Extension and Outreach

cenusa bioenergy

Jill Euken & Jay Staker

Iowa State University

This project is supported by Agriculture and Food Research Initiative
Competitive Grant No. 2011-68005-30411
from the National Institute of Food and Agriculture (RGB 106/128/18)

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National Ag in the Classroom Conference

June 22, 2017

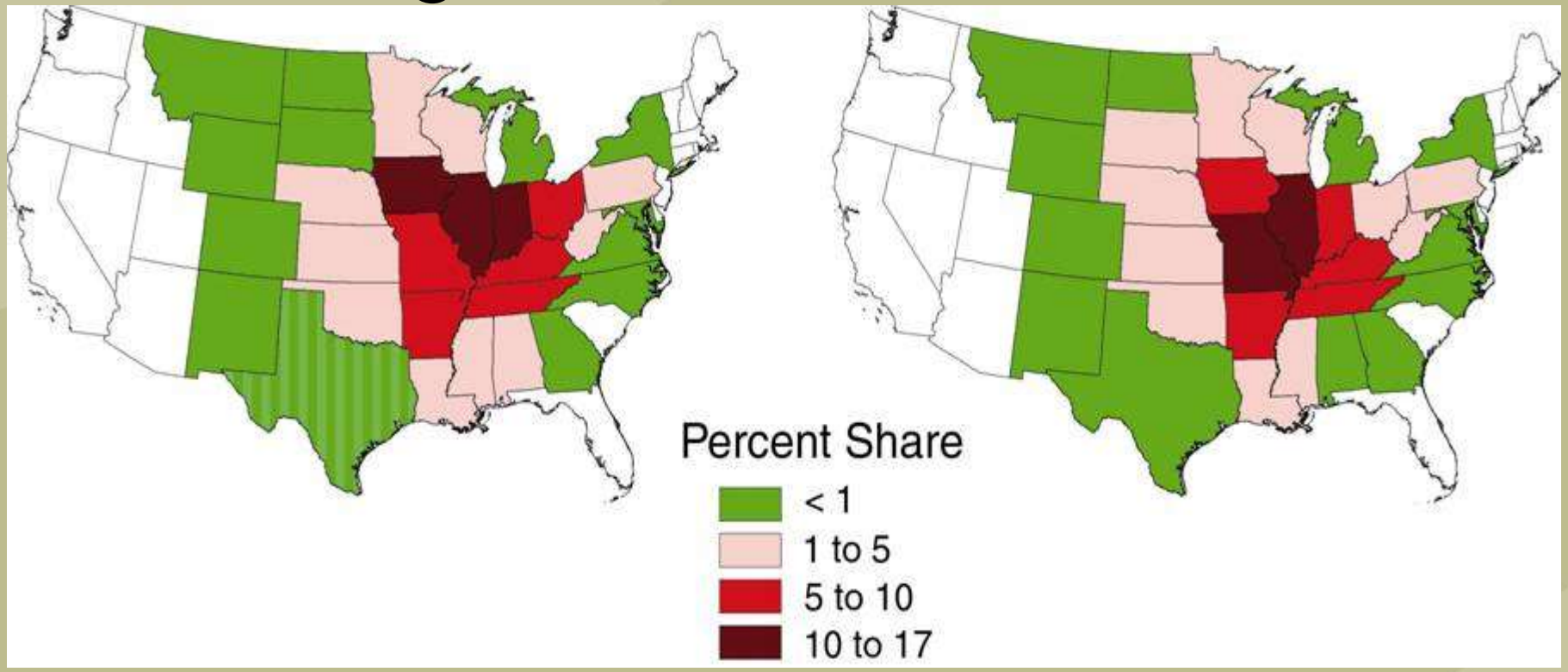
Kansas City, MO

"Corn States with Issues:"
Nutrient delivery to Gulf of Mexico

State shares of the total nutrient flux

Nitrogen

Phosphorus



Source: Alexander et al, *Environ. Sce. Tech.*

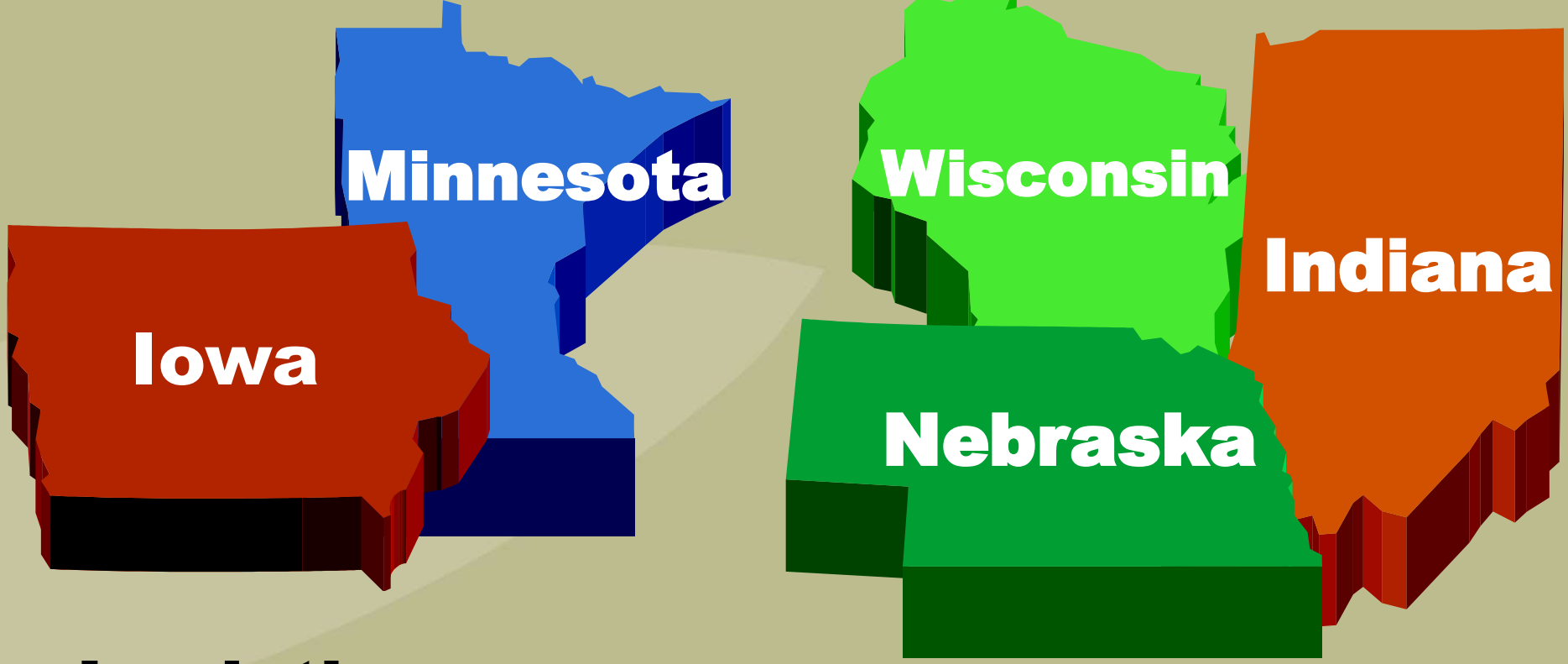
Farm fields near Ames, IA, 12 June 2008.
Source: Ames Tribune, 13 June 2008.

“The survey by the Iowa Department of Agriculture and Land Stewardship shows that an estimated 2.3 million acres — about 10 percent of Iowa’s cropland — has suffered severe erosion damage, which is defined as the loss of 20 tons or more of soil per acre.”

