Strategies for Efficient Irrigation and Nutrient Management to Protect Groundwater Resources

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Conclusions (Playing it safe!)

- Pesticides often not key problem in GW
- Nitrogen is broadly problematic, requiring management of
  - ➢Irrigation
  - ➢Dose
  - ➢Mopping up

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Topics

- Section I: PCAP Sampling
- Section II: Pesticides
- Section III: Nutrients and the Nitrate Problem
- Section IV: Irrigation Effects

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Section I:

PCAPS Sampling

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Why PCAPS ? (Passive Capillary Samplers)

- Are capable of sampling both volume and concentration.
- Good for sampling conditions that change over time
- Easy to operate after initial investment.

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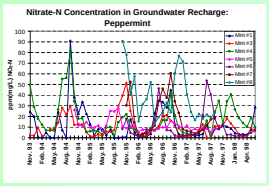
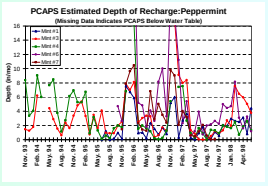
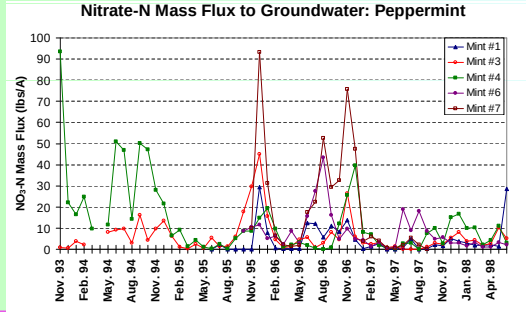
Concentration **Volume =**



Times





Mass

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PCAPS Installation

Section II:

Pesticides

All Data Percolation on Commercial Farms

Experiment

- Two PCAPS installed in each of 21 commercial agricultural fields within a 30-km radius in Lane County, OR.
- Water samples analyzed for both pesticide and nitrate content

Characteristics of Compounds Employed on Fields

Common Name	Water Solubility (ppm @ 20 °C.)	Aerobic Soil Half-Life (weeks)	Drinking Water Standard (ppb)
EPTC	3700	6.7	not available
Cycloate	75	4.3	not available
Pyrazon	400	21	not available
Ethofumesate	110	4.3	not available
Fonofos	13	11-16	10
Acephate	6.5×10^5	3	not available
Bromoxynil	0.08	1	not available
Oxyflourfen	0.1	120-130	not available
Paraquat	1.0×10^6	> 2	30
Propiconazole	110	10	not available
Chlorothalinol	1.2	1-4	not available
Myclobutanil	142	8	not available
Iprodione	13	3-8	not available
Diuron	42	17	14
Atrazine	**33**	**21**	**3**
Simazine	**3.5**	**16**	**3.5**
Terbacil	**710**	**52**	**90**

Observed Concentrations - Terbacil (drinking water standard 90 ppb)

Farm site	Date	Depth volume (cm.)	Concentration (µg/l)
Mint #1	'93 Nov. - '94 Oct.	9.6	21.6
	'94 Nov. - '95 Jan.	7.4	38
	'95 Feb. - '95 Apr.	4.3	12.2
	'95 May - '95 July	2.6	49.5
aggregate	'93 Nov. - '95 July	23.9	**32.4**
Mint #3	'93 Nov. - '94 Oct.	122.5	14.3
	'94 Nov. - '95 Jan.	68.7	10
	'95 Feb. - '95 Apr.	38.3	2
	'95 May - '95 July	53.4	27.5
aggregate	'93 Nov. - '95 July	282.9	**18.0**
Mint #4	'93 Nov. - '94 Oct.	263.2	108.7
	'94 Nov. - '95 Jan.	88.5	40
	'95 Feb. - '95 Apr.	54.8	16
	'95 May - '95 July	12.8	41.1
aggregate	'93 Nov. - '95 July	419.3	**80.0**

