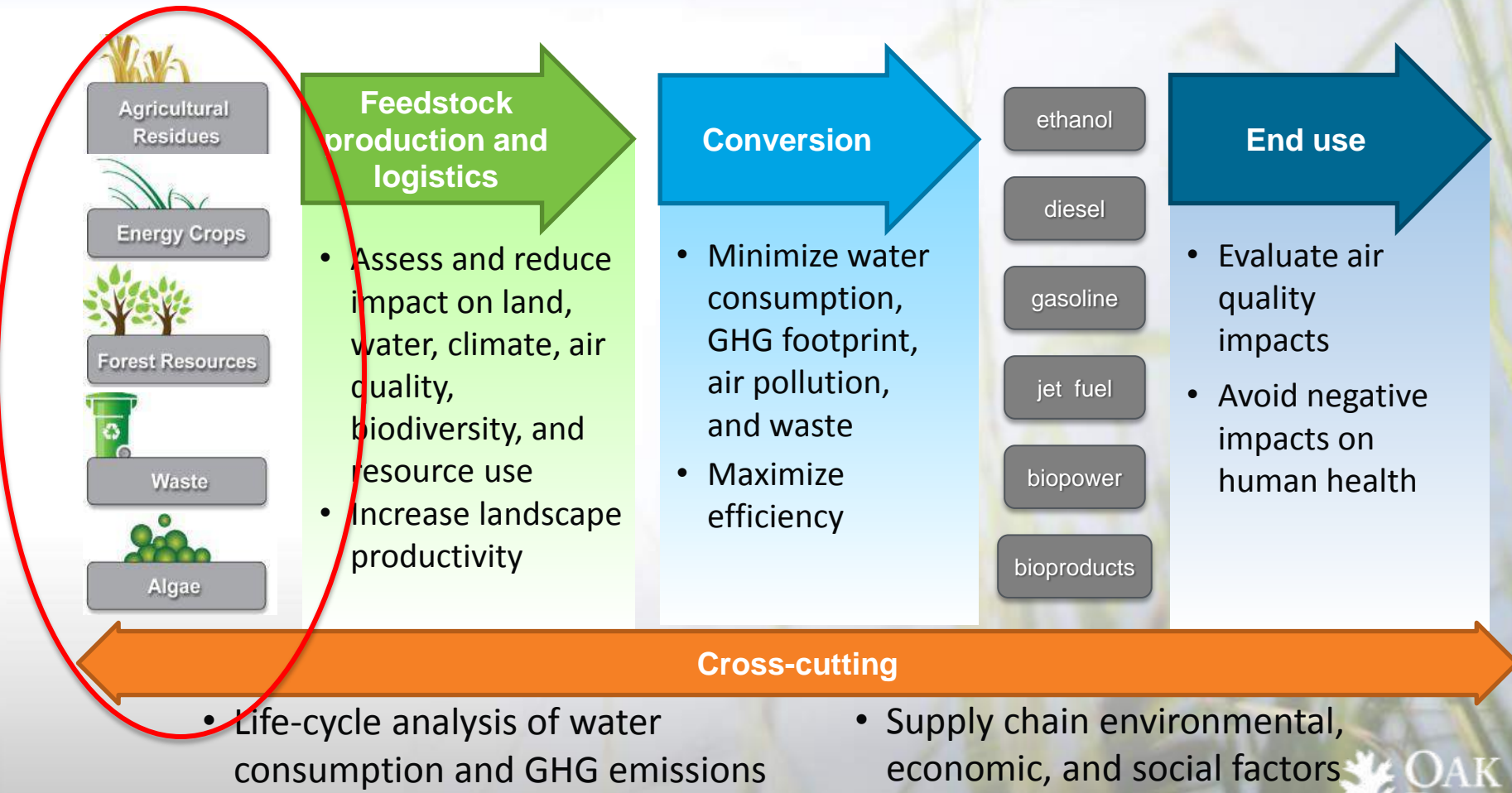


Biomass for bioenergy: Outline

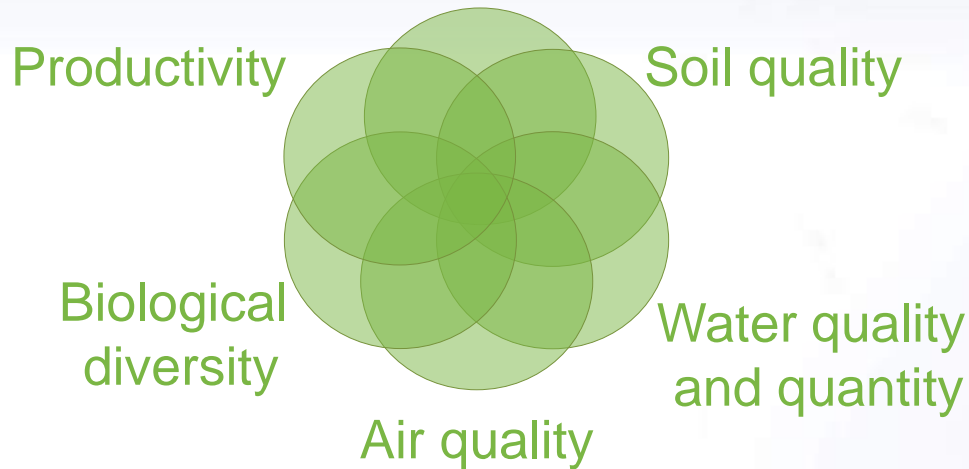
- What?
- Why?
- **Which crops are preferable?**
- Current sources
- Future sources
- Examples
- Discussion
- Resources for more information

Identifying and addressing the challenges for sustainable bioenergy production through field trials, applied research, capacity building, modeling, and analysis.



