REACCH
Regional Approaches to Climate Change – PACIFIC NORTHWEST AGRICULTURE

Predicting Grower Behavior and Environmental Outcomes under Alternative Policy Scenarios for Encouraging Mitigation Practices

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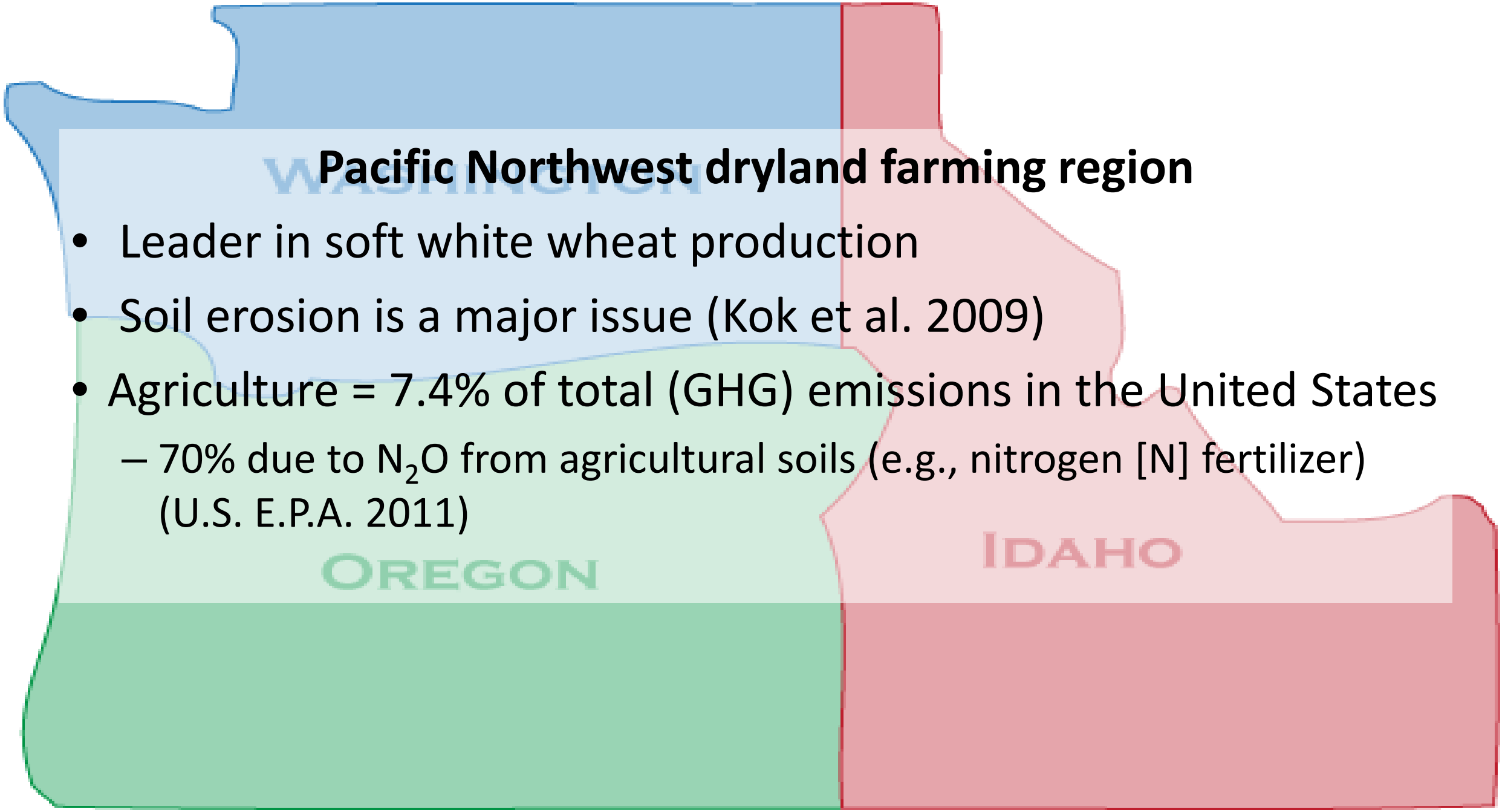
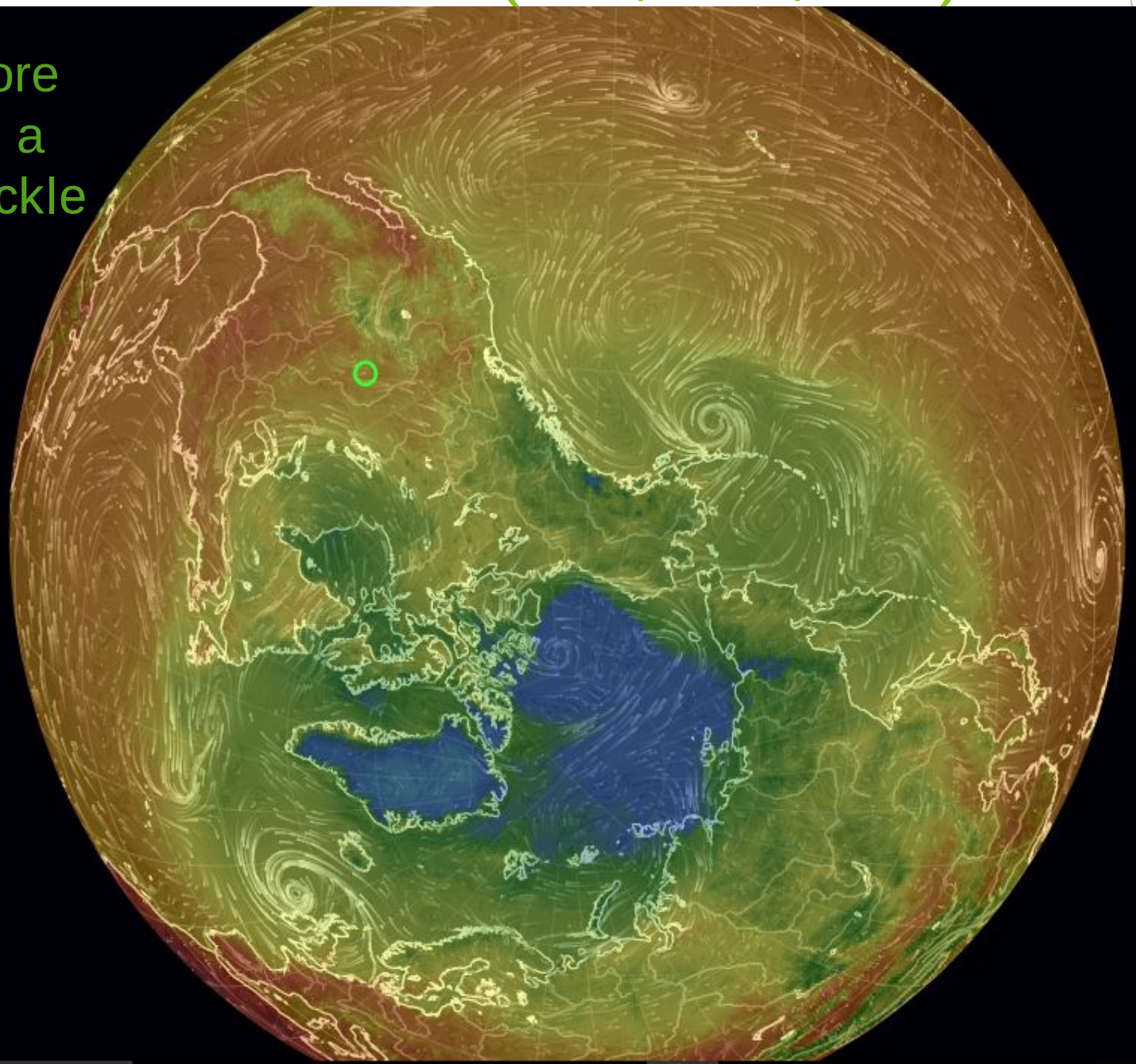


