

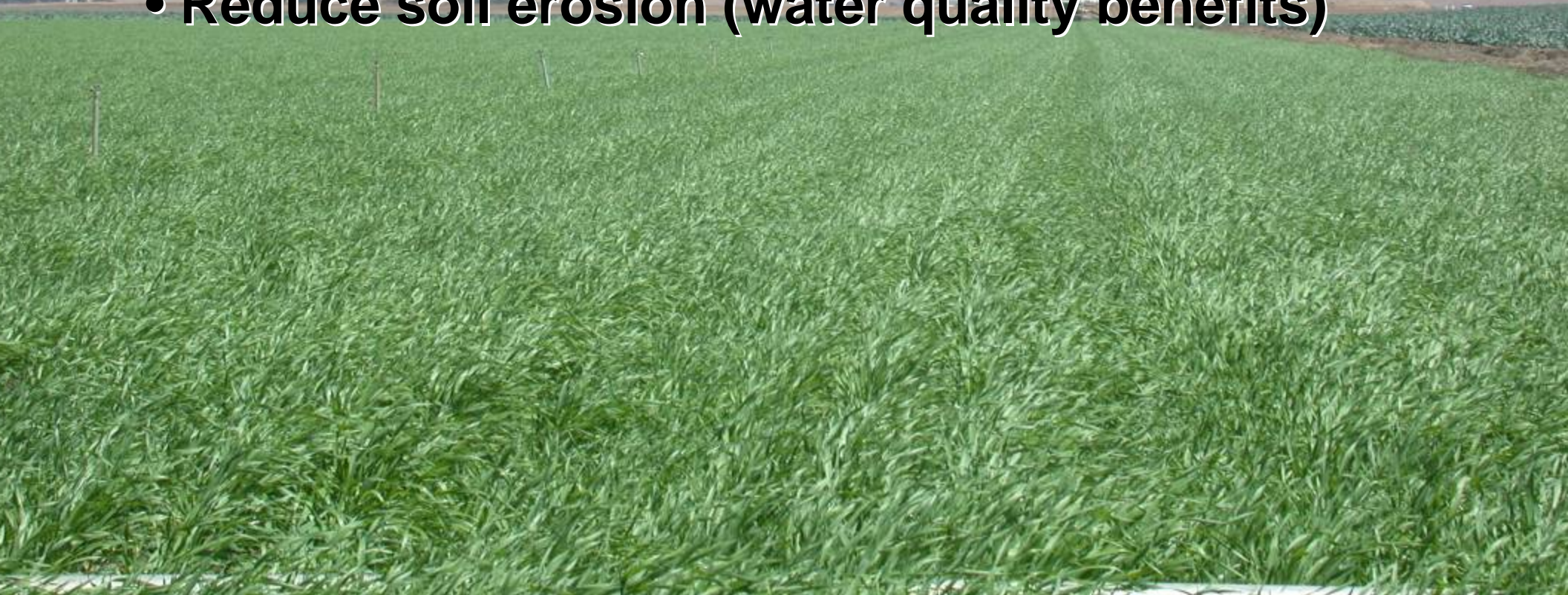


Cover Crops for Organic Vegetable Crop Production

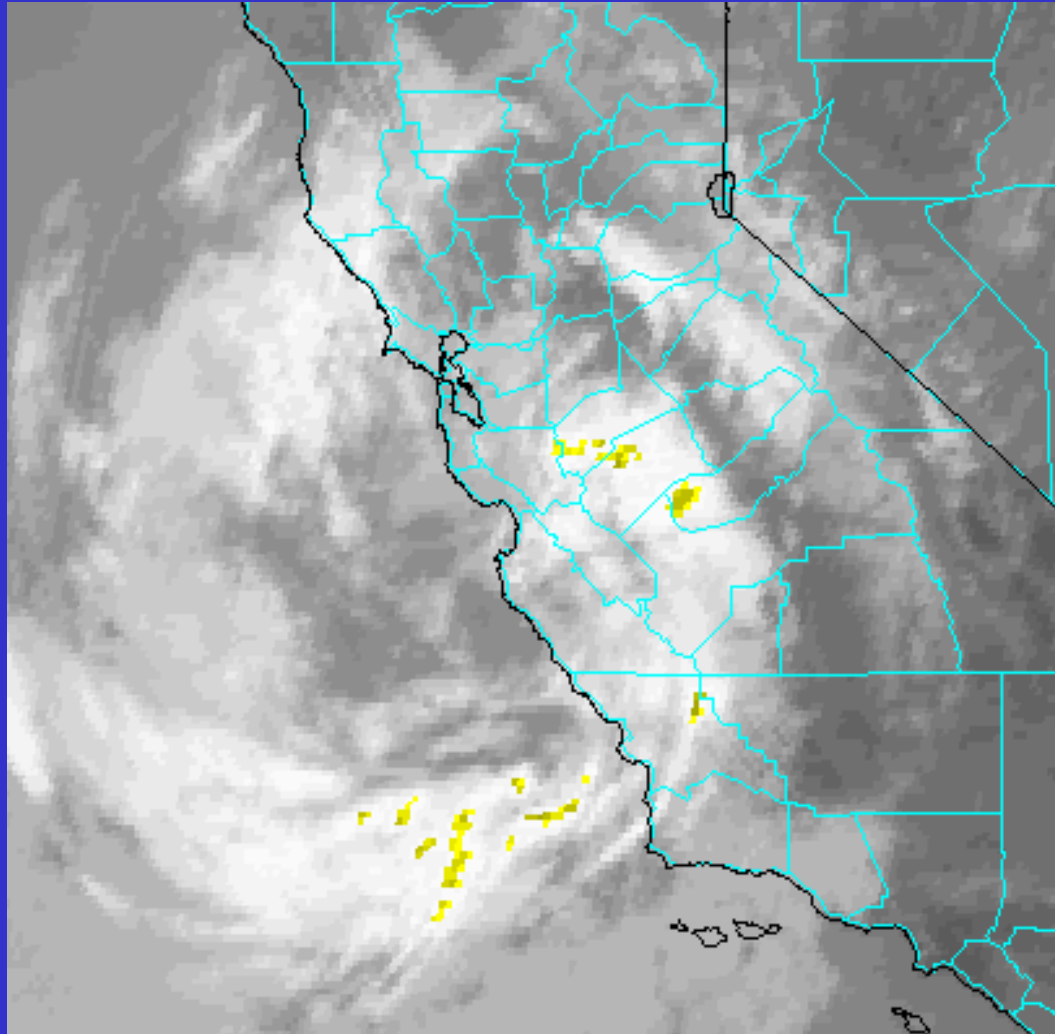
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Cover cropping is an age old agricultural practice that can benefit soils/crops by:

- **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)**



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)

Reality Check on Cover Crops

- There is probably no more than 5% of vegetable acreage in the Salinas Valley that is cover cropped
- High land rents are the biggest problem for greater use of cover crops
- Organic producers generally cover crop more
- Organic growers on the Central Coast that use cover crops average 1.5 to 2.0 crops per year vs conventional growers that can produce an average 2.0 to 2.5 crops per year



Cereals



Legumes



Mustards

Others

A photograph of a field with two distinct types of vegetation. The foreground is dominated by a dense stand of tall, green and yellowish-brown grasses. The background features a large, flat-topped mound of dark green, leafy plants. The text labels are overlaid on the image: 'Sweet Clover' is positioned in the upper right area, and 'Oats' is in the lower left area.

Sweet Clover

Oats

Vegetable Cover Crop Planting Slots

- **Planting Slots**
 - **Winter (Oct. – March)**
 - **Summer**
 - **Fall (Sept. to Oct.)**

Cover Crop Roles

1. Nutrient input and cycling
2. Pest management impacts
3. Soil quality impacts
4. Water quality impacts
(discussed yesterday)

1. Nutrient Input and Cycling of Cover Crops

- Cereals and mustards are good at scavenging N from the soil. In the Salinas Valley, there are often high levels of residual N in the soil left over from intensive crop production**
- Legumes have the ability to fix atmospheric nitrogen and make it available for plant growth**

Productivity of Cover Crops

Six year Average

Cover Crop	Biomass T/A	Nitrogen Lbs/A
Cereals	3.8	131
Legumes	2.0	146
Cereal/Legume Mix	3.1	177
Mustards*	2.3	197

* One year's data

Release of N from Cover Crops

- When cover crops are incorporated into the soil, microbes begin to decompose the tissue and the complex forms of nitrogen that they contain (i.e. proteins)
- Plant available forms of nitrogen (ammonium and nitrate) are released to the soil through this process