-- Associated Press, 30 July 2008

Promote perennial grasses as a nutrient management strategy

	Practice	% Nitrate-N Reduction [Average (Std. Dev.)]
Nitrogen Management	Timing (Fall to spring)	6 (25)
	Source (Liquid swine compared to commercial)	4 (11)
	Nitrogen Application Rate	Depends on starting point
	Nitrification Inhibitor	9 (19)
	Cover Crops (Rye)	31 (29)
Land Use	Perennial – Land retirement	85 (9)
	Living Mulches	41 (16)
	Extended Rotations	42 (12)
Edge-of-Field	Drainage Water Mgmt.	33 (32)*
	Shallow Drainage	32 (15)*
	Wetlands	52
	Bioreactors	43 (21)
	Buffers	91 (20)**

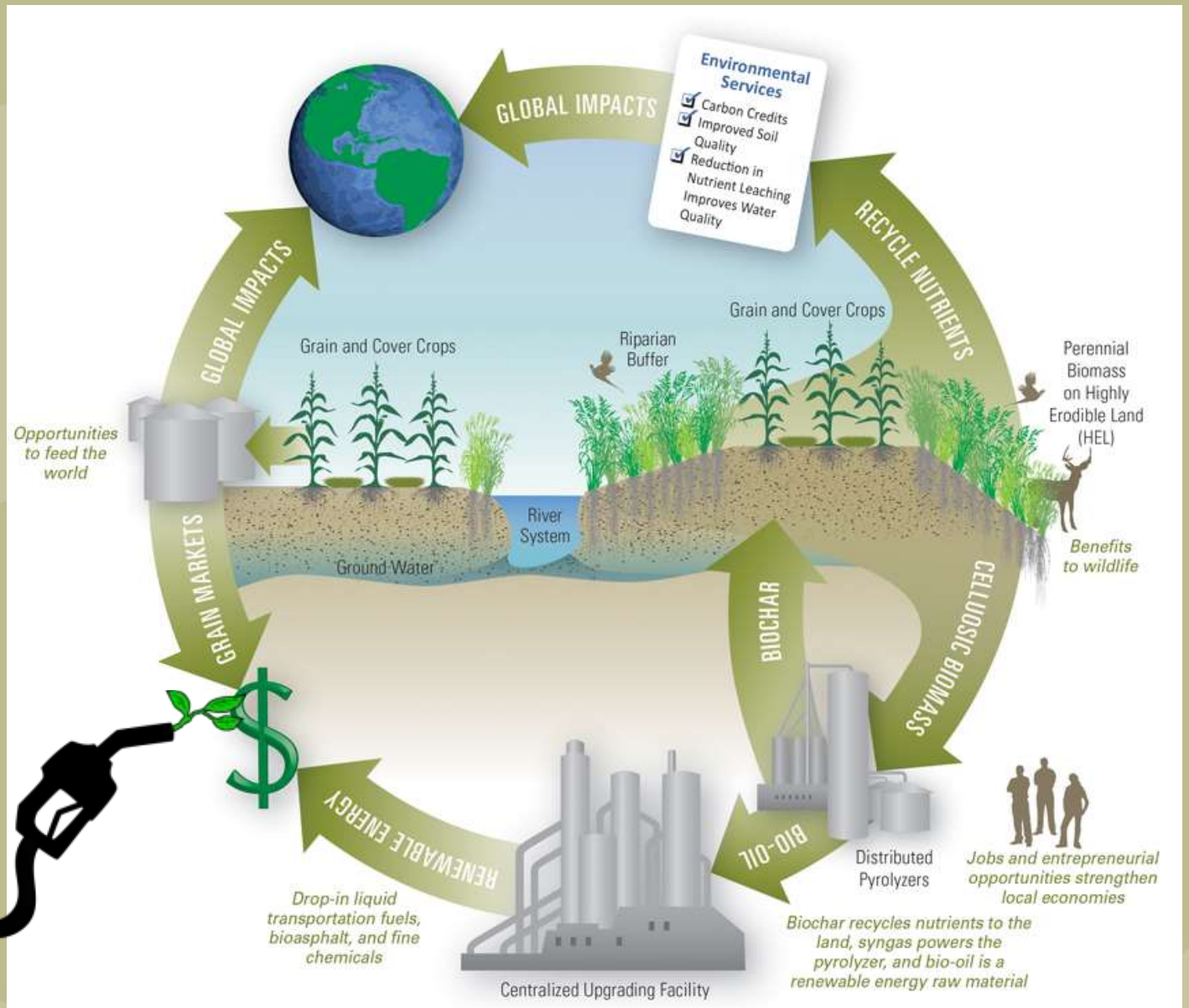


Logistics
Agronomy
Economics
Processing
Extension

Plant Breeding
Agronomy
Education
Extension

“Corn States with issues.”

CenUSA Vision



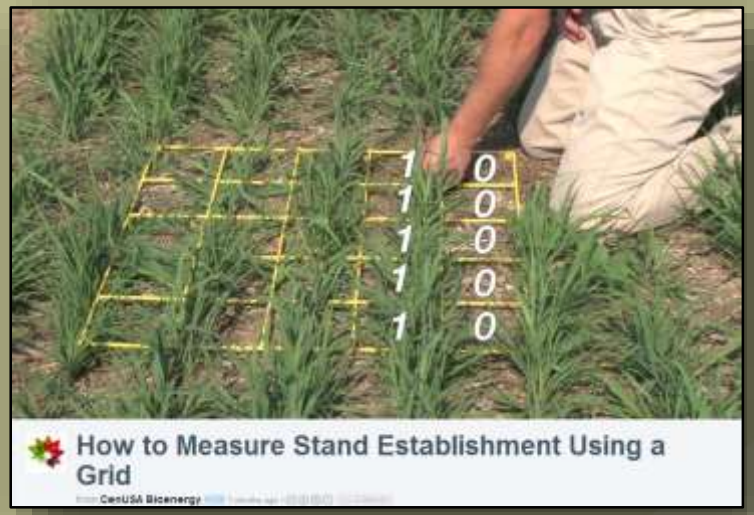
CenUSA Extension

Audiences:

- Farmers
- Industry leaders
- Extension Educators
- Non-farm public/youth

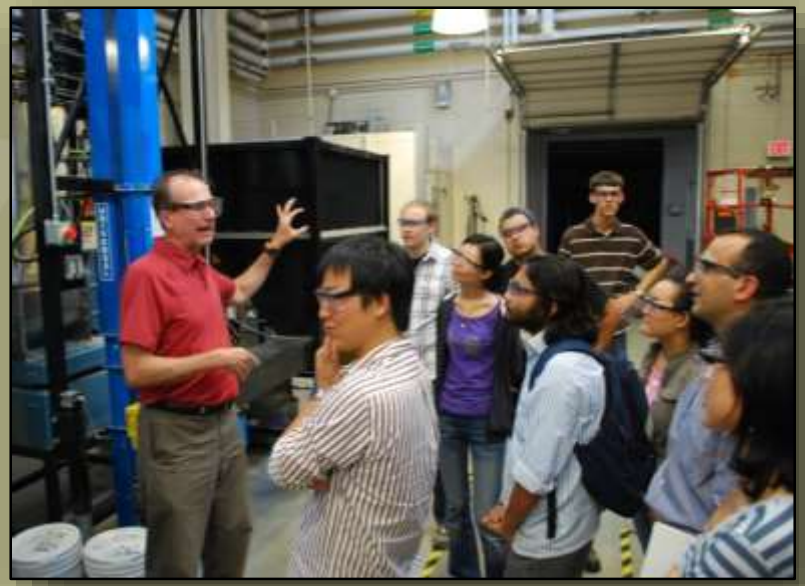
Goals:

- Awareness & knowledge gain
- Stimulate adoption



CenUSA Outreach

- Workshops
- Field days
- Conferences
- Media events
- Networking activities
- Exhibits



- On-line learning modules
- eXtension articles
- Curriculum/iPad app
- Videos
- Webinars
- FAQs
- Fact Sheets

Educational Materials

Outreach for Youth

Meet C6

CenUSA Resources

Meeting Educational Goals

Perennial Grass Field Day Survey

Sorrel Brown
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Iowa State University Extension
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cenusa bioenergy

Location_____ Date:_____

Presenters: _____

Dear CenUSA field day participant,

You are being asked to respond to this survey because you participated in a CenUSA field day. The goal was for you, the participant, to increase your knowledge and awareness of perennial grasses and bioenergy opportunities. Please take 5 minutes to complete this survey to let us know if you value the information. Your input will be used to improve bioenergy Extension and Outreach education.

The survey is completely voluntary and anonymous. You may skip questions you are not comfortable answering and withdraw from participating at any time. Your responses will not be linked directly to you by name; all data will be combined. Responses will be used in summary form only. There is no risk involved in responding to this survey. Thank you for your input.

BEFORE CenUSA Field Day				My level of understanding or skill regarding ...	AFTER CenUSA Field Day			
NONE	LOW	MODERATE	HIGH		LOW	MODERATE	HIGH	SAME
				Establishing perennial grasses				
				Stand measurement of perennial grasses				
				Herbicide use in perennial grasses				
				Positive environmental effects of perennial grasses				
				Energy created from perennial grasses				
				Insects and diseases relevant to perennial grasses				

This project is supported by Agriculture and Food Research Initiative Competitive Grant No. 2011-68005-30411 from the National Institute of Food and Agriculture.

