Agriculture in a Changing Climate: Implications for Educators, Industry, and Producers Workshop

Climate Mitigation and Adaptation

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WASHINGTON STATE UNIVERSITY

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Climate Mitigation and Adaptation

Climate mitigation is any action taken to permanently eliminate or reduce the long-term risk and hazards of climate change to human life, property.

An anthropogenic intervention to reduce sources or enhance the sinks of greenhouse gases.

Greenhouse Gas Concentrations

CO_2, CH_4, N_2O

Climate Change

Weather changes at the global, continental, regional and local levels.

Effects

Warmer temperatures
Reduced snow pack
Extreme weather

Responses

Growing seasons
Pest Increases, fires
Water supply

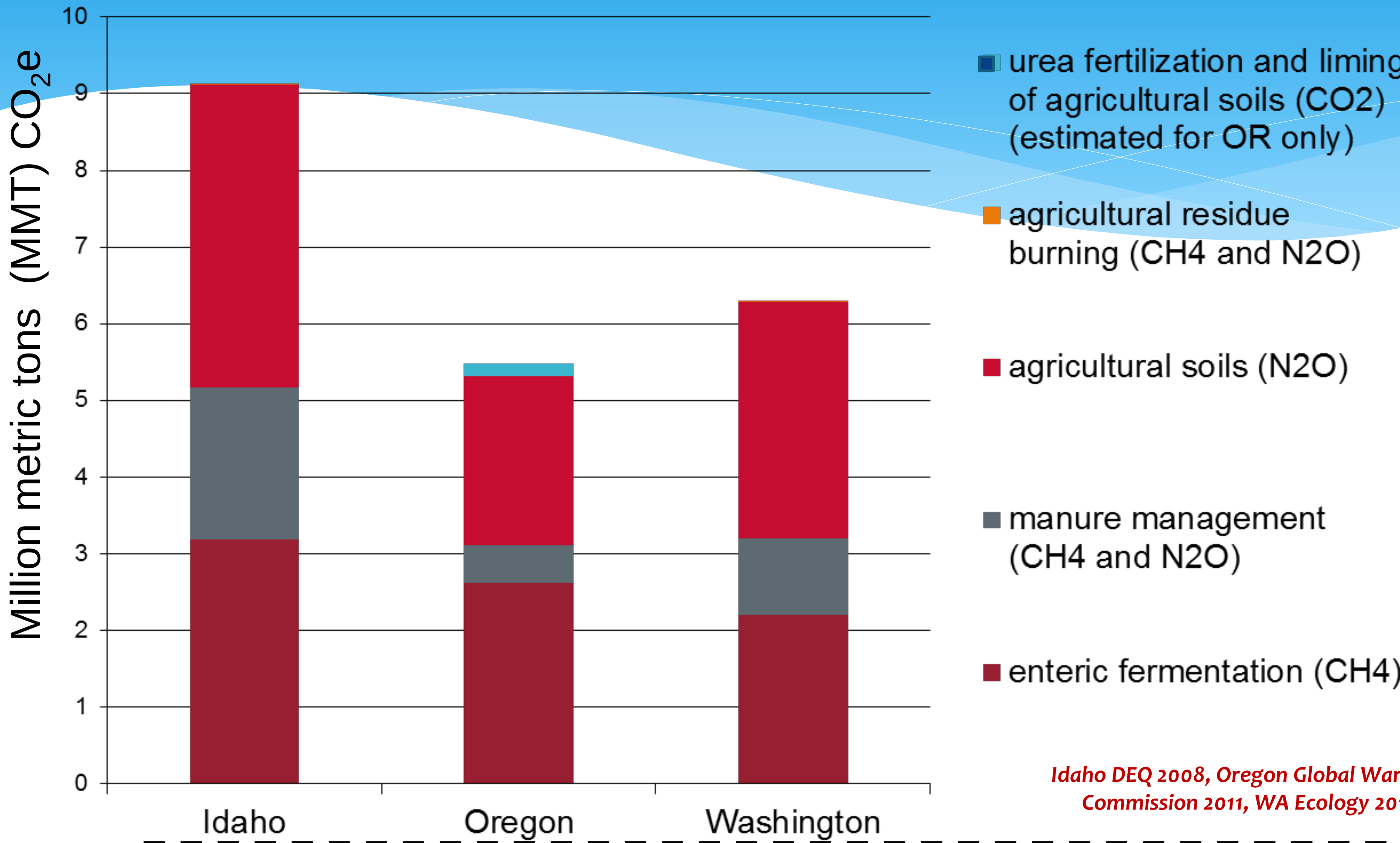
Mitigation

Adaptation

Climate adaptation is the ability of a system to adjust to climate change, to moderate potential damage, or to cope with consequences in a new or changing environment.