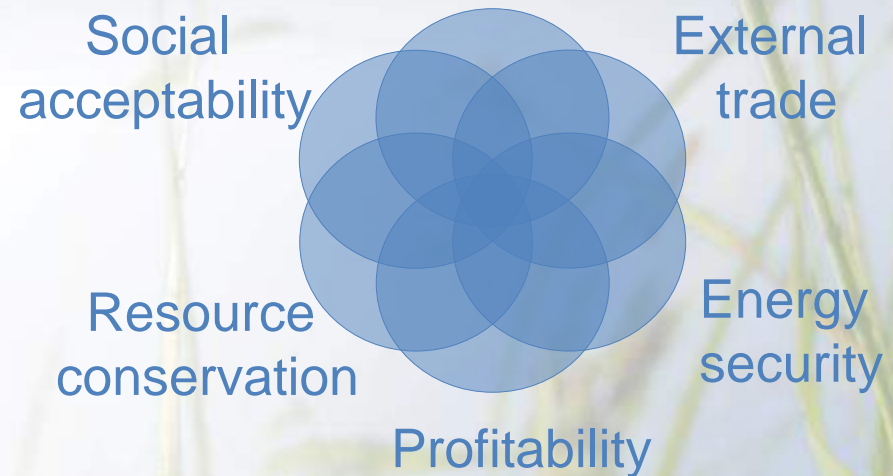
Which crops preferable? Apply criteria: Indicators of environmental and socioeconomic sustainability

Greenhouse gas emissions



McBride et al. (2011)
Ecological Indicators
11:1277-1289

Social well being

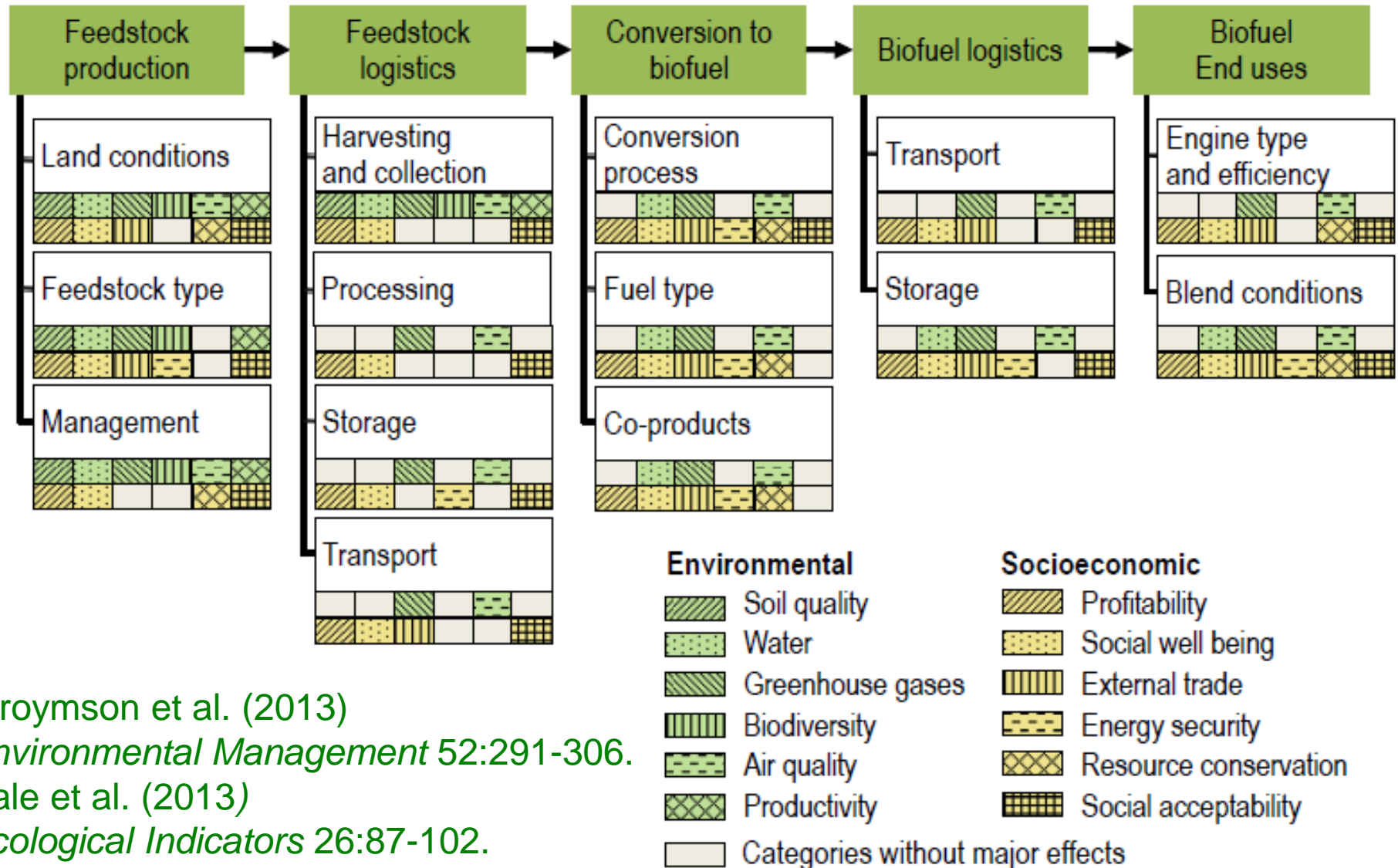


Dale et al. (2013)
Ecological Indicators
26:87-102.

