OAK RIDGE National Laboratory

DOE Bioenergy Technologies Office (BETO) 2019 Project Peer Review

Collaborations to Assess Land Effects of Bioenergy

Science-based approaches to improve assessment of Land-Use Change (LUC)

WBS 4.2.1.41

05 March 2019

Analysis and Sustainability

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ORNL is managed by UT-Battelle, LLC
for the US Department of Energy

U.S. DEPARTMENT OF ENERGY

OAK RIDGE National Laboratory

Goal Statement

- **Goals:**
  a) Science-based approaches generate more consistent and accurate assessments of bioenergy effects on land, including land-use change (LUC).*
  b) Results of BETO sustainability research are disseminated & publicly accessible.

  **Stretch goal:* The bioenergy-LUC debate shifts to increasingly identify opportunities and benefits via improved land management.

- **Impacts:**
  – Sustainability web-pages on KDF provide access to an expanding body of relevant literature.
  – Costs and benefits of LUC associated with an expanding US bio-based economy are more accurately quantified & communicated.
  – Published results reduce controversies and uncertainties associated with effects of bioenergy on LUC.

Quad Chart Overview

Timeline (FY17-19)

- Project start: Oct 2016
- Project end: Sept 2019
- % complete: 80% (sunsetting)

$	FY 17 Costs	FY 18 Costs	Total Planned Funding
DOE Funded	259,000	284,000	875,000

Partners contribute in-kind via support for travel, workshops & research time. They include

- International organizations e.g., Food and Agriculture (FAO) International Energy Agency (IEA)
- private sector trade groups (Ethanol Alliance, National Biodiesel Board)
- Other labs, standards bodies
- US agencies & research centers

Barriers addressed

At-H: Consensus, data and proactive strategies for improving land-use management.

At-A: Analysis to inform strategic direction

At-E: Quantification of Benefits and Costs: estimated LUC factors are key variables in all biomass production assessments.

Objectives: Science-based assessment improves understanding of effects of biomass production on land. Disseminate BETO sustainability research.

End of Project Goal: More consistent, transparent and useful assessments result from the collaborative LUC research, evidence base, & the sharing of improved practices developed in the project.

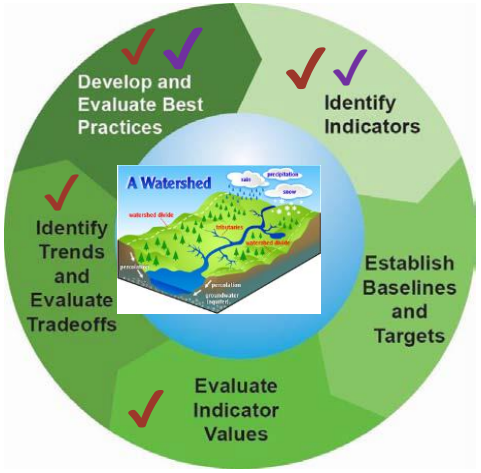
1 - Project Overview

History:

- 2016: Merit-reviewed, new initiative for FY17-19
- Constructive focus, modest funding
  - Promote opportunities for beneficial LUC
  - Coordination with IEA Bioenergy Inter-Task plans

Fit with portfolio & BETO objectives

- **Disseminate research results** (via multiple outreach streams) to help achieve US & BETO goals for
  - Enabling a sustainable bio-economy
  - Maximizing beneficial impacts
  - Technology and pathway validation
- **Build scientific consensus to**
  - More effectively address LUC concerns
  - Provide consistent communications about costs & benefits
  - Encourage pathways & management that improve sustainability



2 – Approach (management)

- Team: Kline (PI), Oladosu & Davis (ORNL), + collaborators
- Integrative, multi-disciplinary research
  - Private & public sector stakeholders
  - International organizations
  - Opportunities to influence larger outcomes
- Project coordination
  - monthly updates, BETO A&S calls
  - quarterly progress reports, milestone reports
  - quarterly reviews, financial & milestones, with BETO
  - conference calls, webinars, virtual meetings with collaborators
- Special issues - response mechanism
  - Leveraging networks to support BETO goals
  - Address issues as they arise
  - Provide timely response to BETO requests
- Strategic use of resources
  - International collaborations primarily via webinars, calls
  - Exchanging views and finding common ground among researchers
  - When required, travel financed by partners (3rd party contributions)

2 – Approach: well-defined milestones

Q	Milestones planned since last Peer Review (Q2 2017)
2	Sustainability standards landing page developed and reviewed with stakeholders (and related go / no-go decision)
3	Collaborations contribute to IEA Bioenergy Inter-task workshop and joint research on indirect effects (case study report)
4	Video presentation on how BT16 parameters and assumptions addressed LUC & ILUC
1	Identify data sources and related opportunities to update and improve LUC analyses
2	Hypotheses to be tested are developed with input from international collaborators
3	Develop proposals and outlines for two LUC research initiatives
4	Invitation issued for partnering and collaboration on LUC research
1	Sustainability indicators webpage operational with multi-agency data - coordinated with Sust. Bioeconomy Inter-agency Work Group (SBIWG)
2	Report summarizes results of the team's research efforts to identify key assumptions lacking support, based on joint research to date

2 – Approach (Success factors, Challenges)

Two *Go/No-go* decision points
(see extra slides)

1. **Stakeholder support for Sustainability Standards landing page on the KDF**
2. **International collaborators committing to contribute to joint LUC research, analyses & publications**

- ***Critical success factors***
  - ***Catalyze evidence-based LUC analysis***
  - ***Collaborate to improve baselines, models & analysis***
  - ***Effectively communicate results***
  - ***Adoption of science-based approaches by others***
- ***Challenge***: no consensus on a consistent approach for accurate LUC assessments

Challenges to a science-based approach

- **Confounding data and terminology**
  - Land cover versus land uses (multiple) & land management
  - Available crop price & trade versus total production, actual uses, losses…
  - Correlation versus causation
- Cost of monitoring

Science evolves as new data & understanding become available

3 – Accomplishments ➔ *Persistent support for science to guide research & analysis*

Progress since last peer review:

- 21 Publications
- 24 additional reports, reviews & key acknowledgements
- 13 pubs in review or prep
- Dissemination: 53 presentations since April 2017

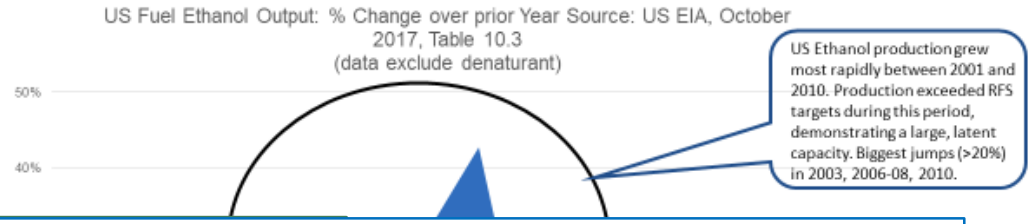
Making progress by applying science: replicable, systematic methods & evidence-based analysis

- ✓ Start with clear definition of problem
- ✓ Test hypotheses
- ✓ Conduct critical analysis
- ✓ Determine cause & effect
- ✓ Document verifiable, replicable results
- ✓ Build on and learn from others, share results
- ✓ Ask the right questions

3 – Accomplishments ➔ data & analysis to improve understanding and assessment of LUC

- ✓ Clarifying relationships
- ✓ Examining potential bias

Data-driven analysis. Background: Collaborations on US case study began by examining historical data on US ethanol production. Ramp-up (25% annual growth) 2002-2010. Published LUC studies (Lark et al. 2015 and subsequent papers building on Lark et al. data, e.g., Wright et al. 2017; Spawn et al., 2017…) focus on changes in selected row crops during select years (2008-12) that do not represent period of growth in biofuels.



Data-driven analysis. Background:

Two-point comparisons can be misleading, especially if focusing on partial data

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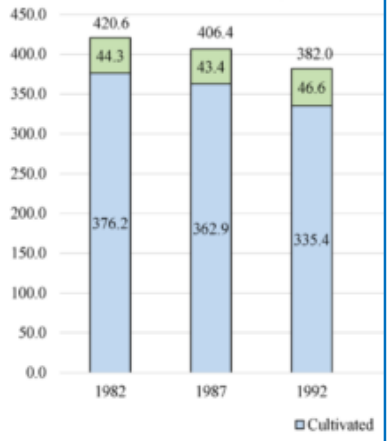
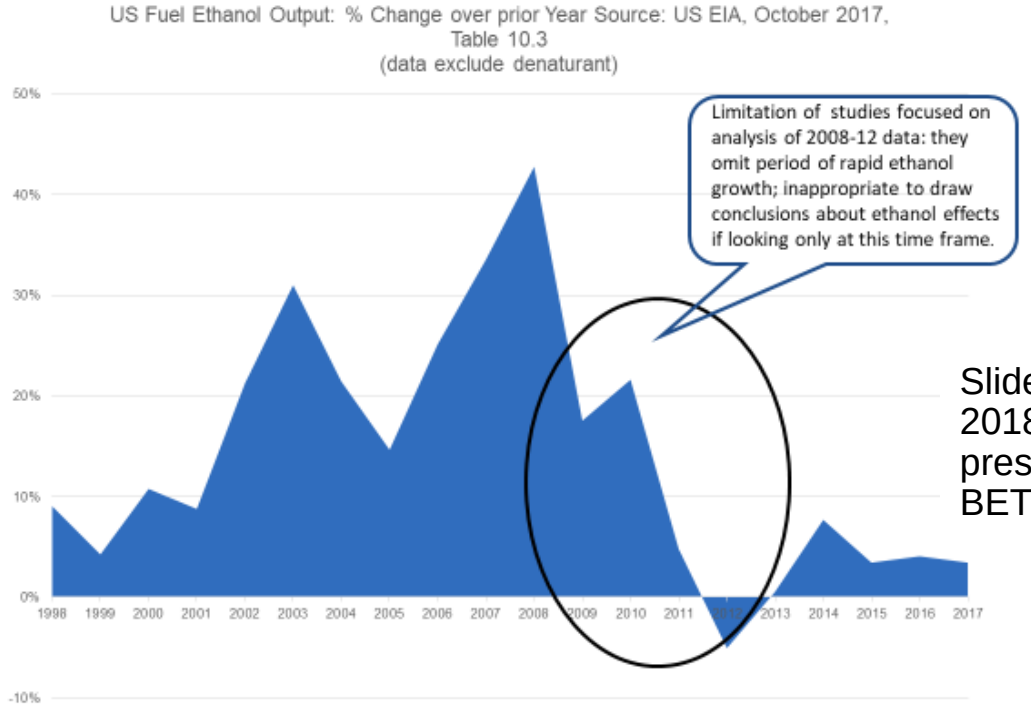
USDA ERS NRI Final Report (2015):



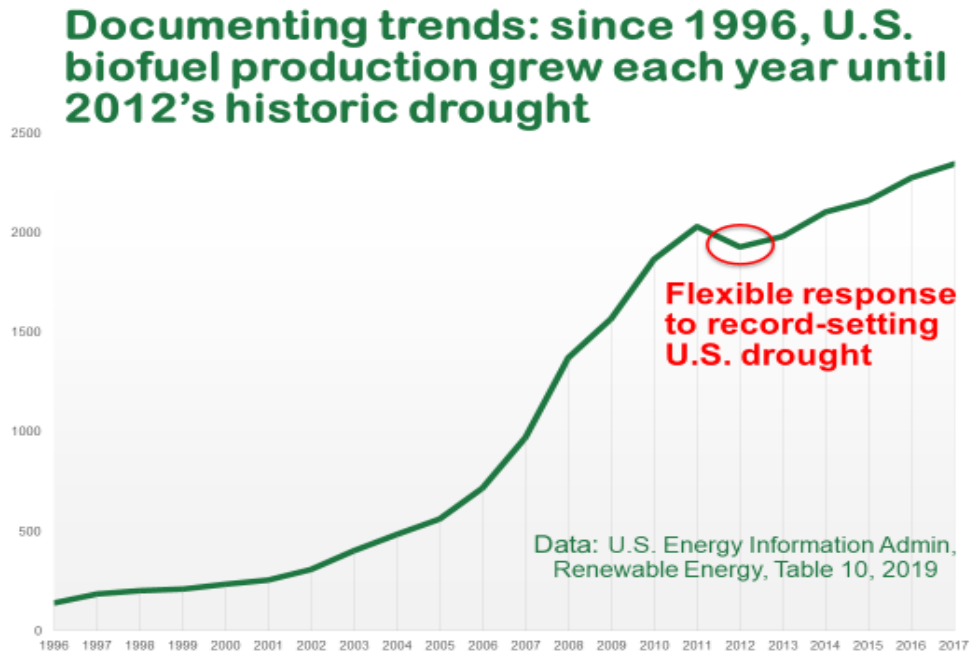
Data-driven analysis. Background:

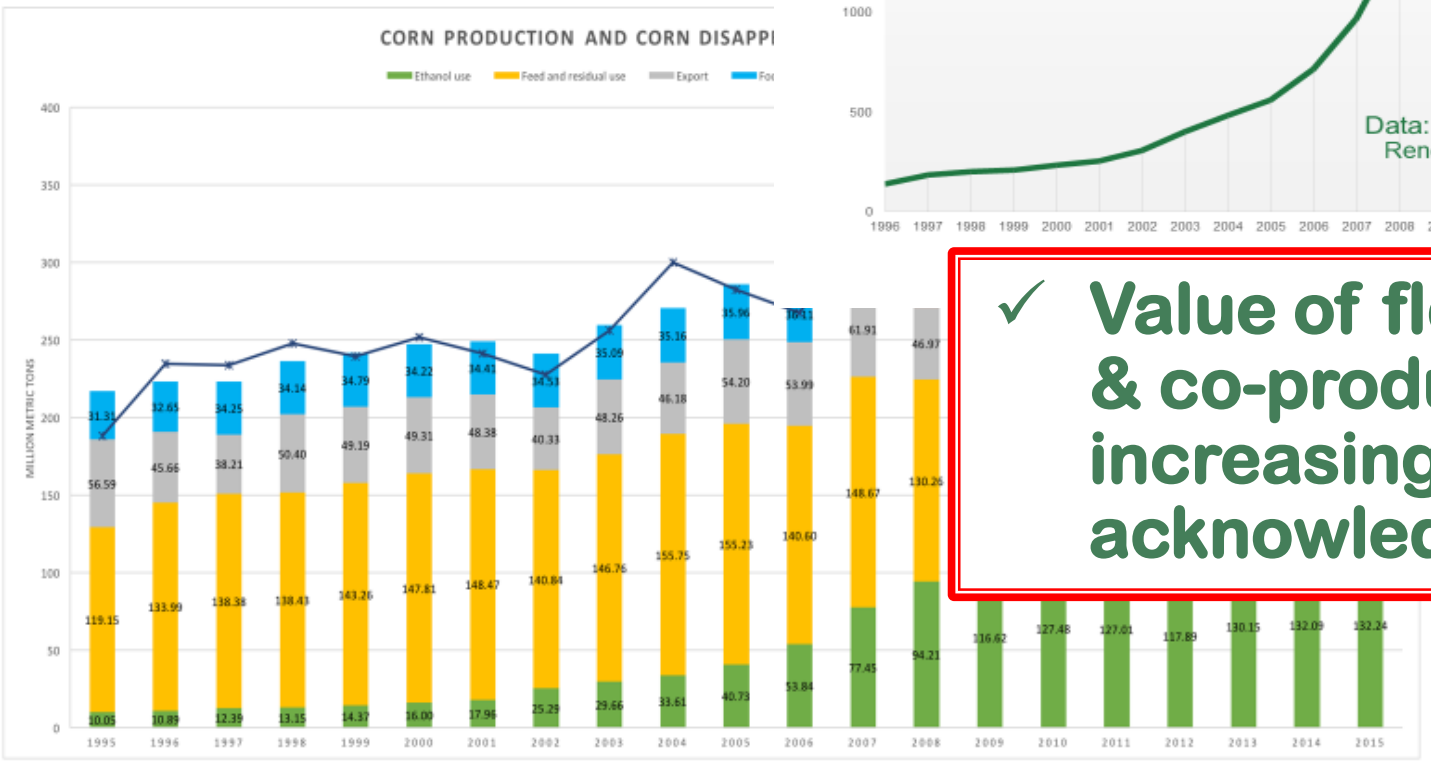


Slides from 2018 ORNL presentation for BETO A&S

3 – Accomplishments ➔ data & analysis to improve understanding and assessment of LUC

- ✓ Look at data in entirety
- ✓ Identify drivers of change





- ✓ Value of flex markets & co-products are increasingly acknowledged

-Brandao et al. (in prep) See list of pubs in extra slides

3 – Accomplishments ➔ data & analysis to improve understanding and assessment of LUC

✓ **Updating analyses with recent data**

Index Decomposition Analysis – ILUC

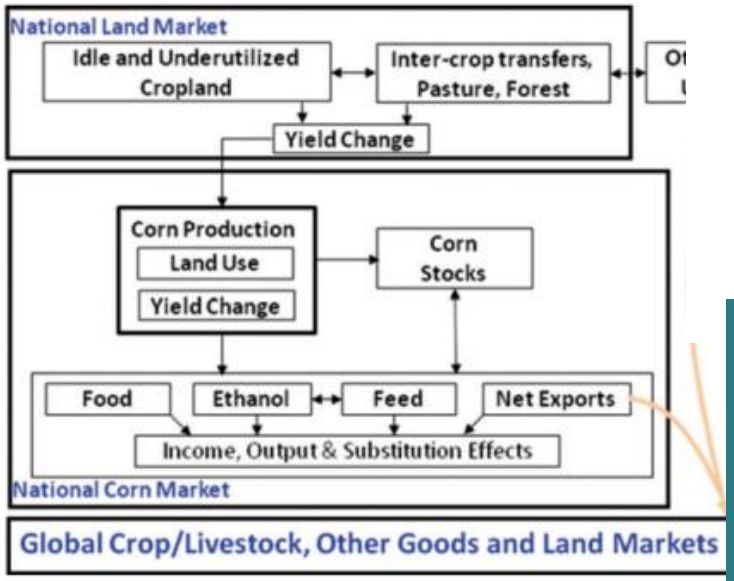
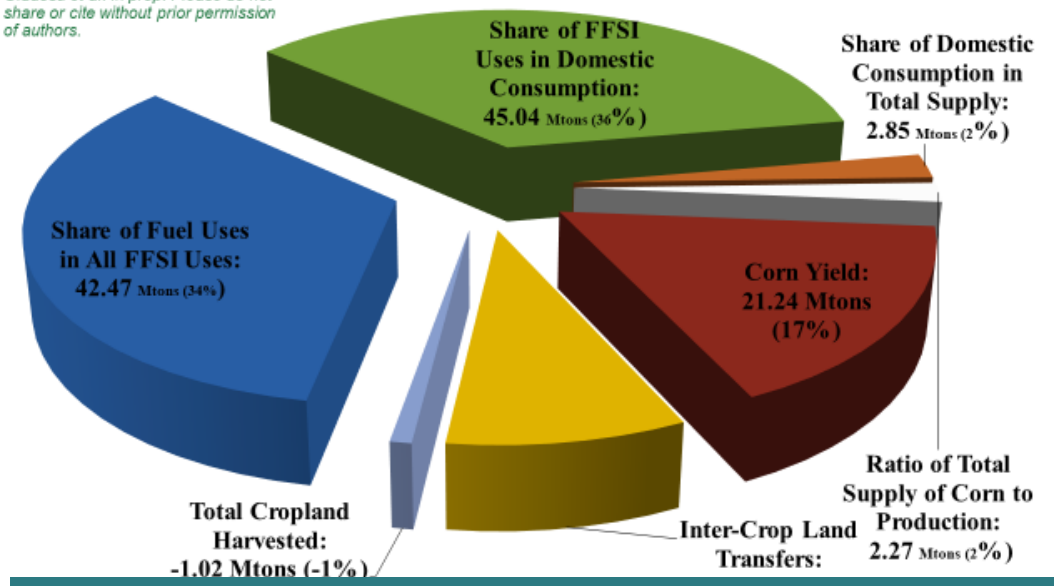


Figure 1. Processes driving the indirect impacts of corn used for ethanol.

IDA update 2018: Sources of corn for US ethanol production 2001-17

2001-2017

Oladosu et al. in prep. Please do not share or cite without prior permission of authors.



2018 IDA Update

- 70% of change: distribution of domestic industrial use
- 26% from increased corn production (mostly yield)
- No evidence for ILUC driver via net exports but any such statistical analysis of production shares merits additional causal analysis

3 – Accomplishments ➔ new data & analysis to improve understanding and assessment of LUC

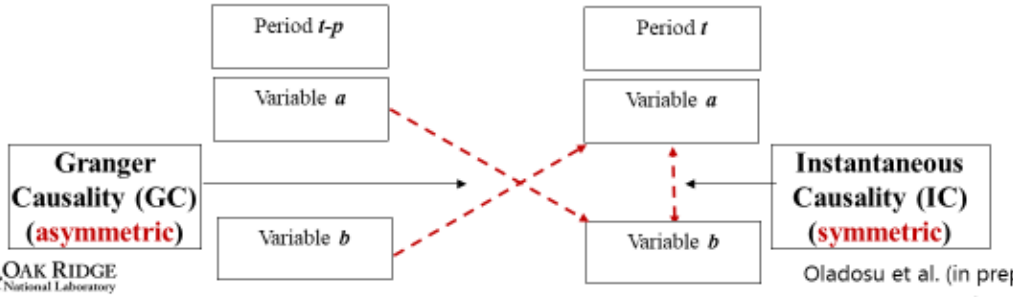
✓ Testing for causality

New initiative - testing caus

- Testing method with data on US co
- Results in brief:
  - Even best available data have limitatic
  - Every variable examined showed IC *ex*
  - US total supply is key causal driver for
  - Causality coefficients signs can contra
    - More corn use for ethanol linked with
    - Results reflect **effects of common dri** or other **confounding factors**
    - **Supply and external economic factor net exports**
- Results point to the crucial role of
  - Potential role for "flex crops"
  - Capacity of bioenergy markets to absorb excess
- A

Methods: Structural break and causality tests

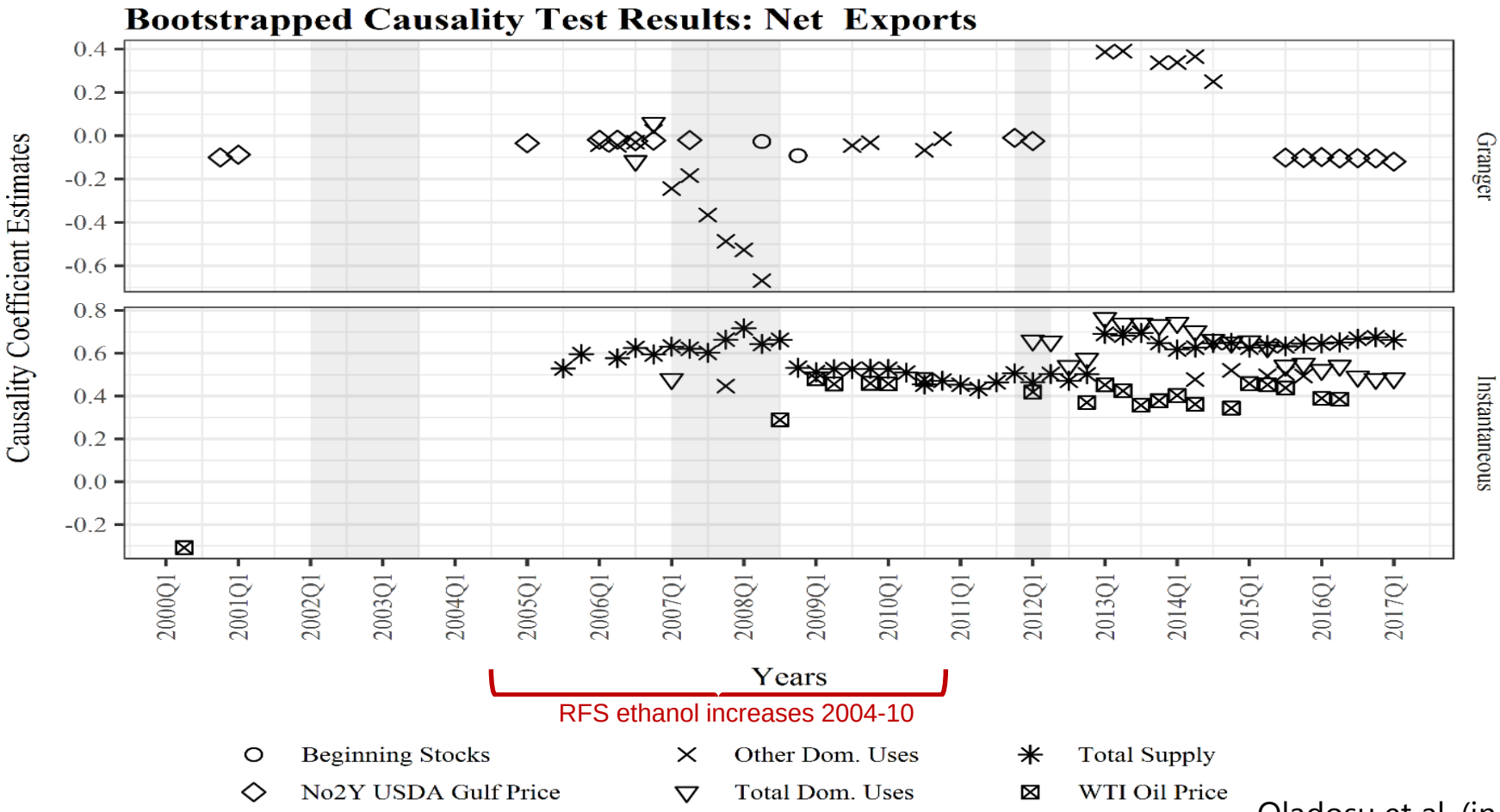
- **Structural breaks** are significant shifts in mean, variance or other statistical properties of a variable
  - Identify events that change a variable's fundamental attributes
  - Tests used in current study:
    - Generalized fluctuation structural break test (Zeileis,2010)
    - Identification of break-dates (Bai and Perron, 2003)
- **Causality analysis: Are past and current values of variable *a* significant drivers of the current value of variable *b*?**
  - **Granger-causality (GC)** and **instantaneous-causality (IC)**
  - Tests in this study are based on rolling bivariate VAR models bootstrapping to correct for sample size