Pacific Northwest dryland farming region

- Leader in soft white wheat production
- Soil erosion is a major issue (Kok et al. 2009)
- Agriculture = 7.4% of total (GHG) emissions in the United States
  - 70% due to N_2O from agricultural soils (e.g., nitrogen [N] fertilizer) (U.S. E.P.A. 2011)

Green House Gas Emission (CO_2, N_2O, CH_4)

N_2O – 300 times more potent than CO_2 on a mass basis (C. Stockle et al. 2012)



Erosion on the Palouse Hills

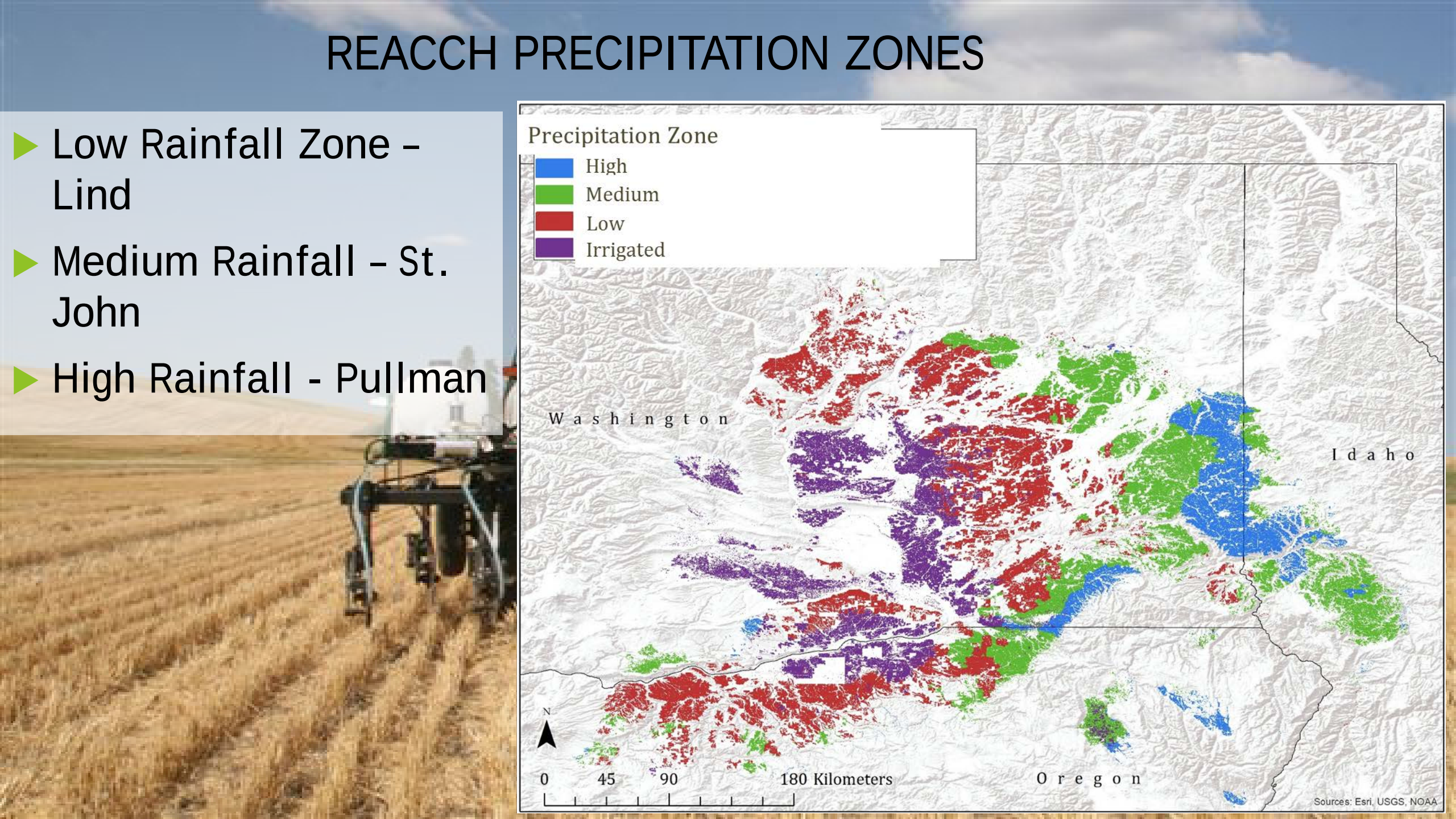
Very fine sand, silt, clay and organic matter are easily removed

Research Questions

- What are the effects of tillage on N_2O emissions?
- How do precipitation zones impact crop yields and economics?
- Why do farmers choose one type of tillage over another?

REACCH PRECIPITATION ZONES

- Low Rainfall Zone – Lind
- Medium Rainfall – St. John
- High Rainfall - Pullman



Methods

- Emission & Erosion values are from C. Stockle et al. 2012
  - Cropsyst model
  - Simulated wind and water erosion
  - Simulated N_2O emissions, expressed as CO_2 equivalent
- Budget (returns over total cost):
  - Input prices from 2011-2014 were averaged to estimate price levels
  - Input prices include fuel, seed, fertilizer, adjuvants etc.