Observed Concentrations -

Atrazine (drinking water standard 3 ppb)
Simazine (drinking water standard 3.5 ppb)

Farm site	Sampling date	Chemical	Concentration (ppb)
Row Crop #2	June 1994	Atrazine	0.25
	July 1994	Atrazine	0.89
	July 1994	Atrazine	0.34
	October 1994	Atrazine	1.51
	January 1995	Atrazine	0.12
	February 1995	Atrazine	0.15
	March 1995	Atrazine	0.12
	April 1995	Atrazine	0.13
Blueberry #2	July 1994	Simazine	3.56
	August 1994	Simazine	1.79
	September 1994	Simazine	1.14
	November 1995	Simazine	0.20
	January 1995	Simazine	0.11
	May 1995	Simazine	0.736
Row Crop #4	August 1994	Atrazine	0.34
	October 1994	Atrazine	0.25
	January 1995	Atrazine	1.23
	April 1995	Atrazine	0.11

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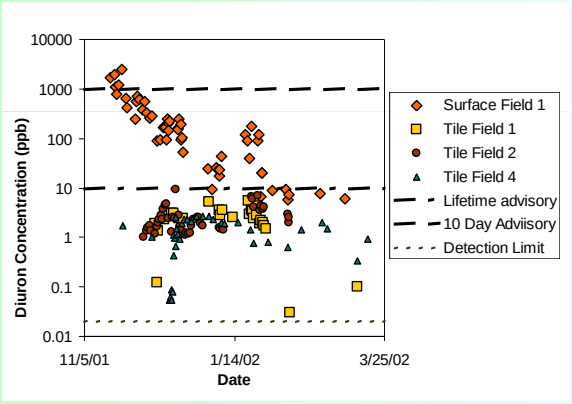
The same is not true of surface water…diuron



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Pesticide in Groundwater?

- Likely to be much more dilute with greater depth
- No reports of high well concentrations or pesticide problems with proper use (State sampled 100 wells with high nitrate: no wells exceeded drinking water standards for pesticides)
- Nitrates and surface water quality are still OR's biggest issues.

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Section III:

Nitrates

Data Collected in Lane and Clackamas County

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Cropping Systems

- Blueberries - 2 sites
- Rye Grass Seed - 1 site
- Tree Fruits (apple, peach) - 2 sites
- Organic Vegetables - 2 sites
- Peppermint - 8 sites
- Vegetable Row Crops - 6 sites

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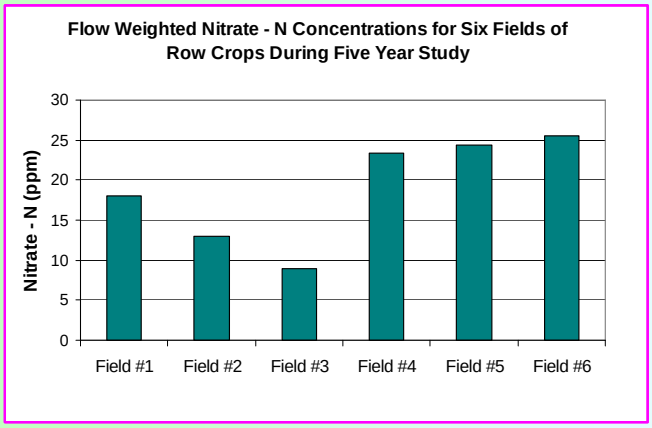
Lane County Row Crops