New: IC and GC causality analysis (preliminary results on next slide). Economic growth is common driver of change in production, exports, prices, and feedstock use for ethanol (Oladosu et al. in prep)

Analyzing data for causality/US net corn exports:

- **Primary GC factors: Corn price & other domestic uses**
- **Primary IC factors: Total supply, domestic uses & crude oil price**
- **No significant influence from corn use for ethanol**

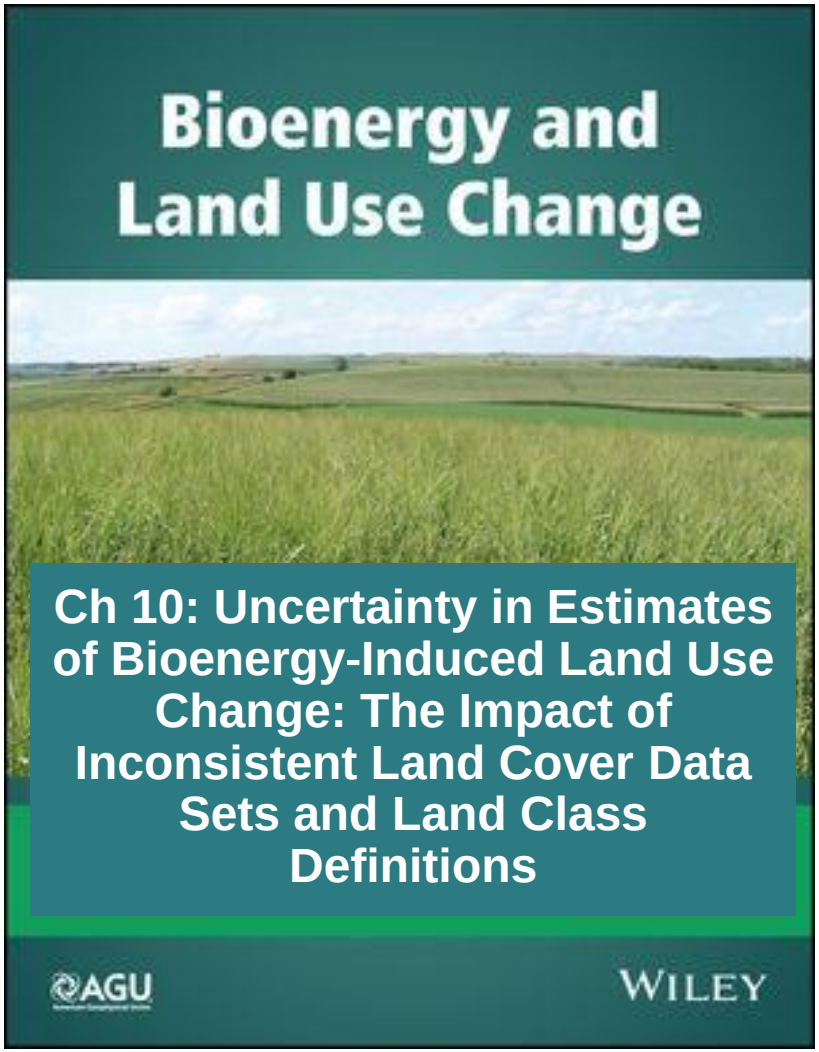


Oladosu et al. (in prep)

3 – Accomplishments ➔ *Persistent support for science to guide research & analysis*

Examples of additional *impacts* of collaborative research

- ✓ IEA Sustainable Bioenergy Roadmap
- ✓ UK Climate Change Commission
- ✓ Improving LUC in Climate Calculators
- ✓ Impacts on broader sectors (forestry, agriculture) and next generation researchers
- ✓ International collaborators (FAO, IINAS, GBEP, UK, EU…)



3 – Accomplishments ➔ *Persistent support for science to guide research & analysis*

Collaborative research - *impacts beyond numbers*

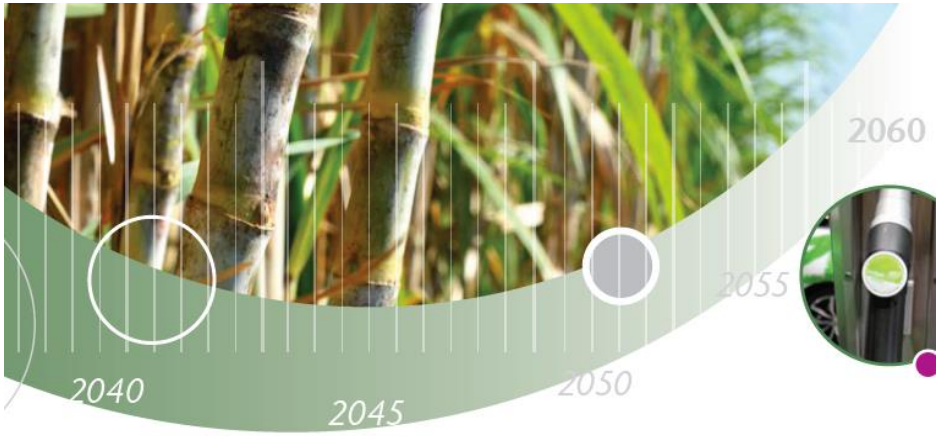
Examples:

- ✓ **IEA Sustainable Bioenergy Roadmap**
- ✓ **UK Climate Change**

Contributions:

- **Submittal of background materials / references**
- **Presentation for stakeholders**
- **Worked with IEA Adan Brown on Ch 5: Delivering Sustainable Bioenergy**
- **Reviews of draft report**

Final Technology Roadmap published Dec. 2017



Technology Roadmap

Delivering Sustainable Bioenergy

International Energy Agency
Secure Sustainable Together

Excerpt on ILUC:

In order not to constrain the use of biofuels unnecessarily, regulation of biofuels should be based on a quantitative assessment of the GHG benefits compared to fossil fuel use when possible, rather than regulating on the basis of feedstock types or processes. This should be coupled with an objective to progressively lower the associated GHG emissions.

3 – Accomplishments ➔ *Persistent support for science to guide research & analysis*

Collaborative research- *impacts beyond numbers*

Examples:

- ✓ IEA Sustainable Bioenergy Roadmap
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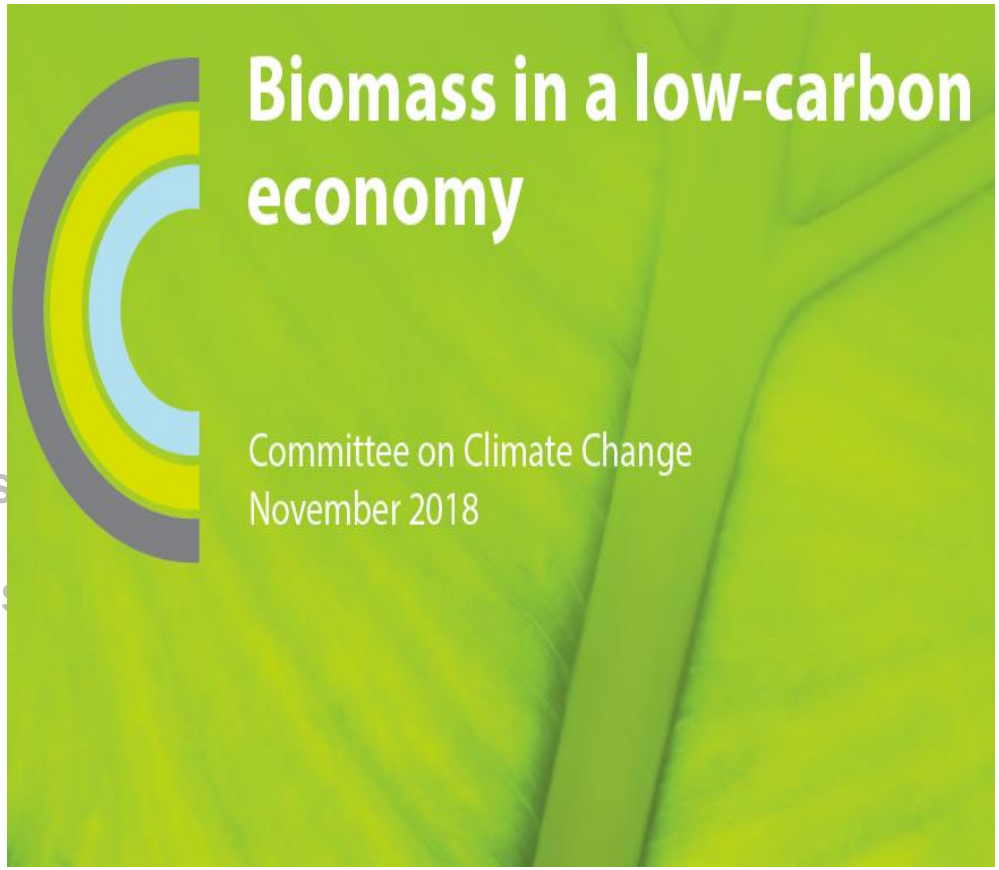
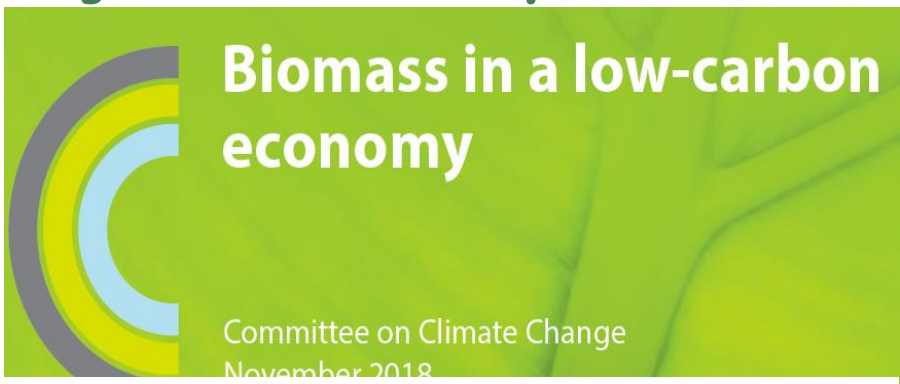
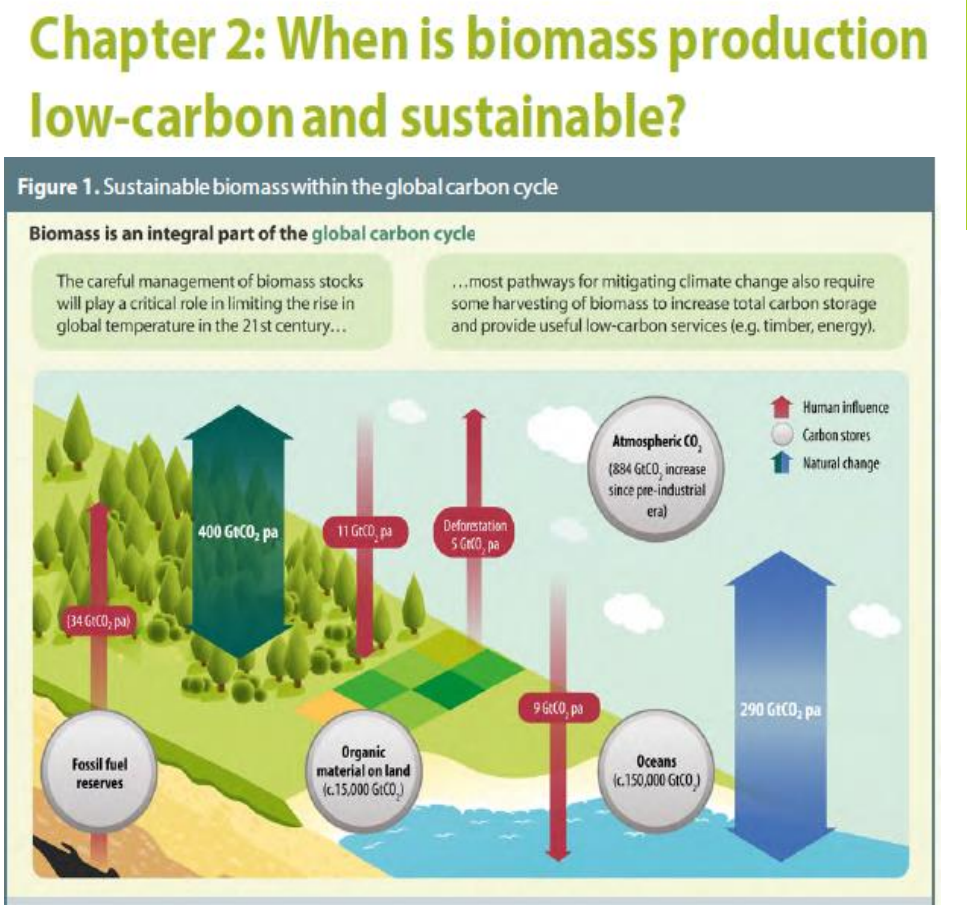


