Vermont Agriculture & Climate Change

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Vermont Agency of Agriculture, Food and Markets
Presentation to: Senate Committee on Natural Resources & Energy
January 10, 2024

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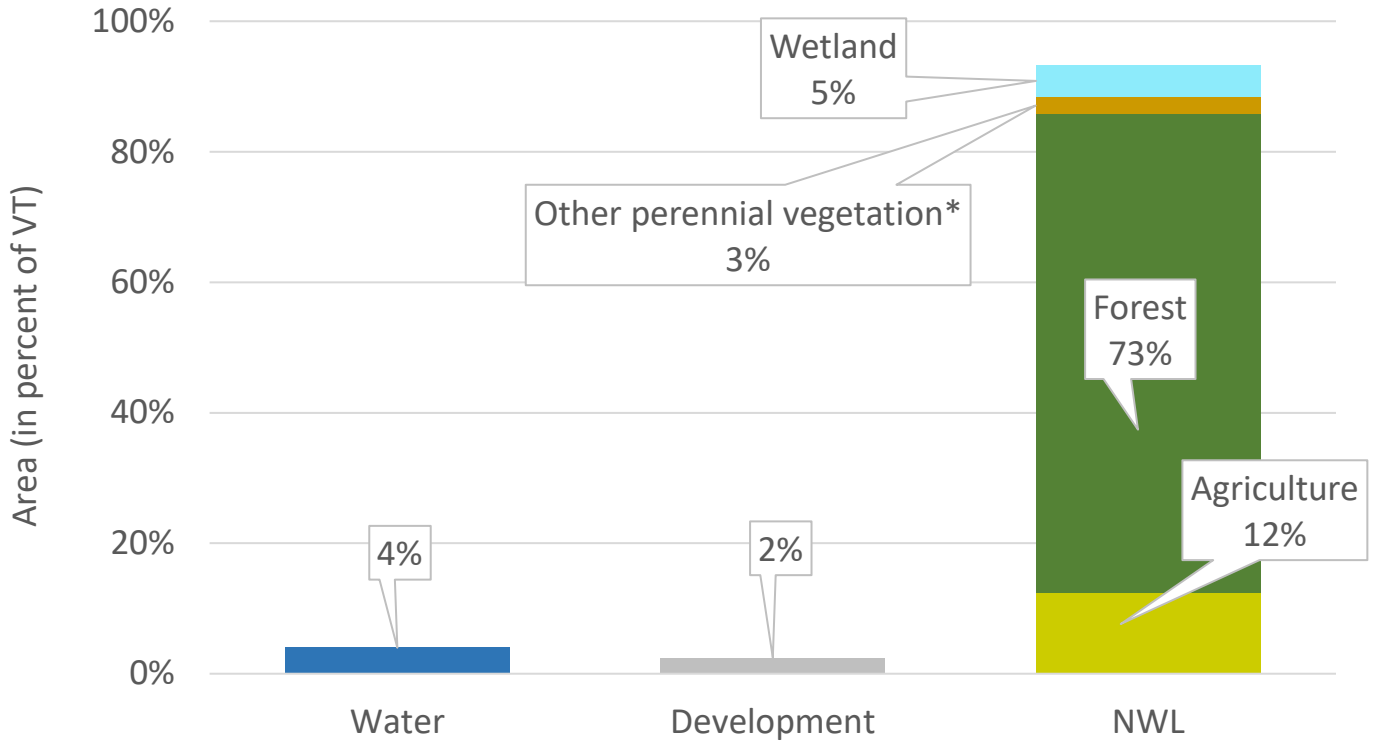
Natural & Working Lands (NWL) cover 94% of Vermont



*Other perennial vegetation includes grasslands, shrub/scrublands, and turf

Data source: 2016 National Land Cover Database; Images courtesy FPR

Ag Land Management

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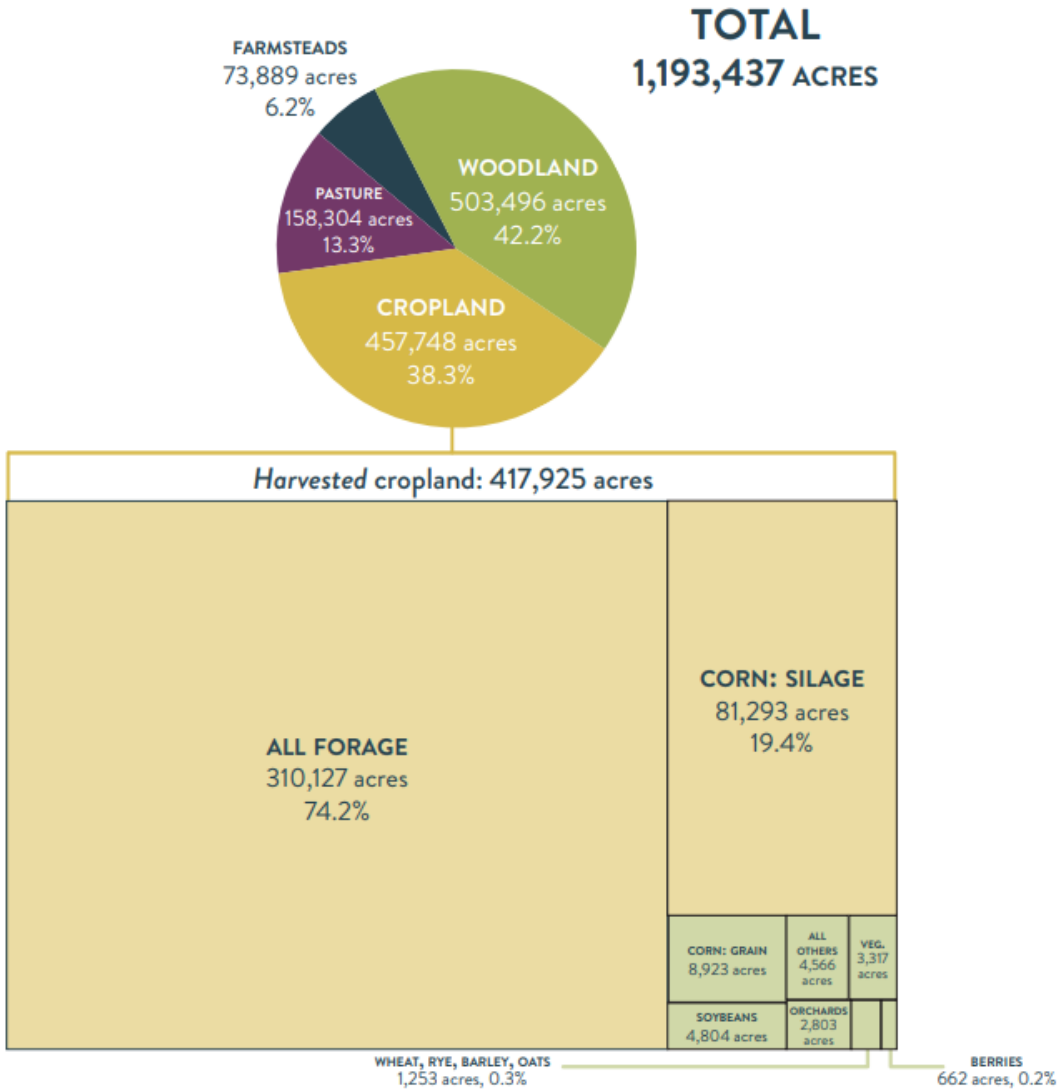
Land in Agriculture



#1 Vermont had the highest agricultural sales of any New England state, largely due to milk production.

47% In 2021, Vermont produced almost half of the country's maple syrup (1.75 million gallons)

-64% Cropland decreased from 1.3 million acres in 1945 to 458,000 acres in 2017

-85% Pastureland decreased from 1.0 million acres in 1945 to 158,000 acres in 2017

END USES

- ANIMAL FEED
- EDIBLE

Source: https://nefoodsystemplanners.org/wp-content/uploads/NEFNE-VERMONT-State-Brief.pdf

The Vermont Statehouse

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WATER QUALITY DIVISION

From: State Curator's Office, BGS. Retrieved from: https://curator.vermont.gov/sites/curator/files/styles/slideshow_image_only/public/images/image_only_slides/historic-state-house-780x450.jpg?itok=lXOLbhmj

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Vermont is Getting Warmer and Wetter: Climate Change Study

The Green Mountain State has warmed nearly 2°F, with a 21% jump in precipitation

Key findings

Climate change is here – and impacting communities across Vermont.

Vermont is getting warmer. Winters are warming more quickly. Snow season is getting shorter.

Vermont is getting wett Heavy rain events happe more often, contributing more flooding and wate quality problems.

Multiple, complex impacts could lead to surprises.

Climate impacts and risks will increase without action.

Dig in to learn more...