Methods cont..

- **Budget (returns over total cost):**

Machinery values for 2011, 2012, 2013, 2014 were increased by 12%, 10%, 8%, 5%, respectively

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University of Idaho Machinery Cost Analysis Program

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hourly cost for each machine used

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summarize the returns over total cost for conventional and no-till farms in each precipitation zone

High Rainfall CT 2014.uimc - University of Idaho Machinery Cost Analysis Program

File Edit Help

Diesel Cost ($/gallon) 3.48

Gasoline Cost ($/gallon) 3.56

Interest Rate (%) 6.31

INSTRUCTIONS:
Enter general parameters to the left.

Double-click on an item in the list to view or edit that item.
Right-click on an item for more options.

Machinery and Equipment Costs Per Acre

Operation	Depreciation	Interest	THI	Repairs	Labor	Fuel/Lube	Total $/Acre
nothing (wagon) and 50HP-WT DIV by...	1.85	1.90	0.36	0.66	5.44	3.60	13.82
2T truck (truck)	0.25	0.15	0.06	0.22	0.24	0.14	1.05
4WD ATV divide by 10 (ATV)	1.65	0.70	0.14	0.29	8.80	1.97	13.54
4WD 3/4 ton pickup (pickup)	0.42	0.20	0.21	0.33	1.92	0.82	3.90
tandem axle (truck)	0.42	0.26	0.42	0.44	0.48	0.26	2.30
30' grain combine (self-propelled combi...	7.17	2.94	1.21	1.44	1.89	2.52	17.17
32' wide split packer (grain drill) and 20...	0.36	0.26	0.10	1.15	1.30	2.30	5.47
25' Disc (heavy-duty disk) and 200HP-...	1.16	0.63	0.09	0.45	1.90	2.76	7.00
36' cultivator + harrow (field cultivator) ...	1.18	0.64	0.10	0.63	0.85	1.39	4.79
40' rodweeder (field cultivator) and 200...	1.09	0.57	0.10	0.64	0.83	1.22	4.45
trap wagon (pickup)	0.25	0.12	0.07	0.09	0.08	0.03	0.64
36' Direct Seed Drill (grain drill) and 350...	1.61	0.94	0.32	1.48	1.57	3.14	9.07
200HP D5 (crawler tractor)							**
200HP-WT (4 wheel drive tractor)							**
36' cultivator (field cultivator) and 200H...	0.45	0.30	0.03	0.40	0.85	1.35	3.36
32' split packer drill (grain drill) and 200...	0.38	0.28	0.11	1.21	1.62	2.36	5.96
32' undercutter sweep (field cultivator) ...	0.39	0.27	0.03	0.42	0.88	1.52	3.51
23' chisel (chisel plow) and 200HP D5 (...	2.29	1.37	0.13	1.67	1.64	2.62	9.73
25' grain combine (self-propelled combi...	4.37	1.89	0.78	3.74	2.51	3.36	16.64
36' JD455 grain drill (grain drill) and 20...	0.85	0.39	0.16	2.11	1.62	2.36	7.51
40' rodweeder (field cultivator) and 200...	0.17	0.11	0.02	0.21	0.76	1.11	2.38
90' sprayer (boom-type sprayer) and 20...	0.21	0.11	0.01	0.21	0.48	0.69	1.71
50' shank fertilizer ap (field cultivator) a...	0.05	0.04	0.01	0.10	0.76	1.21	2.16
30' shank fertilizer ap (field cultivator) a...	0.09	0.06	0.01	0.16	1.26	2.01	3.59

Double-click on an item in the list to view or edit that item. Right-click on an item for more options.

** $/acre figures are not available, and not included in Totals. For $/acre figures, select an implement for a Tractor or ATV, add Miles Per Acre for Trucks, or add Acres Per Hour for ATVs or Wagons

