Potential for Sustainable Deployment of Biofuels Under EISA

American Chemical Society
Science & the Congress
Briefing on Cellulosic Biofuels

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U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY
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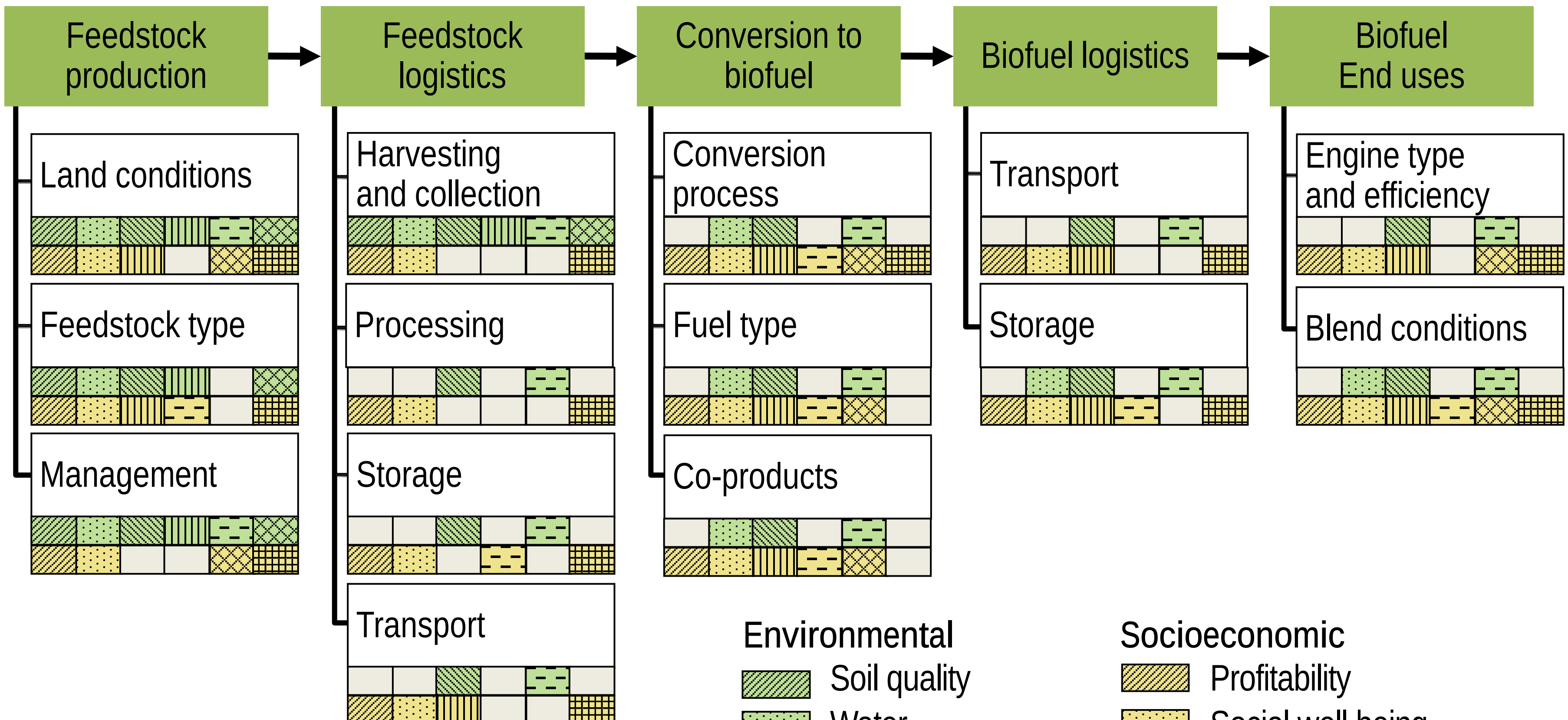
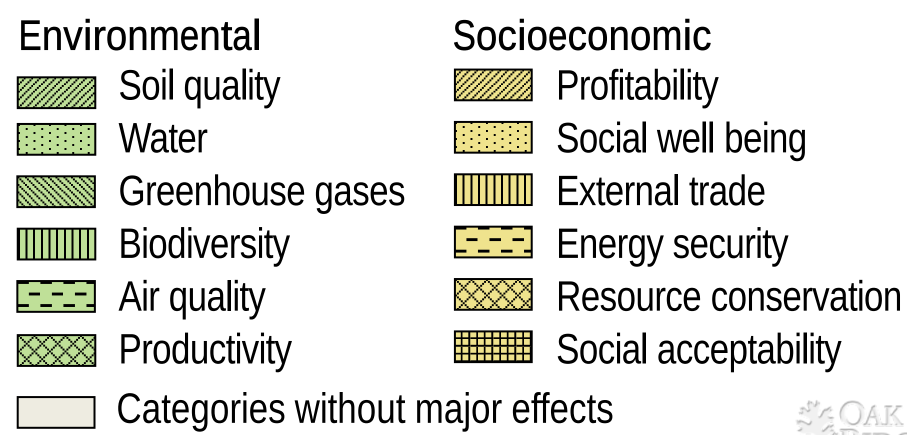
Looking at the biofuel supply chain in terms of sustainability indicators



