

**U.S. Department of Energy (DOE)
Bioenergy Technologies Office (BETO)
2017 Project Peer Review**

WBS 4.2.1.41

**Collaborations to Assess
Land Effects of Bioenergy**

Focus on Land-Use Change (LUC)

**March 8, 2017
Analysis and Sustainability**

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Goal: Transform the LUC-bioenergy debate from its focus on concerns to one targeting *opportunities to improve land management* for food and energy security, and other social and environmental benefits.

- ✓ Develop a new LUC paradigm through collaborations with strategic partners
- ✓ Leverage research, outreach, & publications focusing on priority topics and opportunities
- ✓ Increase international awareness of sound criteria, definitions & measurement methods



Support for DOE Goals

- Consistent science-based message
- Improved LUC assessments facilitate value-added economic growth & jobs
- Exchanges accelerate tech transfer & adoption of best practices for clean, efficient biomass-based technologies

Industry Relevance

- Lower transaction costs
- Reduce uncertainties associated with LUC
- Reduce non-tariff trade barriers for more equitable market access

Quad Chart Overview

Timeline

- Project start: FY17
- Project end: FY19
- Percent completion: 15%

Builds on 2015-16 Addressing Global Barriers & Standards project

Budget

\$k	FY16 Costs	FY17 Plan	Total Planned (FY17-19)
DOE	\$ 300	\$350	\$1,350

Plus cash¹ and in-kind cost share by other partners

¹ National Science Foundation (NSF-IIA #1243444) Michigan Technological University, Sustainable Bioenergy in Americas, Program for International Research & Educ. (PIRE), Research Coordination Network (RCN)...

BETO Barriers

- Scientific consensus on sustainability, supported by consistent *science-based message*... best practices (ST-A,B,C...G)
- *Standards* and approvals; High \$ Risk; and *Acceptance* as viable alternatives (Im-B,C,H)
- Understanding *tradeoffs* including food supply (Mm-A).

LUC: cross-cutting, global

Partners

- >International organizations: Food and Agriculture (FAO), international cooperative research centers (IFPRI on food policy; CIMMYT on sustainable systems, etc.)
- >Private sector, trade groups, & standards bodies (ASTM International, CEN, ISO & >50 national bodies, industry partners & international organizations)
- >Other labs, agencies & research centers: ANL, NREL, INL, EPA, USDA (ARS, ERS, NLAE, Forest Service) University of Tennessee, Lorentz Center, Utrecht, Imperial College, Chalmers...

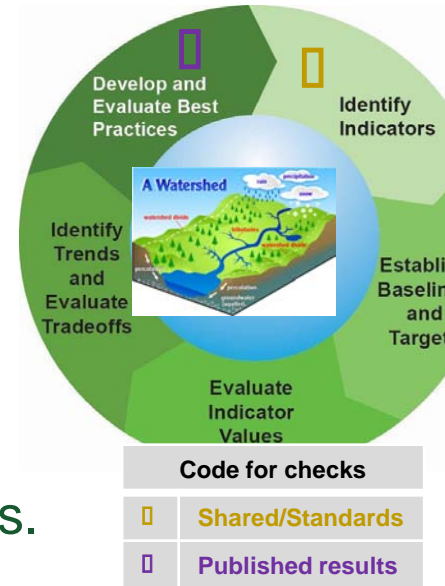
===Contributions based on common interests ===

1. Overview: history & context

Challenge: LUC concerns are major & contentious barriers to a bio-based economy. Regulatory frameworks such as

- US Renewable Fuel Standard
- California Low-Carbon Fuel Standard
- the EU Renewable Energy Directive and
- other state & regional requirements,

establish goals & thresholds sensitive to LUC. Attempts to reduce perceived LUC threats (e.g., certification) are undermined by lack of science-based assessment methods.



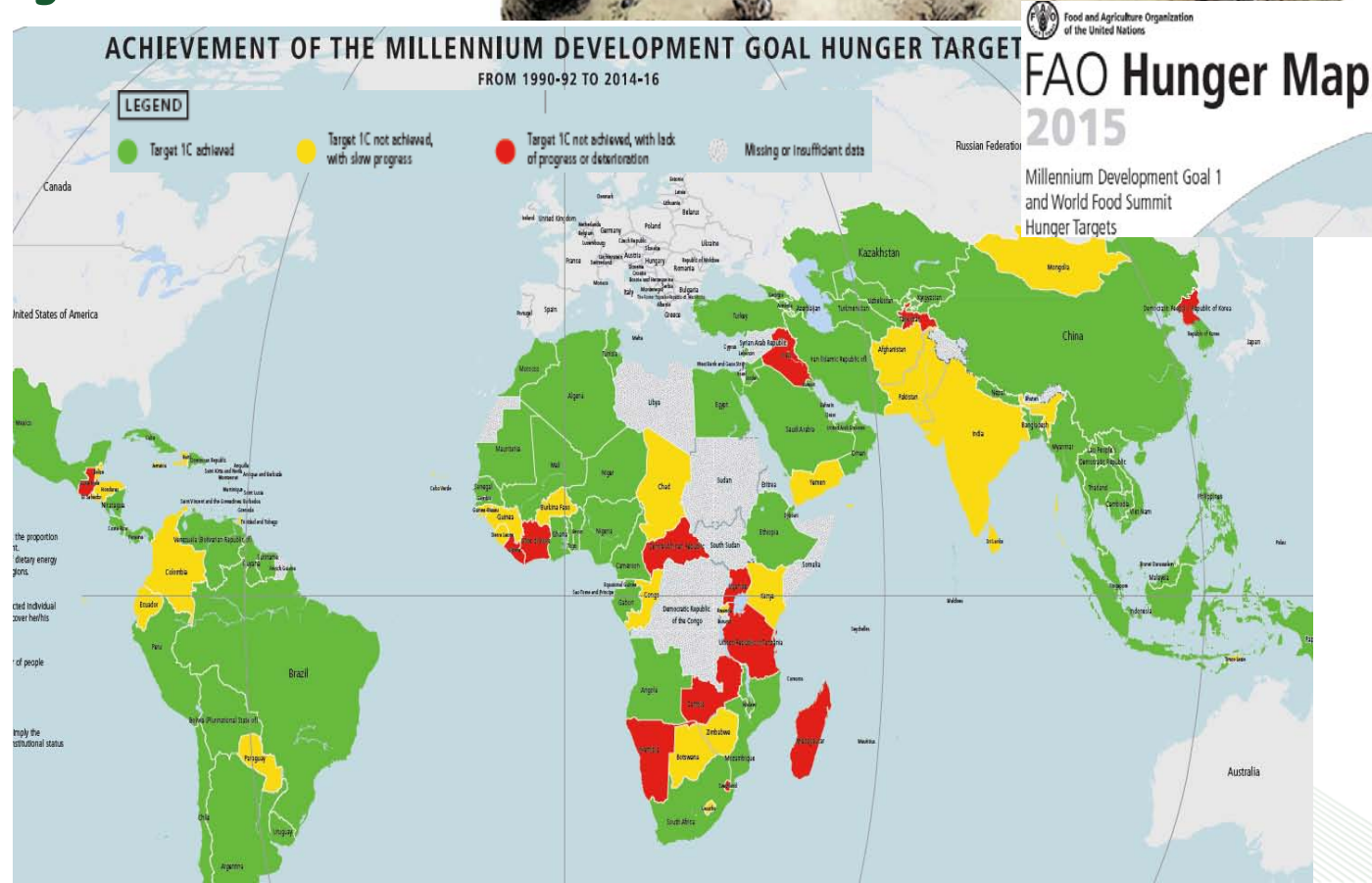
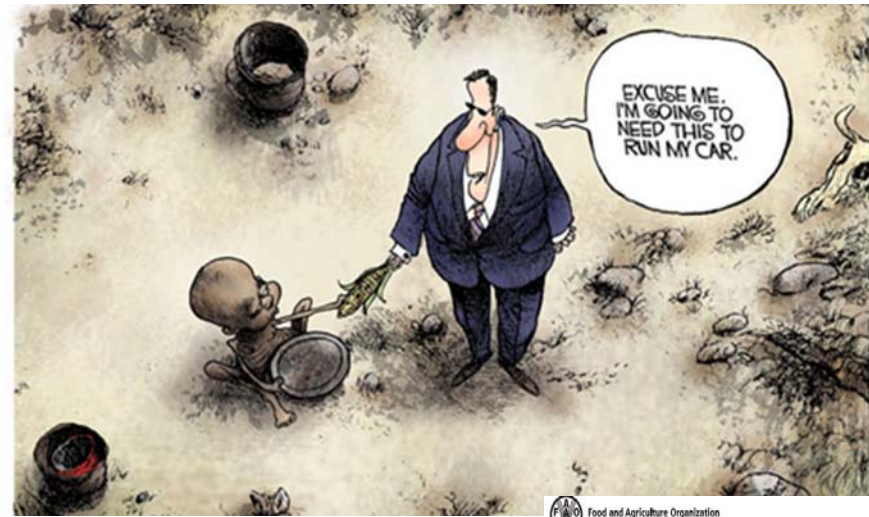
Uncertainties about LUC undercut investment and acceptance of bioenergy with implications for **all** bio-based industries.

Fit in portfolio: Addressing LUC is key to achieving communication goals, technology validation and BETO's vision to enable sustainable markets.

High-level objectives and end-of-project outcomes support DOE goals to promote a clean, sustainable, bioeconomy.



Non-technical challenges: As long as hunger exists in the world, concerns about bioenergy effects on food security will persist.

