How Agroecological Farming Practices Can Help Improve Crop Production & Grazing Systems… & Create a More Resilient Future

Kansas Rural Center

2017 Farm & Food Conference, November 17 – 18

Manhattan, Kansas

Union of Concerned Scientists


Union of Concerned Scientists
Science for a healthy planet and safer world.

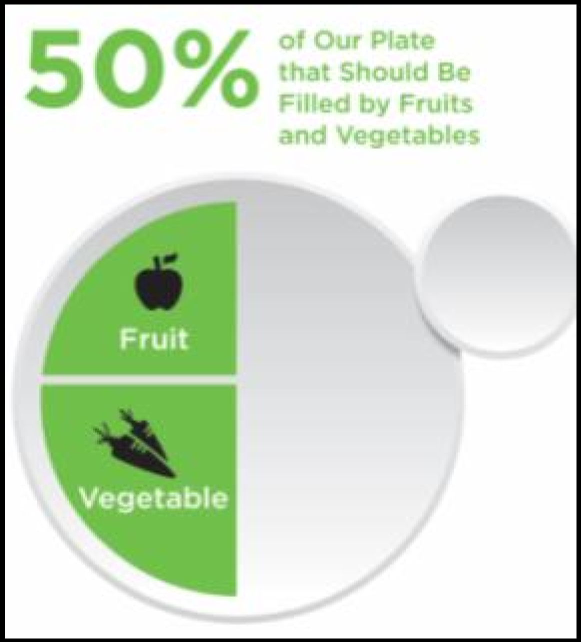
The facts are coming! The facts are coming!

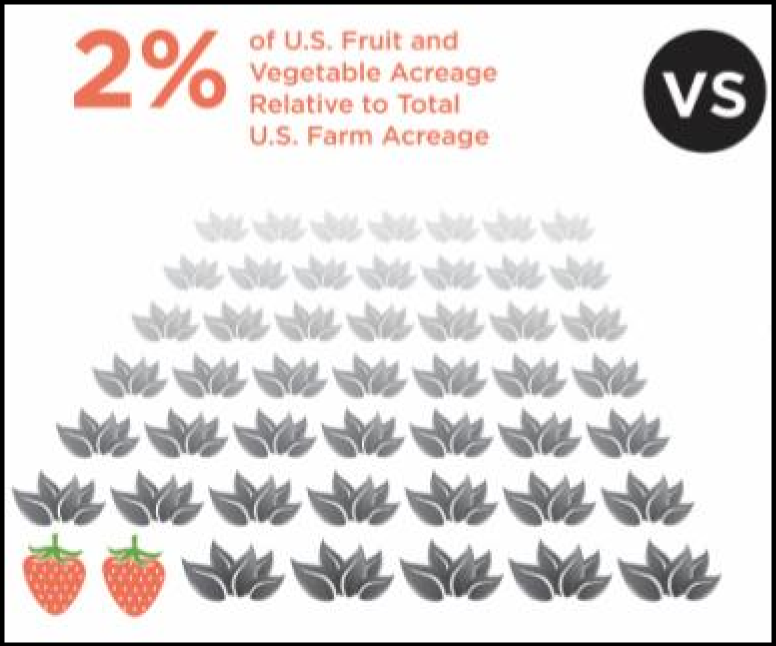

Toward Healthy Food and Farms
Transforming our food system to ensure healthy, sustainably grown food for all.

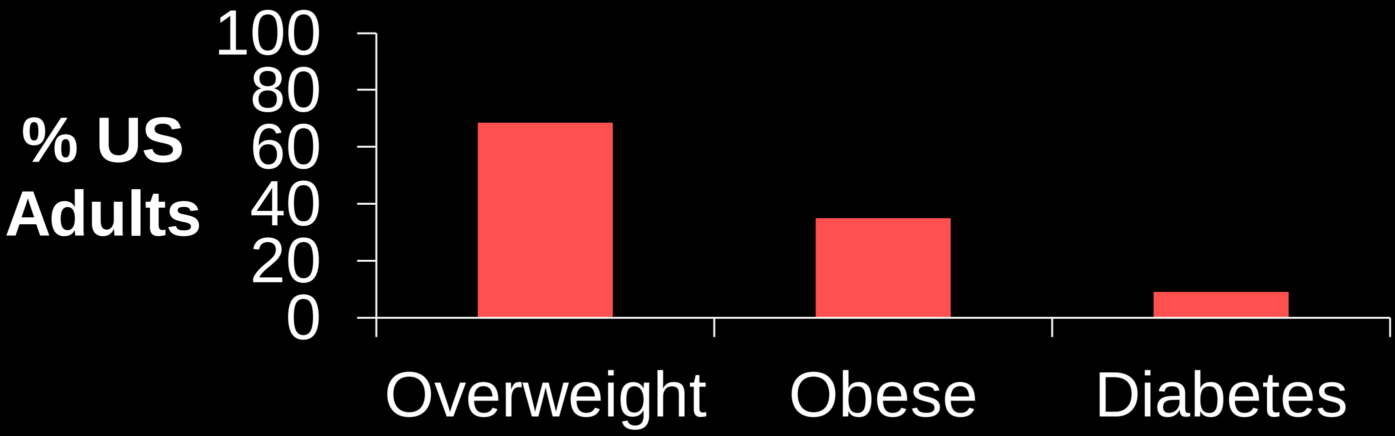
A broken food system

40%

of food is wasted







Losing ground

The Washington Post

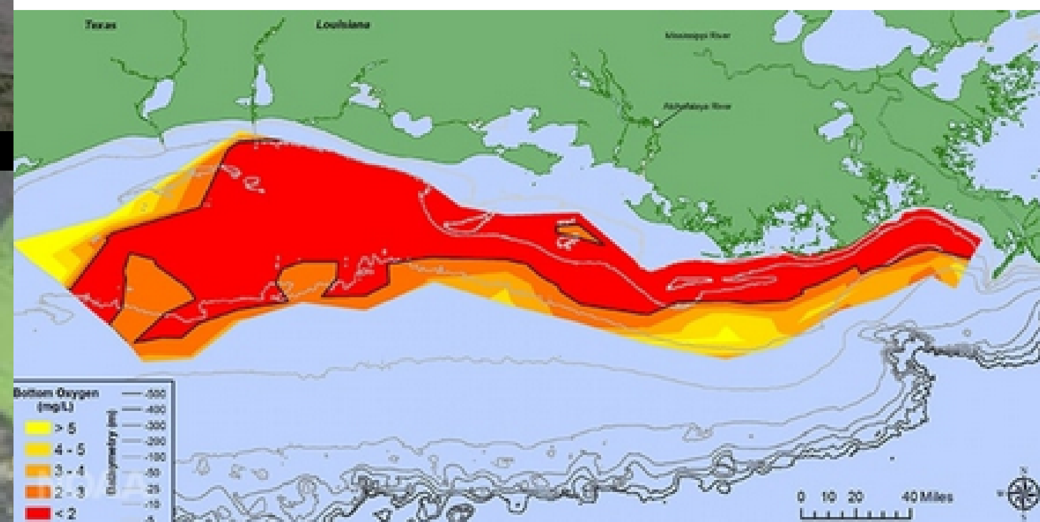
Democracy Dies in Darkness

Energy and Environment

The Gulf of Mexico dead zone is larger than ever. Here's what to do about it.

By Jenna Gallegos

August 4



At 8,776 square miles, this year's dead zone in the Gulf of Mexico is the largest ever measured. (Courtesy of N. Rabalais, LSU/LUMCON)

Scientists just measured the largest dead zone ever recorded for the Gulf of Mexico, a whopping 8,776


A Vanishing Aquifer

Share:

