Climate: Food and Energy Systems and the Built Environment

Texas Envirothon Teacher Training

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Food Systems in the US

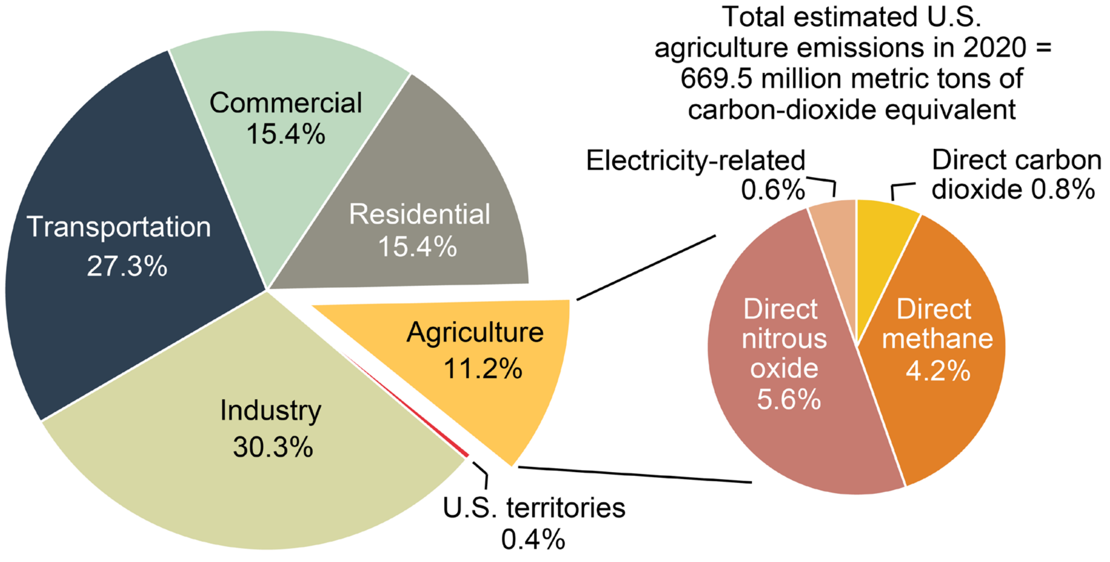
Industrial agriculture: the mechanized farming of crops at an industrial scale

- primarily grains
- reliance on fossil fuels
- reliance on chemical fertilizers and pesticides

Greenhouse Gas Emissions: crop production

Estimated U.S. greenhouse gas emissions by economic sector, 2020

Total estimated U.S. emissions in 2020 =
5,981.4 million metric tons of carbon-dioxide equivalent



Note: Carbon dioxide emissions associated with electricity consumption are allocated to each end-use sector in the left pie chart.
Source: USDA, Economic Research Service using data from U.S. Environmental Protection Agency, April 2022: *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2020*, Table 2-12.

Agriculture contributed 11.2% of total US emissions in 2020

Field crops contribute more to direct NOx and CO_2 emissions
- fertilizers
- tailpipe emissions

Direct methane results from animal production operations

Impacts of climate change on industrial crop production

Additional rainfall in some regions; more drought in others; temperature change; length of growing season; presence or absence of frost/freeze

- *Availability of water resources: too much or not enough*
- *Crop species viability*
- *Soil loss*
- *Pollinators and pests*