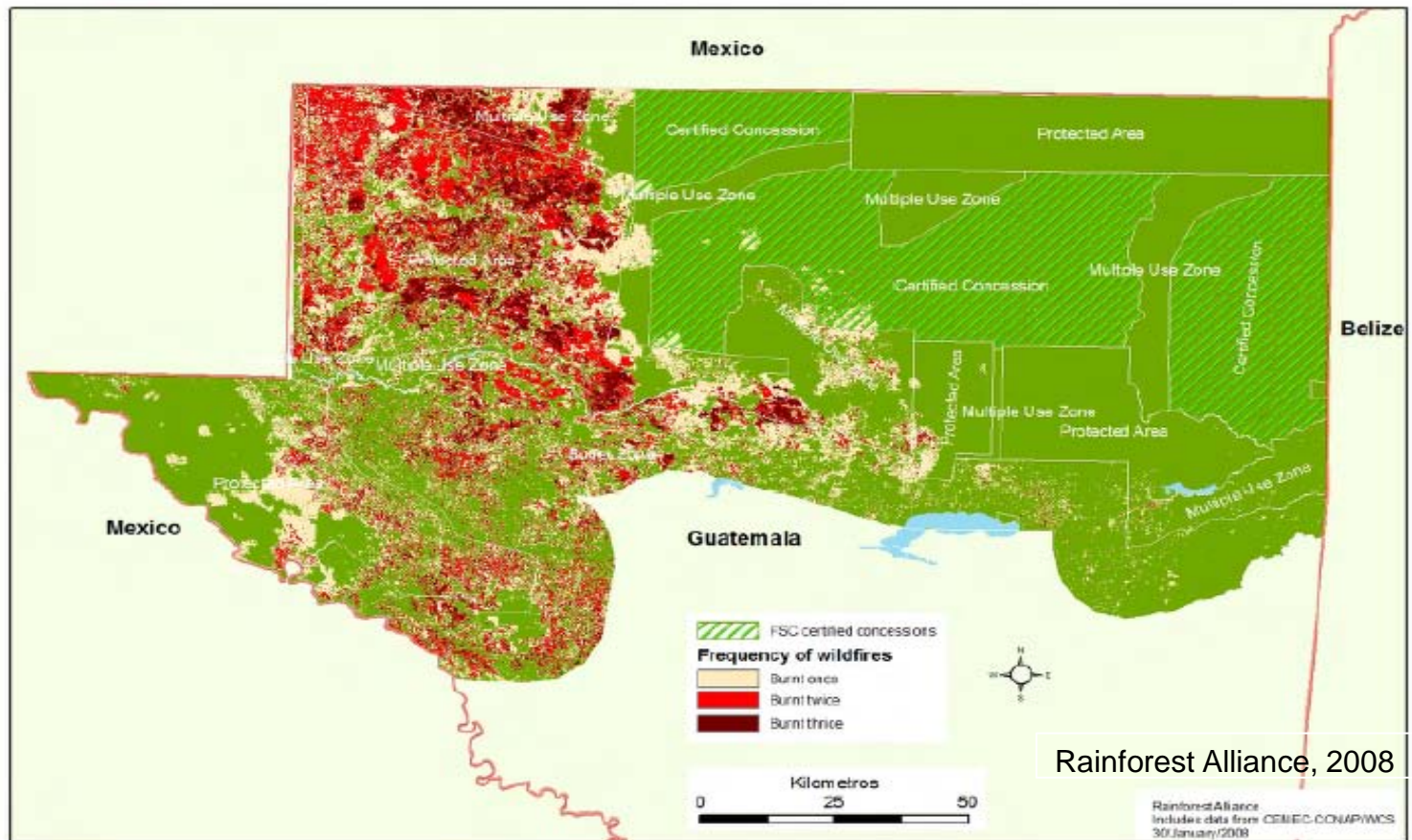


Non-Technical Challenges: As long as deforestation continues, concerns about LUC will persist.

In the Maya Biosphere Reserve, Guatemala, habitat loss, contamination of water & soil, & new settlements, are legacies of oil exploration and extraction, not agriculture.

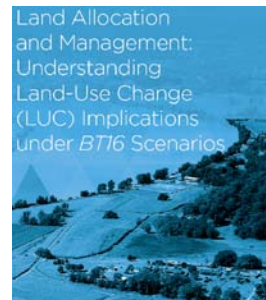


Wildfires - 2003, 2005 & 2007



Overview: history & context (cont.)

- ✓ **Responsive: industry requested BETO help** with standards & practices to avoid non-trade barriers to markets & investment (LUC uncertainties) – consistent with BETO Mission.
- ✓ **Consistent:** emphasis on clear definitions, procedures, & indicators supports DOE communication goals
- ✓ Strategic partnerships are forming around **science-based approaches** to address **technical challenges** that must be overcome to generate more reliable LUC assessments.



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Essential to review assumptions (illustrative list):

- Land use / land management \neq remote sensed land cover
- Drivers of deforestation \neq global commodity prices
- Excess supply capacities \neq 'demand shock'
- Public lands \neq private owner decisions
- Isolated/distorted markets \neq perfect allocations in equilibrated markets
- Bioenergy investments \neq compete with food security

Success factors: catalyze evidence-based LUC analysis & broad ownership of new understandings \rightarrow improve baselines, models & analysis; effectively communicate \rightarrow raise public awareness & support \rightarrow reduce political and economic barriers to investment & growth

- ✓ **Develop standard methods** to reduce costs & complexity of LUC assessment

2. Approach (Collaborative)

Milestones are defined & delivered

- Milestones for 2017-19 were updated based on:
 - Guidance from 2015 Peer Review
 - Learning from prior work
 - 2017 Merit Review, industry, stakeholders
 - **Tasks prioritized** based on criteria
 - **Go/No-go decision points:** approvals and commitments from partners (contribute to joint research and costs); feedback from stakeholders
 - Example: International standards, food security tasks:
 - Defined timelines & decision-points
 - Roles distributed, commitment to follow-up as necessary (e.g., ISO → ASTM International)

**Overall challenge:
Existing
paradigms are
widely held &
supported**

**Build global network
of researchers
committed to
producing evidence-
based analyses**



Work plans, weekly teams meetings, decision points

- BETO IEA & International: biweekly; Center for Bioenergy Sustainability (CBES): monthly; Other labs & teams (as needed) + structured **role in BETO quarterly reviews.**
- Coordinated contributions on standards; gap-filling roles (ISO, IFPRI, ASTM, IEA-Bioenergy...)
- Backup plans at multiple levels (e.g., results, analysis, and follow-up)
- Interpersonal exchanges & networks key to achieve goals (ISO, IEA, NSF-research coordination in Americas, FAO-IFPRI food security... among examples)

Broad report distribution, KDF & CBES web platforms, facilitate coordination & expand BETO impacts.

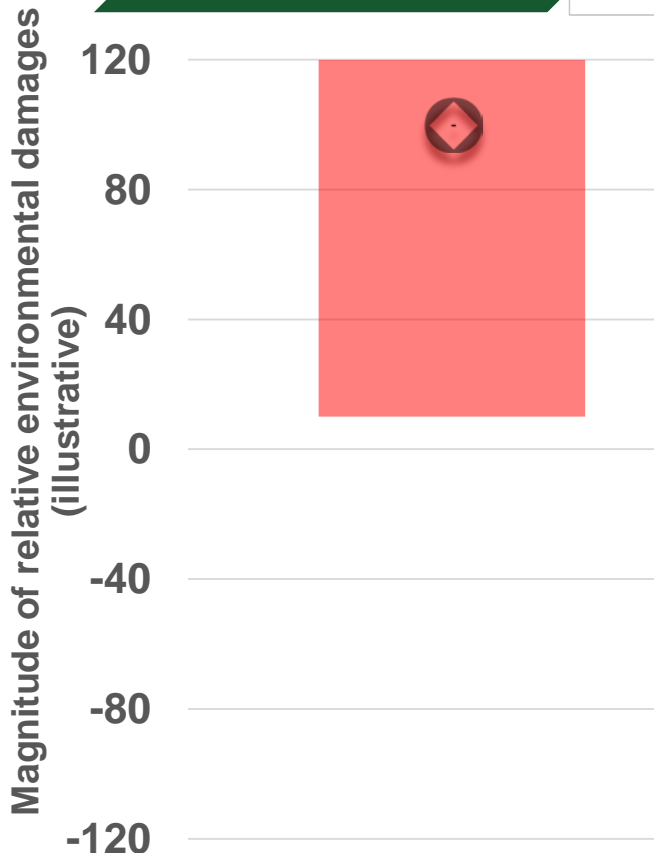
2. Mapping the approach

Where we started

LUC was assumed to have huge impacts with large but undocumented uncertainties.

All LUC impacts were assumed to be negative

(Illustrative Figure: relative damages associated with magnitude of GHG emissions)



2. Mapping the approach

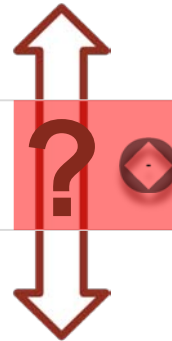
LUC assumed to have smaller but still significant negative impacts. Big uncertainties persist.

New questions arising: Under what conditions could effects be beneficial?

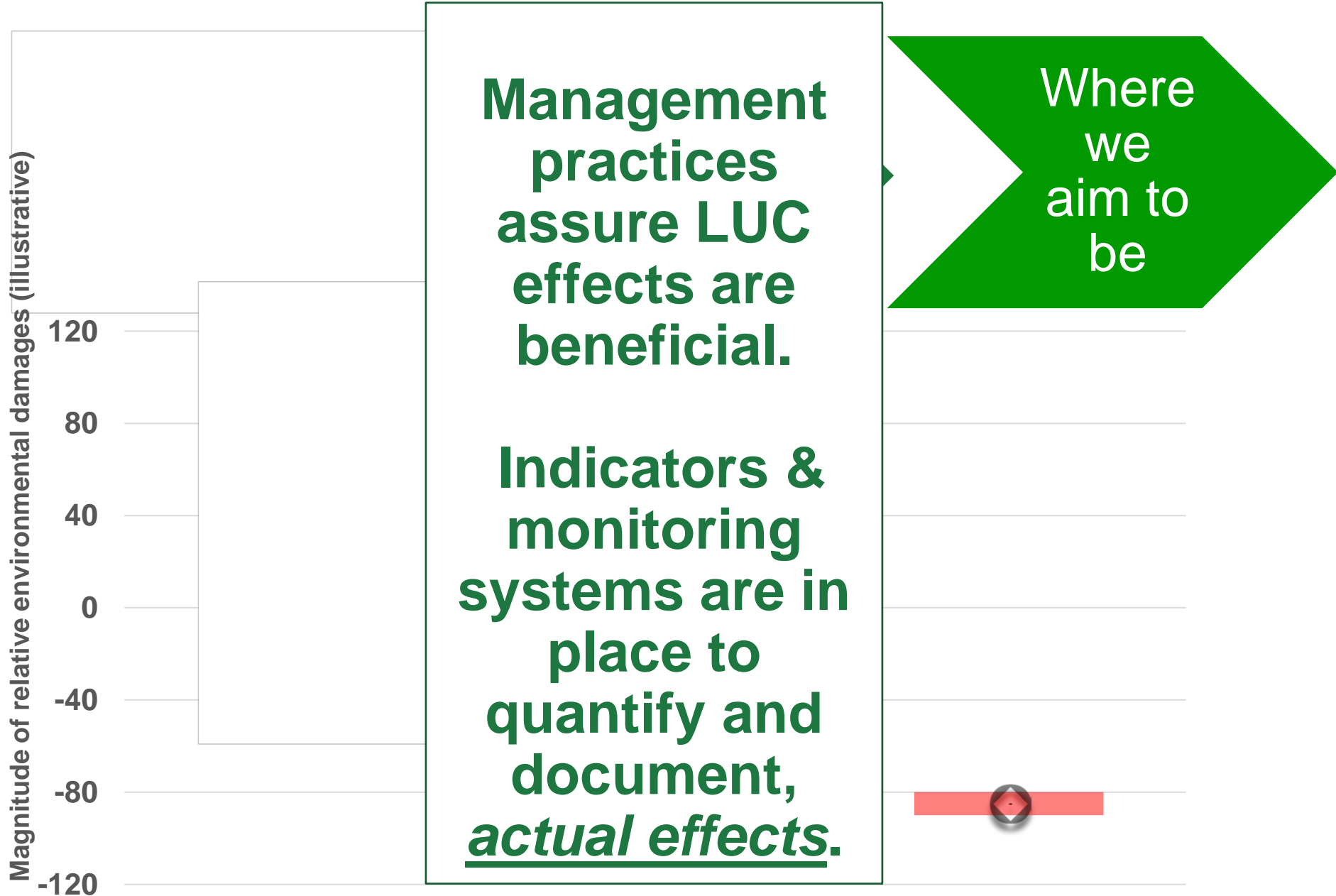
Where we are

Magnitude of relative environmental damages (illustrative)

