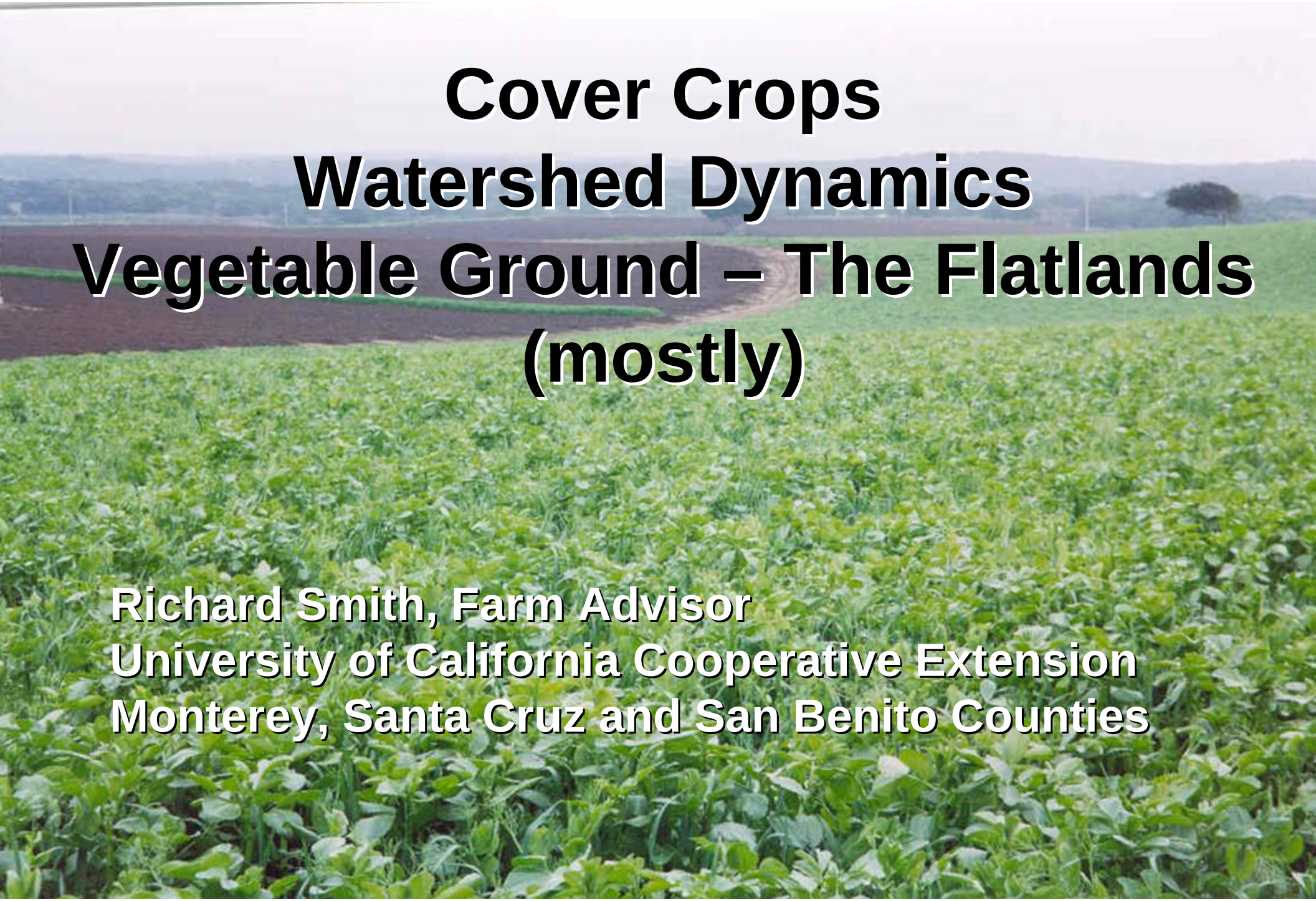


Cover Crops
Watershed Dynamics
Vegetable Ground – The Flatlands (mostly)

Richard Smith, Farm Advisor
University of California Cooperative Extension
Monterey, Santa Cruz and San Benito Counties

Water Quality Issues With Vegetable Production

- Sediment and nutrient TMDLs are issues that growers need to address
- Organic producers can have these problems as well

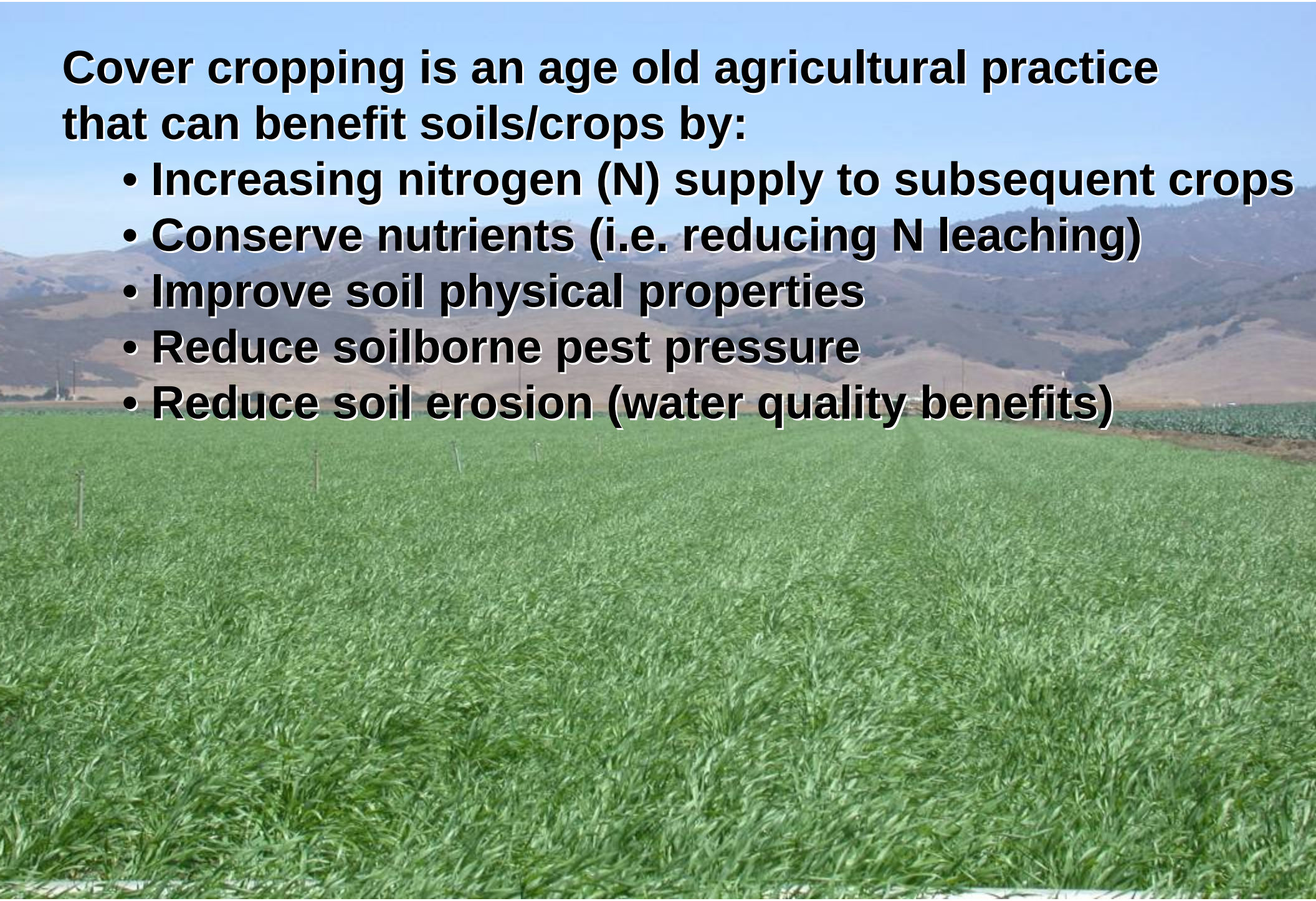
Nitrogen TMDL
Current level:
10 PPM total N

