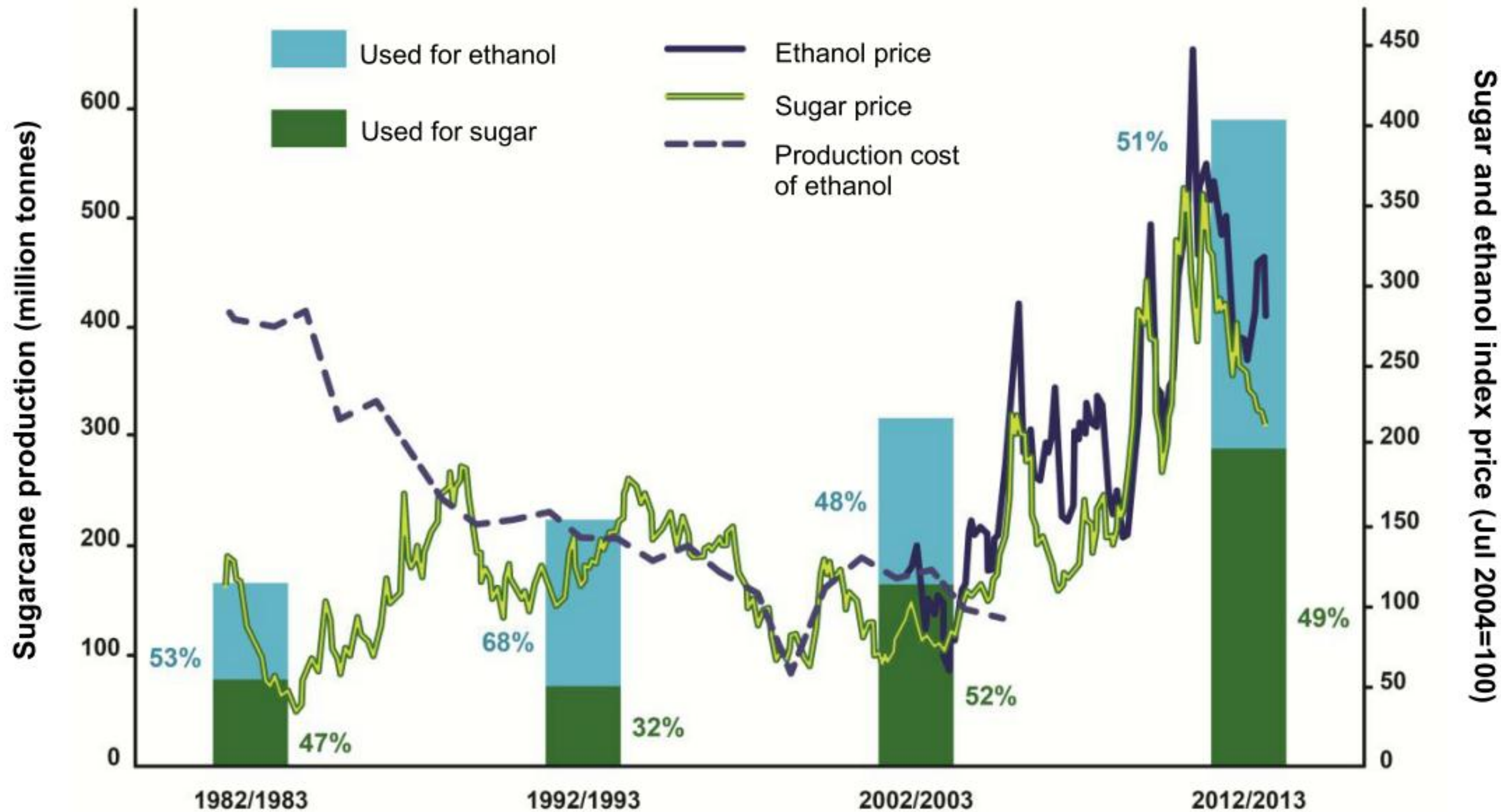
EU biodiesel production and consumption 2002–2010, feedstock mix in 2008