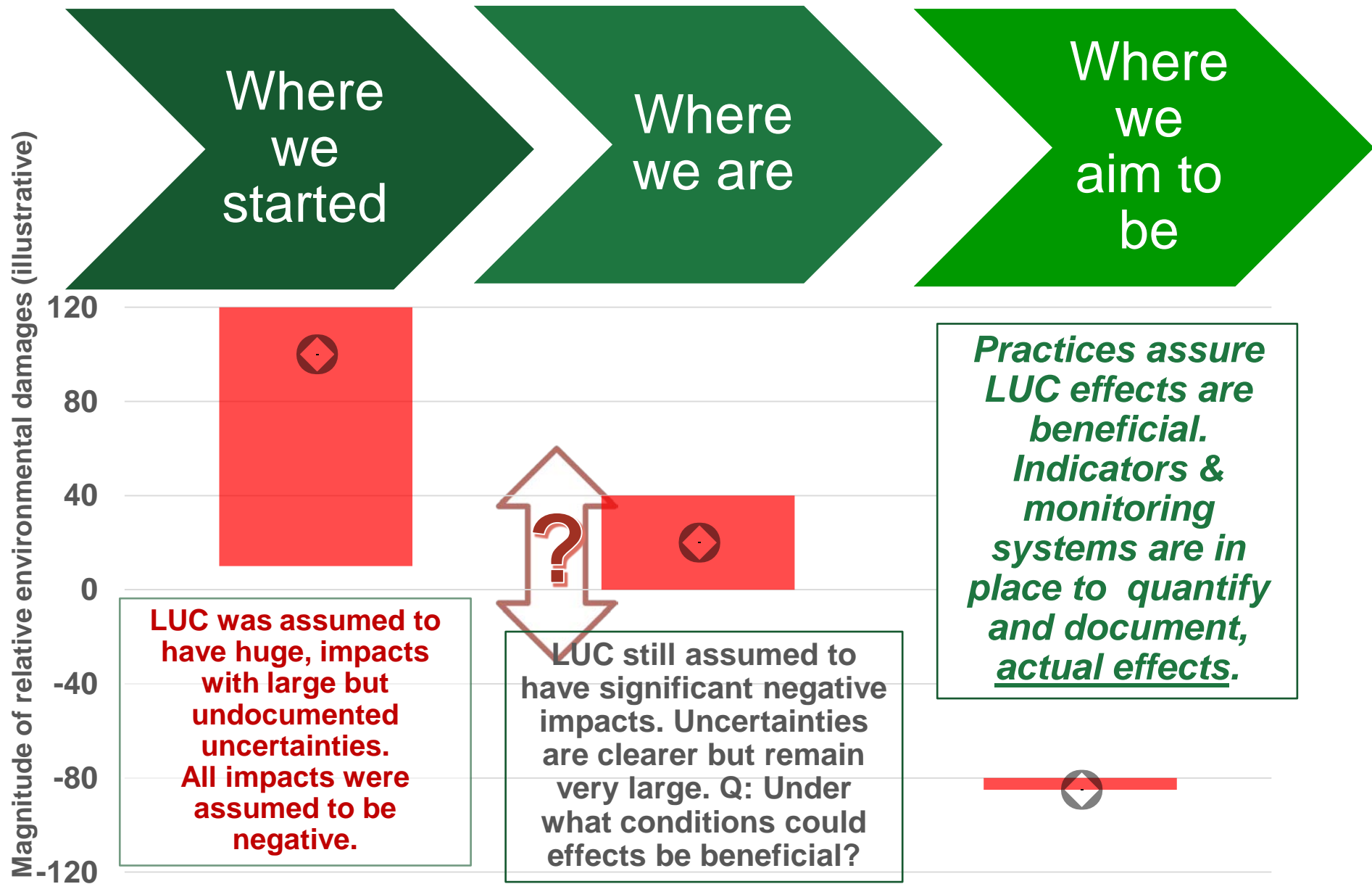
120
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-120



2. Mapping the approach



2. Mapping the approach



2. Approach: technical, science-based

Strategic focus based on criteria

- Target high-impact opportunities
- Fill key gaps (e.g. LUC depends on “reference case” so formed international team: paper forthcoming)

Leverage resources to extend & multiply BETO impacts

- Strengthen partnerships: mutual interests → mutual rewards
- Build broad-based support for analysis (e.g. Research Collaboration Networks-NSF, Consortium of International Agricultural Research Centers (CGIAR system), universities, voluntary standard-setting bodies)
- ✓ Integrate with multi-lateral dialogues (e.g., IEA-Bioenergy)
- ✓ Distribute effort, optimize available resources

Accelerate tech-transfer

- Cost-effectively reach global audiences
- Link expertise from BETO & partners for synergies across labs, platforms, agencies
- Share & apply ‘latest, greatest’ BETO research for transformational change

Disseminate results of technically sound, peer-reviewed, interdisciplinary research



3. Synopsis of Accomplishments (since March 2015)

Shifting the debate through:

- Outreach & communications:
 - ✓ **Publications: 21**
 - ✓ **Presentations: 38**
 - ✓ Other reports, manuscripts: **25**
- International standards: ISO 13065 **Sustainability Criteria for Bioenergy**
 - ✓ US industry partners thank BETO & ORNL for leadership
- International Standards: ASTM International **Standard Practice for Evaluating Relative Sustainability** (with project 3.1.3.2)
 - ✓ Requested by industry
 - ✓ Applied prior learnings (BETO, ISO, networks)
 - ✓ Facilitated input, international partners
 - ✓ Supported Sustainability Subcommittee E48.80 through 4 drafts, 2 votes, final approvals
 - ✓ ASTM-E3066 published 2017
- Other contributions per BETO (IEA-Bioenergy tasks, *Biofuture Platform*, IRENA plan, etc.)



Opportunities and Issues associated with

ASTM E-48 Celebrating thirty-one years

Reconciling food security and bioenergy:

Sustainability metrics

Interactions among bioenergy, food security and ecosystem services

Science-based approaches to improve understanding of LUC and guide decisions

Opportunities and constraints to a bioeconomy: international perspective

Keith L. Kline (klinekl@ornl.gov)
13 July 2016

Bioenergy 2016
Plenary IV

Policy for the bioeconomy
Walter E. Washington Convention Center,
Washington, D.C.

The image contains several logos: the 'BIO ENERGY 2016' logo with a stylized green leaf and '2016' below it; the 'CBES' logo with the text 'Center for Bioenergy Sustainability' below it; and a circular graphic showing a globe with a map overlay and a yellow tractor in the foreground.

FY17-19 tasks build on:

- ✓ **Prior successes & relationships**
- ✓ **External Merit Review**
- ✓ **Input from partner labs (ANL, INL, NREL) & other collaborators**

3. Technical progress: fulfilling work plans and changing the way we think about bioenergy LUC

Qtr	FY15-16 Milestones – summary descriptions	Status
Q2	Represent U.S. goals/ resolve comments & revise Draft International Standard “Sustainability Criteria for Bioenergy”	100%
Q3	Global partnerships identify priority variables that influence measurement of soil organic carbon (manuscript submitted)	100%
Q4	Contribute to ISO 13065, Sustainability Criteria for Bioenergy, meetings & work groups addressing stakeholder issues & encouraging science-based, replicable assessment methods.	100%
Q1	ISO 13065, Final Draft International Standard released	100%
Q2	Draft LUC chapter for BT16 Vol. 2 clarifies issues & terms	100%
Q3	Prepare fact sheet with international partners on achieving biofuel-food security synergies for public distribution & posting on CBES & KDF web sites	100%*
Q4	ISO 13065, Sustainability Criteria for Bioenergy, published; ISO Update Report #15 distributed with discussion of results, analysis of final content, expected outcomes & next steps	100%

*** Go/No-go decision point:** international, peer-reviewed, guidelines highlight opportunities for bioenergy-food security synergies. Result: GCB-Bioenergy (open access), links posted on CBES & KDF, widely publicized by media

3. Technical Accomplishments

Food Security–Biofuels Interactions & Synergies: Published

- Analyzed interactions among **Biofuels & Food Security**
 - Workshop Report published May 2015.
 - Peer-reviewed paper June 2016 <http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12366/full>

Examples of impact:

- **Conclusions show how biofuels can significantly enhance food security**
- **Featured in >60 news outlets, 4 continents, within 2 weeks of publication**
- **The most-downloaded article in 2016 for GCB-Bioenergy (6837 downloads in just 6 months)**
- **Prior to engagement with project, Food & Agriculture Organization (FAO) was critical of biofuels due to food security concerns. FAO became more supportive following collaborations. Director-General recently described food-versus-fuel as a “false dichotomy” and noted that biofuels can be an effective means to increase food security.**

Multi-disciplinary team (six continents, ten institutions) agreed: Integrated planning and production of bioenergy supports food security & other development goals.



Accomplishments: Research & analyses of LUC & empirical data identify ways for bioenergy investments to improve food security ^{1,2,3,4}



Modified cartoon from Gerry Ostheimer, Sustainable Energy for All, 2016 SENER Symposium



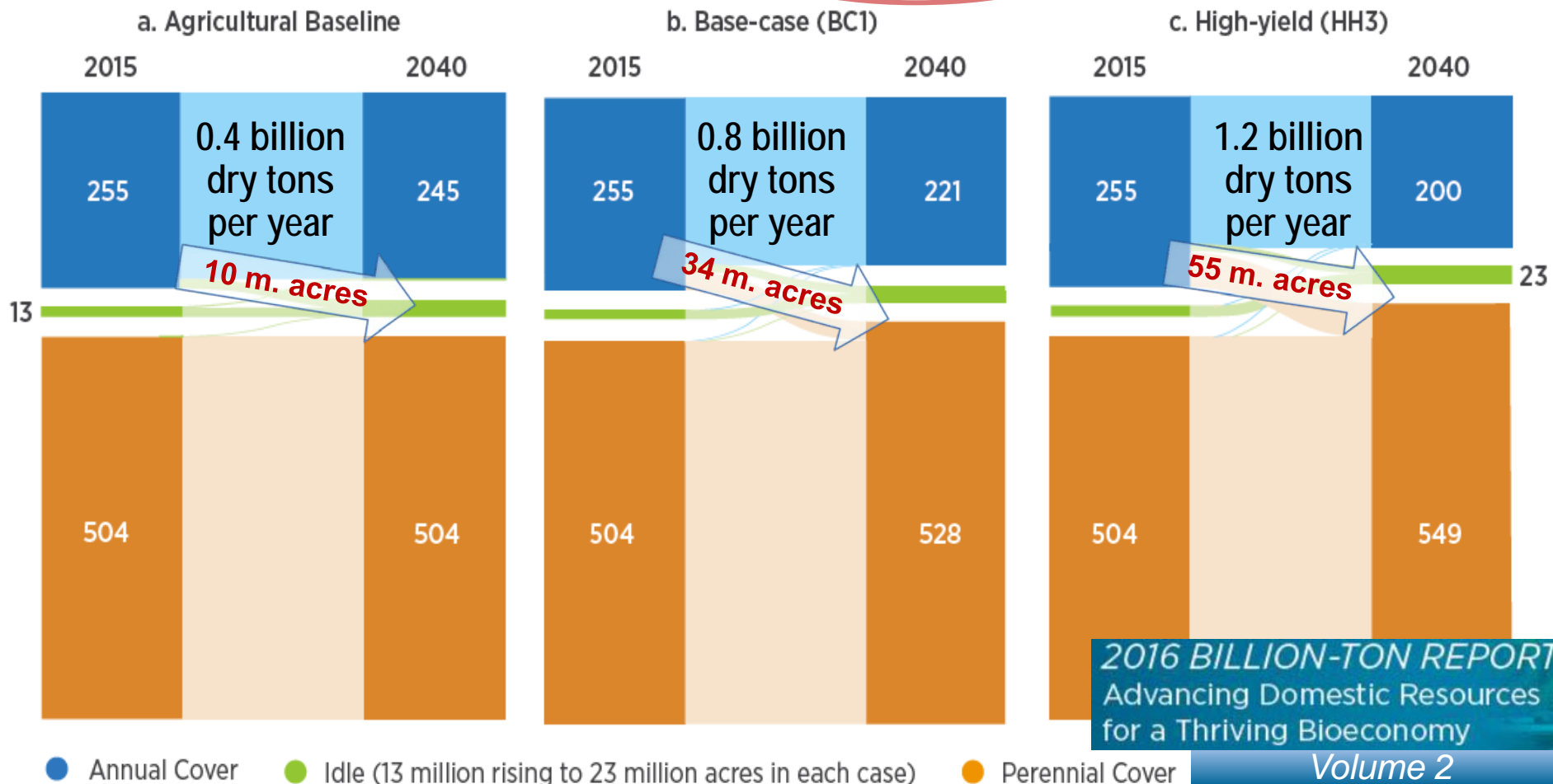
Food insecurity is context-specific & political; not due to lack of global supply^{1,4,5}