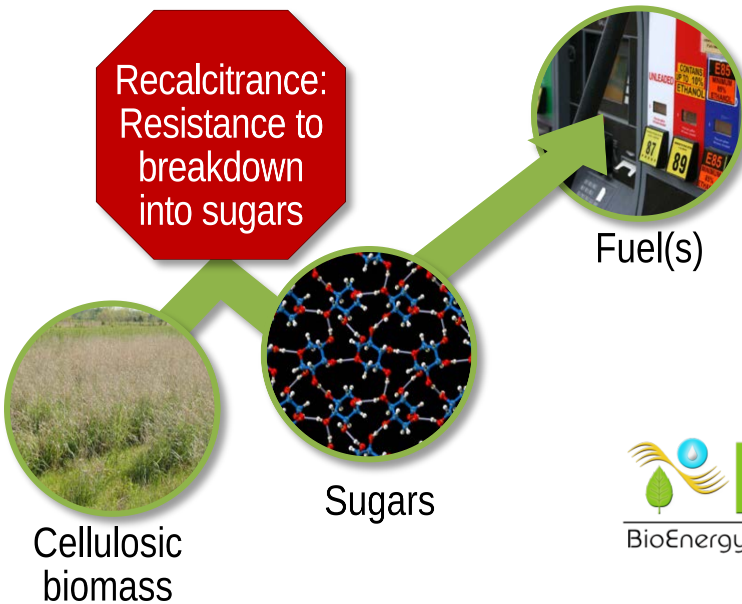


Based on McBride et al. (2011) and Dale et al. (in review)

Ready access to biomass sugars can reduce cost of processing cellulosic biomass

Approach

- Develop modified or natural biomass that is designed to release sugars more easily
- Engineer microbes to consolidate multiple costly processes into a single step



Outcomes to date


Field trials of modified switchgrass at Ceres facility

- Modified biomass: Switchgrass
  – Yields 30% more biofuel
  – Requires less commercial enzyme
  – Now in commercial field trials
- Improved yeast:
  – Combines ability to digest cellulose and ferment
  – Now the basis of a commercial plant

