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

BETO
Analysis & Sustainability
Webinar

Keith L. Kline (klinekl@ornl.gov)
01 August 2016

Acknowledgements:
DOE Bioenergy Technologies Office
Virginia H. Dale and ORNL CBES team

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

This presentation is based on:

EUBCE 2016
AMSTERDAM - THE NETHERLANDS
RAI Amsterdam Exhibition and Convention Centre
6 - 9 JUNE 2016
24th European Biomass Conference & Exhibition

07 June 2016 presentation in the

Workshop: The world needs more land-use change

24th European Biomass Conference and Exhibit (EUBCE 2016)
http://www.eubce.com/parallel-events/workshops/the-world-needs-more-land-use-change.html

Toward positive LUC outcomes: How to get there from here?

- Science-based information to guide decisions
  - Indicators
  - Causal analysis
  - Standards
- Process of monitoring, analysis & continual improvement
- Discussion & examples
  - Natural climate mitigation
  - Food, fuel and other services
  - Guatemala
  - Climate-smart soils
  - Are food prices increasing?

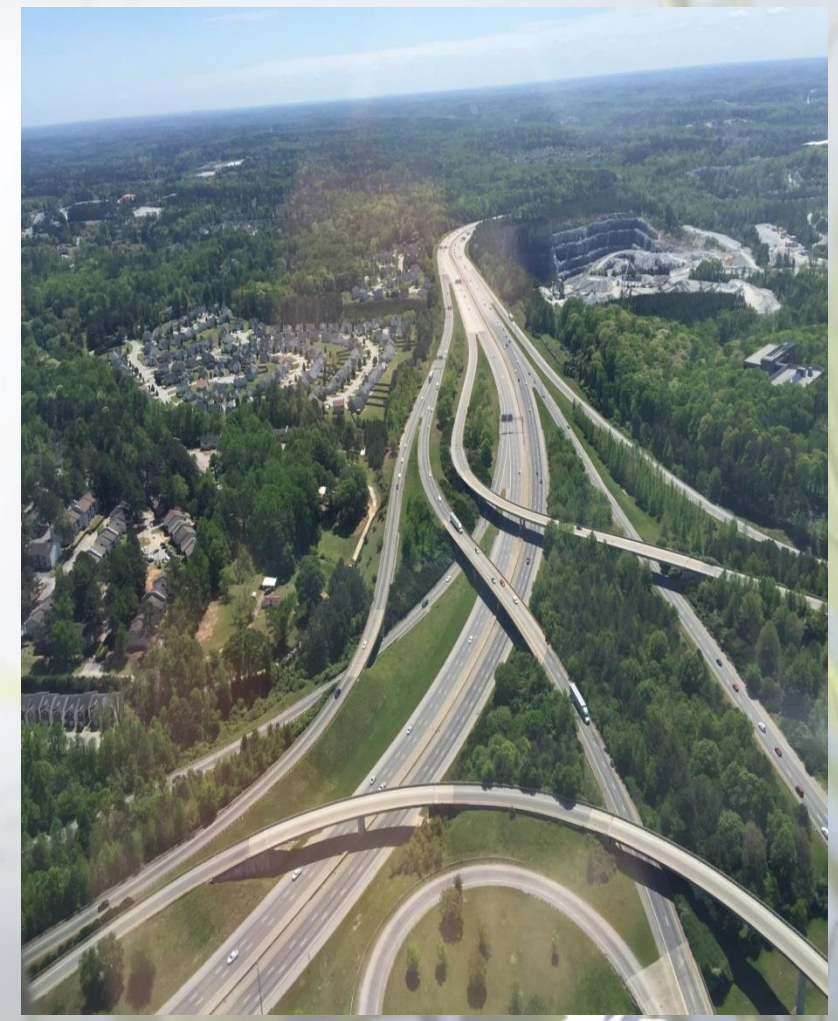


Photo by Kline: LUC near Atlanta, GA

Science-based analysis to guide decisions

Science: systematic methodology based on evidence and observation

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

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

Environmental indicators for bioenergy sustainability & associated ecosystem services

Category	Ecosystem service: type	Indicator
Soil quality	**Supporting and regulating service:** soil quality	Total organic carbon (TOC)
		Total nitrogen (N)
		Extractable phosphorus (P)
		Bulk density
Water quality and quantity	**Regulating service:** drinking water; **Cultural service:** recreation	Nitrate concentration in streams
		Total phosphorus (P) concentration in streams
		Suspended sediment concentration in streams
		Herbicide concentration in streams
		Peak storm flow
		Minimum base flow
		Consumptive water use (incorporates base flow)
Green-house gases	**Regulating services:** carbon sequestration and climate regulation	CO_2 equivalent emissions (CO_2 and N_2O)
Bio-diversity	**Regulating services:** biodiversity, pollination, seed dispersal, pest mitigation; **Supporting service:** habitat	Presence of taxa of special concern
		Habitat area of taxa of special concern
Air quality	**Supporting and regulating service:** air quality	Tropospheric ozone
		Carbon monoxide
		Total particulate matter <2.5μm diameter ($PM_{2.5}$)
		Total particulate matter <10μm diameter (PM_{10})
Produc-tivity	**Production services:** food, feed, fiber and fuel	Yield

McBride et al. (2013) & Dale et al. (submitted 2016)

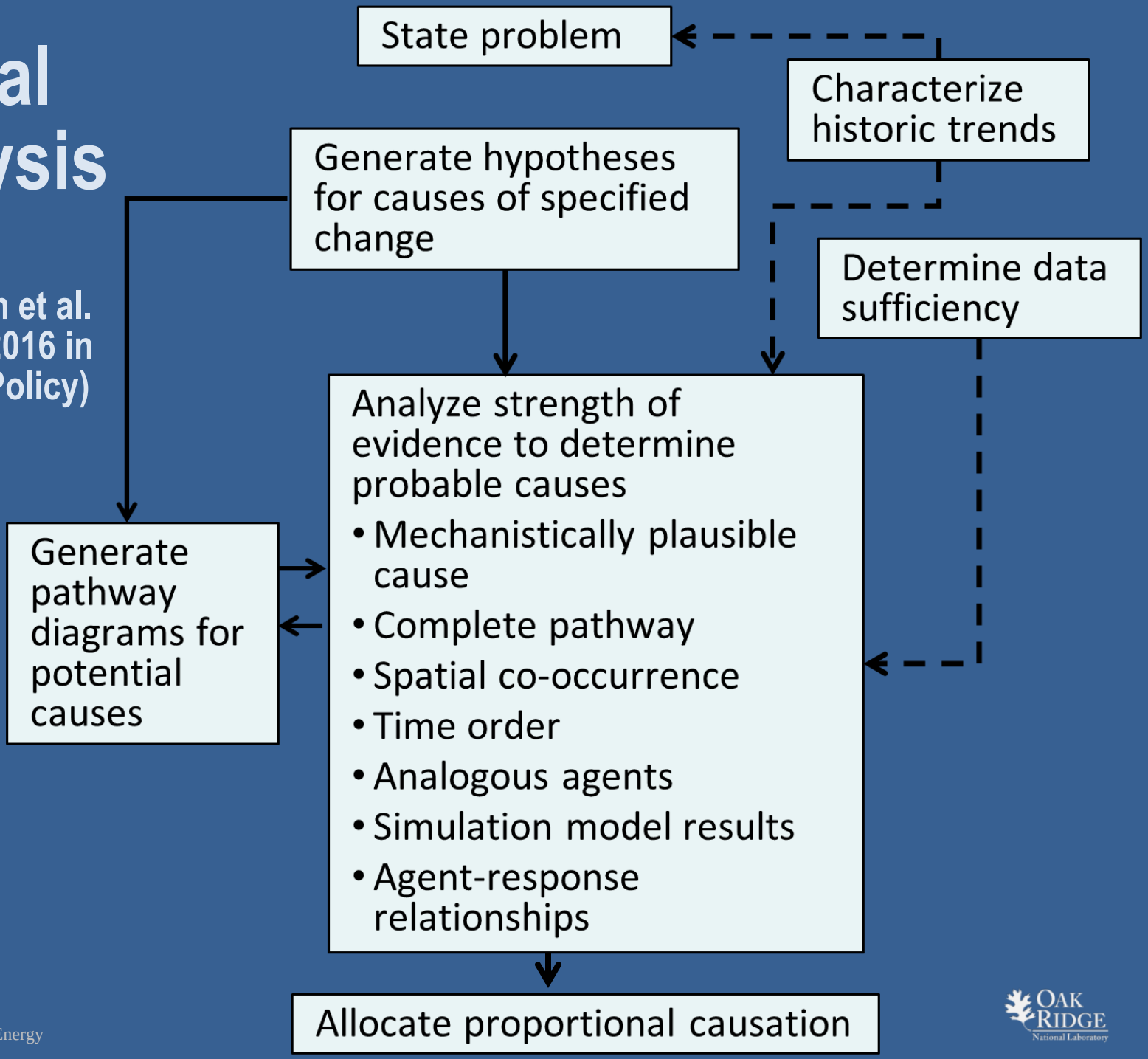
Socioeconomic indicators for bioenergy sustainability & associated ecosystem service

Category	Ecosystem service: type	Indicator
Social well-being	**Cultural services:** jobs and family income; **Provisioning service**: food	Employment
		Household income
		Work days lost due to injury
		Food security
Energy security	**Provisioning service:** energy	Energy security premium
		Fuel price volatility
External trade	**Provisioning services**: food, feed, fuel and fiber	Terms of trade
		Trade volume
Profitability	**Provisioning services**: food, feed, fuel and fiber	Return on investment (ROI)
		Net present value (NPV)
Resource conserva-tion	**Provisioning services:** fuel, chemicals, plastics	Depletion of non-renewable energy resources
		Fossil Energy Return on Investment (fossil EROI)
Social accepta-bility	**Provisioning services**: food, feed, fuel and fiber	Public opinion
		Transparency
		Effective stakeholder participation
		Risk of catastrophe

Dale et al. (2015; and submitted 2016)

Causal Analysis

(Efroymson et al. Accepted 2016 in Land Use Policy)



Policies to Boost Solid Biomass (IRENA)

How to get there?