Source: The Vermont Climate Assessment 2021. Burlington, Vermont: Gund Institute for Environment at the University of Vermont. On the web: https://vtclimate.org

National and Vermont Climate Impacts

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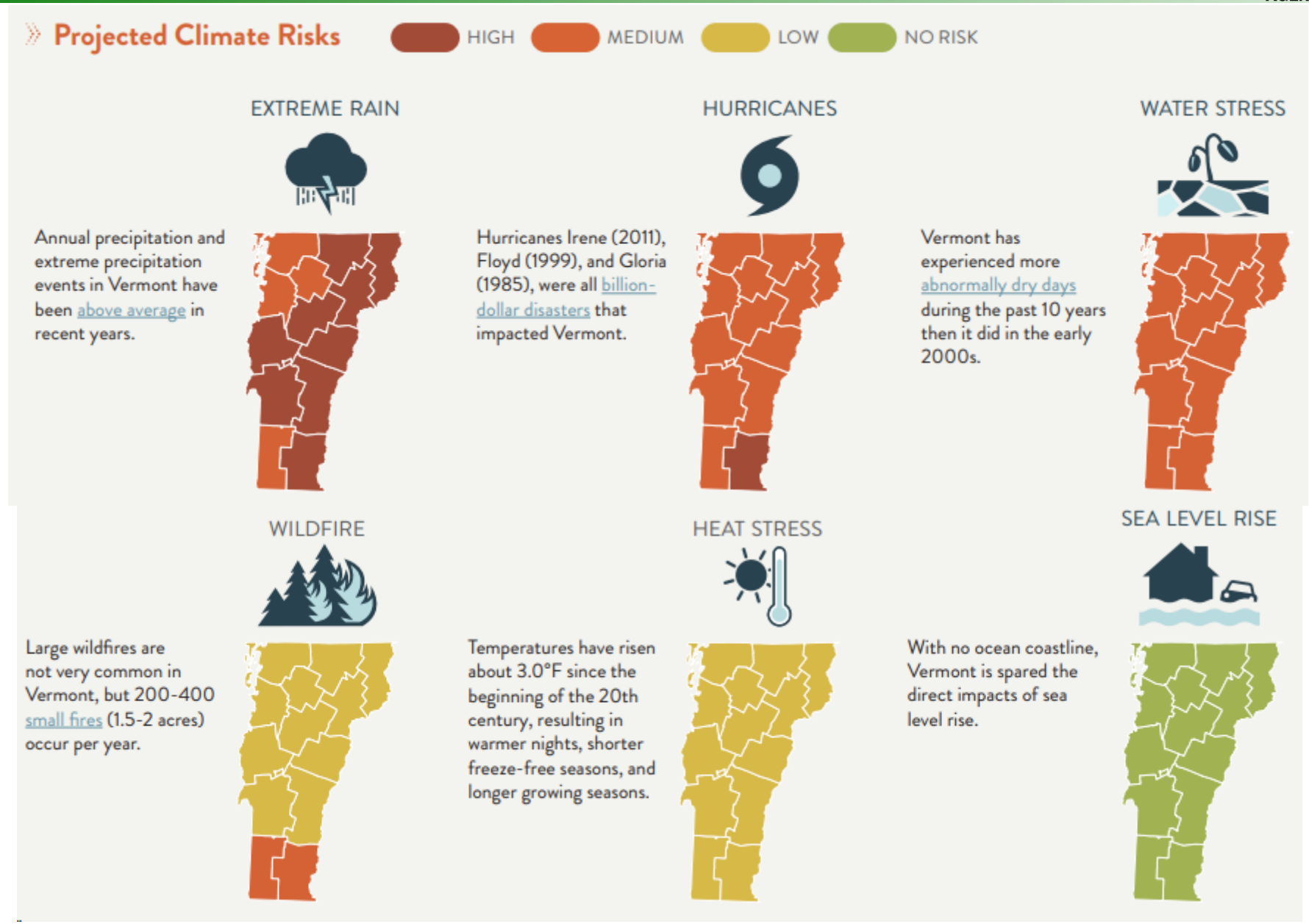

Source: https://nefoodsystemplanners.org/wp-content/uploads/NEFNE-VERMONT-State-Brief.pdf

National and Vermont Climate Impacts

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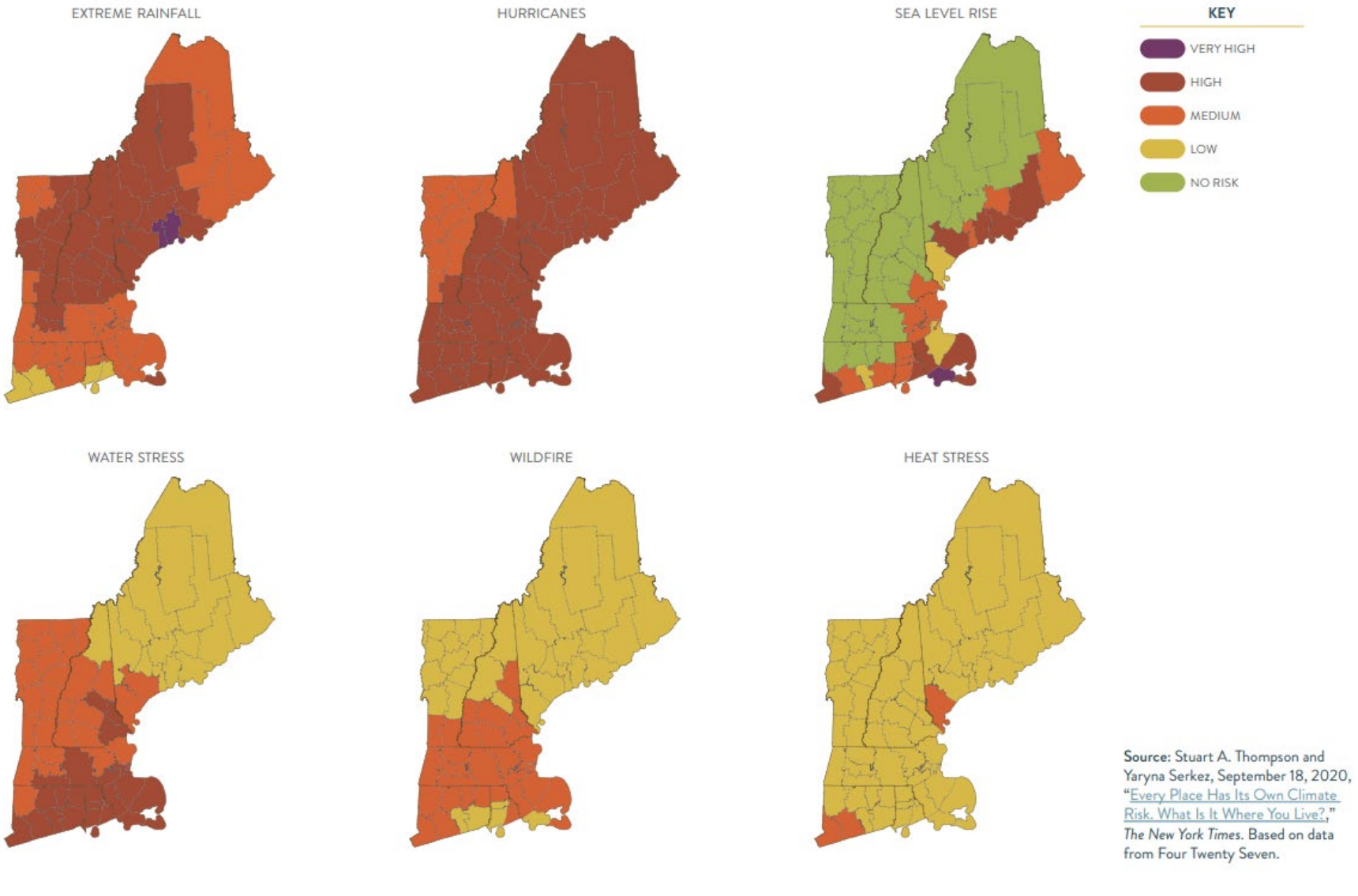
FIGURE 6: Projected Climate Change Risks by New England County



Source: Stuart A. Thompson and Yaryna Serkez, September 18, 2020, "Every Place Has Its Own Climate Risk. What Is It Where You Live?," *The New York Times*. Based on data from Four Twenty Seven.

Source: https://nefoodsystemplanners.org/wp-content/uploads/NEFNE_Common-Food-System-Challenges.pdf

National and Vermont Climate Impacts

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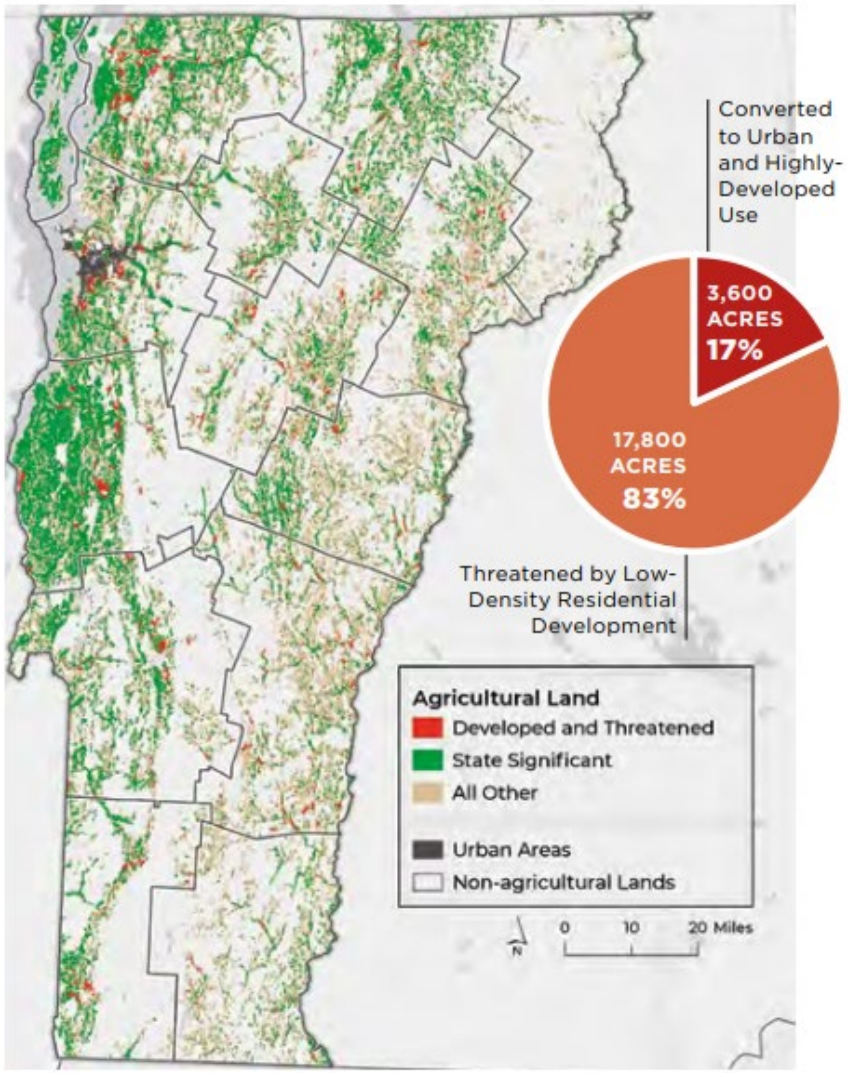