Reducing vulnerability to climate impacts – human health, agriculture water, drought.

PNW - Agricultural Greenhouse Gas Emissions



Idaho DEQ 2008, Oregon Global Warming Commission 2011, WA Ecology 2010

25%	8.1%	6.2%	% of total state emissions

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Mitigation Strategies

Mitigation involves complex interactions between environmental, economic, political, institutional, social, and technological processes.

Two approaches:

1) ***C sequestration of CO2 – increasing soil organic C pools. (finite)***

   - *intervention to enhance the sinks of greenhouse gases.*

2) ***Reduction of greenhouse gases to the atmosphere***

   - *intervention to reduce sources of greenhouse gases.*

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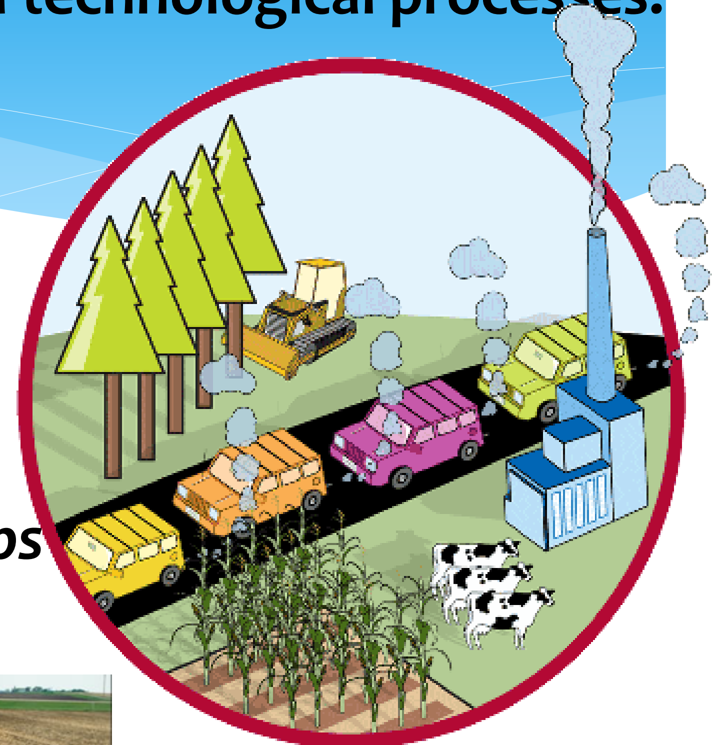

1) ***C sequestration of CO_2 – increasing soil organic C pools. (finite)***

- ***Crop Management***

  - eliminate bare fallow, increase C inputs, cover crops, fertilizer and irrigation, crops with high biomass production

- ***Conservation tillage***

  - reduce soil disturbance, slow decomposition rates

Sequestration and Greenhouse Gas Emissions from Intercropping Switchgrass and Hybrid Poplar

Table 3. Above ground biomass-C and time-integrated growing season CO_2-C emissions for the 2011 – 2014 crop years.

	Biomass Production		
Year	Monoculture Poplar	Poplar + Switchgrass	Monoculture Switchgrass
	---------- Mg DM biomass C ha^{-1} ----------		
2011	†0.5Da	0.7Da	0.6Ba
2012	1.7Cb	5.9Ca	7.6Aa
2013	5.8Bb	10.3Ba	9.3Aa
2014	14.4Ab	19.7Aa	8.0Ac
‡Cumulative	14.4b	27.6a	25.5a
	§CO_2-C emissions		
	------------- Mg CO_2-C ha^{-1} -------------		
2011	4.2Aa	3.6BCa	3.9Ca
2012	3.6ABb	5.5Aa	5.6Aa
2013	3.2Bb	4.2Ba	4.7Ba
2014	3.3Bb	4.3Ba	4.2BCa
Cumulative	14.3a	17.6a	18.4a
	Δ = (DM biomass C) – (CO_2-C)		
	---------- C ha^{-1} $season^{-1}$ -----------		
2011	-3.7Dd	-2.9Db	-3.3Bc
2012	-2.0Cc	0.4Cab	2.0Ab
2013	2.6Bb	6.1Ba	4.7Aa
2014	11.1Aa	15.4Aa	3.8Aa
Cumulative	0.1c	10.0a	7.1b

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Greenhouse Gas Emissions from Intercropping Switchgrass and Hybrid Poplar

Collins et al, 2016

Table 6. Net global warming potentials (GWP) for the 2011-2014 growing seasons of the monoculture poplar, poplar/switchgrass intercrop and monoculture switchgrass treatments.