3 – Data & collaborative analyses with impacts

Example: ORNL research supports UK Committee on Climate Change (report available here)

- Conference calls with Committee members
  - Shared recent publications
- Invited to make presentation for workshop with drafting committee (webinar, and subsequent in-person meeting)
  - Research on sustainable production of wood pellets in the Southeast US
  - Significant contributions toward Committee recommendations
- Final report
  - Cites ORNL & BETO publications
  - Underscores the important role of bioenergy & managing biomass stocks to achieve low-carbon economy





3 – Accomplishments ➔ *Persistent support for science to guide research & analysis*

Collaborative research – *impacts…*

Examples:

- ✓ IEA Sustainable Bioenergy Roadmap
- ✓ UK Climate Change Commission
- ✓ **Improving representation of LUC in Climate Calculators**
- ✓ Impacts on broader sectors

Contributions to Global Calculator & EU Calculator

- **References and input for LUC component of the calculator**
- **Better representation of bioenergy and land effects**

3 – Accomplishments ➔ *Persistent support for science to guide research & analysis*

Collaborative research - *impacts beyond numbers (& beyond bioenergy)*

Examples:

- ✓ IEA Sustainable Bioenergy Roadmap
- ✓ UK Climate Change Commission
- ✓ Improving LUC in Climate Calculators
- ✓ **Impact in broader forestry, agriculture sectors & next generation researchers**
- ✓ **International collaborators (FAO, IINAS, GBEP, EU…)**

- **Interest from Agriculture (CIMMYT) and Forestry (EU) in measures for beneficial LUC**
- **Teaming with students**
- **IINAS (Fritsche) Dec. 2018 Task 43 presentation:**
  - **"ILUC = artefact of tool narrow system boundaries"**
  - **"May need 'positive ILUC'" (beneficial LUC)**
- **Continued FAO collaborations**
- **Input to GBEP "Attribution Report"**
- **JRC invitation to lead US book chapter (see papers listed at end of presentation)**

3 – Data, analyses, outreach having impacts

Examples: Productive collaborations continue

- Food & Agriculture Organization (FAO)
- IEA Bioenergy

"FAO's key messages on bioenergy

Sustainability of bioenergy is context specific. Therefore its assessment must be based on reality not models and global studies. **Tools and knowledge are now available** to help governments and operators reduce risks and enhance opportunities of bioenergy development.

Per se **biofuels are neither good nor bad.** What matters is the way they are managed

Bioenergy should be viewed as another **opportunity for responsible investment in sustainable agriculture and rural development.**"

- Olivier Dubois, Sept 2018, FAO Rome (Olivier.Dubois@fao.org)

IEA Bioenergy Wor
Bioenergy Policy Fr

"Bioenergy provides an opp
responsible investment in s
agriculture…

The key issue is not about
1G or 2G biofuels, but on h
biofuels sustainable.

Regulatory distinctions between conv
(food crop based) and advanced (no
crop based) biofuels may impede the
development of high-performance bio

It is concluded that a fair evaluation
social impact of biofuel production re
an assessment of their impacts on ru
development."

IEA Bioenergy Task 43: https://www.ieabioenergy.com/wp-content/uploads

FAO's Perspective and Work on Sustainable Biofuel Production Source: Marco Colangeli, FAO

FORBIO meeting, Kiev, 21 February 2018

Are food-based feedstocks always unsustainable?

Not necessarily (and assessment always depends on the aspects of sustainability being considered)

"Flex crops" can produce both food and fuel

- Do not compete with food if investments in fuel improve access to food
- Possible but challenging through:
  - –Yield increases
  - –Integrated food-energy systems (IFES)
  - –Outgrower schemes (benefiting small producers)

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

www.fa

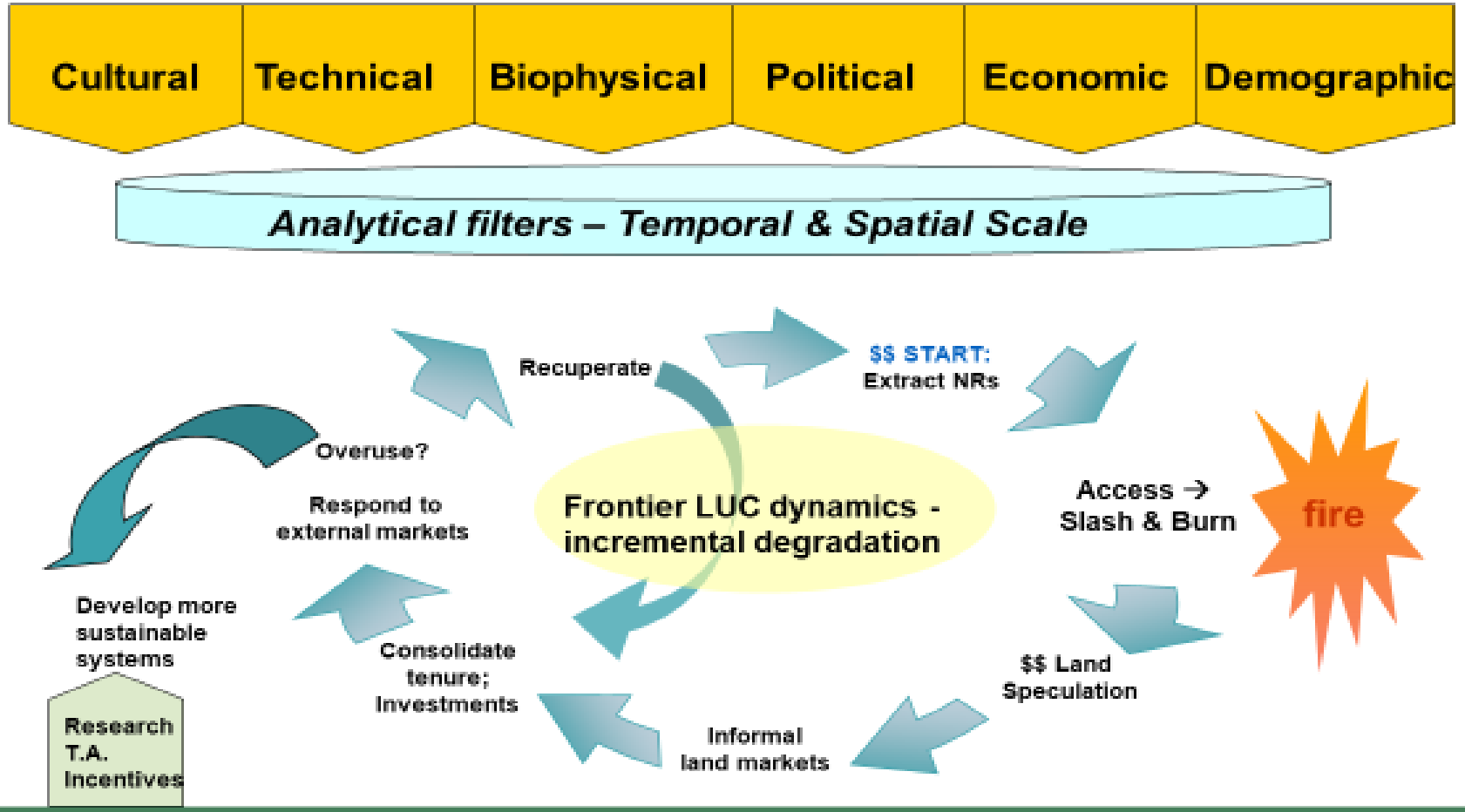
3 – Accomplishments ➔ science to guide research

Conceptual models for LUC – testing key assumptions

(Kline et al. in prep)

Drivers of deforestation

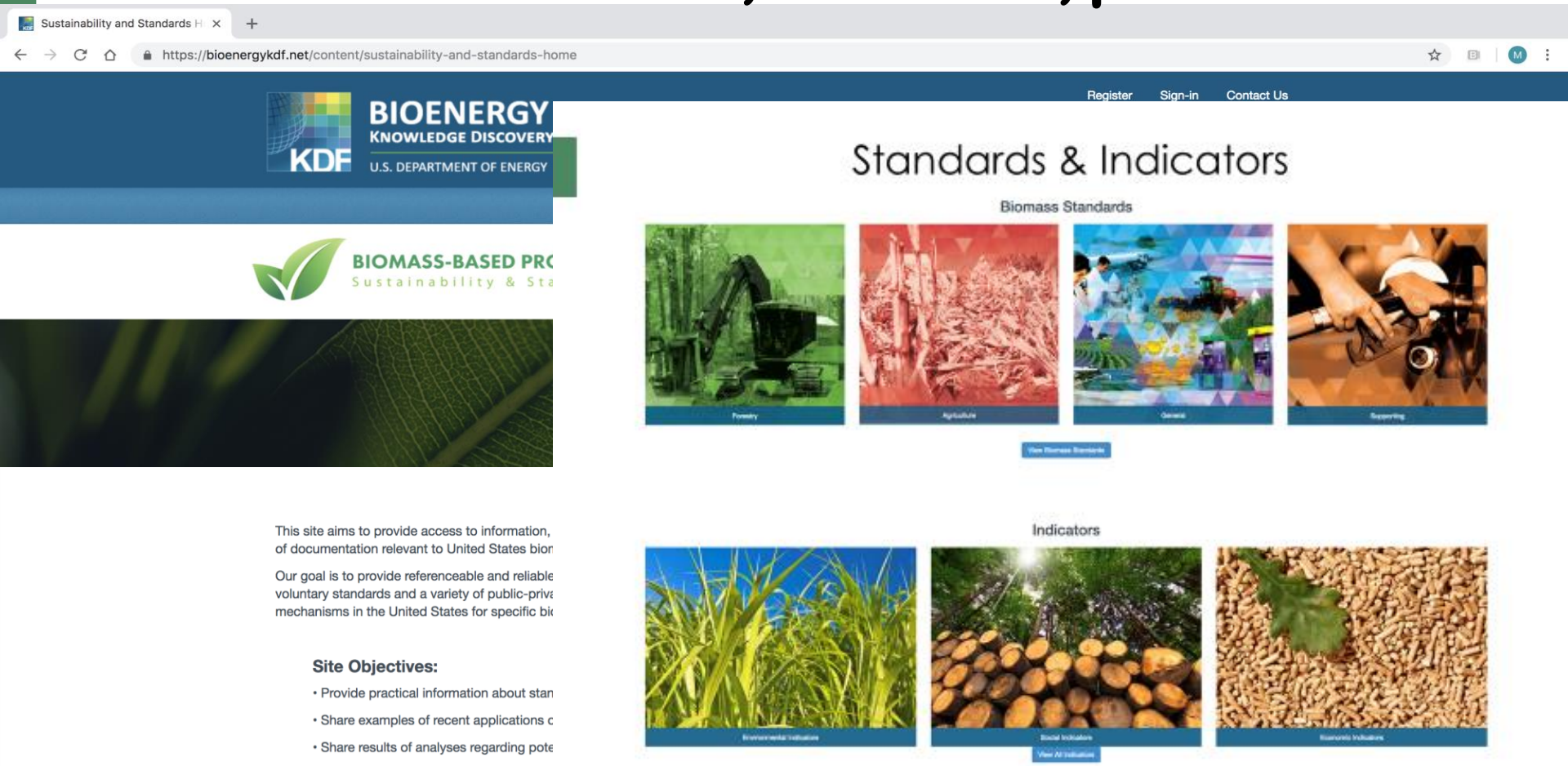
Decades of field work: confluence of local actors & opportunities



Important drivers of initial conversion: access, extractive industries, land scams, poverty... Where & how do the levers interact with model processes?

