Energy in Agricultural Systems

MODULE 1: INTRODUCTION TO AG-ENERGY

Funding provided by The Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR)
We can have the ability to make a change, right here in our everyday lives. It starts here.

https://www.youtube.com/channel/UCbVKIQMvSWEDLnQIAWE9l9A
Introduction to Ag-Energy Overview

1. Importance of energy in ag
   • Where does energy come from?
   • How do we use energy in ag?
   • Why is this important?

2. Environmental considerations
   • Greenhouse gases
   • Climate change
   • Challenges for agriculture

3. Reducing Agriculture’s Footprint
   • Solutions

http://www.climateandenergy.org
1. Importance of energy in agriculture

When you hear “energy in agriculture”, what do you think of?
Where does energy come from?

- Most energy used in ag comes from nonrenewable fossil fuels
  - Nonrenewable - cannot be replaced by natural means
- Petroleum (which includes oil), natural gas, and coal

[Link to video](https://www.youtube.com/watch?v=zaXBVYr9lj0)

U.S. energy consumption by energy source, 2014

- Total = 98.3 quadrillion Btu
- Total = 9.6 quadrillion Btu

1. **Petroleum** 35%
2. **Natural gas** 28%
3. **Coal** 18%
4. **Renewable energy** 10%
5. **Nuclear electric power** 8%
6. **Solar** 4%
7. **Geothermal** 2%
8. **Wind** 18%
9. **Biomass waste** 5%
10. **Biofuels** 22%
11. **Biomass** 50%
12. **Wood** 23%
13. **Hydroelectric** 26%

Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 10.1 (March 2015), preliminary data
How do we use energy in ag?

• INDIRECTLY and DIRECTLY

• Indirect energy use (off-farm) is used to manufacture farm inputs:
  • Produce fertilizers/pesticides
  • Produce electricity

• Direct energy use (on-farm):
  • Heats buildings
  • Fuel tractors/machinery
  • Grain drying
  • Water heating
  • Use of electricity

http://followgreenliving.com/renewable-energy-future/
http://www.extension.umn.edu/agriculture/dairy/facilities/fan-care-for-efficient-ventilation/
http://blog.caseih.com/equipment-technology/agronomy-series-highlights/
Why is this important?

- EVERYTHING from plowing fields to planting seed to raising livestock requires ENERGY
- Demand for agricultural products growing, nonrenewable energy sources shrinking
- Human population growing = demand for more food = pressure on nonrenewable resources to meet demand
- Burning fossil fuels increases harmful greenhouse gases in the atmosphere
What impacts do using nonrenewable resources have on the environment/Earth?
2. Environmental considerations

• The primary fossil fuels we use are nonrenewable

• Extracting, transporting, and burning of fossil fuels is causing global environmental issues
  • Increasing pollution - water, air, soil
  • Increasing greenhouse gases
  • Increasing habitat destruction
  • Increased deforestation
  • Global climate change - the whole planet is affected!
Greenhouse effect

- All life is dependent on solar energy
- A portion of solar energy is absorbed by Earth
- A portion is reflected back into space
  - Reflected by snow caps, glaciers, ice, and clouds
- Greenhouse gases (GHGs) hold heat in the atm
  - Carbon dioxide
  - Methane
  - Nitrous Oxide
- Humans are increasing GHG levels
  - More heat is being retained by the atm
  - Snow caps, glaciers, and ice in Arctic and Antarctic are melting - polar amplification
  - Less sunlight can be reflected back into space because there is less ice to reflect it - dark colored water is absorbing more heat, causing the oceans to warm and expand
  - Parking lots, roofs, working fields
  - Deforestation
  - Permafrost melting
Human Population Growth and Rise of GHGs

• Agricultural Revolution
  • Transition from hunter-gatherer to stationary farming

• Industrial Revolution
  • New manufacturing processes
  • Iron production
  • Chemical manufacturing
  • Rise of the factory
  • Rise of fossil fuel burning

• Green Revolution
  • Increase in agricultural production
  • High-yielding crops
  • Chemical fertilizers
  • Mechanization
  • Infrastructure explosion
  • All burn fossil fuels!
Global carbon emissions from burning coal, oil, and gas and producing cement

http://nca2014.globalchange.gov
Climate change

- Increases in greenhouse gases (GHGs) are already affecting global climate change:
  - Increase in Earth’s average temperature
  - Reduction ice and snow cover
  - Rising sea level
  - Increase in acidity of the oceans
  - Increase in frequency/intensity of extreme weather events
  - Altered ecosystem characteristics
  - Increase in threats to human health
  - Rapidly melting permafrost

https://www.epa.gov/climate-change-science/future-climate-change

http://nca2014.globalchange.gov
Challenges for agriculture

• Climate change is an issue that has large implications for agriculture

How do you think climate change affects agriculture?
How climate change affects ag

• Climate change driven by GHGs is already affecting agriculture:
  • Extreme weather events are increasing
    - Heatwaves and droughts - reduced water for irrigating, stress on crops and livestock
    - Heavy rainfalls (flooding and hail) - damaging to crops and livestock
    - Large winter storms
    - Hurricanes
  • Growing conditions are changing
    - Severe heat
    - Reduced frost days (crop chilling requirement)
    - Early bloom = frost damages
  • Pests and diseases
    - Increasing and spreading
    - Reduced frost days
  • Weeds harder to control
    - Higher CO2 and warmer temps

Sourced from: https://www.agenergyia.org

Graphics show change 50 years in the future as compared to 2000:
How climate change affects ag

• Livestock death and decreased performance
  • Severe heat and droughts
  • Increased degree of stress
  • Fodder and water loss

• Soil erosion
  • Increased by heavy rain and wind

• Air pollution
  • Linked to crop damage and reduced yields (SOURCE)

• Water pollution
  • Affect human health-contaminants into the food system
  • Livestock and crop health
  • Acid rain

(SOURCE)
Case study- pollinators

• Increase in GHGs=warmer Earth=early spring=pollinators seeking food earlier
• Lifecycle is coming out of sync with flowering plants and trees
  • Plants do not adapt and change as quickly
• No food for pollinators earlier in spring=pollinator die-off
• No pollination for flowering plants and trees=reduction in these species
• Reduction in plant species=reduction in food availability up the food chain (to us!)
3. Reducing agriculture’s footprint

How can we reduce agriculture’s footprint?
Solutions

• Key message - producers will not be able to adapt quickly enough! We need to focus on long-term resilience.

• Save money by implementing energy efficiency
  • Reduce amount of energy required to provide products and services
  • Ex: LED lights, efficient air conditioners, fans

• Save money by practicing energy conservation
  • Reducing energy consumption through using less energy
  • Ex: turn off the lights!

• Produce renewable energy on the farm (energy security)
  • Energy is collected from renewable resources such as sunlight, wind, and water.
  • Rapid industry growth and huge potential for investment
  • Quick return on investment
  • Sell energy back to the grid when you over produce
  • Ex: wind turbines, solar panels, hydroelectric dams

http://eartheasy.com
http://www.solarworld.today
Quiz!