What is Sustainable Agriculture?

Why is it important?

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When a process is sustainable, it can be maintained indefinitely.

Can our food and farming systems be maintained indefinitely?
ECONOMIC SUSTAINABILITY

- Family net assets are stable or increasing over time
- Profits from farm products are fair and stable
- Most farm inputs are available from local sources
- Government payments reward ecosystems services

Adapted from Sullivan (2003). Applying The Principles Of Sustainable Farming
SOCIAL SUSTAINABILITY

• The farm supports other businesses and families in the community
• Farms are locally owned and food dollars circulate within the local economy
• The number of rural families is going up or holding steady

Adapted from Sullivan (2003). Applying The Principles Of Sustainable Farming
SOCIAL SUSTAINABILITY

- Young people take over their parents' farms and continue farming
- College graduates return to the community after graduation
- Local people have access to affordable food
- Farmers are generally happy

Adapted from Sullivan (2003). Applying The Principles Of Sustainable Farming
ENVIRONMENTAL SUSTAINABILITY

- Erosion is minimal and soil quality is being maintained or improved
- Farms can maintain or improve the quality of water flowing through their farm
- Wildlife habitat is protected and being improved
- Water temperatures are cool and stable
- Regional landscapes are diverse
IS AGRICULTURE PART OF THE ENVIRONMENTAL PROBLEM OR PART OF THE SOLUTION?

- Biodiversity
- Water pollution
- Soil depletion
- Climate change
Nitrogen Transport

Volatilization/Denitrification  Crop Uptake  Runoff/Erosion

Leaching
Phosphorus Transport

Crop Uptake

Leaching

Runoff/Erosion
Nutrient Pollution: Source and Transport

Sources:
- Nutrient leaching
- Tile flow
- Subsurface flow

Transport:
- Nutrient runoff
- Erosion

Water Body
Soil organic matter is key

SOM also protects water quality

Building Soils for Better Crops. Chapter 4. Why is organic matter so important?
http://www.sare.org/publications/soils.htm
Soil aggregation is important for preventing erosion.

Figure 4.4 Changes in soil surface and water-flow pattern due to soil crusting.
9-year annual system trials: Comparing legume-based, manure-based and synthetic fertilizer systems in 6 States

Organic management led to:

- POM, C & N \(\uparrow 30-40\%\)
- SOC (ave 10yr) \(\uparrow 14\%\)

Legume system \(\approx\) manure system

MLO=manure org, LO=legume org, CV=conventional

(Marriott & Wander, 2006)

Slide courtesy of David Granatstein (WSU)
Organic farms can be more or less sustainable than a conventional farm.

Slide courtesy of David Granatstein (WSU)
Sustainability is more important than "organic"

Many successful organic and conventional farmers are key innovators in efforts to develop a sustainable economy.
Poor nutrient mgt → eutrophication → hypoxia

Too much of a good thing
WATER POLLUTION

World Hypoxic and Eutrophic Coastal Areas

Legend
- Eutrophic and Hypoxic Areas
- Areas of Concern
- Documented Hypoxic Areas
- Systems in Recovery

Data compiled from various sources by R. Diaz, H. Duarte.

Photo: Nancy Rabalais, Louisiana Universities Marine Consortium
400 dead zones around the world
Doubles every decade
Most caused by fertilizer and/or sewage pollution
Climate change is causing PNW dead zone, not agriculture
Overview of Hypoxia around the World

Robert J. Diaz

EFFECTS ON OCEANS

No estuar chang oxygen. While hypoxic and anoxic environments have existed through geological time, their occurrence in shallow coastal and estuarine areas appears to be increasing, most likely accelerated by human activities. Several large systems, with historical data, that never re-

Virginia; Saanich Inlet, British Columbia; Port Hacking, Australia).

The northern Gulf of Mexico may be typical of these systems, but it is also the most studied. The northern Gulf of Mexico is a highly productive marine ecosystem that is supported by a combination of natural and semi-natural processes. The semi-natural processes are primarily associated with the Mississippi River and the Atlantic Ocean.
“No other environmental variable of such ecological importance to estuarine and coastal marine ecosystems around the world has changed so drastically, in such a short period of time.