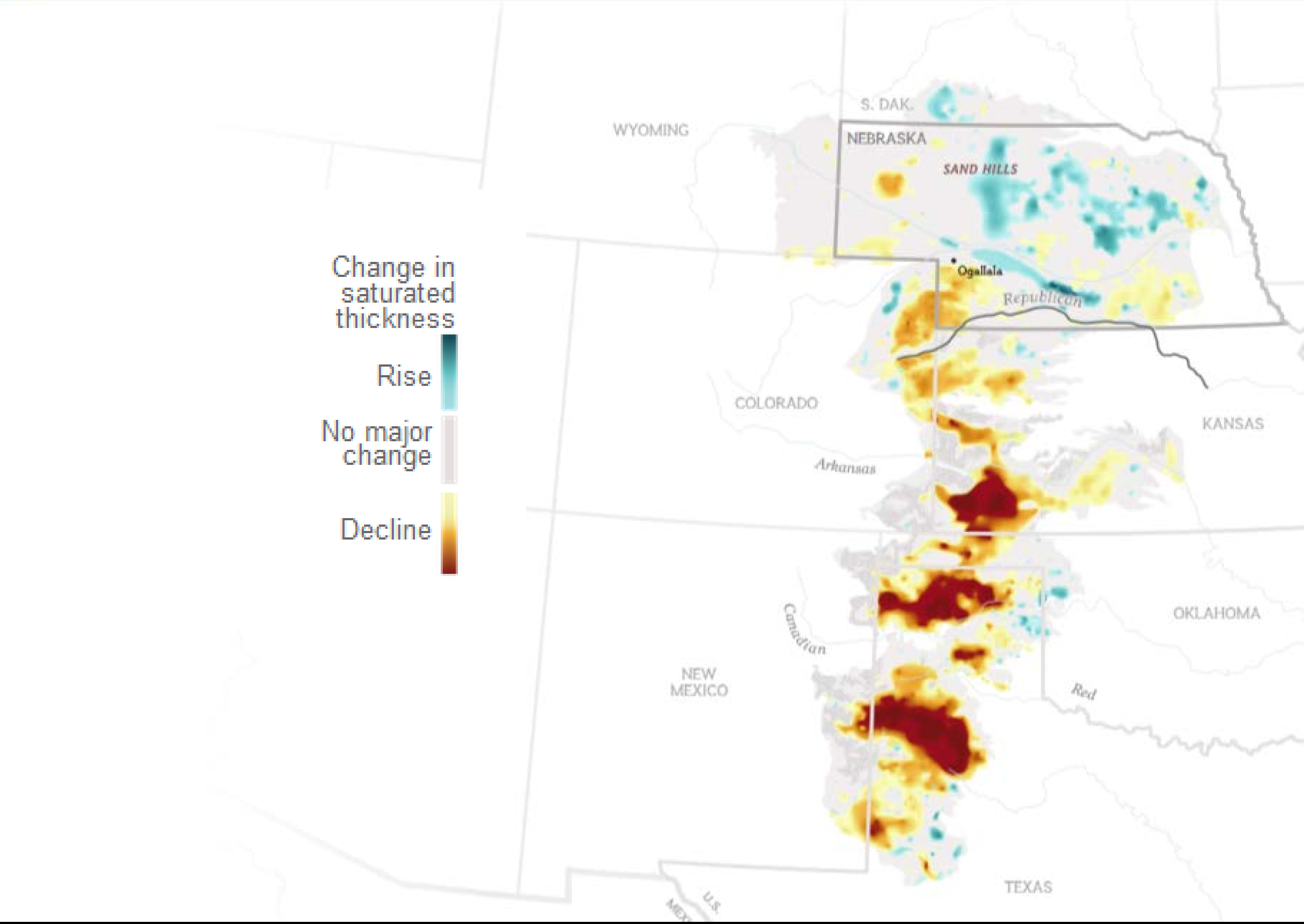


Photo: Dorothea Lange; The Library of Congress, Prints & Photographs Division

Soils: at the roots of many challenges

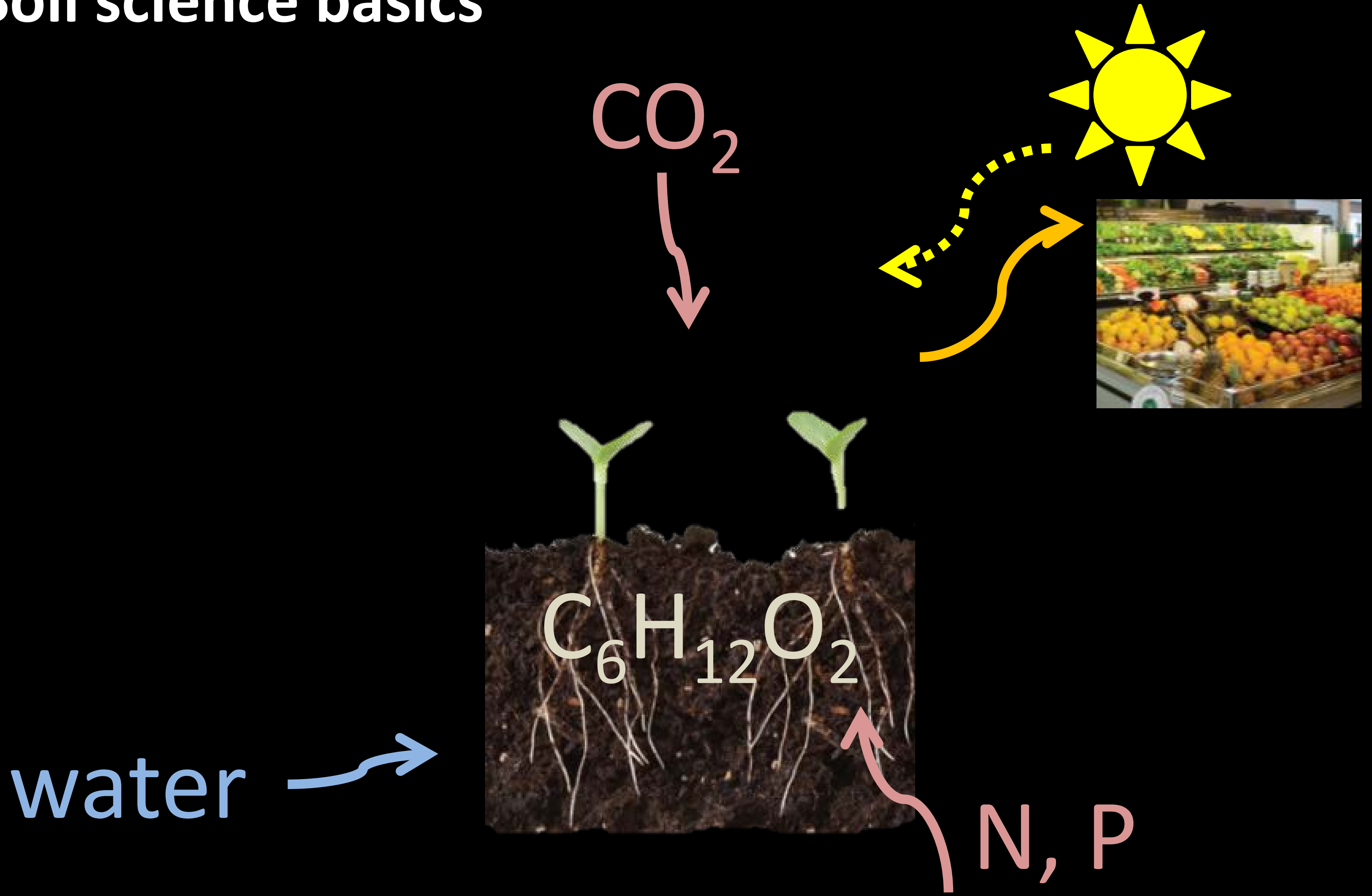






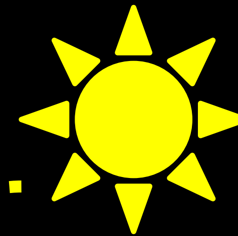


Soil science basics



Soil science basics

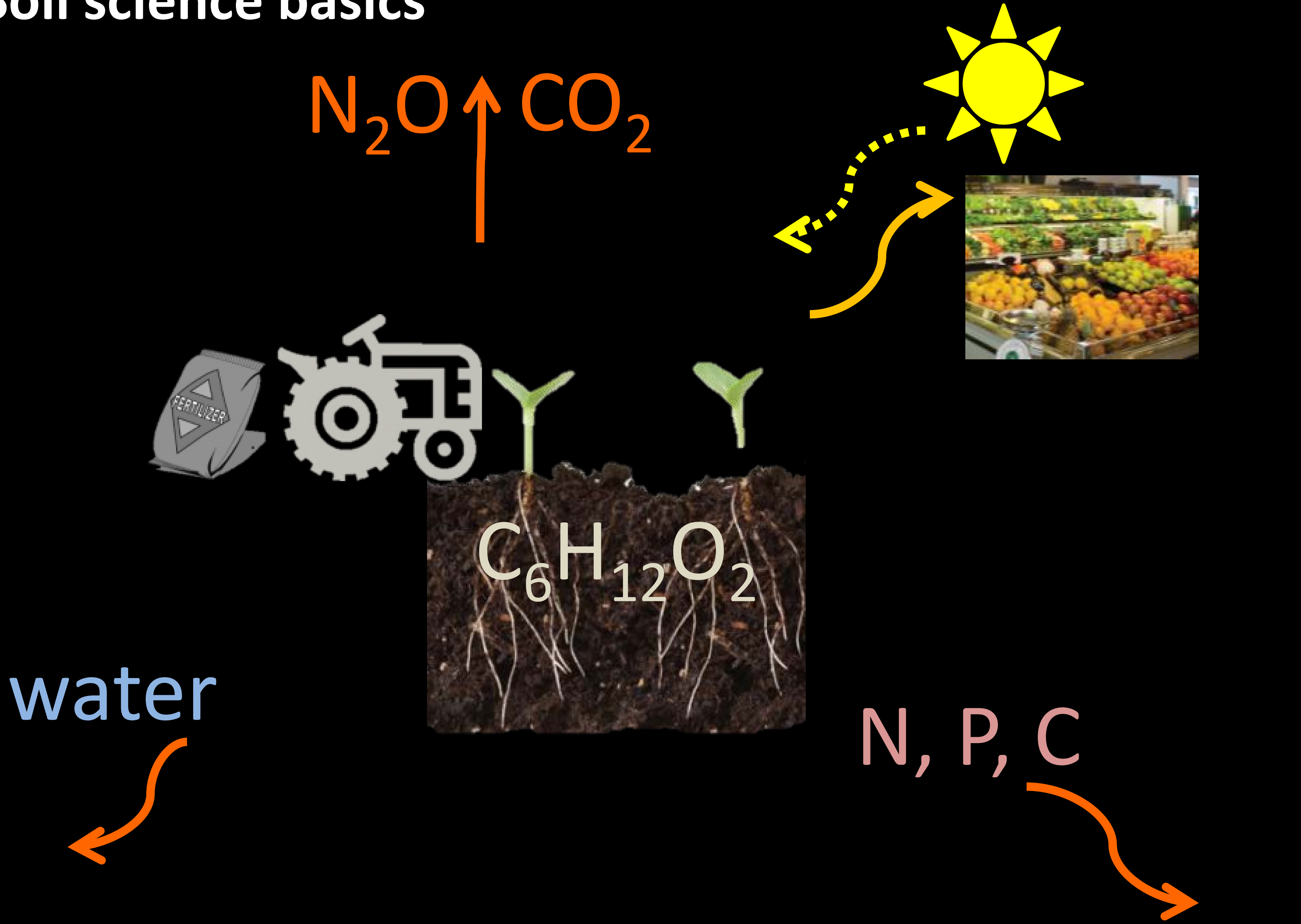
$\uparrow CO_2$



water

N, P, C

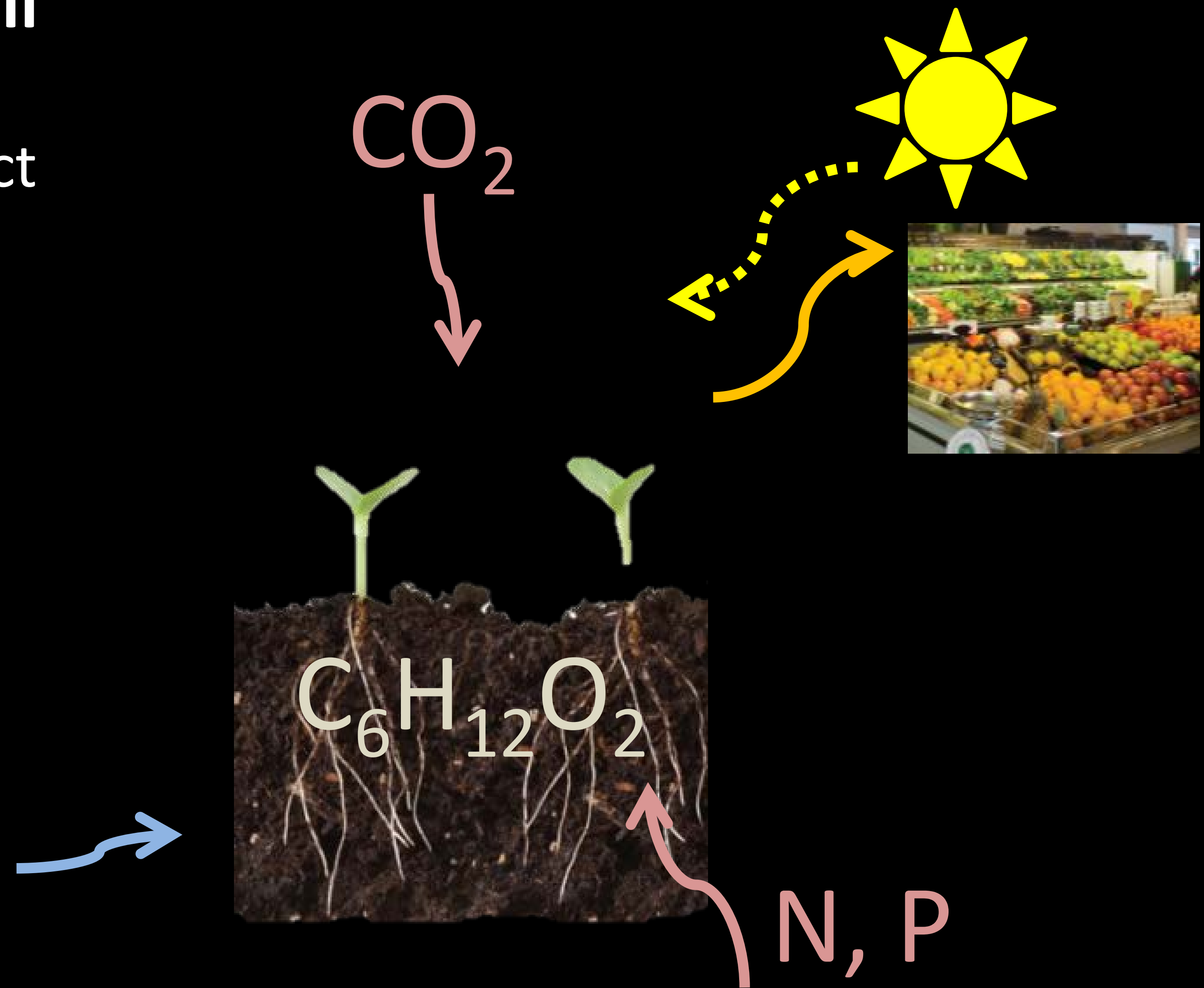
Soil science basics



Healthy soil

-High OM, C

-Not compact

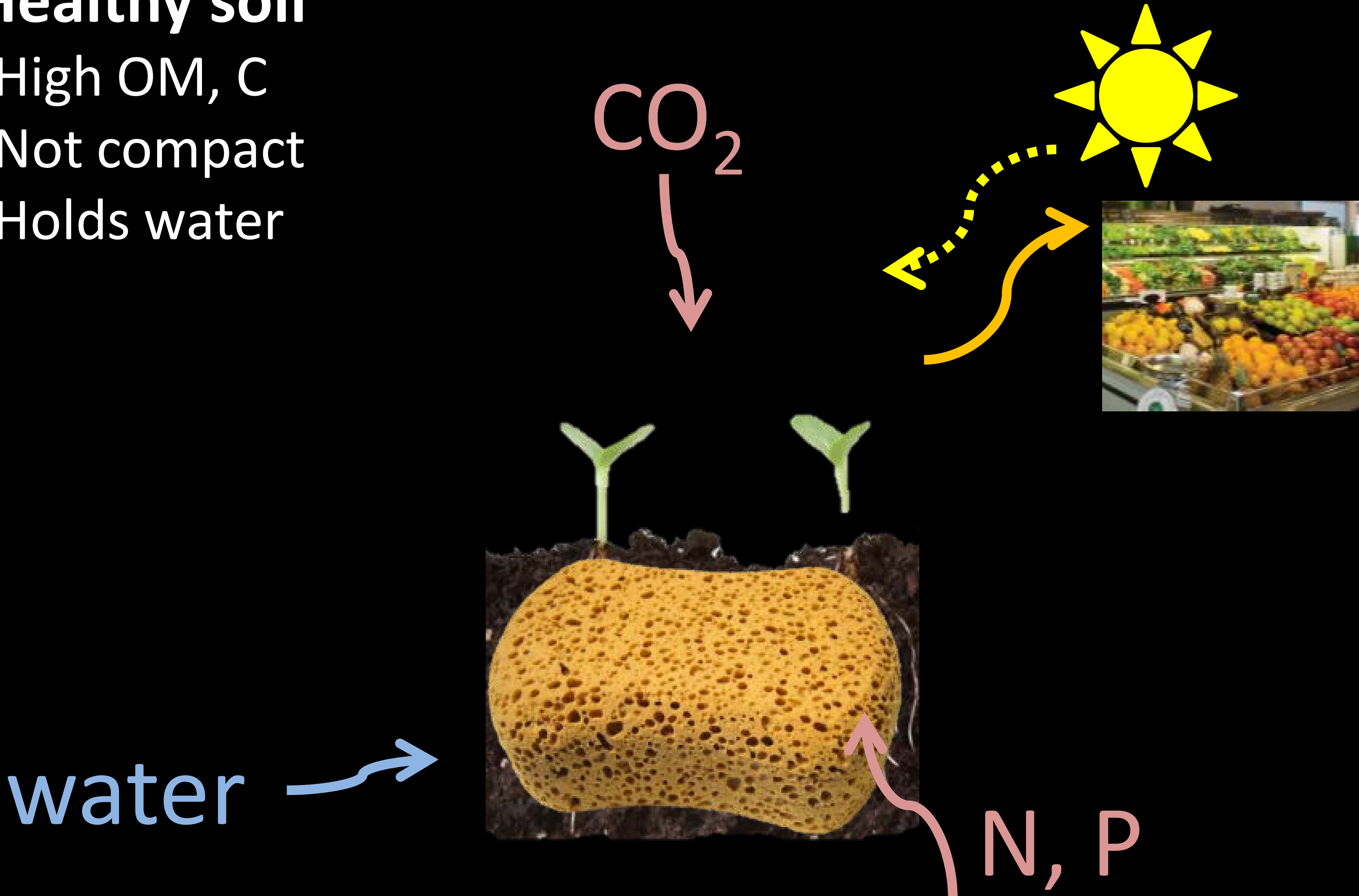


Healthy soil

-High OM, C

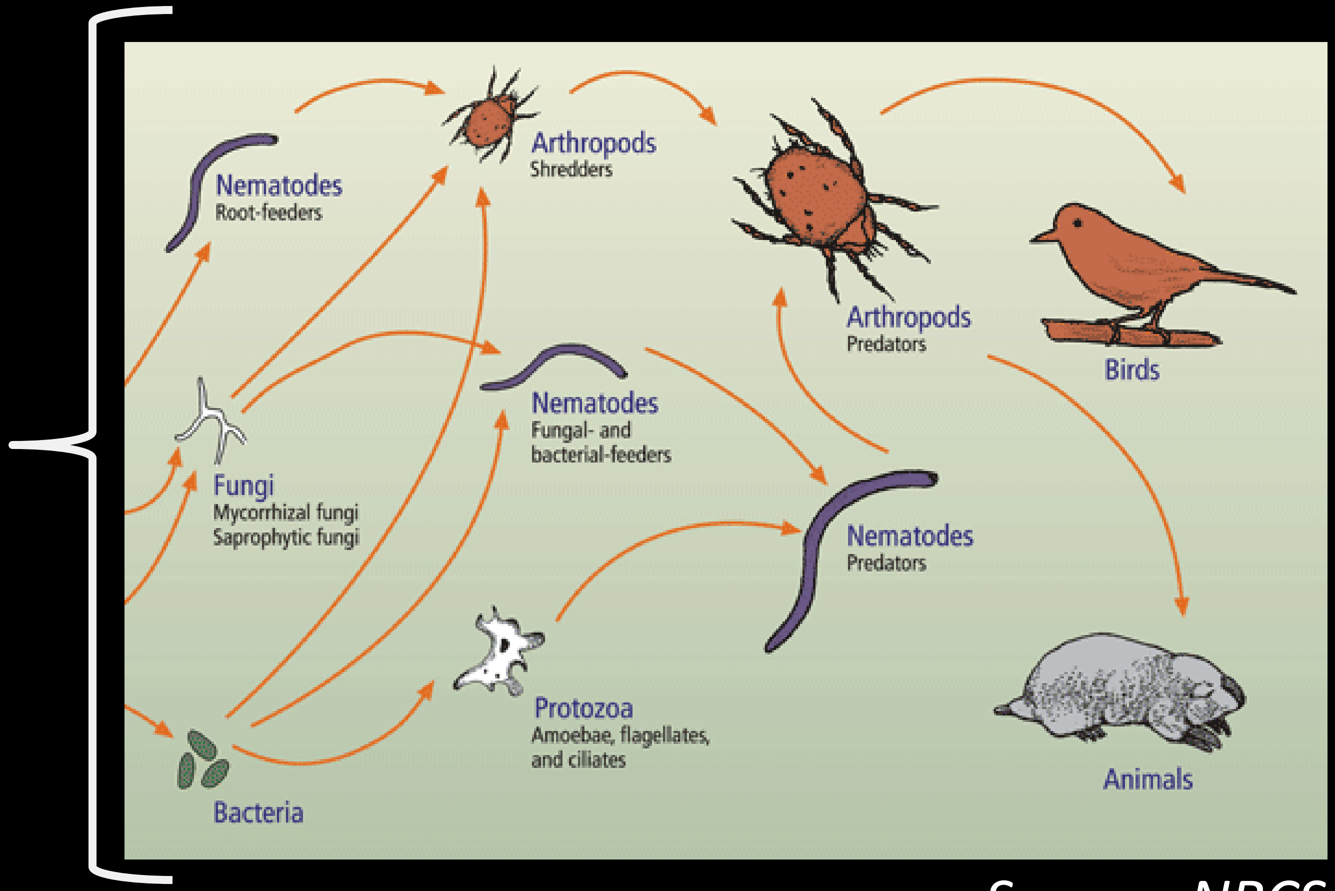
-Not compact

-Holds water



Healthy soil

-High OM, C
-Not compact
-Holds water
-"Full of life"



Source: NRCS

Science is showing how various practices can build soil health

Perennials
Perennial grasses, Agroforestry, Forestry

Crop Rotation

Integrated crop-livestock systems

Grazing Management
Reduced rates, Rotational grazing

Cover Crops

No-Till

Management practices can sequester soil carbon

Cropland:
0.3-0.5 Mg C/ha/y

No-Till

Cover Crops

Crop Rotation

Grassland, grazing land:
0.04-0.2 Mg C/ha/y

Grazing Management

Perennials

Land restoration:
0.1-0.5 Mg C/ha/y

Forest land:
0.1-0.4 Mg C/ha/y

Chambers et al. 2016

Management practices can deliver agronomic & ecological benefits

Crop Rotation (e.g. Marsden Farm)

Hunt et al. 2017
Photo: PR Westerman

Perennials (e.g. STRIPS)

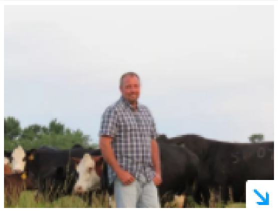
Helmers et al. 2012
Photo: L Schulte Moore

On-farm research is key!

Editorial: To clean up our water, go 'nuts' like this Iowa farmer

The Register's editorial Published 7:30 a.m. CT June 30, 2017 | Updated 5:34 p.m. CT June 30, 2017

Shifting from two-crop cycle can produce profits and environmental benefits



(Photo: Special to the Register)

Seth Watkins has impressive Iowa agriculture bona fides: He's a fourth-generation farmer. He raises 600 cows and tends 3,200 acres east of Clarinda in southwest Iowa. His grandmother, Jessie Field Shambaugh, founded 4-H.

Yet some Iowans have called him "nuts" for sowing grass where he could plant more corn, he told the Register.

Watkins has broken out of the two-crop cycle in which so many farmers are caught. He grows corn but also oats, alfalfa and cover crops. He grazes his cattle on pastureland, and about 400 acres of his land have been restored to prairie or set aside for ponds and protection of wildlife and streams. And he's seen better financial returns as a result, he said, even if it comes at the cost of huge corn yields.