- ***Accelerate improvement of crop yields***:
  - How to promote higher yields with low commodity prices to growers and 40% waste in food systems?
- Collect ***comprehensive data on land*** that could be used for sustainable ***wood and grass crops***, including likely yields.
  - Where is land the constraint? [not globally; see 2015 SCOPE report]
  - Do we understand how land management can accelerate carbon storage *AND* productivity, and strengthen terrestrial sinks? (e.g., Woodall et al. 2015)
- Research ***practices for cultivating rapidly growing trees and grasses*** on pastureland… – grown for what markets?
  - Millions of hectares of pasture burn each year to eliminate encroaching vegetation
- Institute ***more secure land tenure*** and ***better governance*** to provide incentives for more intensive land management. – ***YES !***
- Provide Incentives to plant ***trees on degraded lands.***
  - ***What incentives work best? Who benefits?***
  - ***Can markets provide the right signals?***
  - ***Is certification the answer?***

Policy suggestions in **blue** from Jeff Skeer, IRENA, 2016 presentation, "Boosting Biofuels" in http://www.eubce.com/parallel-events/workshops/the-world-needs-more-land-use-change.html

IEA Bioenergy Joint Task Meeting Question: "Can certification ensure sustainability?"

"No" because –

1. Nothing can ***ensure*** sustainability.
2. There are many opportunities for substitution in biomass markets
3. Transaction costs for certification, monitoring and verification are high relative to the value of the product (biomass)
4. Uncertainties about sustaining political will and market premiums
5. Even well-designed schemes can be "gamed," and a few well-publicized cases undermine credibility.

Photo VH Dale, 2016: Logging residues in East TN left to rot or burn because there is no market for biomass-bioenergy.

Can policies applying standards and certification *facilitate* the transition toward sustainability?"

"Yes, *if" it*

1. Is ***developed with users*** as a cost-effective tool that meets their needs
2. Provides feedback to guide production toward ***continual improvement*** from users' perspectives
3. Is designed to ***adapt*** to changing contexts and priorities
4. Is ***inclusive***
5. Is ***supported*** by government, civil society, and financial incentives

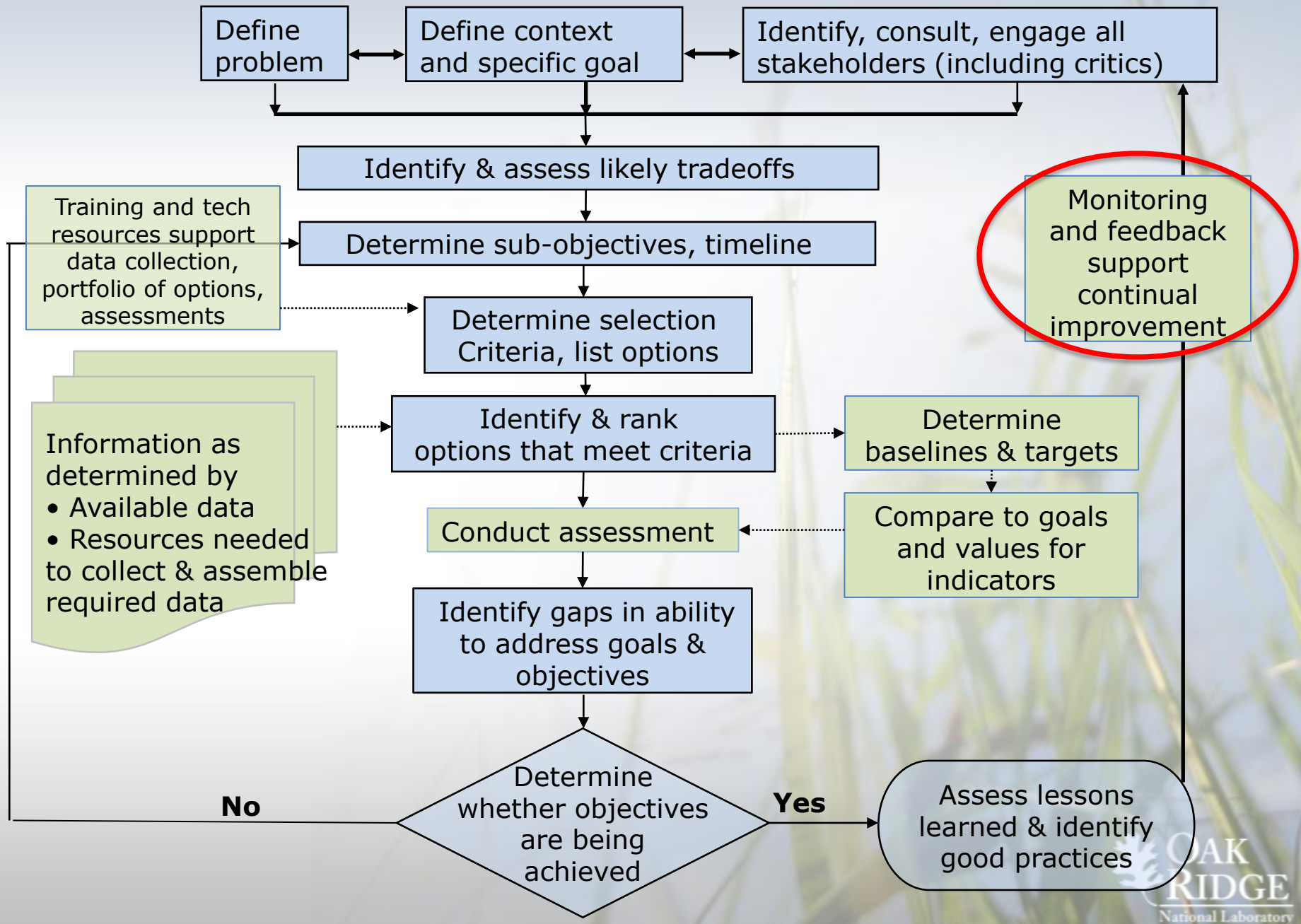
ASTM Standard Practice for Assessing Relative Sustainability (2016 draft, Committee E48)

- Guidance on process for assessments:
  - relevance to local needs
  - information necessary to support continual improvement
  - replicable, measurable and verifiable indicators are not predetermined, and
  - support fair comparisons and informed choices.
- Certification schemes can differentiate products but
  - Are outcomes – documents and labels – what society really wants?
  - Who benefits?

Photos of mixed cropping strategies in Haiti (top, photo by R.Savage) and Mexico (bottom, K.Kline)

See: https://www.astm.org/COMMITTEE/E48.htm

Framework to Support More Sustainable Outcomes



Dale, Efroymson, Kline, Davitt (2015) A framework for selecting indicators of bioenergy sustainability. Biofuels, Bioproducts & Biorefining 9(4):435-416

