Food & Environment

Factoid: In 2000, US airlines used 350,000,000 extra gallons of fuel to carry the added pounds of overweight Americans
Quiz: McMichael et al., 2007

2. Describe two ways that current livestock production creates greenhouse gases.
Vocab – McMichael et al., 2007

- Ischaemic – constricting of blood vessels
- Paleolithic – stone age
- Sedentarism – sitting around
- Zoonoses – diseases originating from animals
- Somatic – human generated
Diversity Indices

Richness \((S)\) = Count of the total number of species in a community or location

\[
\text{Shannon Diversity (H)} = \sum_{i=1}^{s} -\left( P_i \times \ln P_i \right)
\]

Evenness = \(H/\ln(S)\)
The classic resource pyramid

A) In order to sustain 1 human on a diet of meat, 20,000 kcal of plant energy (which become 2000 kcal of meat energy) are required. B) Those same plants could feed 10 humans directly.
Resource Intensive Foods

• Meat protein production takes 6-20x the energy of soy protein

Pimentel & Pimentel, 2003
## Energetic Efficiency of Different Foods

<table>
<thead>
<tr>
<th>Food item</th>
<th>$100 \times \frac{\text{kcal output}}{\text{kcal input}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livestock</td>
<td>18.1</td>
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<tr>
<td>Chicken</td>
<td>20.6</td>
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<td>Milk</td>
<td>11.2</td>
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<tr>
<td>Eggs</td>
<td>6.4</td>
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<td>Beef (grain fed)</td>
<td>3.7</td>
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<tr>
<td>Pork</td>
<td>1.2</td>
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<td>Lamb</td>
<td>110</td>
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<td>Fish</td>
<td>5.8</td>
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<td>Herring</td>
<td>5.7</td>
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<tr>
<td>Tuna</td>
<td>0.9</td>
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<td>Salmon (farmed)</td>
<td>250</td>
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<tr>
<td>Shrimp</td>
<td>415</td>
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<td>Plants</td>
<td>110</td>
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<td>Corn</td>
<td>123</td>
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<td>Soy</td>
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<td>Apple</td>
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<td>Potatoes</td>
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</tbody>
</table>

>100 means we get more out than we put in

Eschel & Martin, 2006
Livestock & Land Cover Change

- 34,000,000 km$^2$ of pasture globally (26% of land)
- 23,000,000 km$^2$ of cropland globally (18% of land)
- ~1/3 of cropland is dedicated to production of animal feed
Land Degradation from Livestock

• Increased soil erosion
• Incised riparian areas
• Change in ecosystem structure

Soil erosion in Indonesia
<table>
<thead>
<tr>
<th></th>
<th>Livestock</th>
<th>Large-scale agriculture</th>
<th>Small-scale agriculture &amp; colonization</th>
<th>Unsustainable logging</th>
<th>Pulp plantations</th>
<th>Fires</th>
<th>Charcoal and fuelwood</th>
<th>Mining</th>
<th>Infrastructure</th>
<th>Hydroelectric power</th>
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<td>Amazon</td>
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**Table 2:** Summary of main pressures on forests in different deforestation fronts

Source: WWF
Estimated distribution of livestock production systems
Global Deforestation Hotspots

Deforestation Index 2012

- Rank 1: Nigeria (extreme)
- Rank 2: Indonesia (extreme)
- Rank 3: North Korea (extreme)
- Rank 4: Bolivia (extreme)
- Rank 5: P.N.G. (extreme)
- Rank 6: DR Congo (extreme)
- Rank 7: Nicaragua (extreme)
- Rank 8: Brazil (extreme)
- Rank 9: Cambodia (extreme)
- Rank 10: Australia (high)
Global Vertebrate Biodiversity

Jenkins et al., 2013
Livestock & Climate Change

Livestock account for ~18% of global GHG emissions

McMichael, 2007
Livestock related land use change:
Deforestation in the Neotropics

~2.4 million ha/year
Forest → Pasture

~0.5 million ha/year
Forest → Feed crops

~2.4 billion tons CO₂

~9% of global CO₂ from livestock-driven deforestation
Methane released from enteric fermentation

Assessment per region and livestock production system

Resulting total of 86 million tons CH$_4$ per year

Methane released from animal manure

Assessment per region and livestock production system, using updated emissions factors