Recognize that measures and interpretations are context specific

Froymsen et al. (2013) *Environmental Management* 51:291-306.

Looking at the biofuel supply chain in terms of sustainability indicators



Efroymson et al. (2013)
Environmental Management 52:291-306.
Dale et al. (2013)
Ecological Indicators 26:87-102.

Which biomass crops are preferable?

Preferred biomass production systems –

- Promote improved land management
- Provide other services to society
- Increase efficiency and help minimize or eliminate:
 - fossil fuels
 - “wastes”
- Reduce “climate forcing” (different from GHG emissions – and worthy of a separate talk)
- Can compete in the local market
- Support adaptive management
- Promote continual improvement toward “sustainability”

What biomass sources are recommended?

- Those that most effectively achieve society goals

Biofuels need to be sustainably managed

THE STATUS QUO

INHERENTLY UNSUSTAINABLE

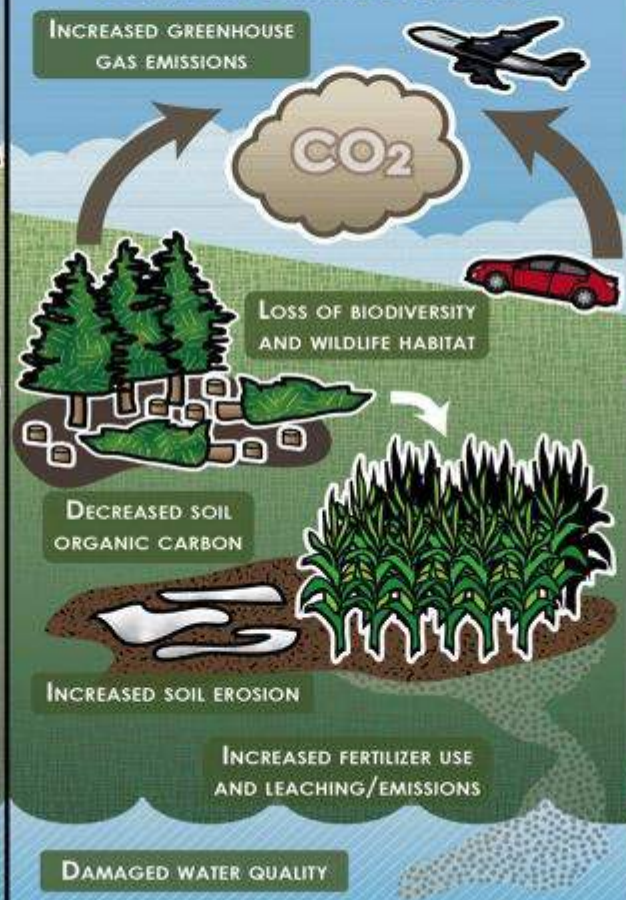
Production of Non-Conventional Petroleum with Loss of and Harm to Natural Ecosystems



BIOFUELS

POORLY MANAGED

Use of Unsustainable Land Management Practices and/or Conversion of Perennial Ecosystems to Intensive Agriculture



SUSTAINABLY MANAGED

Development of Biofuels Based on Sustainable Land Management Practices and Perennial Feedstocks