It appears that many ecosystems that are now severely stressed by hypoxia may be near or at a threshold of change or collapse (loss of fisheries, loss of biodiversity, alteration of food webs).”
# WATER POLLUTION

## Mid Willamette Water Quality (DEQ)

<table>
<thead>
<tr>
<th>Site</th>
<th>STORET Number</th>
<th>River Mile</th>
<th>Summer Average</th>
<th>FWS Average</th>
<th>Minimum Seasonal Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. Santiam R. @ HWY 226 (Crabtree)</td>
<td>40</td>
<td>71.9</td>
<td>84</td>
<td>88</td>
<td>88</td>
</tr>
<tr>
<td>N. Santiam R. @ Greens Br.</td>
<td>40</td>
<td></td>
<td></td>
<td>91</td>
<td>91</td>
</tr>
<tr>
<td>Willamette R. @ Salem</td>
<td>40</td>
<td></td>
<td></td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Willamette R. @ Wheatland Ferry</td>
<td>402012</td>
<td>71.9</td>
<td>84</td>
<td>82</td>
<td>82</td>
</tr>
<tr>
<td>Salt Ck. @ Whiteson</td>
<td>404184</td>
<td>1.8</td>
<td>38</td>
<td>40</td>
<td>38</td>
</tr>
<tr>
<td>S. Yamhill R. @ HWY 99W</td>
<td>402625</td>
<td>16.5</td>
<td>83</td>
<td>74</td>
<td>74</td>
</tr>
<tr>
<td>N. Yamhill R. @ Poverty Bend Rd.</td>
<td>402606</td>
<td>4.5</td>
<td>77</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Yamhill R. @ Dayton</td>
<td>402031</td>
<td>5.0</td>
<td>58</td>
<td>63</td>
<td>58</td>
</tr>
<tr>
<td>Willamette R. @ Newberg Br.</td>
<td>402010</td>
<td>48.6</td>
<td>83</td>
<td>78</td>
<td>78</td>
</tr>
<tr>
<td>Pudding R. @ HWY 214 (u/s Cannery)</td>
<td>402319</td>
<td>26.9</td>
<td>65</td>
<td>57</td>
<td>57</td>
</tr>
<tr>
<td>Pudding R. @ HWY 211 (Woodburn)</td>
<td>402317</td>
<td>22.4</td>
<td>52</td>
<td>46</td>
<td>46</td>
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<tr>
<td>Pudding R. @ Bernard Rd. (Whiskey Hill)</td>
<td>404207</td>
<td>17.5</td>
<td>58</td>
<td>54</td>
<td>54</td>
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<tr>
<td>Pudding R. @ HWY 99E (Aurora)</td>
<td>402594</td>
<td>8.1</td>
<td>60</td>
<td>54</td>
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<tr>
<td>Molalla R. @ Canby</td>
<td>402314</td>
<td>3</td>
<td>86</td>
<td>86</td>
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</tr>
<tr>
<td>Willamette R. @ Canby Ferry</td>
<td>402007</td>
<td>34.4</td>
<td>81</td>
<td>79</td>
<td>79</td>
</tr>
</tbody>
</table>

Summer: June - September; FWS (Fall, Winter, & Spring): October - May

http://www.deq.state.or.us/lab/WQM/wqimain.htm
PUDDING RIVER

Historically impacted by point sources and non-point sources of pollution.

**Point sources** include sewage treatment plants, food processing plants and other municipal activities.

**Non-point sources** include sediment from erosion, and poorly managed fertilizers and pesticides.
### Table 1. Seasonal Average OWQI Results for the Lower Willamette Basin (WY 1986 – 1995)

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</thead>
<tbody>
<tr>
<td>Tualatin R. @ Rood Br.</td>
<td>402131</td>
<td>39.0</td>
<td>78</td>
<td>66</td>
<td>66</td>
</tr>
<tr>
<td>Beaverton Ck. @ 216th Ave. (Orenco)</td>
<td>402150</td>
<td>0.3</td>
<td>36</td>
<td>59</td>
<td>36</td>
</tr>
<tr>
<td>Tualatin R. @ HWY 210 (Scholls)</td>
<td>402129</td>
<td>26.9</td>
<td>50</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>Tualatin R. @ Elsner Rd.</td>
<td>402128</td>
<td>16.2</td>
<td>53</td>
<td>57</td>
<td>53</td>
</tr>
<tr>
<td>Fanno Ck. @ Bonita Rd. (Tigard)</td>
<td>402139</td>
<td>2.3</td>
<td>55</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>Tualatin R. @ Boones Ferry Rd.</td>
<td>402126</td>
<td>8.6</td>
<td>37</td>
<td>40</td>
<td>37</td>
</tr>
<tr>
<td>Clackamas R. @ High Rocks</td>
<td>402913</td>
<td>1.2</td>
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<td>88</td>
<td>87</td>
</tr>
<tr>
<td>Johnson Ck. @ SE 17th Ave. (Portland)</td>
<td>404000</td>
<td>0.2</td>
<td>26</td>
<td>80</td>
<td>30</td>
</tr>
<tr>
<td>Willamette R. @ Hawthorne Br.</td>
<td>402288</td>
<td>13.2</td>
<td>79</td>
<td>74</td>
<td>74</td>
</tr>
<tr>
<td>Swan Island Channel (Willamette R.)</td>
<td>402478</td>
<td>0.5</td>
<td>63</td>
<td>77</td>
<td>63</td>
</tr>
<tr>
<td>Willamette R. @ SP&amp;S RR Br. (Portland)</td>
<td>402000</td>
<td>7.0</td>
<td>74</td>
<td>75</td>
<td>74</td>
</tr>
<tr>
<td>Columbia Slough @ Landfill Rd.</td>
<td>402881</td>
<td>2.6</td>
<td>30</td>
<td>22</td>
<td>22</td>
</tr>
</tbody>
</table>