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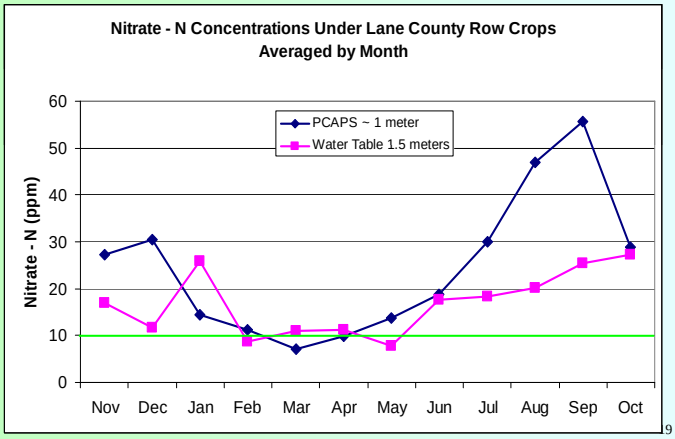
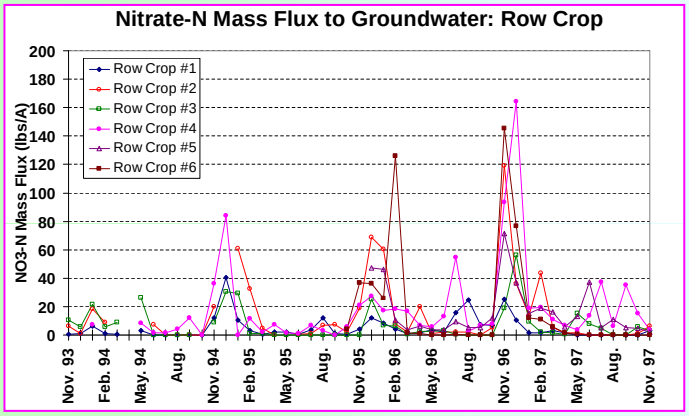
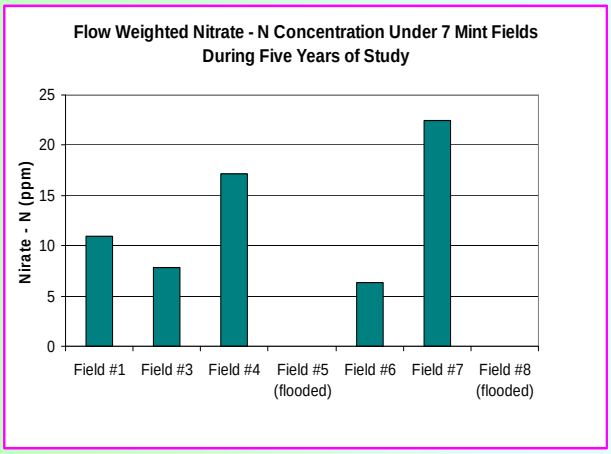
Lane County Row Crops





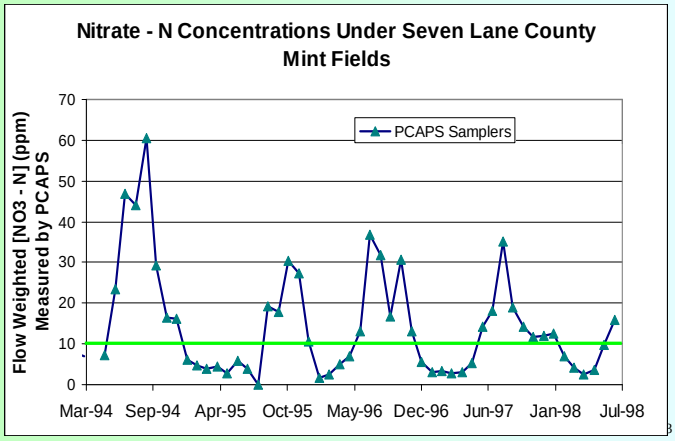
~~#1: 58 lb/A/yr~~ ~~#2: 148 lb/A/yr~~ ~~#3: 80 lb/A/yr~~
#4: 205 lb/A/yr #5: 198 lb/A/yr #6: 242 lb/A/yr