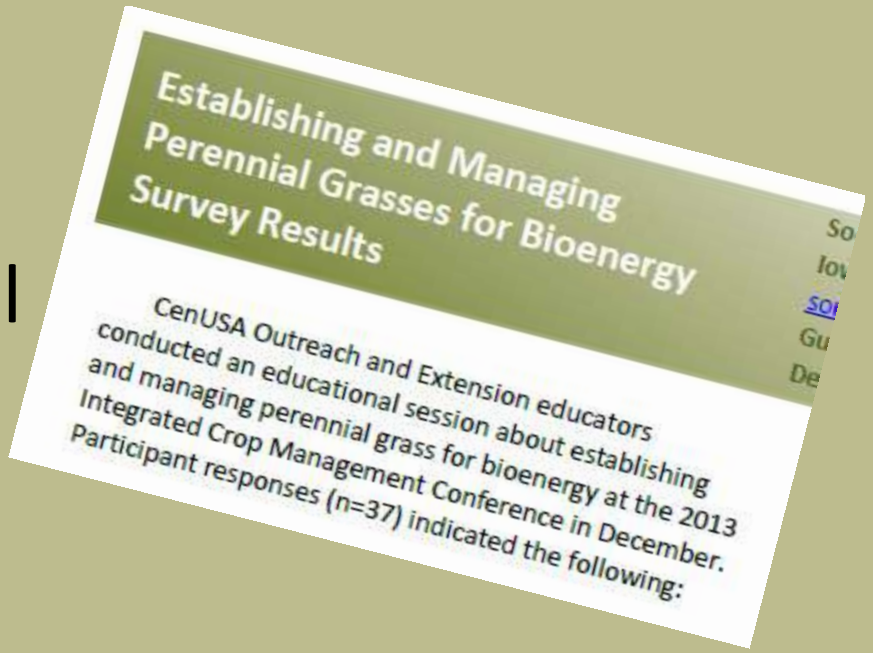
Perennial Grasses for Bioenergy Survey Results

Ranked interests:

Economic benefit

Increasing yield potential

Land conservation


Establishing and Managing Perennial Grasses for Bioenergy Survey Results

CenUSA Outreach and Extension educators conducted an educational session about establishing and managing perennial grass for bioenergy at the 2013 Integrated Crop Management Conference in December. Participant responses (n=37) indicated the following:

Intentions:

Want to learn more

Would consider on marginal land

Wait for market

Integrated Agricultural Landscapes for Profit & Risk Management Survey Results

Increased knowledge:

- Available resources from CenUSA
- Soil constraints for corn stover harvest
- Using yield maps for bioenergy decisions
- Economic opportunities

Interested in:

- Biomass harvest
- Marketing
- Economic benefit


Integrated Agricultural Landscapes for Profit & Risk Management Survey Results

Sorrel Brown, PhD
Iowa State Universi
sorrel@iastate.edu
Guang Han, Gradua
Dept of Agricultura

CenUSA Outreach and Extension educators conducted an educational session about integrated agricultural landscapes for profit and risk management at the 2013 Integrated Crop Management Conference in December. Participant responses (n=46) indicated the following:

- Intention
- 56% wan agricultu practice.
- 12% wou agricultu
- 8% will sh

Decision Tool

http://www.extension.iastate.edu/agdm/crops/html/a1-29.html

Switchgrass Following Pasture/Hay

Ag Decision Maker -- Iowa State University Extension and Outreach

See AgDM File A1-29, Estimated Cost of Establishment and Production of Switchgrass in Iowa for more information on Switchgrass production in Iowa.

Enter inputs in shaded cells

Expected Yield		6.00	tons/acre		8.00bales/acre, rounded to nearest bale					
Bale Size		1500.00	pounds/bale							
Expected Stand Life		7.00	years							
			Price per unit	Units Year 0	Cost in Year 0	Units Year 1	Cost in Year 1	Units Year 2	Cost in Year 2	Units Year 3+	Cost in Year 3+
Land Charge	$ per acre		$77.00	1.00	$77.00	1.00	$77.00	1.00	$77.00	1.00	$77.00
Pre-establishment Cost for Field Preparation											
Brush Mowing	$ per pass		$10.00	1.00	$10.00	0.00	$0.00	0.00	$0.00	0.00	$0.00
Disking, Tandem	$ per pass		$14.20	2.00	$28.40	0.00	$0.00	0.00	$0.00	0.00	$0.00
Soil Finishing	$ per pass		$14.60	2.00	$29.20	0.00	$0.00	0.00	$0.00	0.00	$0.00
Herbicide Tolerant Crop in Previous Year	$ per acre		$268.85	1.00	$268.85	0.00	$0.00	0.00	$0.00	0.00	$0.00
Winter Cover Crop (Oats)	$ per acre		$31.39	1.00	$31.39	0.00	$0.00	0.00	$0.00	0.00	$0.00
Total Cost for Pre-establishment and Field Preparation					$367.84		$0.00		$0.00		$0.00
Pre-harvest Machinery Operations											
Disking, Tandem	$ per pass		$14.20	0.00	$0.00	0.00	$0.00	0.00	$0.00	0.00	$0.00
Soil Finishing	$ per pass		$14.60	0.00	$0.00	0.00	$0.00	0.00	$0.00	0.00	$0.00
Fertilizer Spreading	$ per pass		$5.00	0.00	$0.00	0.00	$0.00	1.00	$5.00	1.00	$5.00
Spraying Chemicals	$ per pass		$7.55	0.00	$0.00	2.00	$15.10	1.00	$7.55	1.00	$7.55
Drilling, grass seed	$ per pass		$16.05	0.00	$0.00	1.00	$16.05	1.00	$16.05	0.00	$0.00
Total Pre-harvest Machinery Operations					$0.00		$31.15		$28.60		$12.55
Operating Expenses											
Soil Test	$ per test		$8.00	0.00	$0.00	0.20	$1.60	0.00	$0.00	0.00	$0.00
Seed Cost (pure live seed)	$ per lb		$15.00	0.00	$0.00	5.00	$75.00	0.50	$7.50	0.00	$0.00
Fertilizer											
Nitrogen (N)	$ per pound		$0.44	0.00	$0.00	0.00	$0.00	60.00	$26.40	60.00	$26.40
Phosphorus (P)	$ per pound		$0.43	0.00	$0.00	0.00	$0.00	0.00	$0.00	0.00	$0.00
Potassium (K)	$ per pound		$0.41	0.00	$0.00	0.00	$0.00	0.00	$0.00	0.00	$0.00
Annual Lime (including its application)	$ per ton		$29.00	0.00	$0.00	0.00	$0.00	0.00	$0.00	0.00	$0.00
Herbicide											
Pre-emergence (Facet L)	$ per ounce		$0.21	0.00	$0.00	32.00	$6.72	0.00	$0.00	0.00	$0.00
Post-emergence (2,4 D L)	$ per ounce		$0.20	0.00	$0.00	32.00	$6.40	32.00	$6.40	32.00	$6.40
Total Operating Expenses					$0.00		$89.72		$40.30		$32.80
			Interest rate								
Interest Expense on Pre-harvest Machinery Operations and Operating Expenses	8 month loan		5%		$0.00		$4.03		$2.30		$1.51
Harvest Machinery Operations											
Swathing	$ per acre		$14.20	0.00	$0.00	1.00	$14.20	1.00	$14.20	1.00	$14.20
Baling	$ per bale		$12.60	0.00	$0.00	4.00	$50.40	8.00	$100.80	8.00	$100.80
Windrowing	$ per acre		$12.90	0.00	$0.00	0.00	$0.00	0.00	$0.00	0.00	$0.00
Moving to Storage	$ per bale		$3.30	0.00	$0.00	4.00	$13.20	8.00	$26.40	8.00	$26.40
Total Harvest Machinery Operations					$0.00		$77.80		$141.40		$141.40
Total Cost of Production					$444.84		$279.70		$289.60		$265.26

Liberty Switchgrass

- High-yielding specifically created for bioenergy use
- Target yield = 6-7 tons biomass per acre
- Lifespan 10+ years

http://www.extension.iastate.edu/agdm/crops/html/a1-29.html

Liberty – 10 year Timeframe

- 5-7 tons biomass per acre
- Total cost $1,921.38
  - not including land cost
- Breakeven price before land: $33.71 per ton
- Given average land charge for improved pasture ($77 per acre), breakeven price with land = $47.22 per ton

Public – Master Gardeners

Biochar 'Survey'

Please Give Us Your Opinion

Based on what you learned about Biochar today, if it were available on the market, would you be interested in applying it to your garden?

cenusa bioenergy
University of Minnesota EXTENSION

Vote by dropping a glass marble in the appropriate vase.