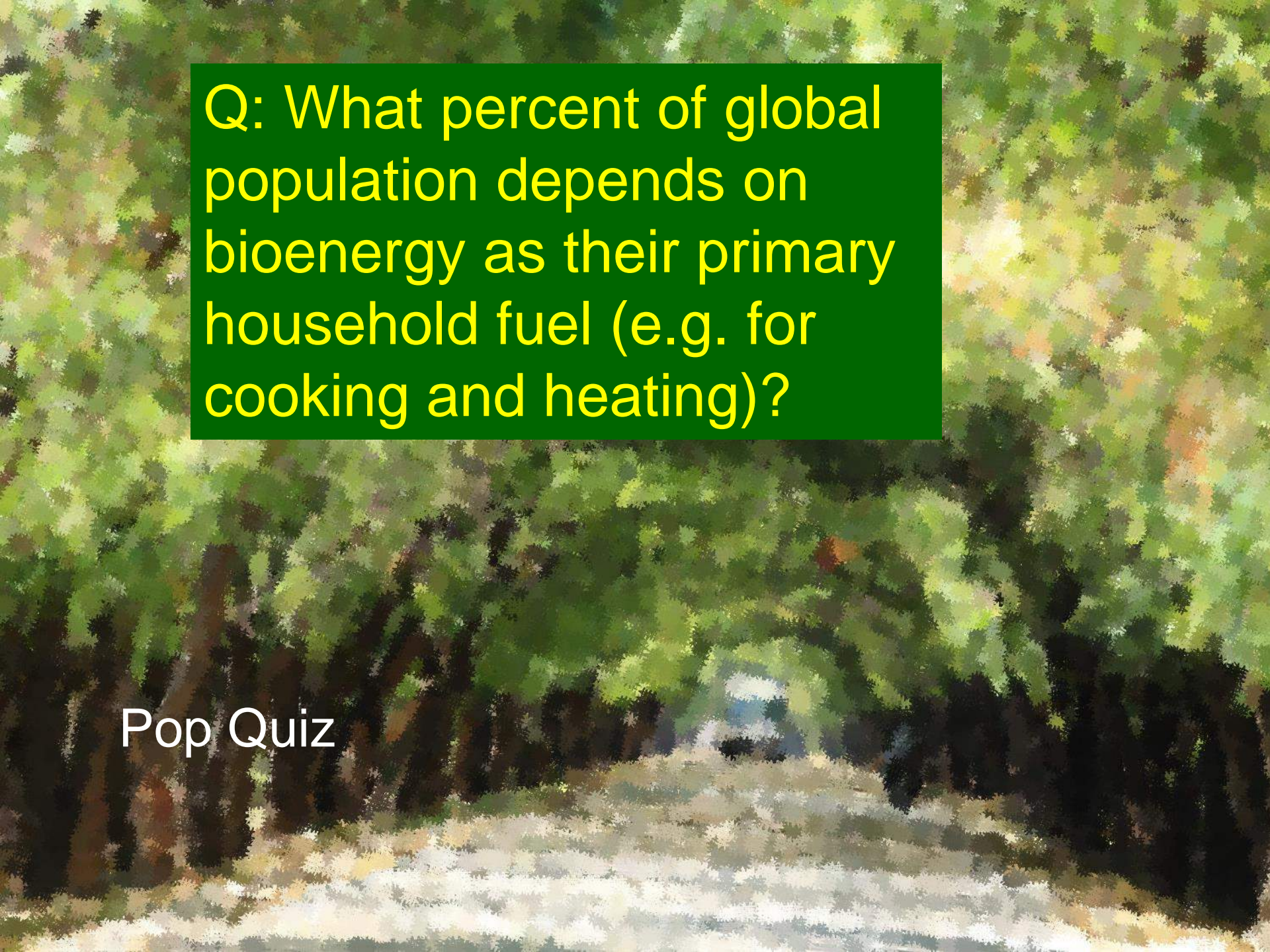
Dale B et al. (2014) Take a Closer Look: Biofuels Can Support Environmental, Economic and Social Goals. Environmental Science & Technology 48(13): 7200-7203.

Biomass for bioenergy: Outline

- What?
- Why?
- Which crops preferable?
- **Current sources**
- Future sources
- Examples
- Discussion
- Resources for more information

Pop Quiz

Photo credit: Ron Savage
<http://sierravistaimages.zenfolio.com/>



Q: What percent of global population depends on bioenergy as their primary household fuel (e.g. for cooking and heating)?

Pop Quiz

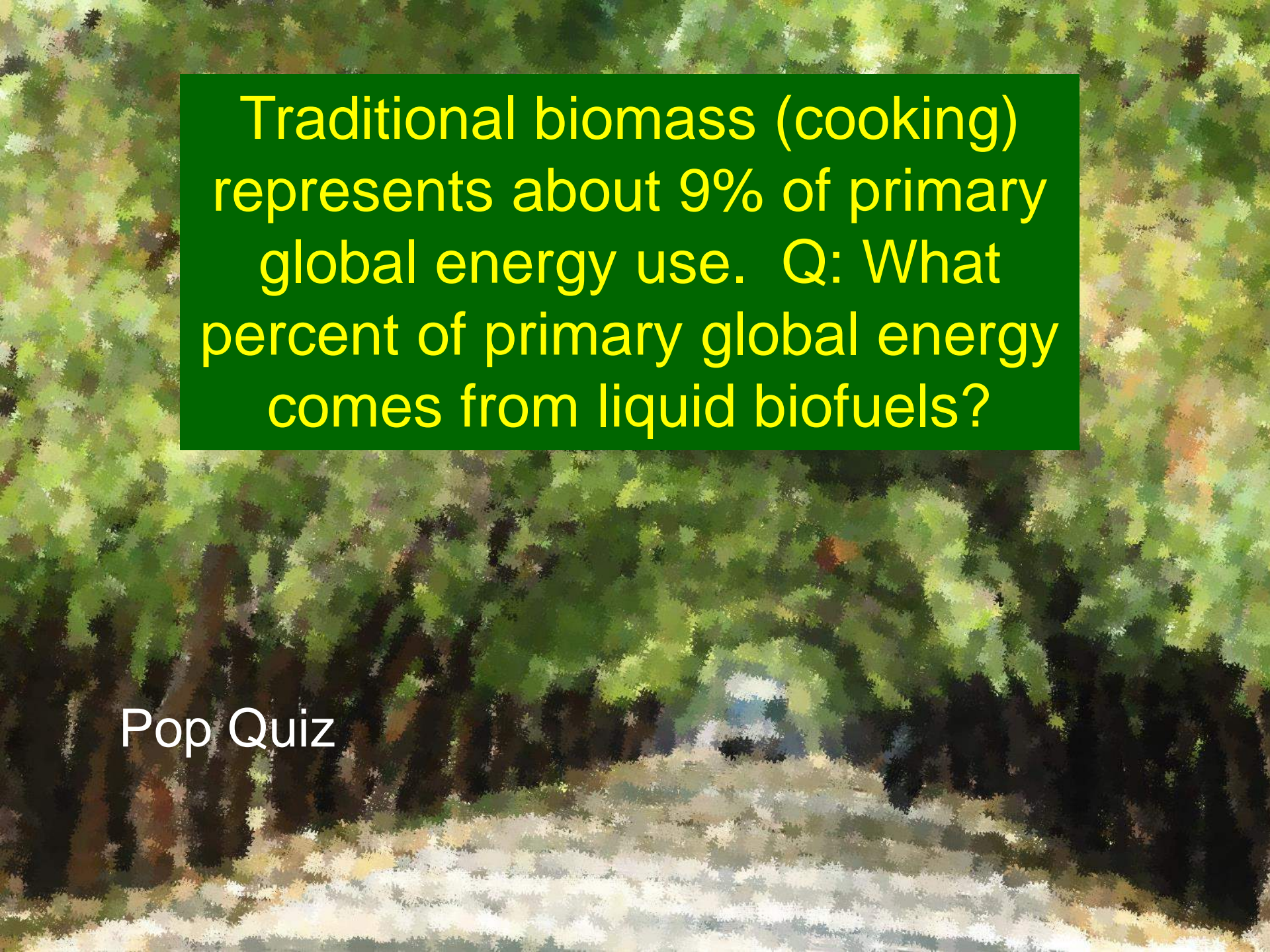
What percent of global population depends on bioenergy as their primary household fuel (e.g. for cooking and heating)?