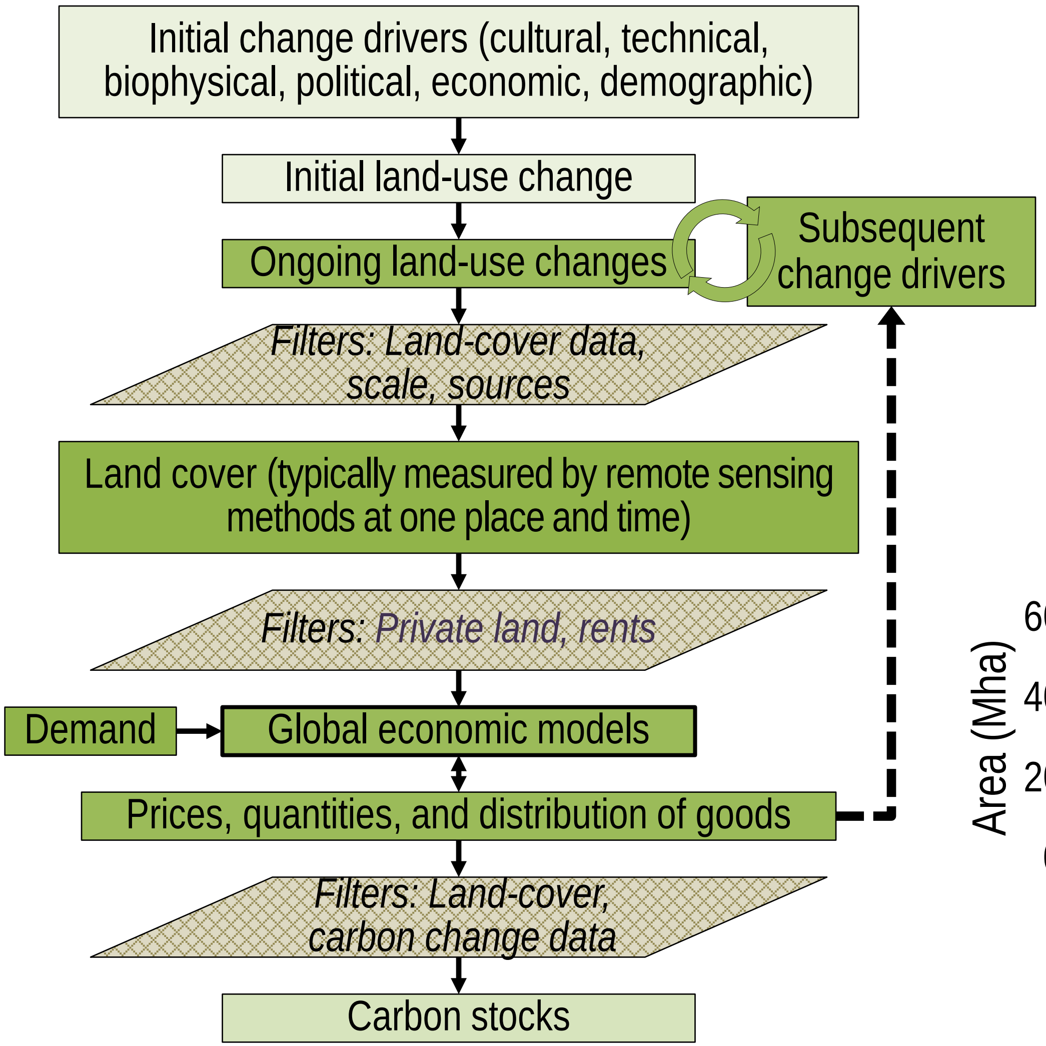
BESC BioEnergy Science Center

Prognosis: Needed technology improvements will impact industry within the next 5 years

Source: U.S. Department of Energy BioEnergy Science Center (http://bioenergycenter.org)

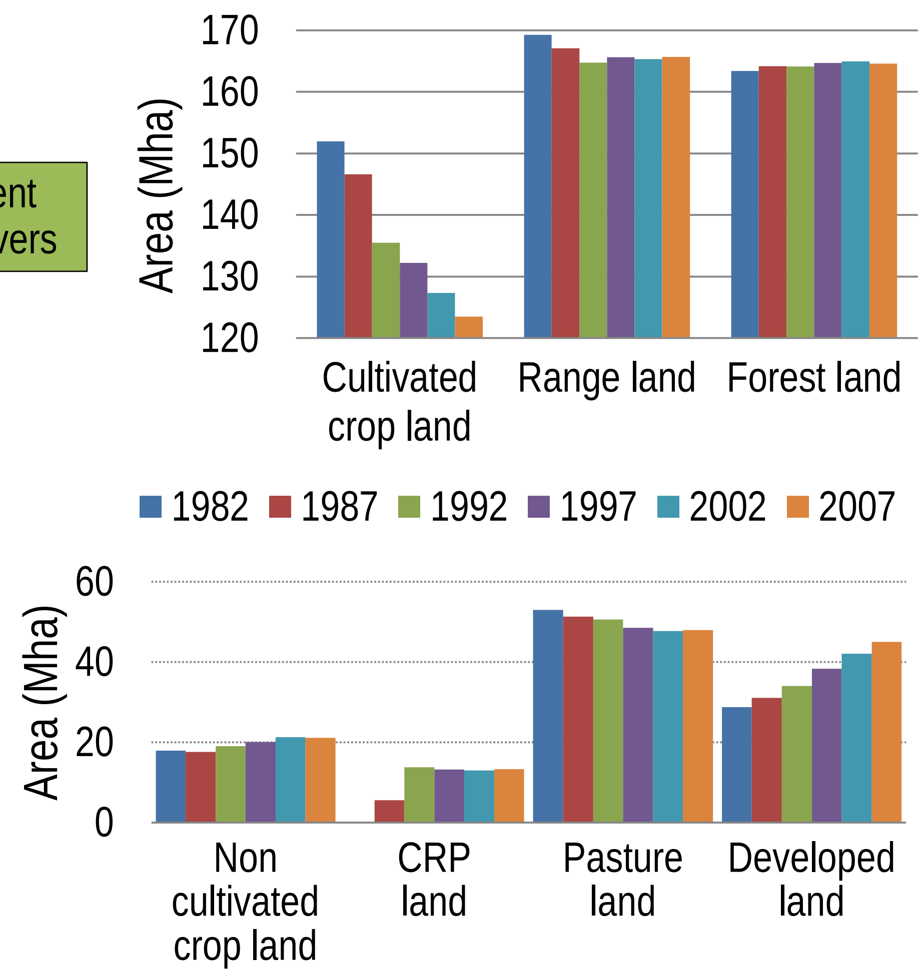
Evaluate land-use effects based on empirical evidence