Strategies for managing climate impact from croplands

Climate-Smart Ag: World Bank funded projects

https://www.worldbank.org/en/topic/climate-smart-agriculture

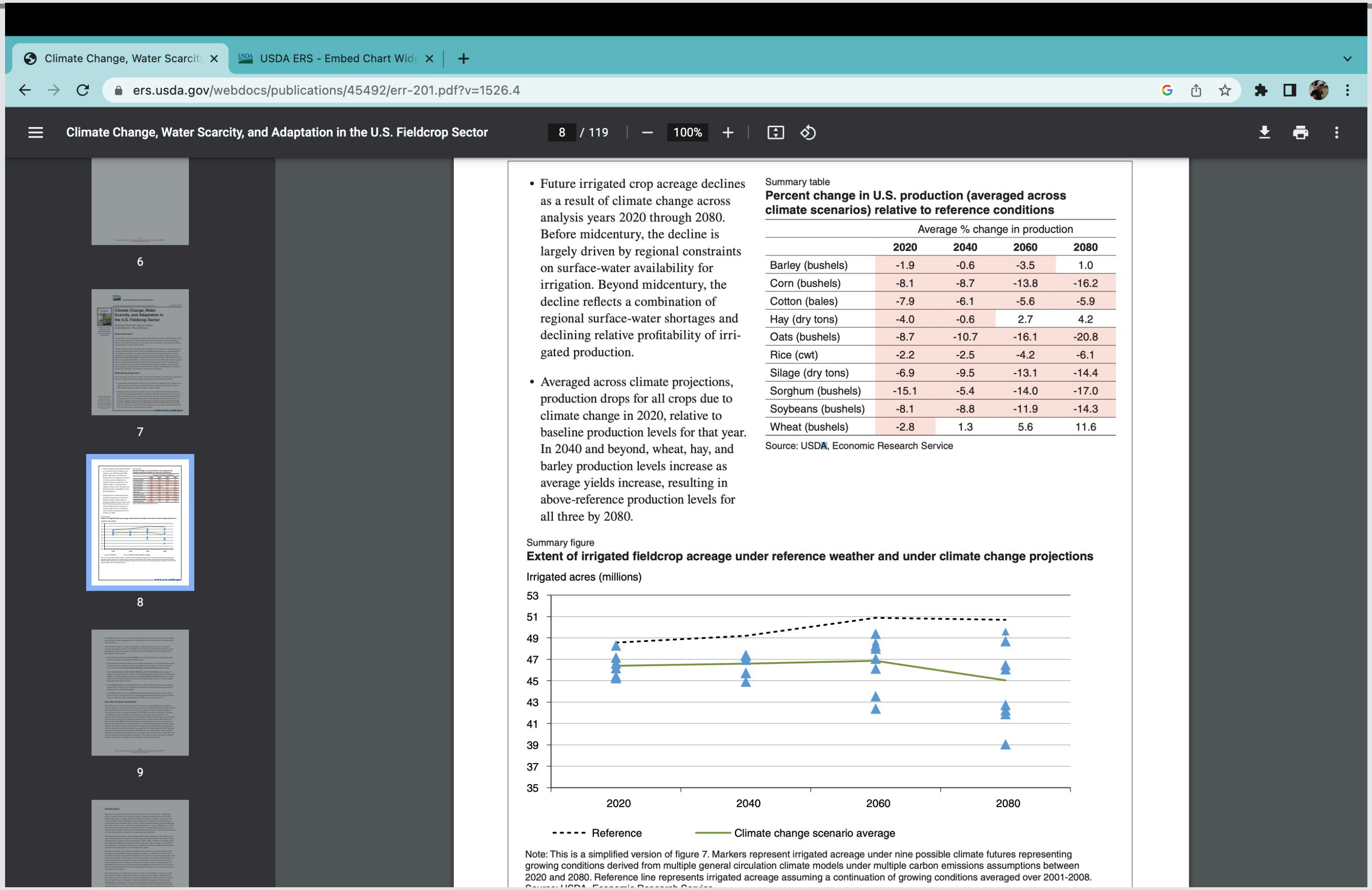
USDA: Conservation tillage, residue management, and cover crops

https://www.sare.org/publications/what-is-sustainable-agriculture/conservation-tillage-and-soil-health/

Regenerative Agriculture

https://farmland.org/regenerative-agriculture-is-a-system-not-a-single-practice%e2%80%af%e2%80%af/

USDA 2015 Report: Climate Change, Water Scarcity, and Adaptation in the US Fieldcrop Sector



- Future irrigated crop acreage declines as a result of climate change across analysis years 2020 through 2080. Before midcentury, the decline is largely driven by regional constraints on surface-water availability for irrigation. Beyond midcentury, the decline reflects a combination of regional surface-water shortages and declining relative profitability of irrigated production.
- Averaged across climate projections, production drops for all crops due to climate change in 2020, relative to baseline production levels for that year. In 2040 and beyond, wheat, hay, and barley production levels increase as average yields increase, resulting in above-reference production levels for all three by 2080.