"My job as farmer is not to produce; my job is to care for the land. And when I do this properly, this provides for all of us," Watkins, 48, told an audience this month at the National Marine Sanctuary Foundation's Capitol Hill Ocean Week in Washington, D.C.

Why is an Iowa farmer talking to marine scientists about his farming practices?

Because they know what Watkins does in the Nodaway River valley affects places like the Gulf of Mexico. The "dead zone" — a region of oxygen-depleted water that harms shrimp and other sea life — is expected to be more than 50 percent larger than average this summer, according to the National Oceanic and Atmospheric Administration. This spring's heavy rains washed excess fertilizer from Midwestern fields down the Mississippi River into the gulf.

Can management practices improve climate resilience & adaptation?

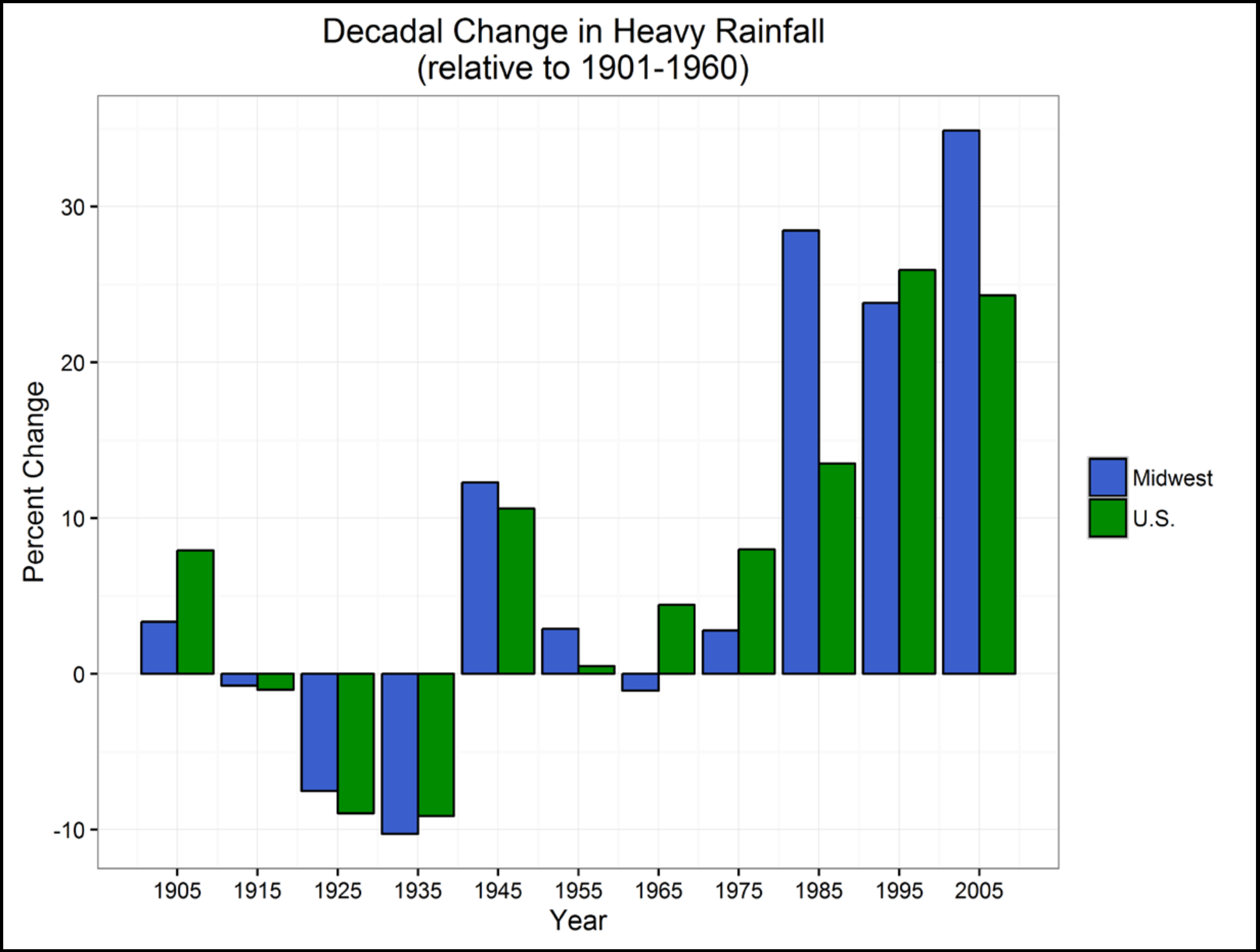
Floods are expensive.

Severe Flooding in Cedar Rapids in 2008: $5 billion

Photo: Dean Becker/USGS

Photo: Russ Munn/AgStock Images

Risks of heavy rainfall are increasing



Source: National Climate Assessment

What was the cost of damages from flooding in 2016?

- $500 million
- $3 billion
- $10 billion
- $20 billion

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What percentage of crop insurance payouts resulted from flood and drought events from 2011-2016?

- 10%
- 25%
- 66%
- 95%

What percentage of crop insurance payouts resulted from flood and drought events from 2011-2016?

- 10%
- 25%
- 66%
- 95%

Judd McCullum, Flickr

Carl Wycoff , Flickr

How do agricultural practices in crop & grazing lands make soil spongier (e.g., higher infiltration rates) on individual fields?

Cropland Grazing

No-Till

Crop Rotation

Cover Crops

Grazing Management
Reduced rates, Rotational grazing, Grazing exclusion

Perennials
Perennial grasses, Agroforestry, Forestry

CONTROL

Crops Only

Conventional or Reduced Tillage

Mono-culture

No cover crop

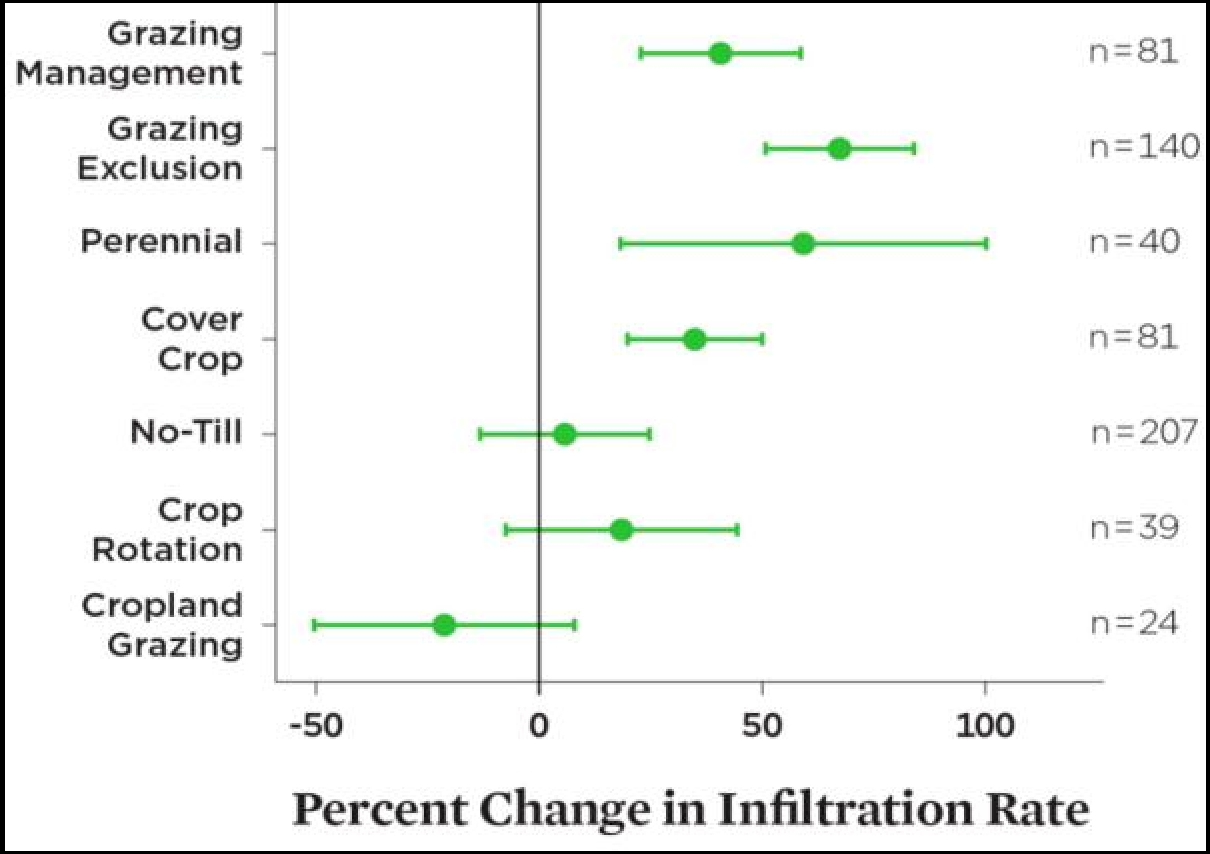
Conventional or Continuous Grazing

Annual Crop System

Meta-analysis of >120 field experiments

Union of Concerned Scientists, Turning Soils into Sponges

Conservation practices improve infiltration rates, especially "continuous living cover"

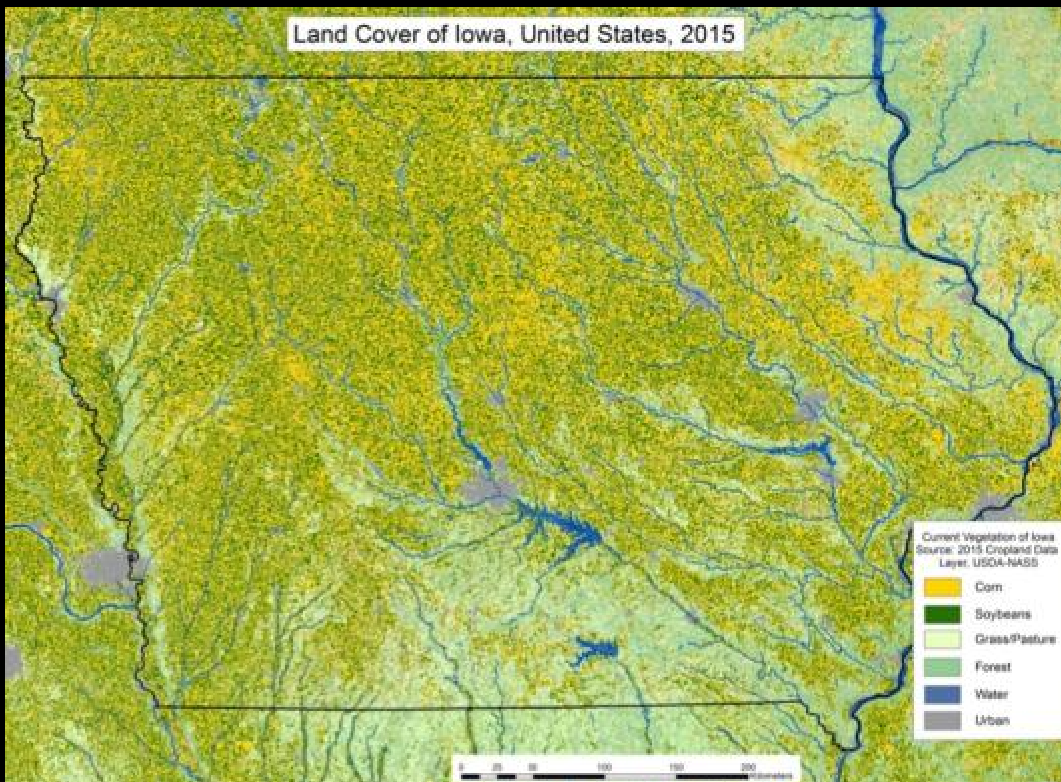


UCS, Basche 2017

Similar findings for porosity & water retained at field capacity

Basche & DeLonge 2017
DeLonge & Basche, in press
Basche & DeLonge, in revision

How do agricultural practices in crop & grazing lands impact water **on a landscape scale**?

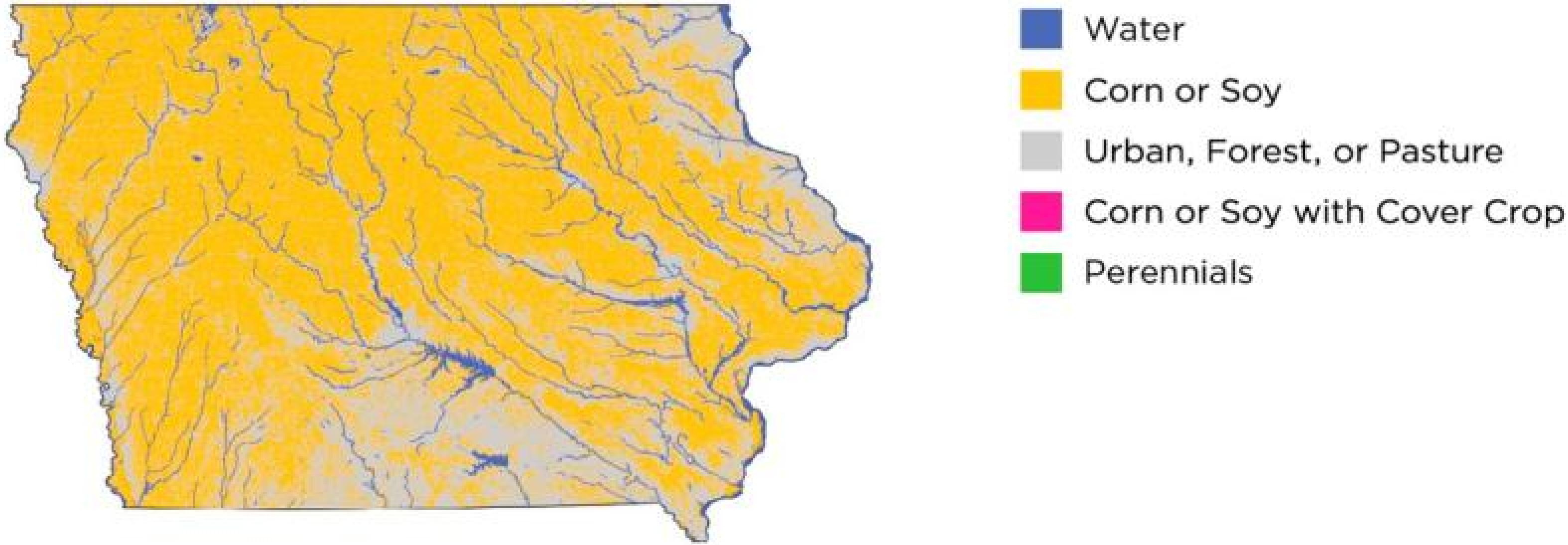


Livestock on perennial grasses

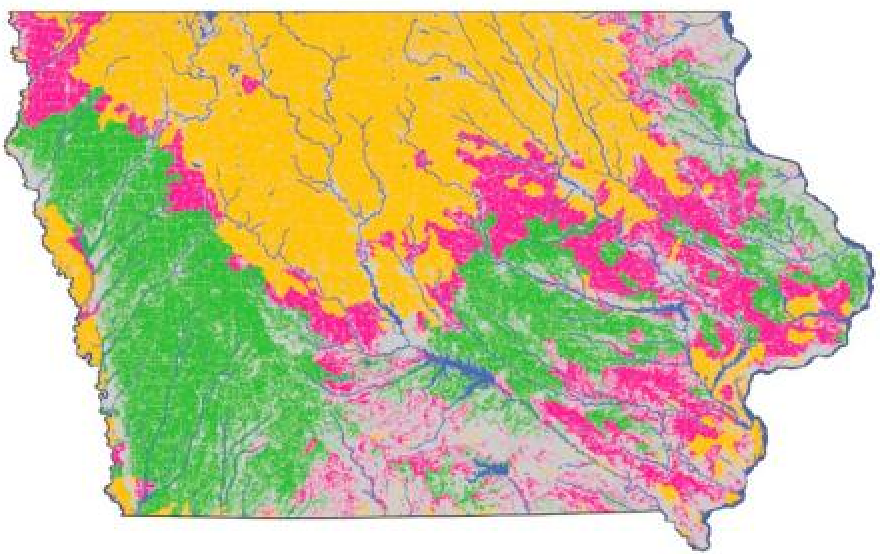
Perennial crops (i.e. alfalfa)

