

Biomass for bioenergy: Resources today and in the future

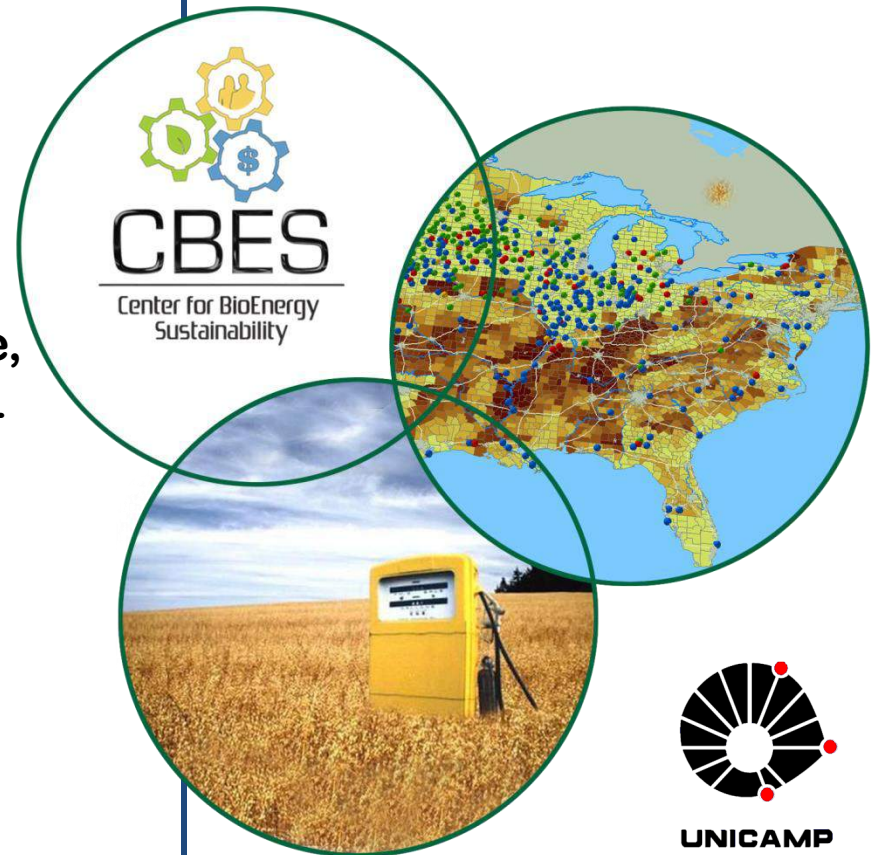
Advanced School on the Present and
Future of Bioenergy
10 October, 2014

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<http://www.ornl.gov/sci/ees/cbes/>

Special thanks to FAPESP for support
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Biomass for bioenergy: Outline*

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

*Title and topics requested by ESPCA organizers

What is Oak Ridge National Laboratory (ORNL)? U.S. Department of Energy's Largest Science and Energy Research Center:

\$1.65B
budget

4,400
employees

3,000
research
guests
annually

\$500M
modernization
investment

Nation's
largest
materials
research
portfolio

Most
powerful open
scientific
computing
facility

World's
most intense
neutron
source

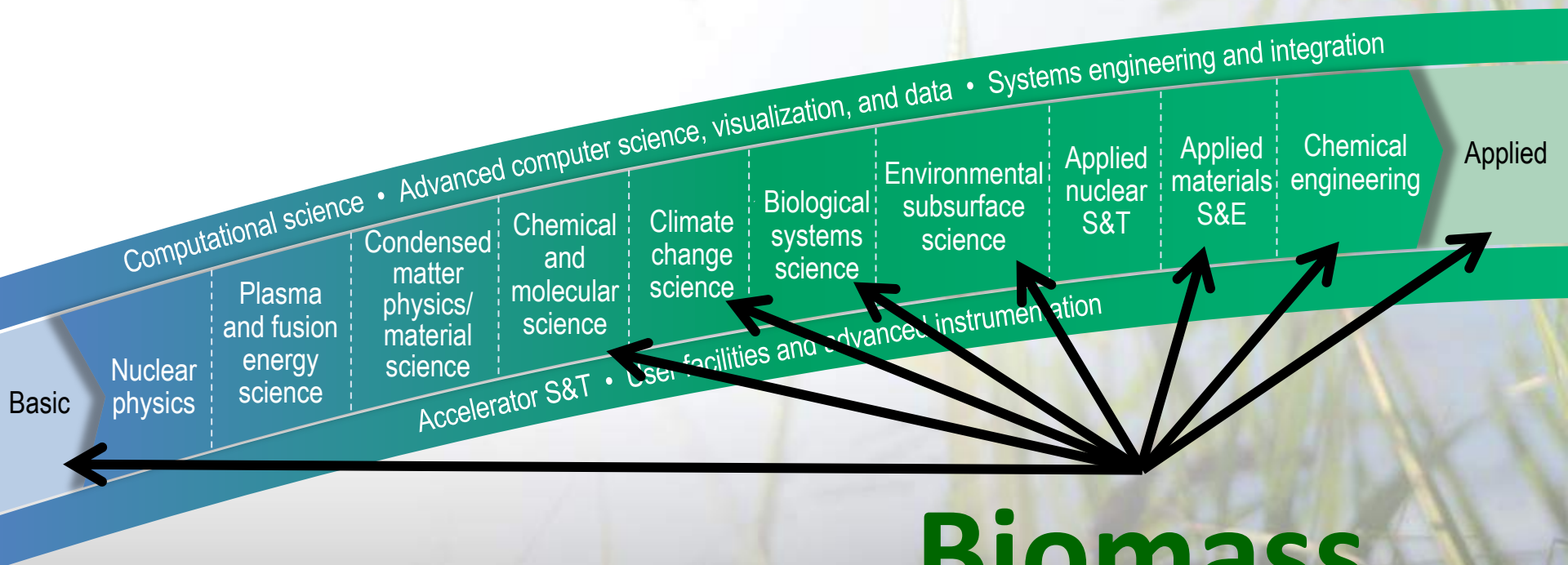
World-class
research
reactor

Nation's