Land use is dynamic and bioenergy contributes to ongoing land-use change



Source: CBES 2010 (http://www.ornl.gov/sci/besd/cbes/)

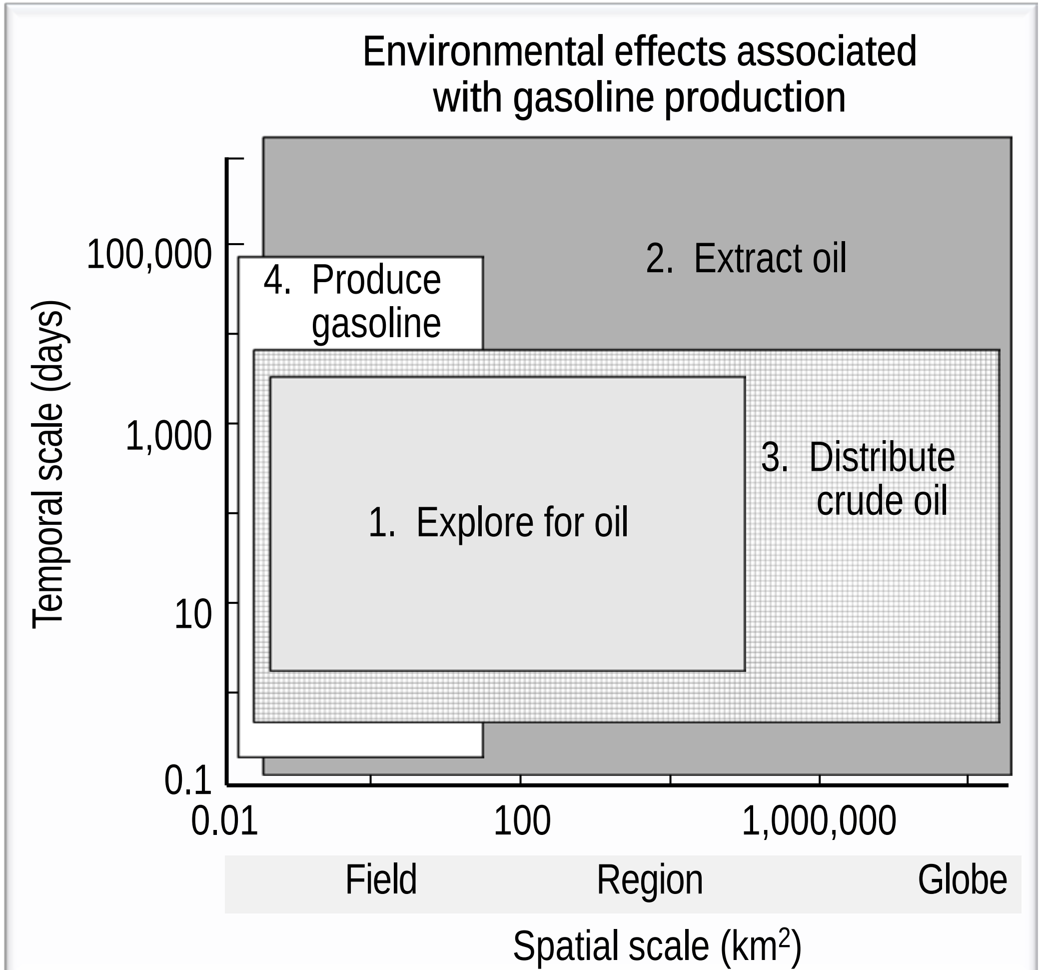
No empirical evidence for land-use changes due to bioenergy