Projected Changes in Land in Agriculture, Business as Usual Scenario

TOTAL

1,193,437 ACRES EXISTING ACREAGE
-41,200 ACRES BUSINESS AS USUAL SCENARIO

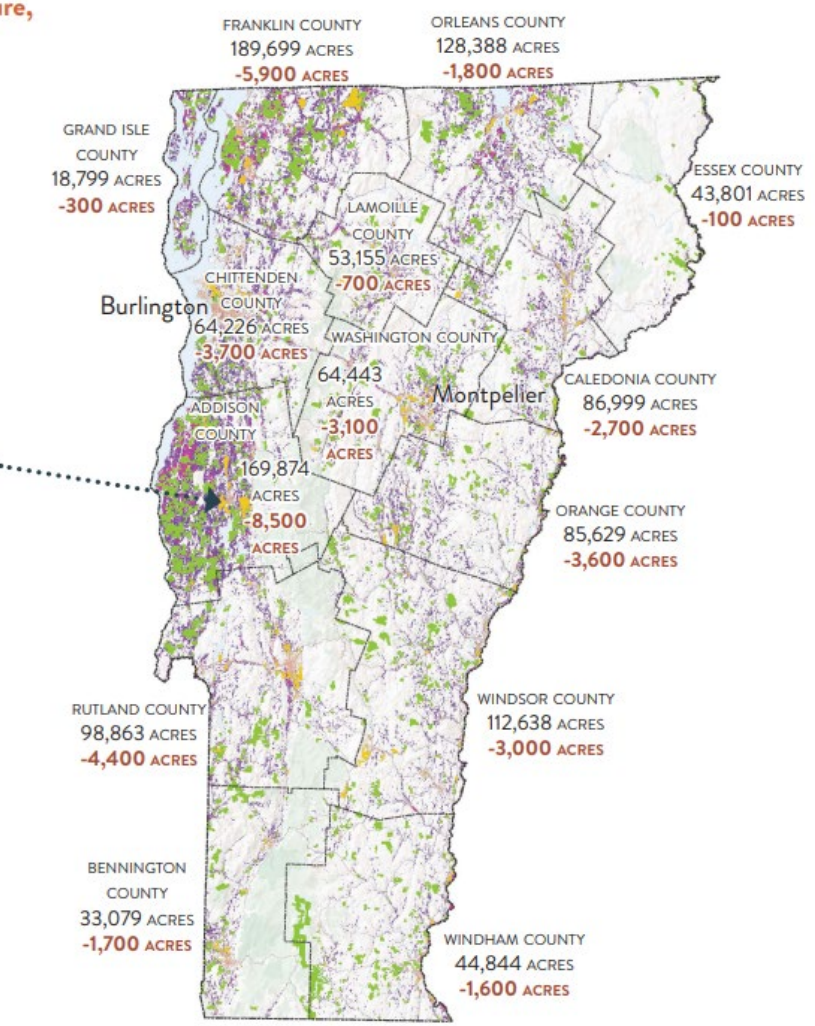
LAND USES

- CULTIVATED CROPS
- PASTURE/HAY
- EASEMENT
- DEVELOPED LAND
- PROJECTED URBAN AND HIGHLY DEVELOPED AND LOW-DENSITY RESIDENTIAL

An analysis from the American Farmland Trust (AFT) estimates that Vermont could lose an additional **41,200 acres** by 2040 under a "Business as Usual" development scenario and **61,800 acres** under a "Runaway Sprawl" scenario.

AFT projects that **Addison, Franklin,** and **Rutland** counties will experience the biggest decreases in land in agriculture.

Source: American Farmland Trust, Farms Under Threat 2040: Choosing an Abundant Future



20.5% Vermont has the highest percentage of agricultural land as a percentage of total land area, 20.5%, of any state in New England, but only a small percentage of agricultural land is used for crops to directly feed people.

Source: https://nefoodsystemplanners.org/wp-content/uploads/NEFNE-VERMONT-State-Brief.pdf
Source: https://farmlandinfo.org/wp-content/uploads/sites/2/2020/10/AFT_NE_FUT-10_14_20_rev.pdf

National and Vermont Climate Impacts

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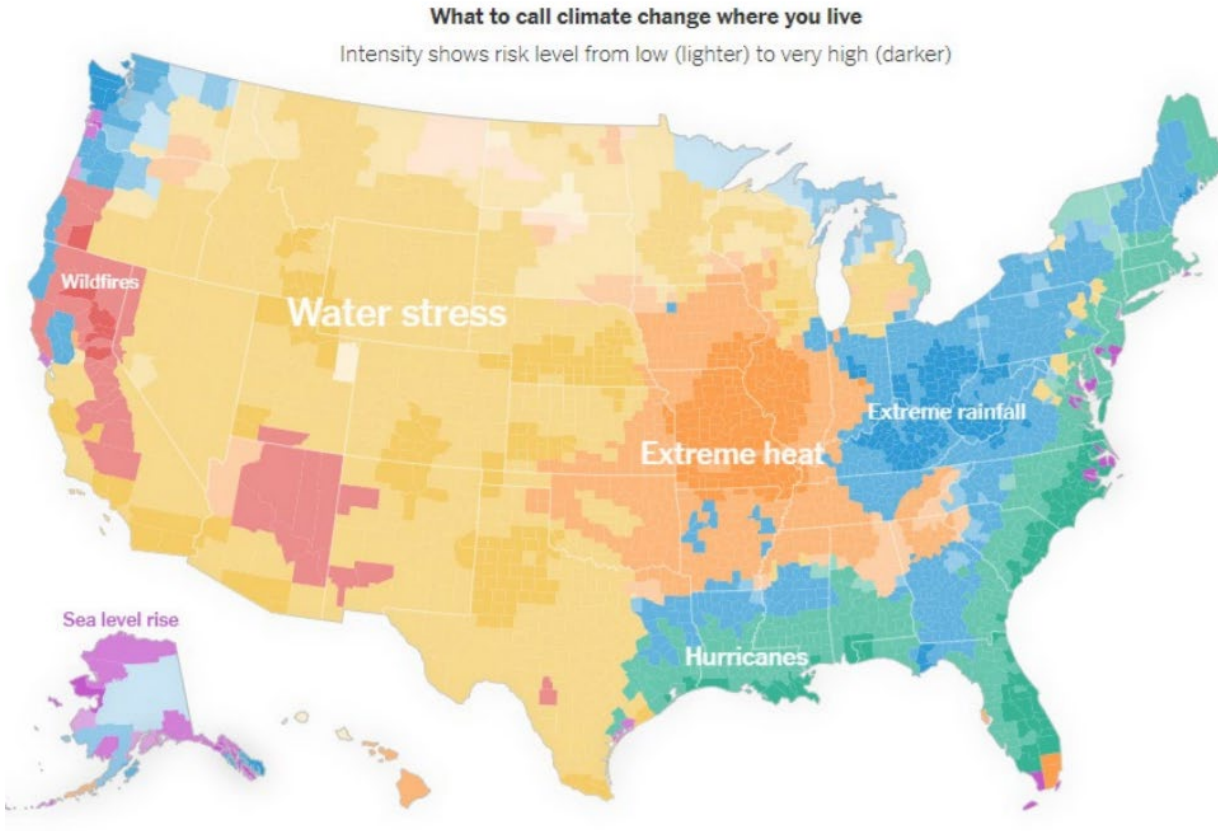

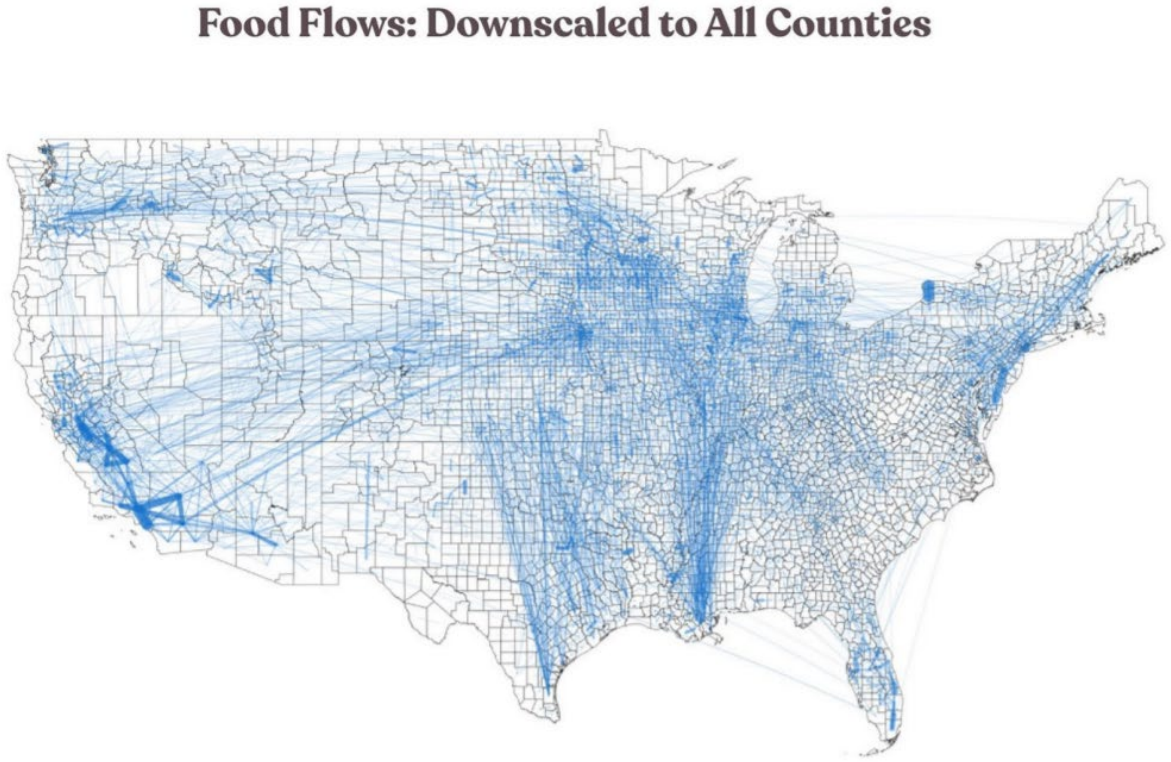

Source: Ellen Kahler, VSJF Presentation to House Agriculture:
https://legislature.vermont.gov/Documents/2022/WorkGroups/House%20Agriculture/Food%20Security/W~Ellen%20Kahler~New%20England%20Feeding%20New%20England-%20Cultivating%20a%20Reliable%20Food%20Supply~1-26-2021.pdf

Can the 6 New England states provide 30% of their food from regional farms and fisheries by 2030?