Vegetable oil commodity prices



Sugarcane production, ethanol and sugar production and prices in Brazil



	1982/1983	1992/1993	2002/2003	2012/2013
Sugarcane	166.1 Mt	223.4 Mt	316.1 Mt	588.4 Mt
Ethanol	5.82 Mm^3	11.73 Mm^3	12.49 Mm^3	23.21 Mm^3
Sugar	8.86 Mt	9.26 Mt	22.38 Mt	38.24 Mt

MAIN FINDINGS

BIOFUELS AND LAND 1

*Debates on the global “availability” of land in light of food demand (up 60%) based on population and income projections to 2050;

*FAO/GAEZ: net balance of 1.4 billion hectares

*Agronomical approaches: problems of definition and data

*”Underutilized” land x traditional land use practices

*Projections – assumptions on crop yields, diet, livestock production/grazing lands

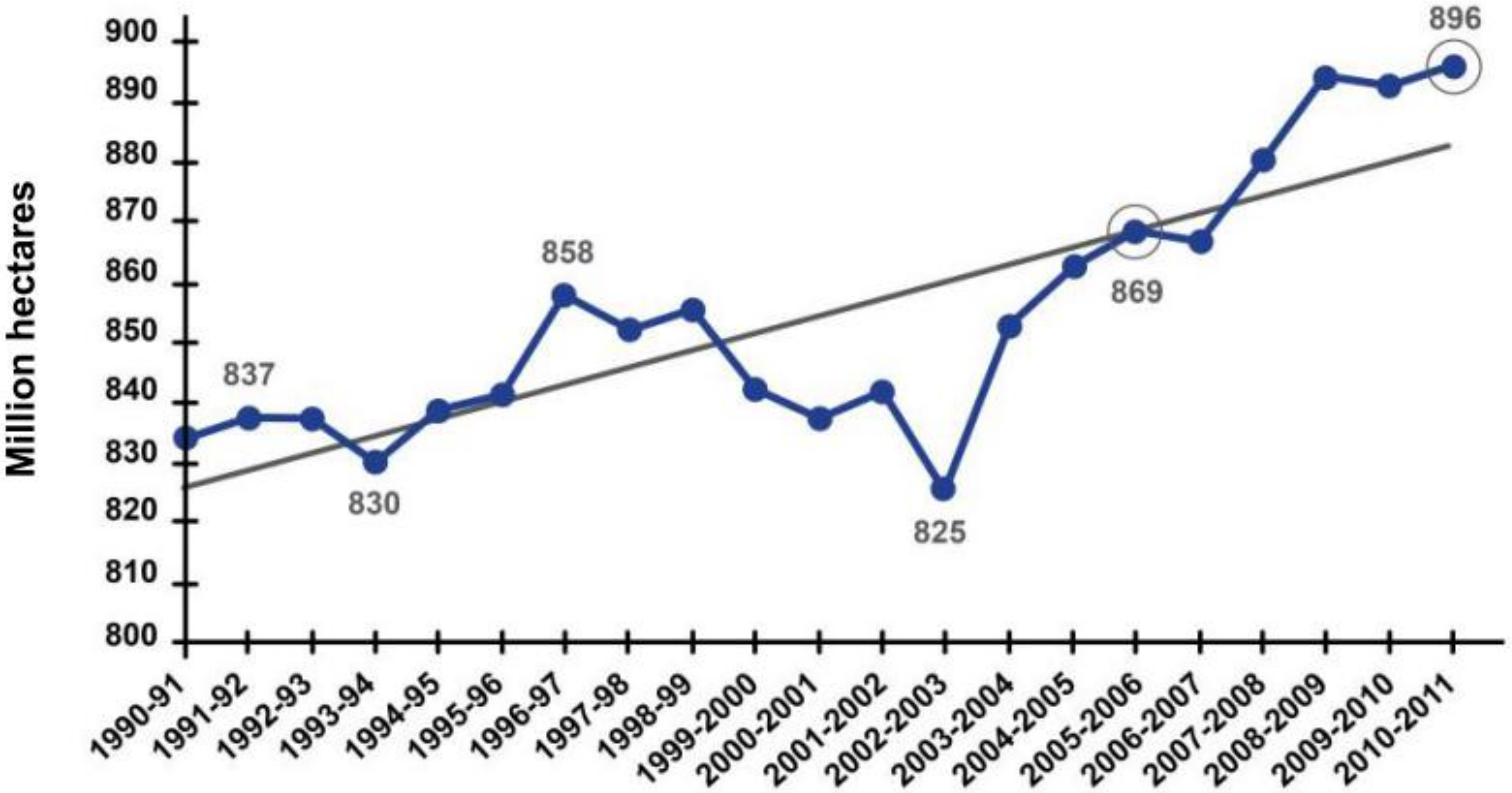
*Current and projected land use for biofuels – OECD