3 – Accomplishments ➔ disseminating results

Landing Page for sustainability: provides data & resources on standards, indicators, publications…



Provides public ease-of-access to resources pertinent to evaluating and monitoring the sustainability of biomass, bioenergy, and the bioeconomy

3 – Accomplishments ➔ disseminating results

Agriculture

National | International | European Union

CSBP

Council for Sustainable Biomass Production

Voluntary standards covering agricultural-based cellulosic bioenergy in the United States.

USDA Organic

United States Department of Agriculture National Organic Program (NOP).

Organic is a labeling term that indicates that the food or other agricultural product has been produced through approved methods. The organic standards describe the specific requirements that must be verified by a USDA-accredited certifying agent before products can be labeled USDA organic. Overall, organic operations must demonstrate that they are protecting natural resources, conserving biodiversity, and using only approved substances. Currently, organic certification is not used for biomass for bioenergy schemes. However, some organizations are considering whether organic residues can be accepted as in compliance with pesticide use and handling rules without additional paperwork.

BMAS

The Biomass Market Access Standard

Voluntary, certification system covering agriculture-based biomass for bioenergy.

Standards: Ag, Forest, General @ National, International, and EU levels

General

International | European Union

ASTM 3066

Standard Practice for Evaluating Relative Sustainability Involving Energy or Chemicals From Biomass Under Subcommittee E48.80

Voluntary, international standard covering all biomass.

BETO's role and contributions to ASTM 3066: BETO contributions centered on helping partners from industry and other agencies develop and apply this ASTM International standard that facilitates the growth of a sustainable United States bioeconomy. The standard will promote trade in clean, biomass-based products, create clear incentives for more sustainable practices, improve business-to-business communications and reduce transaction costs. This standard was created in response to concerns that existing sustainability standards did not provide adequate guidelines to support fair and consistent comparisons.

RSB

Roundtable on Sustainable Biomaterials

Voluntary, international standard that contains many component standards for applicability across any bio-based feedstock, biofuel or biomass-derived products or by-products and covers the complete supply chain.

ISO 13065

Sustainability Criteria for Bioenergy

Voluntary, international standard covering the entire supply chain and all forms of bioenergy.

BETO's role and contributions to ISO 13065: BETO contributions centered on helping partners from industry and other agencies develop this international standard by bringing technical expertise in science-based indicators of bioenergy sustainability and scientific approach to indirect effects of bioenergy.

NTA 8080

Netherlands Technical Agreement 8080

3 – Accomplishments ➔ disseminating results

BETO & related literature, with key word tagging "Sustainability Standards"

BIOMASS-BASED PRODUCTS
Sustainability & Standards

Sustainability Home | Standards | Indicators | BioSTAR | Glossary | Literature | About

Bioenergy Sustainability Literature Search

Filter by DOE Funded:

☐ DOE Funded 26

Filter by Bioenergy Category:

- Feedstock Production 2
- Biofuel Production 60
- Biofuel Distribution 4
- Supporting Data 1

Filter by Keywords:

- ✖ sustainability standards
- biodiversity 1
- bioenergy 1
- Bioenergy sustainability 1
- biofuel 1

Show more Keywords

Filter by Publication Year:

DOE Funded

Can upstream biofuel production increase the flow of downstream ecosystem goods and services?
Advanced biomass feedstocks tend to provide more non-fuel ecosystem goods and services (ES) than 1st-generation alternatives. We explore the idea that payment for non-fuel ES could facilitate market penetration of advanced biofuels by closing the profitability gap. As a specific example, we discuss...
Organization: Oak Ridge National Laboratory
Authors: Henriette I.Jager , Rebecca A. Efroymson

DOE Funded

Risk and resilience in an uncertain world
Ecological disturbances are occurring with greater frequency and intensity than in the past. Under projected shifts in disturbance regimes and patterns of recovery, societal and environmental impacts are expected to be more extreme and to span larger spatial extents. Moreover, preexisting...
Organization: Oak Ridge National Laboratory
Authors: Virginia H Dale , Henriette I Jager , Amy K Wolfe , Rebecca A Efroymson

DOE Funded

Impacts of oil price shocks on the United States economy
Policy makers are interested in estimates of the potential economic impacts of oil price shocks, particularly during periods of rapid and large increases that accompany severe supply shocks. Literature estimates of the economic impacts of oil price shocks, summarized by the oil price elasticity of...
Organization: Oak Ridge National Laboratory
Authors: Gbadebo A.Oladosu , Paul N.Leiby , David C.Bowman , Rocio Uría-Martínez , Megan M.Johnson

DOE Funded

A multi-scale comparison of environmental effects from gasoline and ethanol production
Understanding the environmental effects of alternative fuel production is critical to characterizing the sustainability of energy resources to inform policy and regulatory decisions. The magnitudes of these environmental effects vary according to the intensity and scale of fuel production along...
Organization: Oak Ridge National Laboratory
Authors: Parish ES , Kline KL , Dale VH , Efroymson RA , McBride AC , Johnson TL , Hilliard MR , Bielicki JM

DOE Funded

Potential land competition between open-pond microalgae production and terrestrial dedicated feedstock supply systems in the U.S.
To date, feedstock resource assessments have evaluated cellulosic and algal feedstocks independently, without consideration of demands for, and resource allocation to, each other. We assess potential land

3 – Accomplishments ➔ disseminating results

Indicators Landing Page

Bioenergy Sustainability Indicators

An indicator is defined as a summary measure that provides information on the state of, or change in, the system that is being measured. An example of an indicator is, net primary productivity per unit area and time (gC/M^2-year). Indicators provide information about the potential or realized effects of human activities on environmental, social, or economic phenomena of concern. Published analyses that offer useful recommendations for bioenergy indicators are summarized in the Indicator Checklist.

Criteria for selecting indicators:

Selection and prioritization of indicators for assessing the environmental or socioeconomic effects of a specific bioenergy system depend on many factors. Fewer, more, or different indicators may be required, depending on local context (Dale et al. 2015; Efroymson et al. 2013).

To be effective, indicators must be: Practical, Sensitive and responsive to stresses; Unambiguous with respect to what is measured, how measurements are made, and how response is measured; Anticipatory of impending changes; and Sufficient when considered collectively to reflect issues prioritized by stakeholders. Interest in understanding sustainability of bioenergy systems must be balanced by support for collecting and analyzing the data that are needed to quantify it. (Dale et al. 2013).

Limitations of indicators:

Indicators can be misinterpreted unless they are transparently and consistently applied. While human endeavors will never be indefinitely sustainable, one option can be considered more sustainable than another based on a set of criteria and indicators in a defined context (e.g., ASTM 3066a 2016; Dale et al. 2015). Caution is recommended with approaches that involve sustainability indices, or measures that combine and average the values from multiple indicators as these can mask important trade-offs that are valuable for decision making (Dale et al. 2013). See the Bioenergy Sustainability Trade-offs Assessment Resource (BioSTAR) for more information.

Management statistics, such as number of producers adopting better nitrogen application procedures, or the area under a specified type of management (e.g., no-till agriculture), can be useful and are easier to measure but require validation by objective indicators to verify the degree to which intended results are being achieved by the adoption of the practice (Eichler Inwood, 2018).

Models are useful for estimating effects and making projections but to draw conclusions, simulations require calibration and validation based on observations. Objectively verifiable indicators and transparent analyses to allocate attribution among potential causal agents, are essential ingredients for science-based assessments (Efroymson et al. 2013, 2015). Thus, while indicators such as changes in carbon stocks or biodiversity are valid and important, “land-use change” that relies on simplified model constructs, may be misleading (Kline et al. 2011).

INDICATOR CHECKLIST

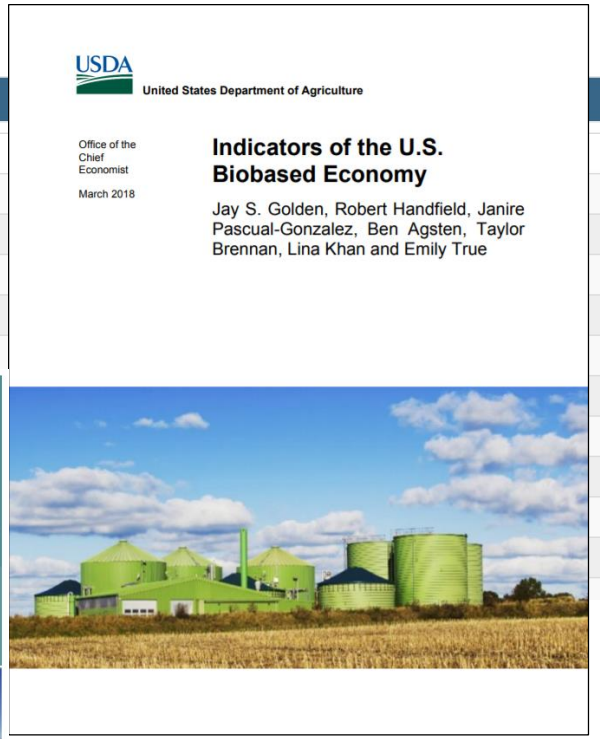
JUMP TO:

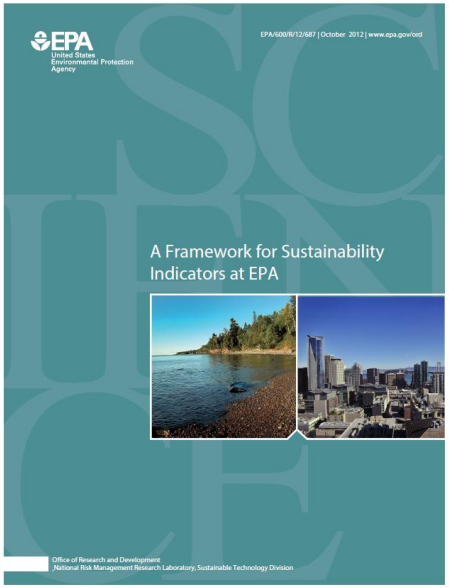
Economic Indicators | Environmental Indicators | Social Indicators