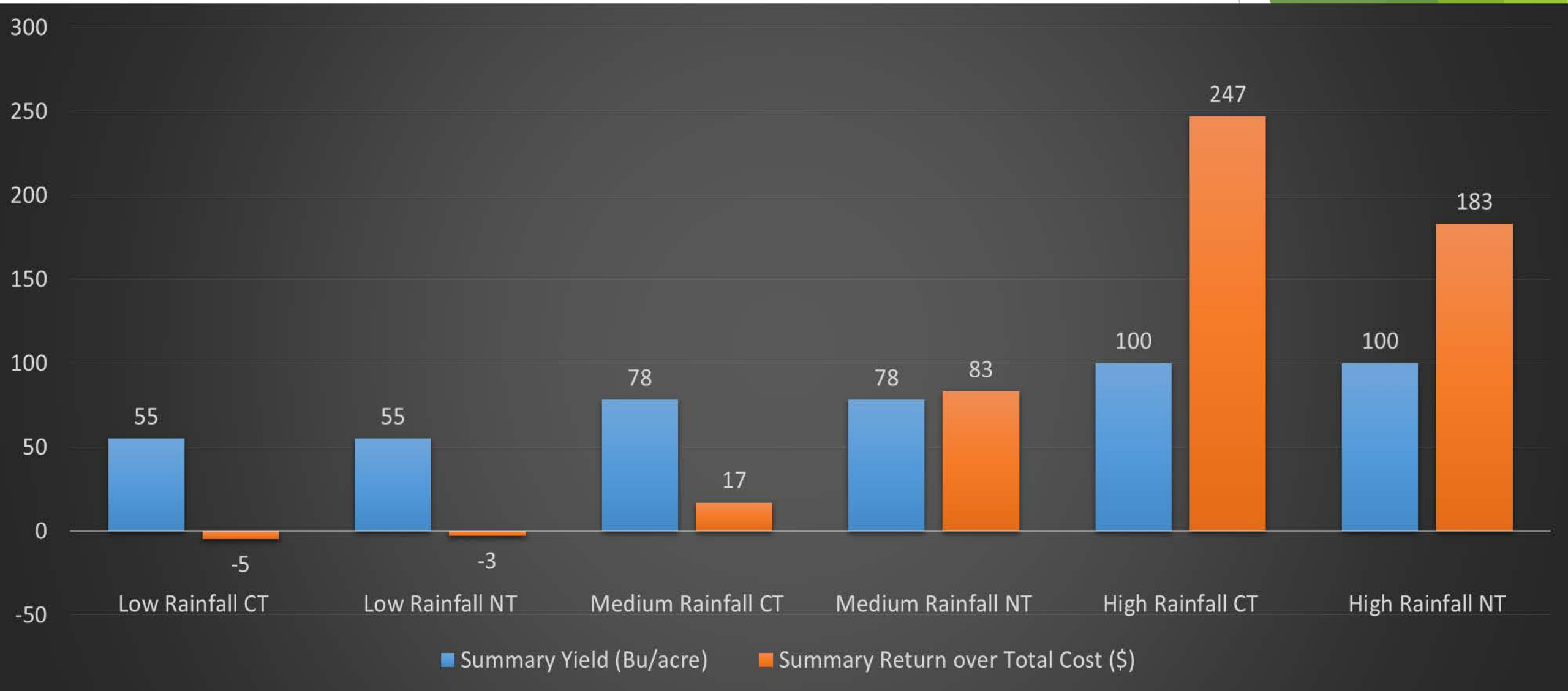
Methods cont..

Returns over total cost (Conventional Tillage & No-till)

Erosion & Emissions (Conventional Tillage & No-till)