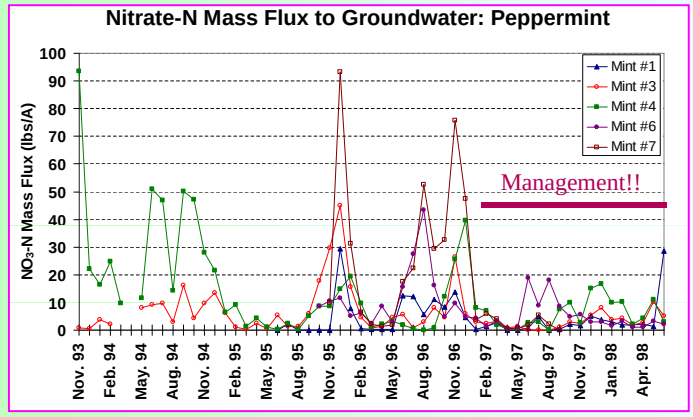
Lane County Mint Crops



Trying to shed some light on that age old question
"How much fertilizer does my crop need?"

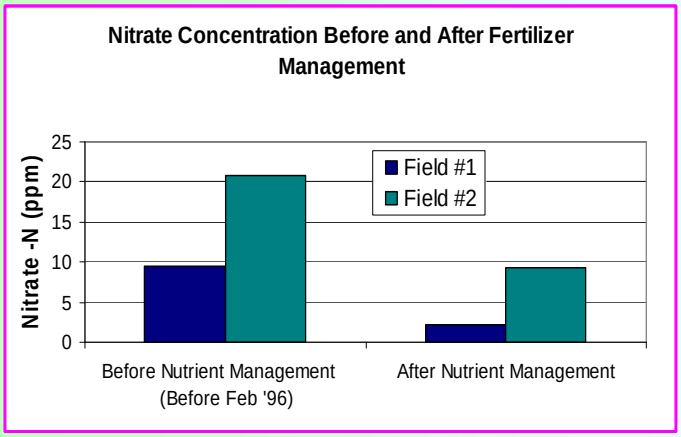
Lane County Mint Crops





Site 1: 49 lb/A/yr Site 3: 75 lb/A/yr
Site 6: 78 lb/A/yr Site 7: 179 lb/A/yr

Organic Farming



Cover Crops Impact on Percolation Quality

- Samples collected after every 2 cm of rain for 12 years

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Experimental Plots

- 32 PCAPS originally installed, 26 remain in operation after 6 were discontinued due to flooding.
- Rotation of plots, crop yields and all chemical inputs were carefully recorded.
- Treatments included cover crop vs. fallow and 3 fertilizer rates (N0, N1, N2).
- All samples analyzed for nitrate.

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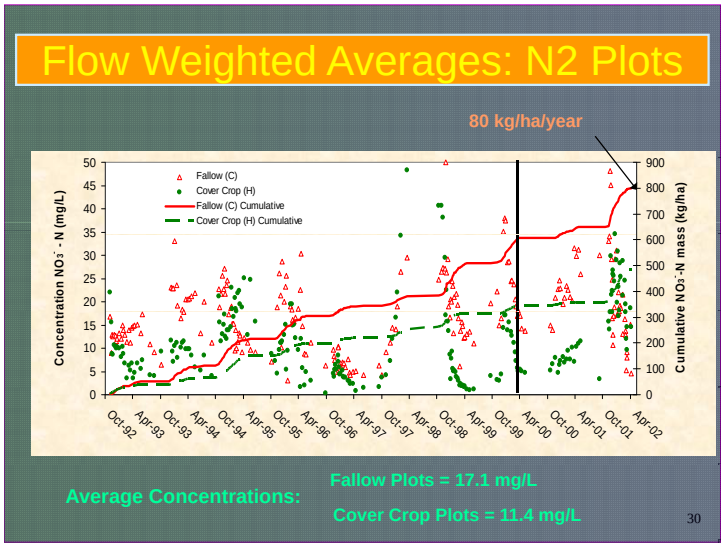
Flow Weighted Averages: N2 Plots