Sources: ¹Kline et al. 2009, 2011, 2016. ²Thornhill et al. 2016. ³Leonardo et al. 2015. ⁴SCOPE 72 (Souza et al. eds.) 2015. ⁵Thurow & Kilman 2009. *Enough: Why the World's Poor Starve in an Age of Plenty.*

3. Accomplishments: *Understanding LUC implications of the Billion-Ton 2016 Biomass Supply Assessment*

<https://www.bioenergykdf.net/billionton2016vol2>

Millions of US agricultural acres allocated to annual crops versus idle and perennial crops under 'low-ILUC risk' supply scenarios

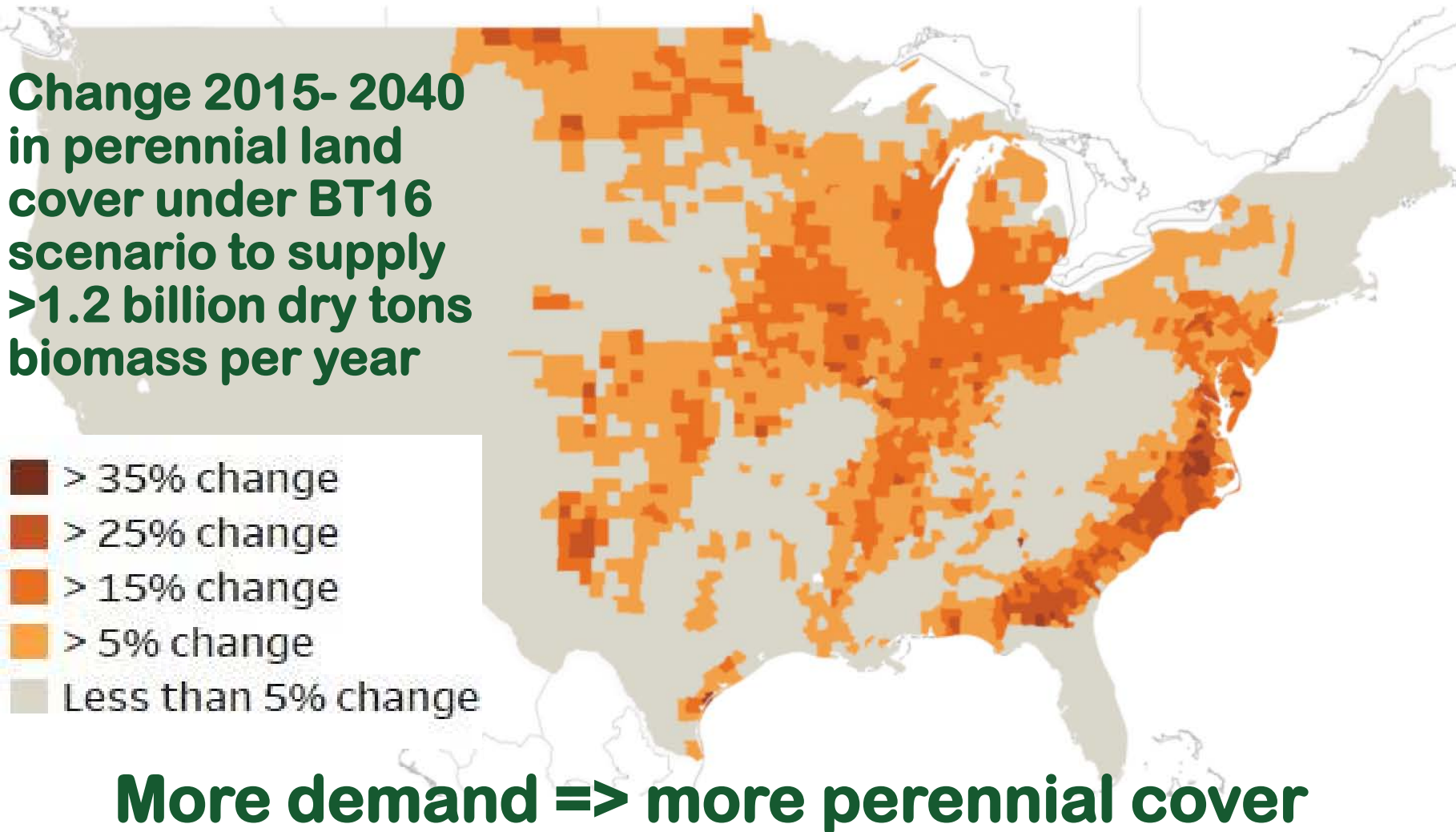


2016 BILLION-TON REPORT
 Advancing Domestic Resources
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Volume 2
 Environmental Effects

3. Accomplishments: communicate and visualize LUC associated with BT16.

Change 2015- 2040
in perennial land
cover under BT16
scenario to supply
>1.2 billion dry tons
biomass per year



More demand => more perennial cover

Understanding LUC Implications under BT16 Scenarios; 2016 Billion-Ton Report (BT16), Volume 2: Environmental Sustainability...Chapter 3, Fig 3.2 Cropland allocations under HH3

https://energy.gov/sites/prod/files/2017/01/f34/2016_billion_ton_report_volume_2_chapter_3.zip

3. Technical Accomplishments

ISO13065 “Sustainability Criteria for Bioenergy” Published!

Contributions

- Leadership role among 200 experts from 40 countries
- **Science-based** approach
- ILUC issue clarifications
- Conflict resolution
- Regular reports to BETO & stakeholders
- Documented “state of science;” shared BETO research on LUC, indirect effects & **causal analysis** (Efroyimson et al. 2016)

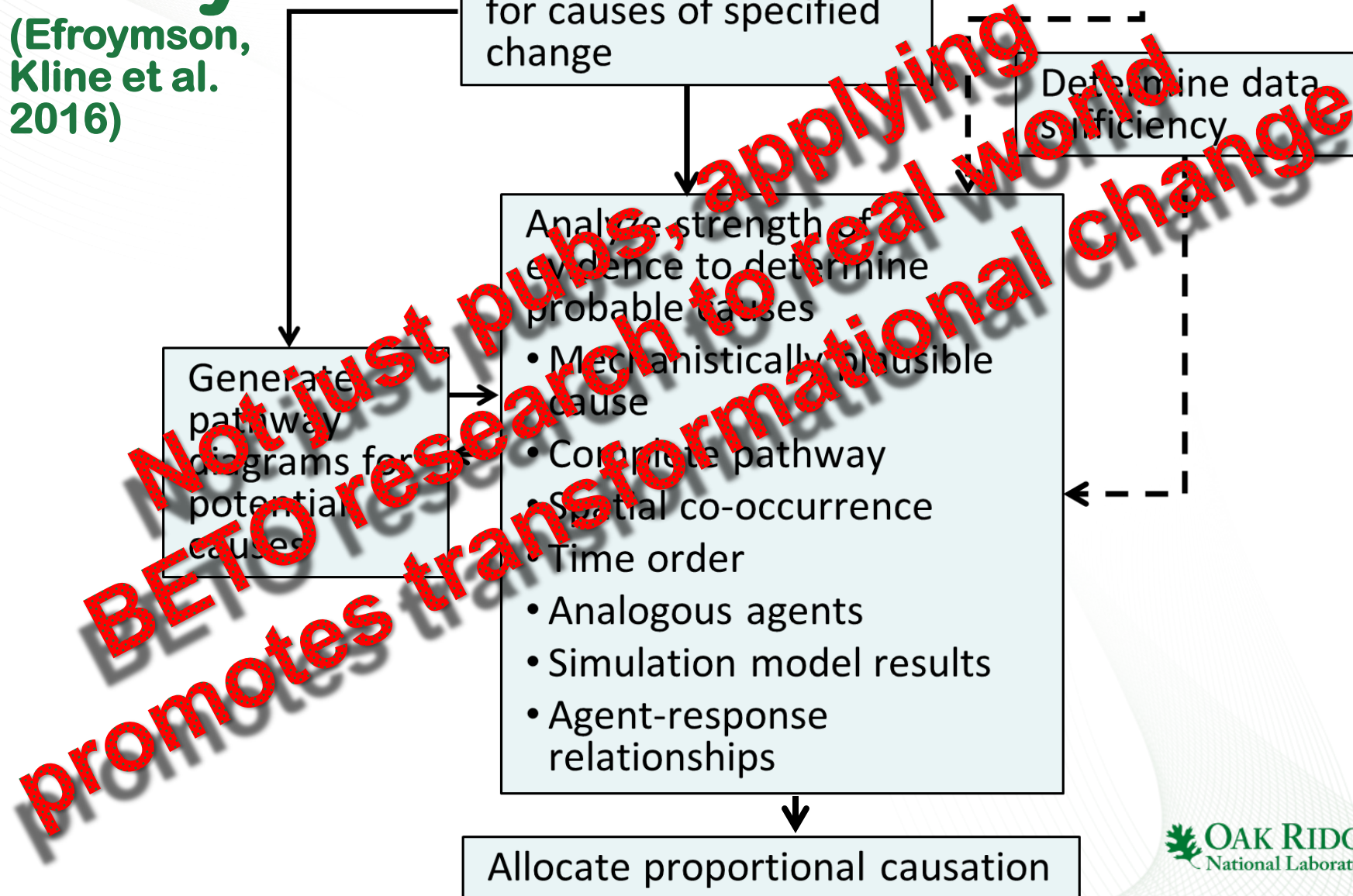
A far better product thanks to US input

*Final text on ILUC
(Indirect Effects)
“The Standard
considers the
measurable effects
under the control of
the economic operator
and **caused by** the
process being
analyzed”*



Causal Analysis

(Efroymson, Kline et al. 2016)



Not just pubs, applying BETO research to real world promotes transformational change

Accomplishments: 38 presentations, 46 reports (since March '15)

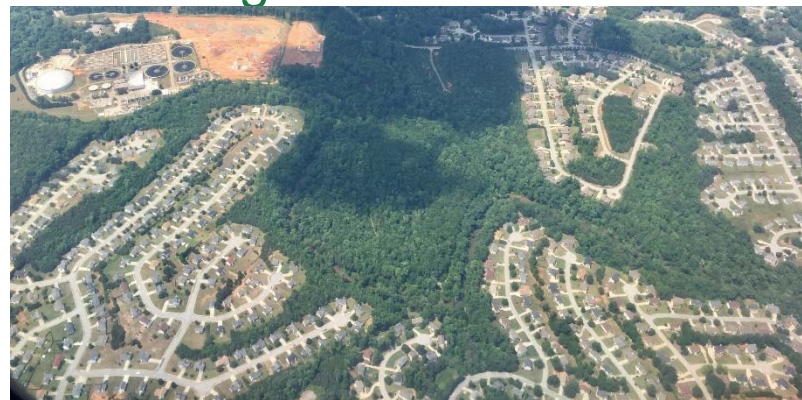
→ Persistent support for science to guide analysis