Diverse cover crops

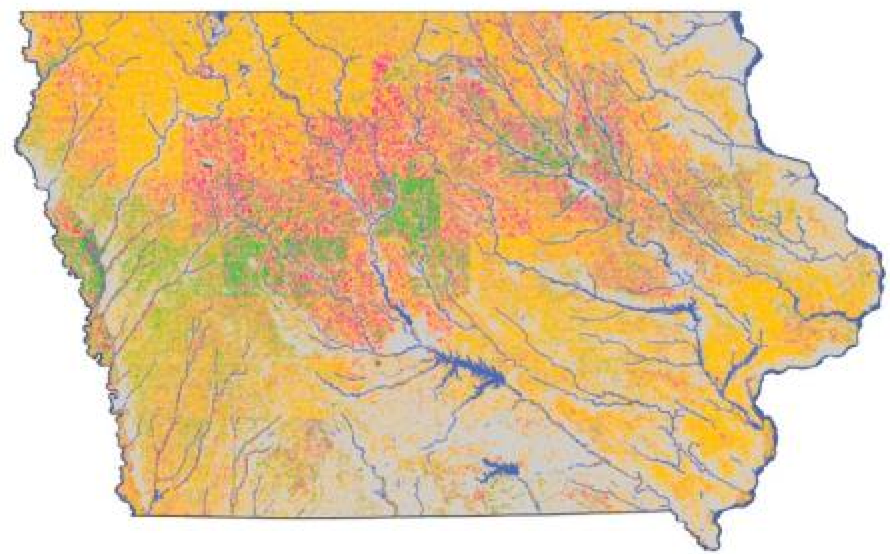
a. Current Farm Landscape



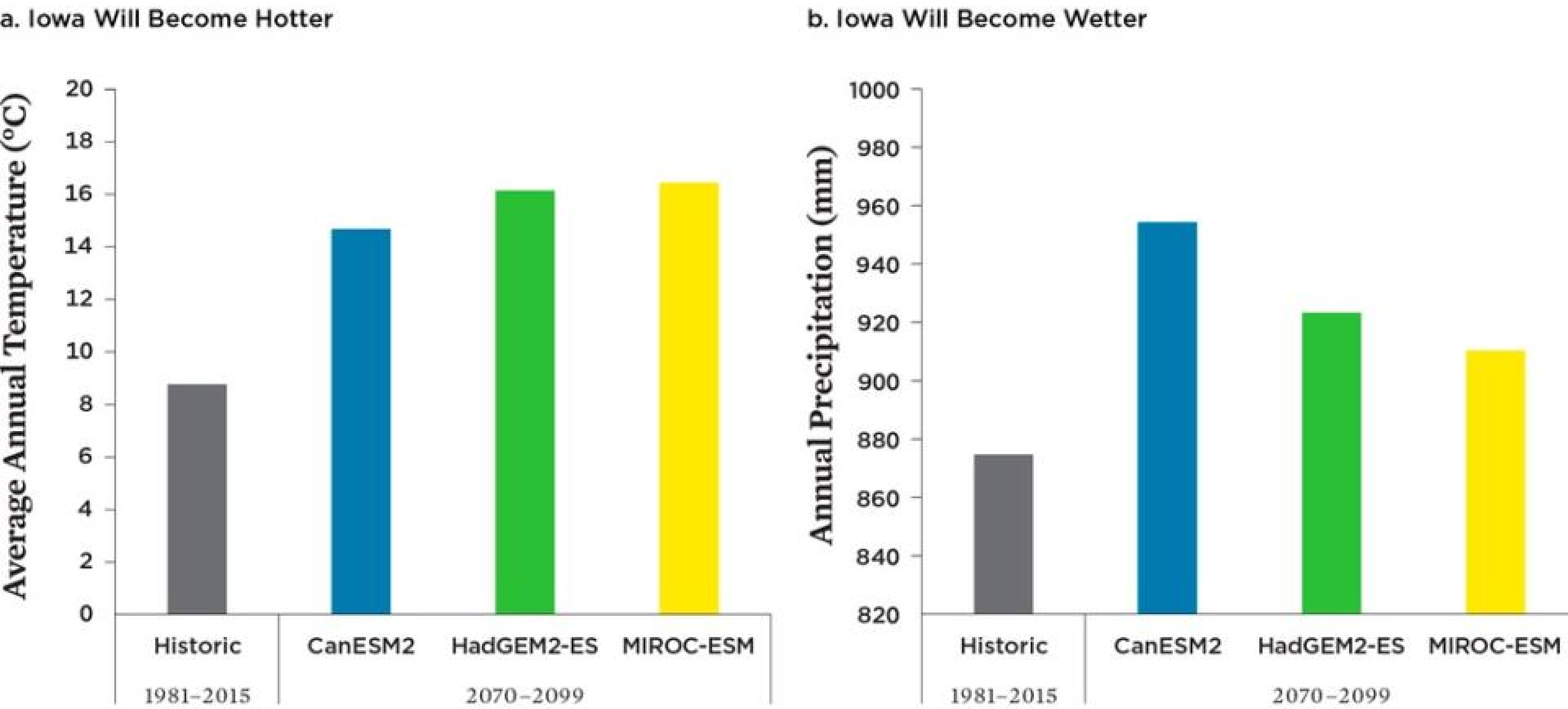
b. Hypothetical Soil Improvements on Today's Most Erodible Acres



c. Hypothetical Soil Improvements on Today's Least-Profitable Acres



Union of Concerned Scientists, Turning Soils into Sponges



Union of Concerned Scientists, Turning Soils into Sponges

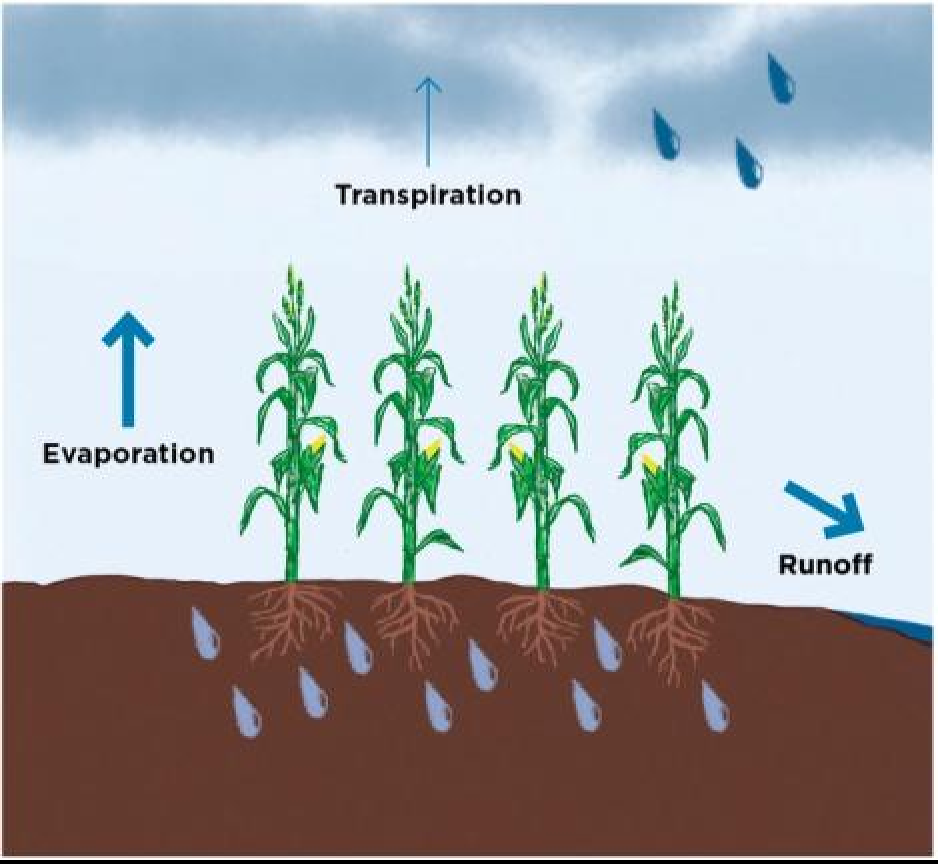
- In severe droughts (1988, 2012) up to 16% greater crop water use
- Up to a 20% reduction in flood frequency
- Similar magnitude benefits with future climate

Livestock on perennial grasses

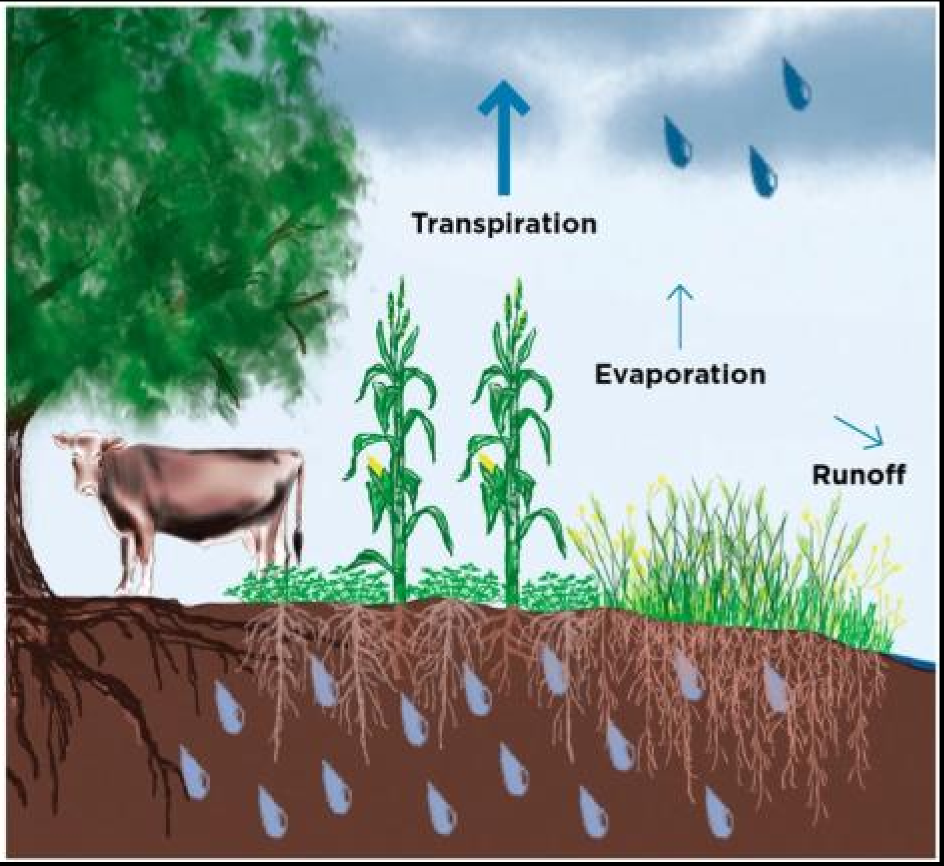
Perennial crops (i.e. alfalfa)

Diverse cover crops

Typical Corn Belt Annual Crop System



System Incorporating Perennials, Cover Crops and Livestock

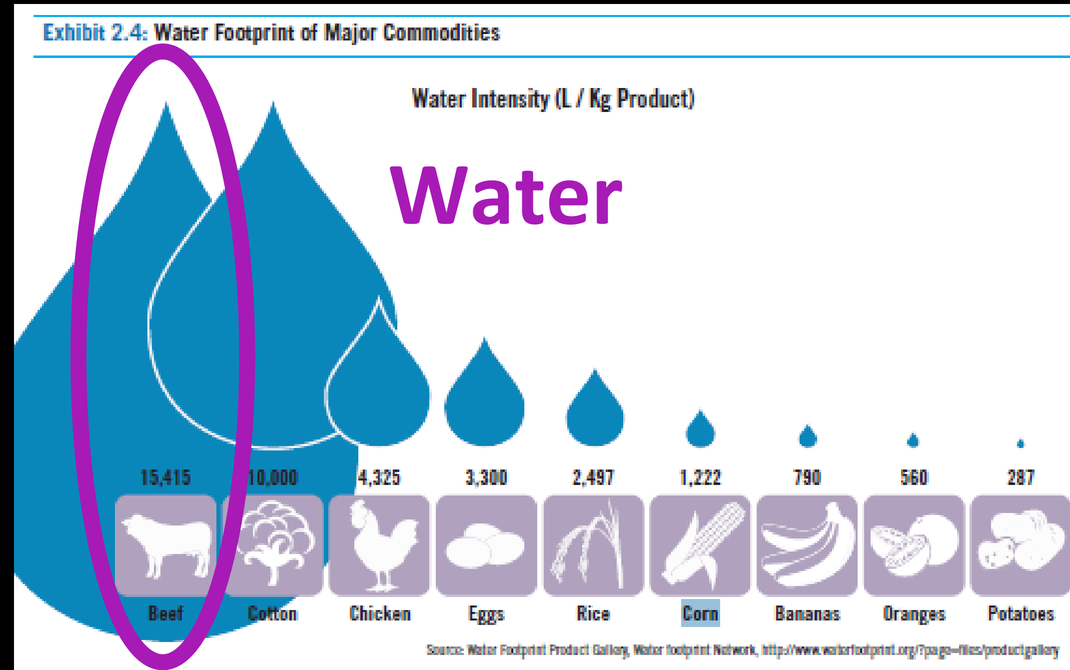


Union of Concerned Scientists, Turning Soils into Sponges

Can ecological practices improve the sustainability of beef?

Why beef?

Opportunity for improvement



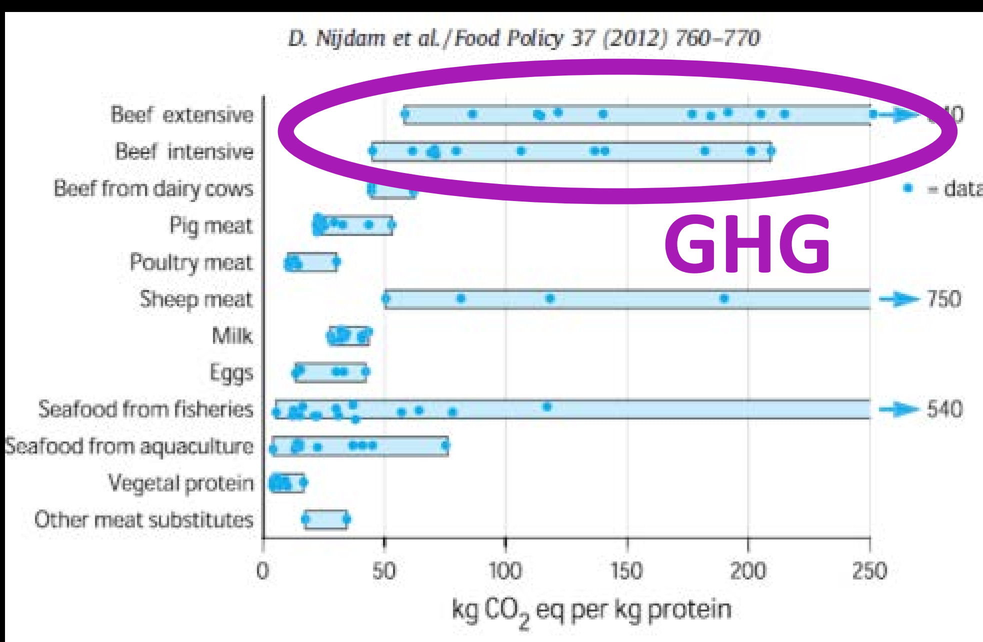


Fig. 1. Carbon footprints per kilogram of protein.

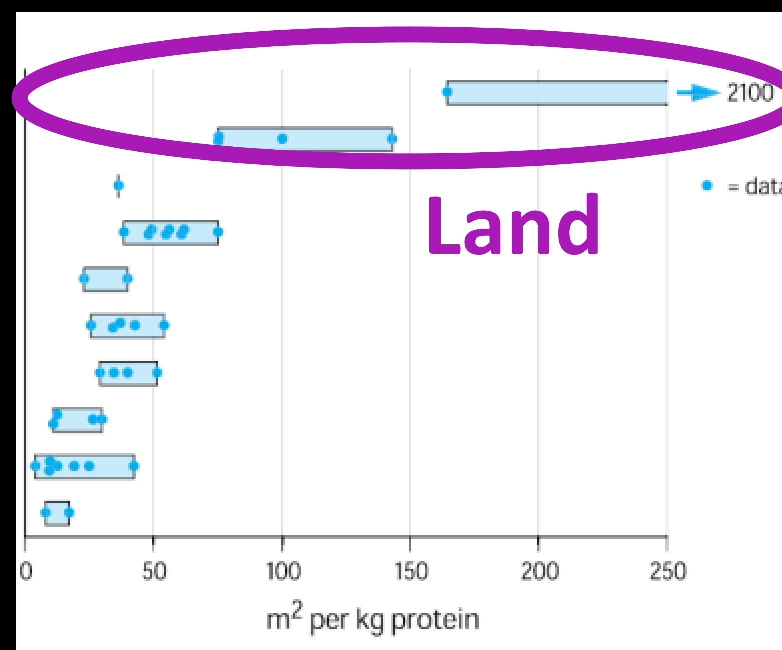


Fig. 2. Land use per kilogram of protein.