Table 15.2: People Relying on Traditional Biomass (million)

	2004	2015	2030
Sub-Saharan Africa	575	627	720
North Africa	4	5	5
India	740	777	782
China	480	453	394
Indonesia	156	171	180
Rest of Asia	489	521	561
Brazil	23	26	27
Rest of Latin America	60	60	58
Total	2 528	2 640	2 727

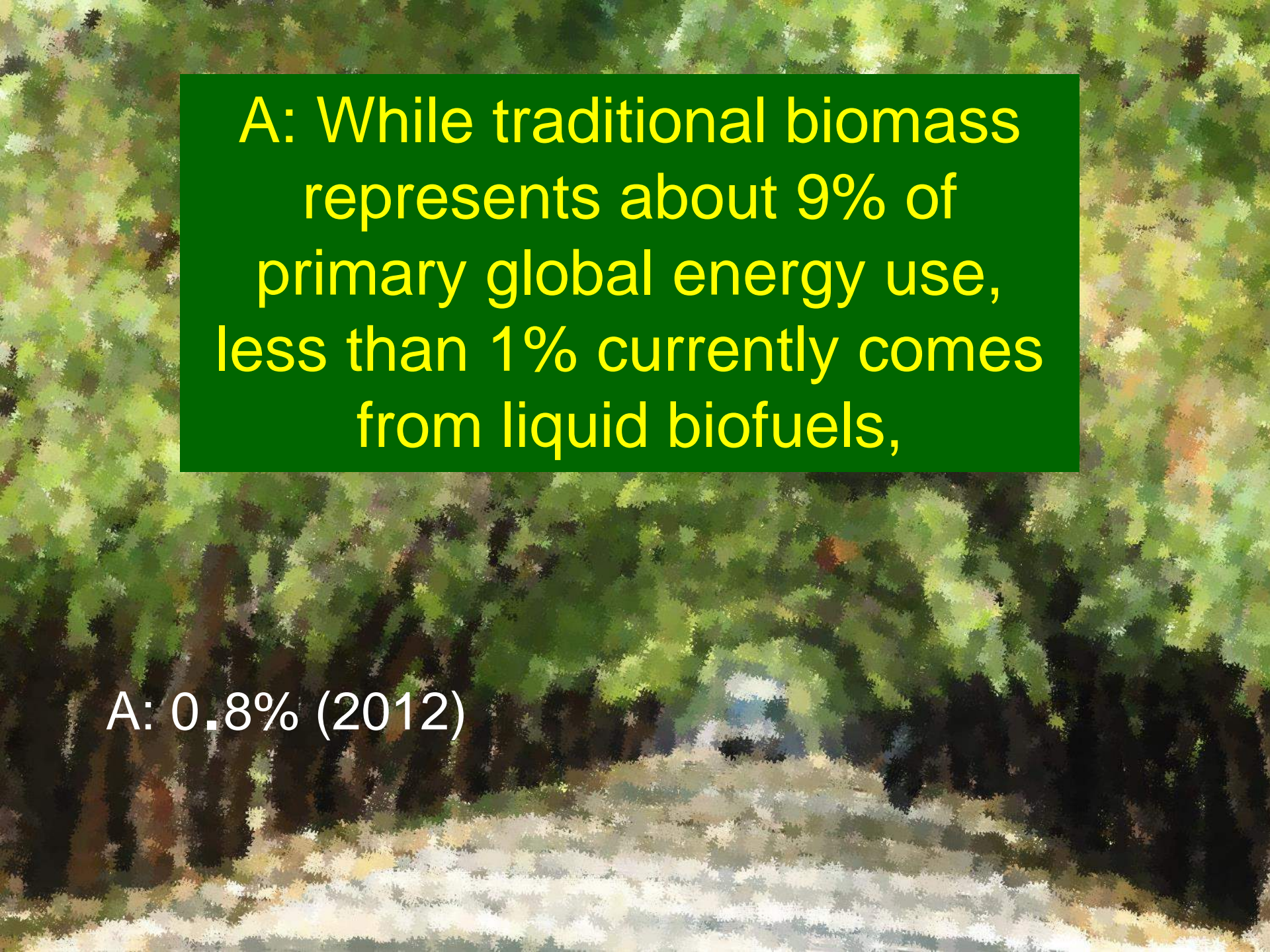
A: 38% (2.5 billion out of 6.5 billion total pop. in 2006; considerable uncertainty with these data)

IEA World Energy Outlook Special Report (2006)



Traditional biomass (cooking) represents about 9% of primary global energy use. Q: What percent of primary global energy comes from liquid biofuels?