*Difference in feedstocks – Brazilian projections

*Broader biomass demands for energy – IEA

*GHG restraints on land-use change - dLUC, iLUC

Harvested areas (1990-2010) for the 13 major crops



MAIN FINDINGS

BIOFUELS AND LAND 2

*Landgrabbing x cross-border large-scale land acquisitions

*Data sources and role of NGOs

*Regional distribution of land investments

*Weight of biofuels in total land investments

*International Land Coalition, Grain, World Bank, EPS-PEAKS

*Differing views on impacts: RECONCILE, CIFOR,FAO/IIED

*Large-scale versus small holder strategies

*Consensus on need for institutional reforms - PRAI, IFC,

RAI/CFS, Voluntary Guidelines on Land Tenure

Land deals in Africa (Chap 4; Annex 2)

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Country	Type of investment	No. of invest-ments	Land (ha)	Feedstock type	Annual production targets (litres/ha)	State of investment			Total (ha)
						Operational	Project stage	Abandoned	
Democratic Republic of the Congo	Foreign	2	154 000	Jatropha, palm oil	No data				154 000
	Domestic	0							
Zimbabwe	Foreign	1	14 000	Sugar cane	44 000	1			164 000
	Domestic	5	150 000	Sugar cane, jatropha	58 400	4		1	
Mozambique	Foreign	27	624 162	Jatropha, sugar cane, sweet sorghum, palm oil	No data	24	1	2	645 162
	Domestic	1	21 000		No data				
Malawi	Foreign	2	>7 000	Jatropha	No data				>7 000
	Domestic	2	No data	Sugar cane	42 000	4			
Zambia	Foreign	12	827 483	Sugar cane, jatropha, palm oil	No data	9	3	1	827 483
	Domestic	1		Jatropha	No data	1			
Angola	Foreign	6	92 600	Sugar cane, jatropha, oil palm	No data	5	1		206 600
	Domestic	3	114 000	Sugar cane, sorghum	No data	1	2		
Namibia	Foreign	3	460 000	Jatropha, sugar cane	No data	2		1	460 000
	Domestic	0			No data				
United Republic of Tanzania	Foreign	17	407 622	Palm oil, jatropha, sugar cane, croton, sweets orghum	No data	13	2	2	409 622
	Domestic	1	2000	Jatropha	No data	1			
Madagascar	Foreign	18	1 249 600	Jatropha, sunflower, palm oil, sugar cane, woody biomass	No data	14	1	2	1 249 600
	Domestic	0			No data				
Kenya	Foreign	3	161 000	Jatropha, sugar cane	No data	3			211 000
	Domestic	1	40 000	Sugar cane	No data	1			
Uganda	Foreign	1	10 000	Palm oil	No data	1			10 000
	Domestic	0			No data				