most diverse
energy portfolio

Managing
billion-dollar
U.S. ITER
project

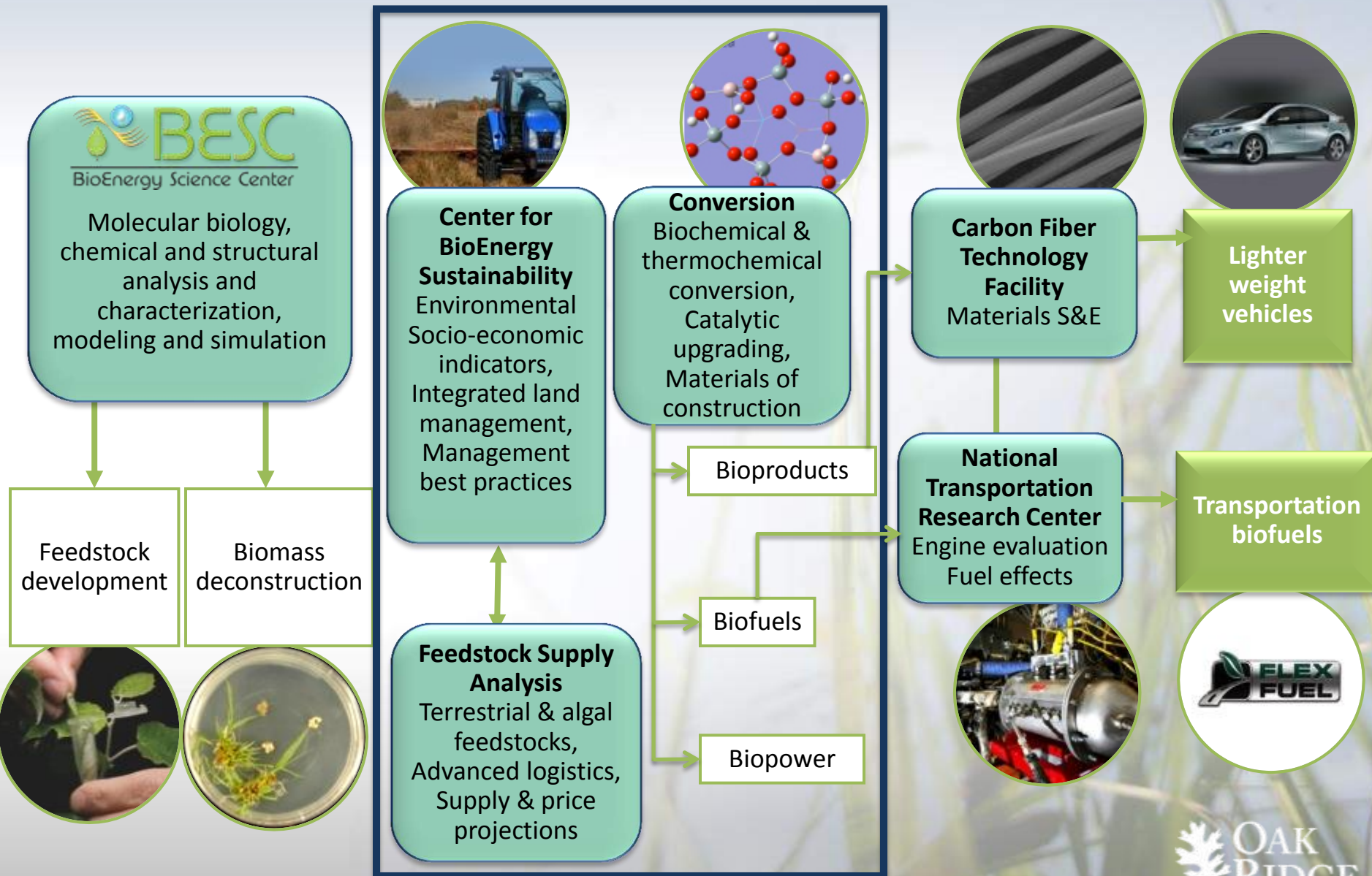
ORNL's Mission

Deliver scientific discoveries that accelerate the development and deployment of solutions in clean energy and global security, and in doing so, create economic opportunities