**Cover Crop
Proteins**

Microbes

Microbes

Depends upon
C:N; lignin and
Polyphenols

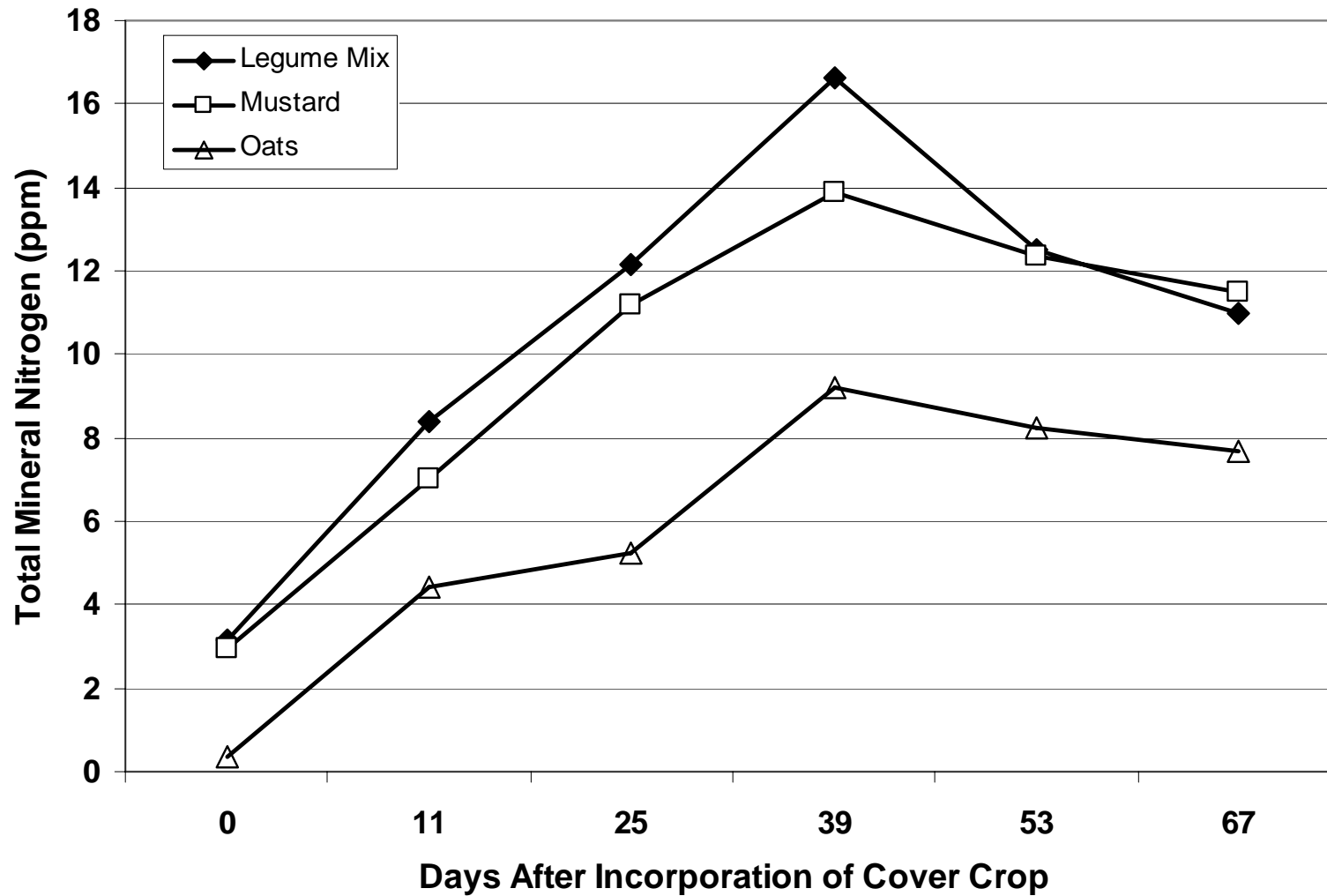
**Available
Mineral
Nitrogen**

Typically <10-30% of cover crop
N is taken up by the first subsequent
crop; however much more is taken up by
later cash crops (i.e. 73%)

Nitrogen release from cover crop residue based on the N content

Nitrogen Release	Percent N in Cover Crop	Examples of Cover Crops
Will Tie up N	0.5	Cereal Straw
Will Tie up N	1.0	Cereal Straw
Will Tie up N	1.5	Cereal at heading
May Tie up N	2.0	Cereal pre heading
May Tie up N	2.5	Mustards at heading and Imm. cereal
Will Release N	3.0	Mustards, legumes and juvenile cereal
Will Release N	3.5	Legumes and immature mustards
Will Release N	4.0	Legumes