Phosphorus TMDL
Current level:
0.5 PPM

Both TMDL levels are likely to be reduced

Techniques to Maintain Nutrients and Sediment in the Field

- Cover Crops
- Vegetative Ditches



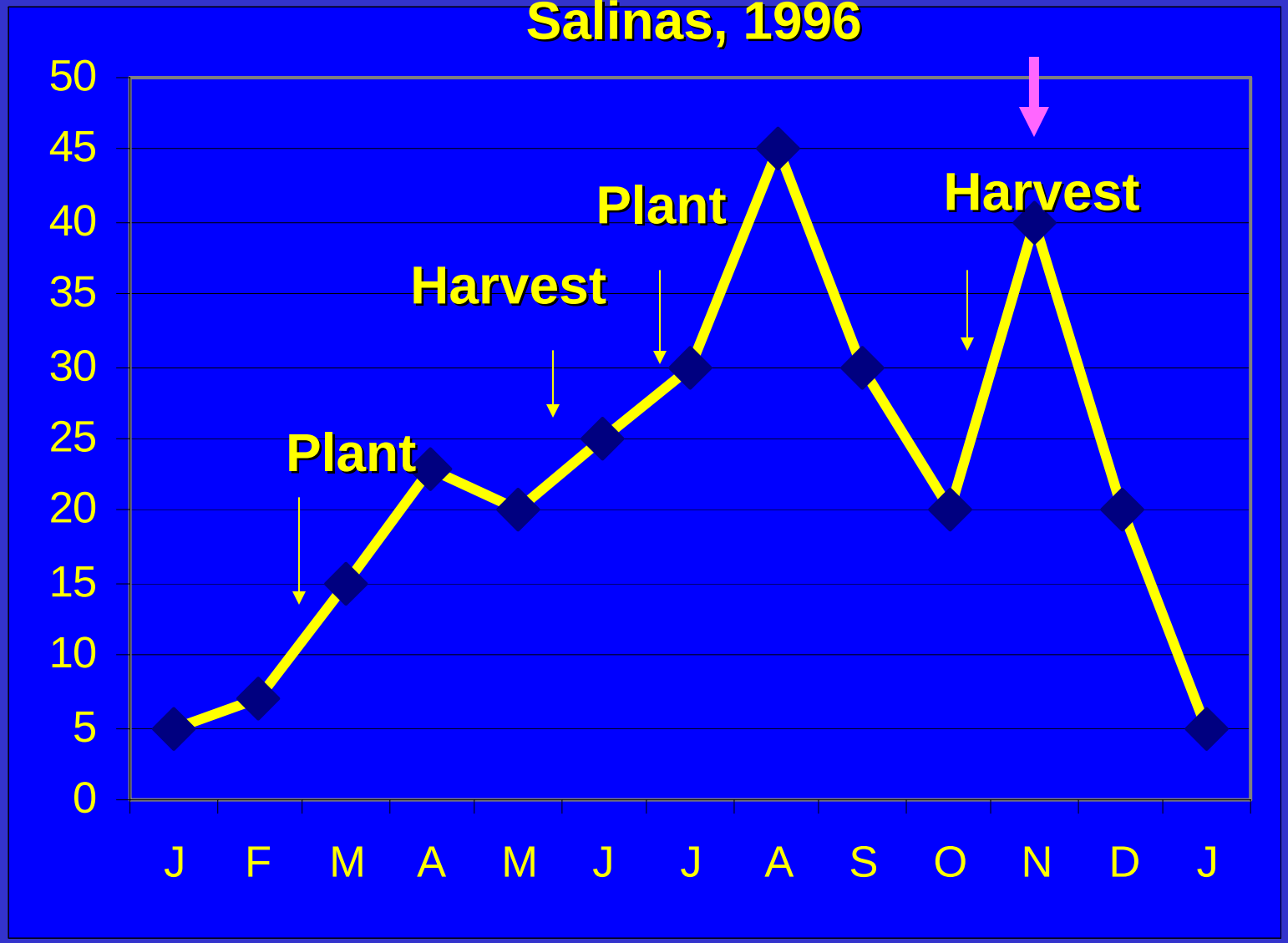
Cover cropping is an age old agricultural practice that can benefit soils/crops by:

- **Increasing nitrogen (N) supply to subsequent crops**
- **Conserve nutrients (i.e. reducing N leaching)**
- **Improve soil physical properties**
- **Reduce soilborne pest pressure**
- **Reduce soil erosion (water quality benefits)**

Impacts on Nitrate Leaching

- Winter cover crops are grown during the critical time of the year
- They can absorb a large percentage of residual soil nitrogen (65 – 70%) and sequester it in the plant biomass during the winter when leaching rains occur

Soil Nitrate Levels in Soil Over Season




Fall-grown cover crops
Mustards, Buckwheat and Barley
August/September to October/November

