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# An Empirical Analysis of the Emergent Bioeconomy

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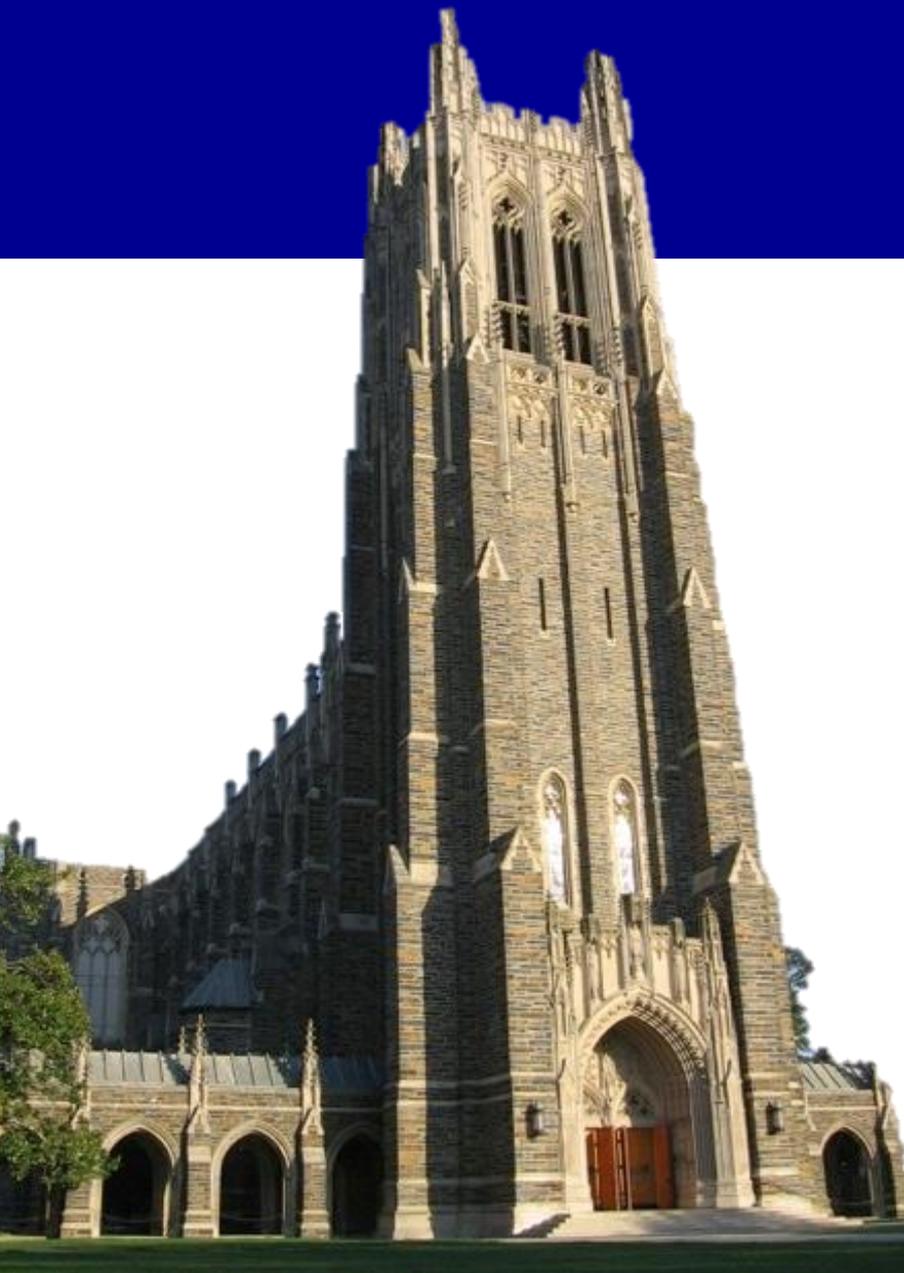
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# Agenda

- Research overview of the bioeconomy
- Existing gaps in biobased feedstock research
- Empirical analysis
- Future implications