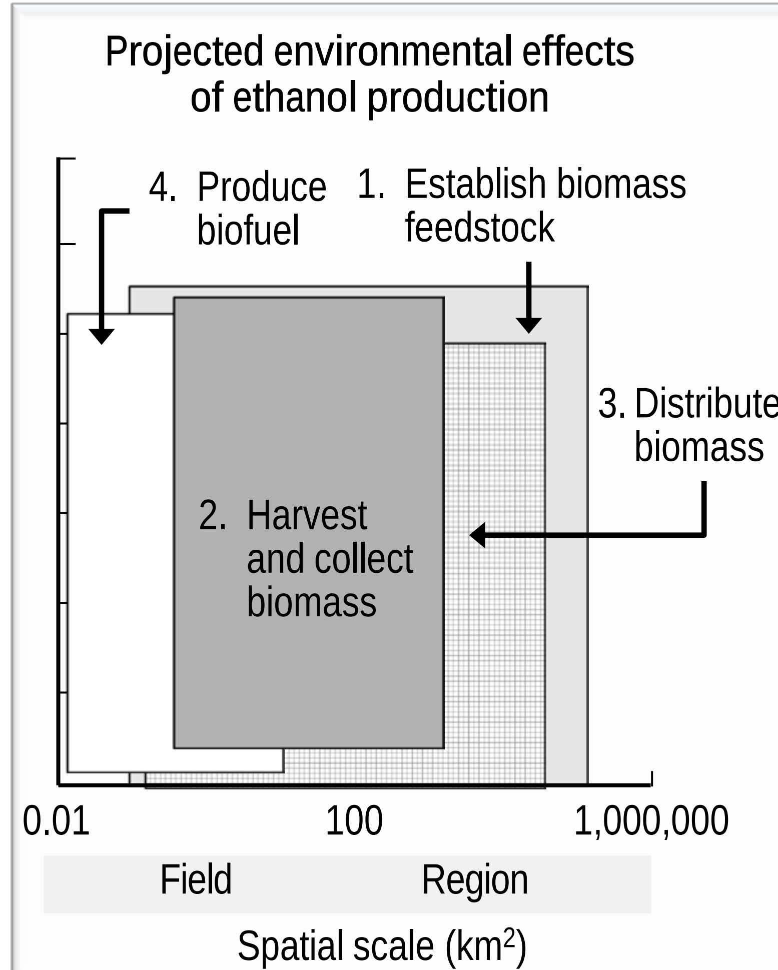


Based on data from USDA 2009-NRI (Dale et al. 2011), supported by recent USDA reports

Compare bioenergy to other energy alternatives

(light grey)	1. Establish fuel sources
(dark grey)	2. Obtain raw material
(grid)	3. Distribute raw material
(white)	4. Produce fuel





Stommel diagrams show spatial extent and duration of effects (Parish et al., in prep)