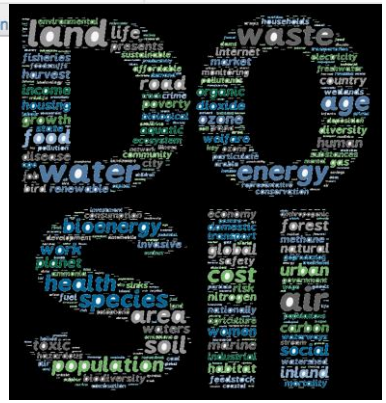
Economic Indicators

Category	Sources	Indicator	Units
Resource Demand	Golden et al., 2018	Total bushels of corn used for fuel ethanol	Billion bushels
Physical capacity to meet demand	Golden et al., 2018	Total ethanol production versus total ethanol consumption	Billion gallons
Physical capacity to meet demand	Golden et al., 2018	Total volume of ethanol exported	Billion gallons
Physical capacity to meet demand	Golden et al., 2018	Total volume of ethanol imported	Billion gallons
Physical capacity of an Industry	Golden et al., 2018	Total ethanol volume from corn stover plants	Million metric tons
Physical capacity of an Industry	Golden et al., 2018	Number of ethanol plants in the Ur	
Physical capacity of an Industry	Golden et al., 2018	Number of existing plants that wer	
Physical capacity of an Industry	Golden et al., 2018	Number of existing plants that wer	
Physical capacity of an Industry	Golden et al., 2018	Number of States that have an eth	
Physical capacity of an Industry	Golden		

df.net/content/indicators-us-biobased-economy







https://docs.google.com/spreadsheets/d/1sWa47dQVT5odiNdwf-WPlT1tt0jO3bg6UA3RgSfupOg/edit#gid=0

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3 – Accomplishments – Milestones achieved

Q	Planned versus progress since last Peer Review	
2	Sustainability standards landing page developed and reviewed with stakeholders (and related go/no-go)	✓
3	Collaborations contribute to IEA Bioenergy Inter-task workshop and joint research on indirect effects (case study report)	✓
4	Video presentation on how BT16 parameters and assumptions addressed LUC & ILUC	✓
1	Identify data sources and related opportunities to update and improve LUC analyses	✓
2	Hypotheses to be tested are developed with input from international collaborators	✓
3	Develop proposals and outlines for two LUC research initiatives	✓
4	Invitation issued for partnering and collaboration on LUC research	✓
1	Sustainability indicators webpage operational with multi-agency data - coordinated with SBIWG	✓
2	Report summarizes results of the team's research efforts to identify key assumptions lacking support, based on joint research to date	Under -way

4. Relevance to DOE goals

supports

Project

- Responds to industry concerns
- Identifies approaches to clarify and reduce negative ILUC risks
- Leverage resources via in-kind collaborations
- Conducts joint science-based research

supports

BETO MYPP

- Reduce uncertainties about market access
- Increase understanding of science-based approaches for assessment
- Support high-quality, reproducible, analyses conducive to
  - Continual improvement
  - Increasing sustainability
  - Adoption of better practices

DOE-EERE Goals

- Address barriers for market acceptance
- Accelerate deployment of domestic sources
  - Clean
  - Secure
  - Bioeconomy
- Lower transaction costs
- Reduce investment uncertainties
- Create value-added jobs

4 – Relevance: Industry perspectives & critical success factors (technical, market, business)

- "*LUC and related issues of leakage and food security are the biggest issues for all pathways involving biomass harvest*."
  - International Sustainability Quality group leading the EU 2020 ProBio Project

- *To avoid a U-turn on advanced biofuels, a "clear and robust" sustainability framework that provides policy certainty and investment security is essential.*
  - Laura Buffet, Industry consultant

Example of risk: US pellet exports value $1 billion (2017)

- UK Royal Society, EU & Industry representatives agreed that the "thorniest barrier" to biofuel acceptance and "largest source of uncertainty" is LUC & ILUC.
  - Fuel of the Future Panel conclusion, 2017

- 2019: EC Regulation proposed for "high versus low ILUC risk" feedstocks: remains controversial but stakeholders increasingly demand that it be evidence-based

Summary

Making a difference:

- Testing hypotheses with evidence & transparency to improve assessment approaches
- Objectively measure & characterize disturbance & land management to clarify meaning of "LUC"
- Apply causal analysis approach for science-based attribution
- Better understanding of food security-bioenergy interactions and potential synergies
- International standards, partner reports, peer-reviewed publications

Relevance: LUC/ILUC remains a determining factor for pathways' acceptance in regulated markets

Outcomes Enduring impacts reflected by:

- Contributions to initiatives that will be continued by others – IEA, FAO, national research bodies, GBEP, Global Calculator…
- Improved understanding among leading researchers

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USDA, FAO, EPA, Universities, NSF…

Future work:

- **Complete publications**
- **Incorporate suggestions in KDF pages (sustainability, standards, indicators)**
- **Continue dialogue and partnerships to share results**
- **Identify opportunities to improve land management**
  - Build on momentum & integrate with ongoing initiatives
    - IEA Bioenergy Task 45 on sustainability
    - Monitor EU initiatives for “sustainability governance” that impact US
  - Idea: Analyses to better characterize current and future land requirements for IPCC

LUC issues link jobs, climate, food security & all indicators of sustainability.

Science-based analysis will reduce uncertainty & support better decisions.

Thank you! Additional Slides

A. Response to prior Peer Review comments
B. Publications 2017-Dec 2018
C. Presentations since April 2017 and Other reports (not listed in publications)

ISO

GBEP
Global Bioenergy Partnership

CTBE
Brazilian Bioethanol Science and Technology Laboratory

CBES
Center for BioEnergy Sustainability

GSB

CONSERVATION INTERNATIONAL

NREL

novozymes
Rethink Tomorrow

Argonne
NATIONAL LABORATORY

Response to 2017 Peer Review

Quoted comments from 2017 Peer Review

1. "Engage more directly with researchers…"
2. Is the intent "to do research or to promote research that has been done"?
3. "Relevance to BETO… appreciated… team [should] broaden its focus to include bioproducts and other aspects of the bioeconomy and not restrict its work to biofuels only"
4. "[Clarify] how and why the deliverables were chosen" – and who are collaborators?
5. "alternative framing of the goal would be to conduct research to build the rigorous evidence base on the actual land-use impacts of bioenergy policies under different approaches"

PI Responses

1. We prioritized direct engagement with research partners including some with conflicting views (see publications completed and underway and Go/No-go #2 --in supplementary slides).
2. We do both: collaborate on research and on the dissemination of results while consistently advocating for science-based approaches to analyze LUC & ILUC.
3. We agree. Effects of expanding bioeconomy have been integrated into this work, as reflected by current research (attribution, co-products, flex-markets etc.) We will publish more results in FY20 with planned carryover funds.
4. We apply EERE criteria for selecting tasks and deliverables, aiming for "high impact, additionality, transparency, and economic benefits to the US. Deliverables are developed via an interactive AOP drafting process with BETO and partners. We collaborate with other BETO projects to increase synergies as exemplified in LUC analyses for BT16 Volume 2, Iowa landscape design project, Defining Sustainability, NREL I/O matrix, and other projects.
5. We agree with this alternative framing which is reflected in the presentation and the publications in preparation.

Go/No-Go Reviews (two since last Peer Review)

1. Go/No-Go Review completed with BETO July 2017

Review comments from BETO and at least two industry stakeholders on the draft content for a KDF web page

Go/No-Go Criteria:

Decision = No-go if a majority (>50%) of review comments received are negative.

"Decision = Go if "Collaborations allow the team to develop draft content for sustainability standards web page that a majority of reviewers consider useful"

- Recommendation: "go" due to positive response from reviewers.
  - Web-page content was distributed to >70 stakeholder
  - Diverse group of industry, standards developers, LCA specialists, government, and academia.
  - Written comments received from respondents were all supportive.
  - Half of the respondents expressly agreed to contribute to next steps

Go/No-Go Reviews (2 since last Peer Review)

2. Go/No-Go Review completed with BETO October 2018

International stakeholders commit (or not) to contribute to a collaborative LUC research activities and joint publications (FY18)

Go/No-Go Criteria:

Decision = No-go if there are not at least two international partners contributing with in-kind effort to joint research initiatives.

"Decision = Go if "At least two international partners contribute to LUC research activities."

- Recommendation: "go" due to contributions documented from multiple international collaborators:
  - Biomass Research, The Netherlands; Hans Langeveld.
  - Imperial College of London, United Kingdom; Jeremy Woods
  - Royal Institute of Technology, Stockholm, Sweden; Miguel Brandao
  - University of New England, New South Wales, Australia; Annette Cowie
  - Wageningen Food & Research, The Netherlands; Wolter Elberson
  - Waterfall Group, British Colombia, Canada; Fred Ghatala
  - Chalmers University, Sweden; Goran Berndes
  - AgriQuest, The Netherlands, Foluke Quist-Wessel

Publications – pg 1

2019 Peer Review: Publications 2017 to Jan 12, 2019 = 21

1. Oladosu G and Kline KL. 2018 (in press) Pity the poor biofuels policymaker: reconsidered. Biofuels, DOI: 10.1080/17597269.2018.1476220

2. Kline KL, Parish ES and Dale VH. 2018. The importance of reference conditions in assessing effects of bioenergy wood pellets produced in the southeastern United States. World Biomass 2018-2019; p 82-86. DCM United Kingdom. *Status: Published*: http://www.dcm-productions.co.uk

3. Eichler Inwood, Sarah E., Keith L. Kline, Ivan Ortiz-Monasterio, Santiago López Ridaura, and Virginia H. Dale. 2018. Review of Sustainability Indicators for Agricultural Landscapes. *Environmental Reviews* 26(3): 299-315, https://doi.org/10.1139/er-2017-0058

4. Singh, N., Kline, K. L., Efroymson, R. A., Bhaduri, B., & O'Banion, B. (Dec. 2017). Uncertainty in Estimates of Bioenergy-Induced Land Use Change. Chapter 10 in *Bioenergy and Land Use Change* (pp. 141–153). John Wiley & Sons, Inc. https://doi.org/10.1002/9781119297376.ch10 (book chapter)

5. Fritsche Uwe R., Göran Berndes, Annette L. Cowie, Virginia H. Dale, Keith L. Kline, Francis X. Johnson, Hans Langeveld, Navin Sharma, Helen Watson, and Jeremy Woods (2017) "Sustainable energy options and implications for land use" for the United Nations Convention to Combat Desertification (UNCCD) & the International Renewable Energy Agency (IRENA). https://global-land-outlook.squarespace.com/s/Fritsche-et-al-2017-Energy-and-Land-Use-GLO-paper-corr.pdf

6. Dimitriou I., Berndes, G., Englund, O., Brown, M., Busch, G., Dale, V., Devlin, G., English, B., Goss, K., Jackson, S., Kline, K. L., McDonnell, K., McGrath, J., Mola-Yudego, B., Murphy, F., Negri, MC., Parish, E. S., Ssegane, H., and Tyler, D. (December) 2018. Lignocellulosic Crops in Agricultural Landscapes: Production systems for biomass and other environmental benefits – examples, incentives, and barriers. IEA Bioenergy Task 43. *Status: Published and available on line:* http://task43.ieabioenergy.com/publications/lignocellulosic-crops-in-agricultural-landscapes/

7. Veronika Vazhnik, Esther Parish, Virginia Dale, Keith Kline, Tom Richard (2018) *Emergent properties of sustainability: Using agroecosystem indicators within spatial and temporal frameworks*, in *Proceedings of the American Society of Agricultural and Biological Engineers*, Annual International Meeting (2018) ASABE 1800439 (doi:10.13031/aim.201800439). *Status: Published:* https://elibrary.asabe.org/abstract.asp?aid=49088&t=1&redir=aid=49088&redir=[confid=det2018]&redirType=techpapers.asp&redirType=techpapers.asp

Publications – pg 2

2019 Peer Review – Publications 2017 to present (Jan 12, 2019) = 21

8. Koponen K, Soimakallio S, Kline KL, Cowie A, Brandão M (2018) Quantifying the climate effects of bioenergy - choice of reference system. Renewable & Sustainable Energy Reviews 81:2, 2271-2280. doi.org/10.1016/j.rser.2017.05.292 https://www.ornl.gov/content/quantifying-climate-effects-bioenergy-choice-reference-system

9. Davis M, Alves BJR, Karlen D, Kline KL, Galdos M, Abulebdeh D. 2018. Review of Soil Organic Carbon Measurement Protocols: A U.S. and Brazil Comparison and Recommendation. Sustainability 10(1)53; doi:10.3390/su10010053 http://www.mdpi.com/2071-1050/10/1/53

10. Parish ES, Dale VH, Kline KL (Dec. 2017) Has pellet production affected SE US forests? World Biomass 2017-2018. DCM Productions, United Kingdom. Pages 38-42. http://www.dcm-productions.co.uk/#World%20Biomass/1