# Research Overview

- With a global population predicted to be 9B by 2050 (UN, 2013), and non-renewable resources being depleted at enormous rates (Heinberg, 2007; UN, 2010; Zagemma, 2011), there is a growing dependence on the use of renewable biological feedstocks.
- By 2020:
  - Biochemicals: 18% of market share (USDA, 2005) (Vijayendran, 2010) (Newes et al. 2012)
  - Bioplastics: 7% of market share (Freedonia Group Inc., 2011) (Nanomarkets, 2012)
  - Biofuels: 10% of market share (Hess et al. 2010) (Silicon Valley Bank Cleantech Practice, 2012)
- Desire to examine the implications of the rapid adoption and industrialization of biological feedstocks for energy and chemicals

# Scope of the Bioeconomy

For the purpose of *this presentation*, “bioeconomy” refers to all activities associated with the production, harvest, transport, conversion, and use of first-generation agriculture and roundwood forestry for industrial use (e.g., biofuel, bioproducts).

# Data Gap: Quantification of the Bioeconomy

**The generic feature of biobased products is both the cause of its high socio-economic potential and a major challenge for biobased products metrics.**

*Anthony Arundel, co-author of *The Bioeconomy to 2030* (OECD, 2009)*

**Measuring the bioeconomy is not straightforward. The biobased sector ... is multidimensional.**

*Biobased Economic Indicators: A Report to the U.S. Congress (USDA, 2011)*

**The overall paucity of relevant data is due largely to the lack of national reporting mechanisms that capture biotech revenues.**

*The Need for Bioeconomy Data and Metrics (Carlson, 2014)*

**Overall message: There is a missing link between raw material production and industrial bioeconomy.**

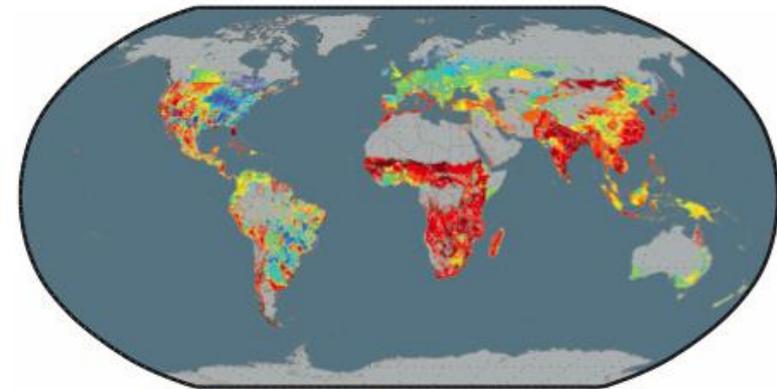
# Empirical Analysis: Objective and Scope

## 1.) Global flows of biological feedstocks

- Quantify
- Spatial Distribution

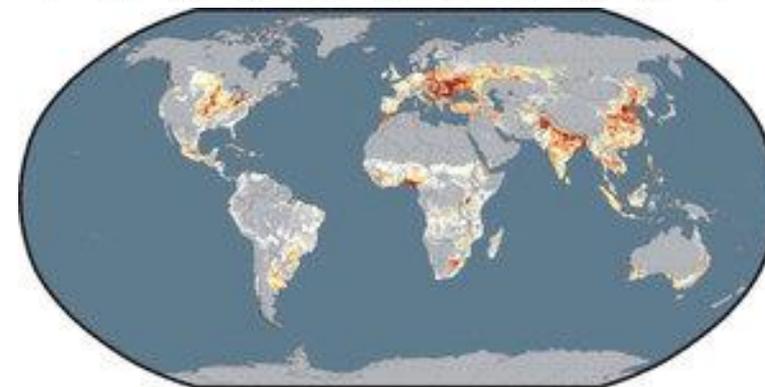
## 2.) Environmental life cycle implications

Analyze trade-offs and unintended consequences resulting from the shift to a larger bioeconomy.