Science: systematic methods based on evidence, testing observations, replication

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

Challenges:

- **Confounding data and terminology**
 - Land cover versus land uses (multiple) & management
 - Crop price & trade versus total production & actual uses, losses
 - Correlation versus causation
- Cost of monitoring
- Science evolves as new data & understanding become available



Accomplishments: persistent support for science to guide LUC analysis: bioenergy crops can create supply cushions

Table 10.1 Renewable Energy Production and Consumption by Source
(Trillion Btu)

	Production ^a			Consumption								
	Biomass		Total Renewable Energy ^d	Hydro-electric Power ^e	Geo-thermal ^f	Solar/PV ^g	Wind ^h	Biomass			Total Renewable Energy	
	Bio-fuels ^b	Total ^c						Wood ⁱ	Waste ^j	Bio-fuels ^k		Total
1950 Total	NA	1,562	2,978	1,415	NA	NA	NA	1,562	NA	NA	1,562	2,978
1955 Total	NA	1,424	2,784	1,360	NA	NA	NA	1,424	NA	NA	1,424	2,784
1960 Total	NA	1,320	2,928	1,608	(s)	NA	NA	1,320	NA	NA	1,320	2,928
1965 Total	NA	1,335	3,396	2,059	2	NA	NA	1,335	NA	NA	1,335	3,396
1970 Total	NA	1,431	4,070	2,634	6	NA	NA	1,429	2	NA	1,431	4,070
1975 Total	NA	1,499	4,687						2	NA	1,499	4,687
1980 Total	NA	2,475	5,428						2	NA	2,475	5,428
1985 Total	93	3,016	6,084						236	93	3,016	6,084
1990 Total	111	2,735	6,041						408	111	2,735	6,041
1995 Total	198	3,009	6,558						531	200	3,101	6,560
2000 Total	233	3,008	6,106						511	236	3,008	6,106
2001 Total	254	3,008	6,106						364	253	2,622	5,163
2002 Total	308	3,008	6,106						402	303	2,701	5,729
2003 Total	402	3,008	6,106						401	404	2,807	5,948
2004 Total	487	3,008	6,069						389	499	3,010	6,081
2005 Total	564	3,117	6,229						403	577	3,117	6,242
2006 Total	720	3,216	6,599						397	771	3,267	6,649
2007 Total	978	3,480	6,528						413	990	3,492	6,541
2008 Total	1,387	3,881	7,219						435	1,370	3,865	7,202
2009 Total	1,584	3,967	7,655						452	1,568	3,950	7,638
2010 Total	1,884	4,332	8,128	2,539	208	126	923	1,981	468	1,837	4,285	8,081
2011 Total	2,044	4,516	9,170	3,103	212	171	1,168	2,010	462	1,948	4,420	9,074
2012 total:	1,929	4,406	8,743									
2013 total:	1,981	4,647	9,249									
2014 Total	2,103	4,849	9,595									
2015 Total	2,161	4,716	9,594									
2016 biofuels are on track to exceed 2015 totals												

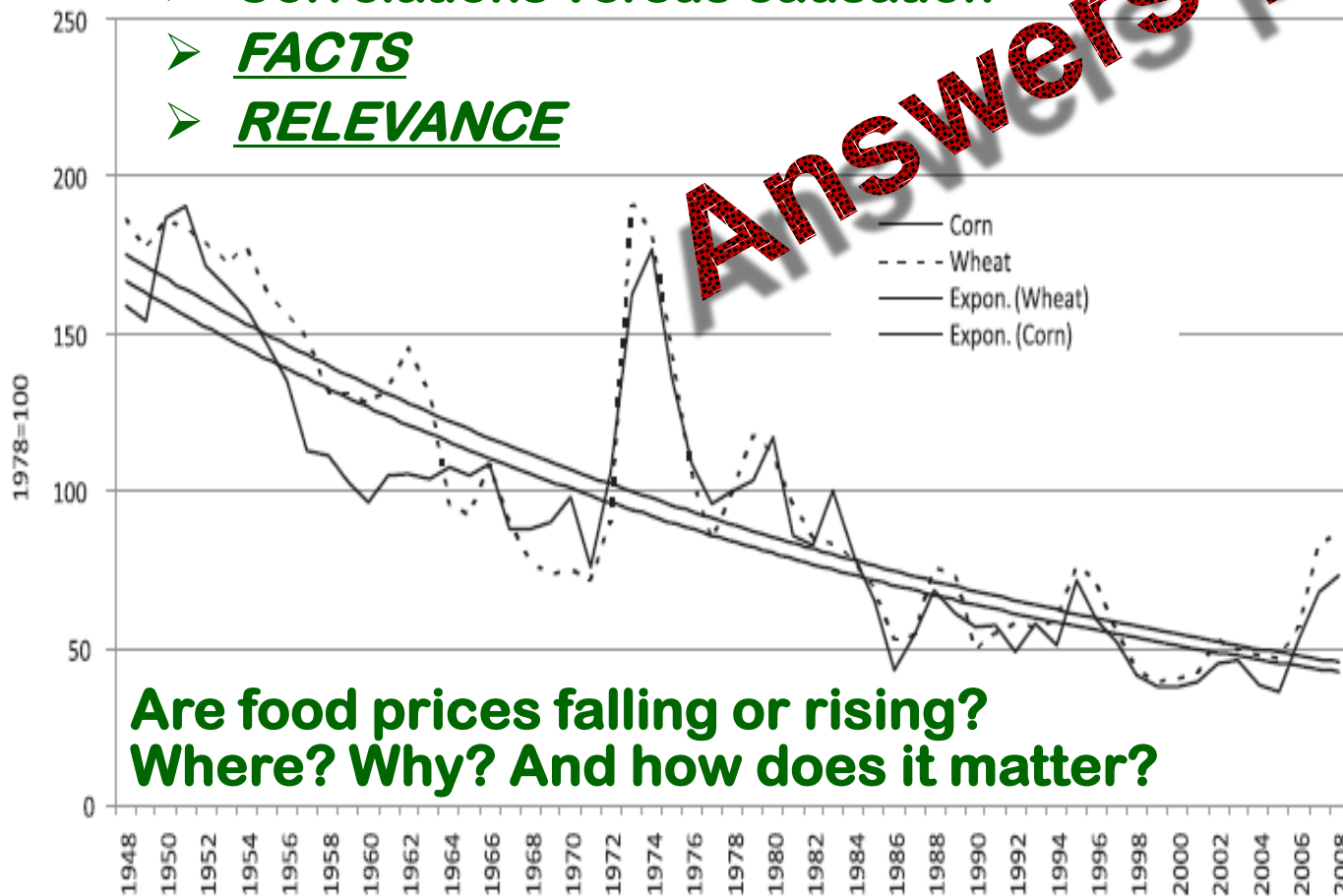
Since records began (1985) US biofuel production grew each year until 2012 drought (US Energy Information Agency, 2016)

Flexible response to record-setting U.S. drought

Results / relevance: Clarifying the issues

Common understanding & agreement on terminology?

- Definitions & key concepts
 - Food – and food security
 - LUC (and ILUC)
- Correlations versus causation
- FACTS
- RELEVANCE



**Are food prices falling or rising?
Where? Why? And how does it matter?**

Answers provided

Source: Kline report on discussion at EUBCE LUC Workshop (June 2016).

The NASS price index in this figure used 1978 as the ref. point; e.g. 1978 values =100 (Sumner 2009).

Indexes, even if based on identical data, can appear to tell many different stories, depending on what reference point is chosen as the initial point of comparison, how interest rates are handled, how index is structured etc.

4. Relevance to DOE goals

supports

Project

- Responds to industry concerns
- Shares results
- Amplifies impacts
- Develops consistent, standard assessment methods
- Reduces investment risks
- Facilitates growth & long-term employment
- Leverage resources via collaborations
- Strategic focus
FY17-19: LUC

supports

BETO MYPP

- Reduce uncertainties about market access
- Increase understanding of science-based approaches for assessment
- Standards 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
 - Renewable energy
- Reduce GHG emissions
- Lower transaction costs
- Reduce investment uncertainties
- Create value-added jobs

Relevance to BETO Platform: Understanding LUC essential to enhance bio-economy sustainability*

Climate Change & Air Quality



Analyzing biofuel pathways to quantify progress towards reducing [lifecycle greenhouse gases, regulated emissions, & fossil energy use](#).

*** Climate forcing → not just GHG emissions**

Soil Quality



[Developing strategies & tools](#) for producing biomass while maintaining or enhancing soil quality.

*** Practices for beneficial LUC to improve soil qualities & carbon storage capacity over time**

Water Quantity & Quality



Assessing the [water resource use & water quality](#) of bioenergy production, & opportunities for bioenergy crops [to improve water quality](#).

*** LUC effects on freshwater, our most endangered ecosystem**

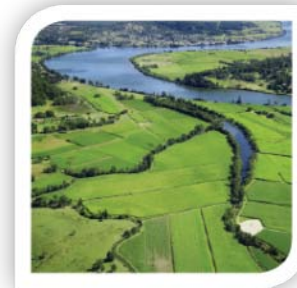
Biological Diversity



Investigating relationships between [bioenergy crops & biodiversity](#), to understand & promote practices that conserve wildlife & biodiversity.

*** Biodiversity is a global concern → international collaborations key**

Landscape Design



[Advancing landscape design approaches](#) that increase biomass while maintaining or enhancing ecosystem services & socio-economic benefits.

*** Leading researchers linked to tackle challenges at multiple scales**

Relevance: Impacts are multiplied by engaging partners to deploy, test & refine BETO approaches via initiatives designed to address MYPP barriers

LUC cuts across BETO goals & barriers: Demonstration, Market Transformation, Analysis & Sustainability (MYPP barrier noted in parentheses):

- ✓ **Lack of acceptance & awareness of biofuels as viable alternatives** (Im-H)– Address LUC & related barriers to acceptance
- ✓ **Codes, Standards** (Im-C)– Focus on most controversial & costly aspects
- ✓ **Scientific consensus** (St-A)– Build consensus = our project goal
- ✓ **Lack of understanding of Environmental/Energy Tradeoffs including food supply** (Mm-A) – Addressing it!
- ✓ **High Risk of Investment** (Im-B)– Reduce risks associated with market access, uncertainties



Dale et al. (2016) *Renew. & Sust. Energy Rev.*

4. Relevance: Industry perspectives = critical success factors (technical, market, business)

Industry representative & US Head of Delegation to ISO 13065, Sustainability Criteria for Bioenergy, stated:

- *An inappropriate ISO standard would create barriers to trade and bioenergy market growth.*
- *ORNL contributions “have been significant and sometimes essential to achieving key goals and outcomes... recognized as a principled and consistent voice in support of science-based, measurable metrics for standards.” (Nov. 2016)*

Jan 2017: UK Royal Society, Industry representatives in Future Fuels Conference & representatives of European Commission... all noted that the thorniest barrier to biofuel acceptance and largest source of uncertainty is LUC & indirect effects.

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, EU biofuel policy expert (2017)

Meeting the expectations of buyers overseas can be a significant hurdle... Dialogue on what the many approaches to sustainability offer is essential.