Biomass

Bioenergy research at ORNL: basic sciences to applications



Biomass for bioenergy: Outline

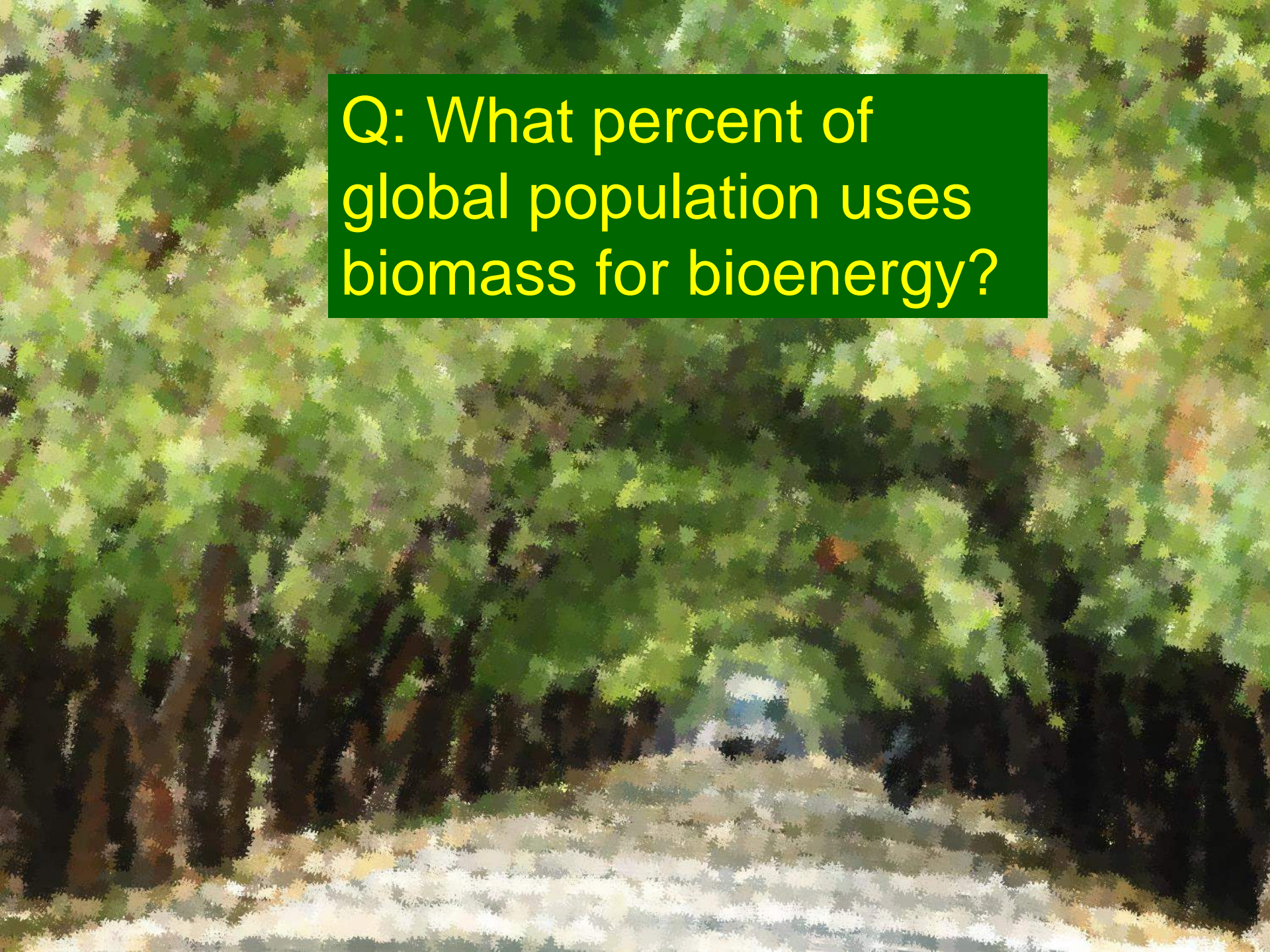
- **What biomass to use?**
- **Why?**
- **Which crops preferable?**
- **Current sources**
- **Future sources**
- **Examples**
- **Discussion**