Food production area as fraction of total cropland

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

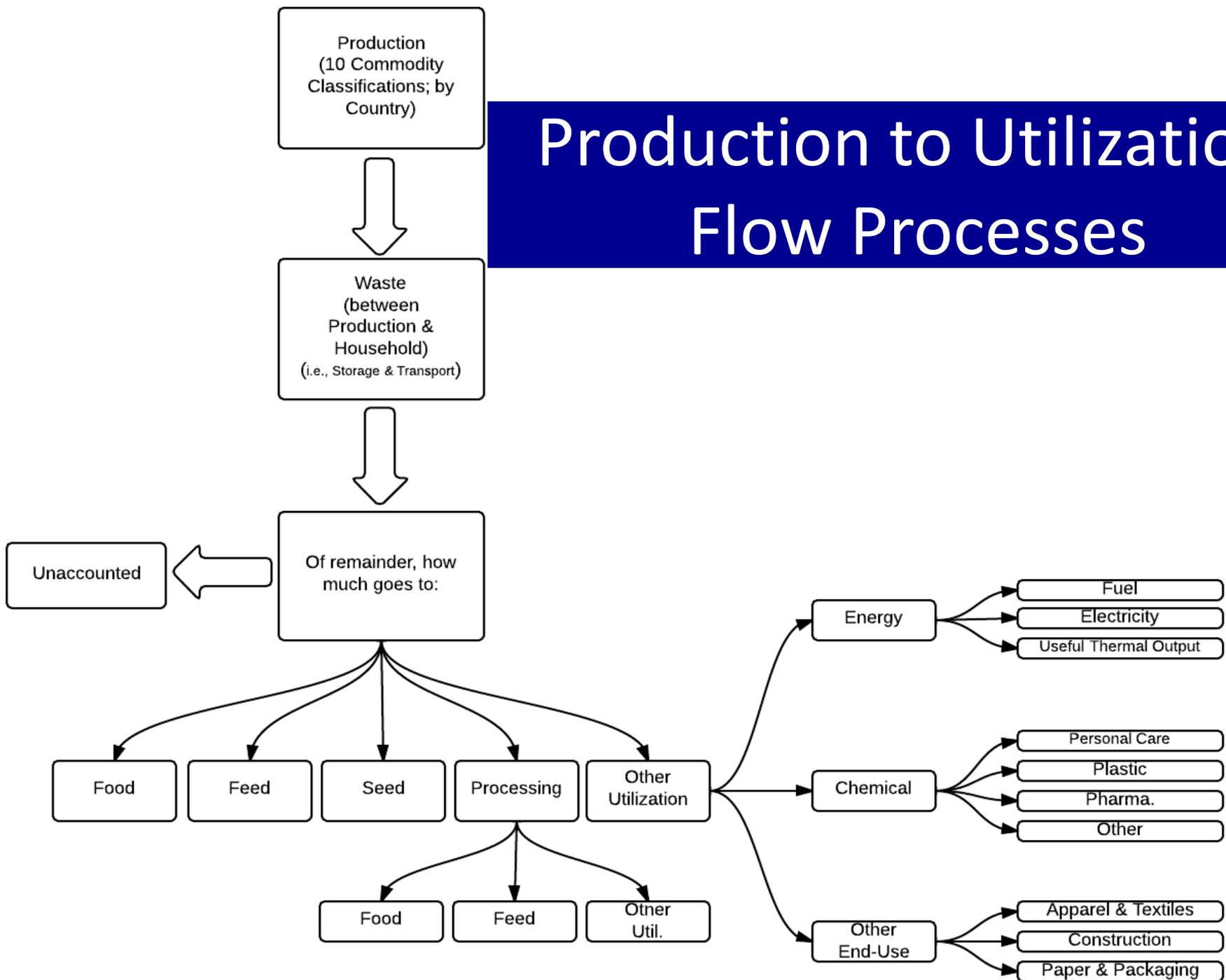


New calories from closing yield gaps for staple crops  
( $\times 10^6$  kcal per hectare)