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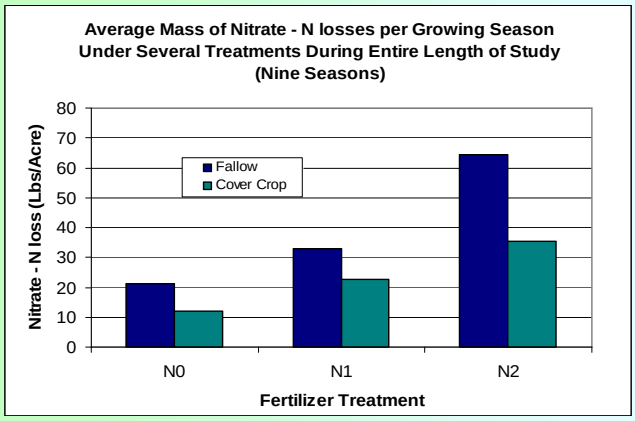
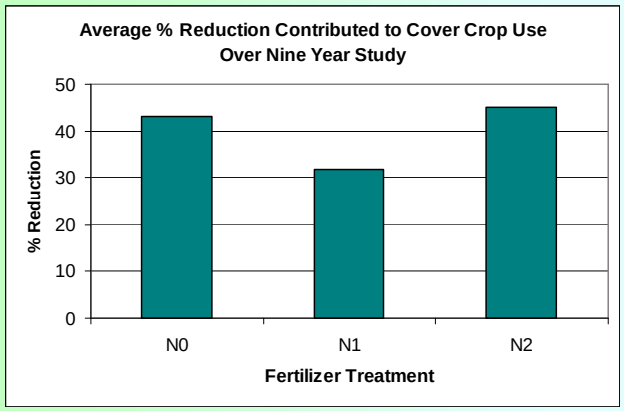
Nitrate Mass Below Root Zone at the NWREC



Cover Crops Are Effective



Section IV

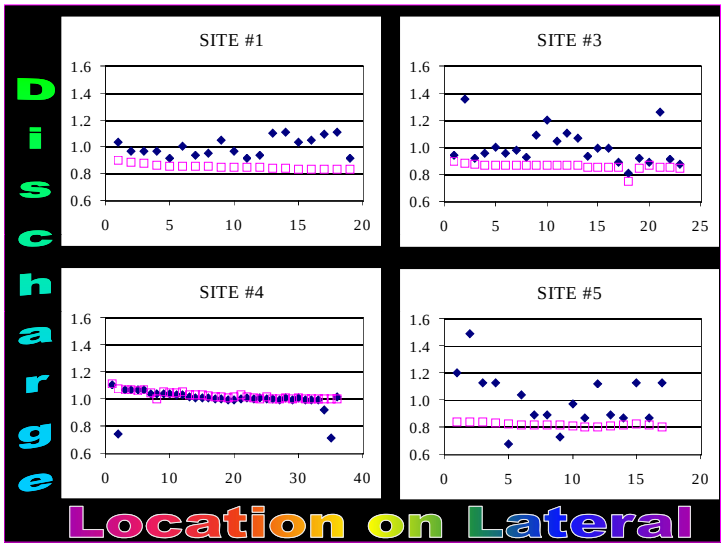
Irrigation and Nitrate Leaching

Introduction

- Field observations of sprinkler irrigation systems revealed a lack of maintenance.
- Sprinkler systems often maintained with a stockpile of miscellaneous parts of different sizes and specifications.
- This result in non-uniform irrigation and inconsistent spraying pressures and discharges.

Field Evaluation

- Study was conducted on 12 commercial agricultural fields in Lane County, OR which utilize hand-move or side-roll sprinkler irrigation systems.
- One sprinkler lateral was selected from each field for evaluation.