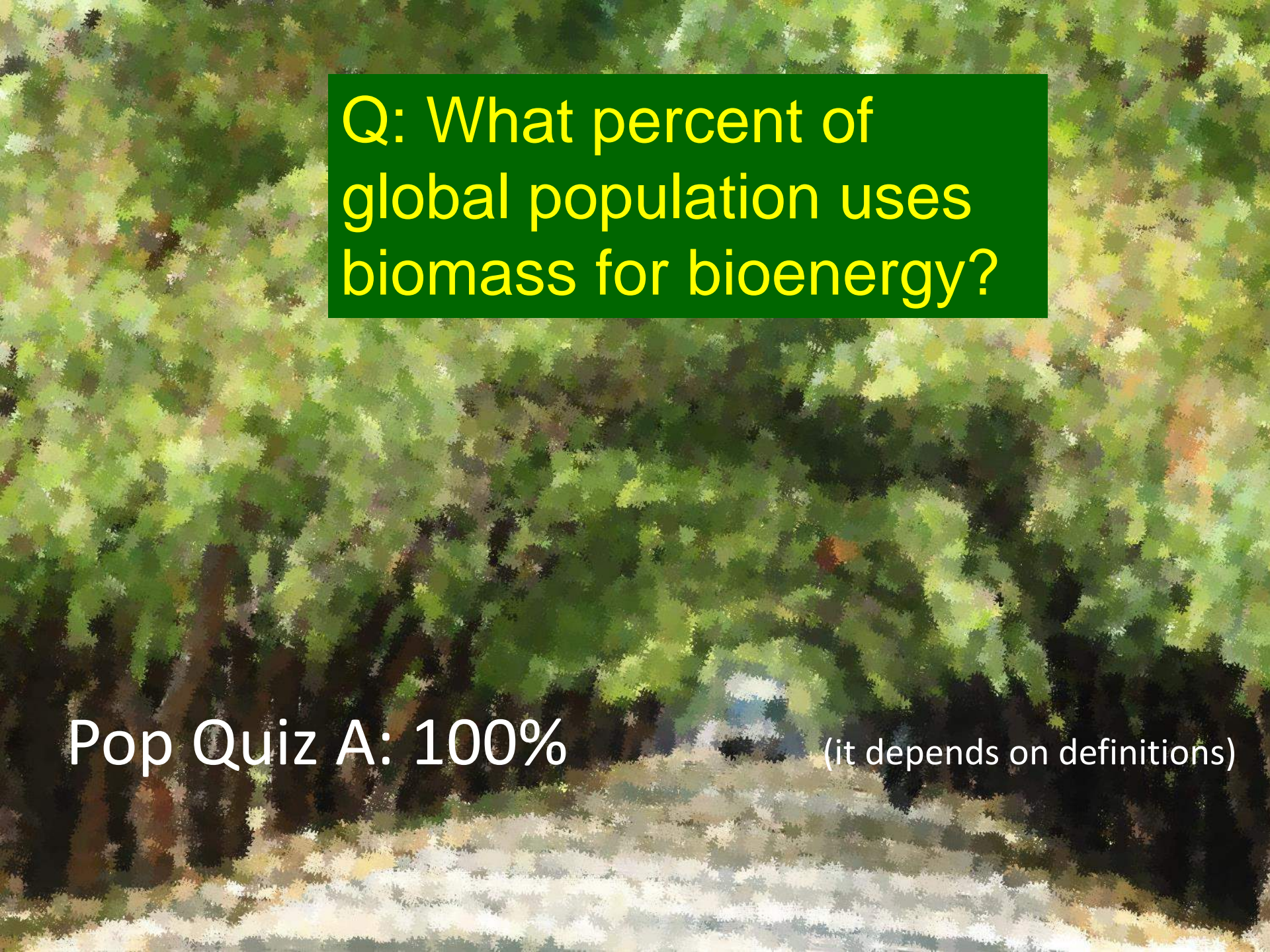
Photo: Ken Goddard, UT Extension

Pop Quiz

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



Q: What percent of global population uses biomass for bioenergy?



Q: What percent of
global population uses
biomass for bioenergy?

Pop Quiz A: 100%

(it depends on definitions)

Defining biomass for bioenergy

- One cannot answer questions about what, where or how much biomass for bioenergy until the terms are clearly defined.
- Definitions are often political or regulatory.
- Example from Environmental Protection Agency of USA (US EPA) for the final rule (2010), under US Energy Independence and Security Act (EISA law, December, 2007) also known as the Renewable Fuel Standard-2 (RFS2):

Defining biomass for bioenergy

US RFS 2: “Renewable biomass means each of the following (including any incidental, de minimis contaminants that are impractical to remove and are related to customary feedstock production and transport):