MAIN FINDINGS

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BIOFUELS AND BIOENERGY:SOCIO ECONOMIC IMPACTS AND DEVELOPMENT PERSPECTIVES

***Income, employment and development impacts**

***Examples from Brazil: ethanol and biodiesel**

***CGE studies of food and energy insecure developing countries**

***BEFS studies and methodological toolkit**

***"Biofuels and the Poor" – studies**

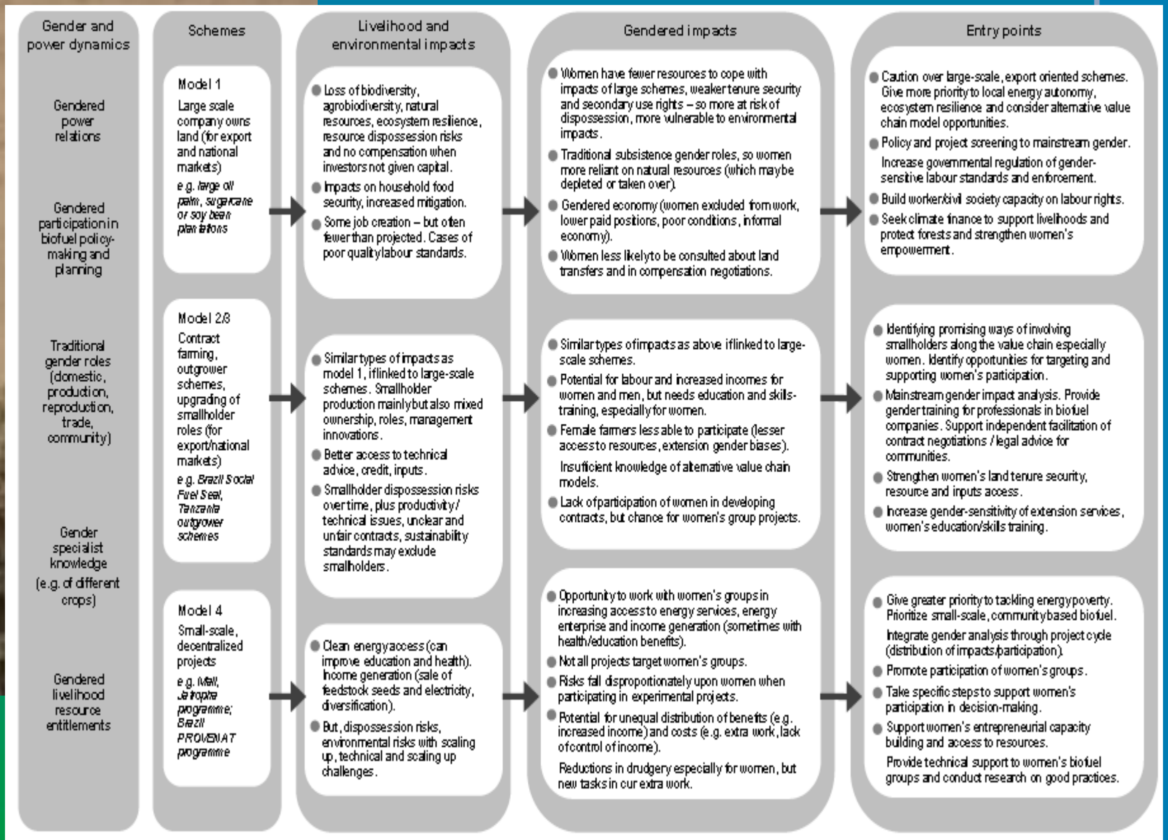
***Micro-level household analyses**

***Biofuels investments from a gender perspective**

***Bioenergy for cooking, heating and local power generation**

***The role of macro and production level typologies and certification schemes**

Gender Issues (Chapter 5 and Annex 3)



Source: Adapted from Nelson and Lambrou (2011a, 2011b).