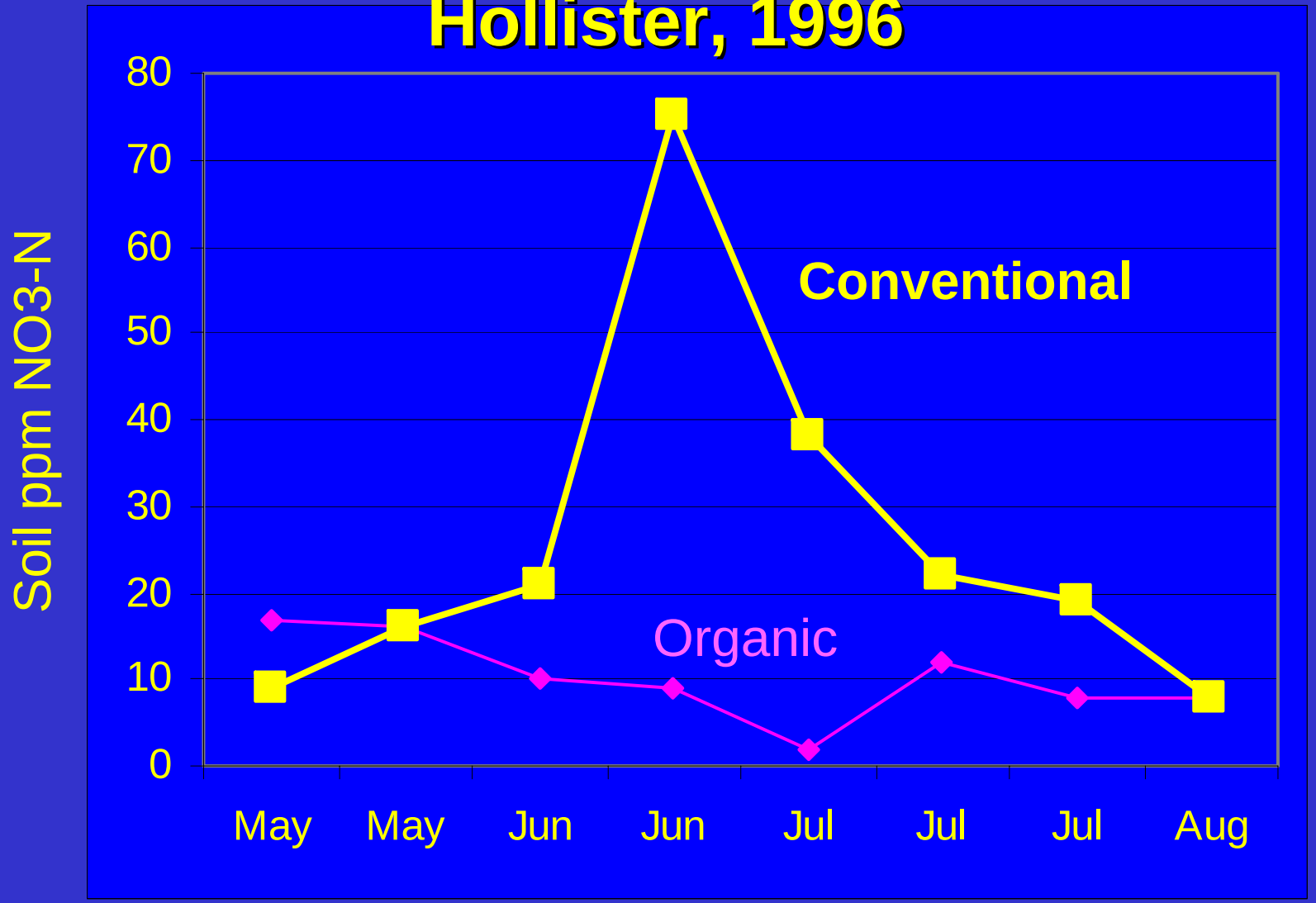
Nitrate-Nitrogen Captured in Resin Bags (@ 3 ft) Following 2 Month Rainy Period*

January 2004

Cover Crop Treatment	Kg/Ha
Cereal Rye 'Merced'	15.6
White Mustard 'Ida Gold'	14.1
Indian Mustard 'ISCI 61'	7.6
Bare Fallow	43.0

* 4.7 inches precipitation

Comparison of Organic and Conventional Onions
Hollister, 1996



Residual Soil Mineral N

- Nitrate is typically low in organic production systems
- It is unclear to me how large a problem nitrate leaching from organic farms is

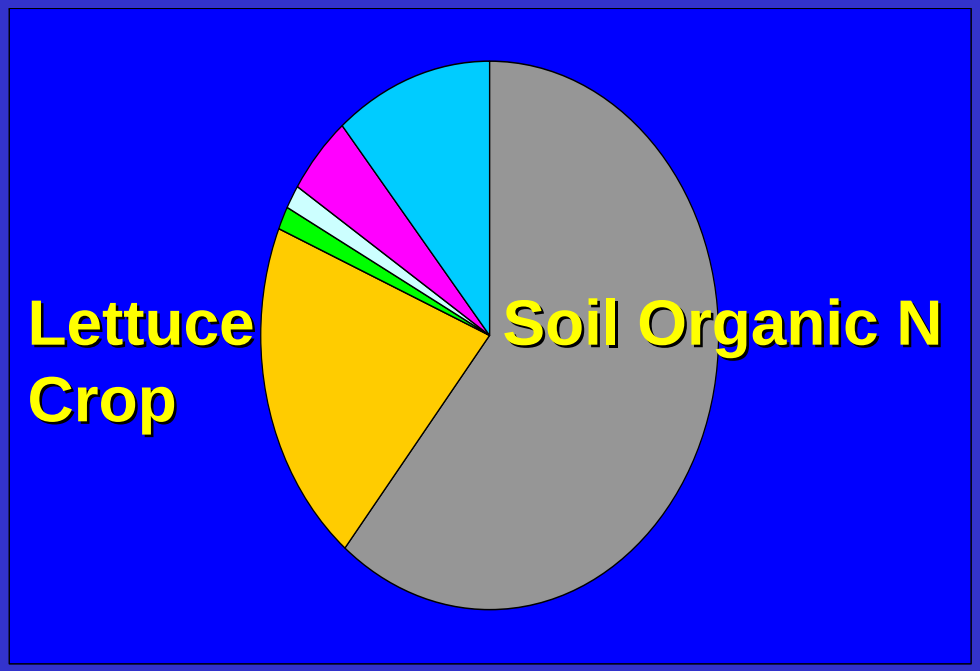
Ten Year Comparison of Management on Nitrogen in Soils (1989-1998) - UCD

Treatment	Organic Matter	Nitrogen Storage* kg N/ha	Nitrogen Loss kg N/ha
Short Rotation Conventional (Low Biomass)	1.10	0	452
Organic (High Biomass)	1.46	901	90

* This difference is probably attributed to N storage in soil organic matter:
(i.e. soils with 1% organic matter contain 2,800 lbs of N)

Poudel et al. 2001

Fate of Cover Crop Nitrogen



Louise Jackson, 2000

- Generally from 10-30% of cover crop N is taken up by the first subsequent cash crop
- However, one study showed that 73% of cover crop N was taken up in five subsequent cash crops following incorporation

Phosphorus as a Concern for Organic Vegetable Production

Phosphorus

- Phosphorus (P) is essential to all forms of life on earth and has no direct toxic effects to humans or animals.
- Concerns associated with P center on its stimulation of biological/ecological activity in water bodies.
- P is normally limiting in most fresh water systems, however elevated P concentrations of as little as 0.02 to 0.10 ppm can stimulate algal growth and cause environmental problems.