1. **Planted** crops and crop residue harvested from existing agricultural land cleared or cultivated prior to December 19, 2007 and that was nonforested and either actively managed or fallow on December 19, 2007.
2. **Planted** trees and tree residue from a tree plantation located on non-federal land (including land **belonging to** an Indian tribe or an Indian individual that is held in trust by the U.S. or subject to a restriction against alienation imposed by the U.S.) that **was cleared at any time prior** to December 19, 2007 and actively managed on December 19, 2007.
3. **Animal waste** material and animal byproducts.
4. Slash and pre-commercial thinnings from **non-federal forestland** (including forestland belonging to an Indian tribe or an Indian individual, that are held in trust by the United States or subject to a restriction against alienation imposed by the United States) that is not ecologically sensitive forestland.
5. Biomass (organic matter that is available on a renewable or recurring basis) obtained from the immediate vicinity of buildings and other areas regularly occupied by people, or of public infrastructure, in an **area at risk of wildfire**.
6. **Algae**.
7. Separated **yard waste or food waste**, including recycled cooking and trap grease, and materials described in § 80.1426(f)(5)(i). Source: <http://www.epa.gov>

Defining biomass for bioenergy

- Simple definition: ***biomass, n—material originating from living or recently living (non-fossil) sources.***

Examples include parts of or whole plants, animals, algae and marine organisms.

Source: This was the shortest of several proposals to ASTM International Standard Committee, based on similar definition in use in EU (current EN Standard); September, 2014 subcommittee work group.

Defining biomass for bioenergy

Many other definitions – even in “international standards”:

- From “ASTM E48.91” SUB-COMMITTEE ON TERMINOLOGY
- Current Definitions of Biomass in E1705: [committee.sub], attribution, Terminology Standard,
- **biomass**—total weight of living matter in a given volume. When considered as an energy source, biomass is further subdivided into: (1) primary biomass, rapidly growing plant material that may be used directly or after a conversion process for the production of energy, and (2) secondary biomass, biomass residues remaining after the production of fiber, food, or other products of agriculture, or biomass by-products from animal husbandry or food preparation that are modified physically rather than chemically. Examples include waste materials from agriculture and forestry industries (manure, sewage, etc.) from which energy may be produced. The above distinction noted between primary and secondary biomass is based on economic factors; these are defined differently in ecological science. E1126
- **biomass**—any material, excluding fossil fuels, which is or was a living organism that can be used as a fuel directly or after a conversion process. Peat is not a biomass. E1126, E1218
- **biomass**, *n* – biological material including any material other than fossil fuels which is or was a living organism or component or product of a living organism. [D02.12] D5864; [D02.14] D6469, 4175

Defining biomass for bioenergy

Key points:

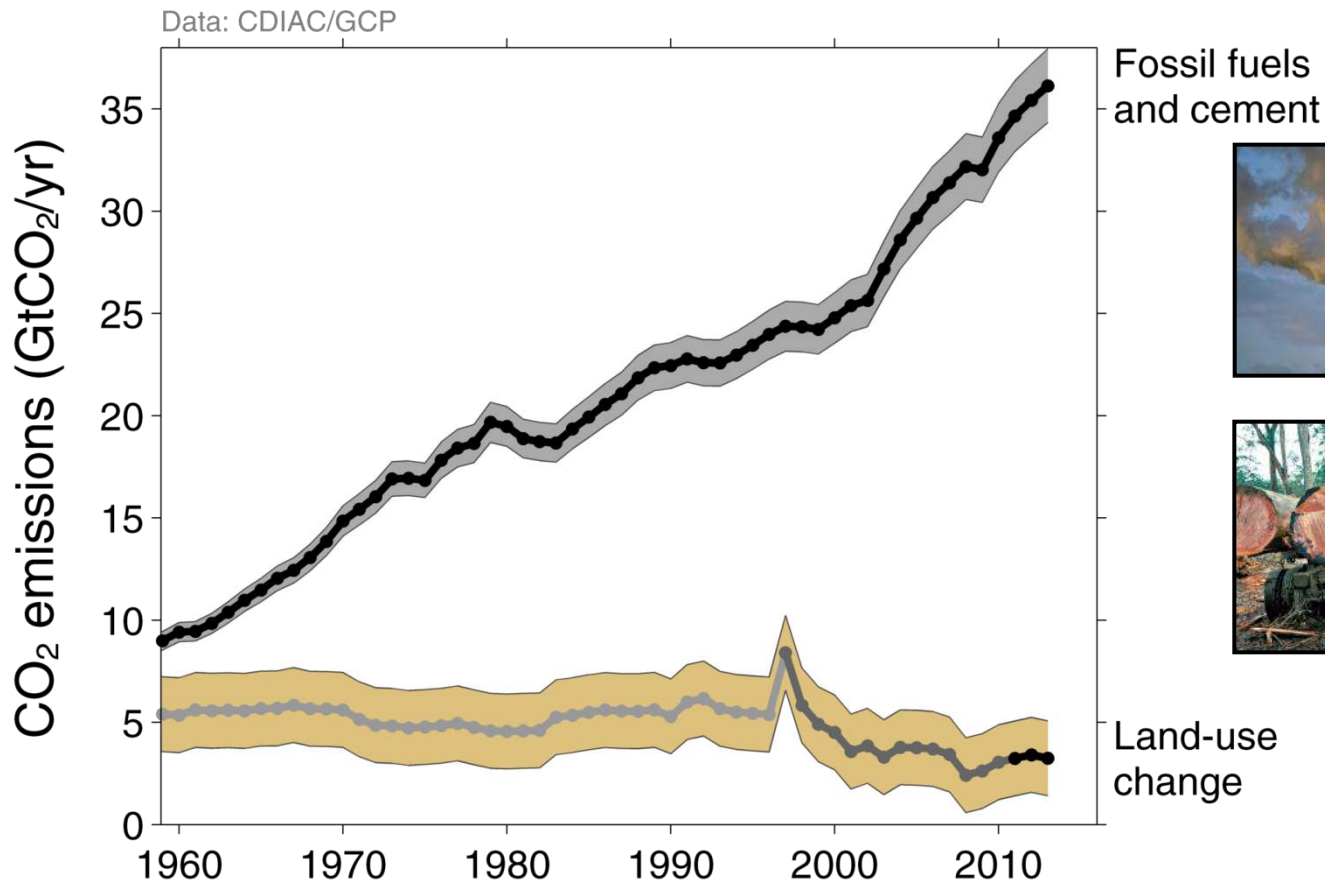
- We cannot answer questions about “what, where, or how much” biomass – current and future – unless we start with a clear definition.
- Definitions vary depending on purpose.
- One consistent aspect of definitions: **when discussing bioenergy, definitions exclude fossil fuel.**

Biomass for bioenergy: Outline

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Why biomass for bioenergy: Total Global Emissions