N Release Pattern from Cover Crops





Cereal Residue
High C:N

Legume Residue
Lower C:N

Release of N from Cover Crops

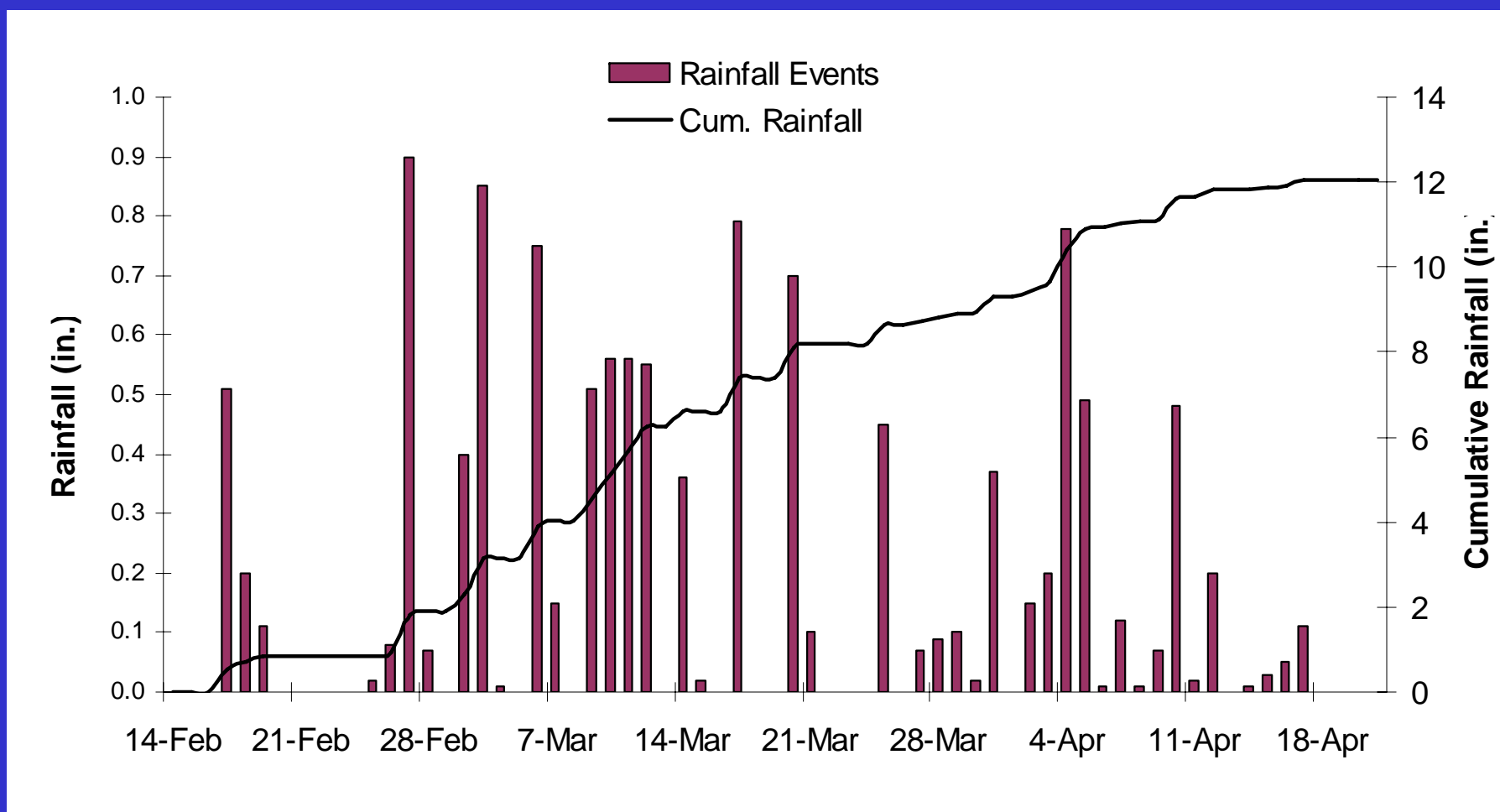
- The ideal scenario would be that the release of N from cover crop residue would match the N demand by crops (i.e. fast enough to match crop demand, but not so fast to leach)