Public - Youth

C6 Game

cenusa bioenergy

Jill Euken: jeuken@iastate.edu
Jay Staker: jstaker@iastate.edu

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Competitive Grant No. 2011-68005-30411
from the National Institute of Food and Agriculture (RGB 106/128/18)

C6 BioFarm: A Sustainability Game for Learning the Role of a Bio-based Economy

The C6 team

- Sponsored by:
  - CenUSA Bioenergy Grant supported by Agriculture and Food Research Initiative Competitive Grant No. 011-68005-30411 from the USDA National Institute of Food and Agriculture. Iowa
  - NSF EPCoR (National Science Foundation grant)
  - Iowa State University Extension and Outreach
    - Ag and Natural Resources
    - 4-H

C6 BioFarm

Background

- Start Point: learning about biochar and the implications of large volume biochar production from switchgrass. (Purdue-developed curriculum delay led to C6 as interim)
- Educational objectives broadened to the carbon economy, transition from petroleum-C economy to bio-C economy. Old to new C
- STEM learning goals and links to learn about the importance of the initiative
  - sustainability from economical, environmental, and social standpoint
  - need to build resiliency into agricultural systems based on natural variations (weather, markets, political, etc.)
- Created C6 BioFarm to implement into classrooms

Goal of C6 BioFarm

- Educate youth about the role of carbon in the bioeconomy though an interactive game on biomass production using agricultural practices , consequences, and technology that:
  - requires real life farming decisions (crop insurance, cropping decisions, fertilizer & pesticides);
  - ranks players on economic, social, and environmental impacts of their decisions that focus on long term viability and efficiency after 3 years of play;
  - is supported by an iBook and Science, Technology, Engineering, and Mathematics (STEM) lessons that provides content on biomass production, processing, products, and STEM careers;
  - has career videos that feature youth, interns, and professionals linked to the bioeconomy.

Results to date UPDATE

Reach: over 3,000 students: Ag Context for CenUSA Region

Use of C6 BioFarm to inform youth about ag production, bioenergy, and show them possible careers in these fields.

- 4-H, FFA, and K-12 science students will gain knowledge of biomass production, biofuels production, and carbon and nutrient cycling by participating in youth activities (measured by pre/post surveys and open-ended questionnaires)
- Youth will gain knowledge about STEM careers by participating in 4-H, FFA, and K-12 as classroom experiences (indicators measured by pre/post surveys and open-ended questionnaires).

START YOUR "GREEN-CARBON" PIGGYBANK!

DEVELOPED BY

IOWA EPSCoR
Building Sustainable Energy Systems

cenusa bioenergy

IOWA STATE UNIVERSITY
Extension and Outreach
Healthy People. Environments. Economies.

What is Carbon?