Resulting total of 18 million tons CH$_4$ per year

Resulting Overall Contribution

About 2.2 billion tons CO$_2$ equivalent:

~8% of global CO$_2$ equivalent greenhouse gas emissions
Grass-fed beef: Emissions central
Reduce Consumption: Food Choices

- Beef production creates 10x more CO₂ equivalent than other foods

Why more CO₂ equivalent from extensive?
- Grass-fed cows release 4x more methane than grain fed cows

Machinova et al., 2015
Nitrogen inputs into the Mississippi watershed under current conditions (top) and with animal feed converted to equivalent vegetable protein (bottom)
Drivers of Livestock Production

**Demand:**
- Population growth (mainly developing countries)
- Income growth (mainly east and south Asia)
- Lifestyle changes

**Supply:**
- Cheap energy
- Cheap grain
- Deforestation & degradation are externalities
Other problems besides meat?
Subsidies make (some) food cheap

2009 subsidy for corn, rice, wheat & soy: $15,400,000,000

2009 subsidy for all fruits, vegetables & organic crops: $800,000,000
By-products of Corn Subsidies

High fructose corn syrup

Graph showing trends from 1965 to 2010 for various sweeteners, with a focus on high fructose corn syrup.
We are a nation of food wasters

Parfitt et al. 2010

Avoidable waste
Food glut in America

Available
Consumed (Modeled)

Hall et al. 2009
Can we all go organic?

- Reduces nitrogen leaching
- Retains more soil carbon

<table>
<thead>
<tr>
<th>Fertilizer Source</th>
<th>N Content %</th>
<th>Leaching Potential</th>
<th>Burn Potential</th>
<th>Low Temp. Response</th>
<th>Residual Effect</th>
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<tbody>
<tr>
<td>Inorganic</td>
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<td>Ammonium nitrate</td>
<td>33-34</td>
<td>High</td>
<td>High</td>
<td>Rapid</td>
<td>Short</td>
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<tr>
<td>Calcium nitrate</td>
<td>16</td>
<td>High</td>
<td>High</td>
<td>Rapid</td>
<td>Short</td>
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<tr>
<td>Ammonium sulfate</td>
<td>21</td>
<td>High</td>
<td>High</td>
<td>Rapid</td>
<td>Short</td>
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<td>Organic–Natural</td>
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<td>Activated sewage sludge</td>
<td>6</td>
<td>Very Low</td>
<td>Very Low</td>
<td>Very Low</td>
<td>Long</td>
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<td>Manures</td>
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<td>Long</td>
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<td>Other natural products</td>
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<td>Very Low</td>
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<td>Synthetic</td>
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<td>Urea</td>
<td>45-46</td>
<td>Moderate</td>
<td>High</td>
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<td>Urea solutions</td>
<td>12-14</td>
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<td>High</td>
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<td>Short</td>
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<td>Sulfur coated urea</td>
<td>14-38</td>
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<td>Low</td>
<td>Moderate</td>
<td>Long</td>
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<td>Resin coated urea</td>
<td>24-35</td>
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<td>Low</td>
<td>Moderate</td>
<td>Long</td>
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<td>Isobutylidene diurea (IBDU)</td>
<td>30-31</td>
<td>Mod. Low</td>
<td>Low</td>
<td>Moderate</td>
<td>Long</td>
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<td>Methylene ureas and</td>
<td>38</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Mod. Long to Long</td>
</tr>
</tbody>
</table>
Household Actions: Food Choices

• Without synthetic fertilizers we could only feed half of the global population

• Tradeoff between intensification (non-organic) and extensification (organic) in order to produce the same food quantity
Solutions?

• Fix the food pricing system
  – Need a market for externalities (carbon cap and trade; polluter pays policies)
  – Remove or reduce subsidies

• Personal/household actions
  – Reduce meat
  – Reduce waste

• Social values (and social norms!)
1. Describe two ways that current agricultural production relies on fossil fuels.

3. Give one example of how energy-intensive food consumption relates to human health.

4. How does your current meat consumption compare with developed country averages? What cultural, policy or economic incentives do you think it would take to reduce average US meat consumption to 90 g/day?

5. Describe one other piece of information you thought was interesting in this paper.