Volume 2

Could the six New England states meet a goal of supplying 30% of the region's food by 2030?

NEW ENGLAND'S FARMERS + FISHERMEN COULD MEET **30%** OF SERVINGS FOR A POPULATION GROWING FROM **15.3** MILLION TO **15.6** MILLION THIS WOULD REQUIRE MAXIMIZING USE OF **401,000** EXISTING UNDERUTILIZED ACRES + **588,000** *ADDITIONAL* ACRES OF CLEARED LAND

New England Regional Self-Reliance for Major Food Groups

	GRAINS	VEGETABLES	FRUITS	DAIRY	PROTEINS
Servings	1.6%	28.3%	8.7%	50.0%	3.2%
Calories	1.7%	41.0%	6.9%	47.4%	2.6%

Source: Volume 2: Estimating Production for 30% Regional Self-Reliance. *Note: vegetables consists of a significant amount of calorie-dense potatoes grown in Maine; dairy includes a significant amount of production in Vermont.*

Source: https://nefoodsystemplanners.org/wp-content/uploads/NEFNE_Executive-Summary.pdf
Source: https://nefoodsystemplanners.org/wp-content/uploads/NEFNE-VERMONT-State-Brief.pdf

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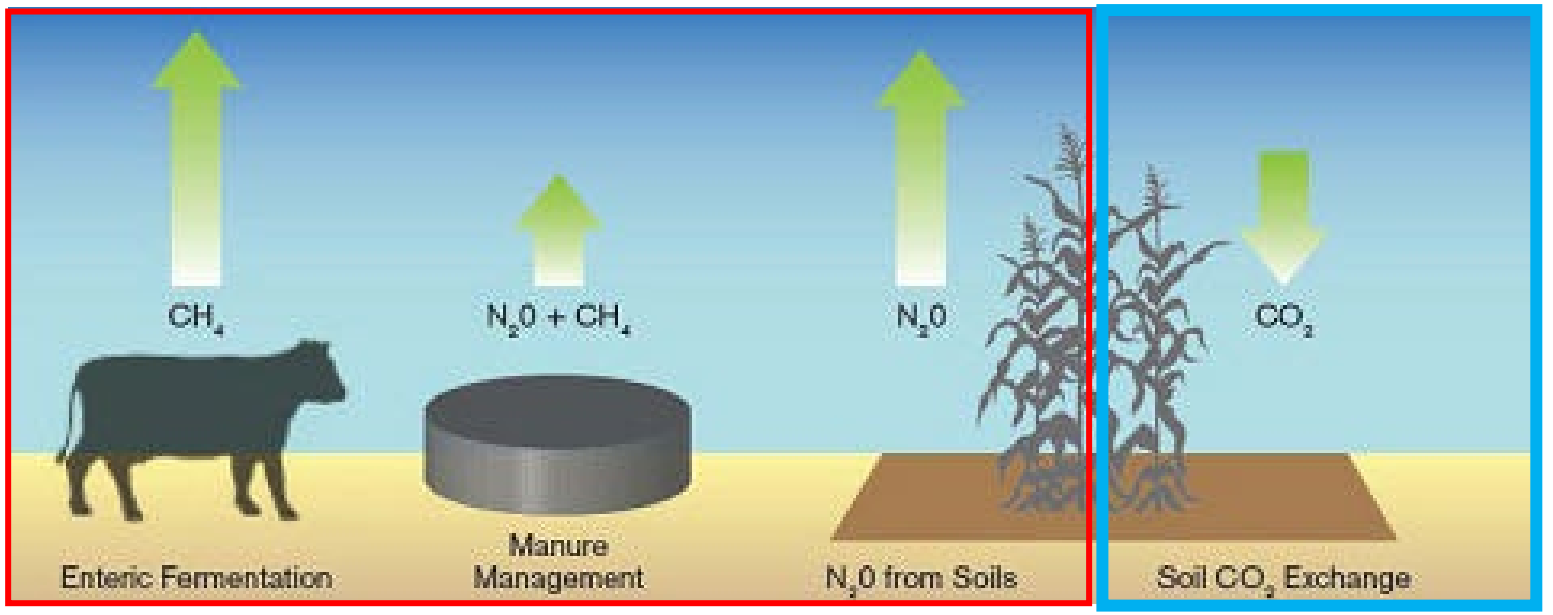
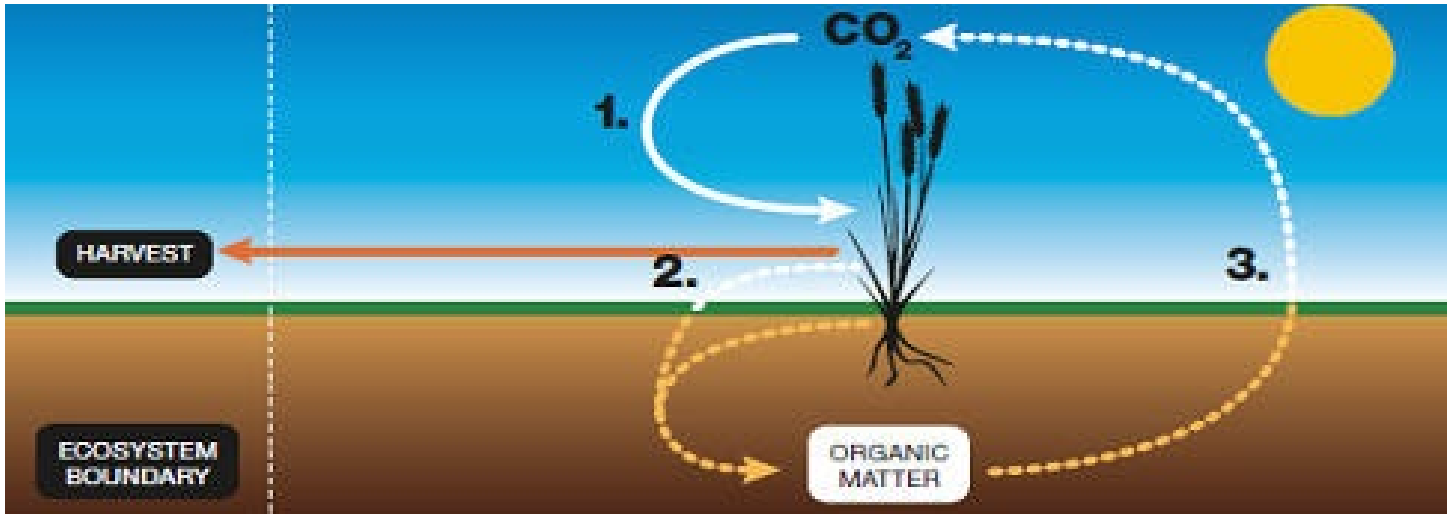
WATER QUALITY DIVISION

GHG Emissions & Sequestration



Carbon Cycle



Source: https://www.agr.gc.ca/eng/agriculture-and-the-environment/agricultural-practices/climate-change-and-agriculture/greenhouse-gases-and-agriculture/?id=1329321969842

GHG Emissions & Sequestration

Vermont GHG Emission Inventory

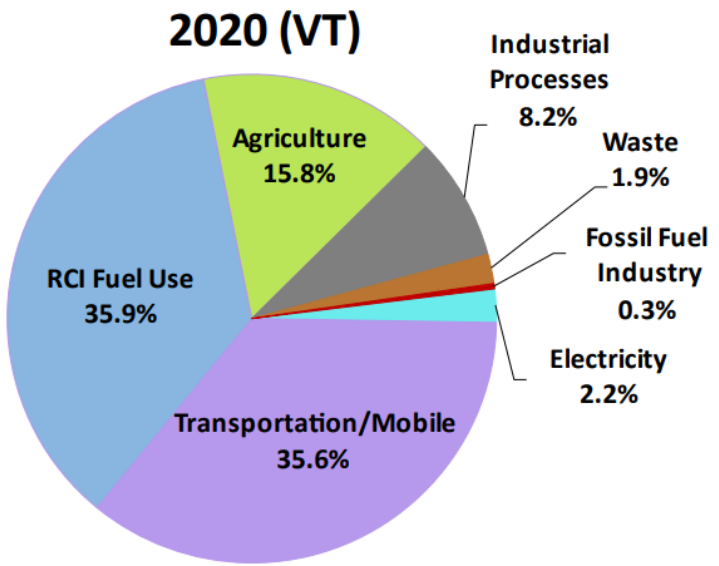
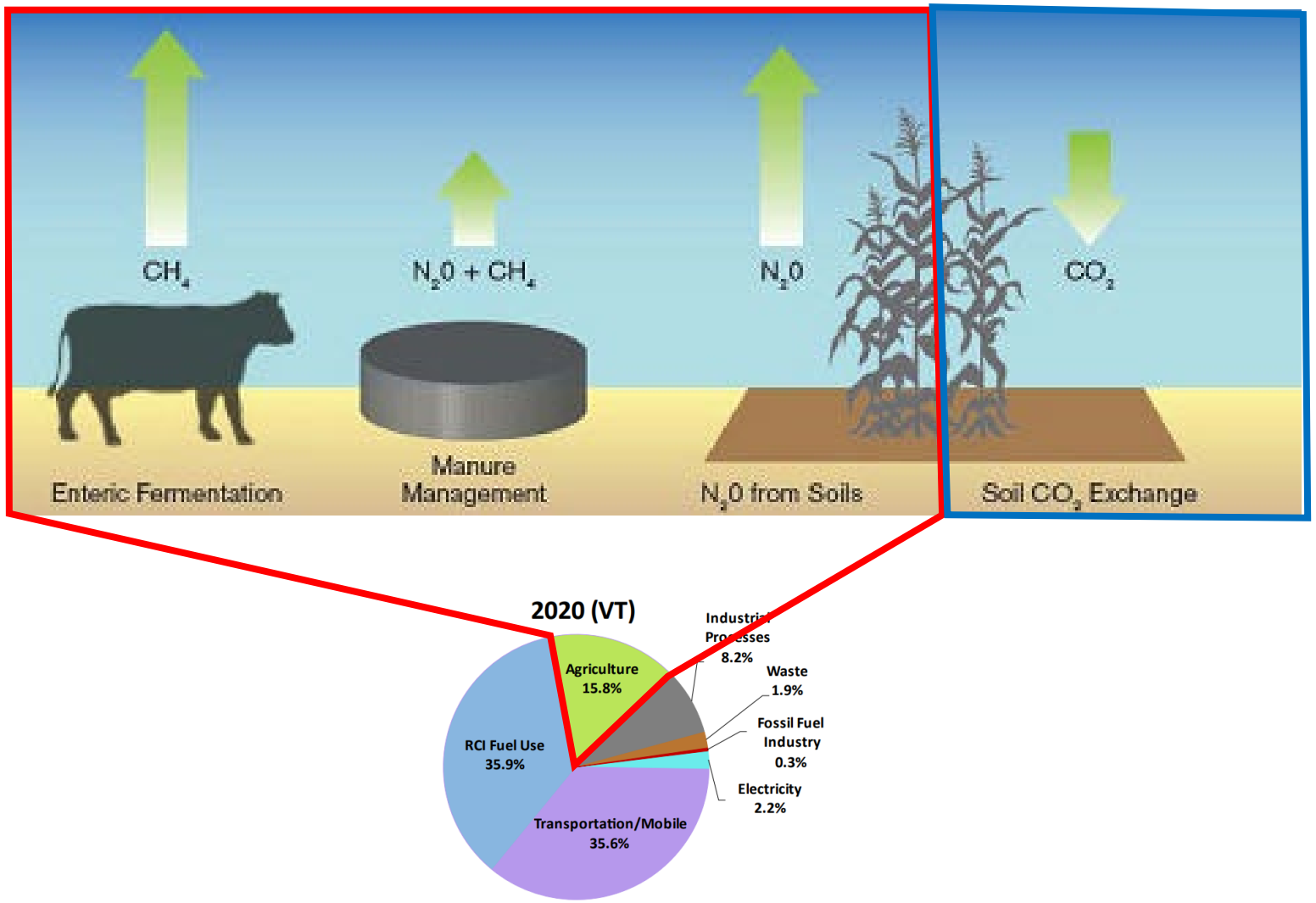