Irrigation Conclusions

- Improper maintenance such as using mismatched sprinkler nozzles leads to non-uniform water application
- Non-uniform irrigation leads to non-uniform nitrate leaching.
- This can lead to deficient nitrogen for crops or excess nitrate to groundwater

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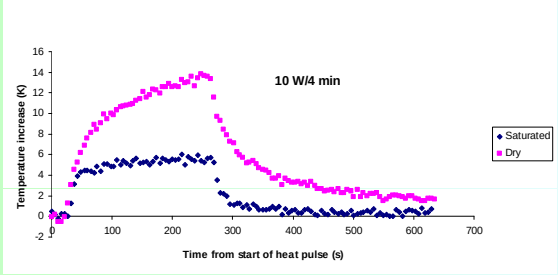
What if we could measure the water content and water flow of sediments at thousands of points?

Concept: Use a fiber optic cable both as a heater and a sensor. Water is hard to heat, and if flowing, takes heat away.

First Laboratory Experiment

Results of a pulse of heat



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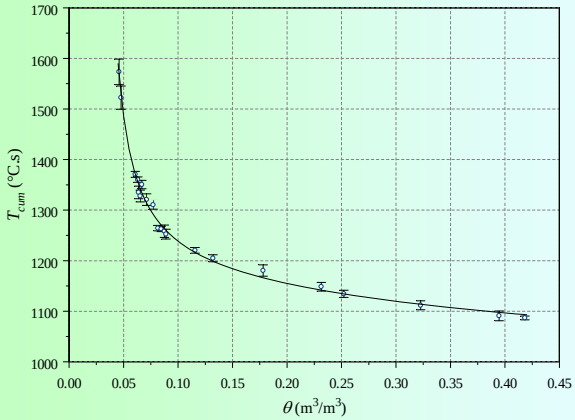
Calibration of Heat Pulse Method



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Installation in irrigated Ag

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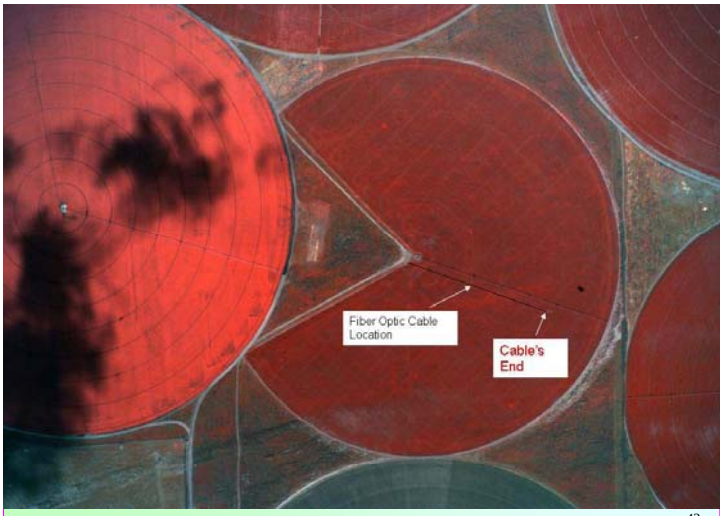
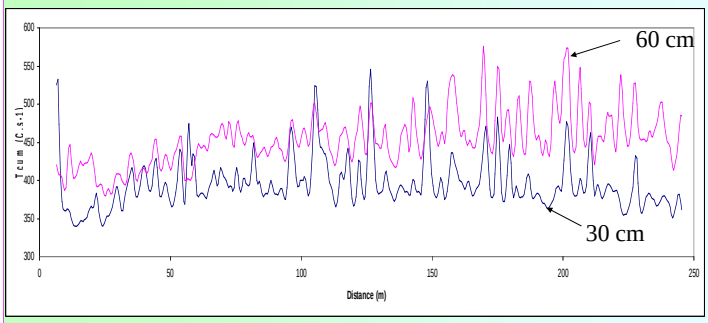


Irrigation…

How Not to Irrigate…

August, 2009 Results: 500 simultaneous moisture measurements



Conclusions

- Large quantities of nitrogen are being lost
- This indicates an economic loss to the growers
- This is associated with increased concentrations observed in aquifers
- Control will require
  - ➢Better irrigation management
  - ➢Improved nutrient management
  - ➢Attention to off-season soil cover