	Biomass C Production	Carbon Dioxide	Nitrous Oxide	Methane	[£]Net GWP
	---------------- Mg CO_2eq ha^{-1} season^{-1} ----------------				
Monoculture Poplar					
2011	[†]1.8Da	15.5Aa	0.136Aa	-0.0029Aa	+13.8Aa
2012	6.1Cb	13.5ABb	0.150Ab	-0.0065Aa	+7.5Ba
2013	21.3Bb	11.7Bb	0.072Bb	-0.0034Aa	-9.5Ca
2014	52.9Ab	12.1Bb	0.164Ab	-0.0059Aa	-40.6Db
[§]Cumulative	52.9b	52.8b	0.522b	-0.0187a	+0.4a
Poplar/switchgrass intercrop					
2011	2.4Da	12.7Ba	0.121Ba	-0.0027Aa	+10.8Aa
2012	21.5Ca	20.2Aa	0.396Ba	-0.0052Aa	-1.0Bab
2013	37.7Ba	15.4Ba	1.395Aa	-0.0028Aa	-20.9Cc
2014	72.1Aa	15.9Ba	1.237Aa	-0.0054Aa	-54.9Dc
[§]Cumulative	101.2a	64.2a	3.149a	-0.0161a	-33.9c
Monoculture Switchgrass					
2011	2.1Ba	14.1Ca	0.129Ba	-0.0023Aa	+12.3Aa
2012	27.8Aa	20.5Aa	0.469Ba	-0.0055Aa	-6.9Bb
2013	34.2Aa	17.2Ba	1.605Aa	-0.0037Aa	-15.4Bb
2014	29.2Ac	15.5BCa	1.143Aa	-0.0019Aa	-14.2Ba
Cumulative	93.3a	67.3a	3.346a	-0.0137a	-22.7b

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Mitigation Strategies

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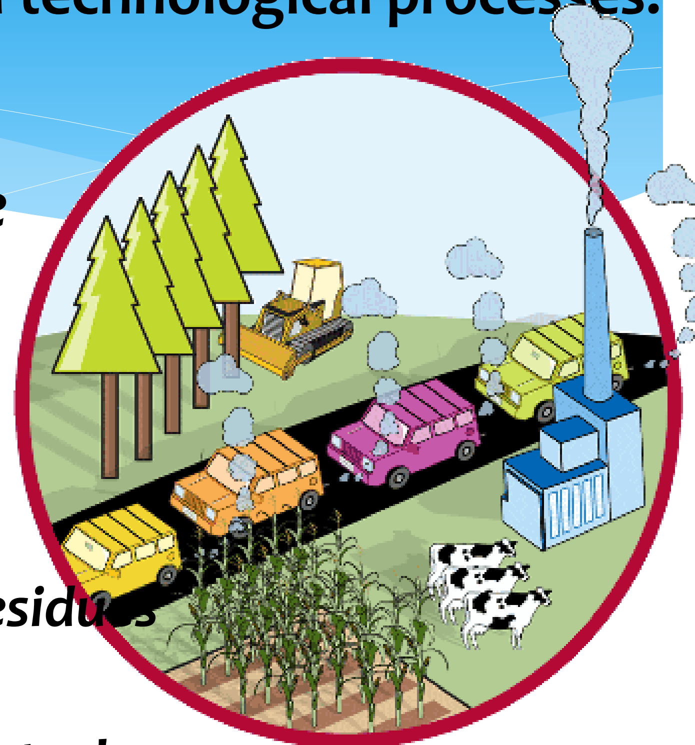

2) Reduction of greenhouse gases to the atmosphere

- ***Conservation Tillage***
  - *slows decomposition rates*
- ***Biofuel Production***
  - *canola, safflower, camelina, switchgrass, residues*
- ***N management***
  - *right place, right time, right source, right rate; legumes*
- ***Livestock Production***
  - *improved feed and nutrient management, manure management, biogas recovery, reducing numbers, reduce grain for feed*