An Element

6

C

Carbon

Atomic Mass 12

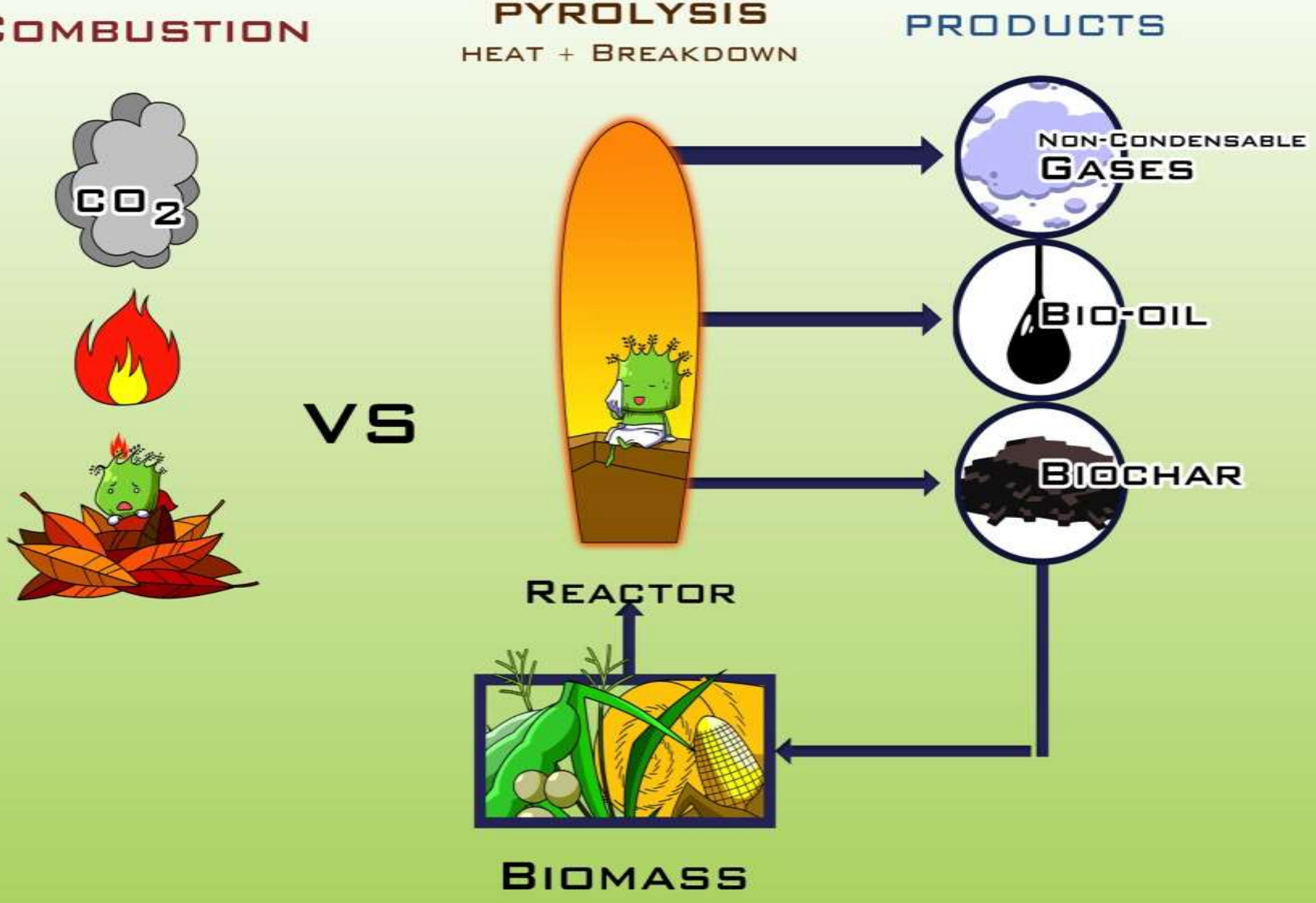
Old (Fossil) Carbon

New (Renewable) Carbon

Carbon is the building block of every **lifeform** and most forms of **energy**

Carbon Flow

Part of a Global System

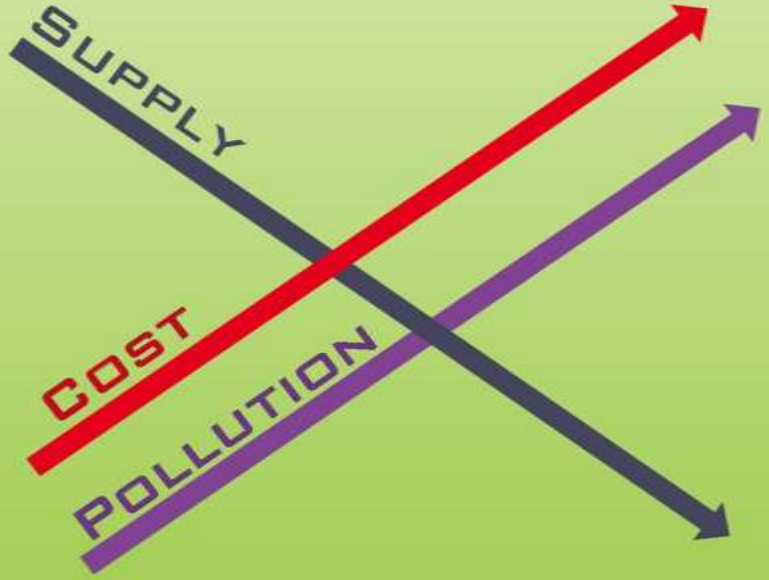


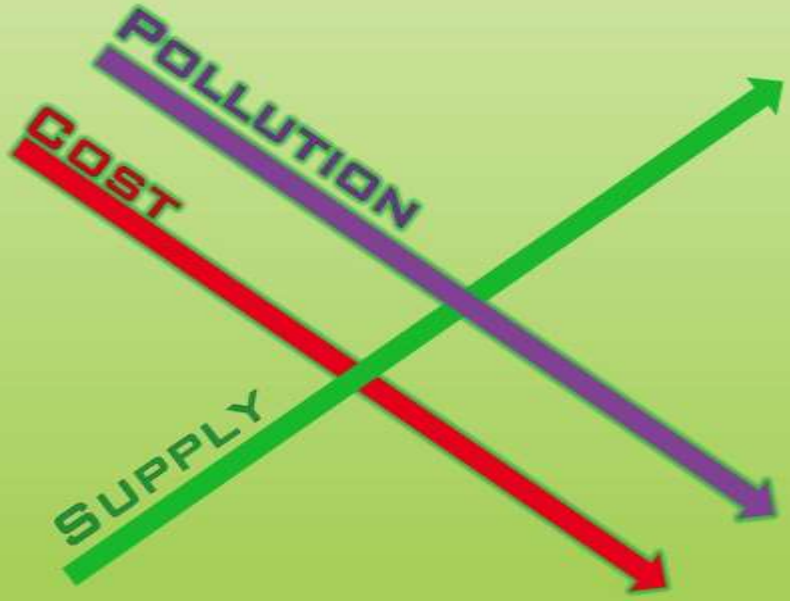
CHANGE THE CO2 EQUATION WITH BIOMASS

Petroleum Economy

VS

Bioeconomy





BIOECONOMY

MAKING BIORENEWABLES INTO REAL-WORLD BUSINESS

PRODUCTS

BIO-OIL

BIOCHAR

SYNGAS

BIOASPHALT

1ST GENERATION BIOFUEL

2ND GENERATION BIOFUEL

BIO PLASTICS

BIODIESEL

WASTE REDUCTION

CARBON SEQUESTRATION

ENERGY INDEPENDENCE

ENVIRONMENTAL

ENHANCED ECOSYSTEMS

BIOECONOMY & SUSTAINABILITY

SOCIAL

PUBLIC AWARENESS

ECONOMIC

JOB CREATION

FUTURE GENERATIONS

RURAL ECONOMIES

ECONOMIC GROWTH

The Bioeconomy Wants You!

Where will you fit?

Potential Careers:

Engineers:
Agriculture, biosystems, chemical, civil, computer, construction, mechanical.

Scientists:
Biologists, biochemists, chemists, geneticists, microbiologists

Producers:
Agricultural lenders, agronomists, farmers, farming experts, farm equiptment sales, fertilizer/seed consultants, plant breeders

Many more:
Businesspeople, communicators, educators, financial, marketing, psychologists

Poster Contributors

Stefanie Dao
Eric Debner
Jill Euken
Jyahao Leong
Kelly Madsen
Bob Mills
Sara Parks
Jay Staker

C6 BioFarm Portfolio

- Learning for middle school and high school students about:
  - Bioenergy
  - Agricultural Production
  - Carbon
  - The Environment
  - Agricultural and Bioenergy Careers

- **iPad game download on App Store**
- **YouTube Channel:** CenUSA C6 Game

Career Videos

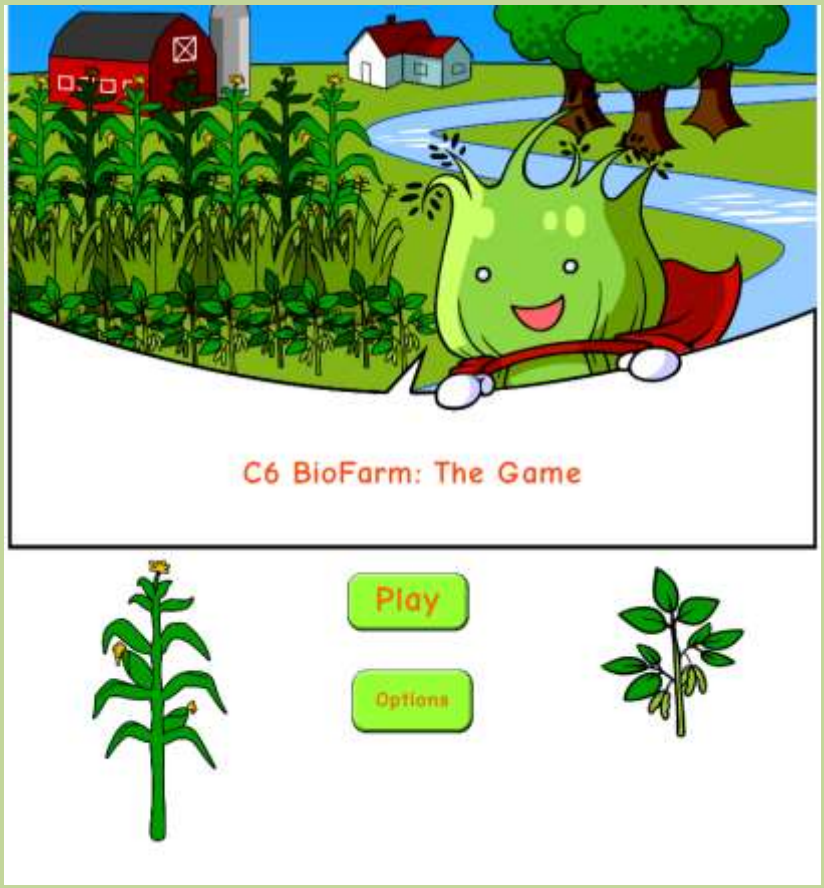
- Technical
- Insurance
- Financial
- Ag Production
- STEM Educator
- Bio-based Dupont plant engineers

Conceptual Frame

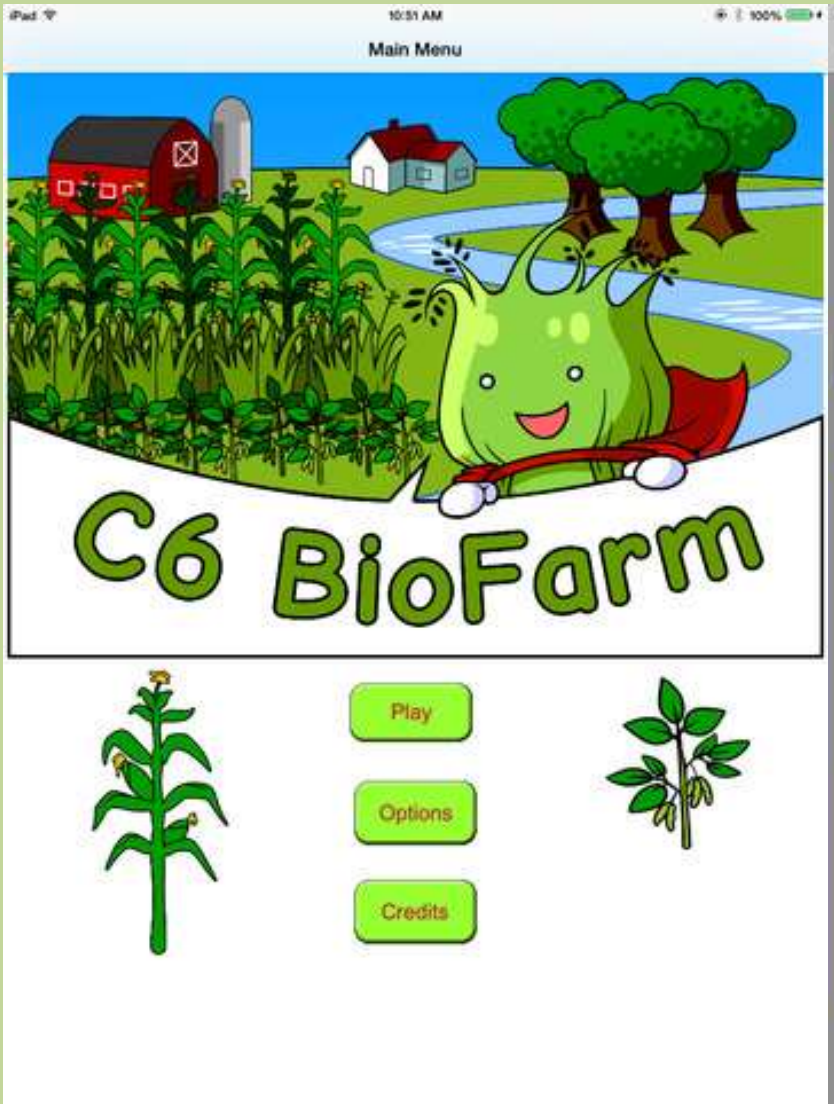
- Carbon's role in the economy
- Carbon source options
- Source option ramifications
- Pyrolysis and the science and engineering processing
  - bio-products
  - Biochar
- Carbon economy
- Production to products
- Sustainability: social, environmental, economic
- Associated careers