SUSTAINABLE DEVELOPMENT GOALS

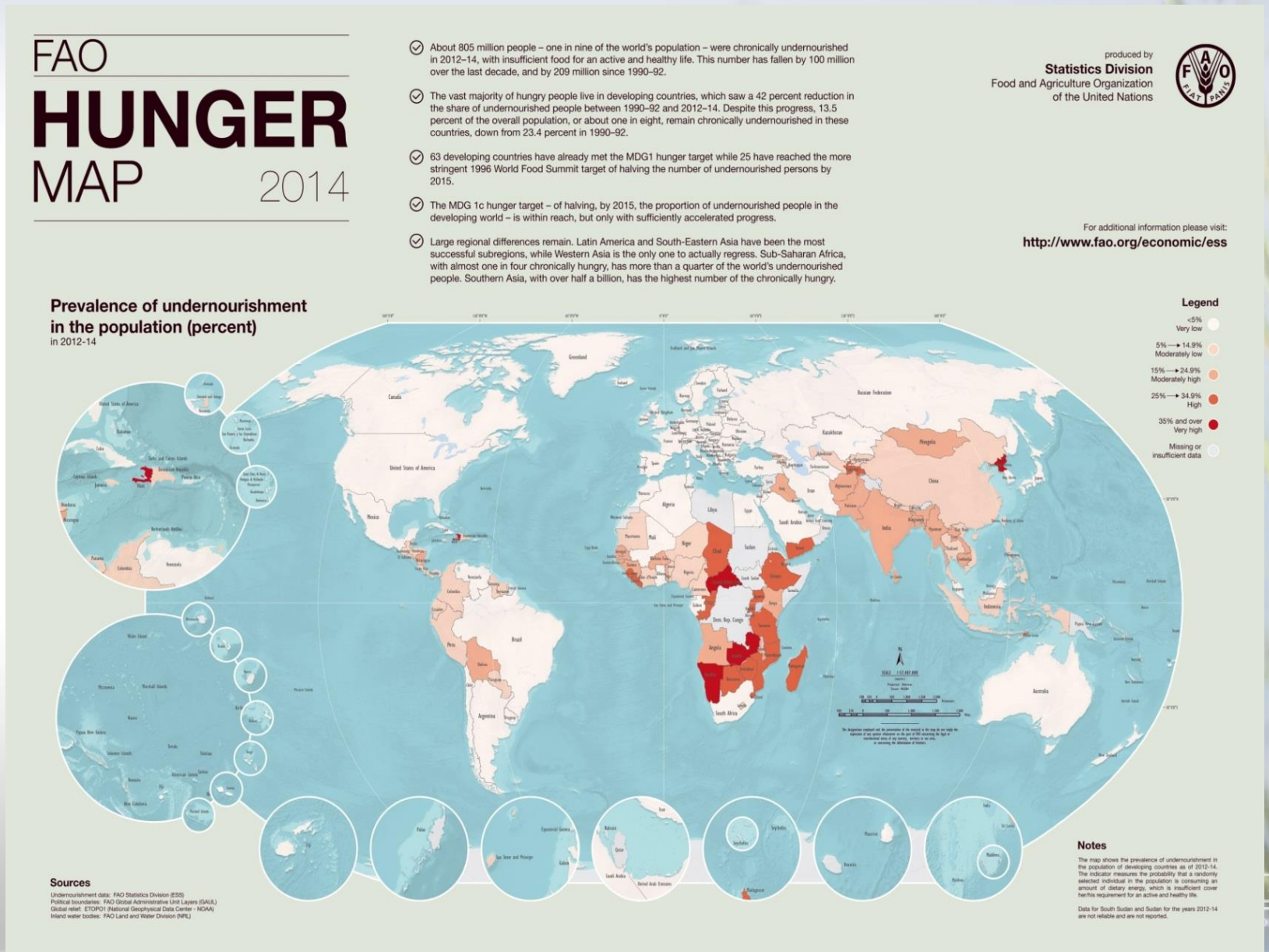
17 GOALS TO TRANSFORM OUR WORLD >160 indicators

http://sd.iisd.org/news/iaeg-sdgs-sets-workplan-for-finalizing-indicators/

Sustainable bioeconomy contributes to SDGs addressing #1 poverty, #2 food security and nutrition, #3 health, #5 gender, #6 water and sanitation, #7 **affordable and clean energy**, #8 **jobs**, #12 sustainable consumption/production, #13 **climate change**, #14 oceans, seas and marine resources, #15 terrestrial eco-systems, forests, land degradation and biodiversity, and #16 strengthened institutions.

Souza et al. 2015

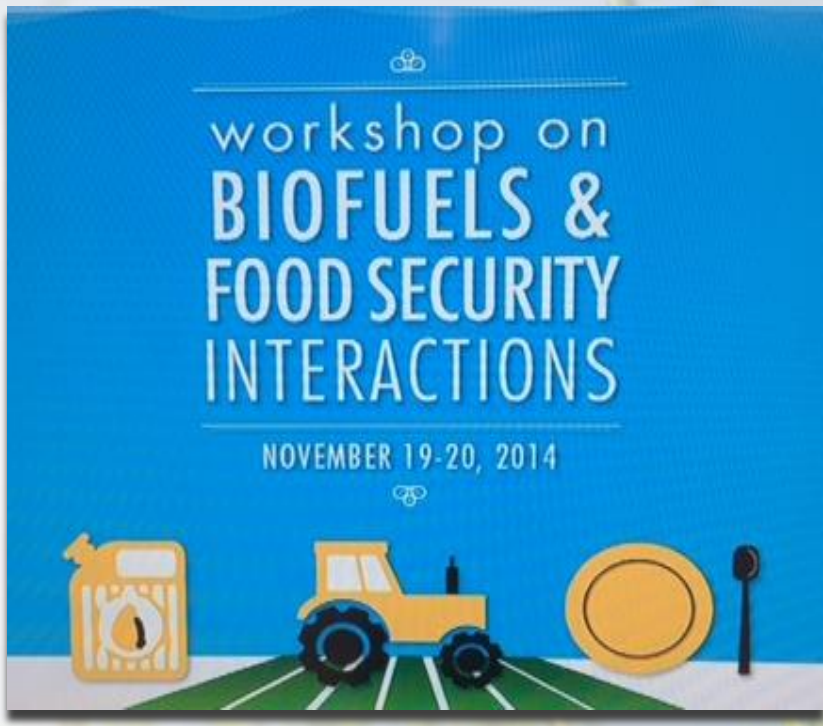
Challenge: As long as hunger continues around the world, concerns about food security will persist



Food security

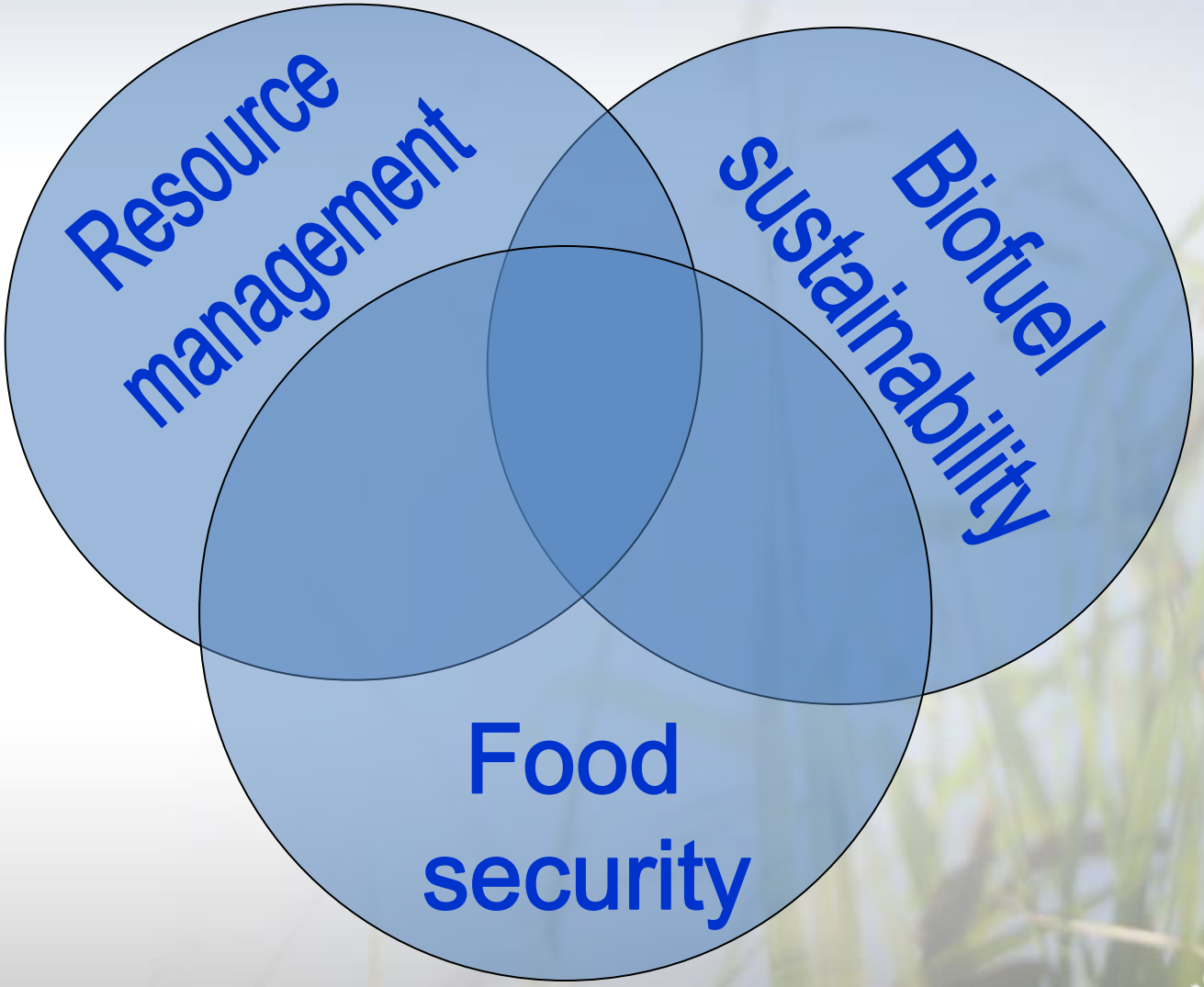
International workshop set forth key issues

- **Identify synergies – for example**
  - Flex crops can be used for food or fuel
  - Rural infrastructure supports food & fuel
  - Sustainable resource management
- **Frame the problem: Ask the questions that matter**
- **Use clear terminology**
  - Workshop report and publication in GCB-Bioenergy (Kline et al 2016)