<u>Finishing:</u>

Grass

12-30/36 mo; 1100–1400 lb

Feedlot

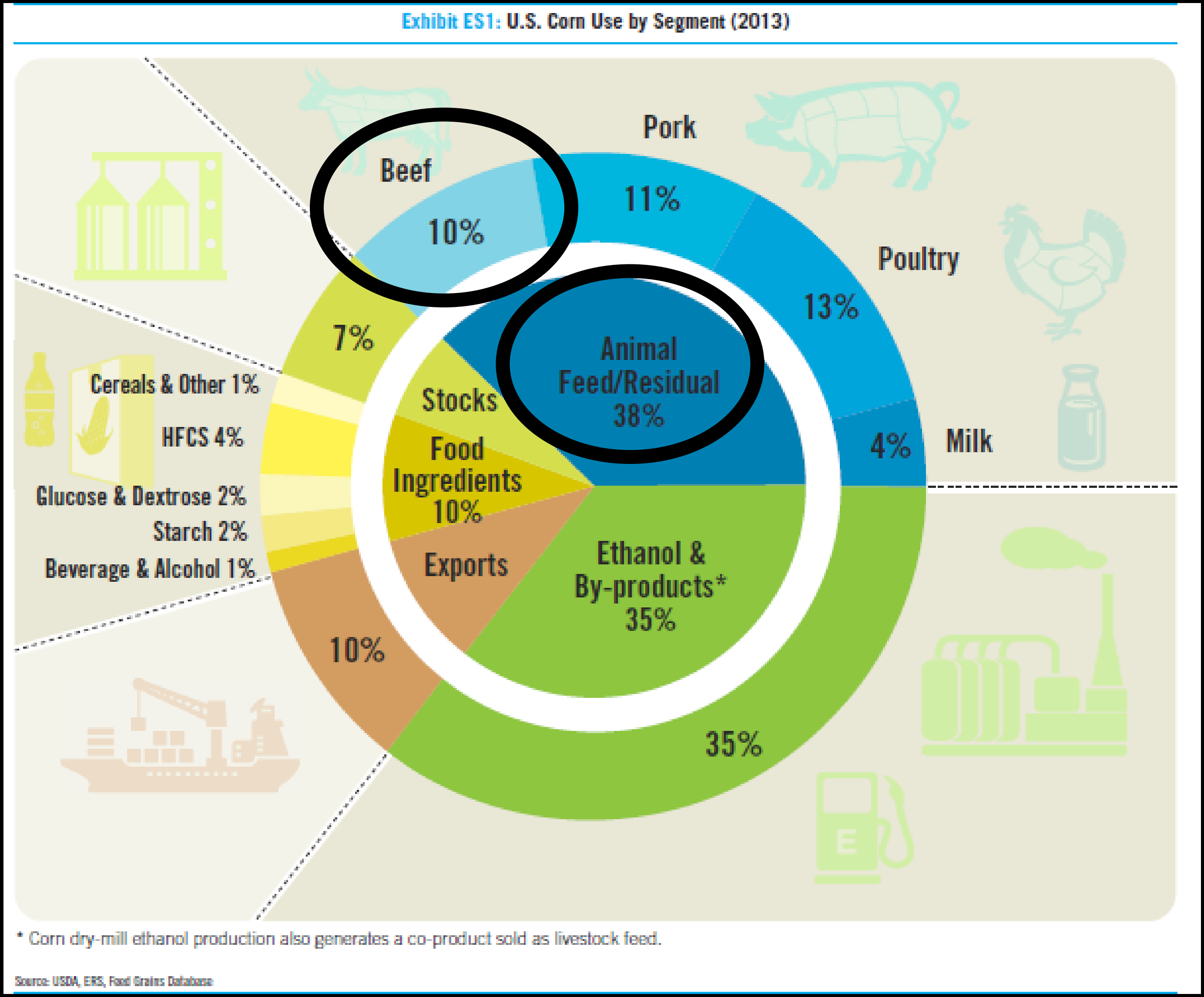
12-16/24 mo; 1100–1400 lb

Backgrounding/Stocking

4-6/8 mo; 600-800 lb

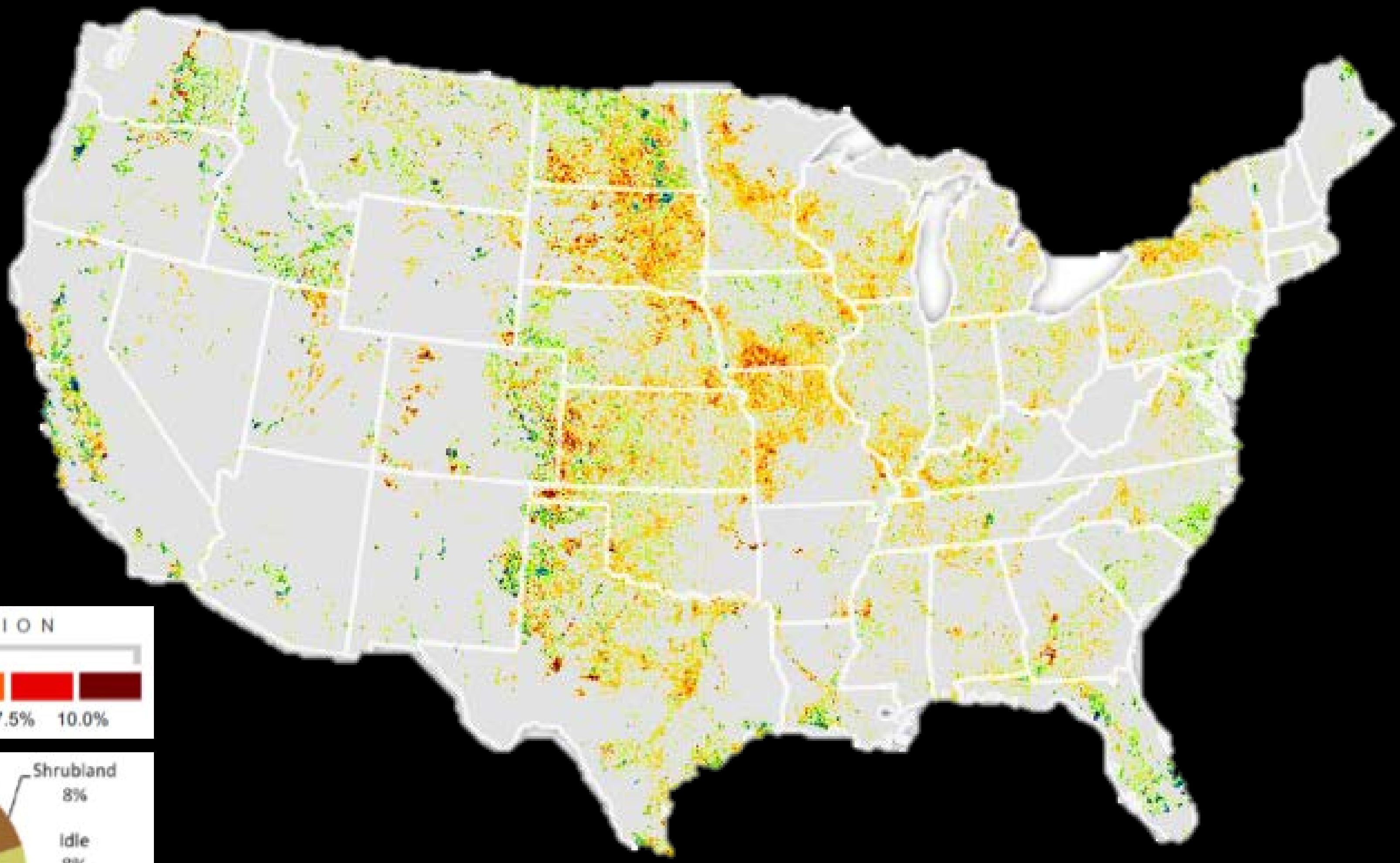
0-4/7 mo; 400-

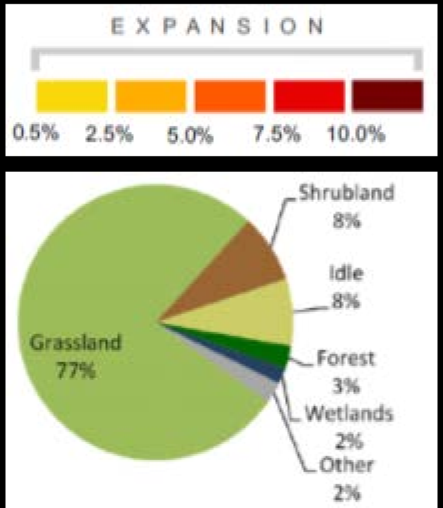
Feed crops & beef linked to commodity crops



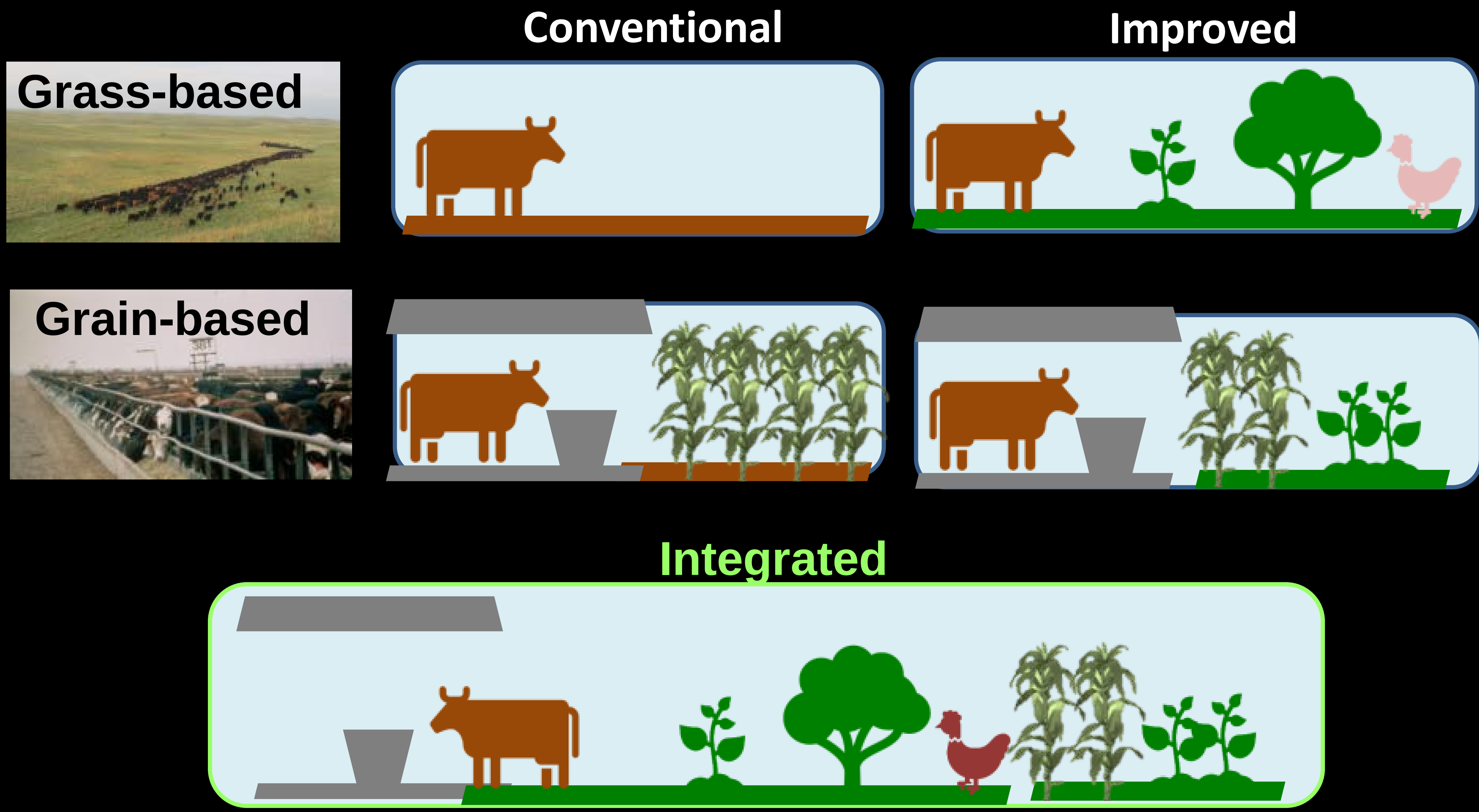
CERES, Barton & Clark

Commodity crops linked to grassland loss





Lark et al. 2015



What are the on-farm economic & ecological impacts of transitioning conventional crops to ecological grass & crops?

Economic Methods

LAND STEWARDSHIP PROJECT

Home | About Us | Stewardship & Food | More Farmers on the Land | Organizing for Change

Stewardship & Food

- CSA Farm Directory
- Food Systems & Land Stewardship
- Chippewa 10% Project
- Chippewa 10% Cropping Systems Calculator
- Chippewa 10% BioBlitz
- Conservation Leases
- Root River: Promise of Pasture
- Soil Health, Profits & Resiliency
  - Soil Health Video Conference: Sept. 21, 2012
- LSP Soil Builders' Network
- Distributing Just Food
  - Western Prairie Area
  - Driftless Area
- Just Food for All
  - Hope Community in Minneapolis
  - Urban Farming Policy

Chippewa 10% Cropping Systems Calculator

When thinking about switching to a different farming system, one of the first questions many farmers want answered is: "How will this work financially?" The Chippewa 10% Project developed the Cropping Systems Calculator to help answer this question by allowing farmers to plug in various planting and grazing scenarios and weigh the financial pros and cons of each option.

Cropping Comparisons

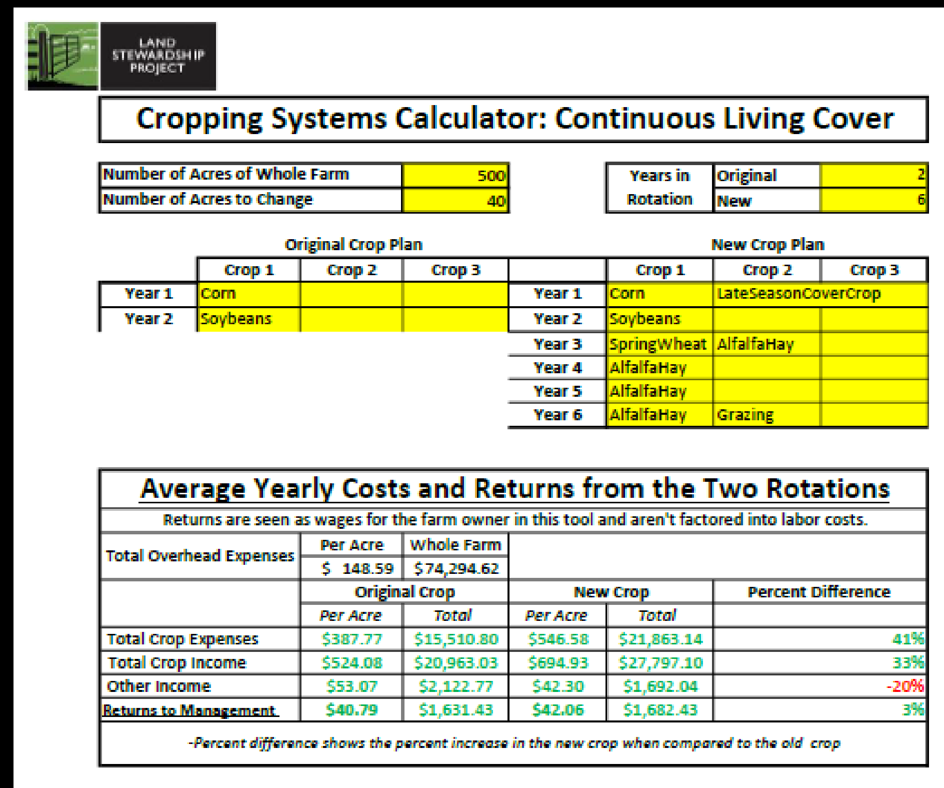
This easy-to-use Excel-based tool (*see example below*) allows you to compare two

Try it for Yourself

The Cropping Systems Calculator is available here. Watch this page for updates. For more information or questions, contact LSP's Rebecca Wasserman-Olin at 612-722-6377 or via e-mail.