Pop Quiz



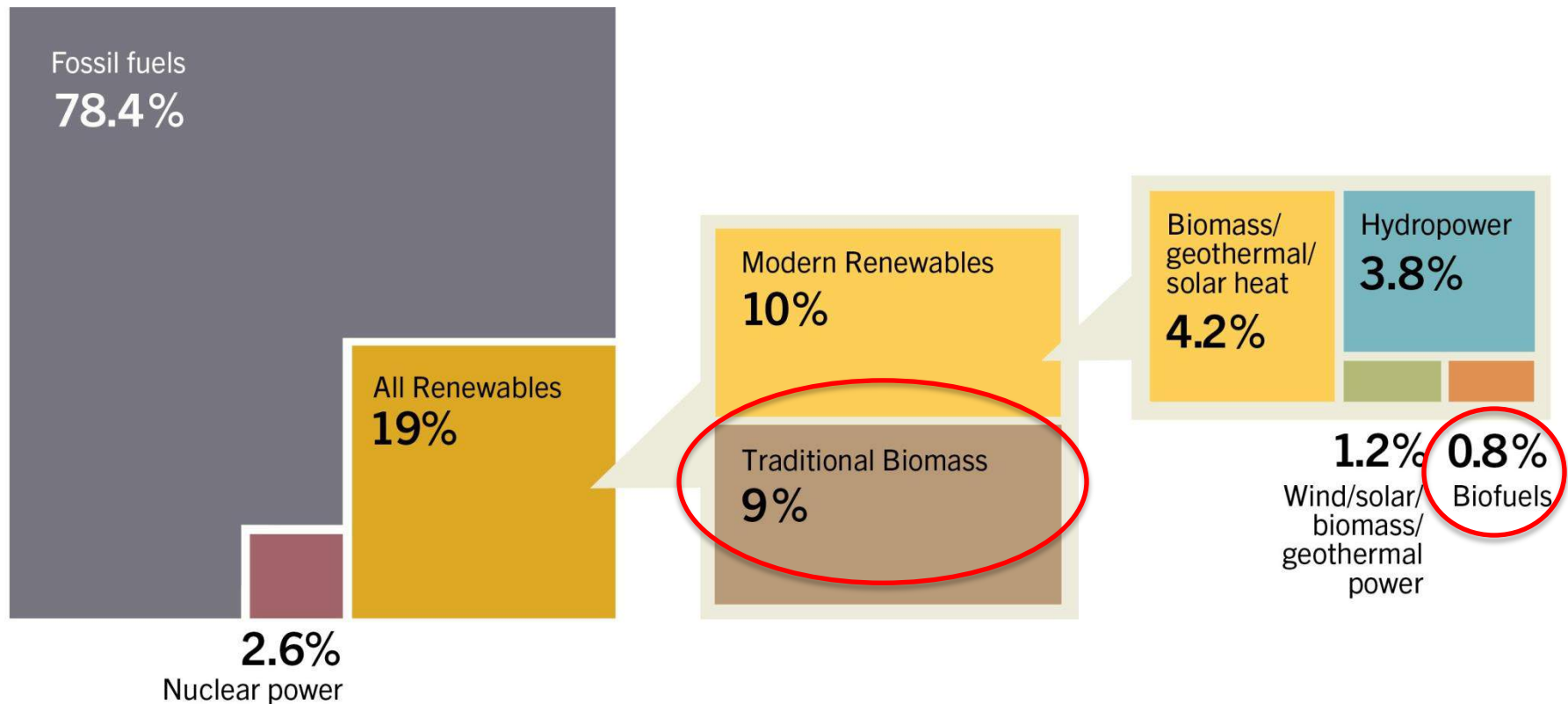
A: While traditional biomass represents about 9% of primary global energy use, less than 1% currently comes from liquid biofuels,

A: 0.8% (2012)

What are current sources of biomass?