Accumulation of P in Salinas Valley Soils*

Site Background	Soil P ppm
Production field (intensive)	**92.6**
Research station (less intensive)	**53.9**
Pasture (with animals)	**37.3**

* Sites within 0.25 mile of each other

Organic Production and Soil Phosphorus

- **Organic farms can have high P as well**
- **6 organic farms sampled and the soil P levels ranged from 33 – 196 ppm Olsen P**
- **Possible reason:**

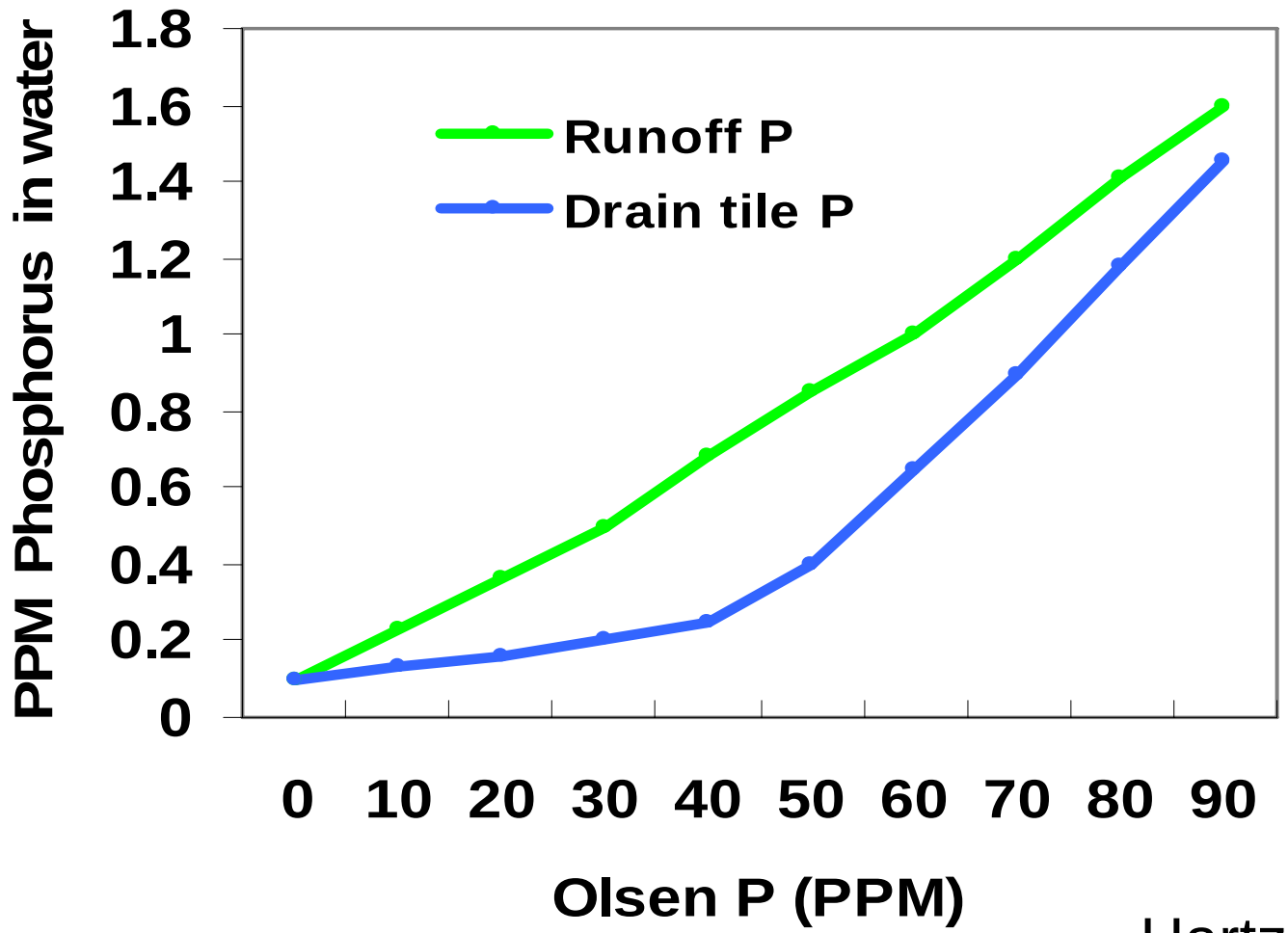
  Compost typically contains 6-10 lbs P/ton

Accumulation of P at an Organic Farm*

Site Background	Soil P ppm
Intensive garden	93.5
Production field (less intensive)	33.8
Adjacent Pasture (no animals)	9.3

* Sites within 0.10 mile of each other

High Soil P Levels Increase the Risk Of P Movement from Production Fields



Hartz, 2002

Management of Phosphorus Fertilization

- Soil tests provide the best measure of available P for crop growth
- The soil test that we typically use in this part of California is the Olsen Bicarbonate Extraction test (used on soils > pH 6.5)

Adequate Phosphorus Levels in Soil for Various Crops

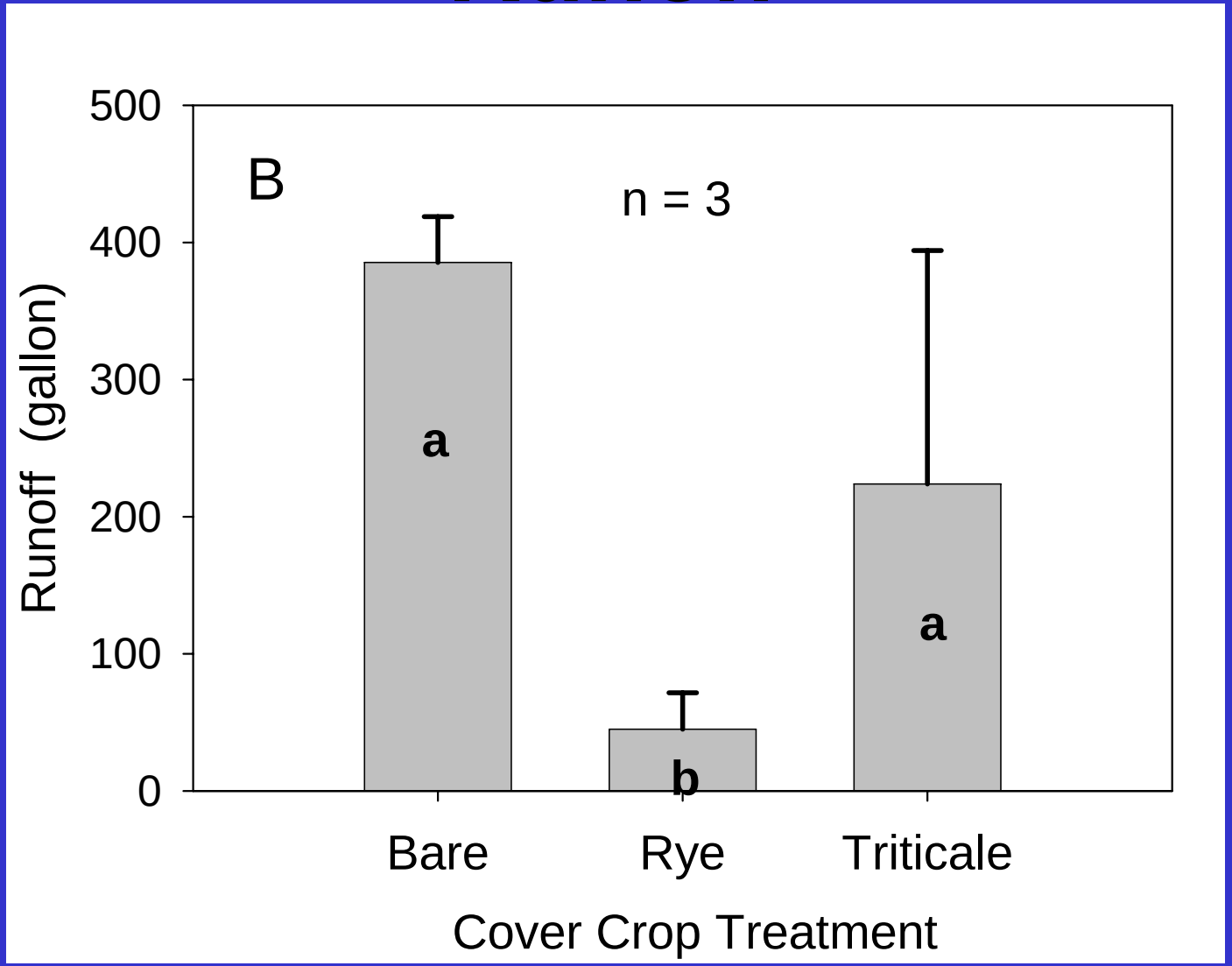
Olsen P Soil Test Value	Crop Type
10 - 15	Most Row Crops
20	Warm Season Vegetables
35 – 40 55 (lettuce)	Cool Season Vegetables