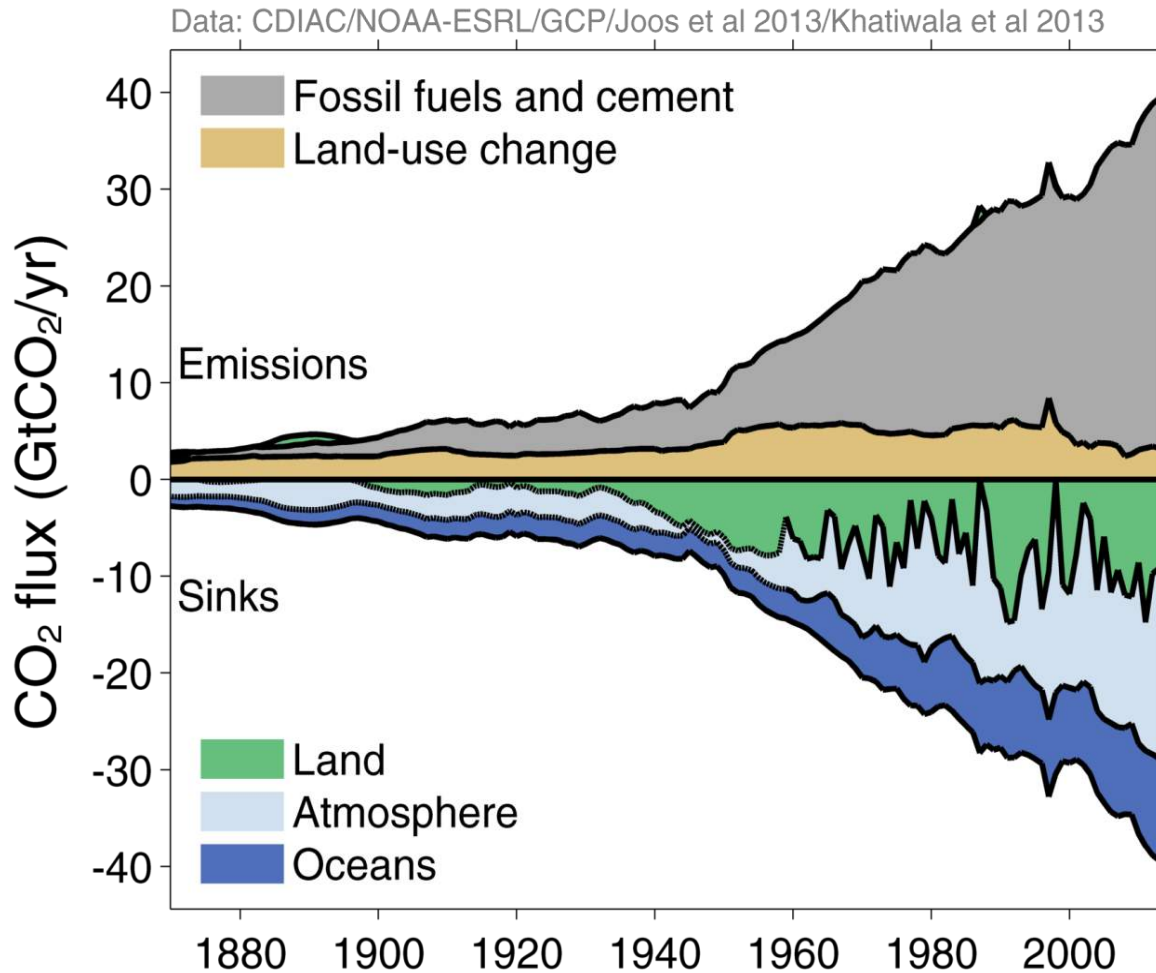
Total global emissions: 39.4 ± 3.4 GtCO₂ in 2013, 42% over 1990
 Percentage land-use change: 36% in 1960, 19% in 1990, 8% in 2013



Three different methods have been used to estimate land-use change emissions, indicated here by different shades of grey

Why biomass for bioenergy: Global Carbon Budget

Emissions are partitioned between the atmosphere, land, and ocean



Source: [CDIAC](#); [NOAA-ESRL](#); [Houghton et al 2012](#); [Giglio et al 2013](#); [Joos et al 2013](#); [Khatriwala et al 2013](#); [Le Quéré et al 2014](#); [Global Carbon Budget 2014](#)

Why biomass for bioenergy?

Key points:

- Fossil fuel consumption is the problem. Impacts
 - Air quality
 - Sustainable employment
 - Equity today and for future generations and
 - Climate change
- Need effective alternatives to fossil. Bioenergy:
 - Is dispatchable for power, electricity, heat, mobility and other services
 - Can replace liquid and gaseous fossil fuels in existing systems
 - Stores chemical energy for future use and helps balance other more variable renewable resources

United Nations Environmental Program (UNEP): Land degradation by soil erosion

- More than a billion hectares affected worldwide
- 2 – 5 Mha cropland severely degraded every year
- Data and effects with high variability
- Way forward to meet future demands: improve local land management



Source: UNEP, Assessing Global Land Use (2013)

Why biomass for bioenergy?

Key points:

- Fossil fuels are primary climate change problem; Land management is one part of the solution.
- Current land management must improve
- Society needs effective incentives to improve land management.
- This leads to another topic requested for today...

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