Figure 2: Vermont GHG percent contributions by sector.

Source: https://www.agr.gc.ca/eng/agriculture-and-the-environment/agricultural-practices/climate-change-and-agriculture/greenhouse-gases-and-agriculture/?id=1329321969842
Source: https://outside.vermont.gov/agency/anr/climatecouncil/Shared%20Documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_Update_1990-2020_Final.pdf

GHG Emissions & Sequestration



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Vermont's Current Greenhouse Gas (GHG) Emissions Profile: Agriculture

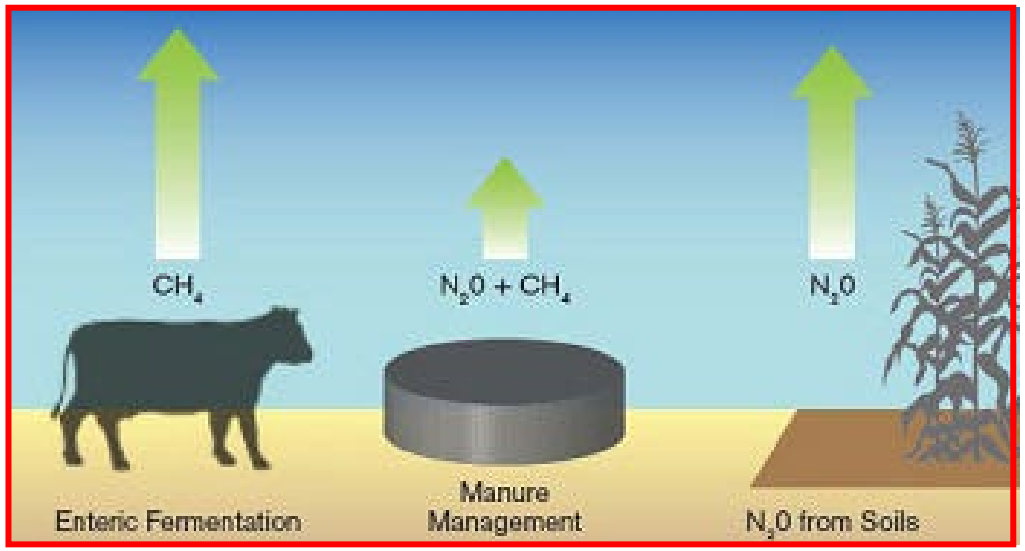

Table 6: GHG emissions contributions of subsectors within the agriculture sector.

Sector	Emissions in $MMTCO_2e$					
	1990	2005	2017	2018	2019	2020
Agriculture	**1.24**	**1.27**	**1.40**	**1.40**	**1.38**	**1.26**
Enteric Fermentation (CH_4, N_2O)	*0.70*	*0.63*	*0.64*	*0.64*	*0.63*	*0.61*
Manure Management (CH_4, N_2O)	*0.18*	*0.33*	*0.35*	*0.36*	*0.35*	*0.33*
Agricultural Soils (CH_4, N_2O)	*0.36*	*0.30*	*0.35*	*0.36*	*0.37*	*0.29*
Liming and Urea Fertilization (CO_2)	*0.00*	*0.00*	*0.05*	*0.04*	*0.04*	*0.03*

Source: https://www.agr.gc.ca/eng/agriculture-and-the-environment/agricultural-practices/climate-change-and-agriculture/greenhouse-gases-and-agriculture/?id=1329321969842
Source: https://outside.vermont.gov/agency/anr/climatecouncil/Shared%20Documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_Update_1990-2020_Final.pdf

Data Units for Tracking Emissions

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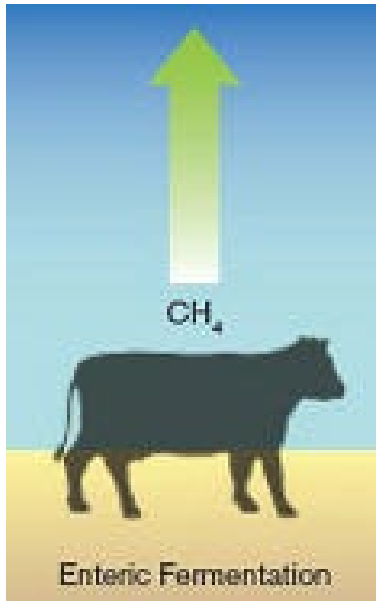
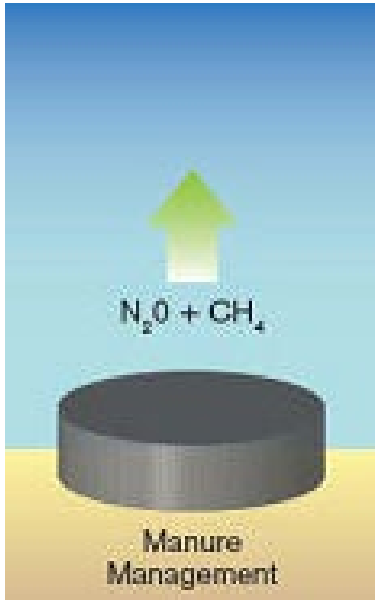


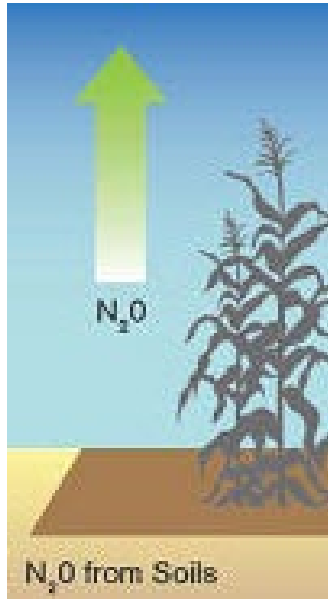
Enteric Fermentation:

1. Animal numbers
2. Type of animal (examples)
   a. Dairy cow
   b. Heifer
   c. Beef cow
   d. Hog
3. Size of cow
4. Milk production values



Manure Storage ("Management")

1. Storage type (examples)
   a. Anaerobic Lagoon
   b. Liquid/Slurry
   c. Daily Spread
   d. Solid Storage
2. Amount of manure stored
3. Duration manure is stored



Agricultural Soils

1. Manure Direct N2O Emissions - Manure Applied to Soils (including Daily Spread)
2. Manure Direct N2O Emissions - Pasture, Range, and Paddock
3. Manure Indirect & Runoff
4. N-Fixing Crops [acres]

Source: https://www.epa.gov/system/files/documents/2023-06/Ag%20Module%20User%27s%20Guide_508.pdf

& fertilizer….