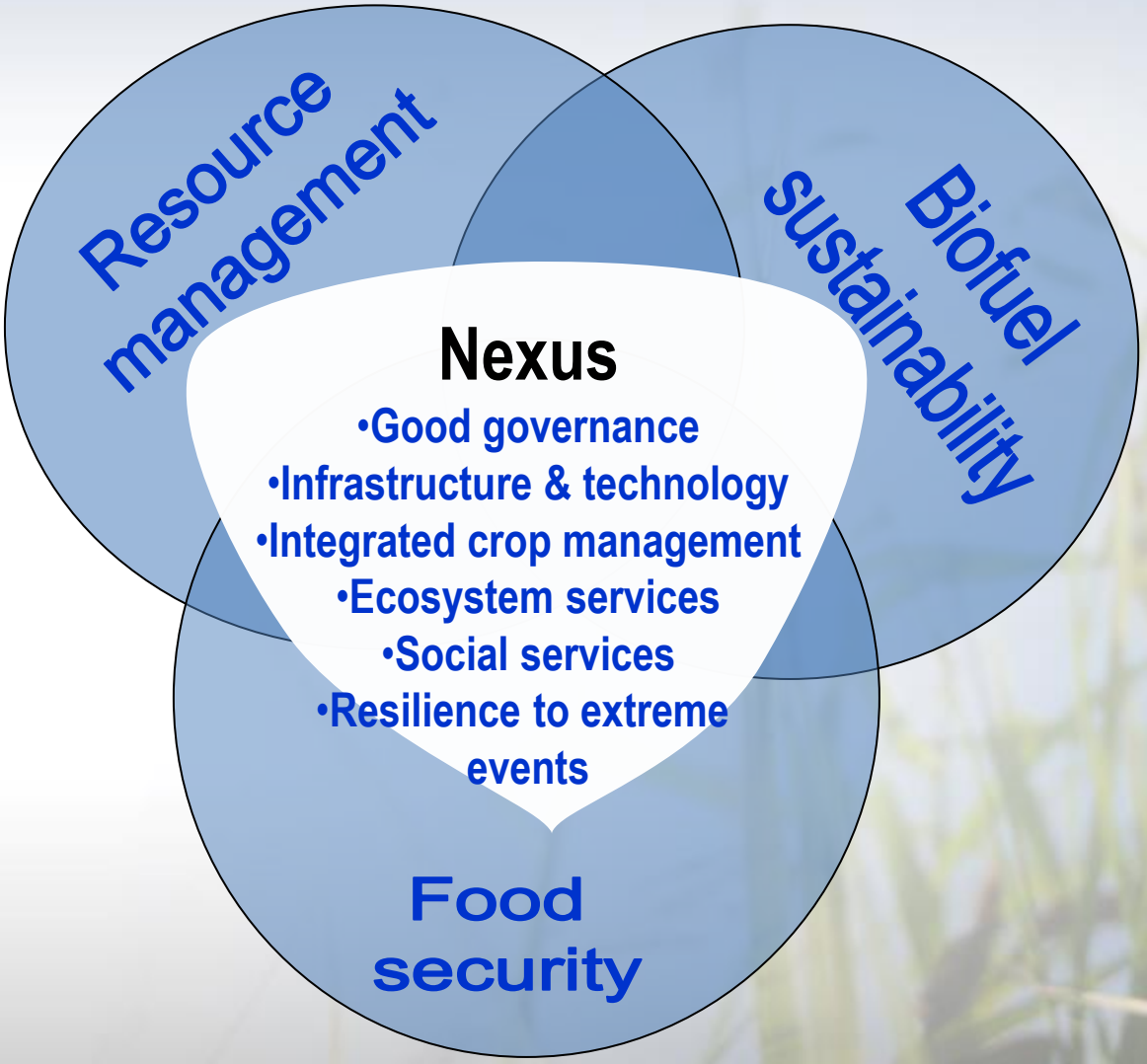
http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12366/full
http://www.ifpri.org/event/workshop-biofuels-and-food-security-interactions

The nexus between biofuel sustainability and food security invokes a focus on resource management



(Kline et al. 2016)

Attributes of the nexus



(Kline et al. 2016)

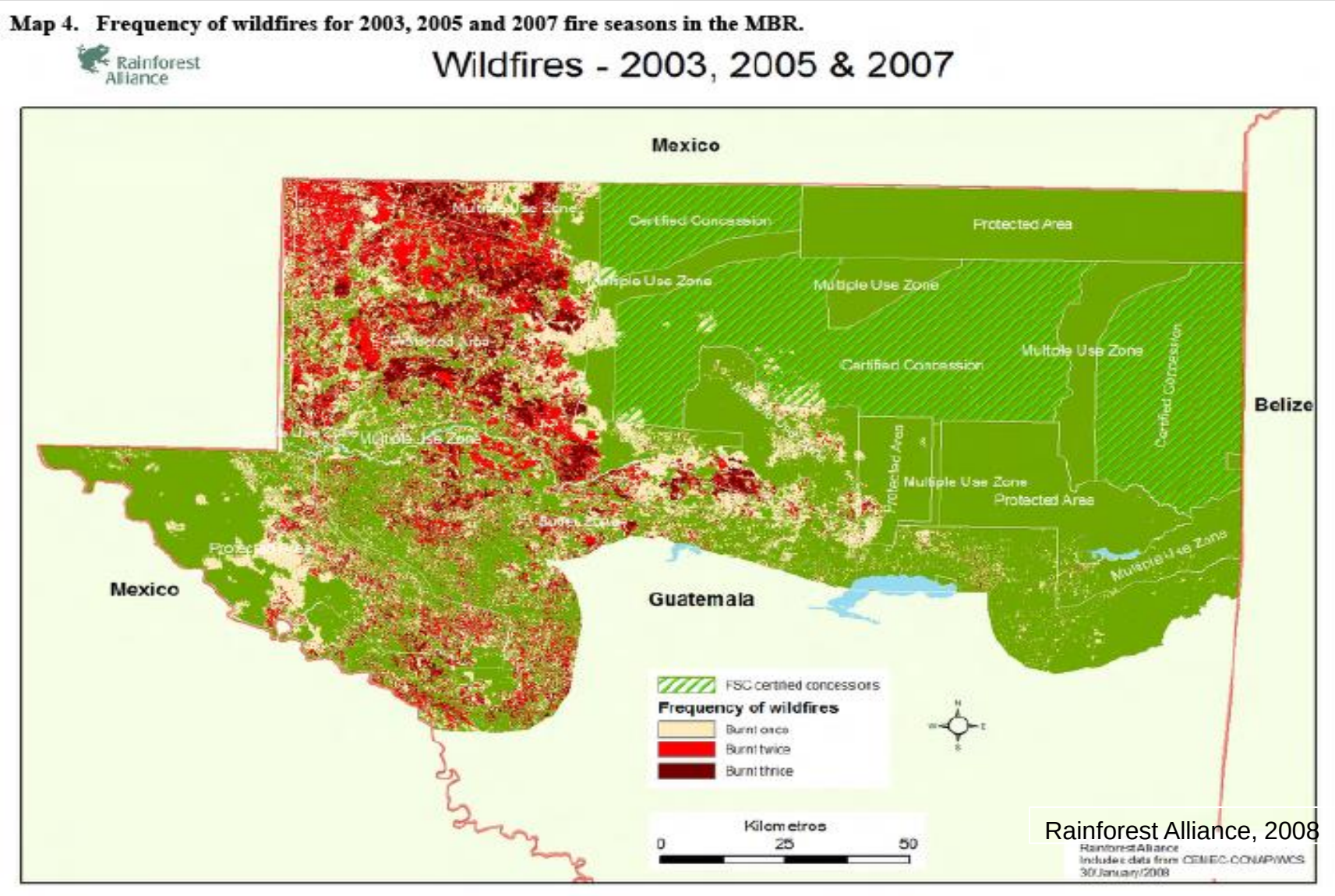
At the nexus of food security and sustainable bioenergy:

- **Address rural poverty**
- **Diversify crops and sources of income**
- **Improve productivity**

USAID photo - Feed the Future annual report 2015

OAK RIDGE National Laboratory

Challenge: As long as deforestation continues, concerns about LUC will persist. Maya Biosphere Reserve, Guatemala: Habitat loss, contamination of water and soil, and new settlements are legacies of oil, not agriculture.