Mac Users

The Calculator currently does not work on Mac operating systems. We are developing a



LAND STEWARDSHIP PROJECT

Cropping Systems Calculator: Continuous Living Cover

Number of Acres of Whole Farm	500
Number of Acres to Change	40

Years in Rotation		
	Original	2
	New	6

Original Crop Plan

	Crop 1	Crop 2	Crop 3
Year 1	Corn		
Year 2	Soybeans		

New Crop Plan

	Crop 1	Crop 2	Crop 3
Year 1	Corn	LateSeasonCoverCrop	
Year 2	Soybeans		
Year 3	SpringWheat	AlfalfaHay	
Year 4	AlfalfaHay		
Year 5	AlfalfaHay		
Year 6	AlfalfaHay	Grazing	

Average Yearly Costs and Returns from the Two Rotations

Returns are seen as wages for the farm owner in this tool and aren't factored into labor costs.

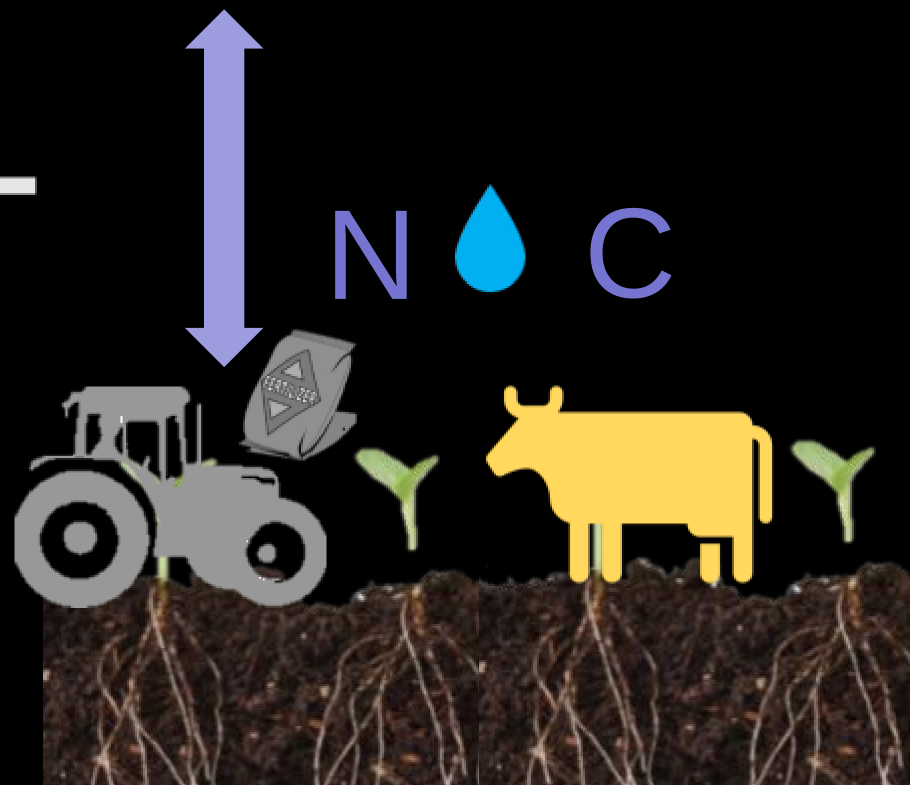
	Per Acre	Whole Farm
Total Overhead Expenses	$ 148.59	$74,294.62

	Original Crop		New Crop		Percent Difference
	Per Acre	*Total*	*Per Acre*	*Total*	
Total Crop Expenses	$387.77	$15,510.80	$546.58	$21,863.14	41%
Total Crop Income	$524.08	$20,963.03	$694.93	$27,797.10	33%
Other Income	$53.07	$2,122.77	$42.30	$1,692.04	-20%
Returns to Management	$40.79	$1,631.43	$42.06	$1,682.43	3%

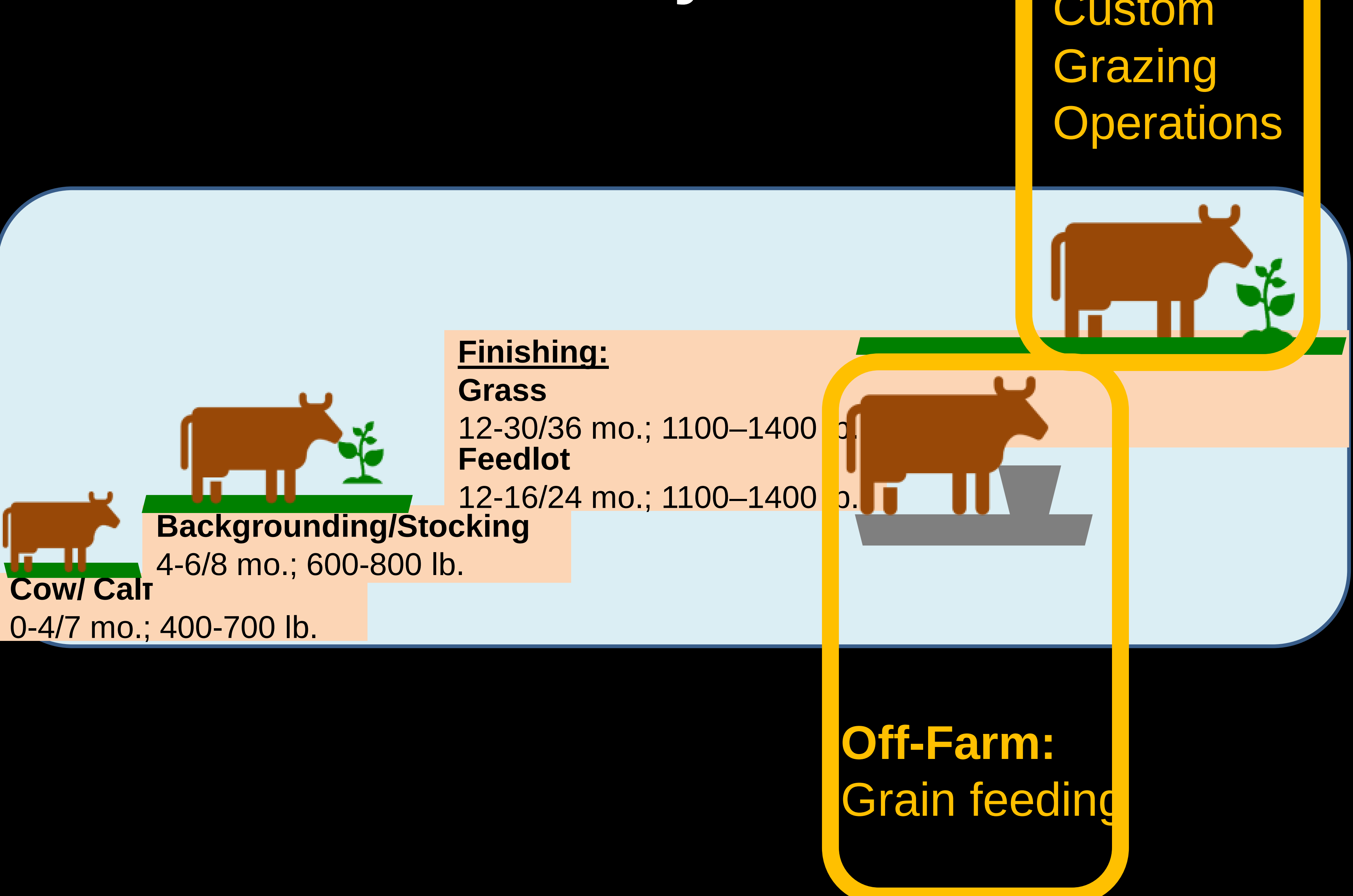
-Percent difference shows the percent increase in the new crop when compared to the old crop