Summary table

Percent change in U.S. production (averaged across climate scenarios) relative to reference conditions

	Average % change in production			
	2020	2040	2060	2080
Barley (bushels)	-1.9	-0.6	-3.5	1.0
Corn (bushels)	-8.1	-8.7	-13.8	-16.2
Cotton (bales)	-7.9	-6.1	-5.6	-5.9
Hay (dry tons)	-4.0	-0.6	2.7	4.2
Oats (bushels)	-8.7	-10.7	-16.1	-20.8
Rice (cwt)	-2.2	-2.5	-4.2	-6.1
Silage (dry tons)	-6.9	-9.5	-13.1	-14.4
Sorghum (bushels)	-15.1	-5.4	-14.0	-17.0
Soybeans (bushels)	-8.1	-8.8	-11.9	-14.3
Wheat (bushels)	-2.8	1.3	5.6	11.6

Source: USDA, Economic Research Service

Summary figure

Extent of irrigated fieldcrop acreage under reference weather and under climate change projections

Note: This is a simplified version of figure 7. Markers represent irrigated acreage under nine possible climate futures representing growing conditions derived from multiple general circulation climate models under multiple carbon emissions assumptions between 2020 and 2080. Reference line represents irrigated acreage assuming a continuation of growing conditions averaged over 2001-2008.

Field crop production projected to decline

Irrigated acreage projected to decline

Industrial Animal Production: CAFOs

Primary sources of GHG's from concentrated animal feeding operations (about 50% of the total GHG emissions from ag)

- Enteric methane: gut-produced (cow burps)
- Manure management systems: manure ponds generate methane and NOx
- Land application of manure: mostly NOx

Impacts of climate change on animal production

Dairy cattle are sensitive to thermal stress with rising temperatures and humidity

- reduced lactation and milk production
- increased rumen health issues
- difficulty conceiving

Mitigating Animal Production impacts

Anaerobic Biodigestors: cover manure to energy

https://www.epa.gov/agstar/anaerobic-digestion-right-your-farm

Diet supplementation: reducing enteric methane

https://www.agric.wa.gov.au/climate-change/carbon-farming-reducing-methane-emissions-cattle-using-feed-additives