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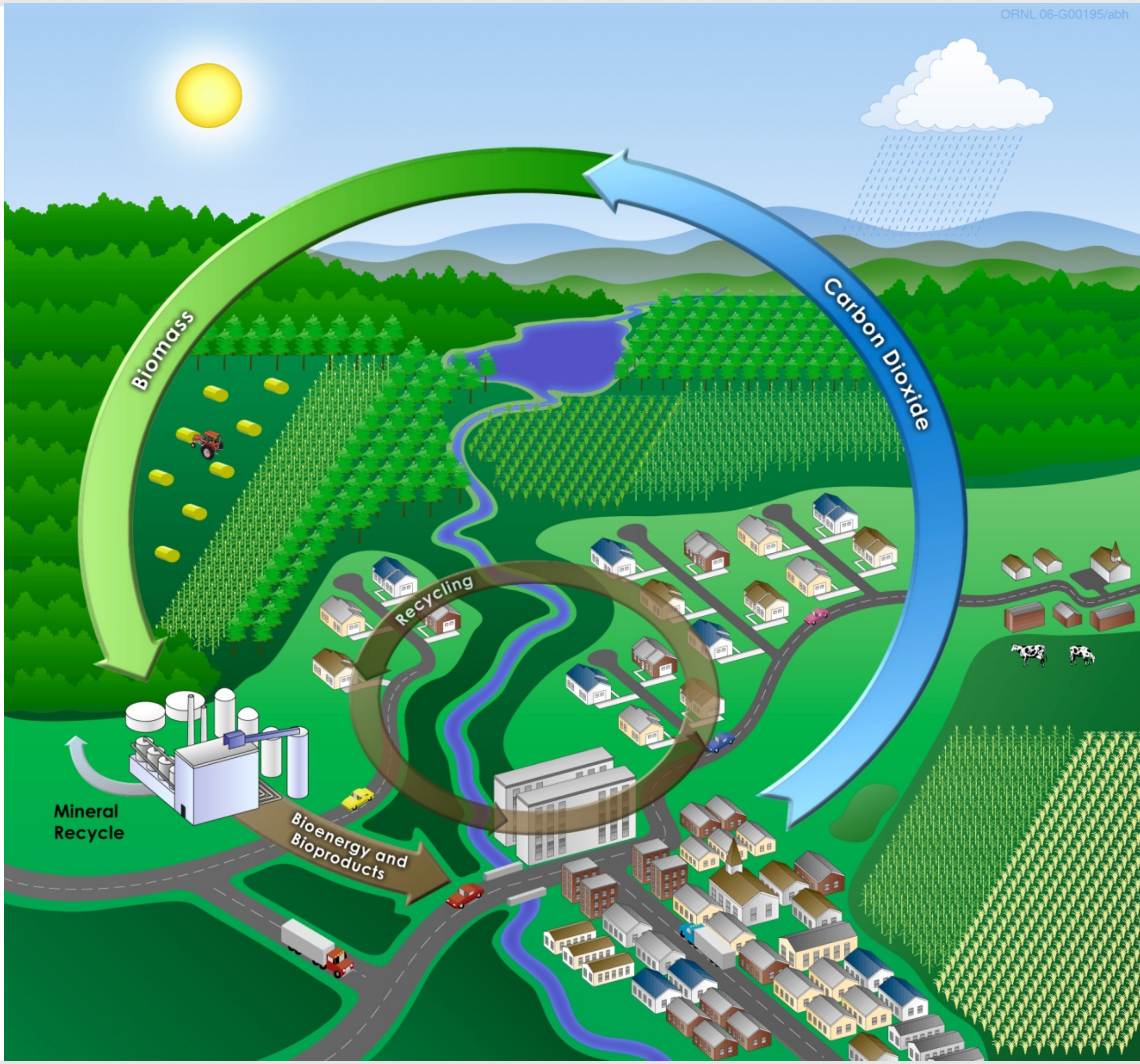
Adopt landscape perspective

Consider fuel production within entire system (interactions and feedbacks) as an opportunity to design landscapes that add value

Dale et al. (2010)



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An optimization model can identify "ideal" sustainability conditions