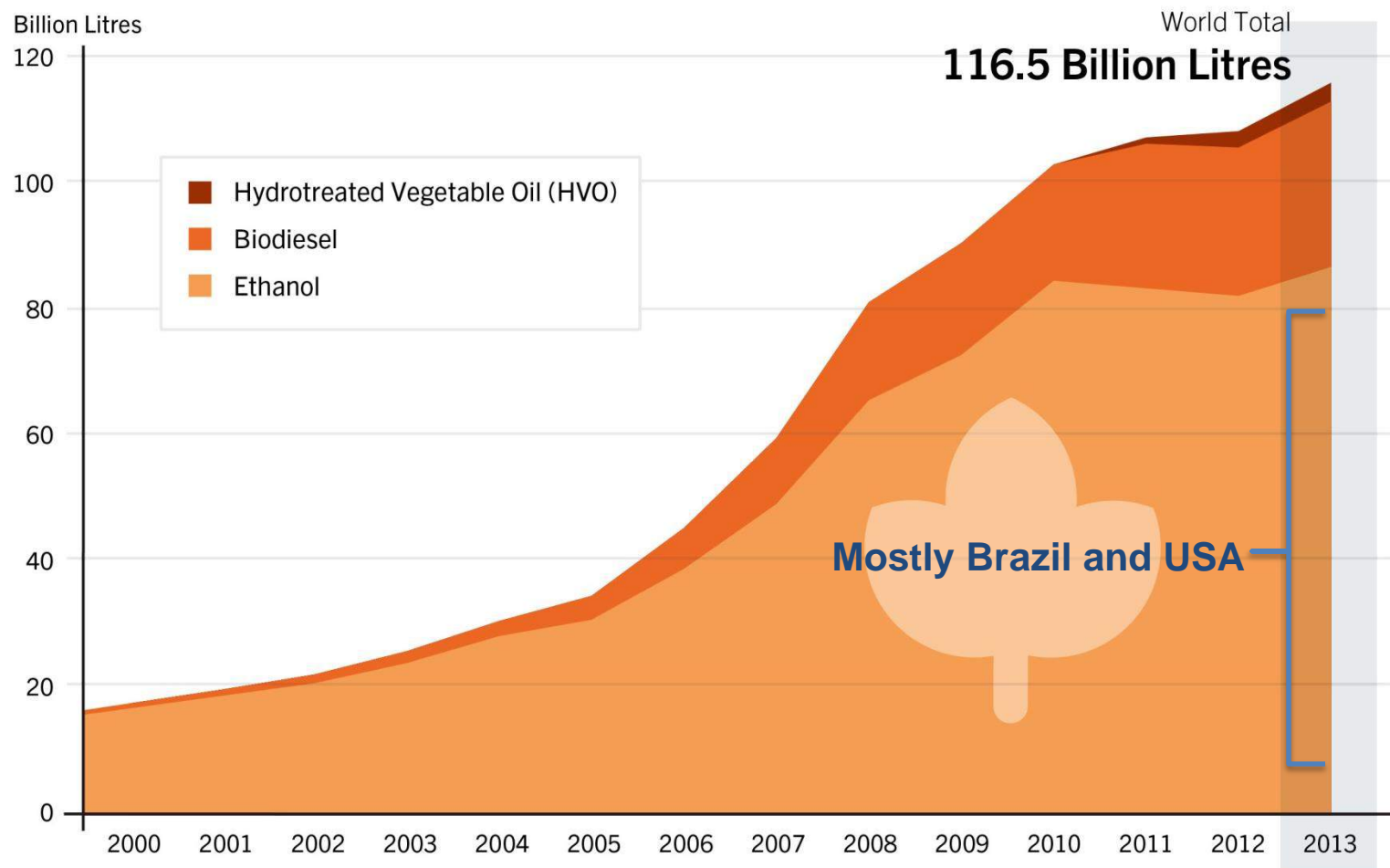
Global consumption: traditional, heat

Estimated Renewable Energy Share of Global Final Energy Consumption, 2012



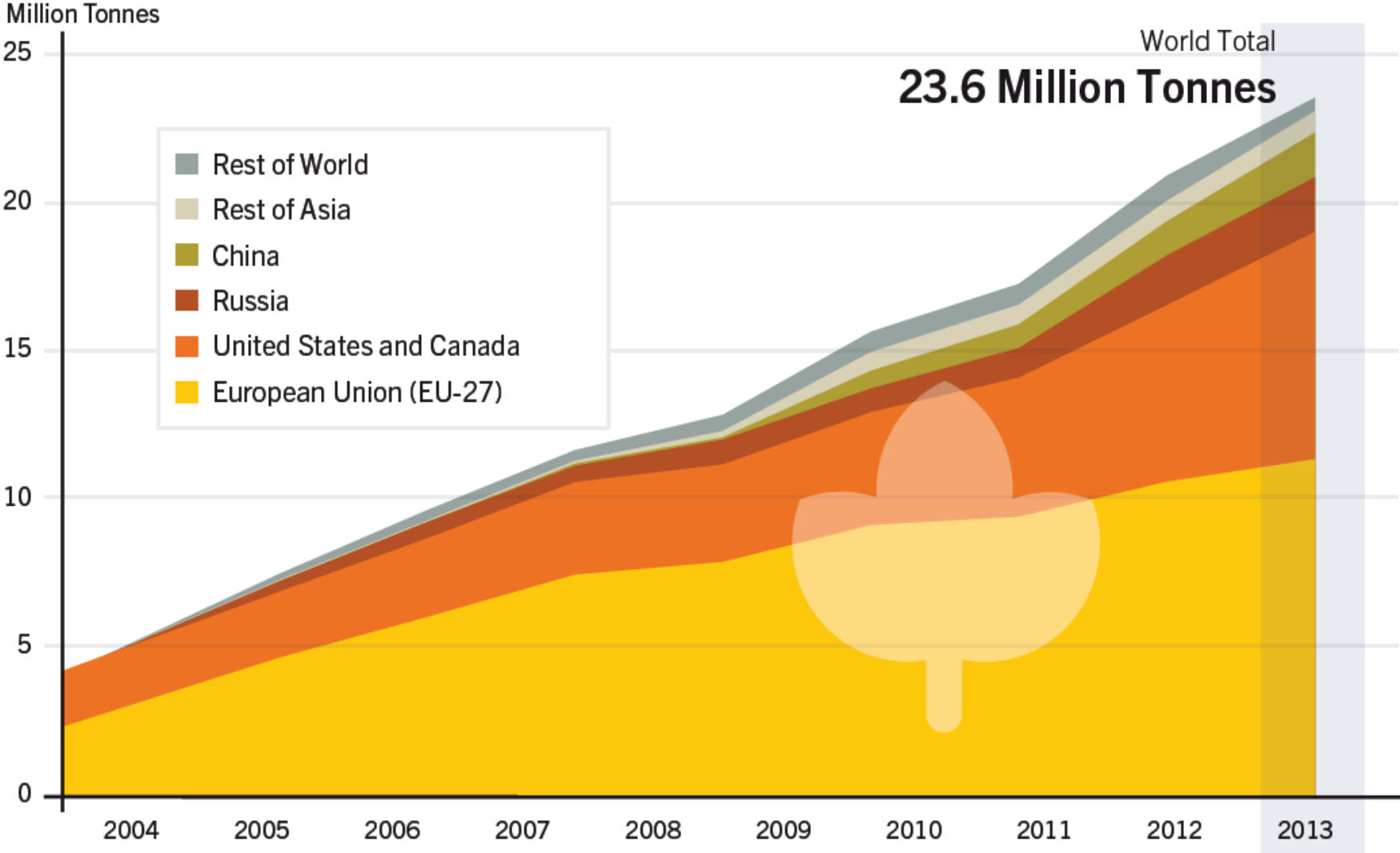
Current biomass sources: biofuels

Ethanol, Biodiesel, and HVO Global Production, 2000–2013



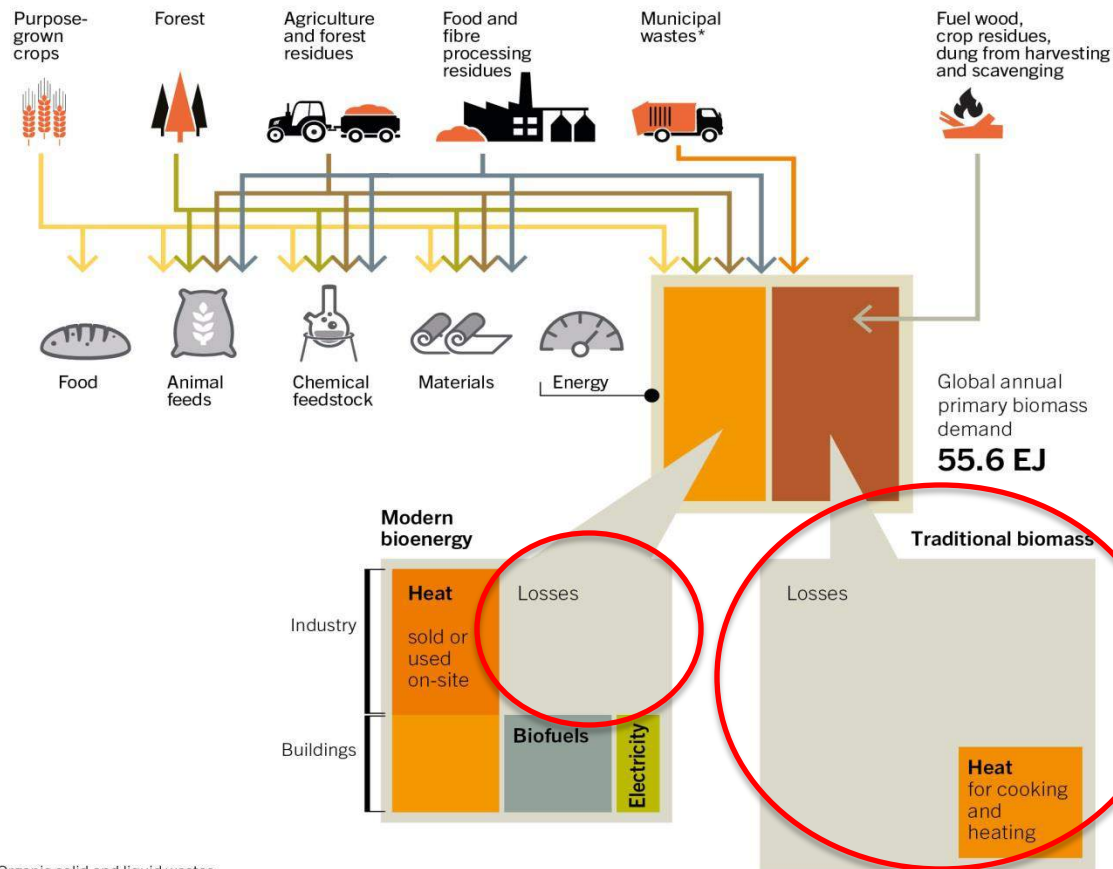
Current biomass sources: wood pellets

Figure 7. Wood Pellet Global Production, by Country or Region, 2000–2013



Current biomass sources: Large losses = opportunities for future improvement

Biomass Resources and Energy Pathways



* Organic solid and liquid wastes

1 Kg of LPG (liquid petroleum gas) is approx. equivalent to 6.5 to 30 kg of traditional biomass:

