ADDRESSING CLIMATE CHANGE WITH AGRICULTURE IN OUR OPEN SPACE
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TODAY’S AGENDA

- GREENHOUSE GASES OVERVIEW

- AGRICULTURE PRACTICES AS POTENTIAL SOURCES OF GREENHOUSE GASES,

- ADAPTING TO CLIMATE CHANGES TO PROVIDE FOR SUSTAINABLE FOOD PRODUCTION
US GREENHOUSE GAS EMISSIONS

EPA 2017
US AGRICULTURE =

9% OF TOTAL U.S. GHG:

4.5% FERTILIZERS/ IRRIGATION (N₂O)

3% BELCHING (METHANE)

1.5% MANURE STORAGE (N₂O/ METHANE)

EPA 2017
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)
Global Greenhouse Gas Emissions by Economic Sector

- Agriculture, Forestry, and Other Land Use: 24%
- Electricity and Heat Production: 25%
- Industry: 21%
- Transportation: 14%
- Buildings: 6%
- Other Energy: 10%

GLOBAL GHG
EPA
2015
Global Agriculture Emissions 2009

AR5 Climate Change 2014: Mitigation of Climate Change
2017 U.S. Carbon Dioxide Emissions, By Source

- Transportation: 34%
- Electricity: 33%
- Industry: 15%
- Residential & Commercial: 10%
- Other (Non-Fossil Fuel Combustion): 7%
THE CARBON CYCLE

Plants absorb carbon dioxide

Living organisms (insects, microbes, roots) respire carbon into the air

Carbon enters the soil

Short-term carbon storage

Long-term carbon storage

HEALTHY SOILS TO COOL THE PLANET / A Philanthropic Action Guide
OPTIMIZING PLANT GROWTH/ROOT HEALTH

SOIL TEXTURE (PER SOIL SURVEY)

SOIL ORGANIC MATTER (PER SOIL O.M. TESTS)

NUTRIENTS/LIME APPLIED (PER SOIL TESTS)

IMPROVED CROP VARIETIES (PER TRIALS)

HARVESTING DECISIONS (PER ROOT STORAGE)
PERENNIALS grasses, legumes, fruits:

- Extensive roots / soil organic matter
- Less planting/ harvesting and soil exposure
- Less machinery fuel burned for planting
ANNUALS
CORN, SOYBEANS, VEGETABLES

Lots of nutrients per acre
BUT, Annual decomposition
SO, Cover crops important
COVER CROPS

- PLANTS THAT KEEP THE SOIL COVERED

- INTER SEEDED INTO GROWING CROPS

- OR SEEDED AFTER THE HARVEST

- PLANTING DEADLINE OFTEN MISSED!
LIVING ROOTS:

- A BIOLOGICAL COMMUNITY IN THE SOIL
- PROTECT SOIL FROM EROSION
- BUILD ORGANIC MATTER TO HOLD WATER
SOIL ORGANIC MATTER

A well structured soil
ROLE OF ORGANIC MATTER IN SOILS

- WATER HOLDING CAPACITY

- SOIL STRUCTURE (AIR/WATER/ROOTS)

- FEEDS MICROBES

- SLOW NUTRIENT RELEASE

- INCREASED PLANT YIELDS
SOIL ORGANIC MATTER

50% BREAKS DOWN OVER

100 - 1000 YEARS

Unless........
TILLAGE
BARE LAND
EROSION

Exposes organic matter
Speeds up decomposition

CO2 EMISSION
NO TILL SEEDING

COULTERS OPEN SLIT

SEED TUBE

DEPOSITS SEED

PACKER WHEELS

CLOSE SLIT
- Organic matter max = 15% in root zone

- Max reached up to 25 years after
  - tillage stops
  - root growth starts
US GREENHOUSE GAS EMISSIONS IN 2017
SOURCES OF NITROUS OXIDE

U.S. NITROUS OXIDE EMISSIONS
By source, 2017

- Manure management: 5%
- Industry or chemical production: 6%
- Stationary combustion, primarily power plants: 8%
- Transportation: 5%
- Other: 2%
- Agricultural soil management: 74%

SOURCE: EPA
PAUL HORN / InsideClimate News
Manure Manager, September, 2016, Maximizing the

N CYCLE

atmospheric nitrogen (N₂)

incorporation into animals

fixation by lightning and bacteria in the soil

gaseous loss (N₂ & N₂O)

organic matter

ammonification

ammonium (NH₄⁺)

nitrification

nitrites (NO₂⁻)

denitrification

nitrates (NO₃⁻)

plant uptake

leaching
NUTRIENT MANAGEMENT TO REDUCE N20 EMISSIONS

- BALANCE RATIONS FOR N NEEDS

- FERTILIZER TIMING / QUANTITY / SITE

- COVER CROPS REMOVE EXCESS SOIL N
MICROBES FIX N IN LEGUME NODULES

SCHOOL OF PERMACULTURE

Nitrogen in the Air

Microbes “fix” nitrogen in nodules on the roots of the crop.
METHANE
BELCHING
SOURCES OF METHANE

- METHANE
  - BELCHING
  - EXCRETION
  - MANURE STORAGE AND APPLICATION
Although CO₂ is a GHG, aerobic processes that produce CO₂ are usually desired over anaerobic processes because CH₄ has 25 times the GHG effect.
METHANE FROM MANURE STORAGE

<1% OF U.S. GHG

ANAEROBIC (NO OXYGEN)

- SOLID STOCKPILES
- LIQUID LAGOONS
- DIGESTORS (NO EMISSION)
LIVESTOCK PRODUCTION EFFICIENCY REDUCES METHANE/UNIT OF FOOD

- Animal health and genetics
- Livestock Nutrition
  - Improved forage quality
  - Healthy supplementation
Improved Forage Quality

• High energy annual forage (c. silage, etc)
• Immature haylage or dry hay
• Rotationally grazed pastures (12 - 4” tall)
Forage Supplementation?