Results & Analysis

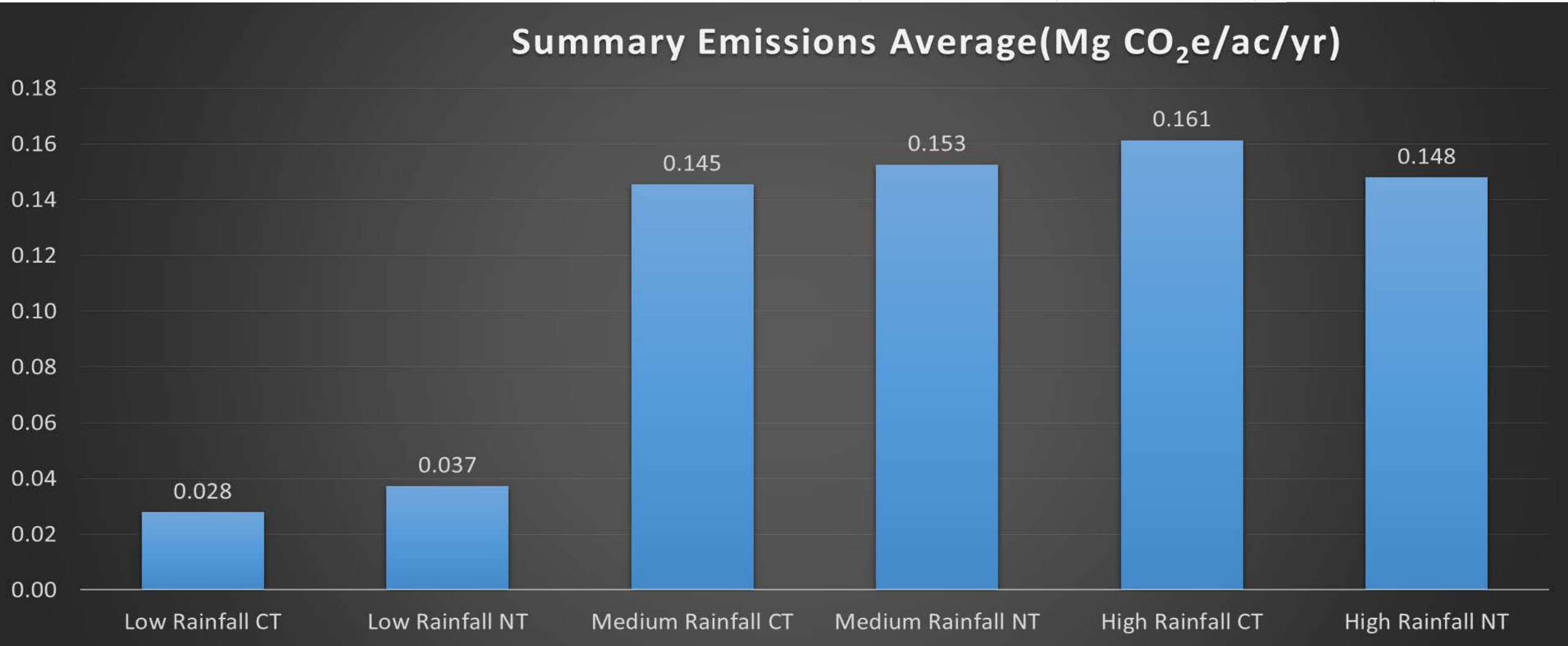
- How do precipitation zones impact crop yields and economics?