Rainforest Alliance, 2008

Climate-smart soils

Markets for biomass and a bioeconomy support additional "yes" responses. And

a. Outreach & awareness
b. Practices that increase
   - Productivity
   - Soil carbon
c. Long-term rotation of trees with annuals to store more carbon, deeper, in more stable forms, than what would occur without 'LUC'
d. Understanding that it's not generic "LUC" that matters, but how matter changes that matters

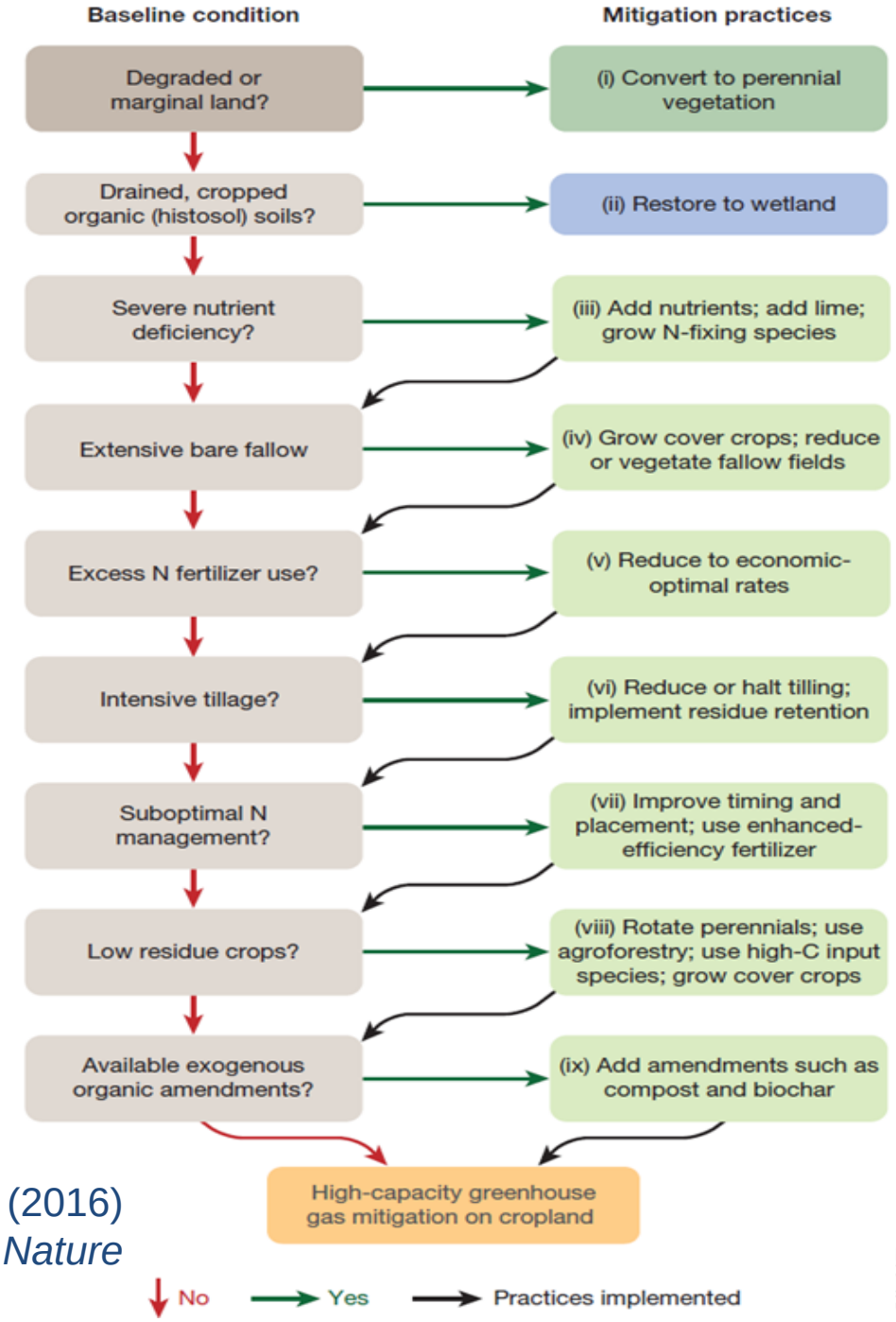


Chart from Paustian et al. (2016) *Nature*

Steps to encourage beneficial LUC

- **Give biomass value! Reduce losses**
  - Fires and other disturbances
  - Wastes
- **Legal and financial motivations to invest in and adopt better management practices**
- **Pathways to "natural climate mitigation"**
  - Better management of occupied lands
  - Conserve remaining forests (no new roads!)
  - Restore and replant former forest lands
  - Create value-added jobs and services that reduce pressure on isolated forest frontiers (reduced deforestation) in LDCs
- **Accelerate shifts to ever higher performing urban and integrated agro-silvo-pastoral systems**
- **Increase scrutiny, awareness and enforcement to end illicit land-management activities**
- **Apply same performance criteria to all sources of energy and all land management (food, feed, fiber, energy…)**

Conclusion: Plenty of biomass, inadequate rewards for good management







We need to

- Learn from experiences
- Build local partnerships
- Develop and apply a suite of metrics that reflect local stakeholder priorities for "sustainability"

Source: Kline training seminar for Advanced School on Present and Future of BioEnergy; ESPCA – FAPESP – University of Campinas, 10-17 October, 2014. Campinas, SP Brazil.

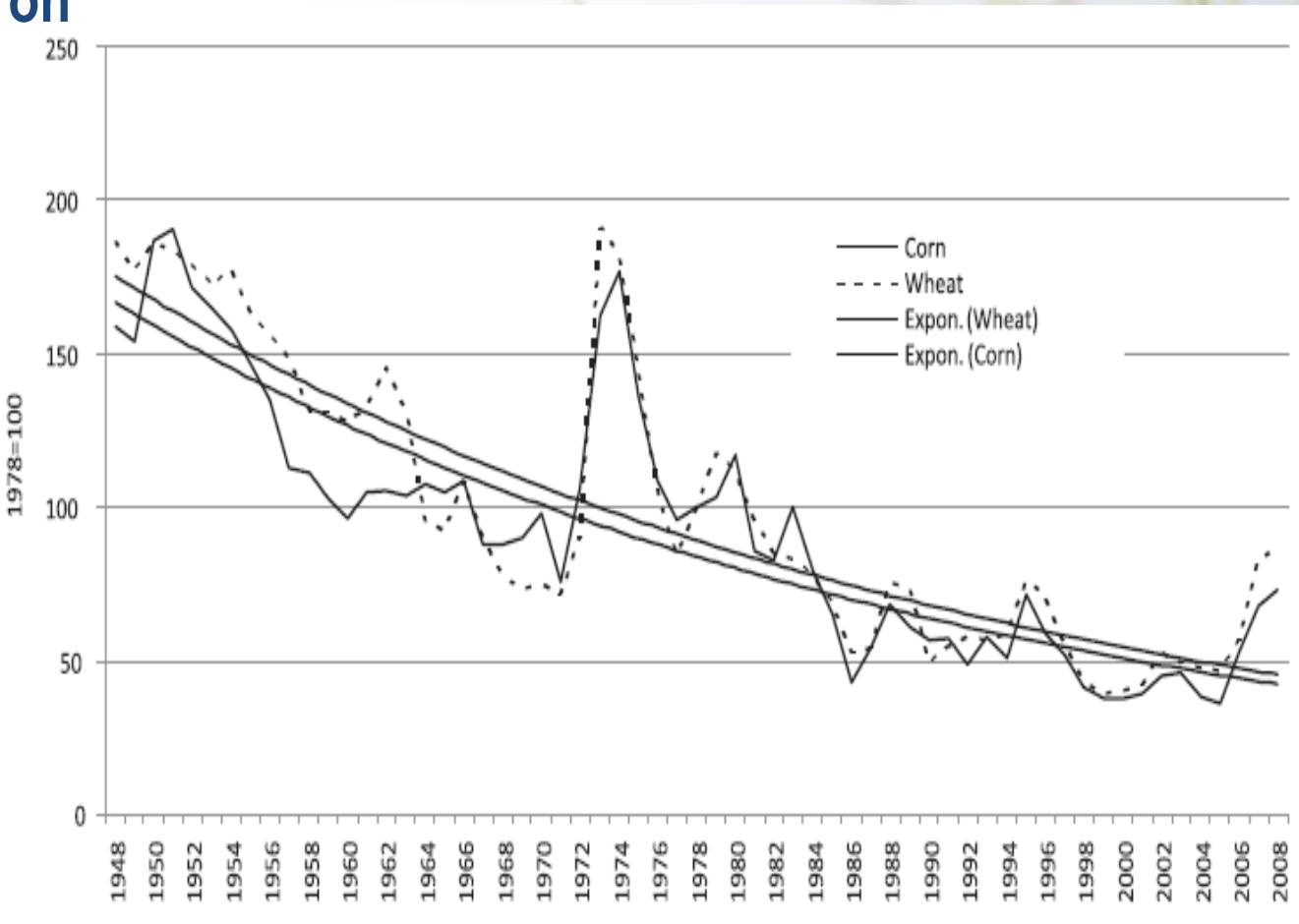
Interesting discussion ensued with audience incl. JRC research staff on ILUC and food prices

Q&A and discussion illustrated:

- Disparate concepts of what ILUC represents
- Lack of agreement on
  - Definitions
  - Facts

Source: Kline notes on discussion following EUBCE Workshop June 2016. Some argued prices are declining, others that prices are increasing. This USDA price index used 1978 as ref. point.