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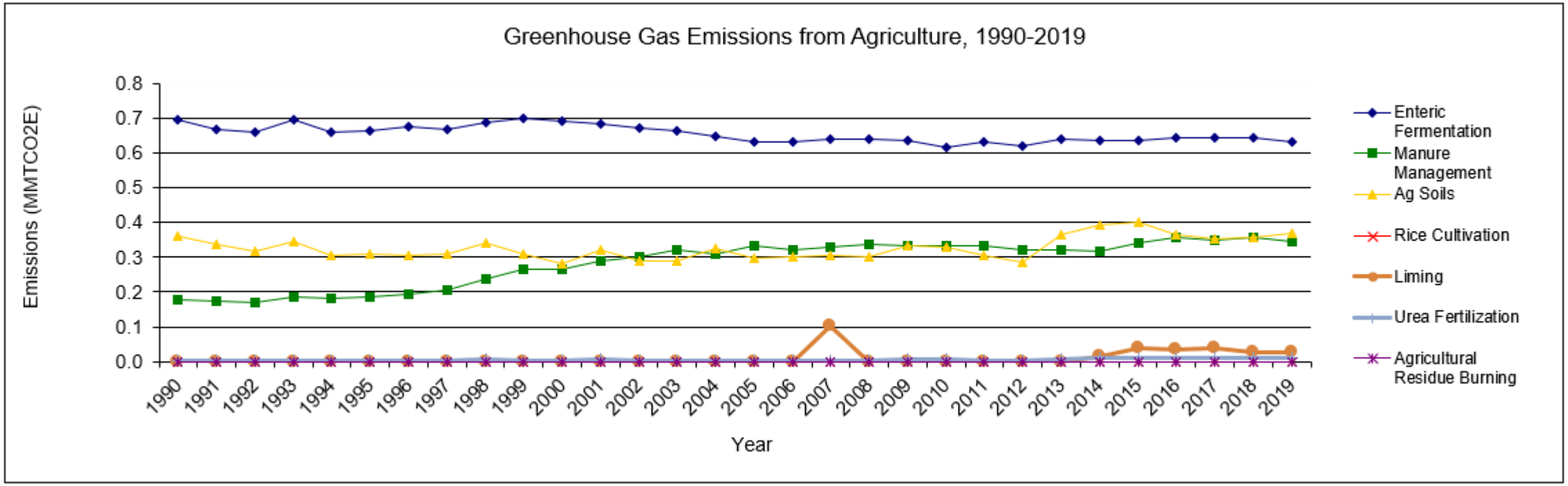

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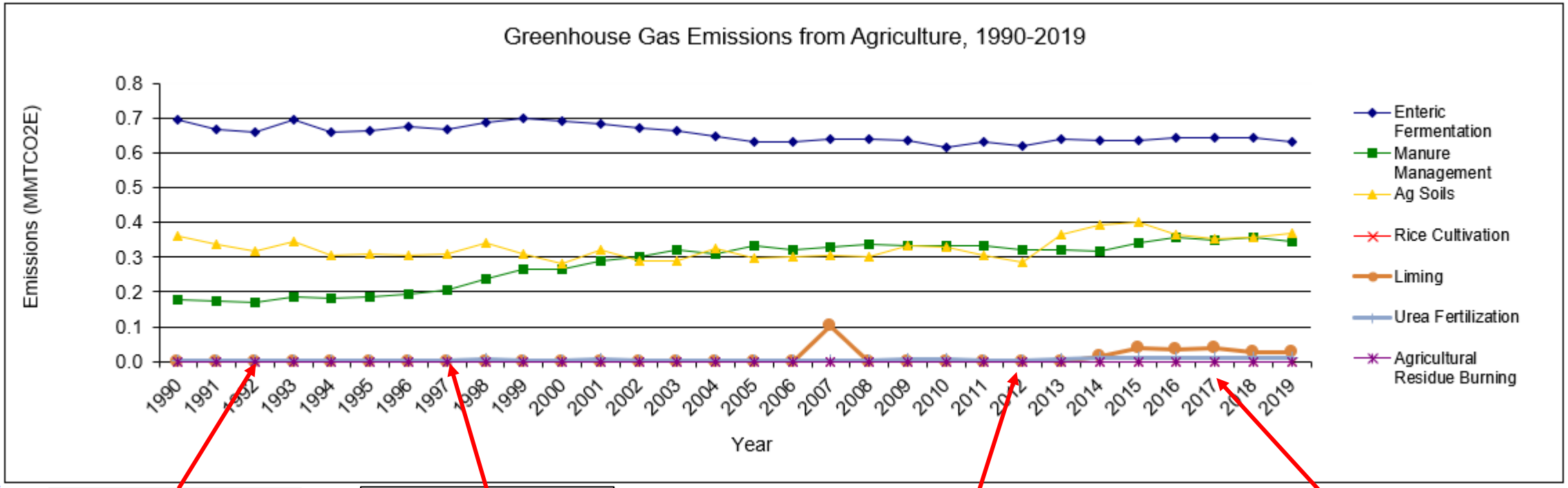


1992
Cows: 296,250

Harvested Cropland: 477,020 acres

Milk Produced: 2,510 MM lbs

1997
Cows: 290,509

Harvested Cropland: 465,489 acres

Milk Produced: 2,600 MM lbs

2012
Cows: 274,251

Harvested Cropland: 446,020 acres

Milk Produced: 2,596 MM lbs

2017
Cows: 254,796

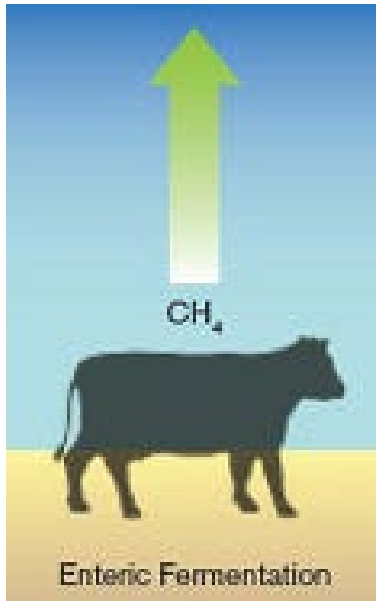
Harvested Cropland: 417,925 acres

Milk Produced: 2,729 MM lbs

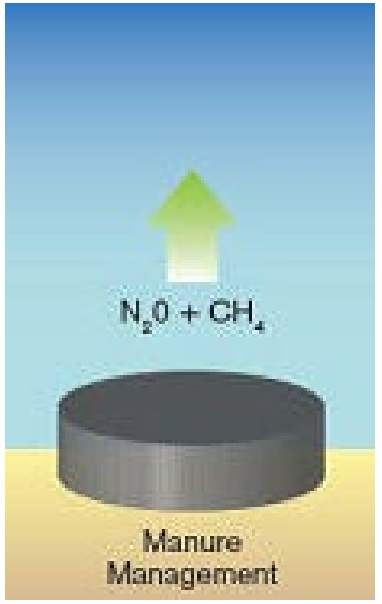
Source: https://www.epa.gov/system/files/documents/2023-06/Ag%20Module%20User%27s%20Guide_508.pdf

Source: USDA NASS Census of Agriculture – Vermont: 1992, 1997, 2012, 2017

GHG Emission Reduction Practices in SIT



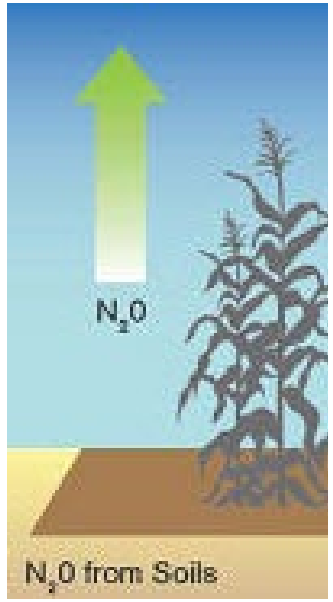
Enteric Fermentation – 49% of Emissions



Manure Storage – 26% of Emissions

1. Digesters – 90% emission reduction

Are 14 digesters in VT reducing emissions of over 17,000 animals. 74,2814 MT of CO_2-e reduced per year. 25,191,750 kWh/yr generated electricty + RNG.



Agricultural Soils – 23% of Emissions

& fertilizer…. @ 2%

GHG Mitigation Reduction Practices in Agriculture

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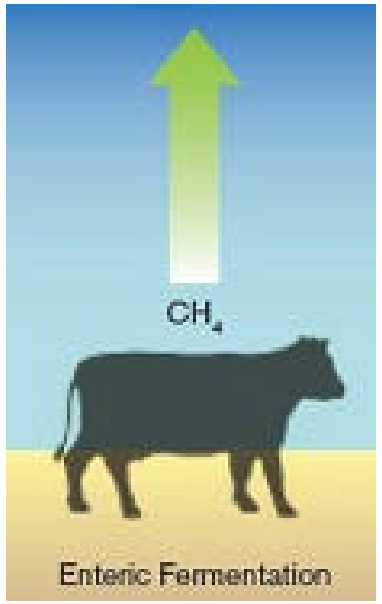
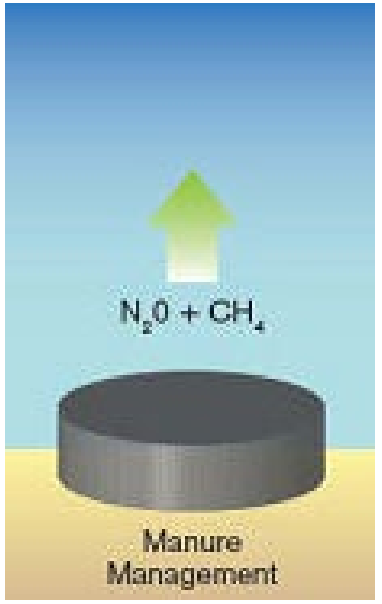


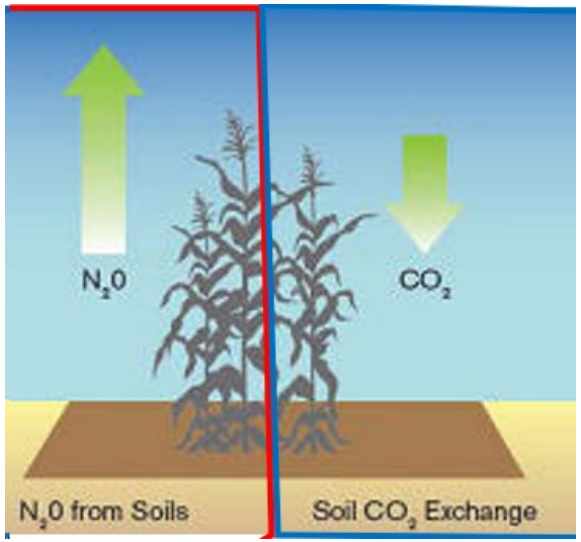
Example Mitigation Strategies being explored:

1. High forage diets
2. Kelp
3. Grazing



Example Mitigation Strategies:

1. Digesters
2. Grazing
3. Composting of livestock manure



Example Mitigation Strategies:

1. Reduced Tillage
2. Cover Crop
3. Crop Rotation

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WATER QUALITY DIVISION

EPA SIT & National Inventory Currently Two Chapters

SIT Chapter 5

EPA SIT	Category	GHG	VT	DEC
	Agriculture (emissions)			
2	**Enteric Fermentation**	CH4	Yes	Yes
3	**Manure Management**	CH4, N2O	Yes	Yes
4	**Agriculture Soils**	N2O		
4a	**Plant Residues & Legumes**	N2O	Yes	Yes
	Histosols (conversion)	N2O	Yes	No
4b	**Plant Fertilizers**	N2O	Yes	Yes
4c	**Animal Calculation Values**	N2O	Yes	Yes
5	**Rice Cultivation**	CH4	No	No
6	**Liming of Soils**	CO2	Yes	Yes
7	**Urea Fertilization**	CO2	Yes	Yes
8	**Ag Residue Burning**	CH4, N2O	No	No

SIT Chapter 6

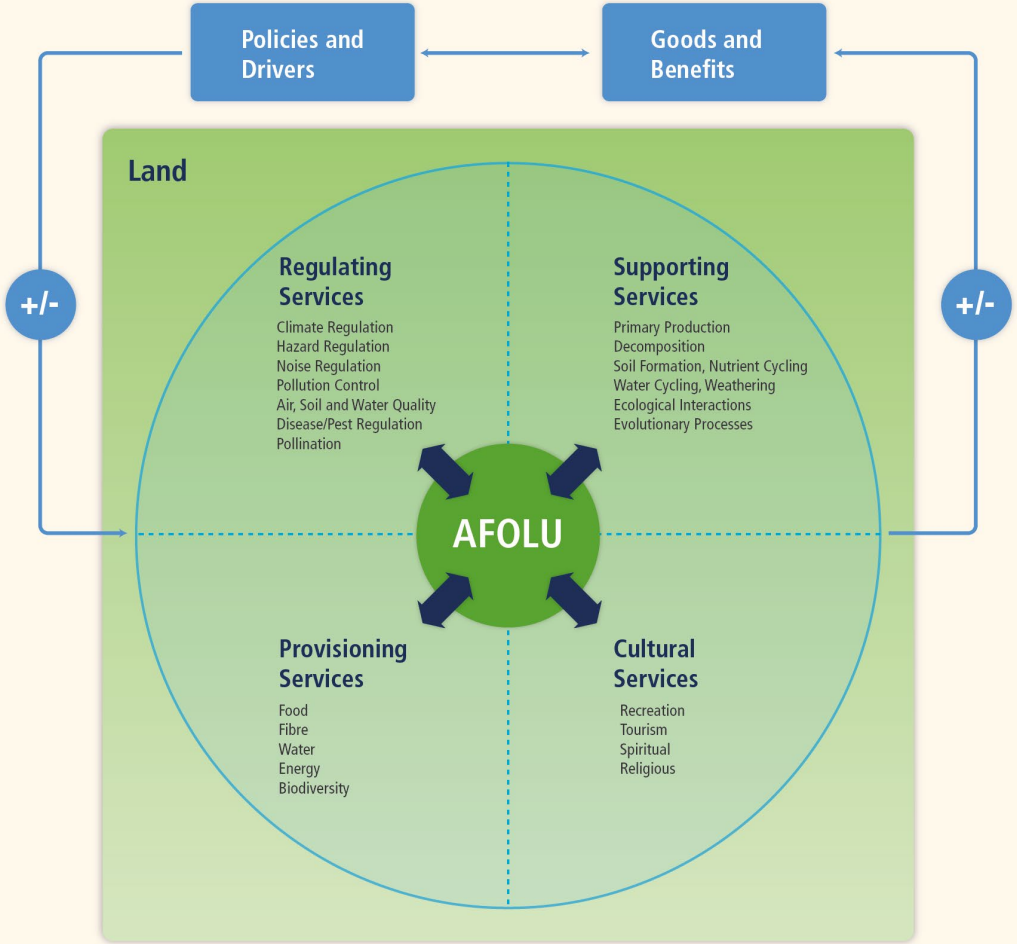
EPA SIT	Category	GHG	VT	DEC
	Land Use, Land-Use Change, and Forestry (sequestration)			
7	**Ag Soil Carbon Flux** (Cropland and Grassland)		Yes	No
	Cropland Remaining Cropland			
	Land Converted to Cropland			
	Grassland Remaining Grassland			
	Land Converted to Grassland			
2	**Forest Carbon Flux**	flux	Yes	No
2a	Forest Remaining Forest			
	Land Converted to Forest			
	Forest Converted to Land			
3	**C Storage in Urban Trees**	storage	Yes	Yes
4	**Settlement Soils** (developed land	N2O	Unknown	No
5	**Forest Fires**	CH4, N2O	No	No
6	**Food Scraps & Yard Trimmings** (la	flux	Unknown	No

Source: https://www.epa.gov/sites/default/files/2018-01/documents/2018_complete_report.pdf

Agriculture, Forestry and Other Land Use (AFOLU)

Executive Summary

Agriculture, Forestry, and Other Land Use (AFOLU) is unique among the sectors considered in this volume, since the mitigation potential is derived from both an enhancement of removals of greenhouse gases (GHG), as well as reduction of emissions through management of land and livestock (*robust evidence; high agreement*). The land provides food that feeds the Earth's human population of ca. 7 billion, fibre for a variety of purposes, livelihoods for billions of people worldwide, and is a critical resource for sustainable development in many regions. Agriculture is frequently central to the livelihoods of many social groups, especially in developing countries where it often accounts for a significant share of production. In addition to food and fibre, the land provides a multitude of ecosystem services; climate change mitigation is just one of many that are vital to human well-being (*robust evidence; high agreement*). Mitigation options in the AFOLU sector, therefore, need to be assessed, as far as possible, for their potential impact on all other services provided by land. [Section 11.1]



Source: https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter11.pdf
Image Source: https://www.ipcc.ch/site/assets/uploads/2018/02/01_figure_11.1.png

IPCC AR5 Revised Ag & LULUCF to a Single Chapter

IPCC AR4 (IPCC WGIII, 2007)
Agricultural and forestry mitigation were dealt with in separate chapters

IPCC AR5
First time - the terrestrial land surface, comprising agriculture, forestry and other land use (AFOLU), is considered together in a single chapter.

- Ensure all land based mitigation options can be considered together
- Minimise the risk of double counting or inconsistent treatment (e.g. different assumptions about available land)
- Consider systemic feedbacks between mitigation options related to the land surface

Working Group III contribution to the IPCC Fifth Assessment Report

ipcc INTERGOVERNMENTAL PANEL ON climate change 2 WMO UNEP

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Section 1.1, Page 1.4
Source: https://unfccc.int/sites/default/files/3_tubiello_sbsta-ipcc_special_event_6june.pdf

ANR Contract to Improve State Inventory

- Focus on improving State Inventory (statewide scale) – incorporating management, checking alignment with IPCC standards
- Researching/reviewing other inventory tools
- Current tool seems most feasible, but hope to add management strategies to **Enteric Fermentation** and **Manure Storage** to make more accurate and provide strategies other than reducing number of animals
- Funded by US Climate Alliance

AAFM contract to quantify emission reduction *and* sequestration from practices implemented

- Focus on agricultural *soils* (cropland, pasture)
- Focus on quantifying emissions and *sequestration*
- Focus on quantifying *management* changes (conservation practices)
- Focus on *farm*-scale
- Funded by USDA NRCS-VT through CIG program

TNC Canada: N&WL NCS GHG Mitigation Opportunities

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WATER QUALITY DIVISION

Source: C Ronnie Drever et al., Natural Climate Solutions for Canada, 7 Science Advances 1 (2021)
Source: https://www.natureunited.ca/what-we-do/our-priorities/innovating-for-climate-change/natural-climate-solutions/

Methods for Growing Crops have different outcomes

Management:

Full width tillage
No Nutrient Management
No Field specific conservation practices

Management:	USDA COMET ERCs:
Cover crop	0.15 tons CO_2e/ac/yr
Reduced and No-Till technology	0.19 tons CO_2e/ac/yr
Nutrient Management	0.37 tons CO_2e/ac/yr
Riparian Buffers	0.74 tons CO_2e/ac/yr
Crop Rotation	0.22 tons CO_2e/ac/yr