Loading of Phosphorous

- Lettuce only removes 10 – 15 lbs P per crop
- Depending upon the amount of compost that is added, it could add further amounts of P to the soil and “load” the soil with P that may have water quality impacts

Sediment Loss as a Concern for Organic Vegetable Production

Cover Crops Reduce the Quantity of Runoff

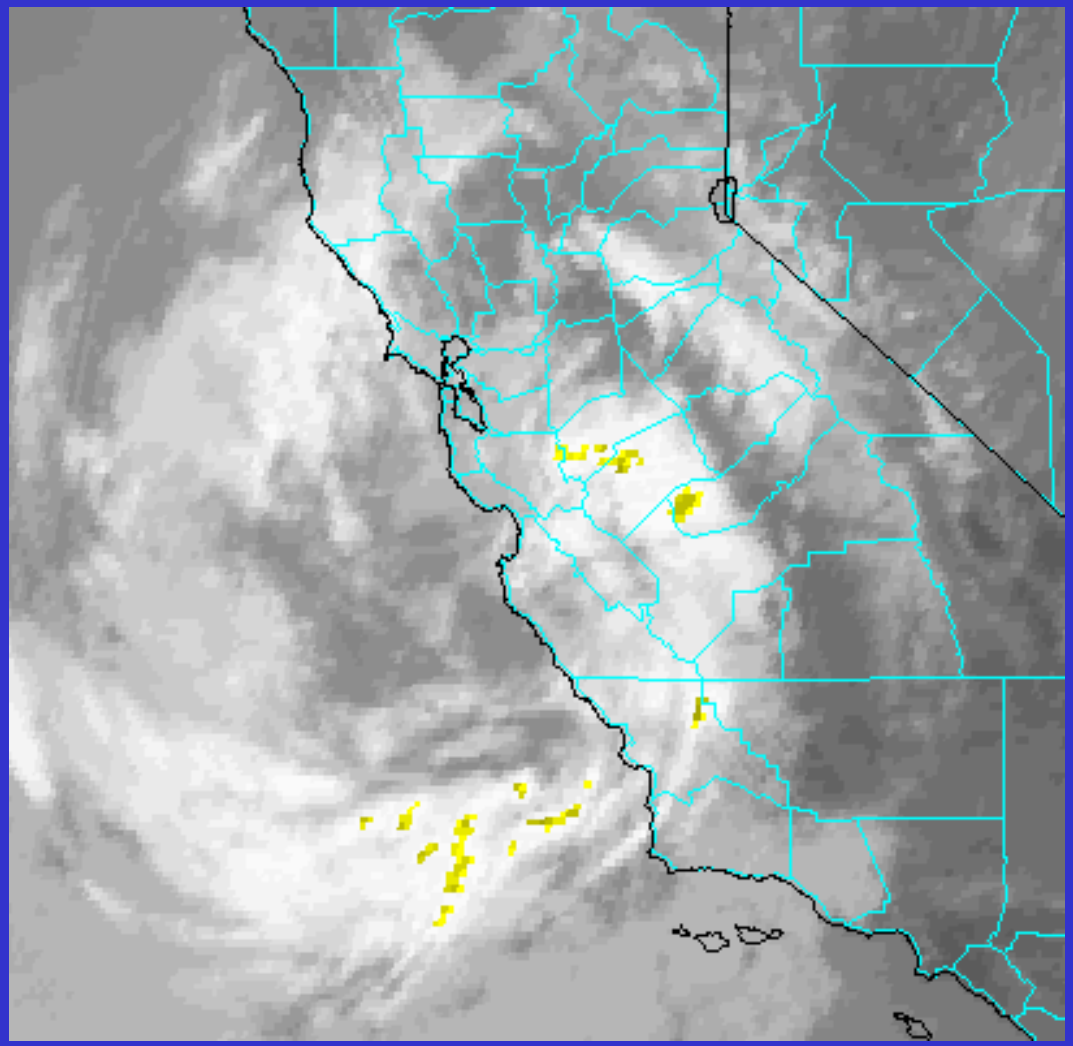


Cover Crops Improve the Quality of the Runoff Water

Importance of Cover Crop Use

- In the Salinas Valley, many vegetables (except broccoli) return low quantities of biomass back to the soil, possibly further aggravating N loss from the soil system, for instance lettuce returns only 1 ton/A
- However, cover crops can routinely return 3-4 tons/A of biomass to the soil
- Cover crops provide a needed source of carbon for vegetable crop rotations in the Salinas Valley

If Cover Crops are So Beneficial, Why are They Not More Commonly Planted



- Direct cost ($150 to $200/A)
- Opportunity Costs
- Risk of missing planting schedules
- Dealing with cover crop residue in the spring (wet soils)
- Negative impacts of cover crop use (pests)

Reality Check on Cover Crops

- There are probably no more than 5% or so of the acreage in the Salinas Valley that is cover cropped
- Organic producers generally cover crop a greater percentage of their land
- High land rents are the biggest problem for greater use of cover crops

Cover Crop Systems to Improve Water Quality

- Traditional winter cover crop – has significant limitations in the Salinas Valley
- Fall cover crops – has increased to some degree due to the use of mustards
- Other options…?