11. Dale VH, Kline KL, Richard TL, Karlen DL, Belden WW. 2018. Bridging biofuel sustainability indicators and ecosystem services through stakeholder engagement. In a Special Issue on "Biofuels and Ecosystem Services" Biomass & Bioenergy 114: 143-156. https://doi.org/10.1016/j.biombioe.2017.09.016 https://www.sciencedirect.com/science/article/pii/S0961953417303100

12. Kanter DR, Musumba M, Wood SLR, Palm C, Antle J, Balvanera P, Dale VH, Havlik P, Kline KL, Scholes RJ, Thornton P, Tittonell P, Andelman S. 2018. Evaluating agricultural trade-offs in the age of sustainable development. Agricultural Systems Volume 163, 2018, Pages 73-88. https://doi.org/10.1016/j.agsy.2016.09.010

13. Duden AS, Verweij PA, Junginger HM, Abt RC, Henderson JD, Dale VH, Kline KL, Karssenberg D, Verstegen JA, Faaij APC and van der Hilst F. 2017. Modeling the impacts of wood pellet demand on forest dynamics in southeastern United States. BioFPR 11:6, 1007-29. doi:10.1002/bbb.1803 http://onlinelibrary.wiley.com/doi/10.1002/bbb.1803/full

14. Dale VH and KL Kline. 2017. Interactive Posters: A valuable means for enhancing communication and learning about productive paths toward sustainable bioenergy. Biofuels, Bioprod. Bioref. http://onlinelibrary.wiley.com/doi/10.1002/bbb.1753/epdf

Publications – pg 3

15. Dale VH, KL Kline, ES Parish, AL Cowie, et al., (April 2017) Status and prospects for renewable energy using wood pellets from the southeastern United States. GCB Bioenergy doi: 10.1111/gcbb.12445. http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12445/full

16. Parish, ES, Dale VH, Tobin E, Kline KL 2017. Dataset of timberland variables used to assess forest conditions in two Southeastern United States' fuelsheds. Data in Brief 13: 278–290. http://dx.doi.org/10.1016/j.dib.2017.05.048

17. Parish ES, Dale VH, Kline KL, Abt RC (2017) Reference scenarios for evaluating wood pellet production in the Southeastern United States. WIREs Energy Environ 2017, e259. doi: 10.1002/wene.259 http://onlinelibrary.wiley.com/doi/10.1002/wene.259/epdf

18. Kline, K. L., Msangi, S., Dale, V. H., Woods, J., Souza, Glaucia M., Osseweijer, P., Clancy, J. S., Hilbert, J. A., Johnson, F. X., McDonnell, P. C. and Mugera, H. K. (2017), Reconciling food security and bioenergy: priorities for action. GCB Bioenergy, 9: 557–576. doi:10.1111/gcbb.12366

19. Kline and Dale in: Stupak I, Mai-Moulin T, Junginger M (editors) June 2017. Sustainability of bioenergy supply chains. Book of abstracts from an inter-Task workshop 18-19 May 2017, Gothenburg, Sweden; Inter-Task project “Measuring, governing and gaining support for sustainable bioenergy supply chains.” http://www.trippus.se/eventus/userfiles/82471.pdf

20. Dale VH, Parish ES, Kline KL, Tobin E (July 2017) How is wood-based pellet production affecting forest conditions in the southeastern United States? Forest Ecology and Management 396: 143-149. http://dx.doi.org/10.1016/j.foreco.2017.03.022

21. Kline KL and Dale VH, Chapters 2.3 and 2.4, in Junginger M et.al., (editors) Measuring, governing and gaining support for sustainable bioenergy supply chains: Summary of IEA Bioenergy Inter-Task Results 2017-2019 (in press as of Jan 2019).

Pubs – pg 4 (future work - papers in process)

2019 Peer Review – Manuscripts in review and preparation (Jan 2019) = 13

1. Dale VH, Kline KL, Parish ES. Sustainability Experiences and Insights. Status: Resubmitted to Landscape Ecology.
2. G.A. Oladosu, J.W.A Langeveld, K.L. Kline, [others tbd per contributions] Update of an Index Decomposition Analysis of uses of corn for ethanol (analysis complete; Status: internal review).
3. Kline, Dale, Langeveld, Brandao, Oladosu, Cowie; in prep. Examining conceptual models of land-use change
4. G.A. Oladosu, J.W.A Langeveld, K.L. Kline [Others per contributions] Structural Break and Causality Analyses of U.S. Corn Supply, Use, Price and Trade Data – Understanding drivers of LUC. Status: in prep.
5. Chordia M, Brandao MMR, Oladosu G, Kline K et al. Has bioethanol demand in the USA resulted in Land Use Change? Analysis of statistical data relevant to use of land and biofuel production in the USA 1994-2018 (in prep).
6. Eichler SE, Ivan Ortiz-Monasterio, Santiago López Ridaura, Keith L. Kline, and Virginia H. Dale. Assessing sustainability of agriculture: Results of a Case Study in Yaqui Valley, Mexico. (in prep for submission to Sustainability Science).
7. Virginia H. Dale, Keith L. Kline, Donald G. Hodges, Neelam C. Poudyal, Perspectives of Family Forest Owners Regarding Wood-Based Bioenergy. (Status: Invited contribution to World Biomass, publication is pending acceptance of parallel paper with Hodges et al.).
8. Hodges DG, Chapagain B, Watcharaanantapong P, Poudyal NC, Kline KL, Dale VH Opportunities and attitudes of private forest landowners in supplying woody biomass for renewable energy. Status: submitted to Renewable and Sustainable Energy Reviews.
9. Handler and Shonnard (eds.) Kline Submitted Chapter for the Research Roadmap Report for Bioenergy in Americas, based on biofuels and biodiversity research priorities by Kline et al.
10. Book Chapter, US Bioenergy Status and Future Outlook, for El Sevier, BIOENERGY: A GLOBAL PERSPECTIVE – Status and Trends at Country Level; Scarlat and Dallemand EU JRC editors.
11. Kline, Davis et al. Are sustainability standards sustainable? (Draft submitted for internal reviews to BETO and ORNL)
12. Kline et al. Developing a US bio-based economy while facilitating beneficial LUC and indirect effects (a path forward to resolve LUC/ILUC concerns associated with U.S. biomass production) –in prep.
13. Davis MR, Kline KL, Goldin Ghatala F. Science-based approaches to consider “indirect effects” for biofuel supply pathways

Other Reports or Reviews requested by sponsors - - NOT listed under publications – pg 1

1. UK Committee on Climate Change, Nov. 2018. Biomass in a low-carbon economy. Acknowledgements - Keith Kline.
2. International Energy Agency (IEA) and OECD. Paris. December 2017. Bioenergy Technology Roadmap. Prepared by Adam Brown et al. [Kline is Acknowledged for contributions to a workshop and to initial report; Kline also reviewed and provided substantive comments on pre-publication draft] http://www.iea.org/publications/freepublications/publication/Technology_Roadmap_Delivering_Sustainable_Bioenergy.pdf
3. Langeveld, Chordia, Kline, et al., Accepted proposal for EUBCE 2018 side event: A new approach to evaluate iLUC and indirect effects using statistics – exploring data from the US. (Abstract)
4. Kline report to BETO: GHG emissions and other effects of SE US wood pellets used for electricity generation – Literature Review and commentary (Oct 13, 2017).
5. Kline KL – Annual Report to Michigan Technological University on Results under the Program for International Research and Education Project on Sustainable Biofuels in the Americas (PIRE) funded by NSF as an SPP.
6. Proposal to CIMMYT for new SPP task- multiple iterations. Final Proposal was approved August 2018 with new funding for FY19.
7. Kline email report 3/27/2018 for ORNL staff, Alberta Carpenter and NREL Project Team: Take-aways from NREL Workshop on Input-Output Framework for Economic and Environmental Assessment of the U.S. Bioeconomy. Meeting highlights and suggestions for cooperation.
8. Review comments provided to BETO and IEA group 3/14 on the draft IEA Inter-Task proposal for “Assessing and governing sustainability” - planning work for the 2019-21 triennium period.
9. Q2 Milestone Completion Report on LUC analytical approaches to BETO (and 5 attachments): hypotheses, definitions.
10. Regular Progress Reports for complementary funding project including CIMMYT (4 reports) and Michigan Tech PIRE (3)
11. March: Review comments provided to BETO on draft reports including LUC aspects of the draft EPA review of RFS environmental effects.
12. Review and substantive comments were submitted to USDA, BETO and FAO for IINAS-GBEP “Guidance for implementing GBEP Indicator 7 (Biological diversity in the landscape) and Indicator 8 (Land use and LUC related to bioenergy feedstock production).” 27 June.
13. June 11: CBES report on ORNL sustainability and LUC research activities (for sponsors and collaborators >100 on distribution list).

Other Reports & Reviews requested by sponsors - NOT listed under publications – pg 2

14. Review and substantive comments were submitted to USDA and BETO on the draft IINAS- GBEP document titled, “Sustainable Development Goals, GBEP Sustainability Indicators and Proxy Indicators.” 12 June.
15. Review and substantive comments were submitted to USDA & BETO (and subsequently FAO) for IINAS-GBEP “Guidance for implementing GBEP Indicator 1 (Lifecycle GHG emissions), Indicator 2 (Soil), and Indicator 3, (Harvest levels of wood resources) 12 June.
16. Response to a BETO request, Kline assembled and submitted a list (with annotations) of twenty recent publications that may be useful to EPA as they develop an updated assessment on the impacts of renewable fuels. 22 May.
17. Reviewed 2nd order draft and submitted comments to BETO on proposed IEA Bioenergy Task for next triennium titled, “Climate and sustainability effects of bioenergy within the broader Bioeconomy” (May)
18. November: Chordia M, Brandao M, Kline K, Cowie A, Dale V and Langeveld J (2017) A new approach to evaluate iLUC and indirect effects using statistics on crop cultivation, land use, trade and deforestation. Abstract submitted for presentation to EUBCE 2018. Approved as side event on ILUC and policy.
19. Nov: Kline K, Dale V, Richard T, Karlen D, Belden W, (2017) Stakeholder perceptions on bioenergy development in midwestern U.S. state of Iowa. Abstract submitted to IEA Bioenergy workshop on “Governing sustainability of bioenergy, biomaterial and bioproduct supply chains from forest and agricultural landscapes” – for workshop in April 2018.
20. Langeveld, Chordia, Kline, et al., for EUBCE 2018: A new approach to evaluate iLUC and indirect effects using statistics – exploring data from the US. (Abstract accepted; Poster presented)
21. Three LUC manuscript Abstracts submitted to IEA Bioenergy team and BETO, targeting Special Issue on ILUC and land competition related to biofuels in journal Sustainability (March 2018).
22. Kline prepared background package on US interests in IEA Bioenergy Task 43 in support of USDA and BETO in a series of meetings and regular conference calls, sharing results with BETO and USDA as appropriate, including draft plans for next Triennium and presentations. (e.g., package distributed 21 May)
23. (Kline) The USDA classification system for subsectors included in the Bioeconomy along with proposed FY19-20 milestones to complement NREL I/O Framework for Bioeconomy- prepared and shared with BETO and NREL Project team for comments (15 May).
24. Nov 2017: Junginger, Stupak, Kline, et al.: “Sustainability and governance of bioenergy supply chains – Presentation of results of the IEA Bioenergy Inter-task project on “Measuring, governing and gaining support for sustainable bioenergy supply chains.” EUBCE side-event description (Abstract accepted for 15May2018)

Presentations since last peer review – pg 1

Presentations April 2017- Jan 2019: (53 total)