- Brian Kittler, Pinchot Institute

Relevance: Applications of outputs

Example: Framework for selecting indicators adopted and published in ASTM International Standard



Designation: E3066 – 16a

Standard Practice for Evaluating Relative Sustainability involving Energy or Chemicals from Biomass

Standard Practice for Evaluating Relative Sustainability



FIG. 1 Representation of Process for Evaluating Relative Sustainability

4. Relevance to USG: benefits of bio-economy

Impact on commercial viability of biofuels & bio-products

- Internationally recognized standards facilitate trade, jobs, value-added processing & broad bio-based industry development
- Insights shared across scientific communities & industry help build consensus on how to address key constraints (LUC, food security)



Photo: Project Liberty

<http://poet-dsm.com/liberty>

Impact on social & environmental performance

- Methods & metrics for more consistent performance measurement
- Cooperation stimulates distributed discovery, innovation, ownership & communications
 - Accelerate development of better practices & technologies
 - Acknowledged ingredient for ***transformational change*** needed to shift the debate → understanding → new paradigm

Collaborative networks share knowledge to speed global research, development and deployment of technologies, thereby creating jobs & increasing supplies of secure, domestic energy resources

(Wilbanks & Kates 1999)

Relevance: What if evidence shows that biofuel markets improve management practices and increase food security while reducing deforestation?

Will biofuels get ILUC bonus points instead of ILUC penalties?



**KRAFTSTOFFE
DER ZUKUNFT**
Internationaler Fachkongress für erneuerbare Mobilität

5. Next Steps: Science-based approaches to promote beneficial LUC: How to get there?

A. Shift debate to improving land management

- Build momentum with research networks
- Focus on case studies that offer empirical evidence, lessons learned
- Side-meetings, workshops identify partners, strengthen collaborations
- Link & integrate multi-disciplinary teams across ongoing initiatives (“Sustainability governance,” certification, LCA, visualization...)



LUC is key issue for certification & standards. LUC links growth, jobs, climate, food security & all sustainability indicators. Science-based analysis will reduce uncertainty & support better standards & decisions

5. Next Steps: Science-based approaches to promote beneficial LUC: How to get there?

B. Build on success

- Continue partnerships to document trials of ASTM *Standard Practice for Assessing Relative Sustainability*
- Link work with IEA-Bioenergy Tasks, Global Land Projects, university research centers to
 - Clarify definitions
 - Develop indicators to characterize disturbance & management (LUC)
- Apply the causal analysis approach in science-based attribution with
- Facilitate food security-bioenergy case studies (with FAO & CGIAR partners)
- Apply, test and improve framework for monitoring, analysis & continual improvement (with industry, Antares & others)



Go/No-Go: (a) Stakeholders input for KDF landing page; (b) Partners commit to joint LUC research

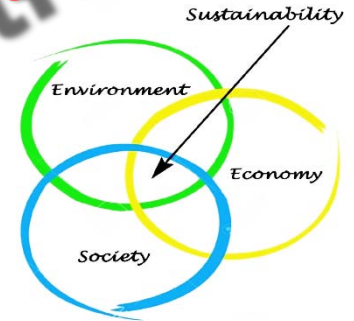
Upcoming Milestones:

- Document how US bio-economy can mitigate LUC
- Sustainability standards landing page design for Bioenergy KDF
- IEA Bioenergy Inter-Task case study: "Measuring, governing and gaining support for sustainable bioenergy"

5. Future Plans (Collaborative reports & publications)

Examples of papers in development via collaborations with international coauthors

- Quantifying the climate effects of bioenergy - choice of reference system.
- Developing a US bio-based economy while facilitating beneficial LUC & indirect effects (a path forward to resolve LUC/ILUC concerns associated with U.S. biomass production)
- Are sustainability standards sustainable?
- Case studies of supply chain governance (SE world pellets; maize stover-Antares project)
- Building trust & understanding of sustainable bioenergy
- Updated Fact Sheet on food security & the bioeconomy
- Clarifying LUC terminology: Words Matter
- How much does sustainability certification cost?
- Science-based approaches to consider “indirect effects” for specified biofuel feedstock pathways
- Opportunities, barriers, & paths forward for sustainable use of bioenergy
- Review Paper: Social, Economic & Ecological impacts of oil palm expansion (NSF PIRE)
- Review paper: Tools for assessing sustainability of landscape designs (CGIAR)
- Criteria for LUC & sustainability case study selection
- Assessing sustainability indicators across socio-economic contexts: case of Tabasco Mexico
- Brazil’s strategic role in future Biofuels: a joint assessment
- Are bioenergy sustainability indicators applicable to improved cookstoves?
- Zen and the Art of LUC Analysis – or – How to know if it’s all just a shell game



Next steps: advance objectives through strategic collaborations focused on better science and standards to address LUC



Success factors:
Catalyze science-based LUC analysis with broad ownership → improve baselines, modeling & communications → raise public awareness & support → reduce barriers to investment & growth

ILUC Poster at IEA Bioenergy meetings

Summary

Approach

- ✓ **Strategic focus aligned to DOE & industry goals; apply criteria to select best opportunities to make a difference**
- ✓ **Collaborations leverage resources & build broad-base of support**

Technical accomplishments

- ✓ **BETO impacts amplified via partnerships (IEA, ASTM, FAO...)**
 - **ASTM & ISO International Standards published**
 - **21 publications include LUC in Vol 2, Food-Biofuel Synergies**
 - **Outreach: 38 presentations**
- ✓ **Milestones met, impact: science removing LUC-related barriers**

Relevance per industry & merit review: “*of paramount importance*”

- ✓ **Foundation for bio-based market growth, trade & jobs**
- ✓ **Extends value of other DOE / BETO projects**

Critical Success Factors / Challenges

- ✓ **Continuity: strengthen & widen base of supportive collaborators**
- ✓ **Build agreement on definitions & methods (LUC)**
- ✓ **Broad ownership of results => transfer key learnings to global community**
- ✓ **Persistence: collaborations are frustrating & time consuming**

Future Work

- ✓ **Joint research develops method for consistent assessment of sustainability**
- ✓ **Results shared via multi-pronged outreach on new methods that are**
 - **Cost-effective, practical, comparable, and provide**
 - **Frameworks, practices & incentives to generate beneficial LUC**



Summary – desired outcomes

Costs, benefits & trade-offs for a US bio-economy are more accurately & consistently quantified & communicated

- Enhance investor confidence, economic growth & trade by mitigating concerns related to LUC & food security
- Reduce investment risk & help industries meet market sustainability requirements more efficiently

Science-based LUC assessments help BETO achieve goals:


- “validate case studies of feedstock production systems costs and benefits [and]... identify strategies to translate beneficial practices into broader applications”
- “quantify and clearly communicate the environmental and socio-economic benefits of emerging advanced bioenergy pathways”

Provide “Additionality”

- ✓ Develop effective incentives for adoption, compliance, & continual improvement of LUC analysis
- ✓ Fill key gaps and catalyze spin-off benefits
- ✓ Demonstrate sustainability with low transaction costs & high value-added
- ✓ Build trust & teamwork to...

Transform the LUC-bioenergy debate from a focus on concerns to one targeting opportunities to improve land management for food and energy security





*So many slides...
My eyes glaze over*

And if I hear that "S"
word one more
time... grrrrr

Are you kitten
me? We've made
it to the finale!



***Oh! Oh! Last slide?
How do ILUC?***

Background music:
Why can't we be friends?

Thank you

Center for Bioenergy Sustainability

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

See the website for

- Reports
- Forums
- Presentations
- Publications



*In memory of my mentor,
distinguished colleague, and dear friend,
Dr. Tom Wilbanks.*

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Photos credits: Ron Savage (USAID), K.Kline, V.Dale.



Additional Slides

- A. Response to prior Peer Review comments
- B. Publications since March 2015
- C. Presentations since March 2015
- D. Acronyms



Response to 2015 Peer Review

Strengths (selected quotes, 2015 Review)

- The relevance to business is high
- Identifying common understanding of sustainability is of paramount importance. DOE should be commended for taking leadership
- More important debates and decisions are being made internationally than domestically [for bioenergy market growth]
- It is vital that BETO have a voice in these discussions to ensure that data and insights find their way into international debate

Weaknesses/suggestions for future work (quotes from 2015 review) and >> Responses to each. *We were able to incorporate nearly all Peer Review suggestions in updated Project Plans approved by BETO for 2017-19.*

- The only weakness apparent is whether or not the resources available to engage in these discussions matches the growing demand.
>> With BETO and stakeholders, project was Merit Reviewed and funded for 2017-19 to allow a continuation of these efforts.
- Broaden the scope to include other venues beyond the scientific community... Carefully define and prioritize efforts to build international consensus.
>> We take care to prioritize and target “windows of opportunity.” The Merit Review input from industry and other stakeholders helped us align future work (2017-19) to focus on LUC in collaboration with IEA Bioenergy, BETO projects, and others associated with sustainability (including visualization, BT16 Vol 2, Landscape case studies for supply chains...)
- Focus on ISO standards for bioenergy are appropriately a top priority.
>> Done including strategic follow-up with ISO partners and ASTM International
- It would be nice to see more of BETOs sustainability portfolio shared among these international forums through this project. >> Underway in current AOP

Results of 2015 Review for existing projects

Evaluation Criteria	A&S Mean	This Project
Project overview	8.1	9
Project approach	7.9	9.2
Technical progress	8.0	8.8
Project relevance	8.4	10
Future work	7.8	8.8
Weighted average	7.8	9.2

Journal Articles, Reports & Chapters: March 2015 to 2017

For more information see <http://www.ornl.gov/sci/ees/cbes/>

4.2.1.41: Addressing global barriers to a bio-economy: International collaborations on LUC and sustainability: Publications and Reports since last peer review (March 2015 to present)

FY16-17 published papers, reports (16)

1. Efroymson RA, Kline KL, Angelsen A, Verburg PH, Dale VH, Langeveld JWA, McBride A (2016) A causal analysis framework for land-use change and the potential role of bioenergy policy. *Land Use Policy* (59) 516–527
<http://dx.doi.org/10.1016/j.landusepol.2016.09.009>
2. Kanter DR, Musumba M, Wood SLR, Palm C, Antle J, Balvanera P, Dale VH, Havlik P, Kline KL, Scholes RJ, Thornton P, Tittone P, Andelman S. 2016. Evaluating agricultural trade-offs in the age of sustainable development. *Agricultural Systems*.
<http://www.sciencedirect.com/science/article/pii/S0308521X1630542X>
3. Dale VH, Parish ES, Kline KL. (Dec. 2016) Lessons from the Forest Pages 18-22 in World Biomass. DCM Productions, UK.
[Http://www.dcm-productions.co.uk/flippages/flipbook/index.html?page=1](http://www.dcm-productions.co.uk/flippages/flipbook/index.html?page=1)
4. Dale VH, Kline KL. (In press) Interactive Posters: A valuable means for enhancing communication and learning about productive paths toward sustainable bioenergy. Biofuels, Bioprod. Bioref.
5. Kline (Oct 2016): Invited abstract (published on line) for EU “**Fuels of the Future 2017**” www.fuels-of-the-future.com/ “Reconciling food security and bioenergy: Priorities for action”
6. ASTM International E3066-16a (2017). Standard Practice for assessing the relative sustainability involving energy or chemicals from biomass. Committee draft first published Aug 2016; Revisions approved by ASTM International Committee E-48 and final version published Jan. 2017.
7. U.S. Department of Energy. 2017. 2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy, Volume 2: Environmental Sustainability Effects of Select Scenarios from Volume 1. R. A. Efroymson, M. H. Langholtz, K.E. Johnson, and B. J. Stokes (Eds.), ORNL/TM-2016/727. Oak Ridge National Laboratory, Oak Ridge, TN. 642p. doi 10.2172/1338837.
<https://www.bioenergykdf.net/billionton2016vol2> (Davis and Kline contributions to data and for multiple chapters and content of Executive Summary and Introduction)
8. BT16 Vol2 Chapter 3: Kline KL, Davis M, Dunn J, Eaton L, Efroymson RA. “Land Allocation and Management: Understanding Land-Use Change (LUC) Implications under BT16 Scenarios”
https://energy.gov/sites/prod/files/2017/01/f34/2016_billion_ton_report_volume_2_chapter_3.zip
9. BT16 Volume 2, Chapter 2: Craig Brandt, Langholtz M, Davis M, Stokes B, Hellwinckel C, Kline K, Eaton L. “Feedstock Assessment Methods and Focal Scenarios.”
https://www.bioenergykdf.net/sites/default/files/BillionTonDownloads/BillionTon_Report_2016_vol2_Chapter2.pdf