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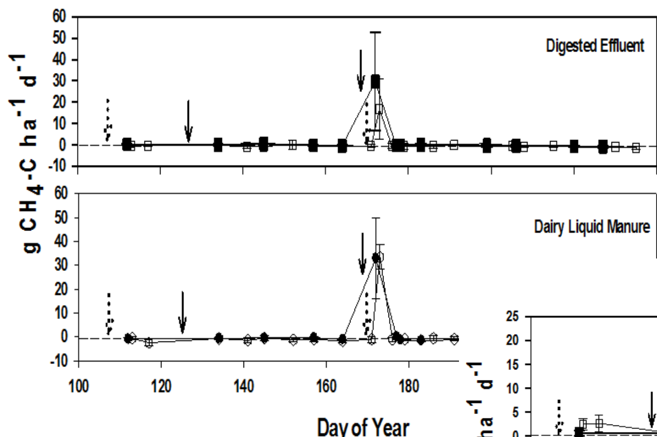
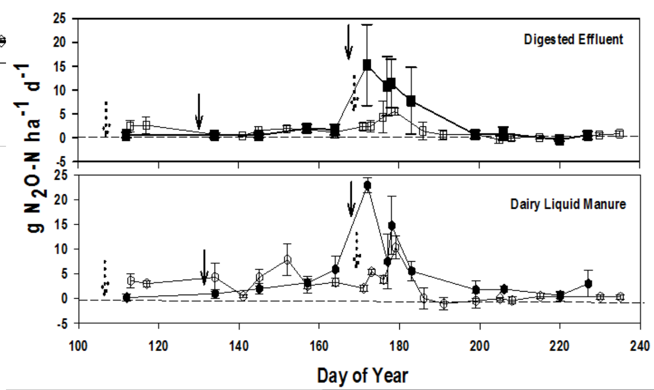
Greenhouse Gas Emissions from Soil Amended with AD-Dairy Manure

Evaluation of liquid dairy manure and digested effluent on GHG emissions from soil.

Global Warming Potentials

Amendment	kg P_2O_5 ha^{-1}	kg CO_2 eq. ha^{-1}	%	% of applied N
Liquid Dairy Manure	161	219		0.33
AD Effluent	109	193	-12	0.29





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Collins et al, 2011

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Greenhouse Gas Emissions from Soil Amended with AD-Dairy Manure: Recovered Nutrients

P-Solids/Polymer Coagulation (WSU/Angar)

Global Warming Potentials

Amendment	kg P_2O_5 ha^{-1}	kg CO_2 eq. ha^{-1}	%	kg CO_2 eq. ha^{-1} From P fertilizer
Liquid Dairy Manure	161	219		
AD Effluent	109	193	-12	
Urea + MAP	56	136	-38	

Struvite Crystallization (Multiform Harvest)

$MgNH_4PO_4 \cdot 6(H_2O)$.

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Summary: AD

- ✓ **AD dairy manure used as a fertilizer results in a minor reduction of GHG emissions compared to untreated dairy manure. ~ -12%.**

- ✓ **P recovered as struvite or fine P solids applied at agronomic rates significantly reduced GHG emissions. ~35%**

- ✓ **Only 6 of the 415 dairies in WA state use AD and some form of nutrient recovery. If the technology is widely accepted GHG's could be reduced by 83,000 Mg CO_2 eq y^{-1}. ~8%.**

USDA-AFRI #2012-6800219814

Barriers Moving from Research of Mitigation Strategies to Implementation

Mitigation is complete when CO_2 is removed from the atmosphere

Farm-level adoption constraints

- **Economics of adoption –** *availability of capital and/or subsidies*
- **Lack of capacity and skills –** *size matters*
- **Lack of information –** *measurement and monitoring*
- **Property rights –** *single party ownership*
- **Uncertainty –** *land based vs industry based options*
- **Leakage –** *increased production and emissions outside project region*
- **Reversibility –** *change in management*

Joyce et al., 2013; FAO, 2012; Rosenzweig and Tubiello, 2007

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Questions?

Conference Session A Goals: GHG Mitigation

- ✓ **Summarize regional information on the environmental and economic benefits and costs of mitigation strategies for rangelands, livestock, and croplands**
- ✓ **Identify pathways and barriers to the adoption of specific mitigation strategies, including:**
  1) **Soil health/carbon sequestration,**
  2) **Nitrogen stewardship,**
  3) **Livestock partnerships, and**
  4) **Energy generation and efficiency**

- ✓ **Produce a draft strategic plan for the next 5 years for educating NW ag resource managers on climate mitigation, including identification of information needs, plans for programming, and the development of evaluation metrics and outcome indicators.**

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