Environmental Impacts

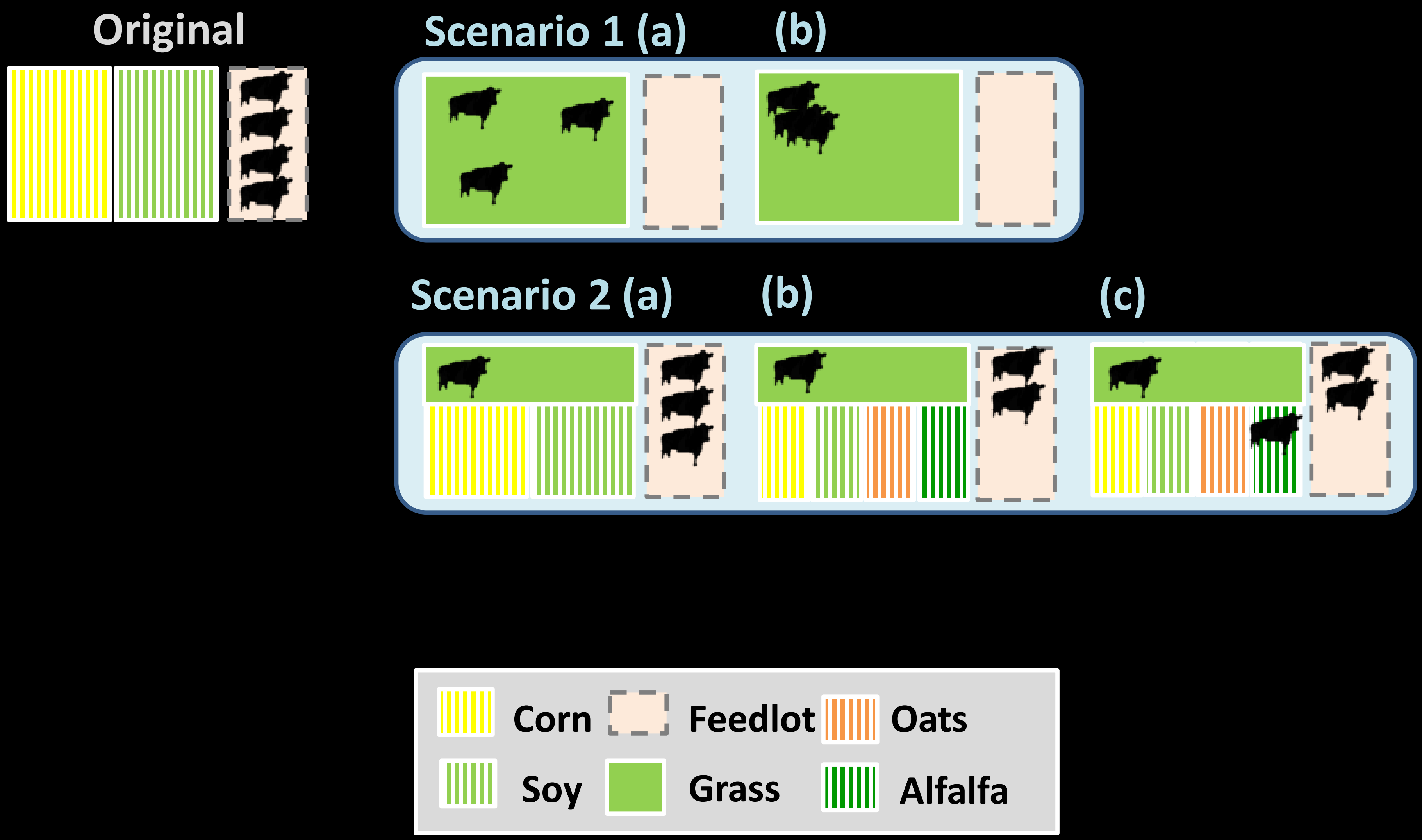
+



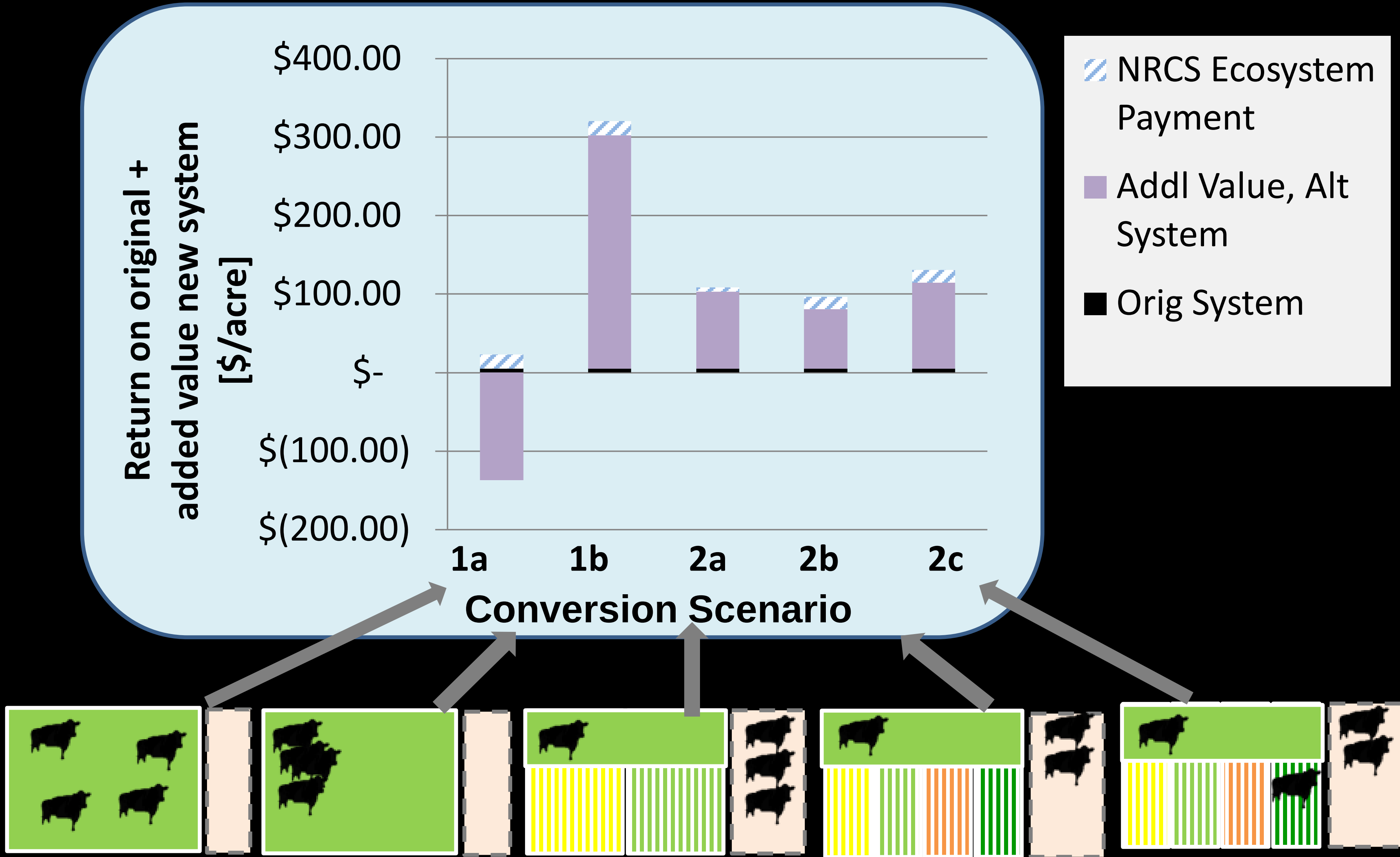
Productivity Estimates



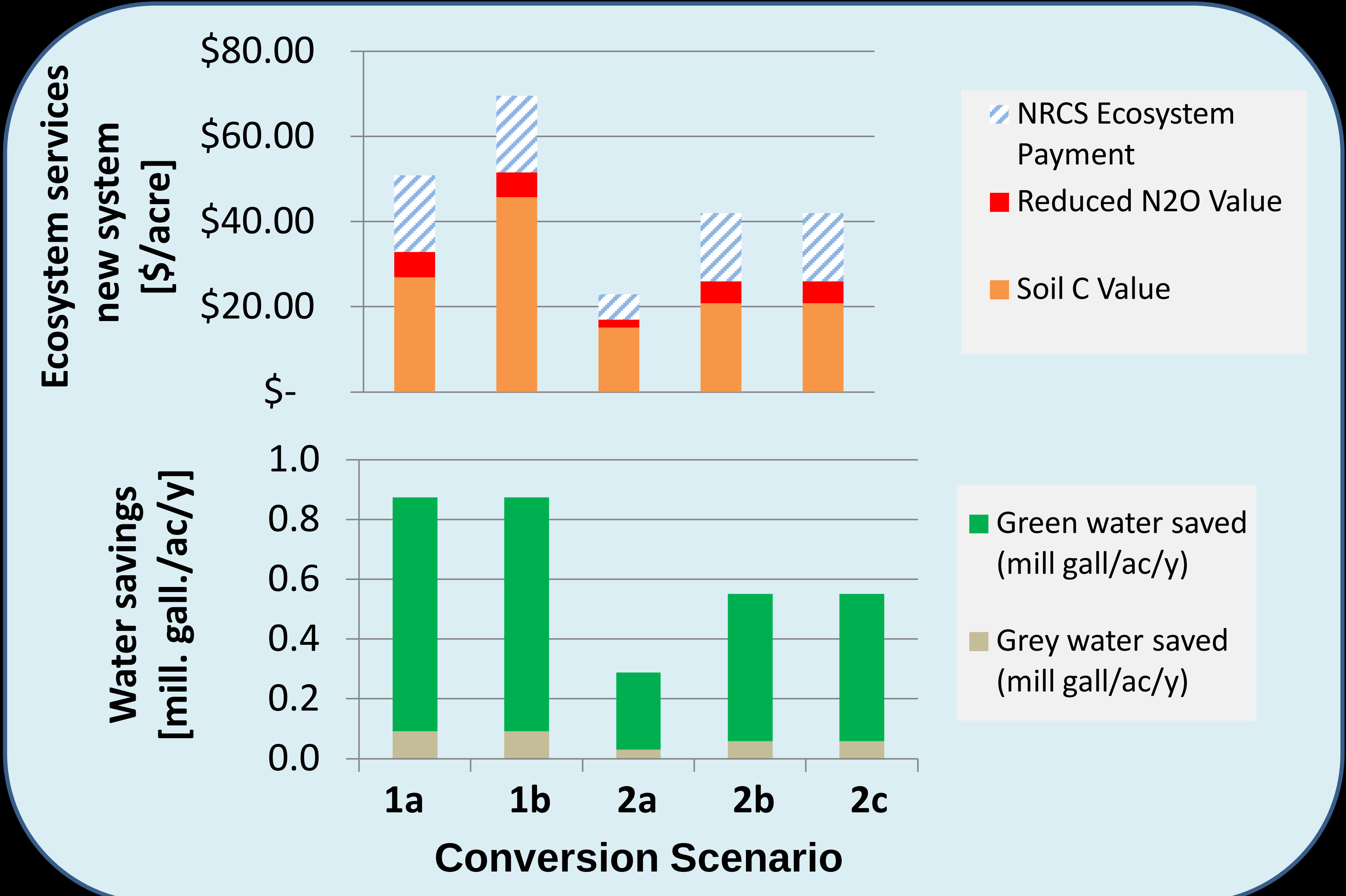
Model Scenarios



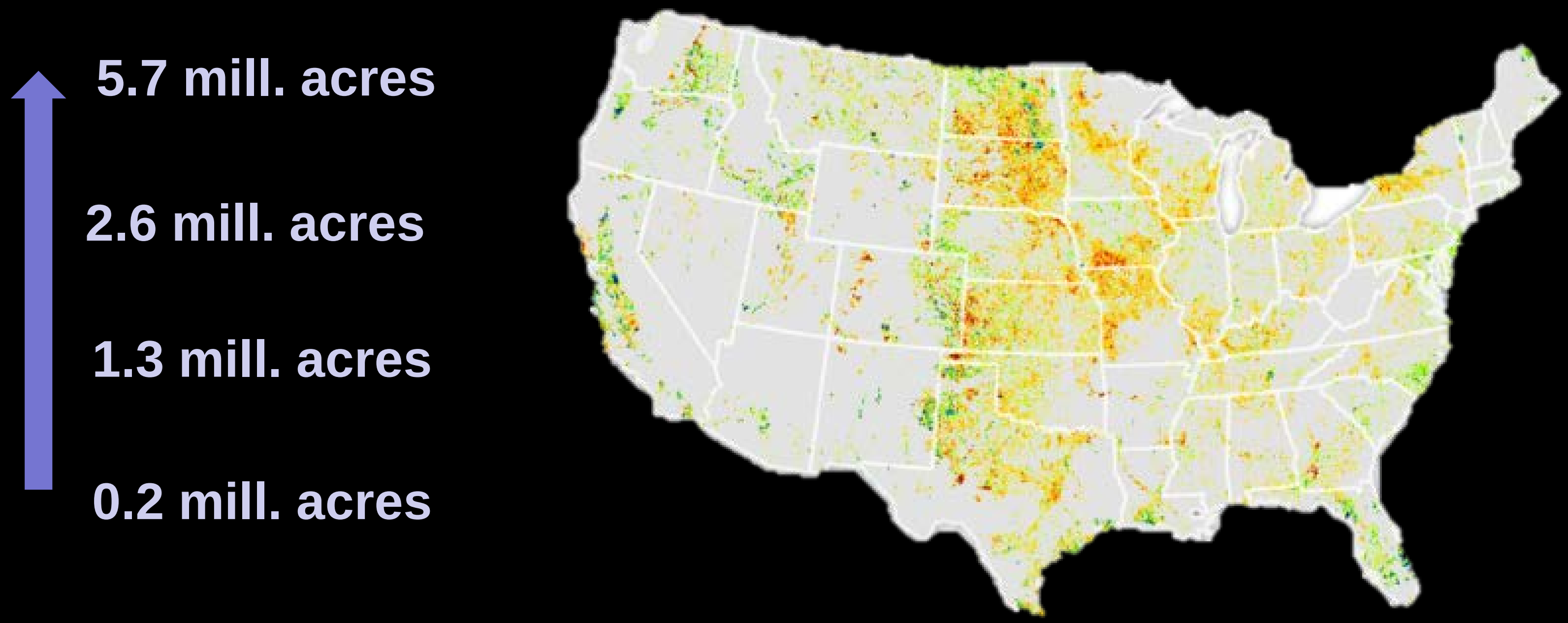
Farmer Profits



Crop, Soil, Water Benefits



Scaling up these farming scenarios to larger regions could bring additional benefits per ha…



… but more challenging to obtain benefits per lb beef

Lark et al. 2015, USDA NASS




Support farmers to adopt & improve ecological practices

Obstacles & opportunities for agroecology

R&D, Metrics

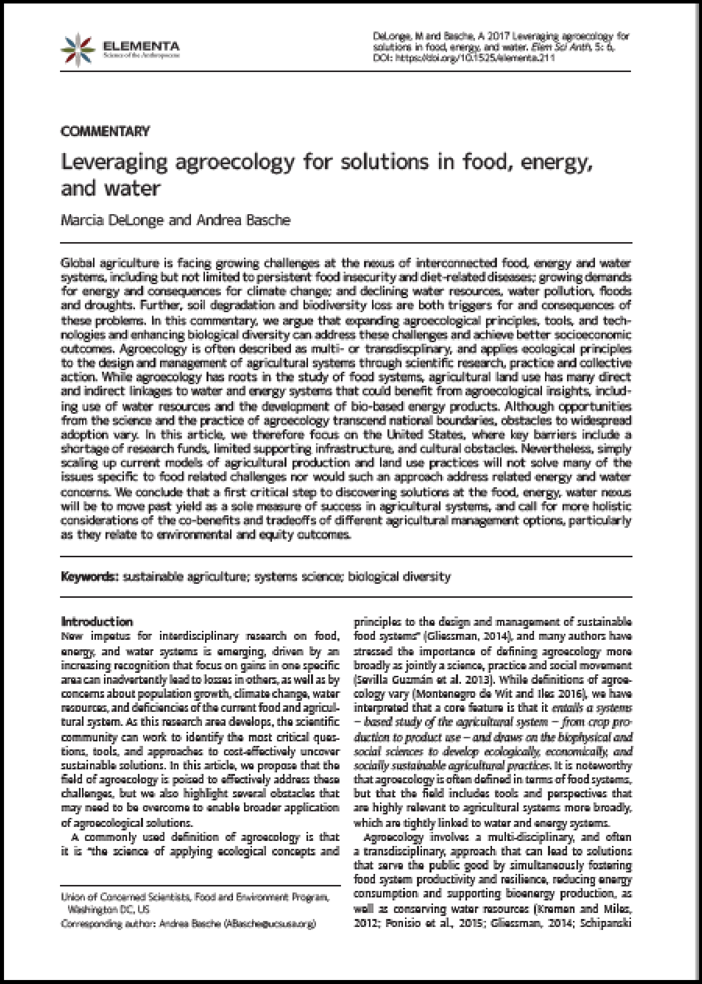
Tools

Training

Markets

Miles et al. 2017

Spreading the word



ELEMENTA
Science of the Anthropocene

DeLonge, M and Basche, A 2017 Leveraging agroecology for solutions in food, energy, and water. *Elem Sci Anth*, 5: 6, DOI: https://doi.org/10.1525/elementa.211

COMMENTARY

Leveraging agroecology for solutions in food, energy, and water

Marcia DeLonge and Andrea Basche

Global agriculture is facing growing challenges at the nexus of interconnected food, energy and water systems, including but not limited to persistent food insecurity and diet-related diseases; growing demands for energy and consequences for climate change; and declining water resources, water pollution, floods and droughts. Further, soil degradation and biodiversity loss are both triggers for and consequences of these problems. In this commentary, we argue that expanding agroecological principles, tools, and technologies and enhancing biological diversity can address these challenges and achieve better socioeconomic outcomes. Agroecology is often described as multi- or transdiscplinary, and applies ecological principles to the design and management of agricultural systems through scientific research, practice and collective action. While agroecology has roots in the study of food systems, agricultural land use has many direct and indirect linkages to water and energy systems that could benefit from agroecological insights, including use of water resources and the development of bio-based energy products. Although opportunities from the science and the practice of agroecology transcend national boundaries, obstacles to widespread adoption vary. In this article, we therefore focus on the United States, where key barriers include a shortage of research funds, limited supporting infrastructure, and cultural obstacles. Nevertheless, simply scaling up current models of agricultural production and land use practices will not solve many of the issues specific to food related challenges nor would such an approach address related energy and water concerns. We conclude that a first critical step to discovering solutions at the food, energy, water nexus will be to move past yield as a sole measure of success in agricultural systems, and call for more holistic considerations of the co-benefits and tradeoffs of different agricultural management options, particularly as they relate to environmental and equity outcomes.

Keywords: sustainable agriculture; systems science; biological diversity

Introduction

New impetus for interdisciplinary research on food, energy, and water systems is emerging, driven by an increasing recognition that focus on gains in one specific area can inadvertently lead to losses in others, as well as by concerns about population growth, climate change, water resources, and deficiencies of the current food and agricultural system. As this research area develops, the scientific community can work to identify the most critical questions, tools, and approaches to cost-effectively uncover sustainable solutions. In this article, we propose that the field of agroecology is poised to effectively address these challenges, but we also highlight several obstacles that may need to be overcome to enable broader application of agroecological solutions.

A commonly used definition of agroecology is that it is "the science of applying ecological concepts and principles to the design and management of sustainable food systems" (Gliessman, 2014), and many authors have stressed the importance of defining agroecology more broadly as jointly a science, practice and social movement (Sevilla Guzmán et al. 2013). While definitions of agroecology vary (Montenegro de Wit and Iles 2016), we have interpreted that a core feature is that it *entails a systems – based study of the agricultural system – from crop production to product use – and draws on the biophysical and social sciences to develop ecologically, economically, and socially sustainable agricultural practices*. It is noteworthy that agroecology is often defined in terms of food systems, but that the field includes tools and perspectives that are highly relevant to agricultural systems more broadly, which are tightly linked to water and energy systems.

Agroecology involves a multi-disciplinary, and often a transdisciplinary, approach that can lead to solutions that serve the public good by simultaneously fostering food system productivity and resilience, reducing energy consumption and supporting bioenergy production, as well as conserving water resources (Kremen and Miles, 2012; Ponisio et al., 2015; Gliessman, 2014; Schipanski

Union of Concerned Scientists, Food and Environment Program, Washington DC, US

Corresponding author: Andrea Basche (ABasche@ucsusa.org)

Making the case: nearly 500 scientists say agroecology needs more public support

Scientist and Expert Statement of Support
For Public Investment in Agroecological Research

We support greater public investment in agricultural research that applies ecological principles and relies, to the greatest extent possible, on ecological processes ("agroecology") to address current and future farming challenges.

Agroecology regards farms as ecosystems embedded in broader landscapes and society. Agroecological approaches are based on understanding and managing ecological processes and biological functions to increase and sustain crop and livestock productivity, efficiently recycle inputs, and build soil fertility, while minimizing harmful impacts on soil, air, water, wildlife, and human health.[i,ii] Hallmarks of agroecological farming practices include increasing the types of crops rotated on fields from year to year; controlling pests and weeds with fewer chemical pesticides; enhancing soil health while reducing the need for synthetic fertilizers; and valuing non-cropped areas of farms for the services they provide.

Agroecology has a proven track record of meeting farming challenges in a cost-effective manner. Research has found that applying agroecological methods, like those detailed above, can result in high yields for each crop in a rotation sequence.[iii] In addition, long-term studies have found that organic practices—a specific set of agroecological practices that eschew the use of all synthetic chemical inputs—typically improve soil health compared to plots where conventional practices are applied, and may produce comparable yields. This research also demonstrated that economic returns for organic crops can be greater than for conventional crops, despite higher labor costs.[iv]

These findings indicate that additional research has the potential to increase our understanding of agroecological methods and increase their adoption. Farmers could benefit from this added knowledge to produce a wide range of crops in many different regions, with greater resilience to variation in pests, weather conditions, markets, and other factors.

While other approaches may also yield promising solutions, they are more likely to already benefit from private sector support. Agroecology is less likely to be supported by the private sector since these farming methods often reduce requirements for purchased inputs. This leaves to the public sector the responsibility to fund agroecological research that serves the interests of farmers and society.