Journal Articles, Reports & Book Chapters: March 2015 to 2017

4.2.1.41: Addressing global barriers to a bio-economy: International collaborations on LUC and sustainability: Publications and Reports since last peer review (March 2015 to present)

FY16-17 **published papers, reports** (16) continued

10. BT16 Vol2, Chapter 14: Efrogmson, Langholtz, Johnson, Negri, Turhollow, Kline, Bonner, Dale. "Synthesis, Interpretation, and Strategies to Enhance Environmental Sustainability."
https://www.bioenergykdf.net/sites/default/files/BillionTonDownloads/BillionTon_Report_2016_vol2_Chapter14.pdf
11. BT16 Vol2, Appendix: Davis M., Turhollow A., Kline K., et al. Glossary of key terms and phrases.
https://www.energy.gov/sites/prod/files/2017/01/f34/2016_billion_ton_report_volume_2_chapter_glossary.pdf

Note: Access to zip files for each Billion Ton Volume 2 Chapter and appendices here:

<https://www.energy.gov/eere/bioenergy/downloads/2016-billion-ton-report-volume-2-environmental-sustainability-effects>

12. Kline KL, Msangi S, Dale VH, Woods J, Souza G, Osseweijer P, Clancy J, Hilbert J, Johnson F, McDonnell P, Mugera H (2016) Reconciling food security and bioenergy: priorities for action. Global Change Biology-Bioenergy. doi: 10.1111/gcbb.12366
<http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12366/full>
13. Kline KL, Mayer AL, Martinelli FS, Medeiros R, Oliveira COF, Sparovek G, Walter A, Venier L. (2015; published in Oct) Bioenergy and biodiversity: Key lessons from the Pan American region. for Special Issue on Biofuels in the Americas. Environmental Management 56: 1377-1396.
14. Dale VH, KL Kline, MA Buford, TA Volk, CT Smith, I Stupak. 2016. Incorporating bioenergy into sustainable landscape designs. Renewable & Sustainable Energy Reviews 56:1158-1171. <http://authors.elsevier.com/sd/article/S1364032115014215>
15. Dimitriou I, Kline KL, Berndes G et al. (November 2015) Chapter 5, Lignocellulosic crop supply chains in Mobilizing Sustainable Bioenergy Supply Chains - Inter-Task Project Synthesis Report (editor: C.T. (Tat) Smith). Study, commissioned by IEA Bioenergy Executive Committee and completed with cooperation between IEA Bioenergy Tasks 37, 38, 39, 40, 42, and 43. 180 pages.
<http://www.ieabioenergy.com/publications/mobilizing-sustainable-bioenergy-supply-chains/>
16. U.S. Department of Energy. 2016. 2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy, Volume 1: Economic Availability of Feedstocks. M. H. Langholtz, B. J. Stokes, and L. M. Eaton (Leads), ORNL/TM-2016/160. Oak Ridge National Laboratory, Oak Ridge, TN. 448p. (Davis and Kline among coauthors)
http://energy.gov/sites/prod/files/2016/07/f33/2016_billion_ton_report_0.pdf

Journal Articles & Book Chapters: March 2015 to 2017

4.2.1.41: Addressing global barriers to a bio-economy: International collaborations on LUC and sustainability: Publications and Reports since last peer review (March 2015 to present)

---FY15---published March-Sept 2015

17. Dale VH, Kline KL, Marland G, Miner RA. 2015. Ecological objectives can be achieved with wood-derived bioenergy. *Frontiers in Ecology and the Environment*. 13(6): 297-299.
18. Dale VH, RA Efroymsen, KL Kline, and M Davitt (2015) A framework for selecting indicators of bioenergy sustainability. *Biofuels, Bioproducts & Biorefining* 9(4):435-446. DOI: 10.1002/bbb.1562; <http://onlinelibrary.wiley.com/doi/10.1002/bbb.1562/epdf>
19. Woods J, Lynd LR, Laser M, Batistella M, de Castro D, Kline KL, Faaij A. (2015). Chapter 9, "Land and Bioenergy" in *Scientific Committee on Problems of the Environment (SCOPE), Bioenergy & Sustainability: bridging the gaps*. SCOPE 72. (Souza GM, Victoria RL, Joly CA and Verdade M, editors) Paris, France and Sao Paulo, Brazil. ISBN: 978-2-9545557-0-6. Available from: <http://bioenfapesp.org/scopebioenergy/index.php>
20. Dale VH, Parish ES, Kline KL (2015) Risks to global biodiversity from fossil-fuel production exceed those from biofuel production. *Biofuels, Bioproducts & Biorefining* 9(2):177-189.
21. International Organization for Standardization (ISO) 2015. ISO 13065 Sustainability Criteria for Bioenergy. [Kline led international editing committee and contributed to sections including GHG emission methods, energy efficiency, terminology, and direct versus indirect effects. See ISO web site: http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=52528

---FY16-17 *submitted / in internal reviews*----

1. Singh N, Kline KL, Efroymsen RA, Bhaduri B, O'Banion B (draft ms submitted in Oct as AGU Book Chapter, Bioenergy and LUC) Uncertainty in estimates of bioenergy-induced land-use change: The impact of inconsistent land-cover datasets.
2. Koponen K, Soimakallio S, Kline KL, Cowie A, Brandão M (Resubmitted Jan 2017.) Quantifying the climate effects of bioenergy - choice of reference system. *Global Change Biology-Bioenergy*
3. Kline, Davis, Dunn 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) – draft in internal reviews.
4. Kline, Davis et al. Are sustainability standards sustainable? (Draft submitted for internal reviews to BETO and ORNL)
5. Dale VH and Kline KL. (in review) Opportunities, barriers, and paths forward for sustainable use of bioenergy. *Biomass and Bioenergy*
6. Dale VH, Parish ES, Kline KL, Tobin E. (In review) How does wood-based pellet production affect forest conditions in the southeastern United States? Submitted to *Frontiers in Ecology and the Environment*
7. Dale VH, Kline KL, Richard TL, Karlen DL. Selecting indicators of changes in ecosystem services due to cellulosic-based biofuel in the midwestern United States (Submitted to *Biomass and Bioenergy* June 2016)
8. Davis M, Alvez, Karlen DL, Kline KL, Galdos M, Abulebdeh D. (Submitted to *Renewable & Sustainable Energy Reviews* 31 May 2016), Soil organic carbon measurement protocols: A US and Brazil comparison and recommendation.
9. Dale VH, Keith L Kline, Esther S. Parish, Annette L. Cowie, et. al., (submitted) Prospects for renewable energy using wood pellets from the southeastern United States. *Nature Energy*

Presentations March 2015 to 2017

4.2.1.41: Addressing global barriers to a bio-economy: International collaborations on LUC and sustainability: Kline – Davis International collaborations on sustainability and LUC Presentations since March 2015

1. Abstract accepted for International Association of Landscape Ecology US-IALE annual meeting (Baltimore, April 2017) “Can sustainability standards and certification improve landscape outcomes?”
2. Jan. 31: Virginia Dale, Keith Kline, and Sarah Eichler–Inwood presented "Evaluating Sustainable Farming Systems and Landscapes" at the Systems Analysis workshop in Louvain La Neuve, Belgium.
3. Jan. 23-24: Keith Kline gave an invited Plenary Presentation, “Reconciling food security and bioenergy: Priorities for action” at the Fuels for the Future International Conference on Renewable Mobility www.fuels-of-the-future.com/ Berlin, Germany
4. Dec 13: Keith presented an Interactive Poster, "Land-Use Change and the Billion Ton 2016 Resource Assessment: Understanding the Effects of Land Management on Environmental Indicators" for the American Geophysical Union (AGU) Fall Meeting <https://fallmeeting.agu.org/2016/>
5. Dec 7: Keith Kline, invited presentation, “ASTM E-48 Celebrating thirty-one years: Biomass past and future” for the ASTM International Meeting, Committee E-48, session on Sustainability Standards, in Lake Buena Vista, Florida. One result: ASTM International Committee E-48 now offers links to BETO information including BT16: “additional information” <https://www.astm.org/COMMITTEE/E48.htm>
6. Nov 4: Maggie Davis presented “2016 Billion-Ton: Advancing Domestic Resources for a Thriving Bioeconomy, volume 1” at Society of American Foresters National Convention, Madisonville WI
7. Nov 6-8: Dale, Kline, Parish presentation on “*Prospects of Renewable Energy Using Wood Pellets from Southeastern United States*” at the 6th annual conference of the US Industrial Pellet Association, US IPA: <http://www.theusipa.org/conference/agenda>
8. Sept 28: “2016 Billion-Ton: Advancing Domestic Resources for a Thriving Bioeconomy, Vol 1” invited presentation, M Davis at International Bioenergy and Bioproducts Conference, Jacksonville FL.
9. Sept 13 2016: Invited presentation on “Interactions among bioenergy, food security and ecosystem services” for Session 1, Biomass from crops and residues, 2nd Research Coordination Network Conference on Pan American Biofuels & Bioenergy Sustainability, Buenos Aires, Argentina
10. Aug 1: Invited BETO Analysis and Sustainability webinar, Kline: "Science-based approaches to improve understanding of LUC and guide decisions toward positive outcomes."
11. July 13: Invited Plenary speaker for BioEnergy 2016, “Opportunities and constraints to a bioeconomy: international perspective” in Plenary IV: Policy for the Bioeconomy—Local, State, Federal, and International Perspectives.
12. June 7: Invited presentation, “Promoting beneficial land-use change: improved methods to guide decisions toward positive outcomes” in a Workshop at the 24th European Biomass Conference and Exhibition, EUBCE 2016. Workshop titled, “The world needs more land-use change” was organized by IEA Bioenergy Task 43, IRENA, GBEP, World Agroforestry Center and others. See <http://www.eubce.com/parallel-events/workshops/the-world-needs-more-land-use-change.html>
13. May 16: Kline presented three proposed collaborative research papers and “Sustainability criteria case studies – Mexico and beyond” for the PIRE team meetings
14. May 15: Keith Kline presented “Sustainability metrics: updates for the Pan American Bioenergy PIRE Project Meeting” Tabasco, Mexico (Program for International Research and Education-PIRE, Sustainable Bioenergy in the Americas; invited by Michigan Technological University under project supported by the National Science Foundation)

Presentations March 2015 to 2017

4.2.1.41: Addressing global barriers to a bio-economy: International collaborations on LUC and sustainability: Kline – Davis International collaborations on sustainability and LUC Presentations since March 2015