*Summer: June - September; FWS (Fall, Winter, & Spring): October - May*

*Scores - Very Poor: 0-59, Poor: 60-79, Fair: 80-84, Good: 85-89, Excellent: 90-100*
### WATER POLLUTION

#### Agriculture

<table>
<thead>
<tr>
<th>Part of problem</th>
<th>Part of solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor manure management</td>
<td>Composting and good manure mgt</td>
</tr>
<tr>
<td>Erosion</td>
<td>soil building i.e. cover crops</td>
</tr>
<tr>
<td>Over fertilization</td>
<td>Good nutrient mgt</td>
</tr>
<tr>
<td></td>
<td>Soil building $\rightarrow$ filtration</td>
</tr>
</tbody>
</table>
Climate Change

U.S. Greenhouse Gas Emissions by Gas

- HFCs, PFCs, & SF₆
- Methane
- Nitrous Oxide
- Carbon Dioxide

Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006, USEPA #430-R-08-005
Climate Change

Emissions Allocated to Economic Sectors

- Electricity Generation
- Transportation
- Industry
- Agriculture
- Commercial
- Residential

Note: Does not include U.S. territories.

Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006, USEPA #430-R-08-005
Climate Change

Figure 2. U.S. Farm Energy Use by Source, 2002

Total Energy Directly and Indirectly Consumed on U.S. Farms in 2002 was 1.7 Quadrillion Btu

- Diesel: 27.3%
- Natural Gas: 3.6%
- LP Gas: 4.5%
- Pesticides: 6.3%
- Fertilizers: 29.0%
- Electricity: 20.7%
- Gasoline: 8.5%


Ag ~1.73% of US direct energy consumption

Target Atmospheric CO2: Where Should Humanity Aim?
J. Hansen, (Director, NASA Goddard Inst.) et al.

“If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted... CO² will need to be reduced from its current 385 ppm to at most 350 ppm, but likely less than that. An initial 350 ppm CO² target may be achievable by phasing out coal use (mainly for electricity generation)...and adopting agricultural and forestry practices that sequester carbon. If the present overshoot of this target CO² is not brief, there is a possibility of seeding irreversible catastrophic effects.”

Target Atmospheric CO2: Where Should Humanity Aim?

J. Hansen, (Director, NASA Goddard Inst.) et al.

Demonstration in Micronesia

www.350.org
Target Atmospheric CO2: Where Should Humanity Aim?

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Ag and forestry could reduce atm. CO2 by 50ppm through carbon sequestration using biochar.
Energy used for N-fertilizer

Leach (1976)

- NH4NO3: 76 MJ/kg
- Urea: 83.5 MJ/kg
- Anhydrous: 62.5 MJ/kg

100lbs N/ac = 2,812-3757 MJ
= 19-26 gallons gasoline

Courtesy of David Granatstein (WSU)
Rye, vetch & peas
~20” canopy
~155 lbs total N & ~60 lbs PAN

Oats & vetch
~26” canopy
~110 lbs total N & ~10 lbs PAN
High biomass crops for vegetable rotations: Sudhan grass

Sept 12th, 2006
Cover Crop Benefits

- Reduce erosion and improve soil structure
- Fix N and reduce nitrate leaching
- Supply N without increasing soil P or introducing human pathogens
- Increase soil organic matter
- Improve mycorrhizal winter survival
- Provide nectar & pollen for beneficial insects
- Reduce weed pressure

www.myco-labs.com/
## CLIMATE CHANGE

### Agriculture

<table>
<thead>
<tr>
<th>Part of problem</th>
<th>Part of solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestrained use of fossil fuels</td>
<td>Increased efficiency and switch to renewable energy</td>
</tr>
<tr>
<td>Long distance transport of ag inputs and products</td>
<td>Inputs are sourced locally and local food systems are restored</td>
</tr>
<tr>
<td>Soil organic matter depletion</td>
<td>soil building i.e. cover crops and compost</td>
</tr>
<tr>
<td>De-forestation</td>
<td>Reforestation and increased use of perennial crops</td>
</tr>
</tbody>
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