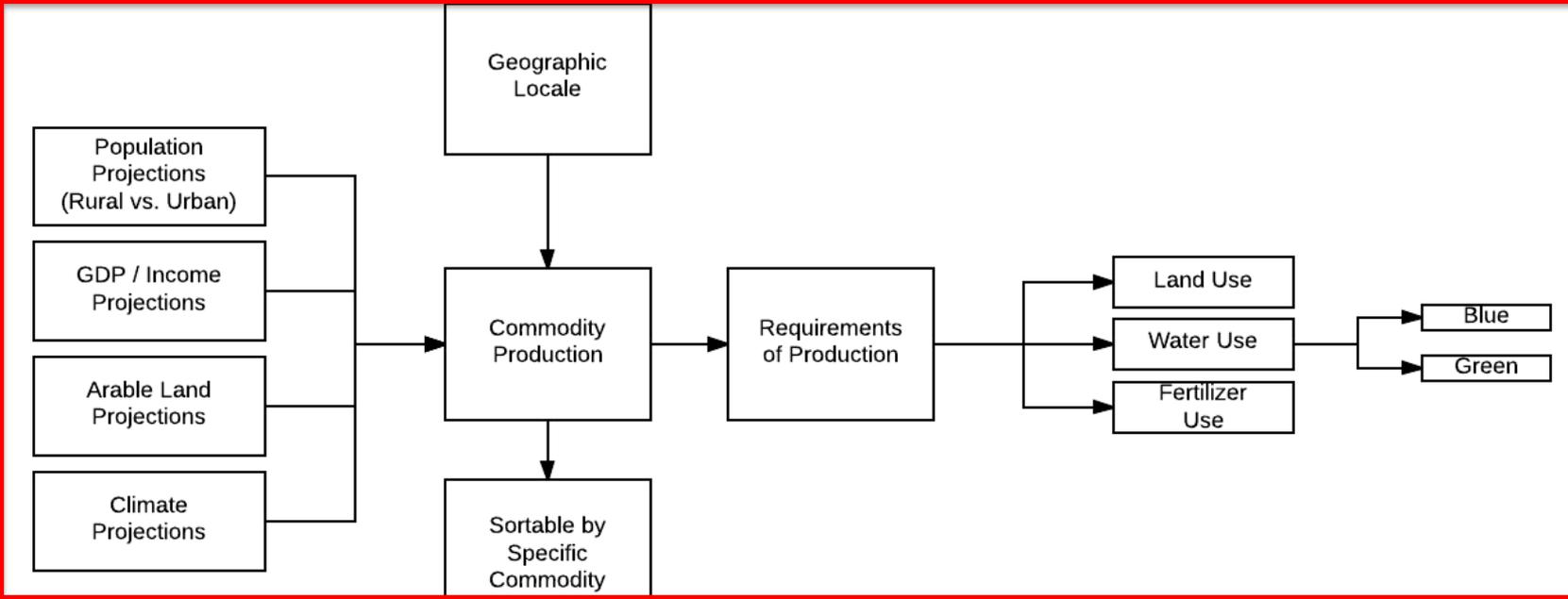
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5

(Foley et al., 2011)