15. May 11: Kline presented “Land, crops, and land-management: Understanding potential direct and indirect land-use change (LUC) under BT16 Scenarios” for the external peer review workshop for the Billion Ton Sustainability Report Volume 2, Washington DC. Keith also co-chair LUC break-out and presented the summary of discussions and comments on the LUC Chapter
16. April 1: Keith Kline presented a poster on improving the scientific basis for characterizing and assessing land-use change to the Science Advisory Board of CCSI and discussed potential future modeling collaborations with Brian O’Neill, National Center for Atmospheric Research (NCAR).
17. April 2016. Kline presented a Fact Sheet on sustainability standards and led discussion on initiatives including the ASTM International standard, for the DOE-ORNL Bioenergy Study Tour.
18. April: Kline presented “Words Matter” for BETO, US Forest Service and DOE Laboratory staff involved in the BT-2016 Resource Assessment Report Volume 2 on Sustainability.
19. Apr 8, Keith organized an international symposium on “Opportunities and Barriers for Sustainable Bioenergy for the US Chapter of the International Association of Landscape Ecology (IALE) meeting in Asheville, NC, <http://www.usiale.org/asheville2016/> Kline presented the “Attendee-choice” on IEA Bioenergy Inter-Task project, “Mobilizing Sustainable Bioenergy Supply Chains”
20. Apr 8, Maggie Davis, Langholtz, Eaton, Kline - Landscape implications of US “Billion-Ton” supply assessments; historical review
21. Apr 8, Kline (presenter), Hans Langeveld, M Breure, P Quist-Wessel - Bioenergy opportunities to increase resource management efficiency: effects of direct land use within a landscape perspective
22. April 6 – invited presentation at US-IALE 2016 Annual Meeting. Presentation/abstract on “Bioenergy opportunities to increase resource management efficiency: Effects on land use within a landscape perspective,” in Asheville, North Carolina.
23. March 30 – CCSI Science Advisory Board Poster Session & Reception. Presentation/abstract on “Sustainability standards: a call for reason,” at ORNL in the Joint Institute for Computational Sciences (JICS) Building.
24. March 30 – CCSI Science Advisory Board Poster Session & Reception. Presentation/abstract on “Understanding Indirect Effects of Policy on Landscapes: Evaluating and Improving Science-based Practices for ILUC assessment,” Joint Institute for Computational Sciences (JICS)
25. March 16 – invited presentation “Sustainability Standards: A call for reason” for the workshop on Landscape management and design for food, bioenergy and the bioeconomy: methodology and governance aspects in Gothenburg, Sweden. <http://www.ornl.gov/sci/ees/cbes/>
26. Jan 29 – presentation “Recent and Upcoming International Events Relevant to sustainable bioenergy and BETO Program,” for the BETO Team Special Topic webinar. <http://web.ornl.gov/sci/ees/cbes/>
27. Jan 28: invited presentation on “Land Use Change (LUC) and Indirect LUC (ILUC): Definitions and science-based measurement” for American Lung Association visit to the National Transportation Research Center, Oak Ridge National Laboratory.
28. Jan 20, 2016: invited presentation on “Context Dependence: Food Security and Land Use Challenges Associated with a More Sustainable Bioeconomy” at the Bridging Technological and Social Innovation for a Bio-Based Economy Workshop, at the Lorentz Center, Leiden, NL
29. Nov 2-6, 2015 – invited presentation on “Bioenergy Trade and Sustainability Assessment: Science, Truth and Consequences” at the 2015 annual convention of the Society of American Foresters, in Baton Rouge, LA.
30. Oct 30, 2015 – invited presentation “Indirect LUC (ILUC) definitions and science-based measurement” for IEA Bioenergy Task 38 and Task 43 Joint Meeting 30 October in Berlin, Germany.

Presentations March 2015 to 2017

4.2.1.41: Addressing global barriers to a bio-economy: International collaborations on LUC and sustainability: Kline – Davis International collaborations on sustainability and LUC Presentations since March 2015

31. Oct 26-30 – invited ILUC poster presentation at 2015 IEA Bioenergy Workshop and Semi-Annual Task 43 Meeting, Berlin, Germany: “Understanding Indirect Effects of Bioenergy: Practices for Science-based ILUC Assessment.”
32. Sept. 22: Overview of the pellet industry in the Southeastern US Virginia Dale, Keith Kline, Esther Parish and Emma Tobin spoke on the use of woody biomass for energy from forestry operations in the Southeastern United States (SE US) at ORNL’s CBES Forum
33. Aug 8-14 – gave invited presentation “Landscape design for assessing sustainability of SE USA woody biomass production” for the 2015 Ecological Society of America (ESA) Annual Meeting, Baltimore, MD
34. Jun 24 – gave an invited presentation to the ASTM International Committee E48 titled: Thirty years later: Reflections on the past and future of biomass utilization;” Fort Lauderdale, FL
35. June 1-5 – PIRE and Research Coordination Network on Sustainable Bioenergy across the Americas Conference (Houghton, MI). Update on sustainability metrics and cross-cutting research themes.
36. May 20-22, 2015 – coauthored presentation on strategies to better address ILUC and governance (sustainability certification issues) for International Energy Agency (IEA) Bioenergy Task 43 in Dublin, Ireland
37. April 13 – Overview of ORNL research on sustainability of SE Forest Sector for the International Working Group webinar on sustainability of SE wood pellet production, organized by ORNL with stakeholders in private and academic sectors.
38. April 10 – Landscape Design Approach for Assessing Sustainability of Pellet Production from Southeast United States Forest Residues co-author presentation for the University of Tennessee, Institute of Agriculture and international visitors.

Over 40 international visitors hosted including Hans Langeveld, Jem Woods, Annette Cowie, Steef Hanssen, Anna Duden, and the BETO US “Study Tour” group.

Other publications and reports March 2015 to 2017

4.2.1.41: Addressing global barriers to a bio-economy: International collaborations on LUC and sustainability: Publications and Reports since last peer review (March 2015 to present)

Other reports (FY16-17) submitted to DOE BETO and other sponsors (9)

- a) Kline KL and Davis M (July 2016). Sustainability, Ecosystem Services, and Bioenergy Development across the Americas Michigan Technological University PIRE Project: ORNL update on sustainability indicators - status report.
- b) Special Media Report on the impacts of a coordinated press release and coverage in >60 outlets across five continents following publication in GCB-Bioenergy of international report on how and why bioenergy can enhance food security (May 2016).
- c) Kline KL (2016) Abstract in proceedings of the 2nd Research Coordination Network in Pan America on Sustainable Biofuels (Aug 2016, Argentina): Bioenergy can help feed the world while supporting climate goals. Abstract accepted for inclusion in proceedings
- d) Fact sheet on food security: draft delivered to BETO and international team of researchers for comment (June 2016)
- e) Words Matter: Notes on terminology related to agricultural land and crops (2016) 7-pg. white paper defining terms and providing guidance on words to use or avoid in BT16 Vol 2
- f) Talking Points and references on food security and biofuels provided to DOE Valerie Reed and Kristen Johnson for Tufts University Energy Conference (Feb 2016). "Preparation was perfect. I was able to use most everything as well as some of the references. Thanks again" – Valerie Reed.
- g) Comments and contributions for revision of draft book chapter on Sustainability being developed as an IEA Bioenergy multi-Task book project, at request of DOE sponsor (Diaz-Chavez, Stichnothe, and Johnson; 15 Dec, 2015).
- h) Research Roadmap Report for the Research Coordination Network on Pan American Biofuels and Bioenergy Sustainability. Michigan Technological University (Handler, Shonnard...Kline et al.) Dec. 2015.
- i) Update Reports #14 and #15 on ISO Project Committee 248, "Sustainability Criteria for Bioenergy" including analysis of content and the Final Draft International Standard ballot results and "next steps" (Nov 2015).

--- Other Reports FY15---(6)

- a) Submitted chapter for the Research Roadmap Report for Bioenergy in Americas, based on biofuels and biodiversity research priorities in <http://link.springer.com/article/10.1007/s00267-015-0559-0>
- b) Biofuels and Food Security Interactions – IFPRI Workshop Report (21 pg.) <http://www.ifpri.org/publication/workshop-biofuels-and-food-security-interactions-report-scientific-committee>
- c) IEA Bioenergy Synthesis Chapter and section on Barriers and Opportunities. In <http://www.ieabioenergy.com/publications/mobilizing-sustainable-bioenergy-supply-chains/>
- d) IEA Triennium Plan – Contributions to content for issues of governance, beneficial LUC and indirect effects.
- e) BT16 Vol. 1 Submitted section on importance of global trade for developing a US bio-economy (Aug 2015)
- f) Kline KL and Davis M (July 2015). Sustainability, Ecosystem Services, and Bioenergy Development across the Americas Michigan Technological University PIRE Project: ORNL update on sustainability indicators - status report (July 2015).

Useful abbreviations

Funding partners:

- MTU-NSF-PIRE: Michigan Technological University - National Science Foundation award for "Sustainability, Ecosystem Services, and Bioenergy Development Partnerships across the Americas" (Program in Research and Education, PIRE)
- RCN: Research Coordination Network on Bioenergy in the Americas (RCN-Pan American Bioenergy) also funded by NSF-MTU.
- Chalmers University, Sweden (for travel to address LUC and governance issues in conjunction with IEA Bioenergy Inter-Task work groups.
- CIMMYT: International Crop Research Center for Maize and Wheat
- IEA-Bioenergy Task 43: Biomass Feedstocks for Energy Markets (LUC and governance work products)
- Lorentz Center, Utrecht, Netherlands: travel for workshops to address barriers to a Sustainable Bio-Economy.
- GSB: Global Sustainable Bioenergy Project (matching financial support from UT/Battelle and Sao Paulo Science Research Foundation (FAPESP): for the Latin America, Caribbean and Africa sustainable biofuels project (LACAf)

Other collaborating organizations and initiatives:

- ANL = Argonne National Lab
- ASTM International, known until 2001 as the American Society for Testing and Materials (ASTM)
- BESC = Bioenergy Science Center (DOE BER-funded)
- BMAS = Biomass Market Access Standards (formerly known as the Council for Sustainable Biomass Production (CSBP))
- BMP = Best Management Practices (potentially misleading term in light of sustainability principles for continual improvement)
- CBES = Center for Bioenergy Sustainability (at Oak Ridge National Lab)
- CEN = European Committee for Standardization
- CGIAR: Consortium of International Agricultural Research Centers

Other collaborating organizations and initiatives (cont.)

- CTBE = Brazil Research Center for Bioethanol Technology
- CRC = Coordinating Research Council (includes EPA, fuels and auto industries)
- FAO = Food and Agriculture Organization
- GBEP = Global BioEnergy Partnership
- GLBRC = Great Lakes Bioenergy Research Center (DOE BER-funded)
- IPCC = International Panel on Climate Change
- IBSS = Southeastern Partnership for Integrated Bioenergy Supply Systems
- IEA = International Energy Agency
- IFPRI = International Food Policy Research Institute
- INL: Idaho National Lab
- ISO = International Organization for Standardization
- NCASI = National Council on Air and Stream Improvement
- NREL = National Renewable Energy Laboratory
- NSF = National Science Foundation
- PC 248 = ISO Project Committee 248 on sustainable bioenergy
- RCN = Research Collaborative Network (a project at Michigan Tech supported by NSF)
- RSB = Roundtable for Sustainable Biomaterials
- SCOPE = Scientific Committee on Problems of the Environment
- UN-CFS = United Nations Committee on Food Security
- UNICAMP = University of Campinas, Brazil; (USP) University of Sao Paulo, Brazil,
- USDA = United States Department of Agriculture, FAS = Foreign Agricultural Service; ERS = Economic Research Service;
- USFS = United States Forest Service