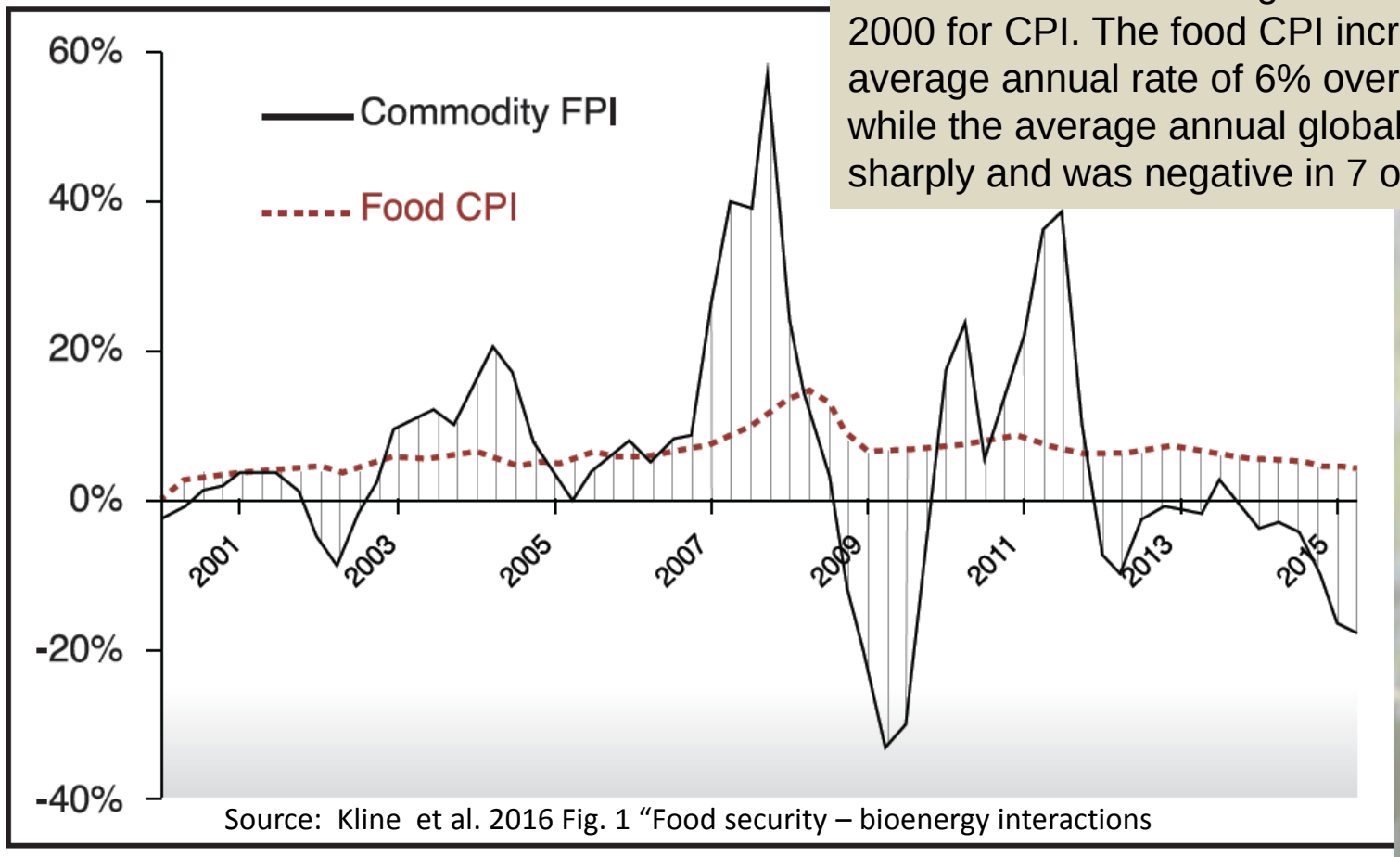
Indexes based on identical source data sets can tell many different stories, depending on what reference point is chosen as the initial point of comparison and how interest rates are handled.



Interesting discussion ensued with JRC research staff on ILUC and food prices

Are food prices increasing?

FAO global Food Price Index (FPI) based on commodities versus the FAO global food Consumer Price Index (CPI), 2000-2015 (FAOStat, 2015). % change is relative to the 2002-2004 average for FPI and year 2000 for CPI. The food CPI increased at an average annual rate of 6% over 2000-2015, while the average annual global FPI varied sharply and was negative in 7 of the 15 years.