POLICY RECOMMENDATIONS

Food security policies and biofuel policies cannot be separated

Food security and the right to food should be priority concerns in the design of any biofuel policy.

Governments should adopt the principle: biofuels shall not compromise food security

Trend to the emergence of a global biofuels market, **and** the shift from policy-driven to market-driven biofuels:

>> urgent need for **close and pro-active coordination** of food security, biofuel/bioenergy policies and energy policies, at national and international levels,

>> as well as **rapid response mechanisms** if crisis.

A coordinated strategy for national food security and energy security, around the 5 dimensions

1. Adapt to the change to global market-driven dynamics
2. Address the land, water and resource implications of biofuel policies
3. Foster the transition from biofuels to comprehensive food-energy policies
4. Promote Research and Development
5. Develop methods and for coordinated food, biofuels, bio-energy policies at national and international levels

Adapt to the change to global market-driven dynamics

Adjust biofuel policies and devise mechanisms to prevent (market-driven) biofuel demands posing a threat to food security (from price rises and competition for resources)

International coordination of such policies and mechanisms in an appropriate forum

Short-term, coordinated responses in times of crisis.

Global Bioenergy Partnership (GBEP), the Committee on Commodity Problems and its Intergovernmental Group on Grains to make a proposal on possible response mechanisms

Governments to communicate biofuels policies and targets to the Agricultural Market Information System (AMIS).

Address the land, water and resource implications of biofuel policies

Principles for responsible investment in agriculture elaborated by the CFS, implemented and monitored, for investments for biofuel production.

The principles of free, prior and informed consent and full participation of all concerned in land-use investment.

Implementation of Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security.

Policies to integrate land and water impact assessment

Non-food/feedcrops to be assessed with the same rigour as food/feedcrops for their direct and indirect food security impacts.

Foster the transition from biofuels to comprehensive food-energy policies

Comprehensive bioenergy policy approach,

A modern biomass-based sector,

Development strategy towards high-value products, electricity and alternative power for cooking, water management, local productive facilities, in addition to transport fuel.

Support smallholder participation in biofuels and bioenergy value chains on the basis on fair and equitable market access.

Explore alternative policy measures (fuel efficiency, collective transport, alternative renewable fuels)

Promote Research and Development

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Efficiency of the technologies used for biofuels (resources and processes)

Solutions adapted to the needs of the least developed countries and of smallholders (most in need of access to energy).

Examine if and how first- and second-generation biofuels could contribute to restoring degraded land and to the better management of watersheds (Global Soil and the Global Water Partnerships)

Accelerate the commercial feasibility of more advanced renewable energy pathways.

Exchange of information and cooperation for food security and biofuels assessments and projections (assumptions, methods, tools and data used).

Develop methods and for coordinated food, biofuels, bio-energy policies at national and international levels

Elaborate methodologies, including typologies, for assessing national biofuel potential (land and water availability, population density, food and energy needs, agricultural production, per capita income)

GBEP to launch an inclusive process to ensure that only certification schemes that are multistakeholder, fully participative and transparent be recognized for access to the biofuels market. Limit transaction costs to avoid excluding smallholders.

Committee on Agriculture (COAG) to prepare proposals for the development of sustainability criteria, testified by certification schemes, for farming activities and products.

Develop methods and guidelines for coordinated food, biofuels, bio-energy policies at national and international levels

The CFS could launch, with support of FAO and GBEP, the **development of guidelines** to evaluate the impact and viability of biofuels policies and impact on domestic and international food security.

- technical, social and environmental zoning to delimit “available land” and accompanying resources;
- “responsible land investment” practices;
- mechanisms to react quickly to food price spikes and problems of food availability (price triggers, waivers, “minimum” levels of food stocks);
- evaluation of the implications for the origin of feedstock provision (domestic/imported); and for trade;

More information

www.fao.org/cfs/cfs-hlpe