At present, however, public research into agroecology is drastically inadequate. Land-grant universities were once guided by their original missions to enhance understanding of agriculture that served the public interest. But these institutions have fallen victim to budget cuts that have driven them to rely upon private dollars to fund research[v], leveraging public investment largely for the benefit of the private sector. And past analyses have found that funding for agroecology is a very small part of the federal research budget.[vi,vii]

Agroecological research can further our understanding of productive and profitable farming methods that will minimize harmful impacts on human health, the environment, and rural communities. These methods will

Quantifying opportunity…
by quantifying sustainable agriculture research funding

Level 1

Input efficiency

Level 2

Input substitution

Level 3

Agroecology Practices

\+

Level 4

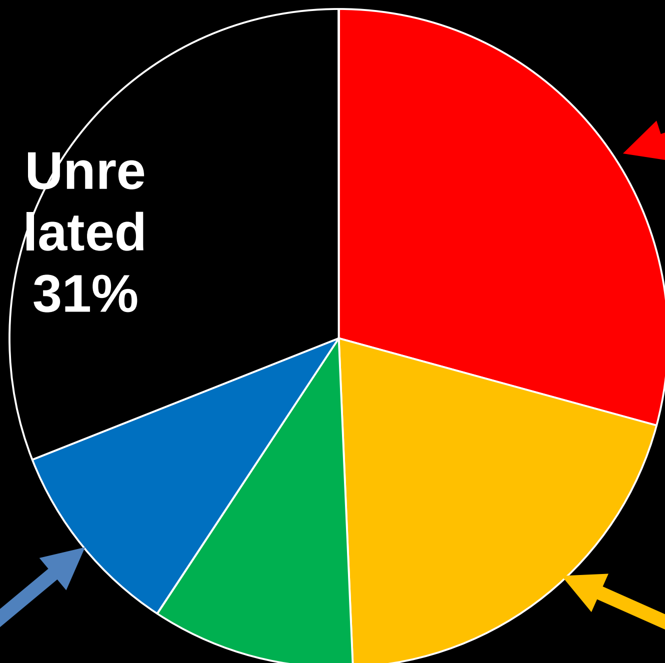
Socioeconomic support

Level 5

Global sustainable food system

Gliessman 2015

Agroecological practices & social support for transformation are found in relatively few projects



More efficiency, less waste

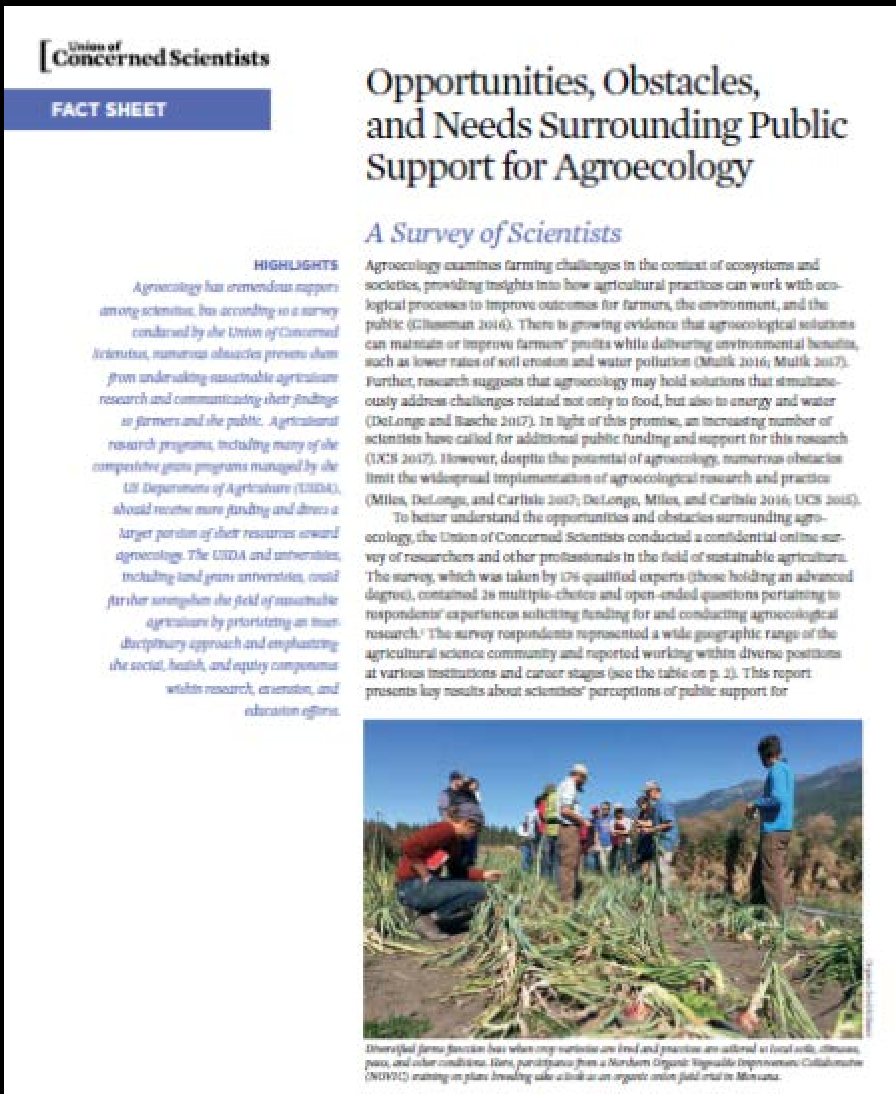
Substitute better materials

Provide social support

Redesign based on agroecology

DeLonge et al. 2015
Gliessman 2015

New survey identifies specific needs for agroecology



[Union of Concerned Scientists

FACT SHEET

Opportunities, Obstacles, and Needs Surrounding Public Support for Agroecology

A Survey of Scientists

HIGHLIGHTS

Agroecology has tremendous support among scientists, but according to a survey conducted by the Union of Concerned Scientists, numerous obstacles prevent them from undertaking sustainable agriculture research and communicating their findings to farmers and the public. Agricultural research programs, including many of the competitive grants programs managed by the US Department of Agriculture (USDA), should receive more funding and direct a larger portion of their resources toward agroecology. The USDA and universities, including land grant universities, could further strengthen the field of sustainable agriculture by prioritizing an interdisciplinary approach and emphasizing the social, health, and equity components within research, extension, and education efforts.

Agroecology examines farming challenges in the context of ecosystems and societies, providing insights into how agricultural practices can work with ecological processes to improve outcomes for farmers, the environment, and the public (Gliessman 2016). There is growing evidence that agroecological solutions can maintain or improve farmers' profits while delivering environmental benefits, such as lower rates of soil erosion and water pollution (Mulik 2016; Mulik 2017). Further, research suggests that agroecology may hold solutions that simultaneously address challenges related not only to food, but also to energy and water (DeLonge and Basche 2017). In light of this promise, an increasing number of scientists have called for additional public funding and support for this research (UCS 2017). However, despite the potential of agroecology, numerous obstacles limit the widespread implementation of agroecological research and practice (Miles, DeLonge, and Carlisle 2017; DeLonge, Miles, and Carlisle 2016; UCS 2015).

To better understand the opportunities and obstacles surrounding agroecology, the Union of Concerned Scientists conducted a confidential online survey of researchers and other professionals in the field of sustainable agriculture. The survey, which was taken by 176 qualified experts (those holding an advanced degree), contained 26 multiple-choice and open-ended questions pertaining to respondents' experiences soliciting funding for and conducting agroecological research.[1] The survey respondents represented a wide geographic range of the agricultural science community and reported working within diverse positions at various institutions and career stages (see the table on p. 2). This report presents key results about scientists' perceptions of public support for

1. **Grants** at wider range of scales
2. **Interdisciplinary,** systems-level research, emphasizing economics, human health, equity
3. Programs that train & encourage **communication**

Lots of opportunity… but much work to do

A better farm future starts with the soil

BY ALYSSA CHARNEY, OPINION CONTRIBUTOR — 09/19/17 03:00 PM EDT
THE VIEWS EXPRESSED BY CONTRIBUTORS ARE THEIR OWN AND NOT THE VIEW OF THE HILL

74 SHARES

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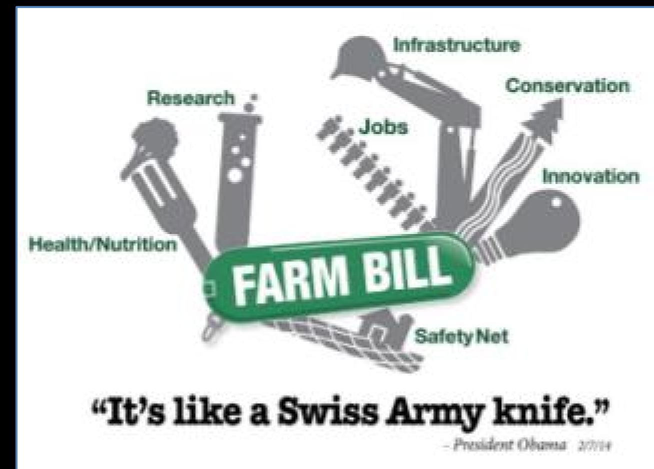
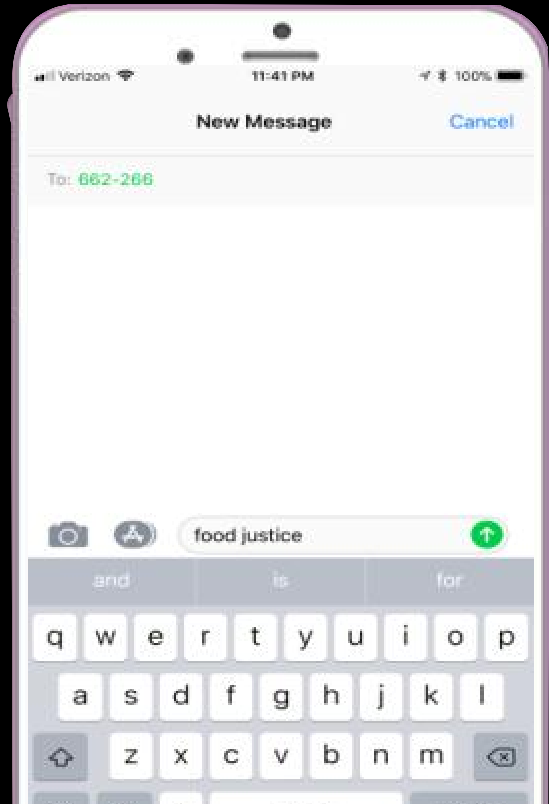
THE HILL

Within the next year Congress will reauthorize the massive amalgamation of legislation we commonly refer to as "the farm bill." The farm bill, which



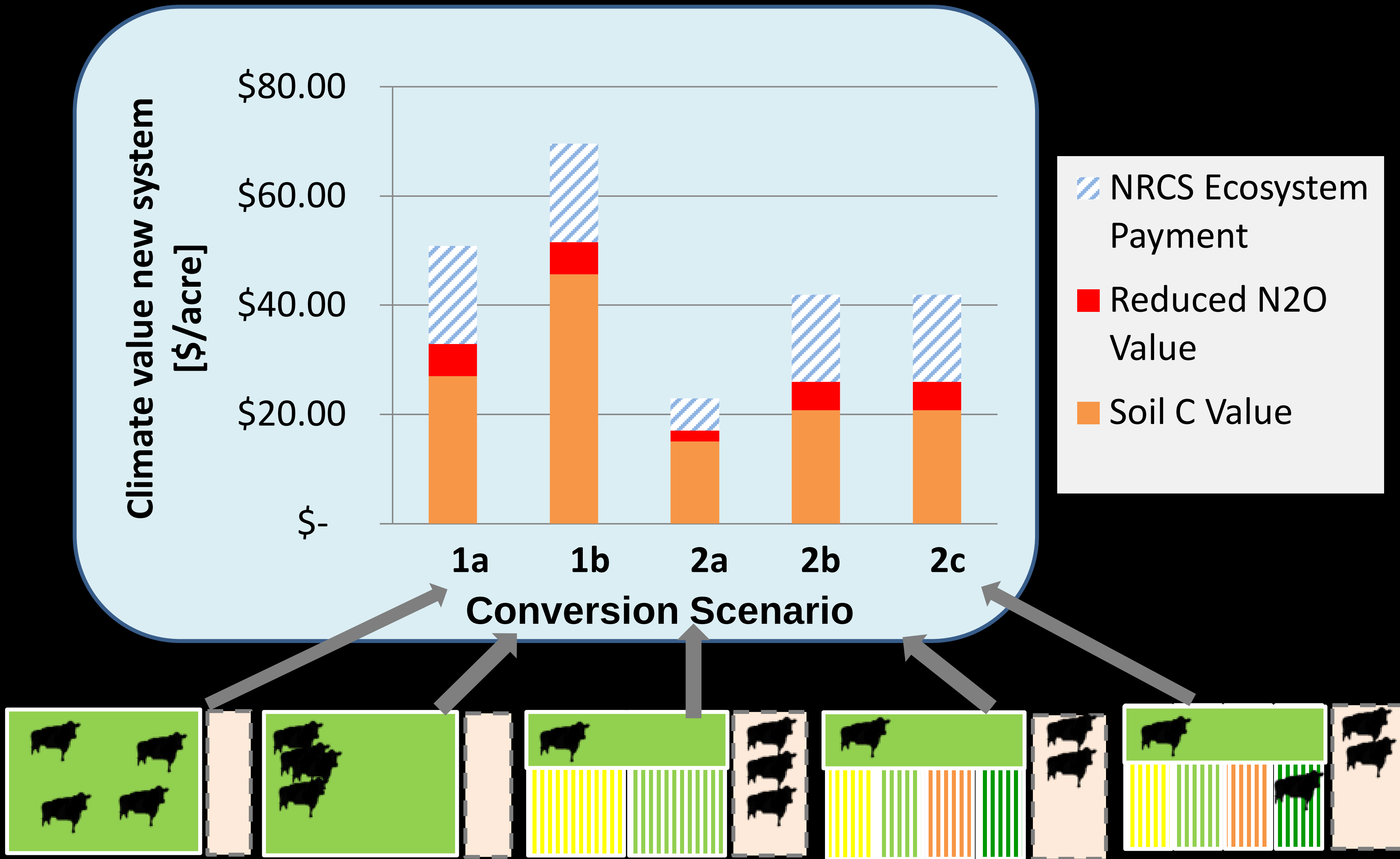
Thank you!

To be kept in the loop on UCS food & farm work, text **“food justice”** to **“662-266”**

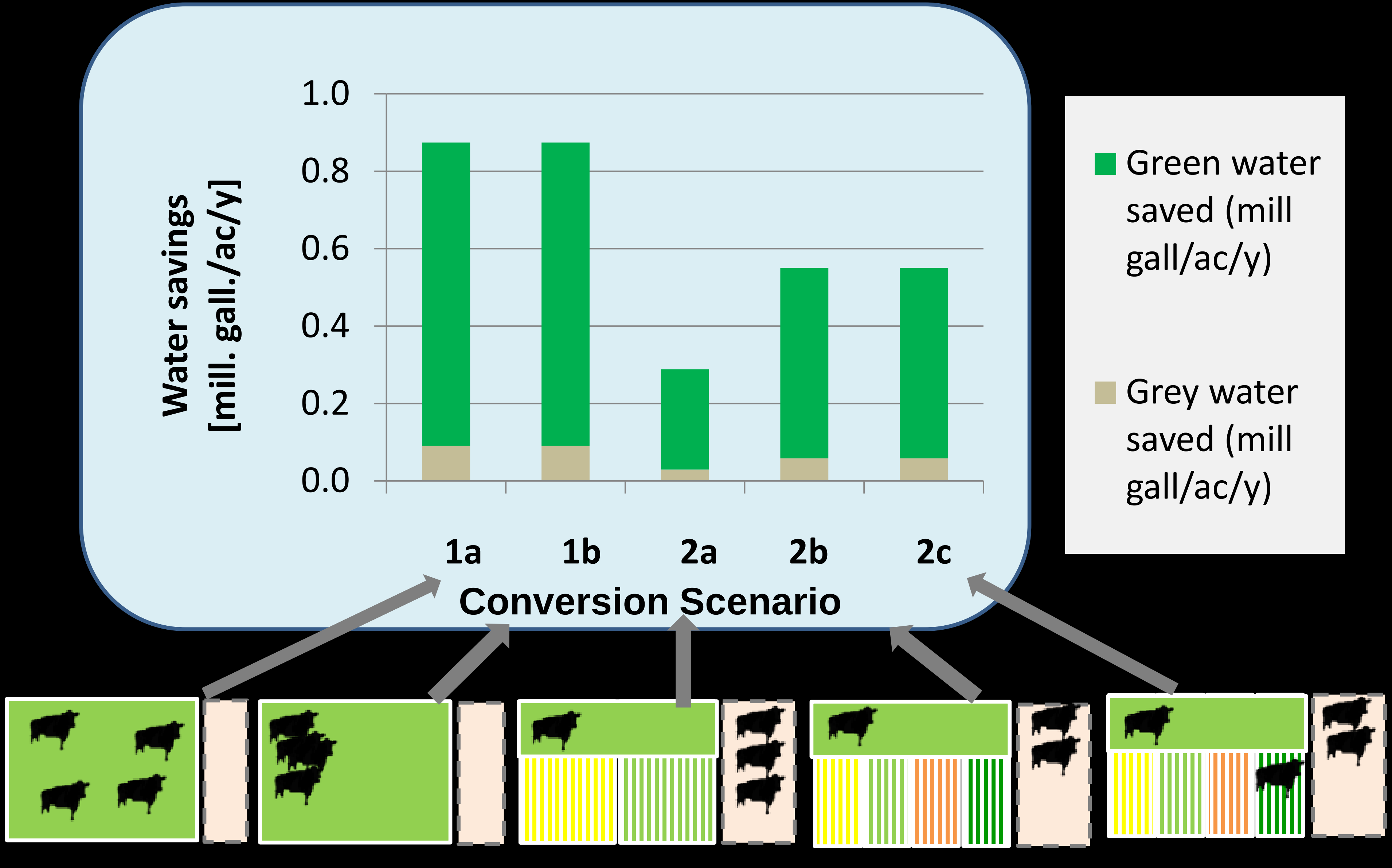


Union of Concerned Scientists

Crop & Soil Climate Value



Water Footprint Savings



Reduction in beef production?