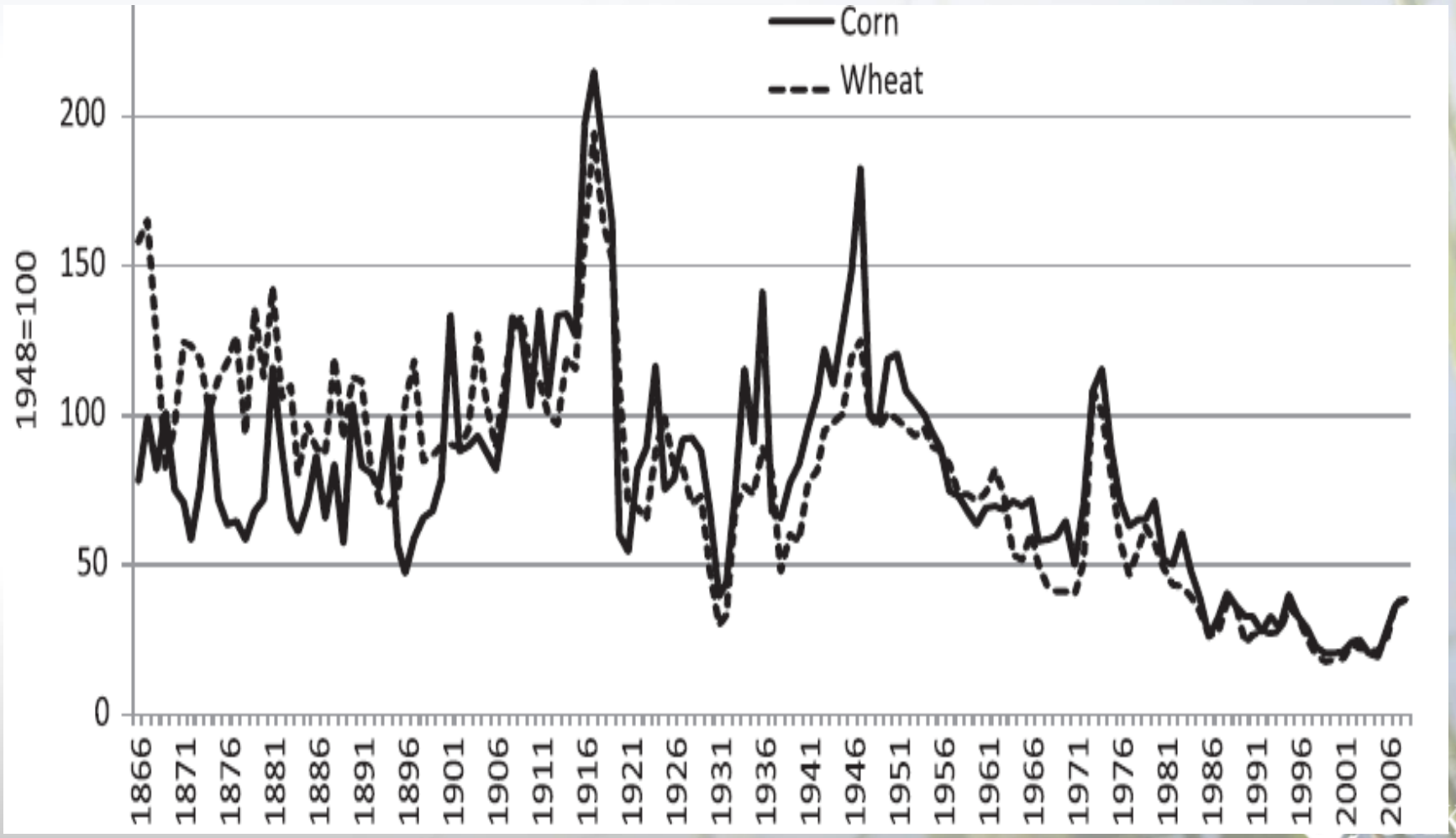


Source: Kline et al. 2016 Fig. 1 "Food security – bioenergy interactions

OAK RIDGE National Laboratory

Interesting discussion ensued

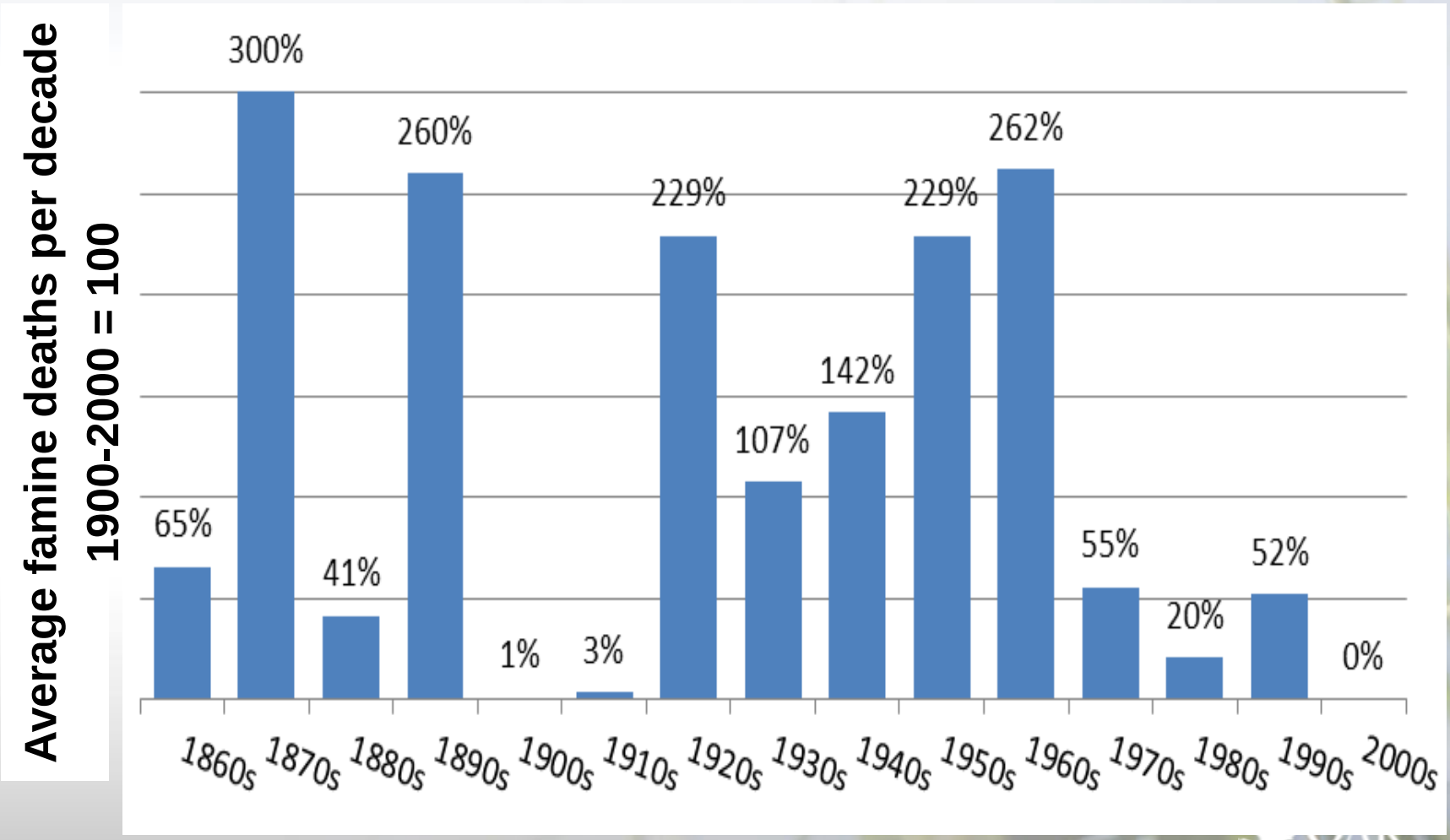
Are food prices increasing?
Define food. What are the right questions to ask?



Source: Kline et al. 2016 Fig. 1 "Food security – bioenergy interactions

Interesting discussion ensued

Are food prices increasing?
Why do we care? Assumed relationships?



Source: Kline et al. 2016 Fig. 1 "Food security – bioenergy interactions

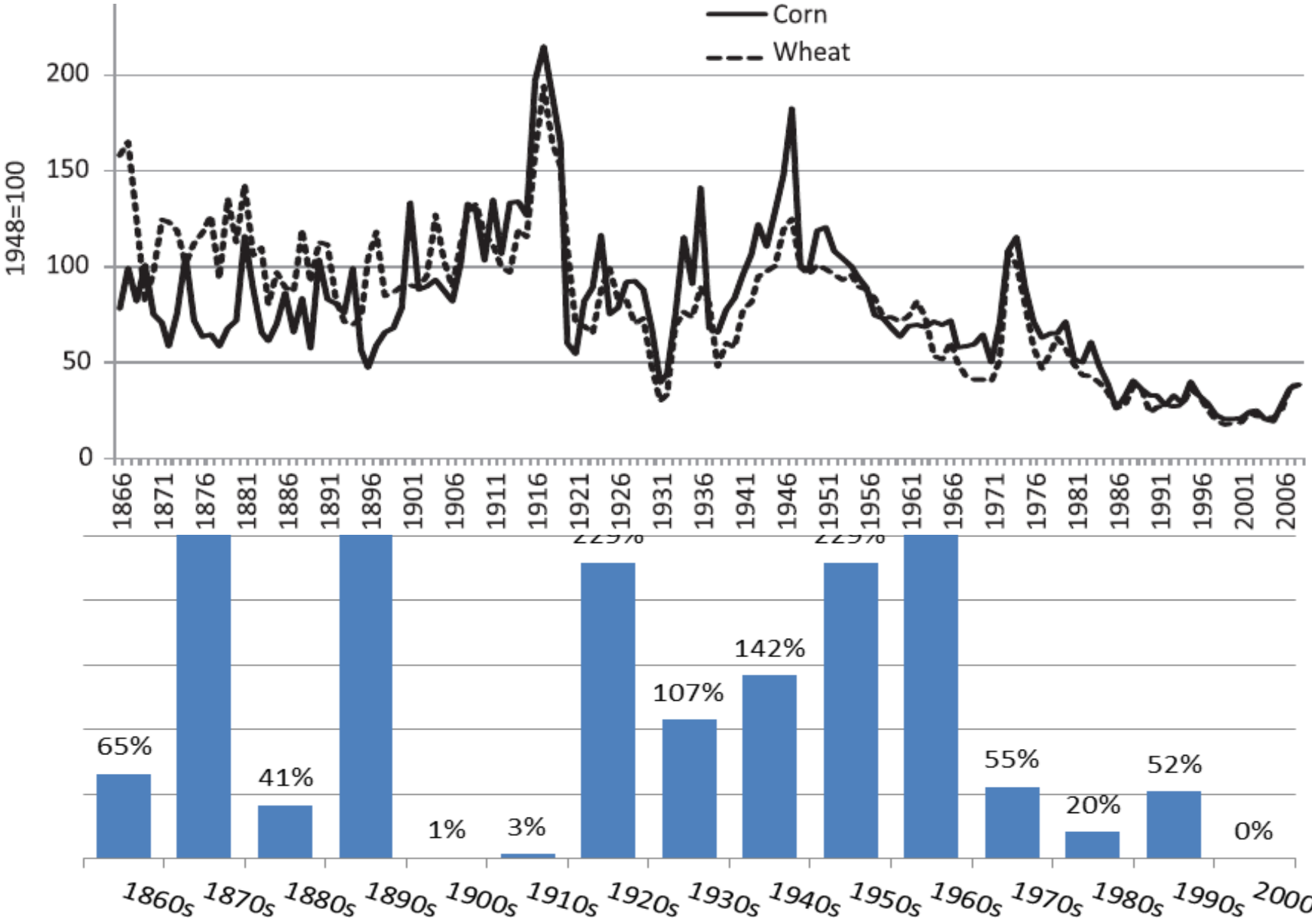


Figure Global food commodity price indices (1866-2008 per Sumner 2009) and Famine Index based on the average famine deaths reported by decade, (average for 1900-2010 = 100; index calculated based on Roser 2015) Chart prepared by Kline for draft MS on Food Security-Bioenergy interactions

Thank you

Center for Bioenergy Sustainability

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

See CBES website for

- Reports
- Forums on current topics
- Recent publications

Most recent paper, Reconciling food security and biofuels" out 14 June 2016: http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12366/full

CBES
Center for BioEnergy Sustainability

Acknowledgements: Virginia Dale, Matt Langholtz, Laurence Eaton, Maggie Davis, Tom Wilbanks and other colleagues at ORNL. Papers cited and in preparation supported by: US Department of Energy Bioenergy Technologies Office (BETO), the US National Science Foundation (NSF) PIRE for Environmental and Social Sustainability Assessment of Bioenergy in Pan America and ORNL. Thanks also to Kristen Johnson, Allison Goss-Eng, Alicia Lindauer, and many more at DOE

This research is supported by the U.S. Department of Energy (DOE) Bio-Energy Technologies Office and performed at Oak Ridge National Laboratory (ORNL). Oak Ridge National Laboratory is managed by the UT-Battelle, LLC, for DOE under contract DE-AC05-00OR22725.