1. December 13, 2018: Maggie Davis, Keith Kline, Erin Slattery. *Bioenergy Sustainability Indicators*. Webinar Presentation to the Sustainable Bioeconomy Interagency Working Group (SBIWG).
2. Dec 05, 2018: Langholtz et al. (incl. Kline) *Lipid-based biomass resources*. CAAFI Biennial General Meeting & Integrated ASCENT Symposium, Washington, DC.
3. Dec 03, 2018: Kline KL: "*Reconciling food and biofuel, the role of flex-crops*." Invited presentation to kick-off the IEA Bioenergy and Wageningen University "Expert Workshop on variable demand as an avenue to sustainable biofuels and biobased chemicals" The Hague, Netherlands.
4. Nov 7, 2018: Stupak et al. (Kline) *Approaches to creating trust in sustainability of bioenergy through effective governance -- Results from collaboration within IEA Bioenergy and other research networks.* Advanced Bioenergy Leadership Conference (ABLC) Global+ DOE-BETO+ IEA Bioenergy Triennial Summit; 6-9 Nov; San Francisco CA.
5. Nov 7: Fritsche et al. (Kline). *Positions, perception and vision of stakeholder groups on bioenergy: Key Results from IEA Bioenergy InterTask*. ABLC Global 2018-IEA Bioenergy Triennial-DOE-BETO Summit, San Francisco, CA.
6. Nov 8: Cowie, Berndes et al. (Kline) *Methods & tools to assess the sustainability of bioenergy.* ABLC Global 2018-IEA Bioenergy Triennial-DOE-BETO Summit, San Francisco, CA.
7. Oct 11, 2018: Kline KL, Negri C and Dale VH: *Landscape planning incorporates bioenergy crops for ecosystems services*. Invited presentation for the Joint FAO-IEA Bioenergy Task 43 Workshop: Sustainable Landscape Management for Bioenergy and the Bioeconomy. 11-12 October 2018, Rome.
8. Oct 12, 2018: Kline KL: Presentation and report-out: "*How likely is your organization to collaborate with IEA Bioenergy to affect biomass outcomes*?" for the IEA Task 43-FAO Workshop, Rome Italy.
9. Oct 12, 2018: Dale, Kline, and Parish: *Cellulosic-based biofuels are strengthening rural investment – or – Opportunities for wood pellet production for energy in the Southeast US*. Invited presentation for the Joint FAO-IEA Bioenergy Task 43 Workshop: Sustainable Landscape Management for Bioenergy and the Bioeconomy. 11-12 October 2018, Rome, Italy.
10. Sept 26: Kline and Oladosu: Invited presentation: "Science and "land-use change" – Can better data and analysis address priority development needs?" Sustainability & Land-Use Change Workshop; Sponsored by the National Biodiesel Foundation. Sept 26-27, 2018. Saint Louis, MO
11. Sept 20: Kline: Invited keynote presentation titled, "Global perspectives and challenges to common assumptions about land-use change, water and biodiversity." Presented in the EU-Calc workshop "Expert consultation on the future of land use, water and biodiversity." Imperial College, London, UK. Sept 19-21, 2018.

Presentations since last peer review –pg 2

Presentations April 2017- Jan 2019: (53 total)

12. August 30: Kline and Oladosu: Invited presentation for International Energy Agency Task 38 Business Meeting, Uppsala Sweden: "ORNL& IEA Bioenergy Inter-Task Land-Use Change (LUC) Research Collaborations"
13. August 29: Kline KL. Invited presentation on "Reference Scenarios involving bio-based product systems and implications for land sector carbon accounting" for IEA Bioenergy Task 38 & 43 Workshop on "CONSEQUENCES FOR CLIMATE AND BIOENERGY OF LAND SECTOR CARBON ACCOUNTING" Uppsala, Sweden; August 28-29, 2018.
14. Aug 10, 2018: Kline KL and Dale VH. Meeting future needs for food, energy, water & nature: when & where does land matter? Ecological Society of America (ESA) Annual Meeting. New Orleans 2018.
15. Aug 8, 2018: Dale, Kline and Parish. Environmental effects of US wood pellet production for energy. Ecological Society of America Annual meeting. New Orleans 2018.
16. July 25, 2018: Kline. Invited presentation. "Humans & Nature, or Human Nature? Why it's Important to Consider Human Decisions and Socio-Economic Drivers when assessing Options." USDA-DOE Summit on Realizing the Circular Carbon Economy, July 25, 2018. Golden, CO, USA
17. June 14-15: Invited presentation for 13th Annual Energy Conference on Bioenergy & Natural Systems, New York Institute of Technology: Food Security Challenges for Bioenergy (K.Kline) https://www.nyit.edu/events/energy_conference
18. 15 May EUBCE Side-event approved: "Sustainability and governance of bioenergy supply chains – Presentation of results of the IEA Bioenergy Inter-task project on "Measuring, governing and gaining support for sustainable bioenergy supply chains" (M. Junginger et al.)
19. 16 May: Stupak, Smith, Kline, et al. Governing Sustainability of Biomass Producing Landscapes and Biomass-Based Supply Chains: Key messages from a conference on state of the art and future prospects (PPT prepared for EUBCE).
20. O7 May: Maggie Davis (Kline coauthor) invited: presented the Special Topic, "Sustainability Standards Landing Page" for the BETO- A&S Monthly Lab Call.
21. 17 April: Kline, Langeveld, Dale and Efroymson: Understanding Indirect Effects of Bioenergy: Science-based ILUC Assessment. For the IEA Bioenergy Workshop on sustainability governance in Copenhagen. An Abstract was also submitted and published in proceedings.
22. 18 April 2018: Dale, Kline, Parish, Hodges – IEA Bioenergy Workshop on sustainability governance in Copenhagen; "Governance and issues related to wood pellet production in the Southeast United States"
23. 19 April 2018: Kline K, Dale V, Richard T, Karlen D, Belden W. Invited presentation. Stakeholder perceptions on bioenergy development in midwestern U.S. state of Iowa. Abstract published in workshop proceedings and Book of Abstracts for IEA Bioenergy, "Governing sustainability of bioenergy, biomaterial and bioproduct supply chains from forest and agricultural landscapes" April 2018.

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<u>Presentations April 2017- Jan 2019</u>: (53 total)

24. 11 April 2018: Kline K, Chordia M, Brandao M, Cowie A, Dale V, Langeveld J: Examining Evidence for Drivers of Indirect Land-use Change Associated with Biofuel Policies. Oral presentation for the International Association for Landscape Ecology – US IALE – Annual Meeting.
25. 06 April: Kline prepared summary slides for two projects that comprise part of the new "Landscape Ecology and Regional Analysis" research team, led by Matt Langholtz, in Environmental Sciences Division of ORNL.
26. 05 April: Kline and Eaton provided an overview on BT16 Vol1 and Vol2 results to the consultant team working with the RSB on an Airbus collaboration to identify sustainable feedstock potentials in Alabama.
27. March 26, Golden CO: Keith presented and discussed recommended next steps with the NREL team on the "Input-Output Framework for Assessing Effects of US Bioeconomy."
28. March 23rd, 2018, Chicago, IL: Invited presentation prepared by Kline and Oladosu, presented by Oladosu: Food AND fuel not food vs fuel, updated science perspectives. For the US Grains Council Meeting and Japanese Ethanol stakeholders.
29. March 20, 2018. Washington, D.C: Energy and Land Use. Presented by Francis Johnson on behalf of Uwe Fritsche, Kline, Dale, et al., for World Bank Conference on Land & Poverty special session on "Leveraging Land Governance and Sustainability." https://www.conftool.com/landandpoverty2018/index.php?page=browseSessions&form_session=574#paperID883
30. March 14: "Assessment of Environmental Sustainability Indicators: ORNL Contributions to Landscape Design for Sustainable Bioenergy Systems, presented by Esther Parish (coauthors Kline, Dale, Baskaran and Efroymson) Des Moines, Iowa for Landscape Design Project stage-gate Review.
31. Feb 27: Kline invited: prepared and presented "Bioeconomy Scenarios, Indicators, Economic Analysis & ORNL research related to framework for assessing effects of expanding US Bioeconomy" to identify potential collaborations, in the NREL Workshop on a "Framework to assess effects of expanding Bioeconomy."
32. Feb 5, 2018: Esther Parish presented the Special Topic, "ORNL's Research into the Sustainability of Southeastern United States' Wood Pellet Production" (Kline and Dale, coauthors) for the BETO- A&S Monthly Lab Call.
33. Dec 21, 2017: ORNL Update on Sustainability Aspects of Antares Landscape Design Project, by Dale, Kline, Parish et al. Presented for the Antares Team meeting.
34. Dec 4th : Davis, Kline and Raschke organized the Reference Scenario kick-off webinar. Davis led the presentation (Kline coauthor) describing the project goals, next steps, timeline.

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Presentations April 2017- Jan 2019: (53 total)

35. Dec. 6: Keith gave a presentation in Houston, Texas, about the new project to develop a Protocol for Reference Scenarios involving Bio-based Product Systems in conjunction with the annual meeting of ASTM International Committee E48 on Bioenergy and Industrial Chemicals from Biomass.
36. Dec. 7: Virginia Dale, Keith Kline, and Esther Parish. Invited. Environmental Challenges and Opportunities in the Food-Energy-Water Nexus; First workshop of the US-China Food-Energy-Water Systems Transdisciplinary Environmental Research Network (FEWSTERN) in Nashville, TN.
37. Dec. 8: Esther Parish, Keith Kline, V Dale. Invited. "Development of an indicator approach to assessing bioenergy sustainability" FEWSTERN
38. Dec. 8: Keith Kline. Invited, "Food and Fuel: when does land matter?" FEWSTERN, Nashville, TN.
39. 39. Nov 29: Keith presented, "Of time steps and partial analysis: Comparing periods of growth in US ethanol production with US NRI data on changes in land cover and land use in the U.S." for BETO sponsors and other lab representatives invited to join the Quarterly Project check-in. This presentation fulfills part of the Q1 milestone and was also shared with colleagues reviewing issues concerning documentation of LUC effects of the RFS.
40. Nov. 15-17: Maggie Davis (with Kline et al.) presented at the Annual Society of American Foresters (SAF) National Convention in Albuquerque, NM. Davis, M., Kline, K., and Langholtz, M. 2017. "Measuring Sustainability: The Role of International Standards & Relevance to Bioenergy Trade & Industry."
41. Nov 7-8: Keith Kline gave an invited presentation on "Measuring Sustainability of Bioenergy Systems" at "Ethanol in the Americas Workshop" sponsored by the Global Bioenergy Project and Bioenergy for Latin America, Caribbean and Africa (LACAf) Project at the University of Florida Gainesville http://bioenfapesp.org/gsb/lacaf/index.php/workshop-ethanol-in-the-americas
42. Oct. 19: Virginia Dale gave a presentation (coauthors Kline, Parish, Baskaran) to the BETO Landscape Design team led by Antares Inc. about how the ORNL approach to quantify progress toward sustainability would be implemented and describing proposed scenarios and key indicators for the project.
43. Oct. 19, 2017: Keith Kline gave an invited keynote presentation on the interactions among bioenergy and food security for the "Ethanol Summit of the Americas," Houston, Texas.
44. July 12: Keith Kline invited presentation in BioEconomy 2017 (US DOE) Conference in plenary session entitled Catalyzing a Global Advanced Bioeconomy: "Biomass Feedstocks for Energy – IEA Bioenergy Task 43"
45. Aug. 6-11: Keith Kline presented "Estimating land-use change effects associated with supplying a billion-ton U.S. bioeconomy" at the Ecological Society of America annual meeting in Portland.

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<u>Presentations April 2017- Jan 2019</u>: (53 total)

46. Aug. 6-11: Keith Kline co-authored the presentation, “status and prospects for renewable energy using wood pellets from the southeastern United States” (presented by V.H. Dale) at the Ecological Society of America annual meeting in Portland.
47. June 6: Status and prospects for renewable energy using wood pellets from the southeastern United States,' Virginia Dale (Kline coauthor) presented to the bioenergy working group of the European Commission. Webinar.
48. June 21: Keith Kline gave an invited presentation to the United States Agency for International Development (USAID) in Guatemala on “Progress toward Sustainable Farming Systems and Landscapes.”
49. May 18-20: Keith Kline and Virginia Dale coauthored overview presentation for the workshop organized by the IEA Bioenergy Intertask on Sustainability.
    May 18th, Dale and Kline: "Relating ecosystem services to indicators of progress toward a sustainable bioeconomy."
50. May 18: Kline and Dale: "Bridging ecosystem services and sustainable bioenergy indicators with stakeholders” for IEA Bioenergy Inter-task workshop.
51. May 19: Dale and Kline: "Linking measurement and governance: wood pellets from the southeastern United States," IEA Bioenergy Intertask workshop.
52. April 25: Keith Kline gave invited presentation, “Biomass Resources & Sustainability Assessment in the United States” for the IEA Bioenergy Biomass Roadmap Workshop on Sustainability Governance, Ministry of Foreign Affairs, Paris, France. IEA: “The aim of this workshop is to review the criteria which “sustainable biomass” needs to meet – not only for bioenergy but also for other components of the bioeconomy.”
53. April 9 2017: Keith Kline gave a presentation on “Can sustainability standards and certification improve landscape outcomes?” for the US Regional Association of the International Association for Landscape Ecology (US IALE).

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