Source: https://comet-planner.com

Acres

294,947 Acres of Conservation Practices Implemented

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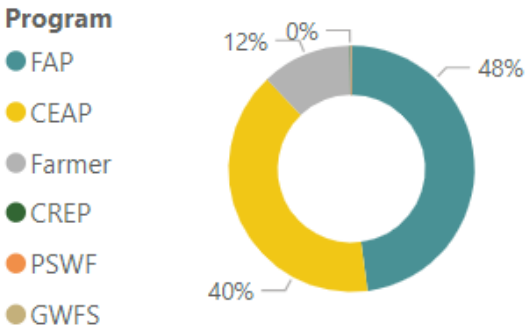
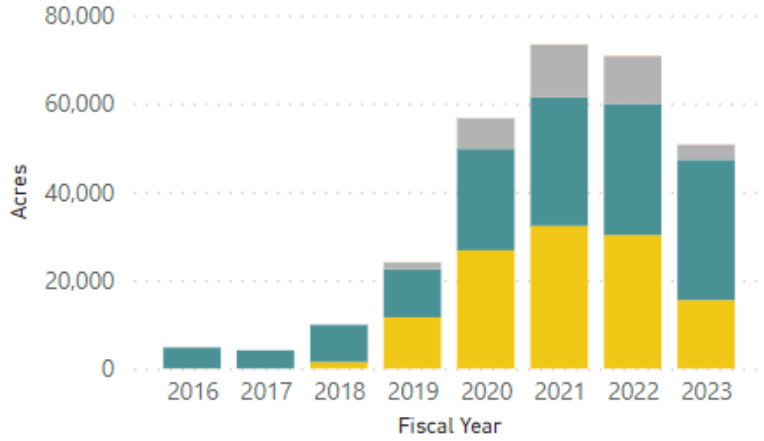
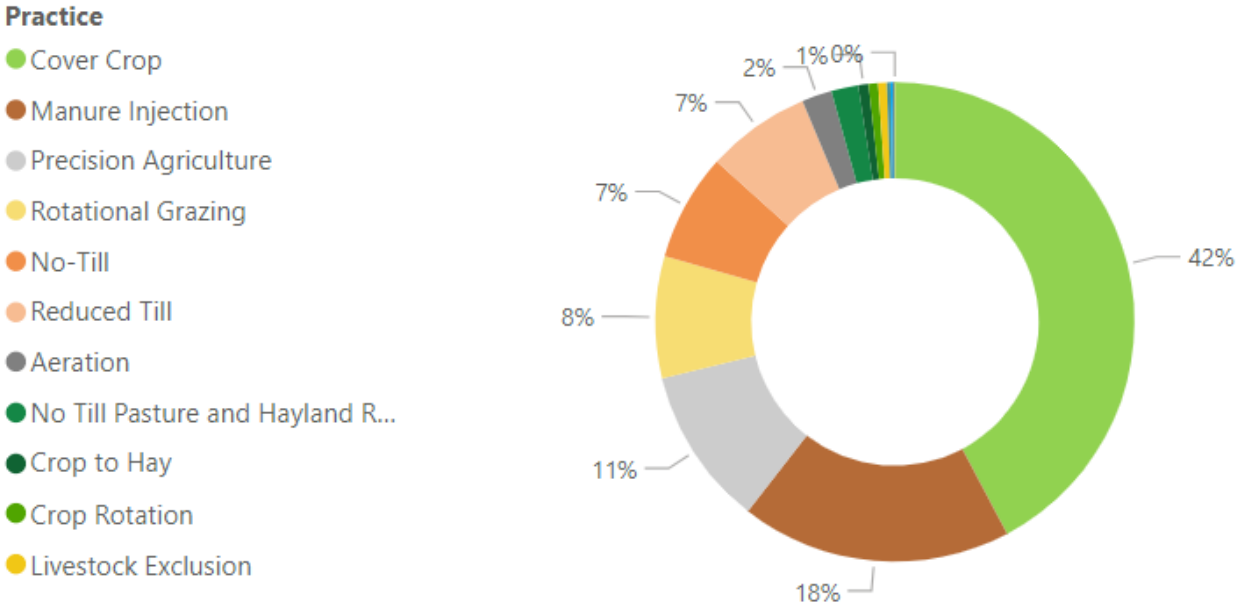
Acres by Program



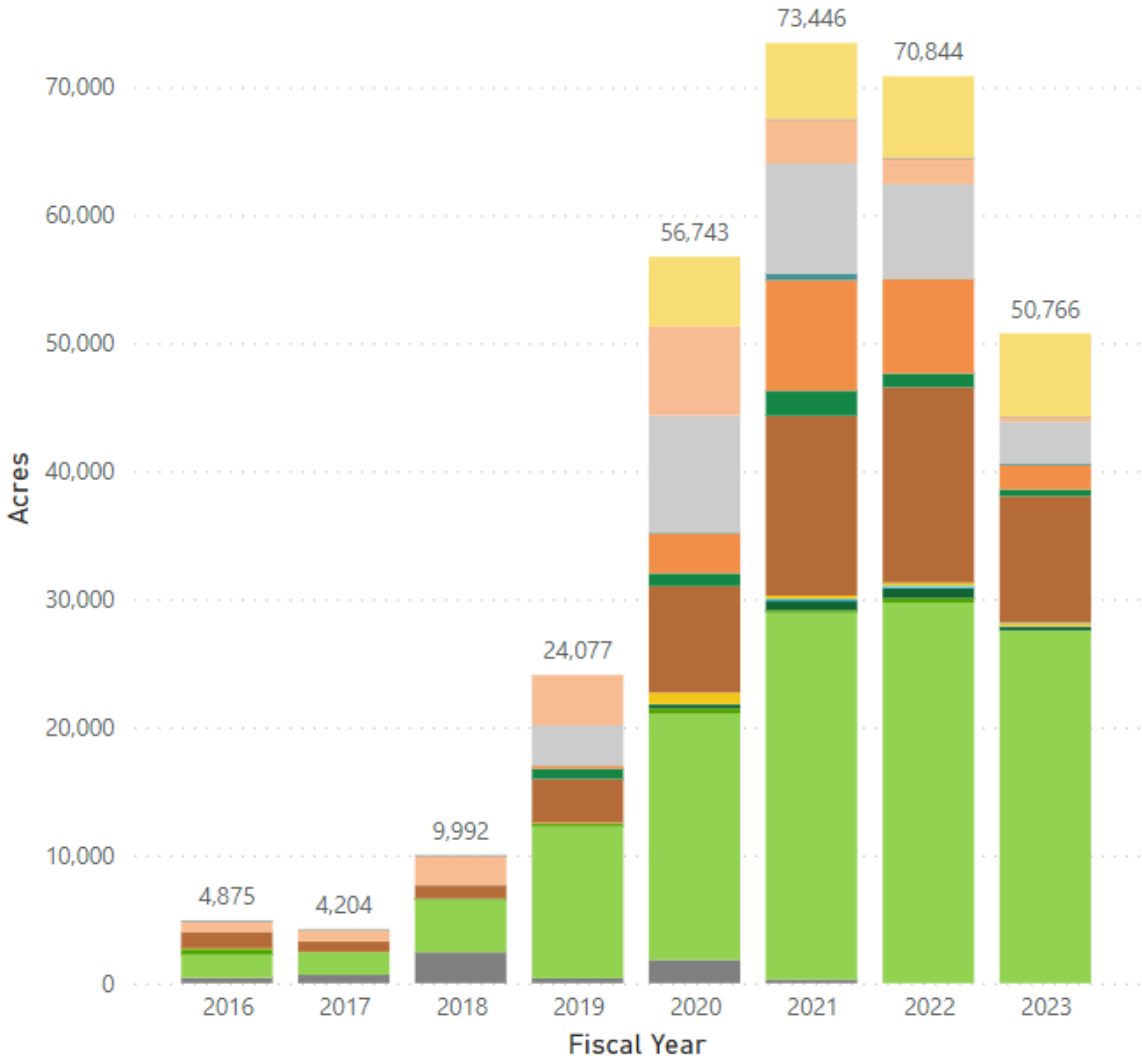
Acres by Fiscal Year and Program



Acres by Practice



Acres by Fiscal Year and Practice



Due to ongoing projects, data reported in the most recent fiscal year is not complete until the following fiscal year, i.e. fiscal year 2023 data is not complete.

Agricultural conservation practice tracking

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COMET-Planner Emission Reduction Coefficients (ERC)	Units:	tons CO2e/ac/yr		*CO2 Equivalents*		*Addison County*		Vermont		Negative = Emissions				http://comet-planner.com/	
NRCS Conservation Practices	**Soil Carbon**	**Biomass Carbon**	**Fossil CO2**	**Biomass Burning CO2**	**Biomass Burning N2O**	**Biomass Burning CH4**	**Liming**	**Total CO2**	**Direct Soil N2O**	**Indirect Soil N2O**	**Total N2O**	**Soil CH4**	**Total Emission Reductions**	**Minimum Total Emission Reductions***	**Maximum Total Emission Reductions***
Crop Land															
Cover Crop (CPS 340) - Add Non-Legume Seasonal Cover Crop (with 25% Fertilizer N Reduction) to Non-Irrigated Cropland	0.16	0	0	0	0	0	0	0.16	-0.01	0	-0.01	0	**0.15**	-0.09	0.54
Cover Crop (CPS 340) - Add Legume Seasonal Cover Crop (with 50% Fertilizer N Reduction) to Non-Irrigated Cropland	0.39	0	0	0	0	0	0	0.39	-0.19	-0.04	-0.23	0	**0.16**	-0.15	0.84
Conservation Crop Rotation (CPS 328) - Decrease Fallow Frequency or Add Perennial Crops to Rotations	0.21	0	0	0	0	0	0	0.21	0.01	0	0.01	0	**0.22**	N.E.**	N.E.**
Residue and Tillage Management - Reduced Till (CPS 345) - Intensive Till to Reduced Till on Non-Irrigated Cropland	0.17	0	0	0	0	0	0	0.17	0.01	0	0.01	0	**0.19**	0.05	0.34
Residue and Tillage Management - No-Till (CPS 329) - Intensive Till to No Till or Strip Till on Non-Irrigated Cropland	0.5	0	0	0	0	0	0	0.5	0.04	0.01	0.05	0	**0.56**	0.29	0.77
Residue and Tillage Management - No-Till (CPS 329) - Reduced Till to No Till or Strip Till on Non-Irrigated Cropland	0.4	0	0	0	0	0	0	0.4	0.03	0.01	0.04	0	**0.44**	0.22	0.61
Nutrient Management (CPS 590) - Improved N Fertilizer Management on Non-Irrigated Croplands - Reduce Fertilizer Application Rate by 15%	-0.02	0	0	0	0	0	0	-0.02	0	0	0	0	**-0.01**	-0.17	0.13
Nutrient Management (CPS 590) - Replace Synthetic N Fertilizer with Compost (CN ratio 10) on Non-Irrigated Croplands	0.2	0	0	0	0	0	0	0.2	-0.15	-0.04	-0.19	0	**0.01**	-0.27	0.23
Nutrient Management (CPS 590) - Replace Synthetic N Fertilizer with Compost (CN ratio 25) on Non-Irrigated Croplands	0.49	0	0	0	0	0	0	0.49	-0.1	-0.02	-0.12	0	**0.37**	0.11	0.6
Nutrient Management (CPS 590) - Replace Synthetic N Fertilizer with Dairy Manure on Non-Irrigated Croplands	0.22	0	0	0	0	0	0	0.22	-0.13	-0.03	-0.16	0	**0.06**	-0.18	0.27

*Minimum and maximum emission reductions represent the minimum and maximum total emissions over a range of soil, climate and management conditions within multi-county regions. Min/Max emissions are not estimated for all practices, due to limitations in quantification methods

**Values were not estimated due to limited data on reductions of greenhouse gas emissions from this practice

Source: https://dec.vermont.gov/sites/dec/files/wsm/erp/docs/2021-01-15_CleanWaterPerformanceReport_SFY2020-FINA-PDF-A.pdf

WQ Conservation Practices – Estimated GHG Mitigation Benefit w/ COMET-Planner ERC

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