# Production to Utilization: Flow Processes

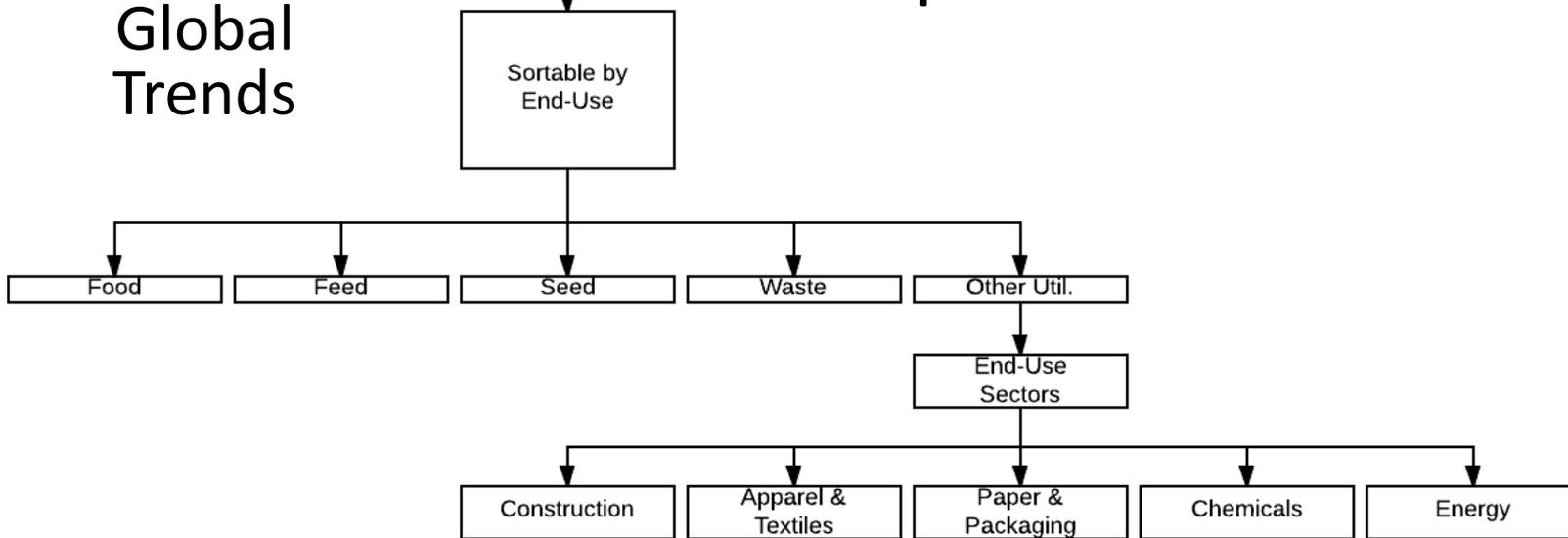




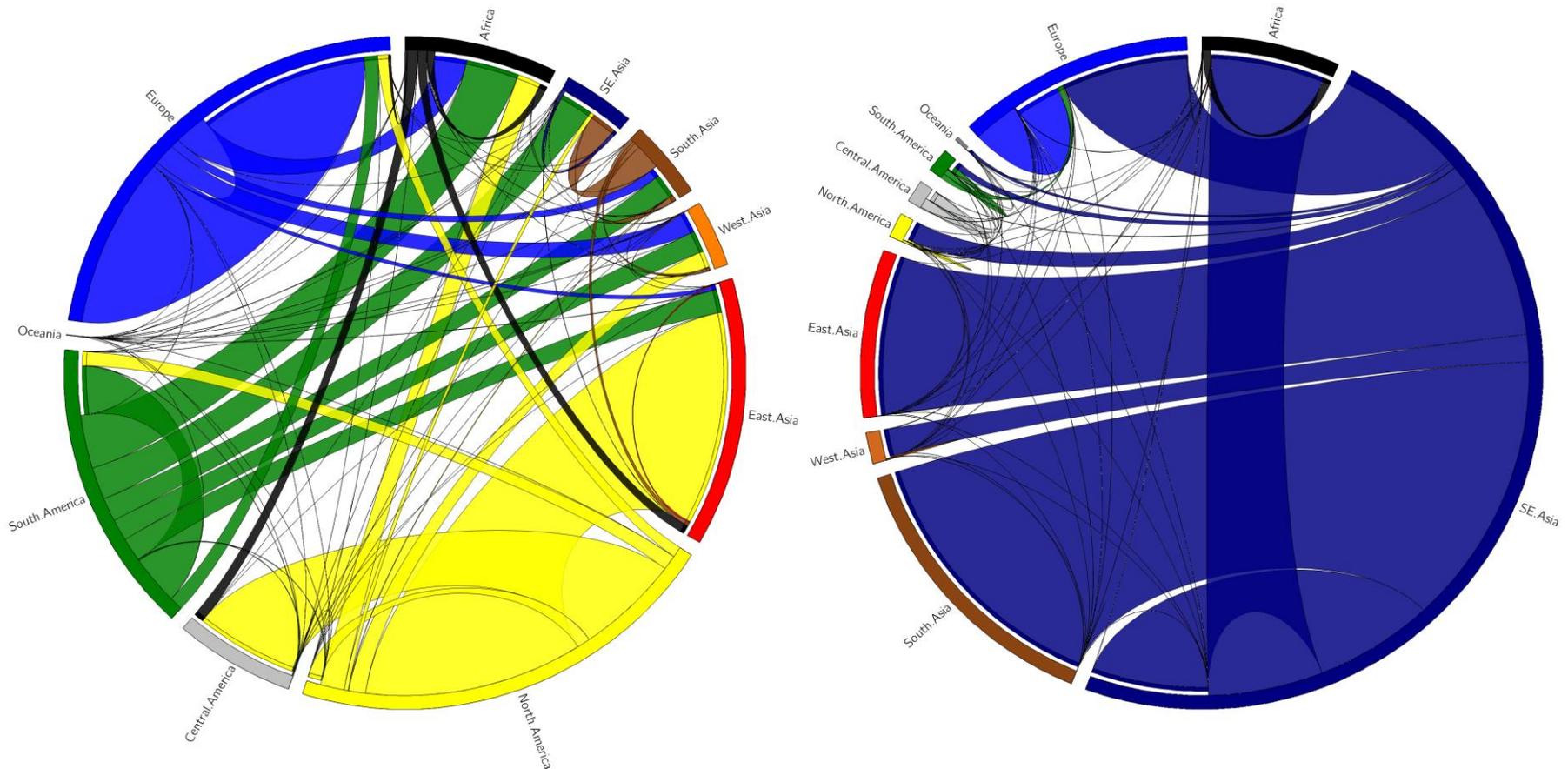


## Impact of Global Trends

## Requirements of Production



# Spatial Variability of the Bioeconomy



# Future Implications and Shifting Frontiers of Resource Consumption

- Continued demand growth for major resources – fossil fuels, food, minerals, fertilizers, timber – until at least 2030 (Chatham House, 2012).
- Industrial demands for biobased feedstocks have already increased demand for foreign land acquisitions and infrastructure development.
- Future demands of the bioeconomy have the potential to create new emergent markets and shipment hubs.
- Greater LCA analysis of biobased feedstocks and products is necessary to understand the larger system implications of shifting to biobased feedstocks.

# Report to U.S. Congress

Related, Drs. Golden and Handfield are leading a report to be delivered to Congress as required by the Farm Bill Reauthorization - follow-up to “Why Biobased?” report to right.

- Identify key biobased sectors
- Attempt to quantify the volume of biobased products sold and their value
- Determine U.S. employment
- Model the environmental benefits, including petroleum displaced and;
- Provide an understanding of technical, policy and economic obstacles to greater market penetration of biobased products.

- If you are interested in providing input/guidance, please contact them here at the conference.

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## News Release

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### USDA Report Outlines Opportunities in the Emerging Bioeconomy

WASHINGTON, Oct. 7, 2014 —Agriculture Secretary Tom Vilsack today announced that the U.S. Department of Agriculture (USDA) has released a comprehensive report synthesizing current literature that explores opportunities in the emerging bioeconomy. The report, entitled *Why Biobased?*, was created as a precursor for a more comprehensive economic study to be released in the coming months by the USDA BioPreferred program on the economic impacts of the biobased products industry.

"This new report presents the opportunities U.S. agriculture and forests have in the emerging bioeconomy," said Vilsack. "The recent inclusion of mature market products into the BioPreferred program strengthens our commitment to the U.S. biobased economy and brings together two of the most important economic engines for rural America: agriculture and manufacturing."

Synthesizing findings from existing government, academia, and non-governmental organizations, the new report explores how government policies and industry business-to-business sustainability programs are driving the biobased economy. The report further demonstrates that the biobased economy is, in fact, growing and it offers great potential for increased job creation in numerous sectors across the U.S.

For instance, one report cited concludes that biobased chemicals are expected to constitute over 10 percent of the chemical market by 2015. Another report in the study concludes that there is a potential to produce two-thirds of the total volume of chemicals from biobased materials, representing over 50,000 products, a \$1 trillion annual global market.

On the heels of this completed study, the USDA BioPreferred program has awarded a contract for a more in-depth economic study of biobased products and economic impacts, including research on job creation and economic value. It will be the first federally sponsored economic report of its kind targeting the biobased products industry in the U.S. Congress mandated the upcoming study in the 2014 Farm Bill.



# Questions?

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2014 Pacific Rim Summit on Industrial Biotechnology and Bioenergy