OAK RIDGE National Laboratory

“memorable” musical introduction from EUBCE:

What the world needs now is land-use change
Not what you were thinking of, but the kind we all can love

What the world needs now is land-use change
Growing more crops and trees, can provide for many needs

What our lands need now is more science-based love
That’s the only thing that there’s just too little of

To the tune of, “What the world needs now is love,” *with apologies to Jackie Deshannon, author of original lyrics (below)*. *Note: the original lyrics are great, and fit the thoughts above. Indeed, these were on my mind when we conceptualized this workshop last November. -KLK*

What the world needs now is love, sweet love, It's the only thing that there's just too little of
What the world needs now is love, sweet love, No, not just for some but for everyone…

Lord, we don't need another meadow
There are cornfields and wheat fields enough to grow
There are sunbeams and moonbeams enough to shine
Oh, listen, lord, if you want to know

What the world needs now is love, sweet love
It's the only thing that there's just too little of
What the world needs now is love, sweet love
No, not just for some, oh, but just for ever, every, everyone

References

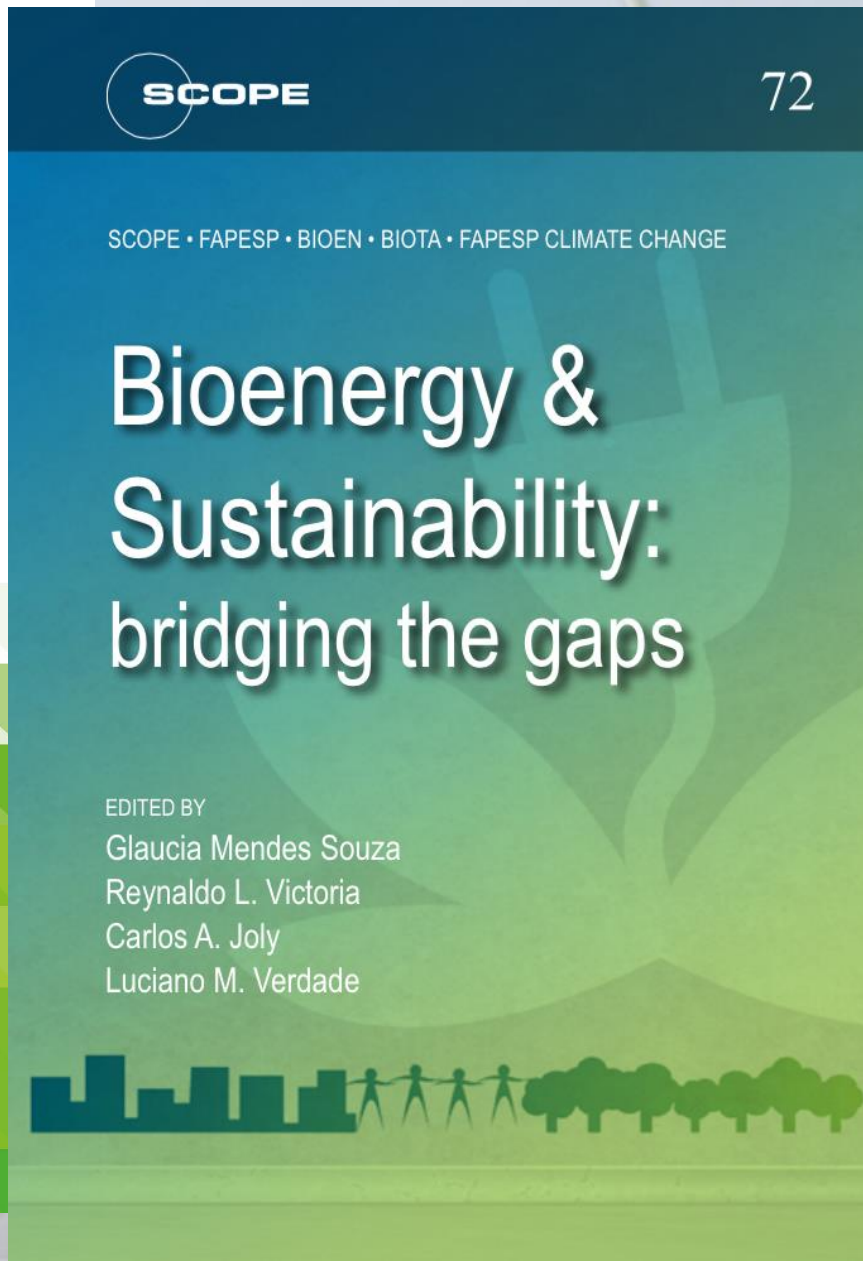
- Dale B et al. 2014. Take a closer look: biofuels can support environmental, economic and social goals. ES&T48(13):7200-7203
- Dale VH et al. 2013. Indicators for assessing socioeconomic sustainability of bioenergy systems: A short list of practical measures. Ecological Indicators 26: 87-102. http://dx.doi.org/10.1016/j.ecolind.2012.10.014
- Dale VH et al. 2016. Incorporating bioenergy into sustainable landscape designs. *Renewable & Sustainable Energy Reviews* 56:1158-1171. http://authors.elsevier.com/sd/article/S1364032115014215
- Dale VH et al.(Submitted 2016 for Biomass & Bioenergy Special Issue on Biofuels and Ecosystem Services) Selecting indicators of changes in ecosystem services due to cellulosic-based biofuels in the midwestern US.
- Efroymson RA et al. 2013. Environmental indicators of biofuel sustainability: What about context? Environmental Management 51(2): 291-306. http://web.ornl.gov/sci/ees/cbes/Publications/EfroymsonetaI2012biofuelindicatorcontextEMfinal10%201007_s00267-012-9907-5.pdf
- FAO (2015a) Hunger Map 2015. FAO Statistics Division, Rome. Available: http://www.fao.org/hunger/en/
- FAO (2015b) Forty-second Session Report, Committee on World Food Security, Rome, Italy, 12-15 October 2015. Global Strategic Framework for Food Security & Nutrition (GSF) Available at: http://www.fao.org/3/a-mo187e.pdf Last Accessed 10/10/2015.
- FAO, IFAD, WFP (2013) The State of Food Insecurity (SOFI) in the World 2013 -The multiple dimensions of food security. And FAO, IFAD, WFP (2014) SOFI Strengthening the enabling environment for food security and nutrition. FAO Rome. And FAO, IFAD, WFP (2015) SOFI Meeting the 2015 international hunger targets: taking stock of uneven progress. FAO, Rome, Italy
- Kline KL, Dale VH (2008) Biofuels, causes of land-use change, and the role of fire in greenhouse gas emissions. Science, 321, 199.
- Kline KL, Dale VH, Lee R, Leiby P (2009) In Defense of Biofuels, Done Right. Issues in Science and Technology, 25(3), 75-84
- Kline KL, Oladosu GA, Dale VH, McBride AC (2011) Scientific analysis is essential to assess biofuel policy effects. Biomass and Bioenergy, 35, 4488-4491
- Kline KL (2014) Advanced School on Present and Future of BioEnergy, ESPCA–FAPESP–University of Campinas, 10-17 October, 2014. Campinas, SP Brazil.
- Kline KL et al. (2016) Reconciling biofuels and food security: priorities for action. GCB-Bioenergy. http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12366/full
- McBride A et al. (2011) Indicators to support environmental sustainability of bioenergy systems. *Ecological Indicators* 11(5) 1277-1289.
- Parish ES et al. (2012) Multimetric spatial optimization of switchgrass plantings across a watershed. *BioFPR*. 6(1):58-72
- Parish ES, Kline KL, Dale VH, Efroymson RA, et al., (2013) Comparing Scales of Environmental Effects from Gasoline and Ethanol Production. Environmental Management 51(2):307-338
- REN 21 Renewables (2016) and (2014) Global Status Report Paris, REN21 Secretariat. http://www.ren21.net/status-of-renewables/global-status-report/
- IRENA (Jeff Skeer) (2016) Boosting Biofuels: Sustainable paths to greater energy security. www.irena.org
- Rainforest Alliance (2008) Impact of FSC Certification on Deforestation and the Incidence of Wildfires in the Maya Biosphere Reserve. http://www.rainforest-alliance.org/forestry/documents/peten_study.pdf
- Roser M (2015) Our World in Data. www.OurWorldinData.org
- Souza et al. (eds.) 2015. Scientific Committee on Problems of the Environment (SCOPE), Bioenergy & Sustainability: bridging the gaps. SCOPE 72. Paris, France and Sao Paulo, Brazil. ISBN: 978-2-9545557-0-6.
- Sumner DA (2009) Recent commodity price movements in historical perspective. American Journal of Agricultural Economics, 91(5) 1250-1256
- UNEP (2016) Unlocking the Sustainable Potential of Land Resources: Evaluation Systems, Strategies and Tools. Working Group on Land and Soils, International Resource Panel (IRP UNEP). Herrick, JE, O Arnalds, B Bestelmeyer, S Bringezu, G Han, MV Johnson et al. , ISBN: 978-92-807-3578-9
- USDA Economic Research Service (2015) Definitions of Food Security: Ranges of Food Security and Food Insecurity. U.S. Department of Agriculture
- Woodall et al. 2015. Monitoring Network Confirms Land-Use Change is a Substantial Component of the Forest Carbon Sink in eastern United States

IRENA
International Renewable Energy Agency

BOOSTING BIOFUELS

Sustainable Paths to Greater Energy Security

- **Close yield gaps**
- **Better use and management of pasture, marginal land**
- **Reduce food chain losses**
- **Forestry**



BETO Bioenergy research at ORNL-CBES

- Advance common definitions of environmental & socioeconomic costs & benefits of bioenergy systems
- Quantify opportunities, risks, & tradeoffs associated with bioenergy production in specific contexts
- Support efforts to improve stainability assessment via agreements on definitions, criteria, baseline & targets & a manageable set of relevant indicators
- Support improved standards, recognizing that c*ertification ≠ sustainability*

CBES
Center for BioEnergy Sustainability

OAK RIDGE National Laboratory

U.S. DEPARTMENT OF ENERGY

Enable long-term supply of renewable biomass for clean, domestic bioenergy