Minimum tillage incorporation of cover crops

Conservation Tillage

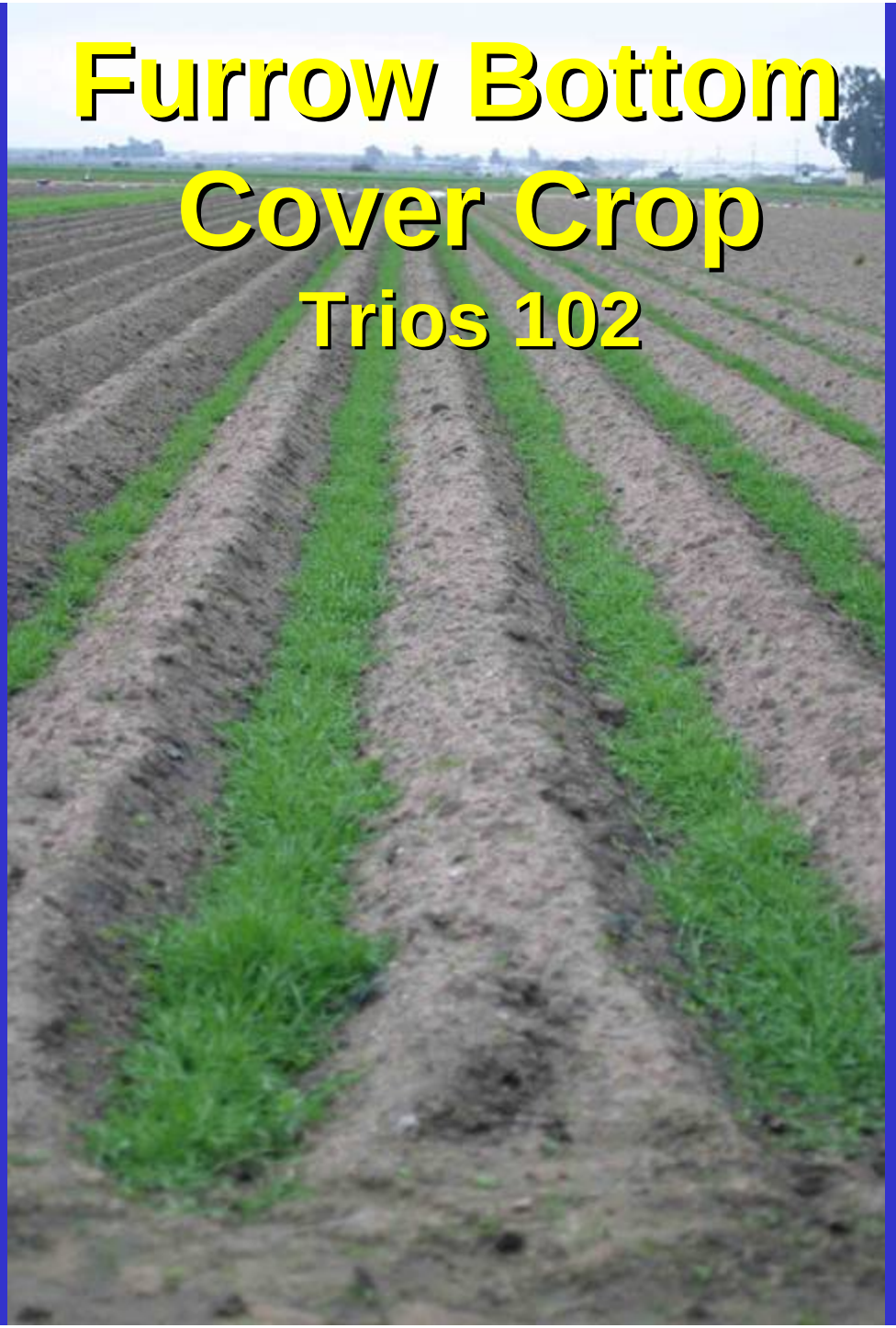
Cover Cropped residue on soil surface

Bare

Planting into Residue

Cover Crop Water Quality Trial

Full Cover Crop



Furrow Bottom Cover Crop

Trios 102

Sediment and Nutrient Concentrations in Run-off

Treatment	Turbidity	Total-P	Total-N
Full Cover Cover Crop	52	1.4	1.2
Furrow Cover Crop	460	1.3	1.4
Bare	910	1.3	2.4

Strawberry Runoff Trial

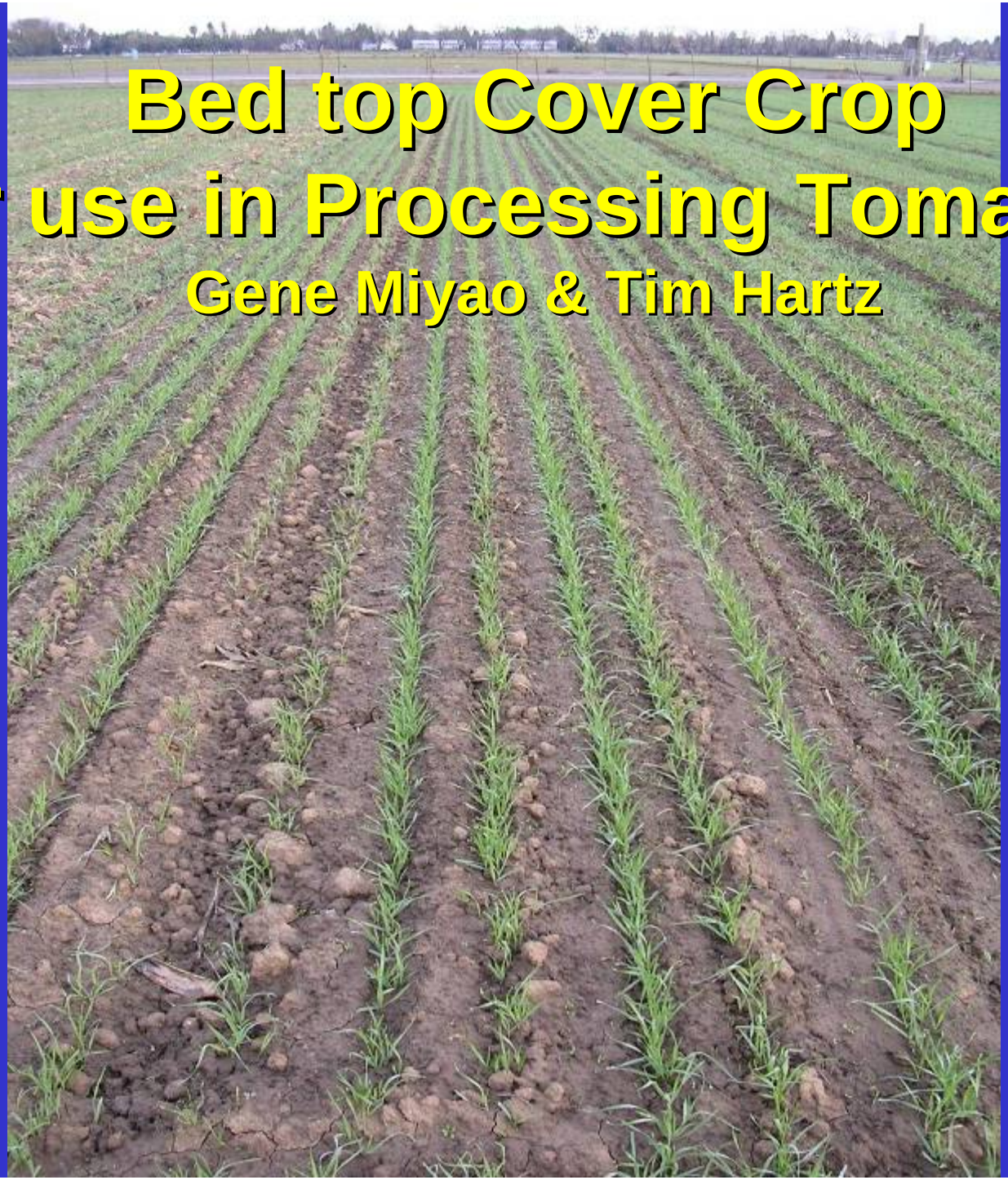
Sediment and Nutrient Concentrations in Run-off