- Forage tested.....animal needs met?

- Supplemented for desired rate of gain/
  product quality and yield
  Corn, small grains, food by-products

- Income above feedcosts determined
More Milk Produced per Cow = Less Methane and Waste

- U.S. Cow: 500 g Methane Production → 22,248 lbs/yr/cow
- Mexican Cows: 800 g Methane Production → 10,500 lbs/yr/cow
- Indian Cows: 4000 g Methane Production → 2,500 lbs/yr/cow

Source: 2014, Compassion in World Farming
It Depends on Forage Quality!

Marbling of beef requires over 2 lbs gain/day during finishing phase.

Lambs/kids need 0.25 lbs gain/day to reach desired 100 pounds yearling wt.
## FINISHING PHASE

<table>
<thead>
<tr>
<th></th>
<th>GRAIN</th>
<th>VS</th>
<th>GRASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Daily Gain, lbs</td>
<td>4.0</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Days of finishing</td>
<td>172</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Carcass weight, lbs</td>
<td>900</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Feed / gain</td>
<td>5.7</td>
<td>13.0</td>
<td></td>
</tr>
<tr>
<td>Acres per animal</td>
<td>0.6</td>
<td>1.0</td>
<td></td>
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MICHIGAN STATE U., 2018 STUDY
<table>
<thead>
<tr>
<th>FINISHING PHASE</th>
<th>GRAIN</th>
<th>VS</th>
<th>FORAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel emissions</td>
<td>+ 0.1</td>
<td></td>
<td>+ 0.2</td>
</tr>
<tr>
<td>Feed emissions</td>
<td>+ 2</td>
<td></td>
<td>+ 2</td>
</tr>
<tr>
<td>Manure emissions</td>
<td>+ 2</td>
<td></td>
<td>+ 2.5</td>
</tr>
<tr>
<td>Belching emissions</td>
<td>+ 2</td>
<td></td>
<td>+ 5</td>
</tr>
<tr>
<td></td>
<td>+6.1</td>
<td></td>
<td>+9.7</td>
</tr>
<tr>
<td>Soil carbon sequestered</td>
<td>0</td>
<td></td>
<td>-16.0</td>
</tr>
<tr>
<td>Net, lb CO2e/lb carcass</td>
<td>+6.1</td>
<td></td>
<td>- 6.3</td>
</tr>
</tbody>
</table>

*Until Soil Organic Matter reaches saturation point

*MICHIGAN STATE U., 2018*
<table>
<thead>
<tr>
<th>Alternative choices to reduce Greenhouse Gases</th>
<th>Action</th>
<th>Per year GHG savings CO2 e,lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet vegetables reduced</td>
<td>180 days X 0.1/ per 8 oz</td>
<td>- 36</td>
</tr>
<tr>
<td>Diet cheese reduced</td>
<td>180 days X 1.5/ per 4 oz</td>
<td>- 270</td>
</tr>
<tr>
<td>Diet white meat reduced</td>
<td>180 days X 1.5/ per 4 oz</td>
<td>- 270</td>
</tr>
<tr>
<td><strong>Diet beef reduced</strong></td>
<td>180 days X 6.6 / per 4 oz</td>
<td>- 1200</td>
</tr>
<tr>
<td>Clothesline for drying</td>
<td>10,000 mi</td>
<td>- 1200</td>
</tr>
<tr>
<td>Improve car efficiency,+5 mpg</td>
<td>10,000 mi</td>
<td>- 1200</td>
</tr>
<tr>
<td>Upgrade to Energy Star</td>
<td>Bulbs, boiler, fridge, windows replaced</td>
<td>- 5500</td>
</tr>
</tbody>
</table>
2070-2100

Climate Change Impacts in the US
Projected Precipitation Change by Season

Higher Emissions (A2)

Winter

Spring
How will farmers adapt to Summer Droughts?

1. Drought resistant species/varieties

2. Soil moisture protected (conservation tillage, plastic)

3. Cover crops/perennials to increase OM
Continued:

4. Water sources upgraded (irrigation, waterers)

5. Emergency feed (barn feeding to rest pastures)

6. High tunnels / barns  (protection from hot sun)
HOW WILL FARMERS ADAPT TO CLIMATE CHANGE?

Heavy Precipitation Events

1. Disease resistant species/varieties
2. Select crops resistant to lodging
3. Slopes planted to perennial crops
4. Annual crops in flood prone areas
5. Drainage tiles on cropland

6. Drainage of livestock heavy use areas

7. High tunnels (for high value crops)

8. Surface protected with residue or cover crops
CONSERVATIONLEASES

DEVELOPING A WIN-WIN ARRANGEMENT
Operation and Maintenance of Land:

“The land shall be continuously covered with growing perennial or annual crops, ensuring adequate soil organic matter. Winter cover crops will be seeded as the cash crop is harvested, with a deadline of _______ to protect land from erosion until spring seeding. Crops will be fertilized at proper rate and timing.”
THANK YOU!

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