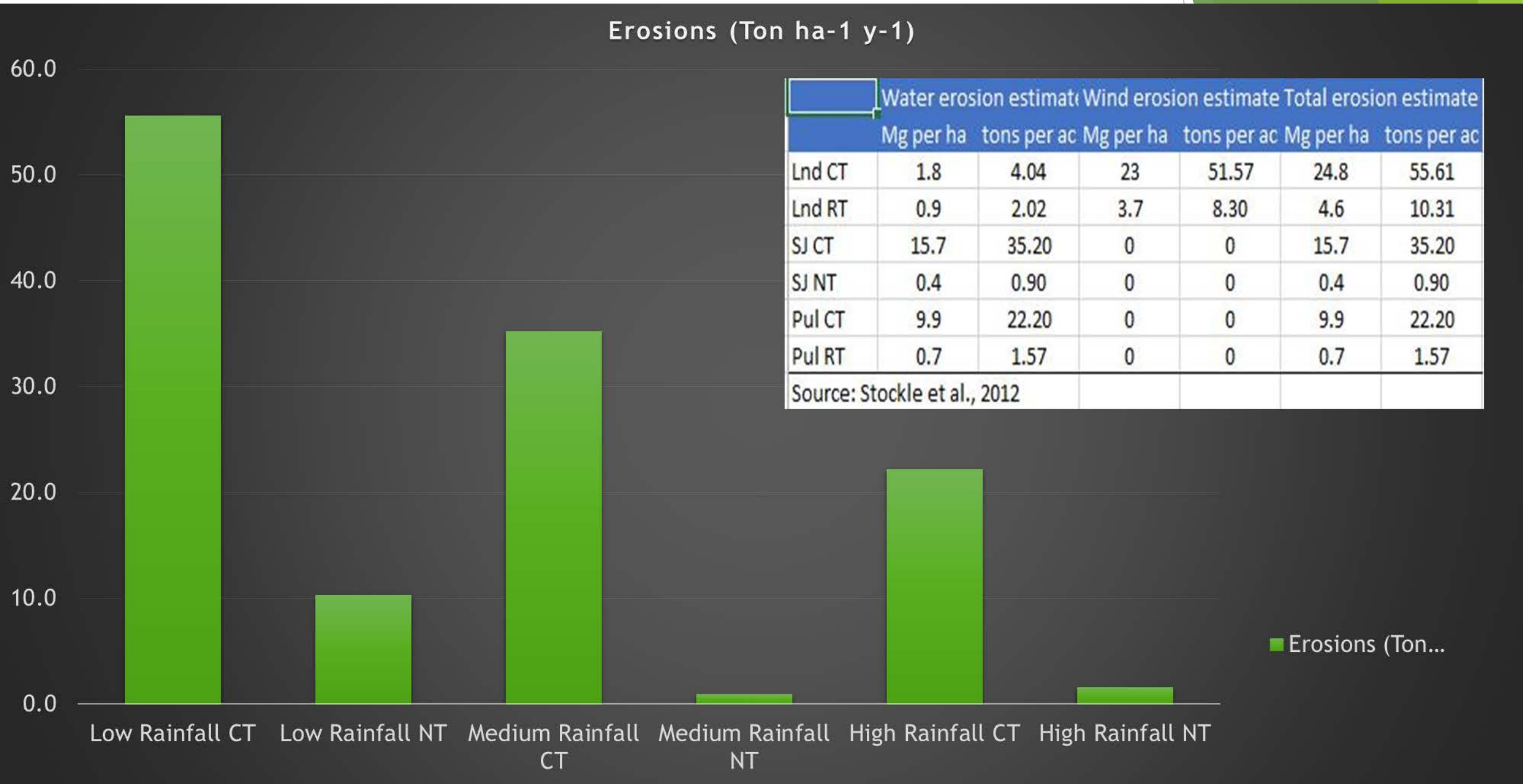


Results & Analysis

- What are the effects of tillage on N_2O emissions?

Location	Rainfall (mm) intensities	Tillage Crop rotation	Average annual fertilization (kg N ha−1)
Lind	250	CT, RT WW–SF	40
St. John	435	CT, NT WW–SB– SF	67
Pullman	550	CT, RT, NT WW–SW–SP	80





	Water erosion estimat		Wind erosion estimate		Total erosion estimate	
	Mg per ha	tons per ac	Mg per ha	tons per ac	Mg per ha	tons per ac
Lnd CT	1.8	4.04	23	51.57	24.8	55.61
Lnd RT	0.9	2.02	3.7	8.30	4.6	10.31
SJ CT	15.7	35.20	0	0	15.7	35.20
SJ NT	0.4	0.90	0	0	0.4	0.90
Pul CT	9.9	22.20	0	0	9.9	22.20
Pul RT	0.7	1.57	0	0	0.7	1.57
Source: Stockle et al., 2012						

Results & Analysis

- Why do farmers choose one type of tillage over another?

Based on longitudinal survey from 2011-2013 (48 farmers)

- NT difficult to learn and operate
- Unsure of long term profitability
- Initial investment for NT is high

Conclusion

- Crop yields do not vary by tillage assumptions for each AEC, but returns over TC does vary due to different machinery operations and input usage
  - For example, herbicides replace tillage for weed control in NT.
- Soil erosion rates under CT in the study region are high, negatively impacting soil quality, yields, and water quality.
- Simulated N_2O emissions, expressed as CO_2 equivalent, were not very different under CT and NT.
- However, N_2O emissions were sufficiently high to offset gains in SOC from the conversion of CT to RT or NT.

Conclusion Cont…

- Thus, reducing tillage intensity can result in net C storage, tillage practices will help reduce GHG on each AEC but it will be hard to achieve without full consideration of Nitrogen Fertilizer management.
- It will be easier to persuade farmers in Medium CT to move to Medium NT because of the profit because farmers want assurance on return
- This program should be expanded to offer additional incentives, particularly in areas that show reduced profitability or no gain under reduced tillage. (For erosion not N_2O)

Extension

- How do precipitation zones impact crop yields and economics?
- Importance: soil quality, yields, water quality, reduce N_2O emission
- If the information for this research were consider valid enough, pamphlet could be created and information in it should encourage careful nitrogen management based on the annual application
- Stakeholders: Farmers

Reference

- Kok, H., R.I. Papendick, and K.E. Saxton. “STEEP: Impact of Long-term Conservation Farming Research and Education in Pacific Northwest Wheatlands.” *Journal of Soil and Water Conservation* 64.4 (2009): 253-64. Print.
- Stockle, C., S. Higgins, A. Kemanian, R. Nelson, D. Huggins, J. Marcos, and H. Collins. "Carbon Storage and Nitrous Oxide Emissions of Cropping Systems in Eastern Washington." *A Simulation Study* 67 (2012)