Average of 6 storm events

Treatment	Turbidity	Total-P	Total-N
Triticale	320	0.89	2.05
Barley	266	0.80	2.04
Bare	909	1.42	3.86

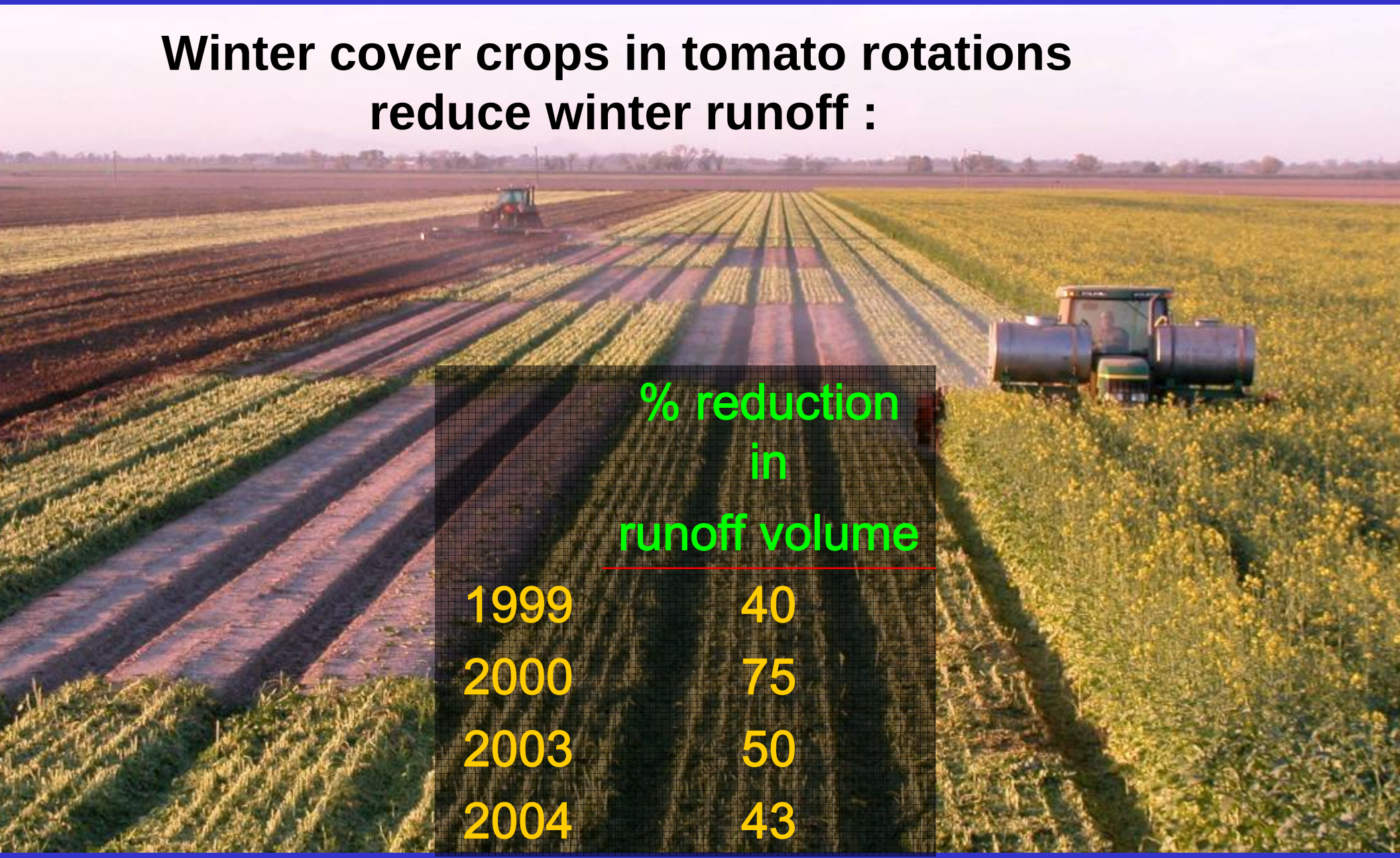
Bed top Cover Crop
For use in Processing Tomatoes

Gene Miyao & Tim Hartz




Cover Crop Management:
Killed (chemically) and mechanically incorporated
or strip tilled and then transplant tomatoes

Winter cover crops in tomato rotations reduce winter runoff :