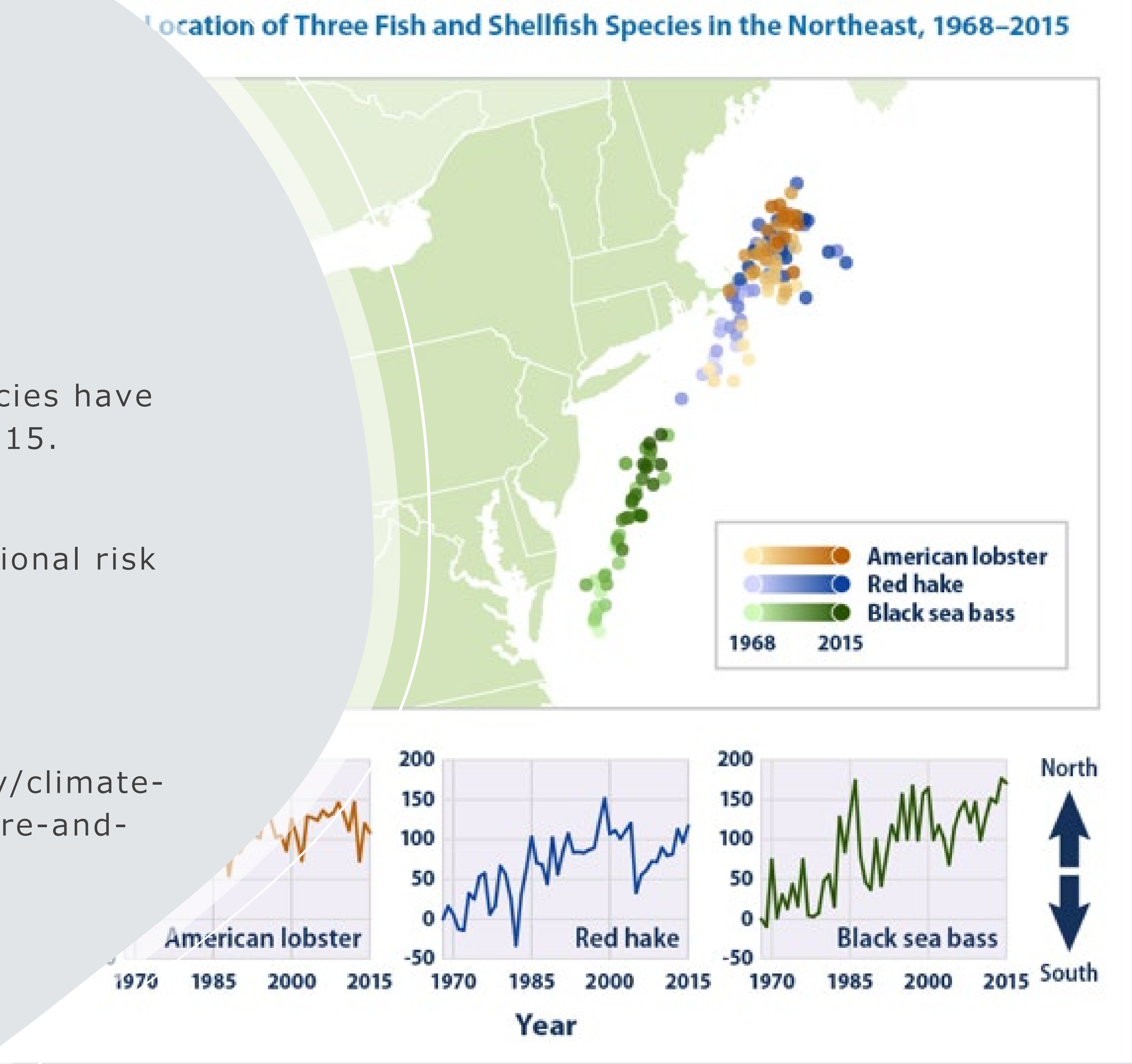
Grass-fed cattle instead of CAFOs

Impact on Fisheries

Three important fish/shellfish species have migrated northward from 1970-2015.

Ocean acidification poses an additional risk particularly to shellfish

https://climatechange.chicago.gov/climate-impacts/climate-impacts-agriculture-and-food-supply#crops



Climate Impacts of Energy Systems

https://www.eia.gov/energyexplained/energy-and-the-environment/where-greenhouse-gases-come-from.php

Renewables and nuclear also have a carbon footprint

- resource extraction: aluminum, silicon, uranium
- manufacturing
- transportation

Climate impacts on energy systems

This is really complicated to model…

- physical impacts of extreme weather
- changing patterns of consumption
- population growth and migration
- water availability
- raw material availability and distribution

Climate Impacts of Buildings

Globally, in 2019, buildings and construction accounted for:

- 36% of all energy use
- 39% of energy- and process-related CO_2 emissions
- *11% of emissions came from manufacturing of building materials such as glass, steel, and cement*

https://www.iea.org/reports/global-status-report-for-buildings-and-construction-2019

Climate impacts on the built environment

- Stress and damage to infrastructure
- Urban heat islands
- Logistical challenges: impacts to supply and distribution of goods
- Air and water quality impacts
- Environmental justice issues: these problems disproportionately affect lower-income and minority communities
- https://www.epa.gov/climateimpacts/climate-change-impacts-built-environment#impacts

Reducing climate impacts of and on the built environment: climate resilience

https://www.gensler.com/blog/how-the-built-environment-can-help-the-climate-crisis

Renewable energy sources

High-density development

Mass transit

Using buildings as energy sources, water purification systems, water catchments…so many possible uses for buildings to help make urban areas more climate-friendly