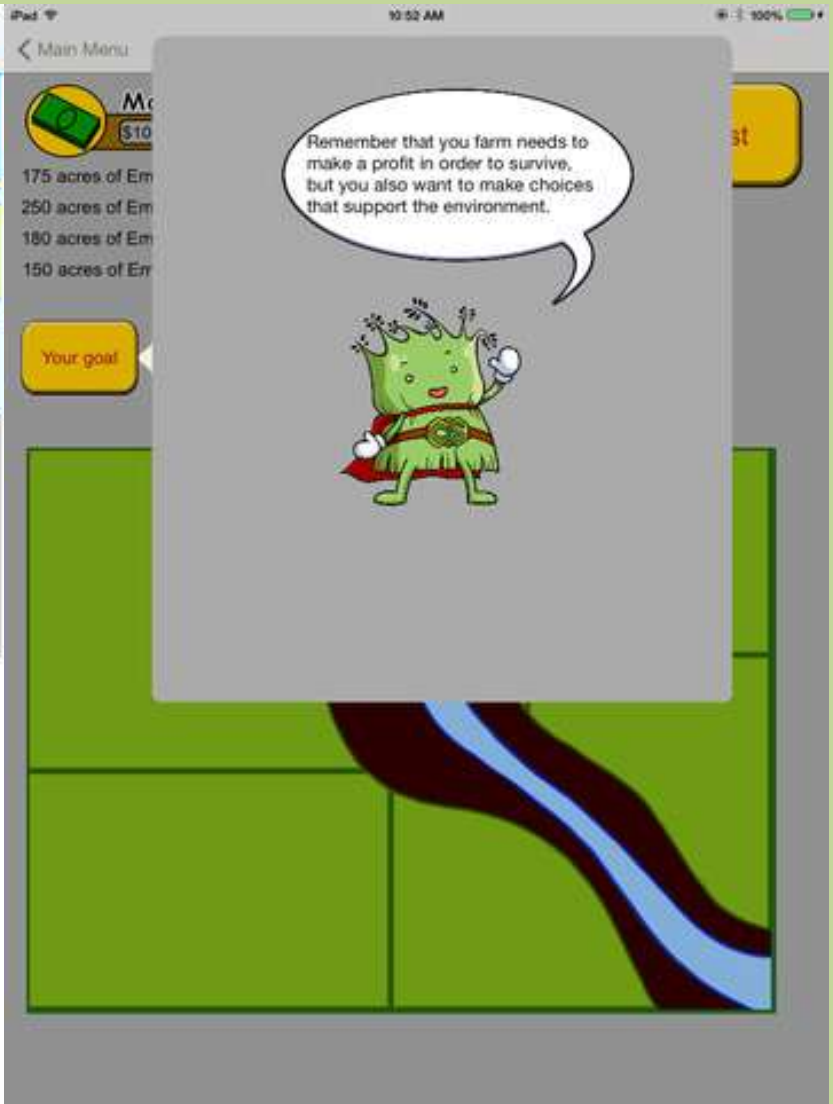
C6 BioFarm

- An ag-based game linked to curriculum and iBook.
- Suite of learning materials that:
    - focuses on STEM content and ag practices
    - allows player to make choices and understand the realities of replacing petroleum Carbon with bio-based carbon.

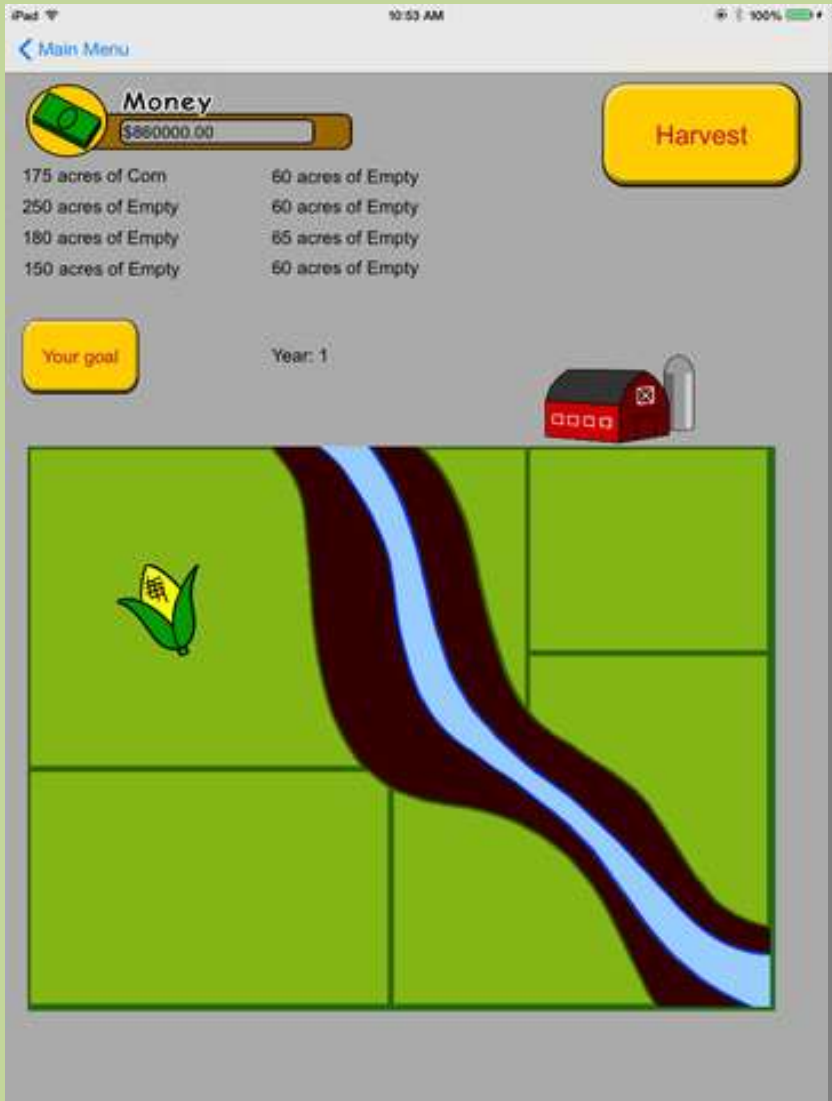


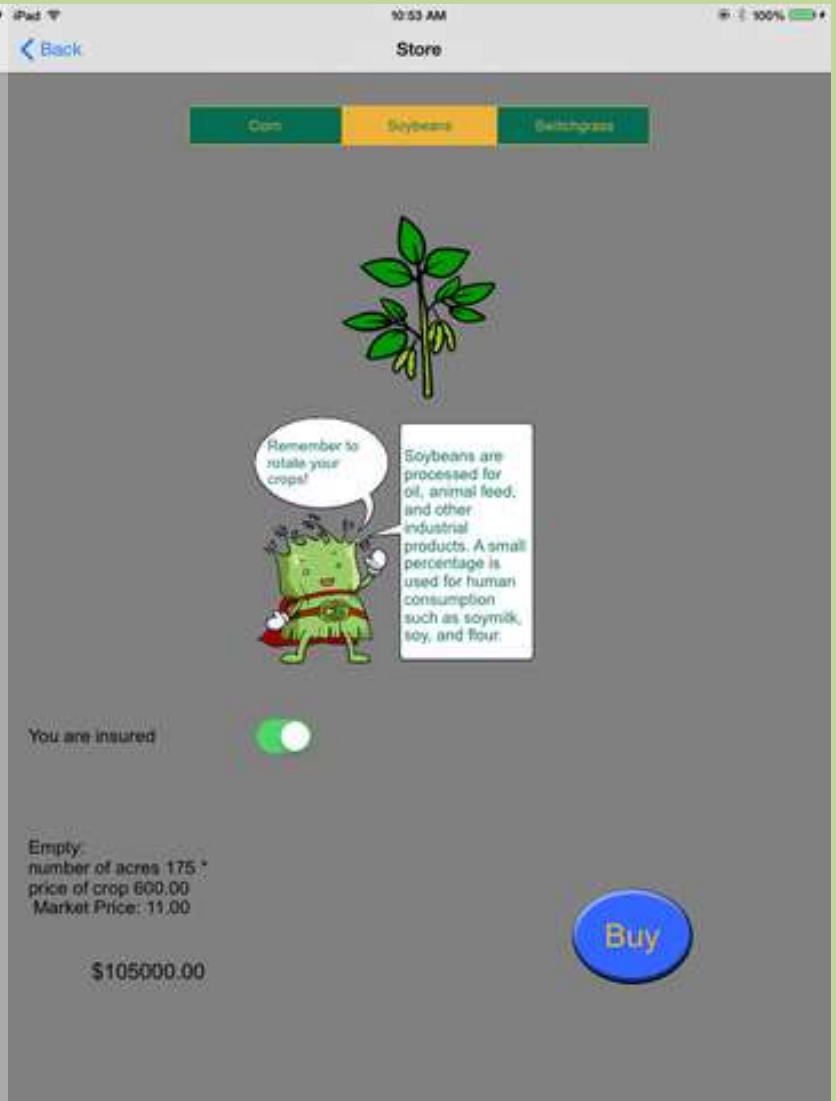
iOS


Main Menu
C6 BioFarm
Play
Options
Credits


Main Menu
Remember that you farm needs to make a profit in order to survive, but you also want to make choices that support the environment.
Your goal

iOS


iPad
10:53 AM
100%
Main Menu
Money
$860000.00
Harvest
175 acres of Corn
250 acres of Empty
180 acres of Empty
150 acres of Empty
60 acres of Empty
60 acres of Empty
65 acres of Empty
60 acres of Empty
Your goal
Year: 1


iPad
10:53 AM
100%
Back
Store
Corn
Soybeans
Switchgrass
Remember to rotate your crops!
Soybeans are processed for oil, animal feed, and other industrial products. A small percentage is used for human consumption such as soymilk, soy, and flour.
You are insured
Empty:
number of acres 175 *
price of crop 600.00
Market Price: 11.00
$105000.00
Buy

Game Flow

Game Play

- **Year 1**
  1. Select the crop you will plant in each field.
  2. Calculate cost for each field using the planting costs table on Page 1.
  3. Select yes or no for Insurance (Factor this decision into your planting costs)
  4. At the end of the cycle fill in the yield, using a random number generator to identify the yield modifier factor number (for all fields).
  5. Determine final yield = *(yield/acre)* yield modifier factor*

     Crop insurance factor modifier = .75

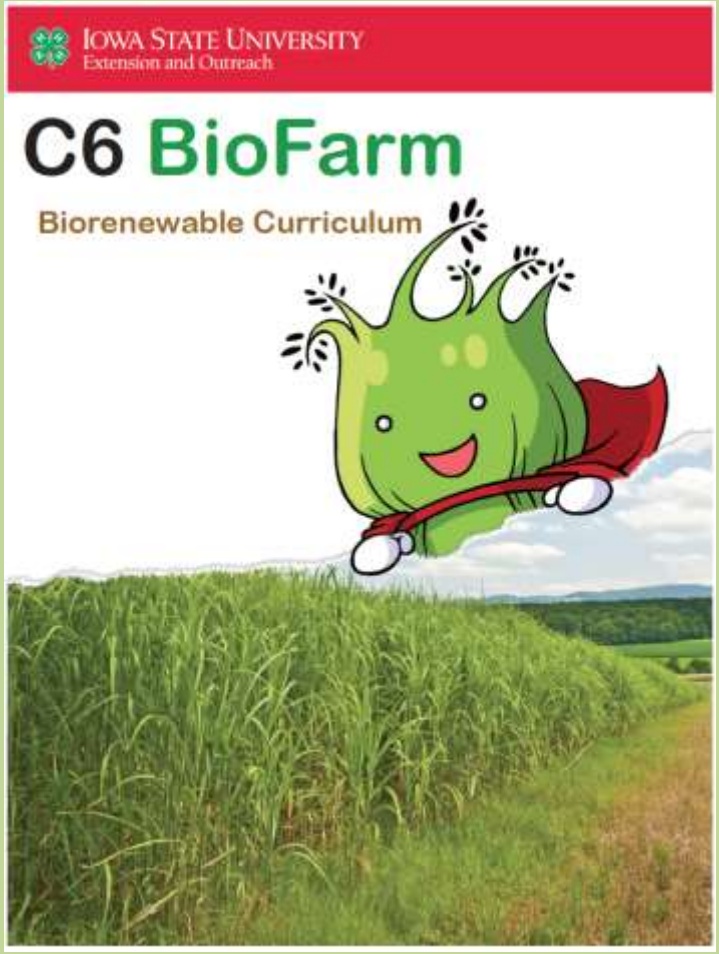
     Use number generated from random number generator and apply to table on the bottom.
  6. Fill in price/unit for each crop in each field that is supplied by game leader.
  7. Profit = *final yield*price/unit-planting costs+field profits total*

     Add or subtract from account balance

Random acts of fate

Yield Modifier	Modifier Number
1-600 have a good year! Full Yield	1
601-760 drought	.6
761-868 excess moisture	.7
869 - 884 - flooding	0
885 - 896 - late frost	.6
897 - 944 - hail damage	.5
945 - 952 - insect and pests	.6
953 - 960 plant disease	.4
961 - 972 wind damage	.7
973-975 tornado	.7
976 - 980 someone drives through the field, Dukes of Hazzard style	.8
981-985 crop circles	.9
986-990 freak snowstorm	.4
991-995 lightning causes a fire in the field	0
996-1000 a combine lights on fire	0

C6 BioFarm Curriculum
Iowa 4-H Reviewed and approved



Overview

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Introduction

C6 BioFarm was created with a goal of teaching middle and high school youth about the importance of creating a renewable energy based world.

Biofuels are projected to provide 27% of the world's transportation fuels by 2050. As such, it is important that we educate today's youth about the fuels that will be a part of their future consumption practices. By teaching youth about biofuel use and production, they will become better informed as future consumers and citizens. Additionally, they will be more aware of career opportunities in the biorenewable energy industry.

In this curriculum, biorenewable sources of energy are referred to as new carbon, while nonrenewable energy sources are called old carbon. Through this curriculum and set of learning tools (including a *C6 Biofarm (Paid* game), youth learn more about old and new carbon as well as discovering the benefits of creating fuel sources from new carbon, how new carbon is grown, where new carbon is located, and more.

Each lesson in this curriculum is designed to teach young people about a specific subject matter related to biorenewable energy. Lesson guides contain background information on the topics covered as well as hands-on activities, links to online resources and content, and ideas for how to implement different parts of the lessons in your classroom.

Each lesson also implements specific educational standards from the *Next Generation Science Standards (NGSS)*, as well as the *Agriculture, Food, and Natural Resources Career Cluster Standards (AFNRCCS)* and the *Common Core State Standards Initiative (CCSSI)*. We have indicated which standards are met by each activity within each lesson, as well as how students will meet those standards.

We are passionate about creating content that integrates easily into classroom application. With this goal in mind, we organized the content of this curriculum into lessons and made teacher's guides for each lesson, and activity within it.

The curriculum is designed to be usable as an online document, or easily printed with a home printer or copier, in color or greyscale. You can download and/or print the entire curriculum, including this prefix and the appendix, or just access specific lessons or activities as needed through our *C6 BioFarm* website at:

www.extension.iastate.edu/4h/content/c6-biofarm

Curriculum Guide

Curriculum Guide

How to Use this Curriculum

The introduction of each lesson of the C6 BioFarm curriculum contains several sections intended to provide teachers with helpful information for implementing the lesson in the classroom.

Each lesson's **Title** and **Icon** appears at the top of the first page and in the header of each subsequent page.

The **Lesson Overview** explains what the lesson seeks to accomplish and how it will do so.

The **BIG IDEAS and Learning Objectives** text box explains the big ideas addressed in the lesson and how those translate into specific learning objectives.

The **Standards** text box indicates what NGSS, AFNRCCS, and CCSSI education standards are met by each activity included in the lesson as well as which Learning Objectives (LOs) is accomplished by each activity.

The **Lesson Outline** guides users step by step through implementing the lesson with images of each activity guide for your reference.

The **Time Requirements** text box provides anticipated time needed to prepare and implement each part of the lesson.

The **Key Words** text box lists vocabulary words for the lesson.

Each lesson of the C6 BioFarm curriculum contains several pages designed for easy replication in grey scale including:

a **KWL (What I know, What I want to learn, What I have learned)**;

various **Lab Directions**;

and **Activity Sheets** for students to complete.

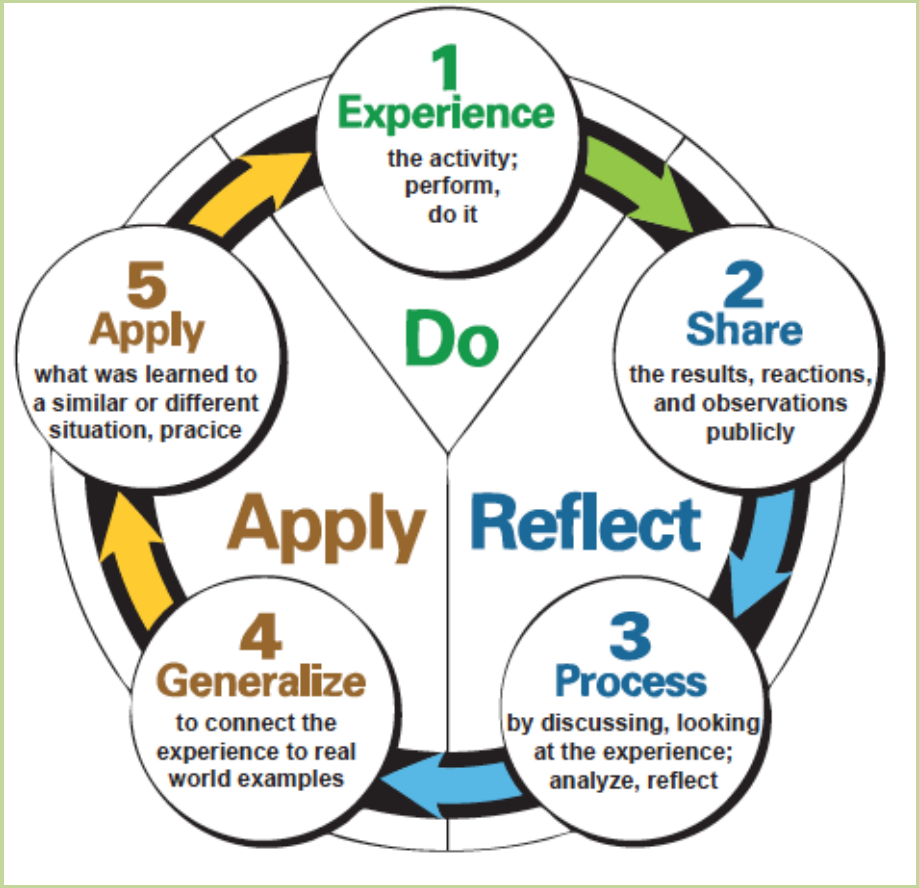
Many C6 BioFarm lessons also contain **Overheads** that teachers can prepare to project and use during group activities.

C6 BioFarm lessons contain between one and three activities, each with its own **Activity Guide**. Activity guides contain:

- A **Title** at the top, and in the header of each subsequent page
- **Background** information, including links for more information
- **Directions** for facilitating the activity
- A **Materials** list of supplies you will need to complete the activity
- A list of **Handouts & Overheads** used in the activity
- A list of **Online Resources** needed for the activity or that provide helpful background information
- A description of the **NGSS Based Concept** addressed by the activity
- **Big idea** bubbles that illuminate what types of answers a question is trying to elicit
- **Links** and **Images** of online resources used in the activity
- And **Discussion Guides** with a suggested questions or points to bring up during class discussions.

Each lesson in C6 BioFarm concludes with an **Educational Standards** section that details how each activity applies to the standards and what students will do to meet them.

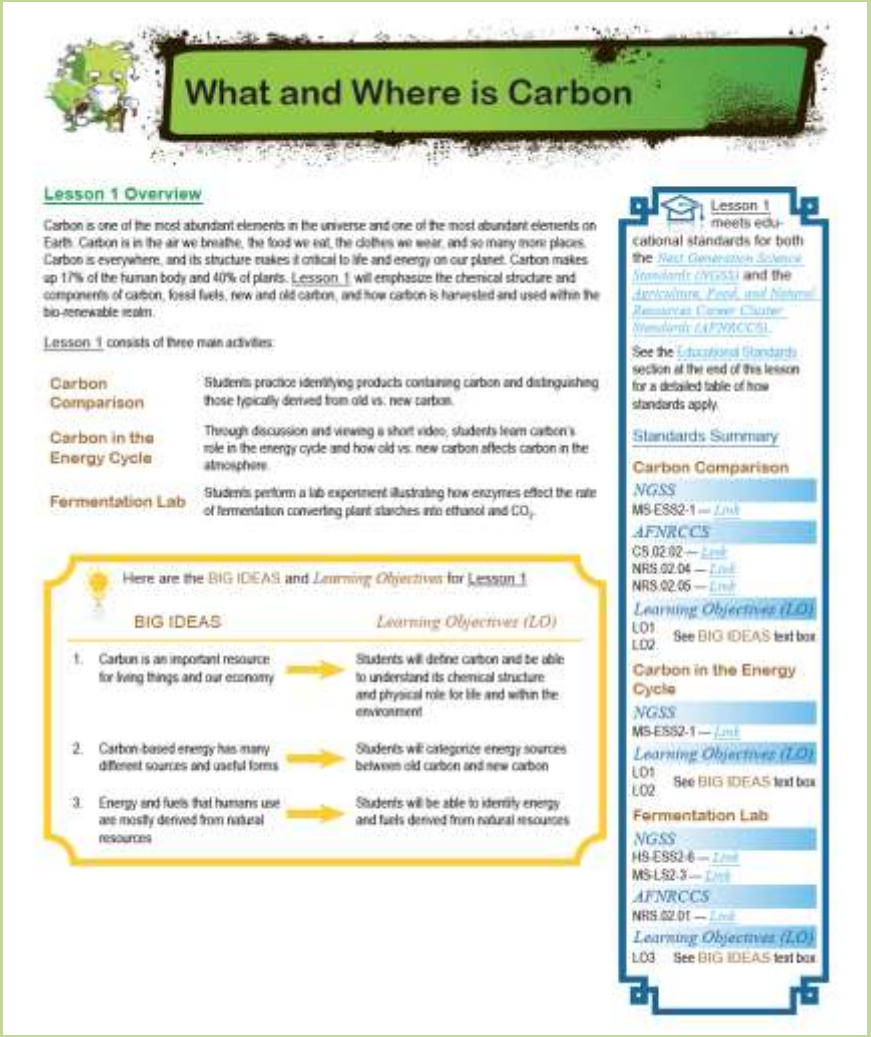
4-H Experiential Model



Sample Lesson

http://www.extension.iastate.edu/4h/content/c6-biofarm

- Carbon: What and Where is Carbon?
- Lesson 1, Activity: Where is Carbon



What and Where is Carbon

Lesson 1 Overview

Carbon is one of the most abundant elements in the universe and one of the most abundant elements on Earth. Carbon is in the air we breathe, the food we eat, the clothes we wear, and so many more places. Carbon is everywhere, and its structure makes it critical to life and energy on our planet. Carbon makes up 17% of the human body and 40% of plants. Lesson 1 will emphasize the chemical structure and components of carbon, fossil fuels, new and old carbon, and how carbon is harvested and used within the bio-renewable realm.

Lesson 1 consists of three main activities:

Carbon Comparison	Students practice identifying products containing carbon and distinguishing those typically derived from old vs. new carbon.
Carbon in the Energy Cycle	Through discussion and viewing a short video, students learn carbon's role in the energy cycle and how old vs. new carbon affects carbon in the atmosphere.
Fermentation Lab	Students perform a lab experiment illustrating how enzymes effect the rate of fermentation converting plant starches into ethanol and CO_2.

Here are the BIG IDEAS and *Learning Objectives* for Lesson 1

BIG IDEAS	*Learning Objectives (LO)*
1. Carbon is an important resource for living things and our economy	Students will define carbon and be able to understand its chemical structure and physical role for life and within the environment
2. Carbon-based energy has many different sources and useful forms	Students will categorize energy sources between old carbon and new carbon
3. Energy and fuels that humans use are mostly derived from natural resources	Students will be able to identify energy and fuels derived from natural resources

Lesson 1 meets educational standards for both the Next Generation Science Standards (NGSS) and the Agriculture, Food, and Natural Resources Career Cluster Standards (AFNRCCS).

See the Educational Standards section at the end of this lesson for a detailed table of how standards apply.

Standards Summary

Carbon Comparison

NGSS
MS-ESS2-1 — Link

AFNRCCS
C5.02.02 — Link
NRS.02.04 — Link
NRS.02.05 — Link

Learning Objectives (LO)
LO1
LO2
See BIG IDEAS text box

Carbon in the Energy Cycle

NGSS
MS-ESS2-1 — Link

Learning Objectives (LO)
LO1
LO2
See BIG IDEAS text box

Fermentation Lab

NGSS
HS-ESS2-6 — Link
MS-LS2-3 — Link

AFNRCCS
NRS.02.01 — Link

Learning Objectives (LO)
LO3
See BIG IDEAS text box

Where is Carbon

- Show students the examples of new and old carbon. The examples can be shown as one group or two groups (one group of new carbon and one group of old carbon). Without giving them any hints, ask them to write down what is similar and different about the items. Think about where they came from, uses, textures, looks, and more.

What is Carbon?

An Element

6

C

Carbon

Atomic Mass 12

Old (Fossil) Carbon

New (Renewable) Carbon

Carbon is the building block of every **lifeform** and most forms of **energy**

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- College of Design
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