	% reduction in runoff volume
1999	40
2000	75
2003	50
2004	43

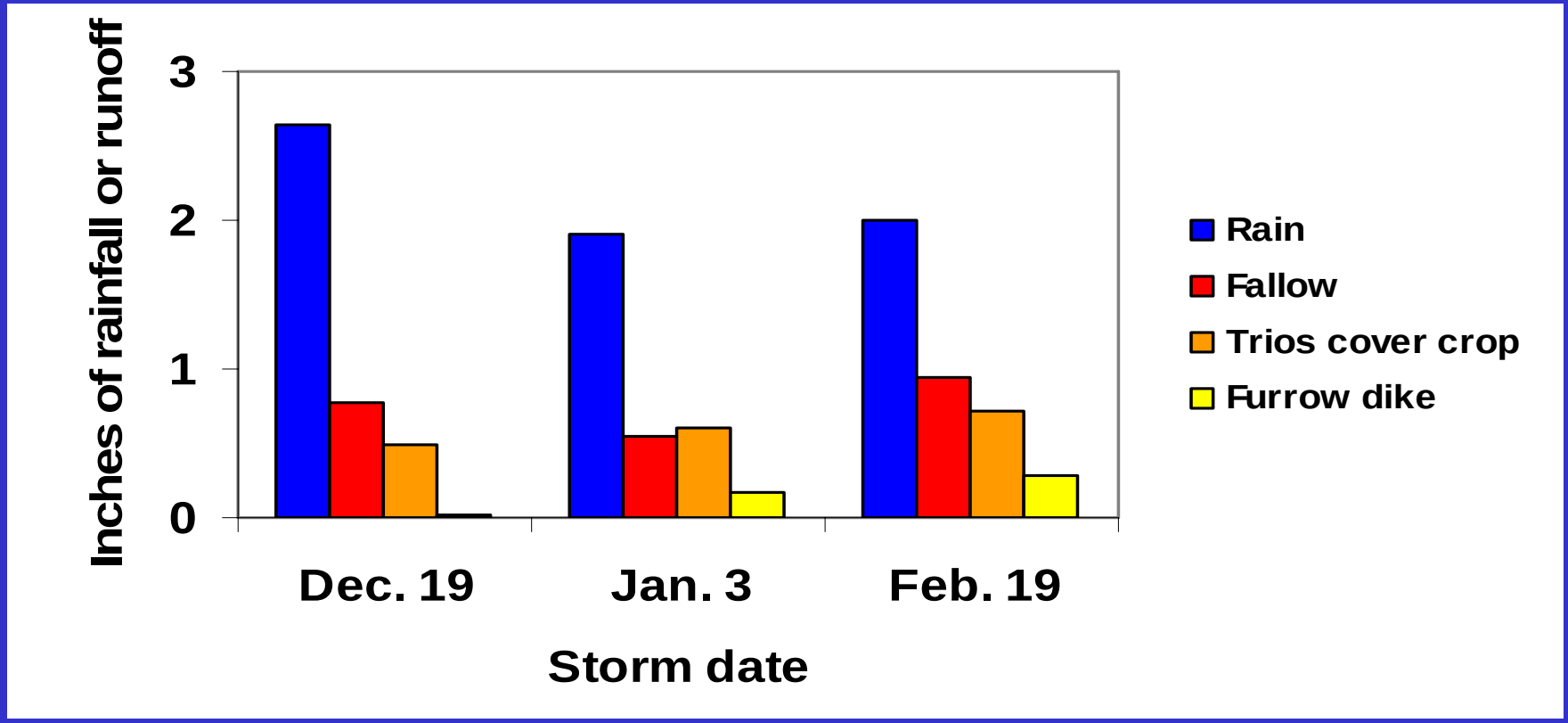
2005 winter cover crop studies :

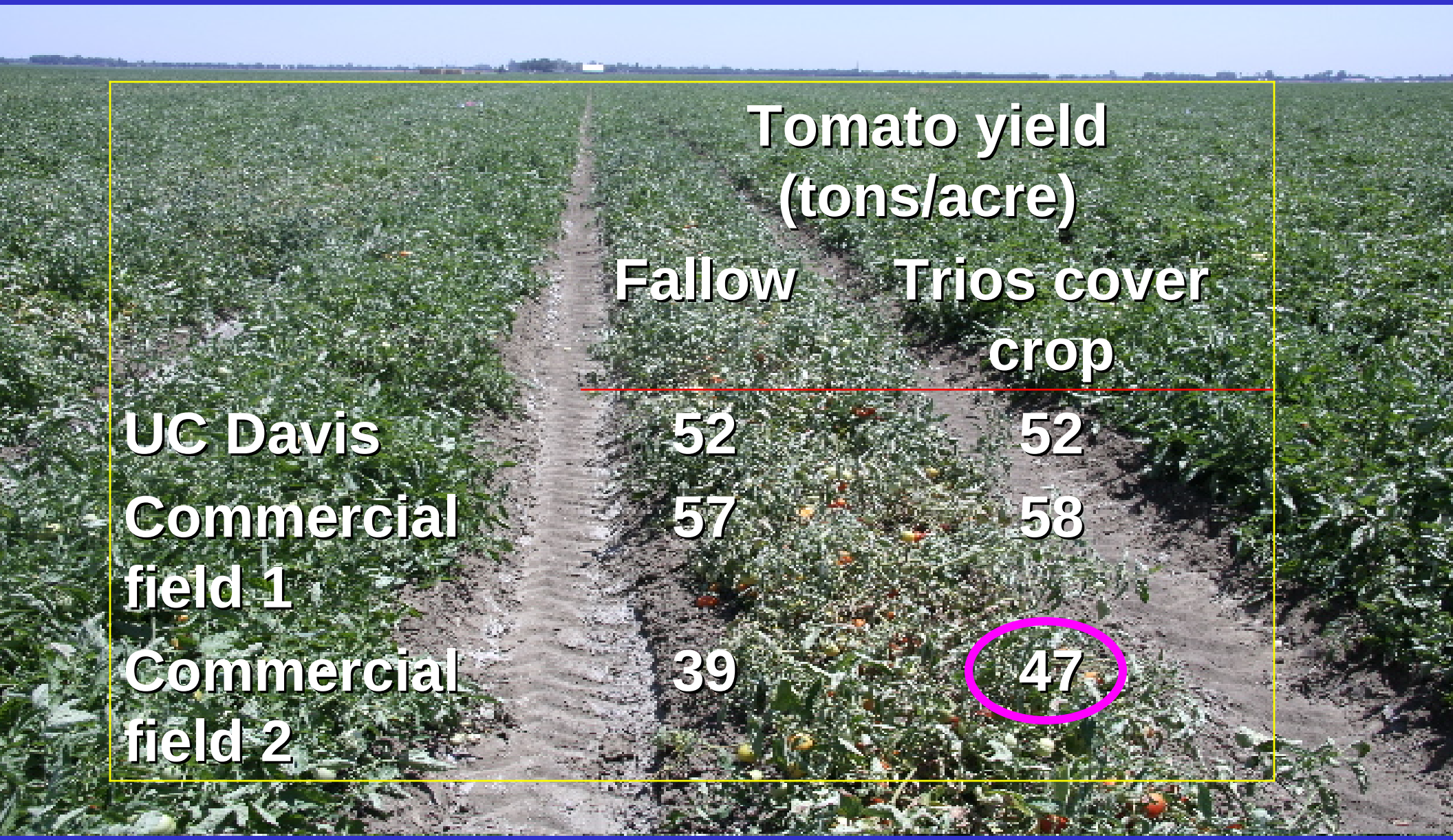
- Low biomass cover crop
- Furrow dikes

Low-growing bedtop Cover crop

Furrow Dike

2005-06 UC Davis runoff trial :





	Tomato yield (tons/acre)	
	Fallow	Trios cover crop
UC Davis	52	52
Commercial field 1	57	58
Commercial field 2	39	47

Impact of Vegetated Ditches

Mike Cahn and Don Weston


Vegetated Ditch
Barley


Sediment Trap

Comparison of Conservation Practices: Nutrients and Sediments in Sprinkler Run-off

Treatment Description	Total N	NO3-N	Total P	Soluble P	Total Suspended Solids	Turbidity
	---------- ppm ----------					NTU
Untreated control	7.45	2.17	3.33	1.09	1540	4130
Sediment trap	6.15	2.42	3.03	1.18	1165	3447
Vegetated ditch	3.55	2.32	1.80	1.00	740	1689
PAM (7.5 ppm)	1.40	1.94	0.88	0.81	50	54
$LSD_{0.05}$	2.37	0.32	0.95	0.18	584	1418

Summary:

* To improve water quality in vegetable operations, plant cover provided by cover crops plays a very important role
* The challenge is to find ways to include the use of cover crops on high rent ground