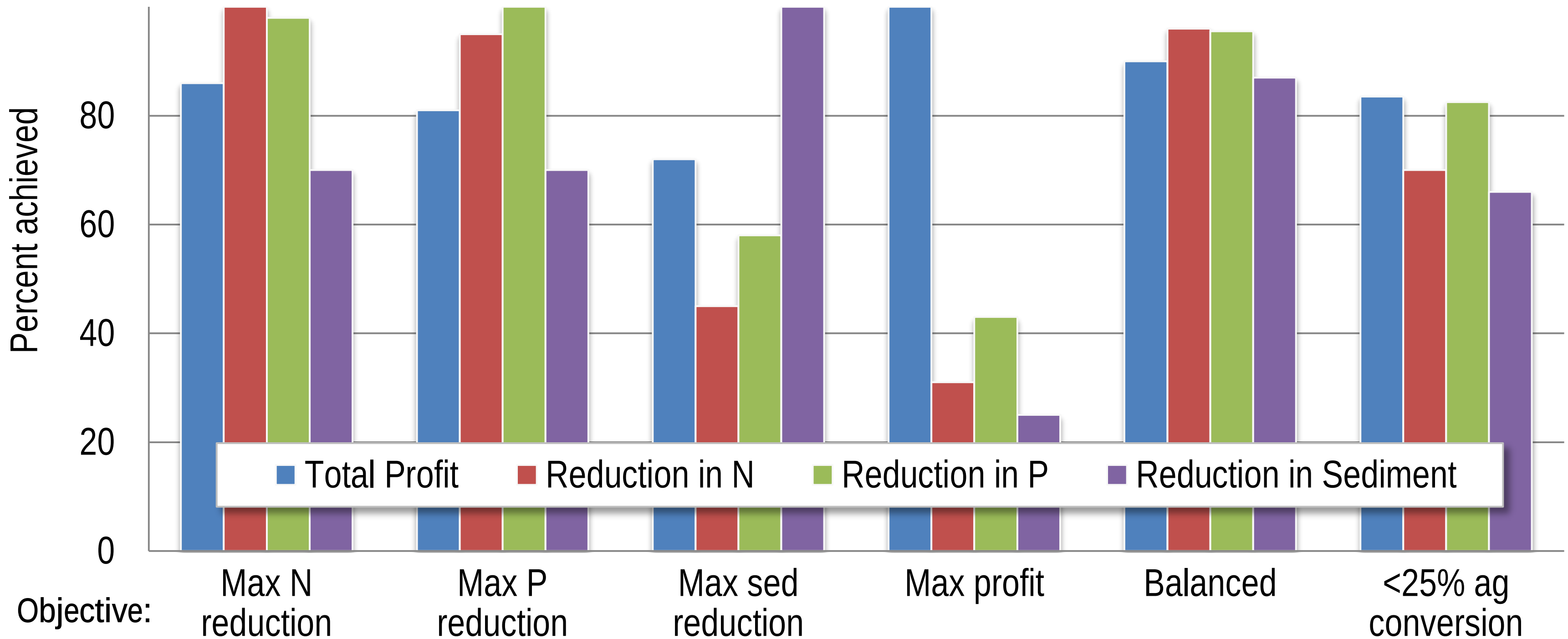
Spatial optimization model

- Identifies where to locate plantings of bioenergy crops given feedstock needs for Vonore refinery
- Considering
  - Farm profit
  - Water quality constraints

Parish et al., *Biofuels, Bioprod. Bioref*. 6,58–72 (2012)

Balancing objectives:

A landscape design of cellulosic bioenergy crop plantings may simultaneously improve water quality and increase profits for farmer-producers while achieving a feedstock-production goal



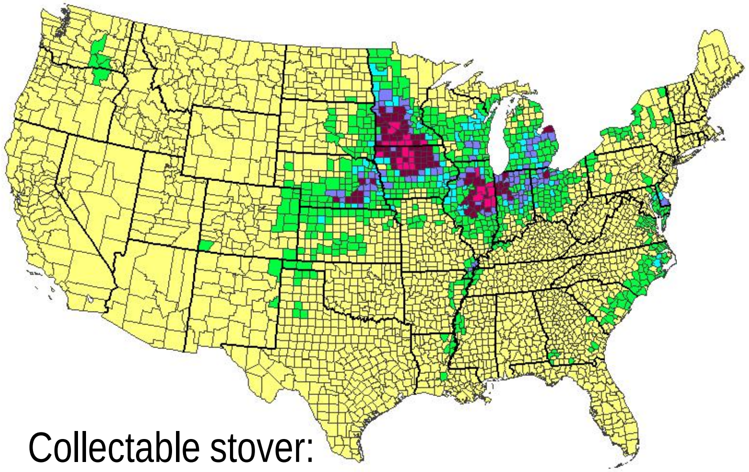
Ag land converted	58%	51%	44%	27%	60%	25%

Land area recommended for switchgrass in this watershed:
1.3% of the total area (3,546 ha of 272,750 ha)