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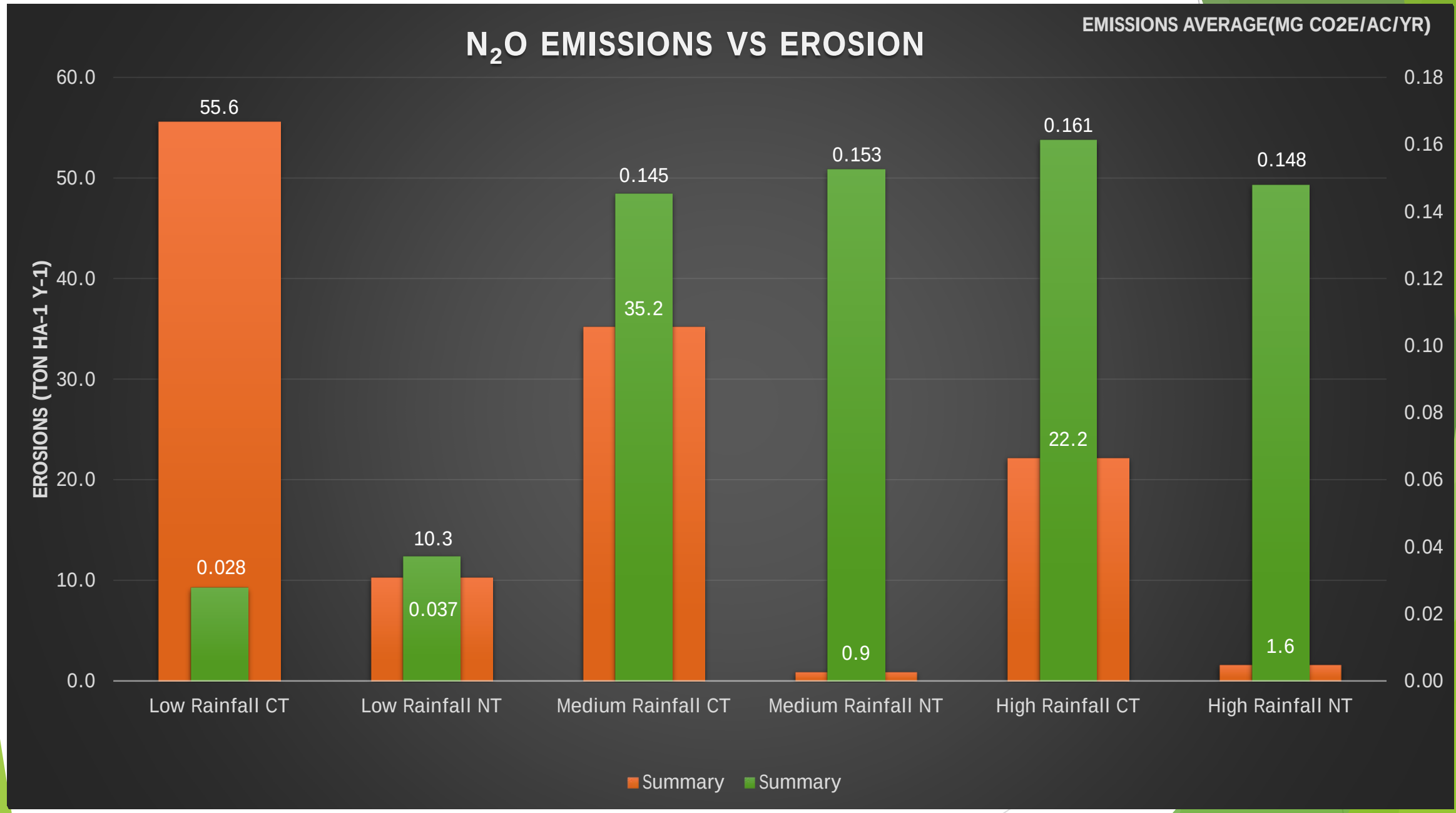
N_2O EMISSIONS VS EROSION
EMISSIONS AVERAGE(MG CO2E/AC/YR)
EROSIONS (TON HA-1 Y-1)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
55.6
0.028
10.3
0.037
0.145
35.2
0.153
0.9
0.161
22.2
0.148
1.6
Low Rainfall CT
Low Rainfall NT
Medium Rainfall CT
Medium Rainfall NT
High Rainfall CT
High Rainfall NT
Summary
Summary