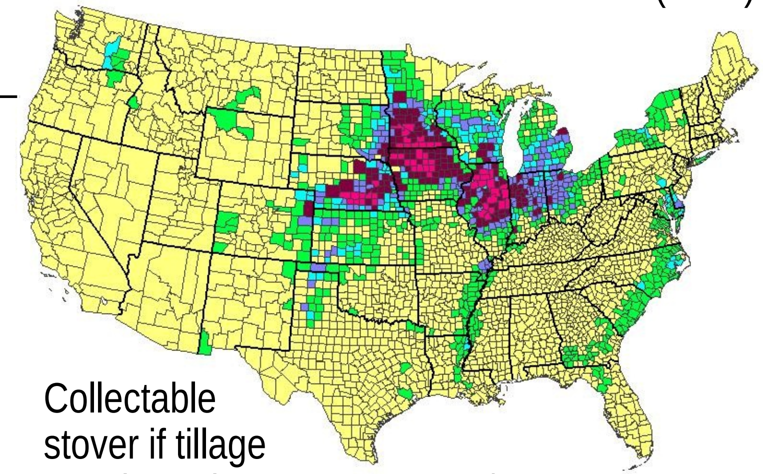
Recognize place-based options

Residue availability is specific to each place and management

Wilhelm et al. (2007)



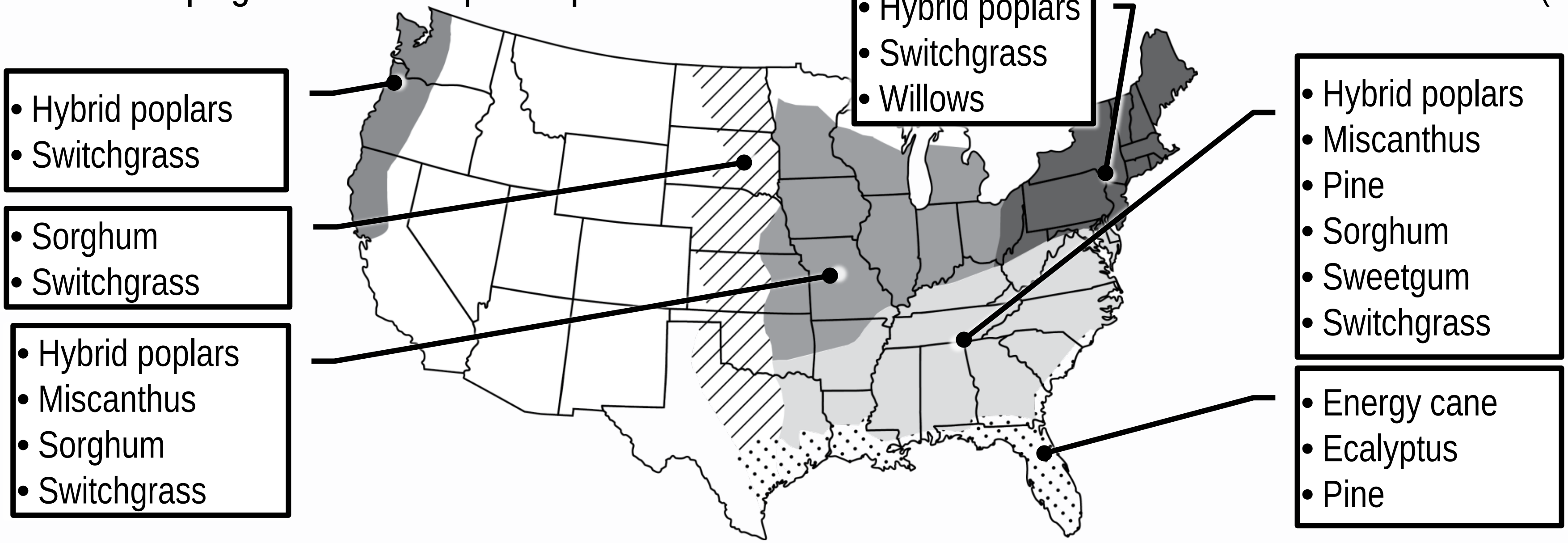
Collectable stover: 64M tons/year



Collectable stover if tillage practices change: 111M tons/year

Different crops grow better in specific places

Dale et al. (2011)



Thank you!

CBES
Center for BioEnergy Sustainability

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