2006 Cover Crop x Fertilizer Trial

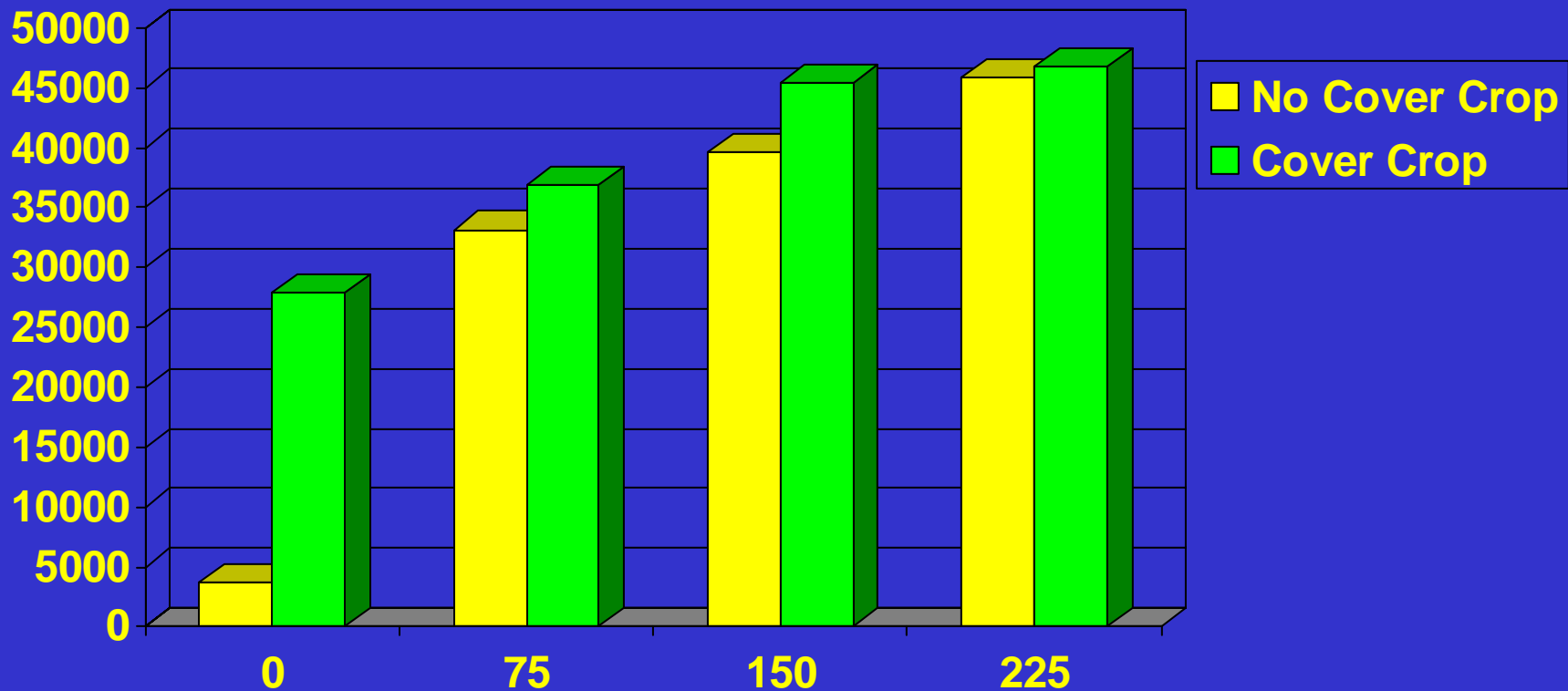


- The cover crop plots produced 3.2 tons of biomass and contained 195 lbs N/A
- The cover crop was incorporated February 14
12 inches of rain fell between incorporation of the cover crop and transplanting broccoli on April 20

Rain Events Between Cover Crop Incorporation and Transplanting Broccoli



Harvest – Numb of Heads Number/A



N availability from cover crops

- **Legume cover crops contained 195 lbs of N/A**
- **A portion of the nitrogen contained in the cover crop was initially lost to leaching prior to planting the broccoli**

N availability from cover crops

- In spite of these conditions, there was an increase of 25 lbs of N/A in the biomass of broccoli in cover cropped plots vs non-cover cropped plots at the end of the growing season.**
- In a similar trial conducted at UCSC, Joji Muramoto observed 75 lbs of N in the broccoli from the cover crop (no rain fell on the cover crop residue)**

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

Poudel et al. 2001

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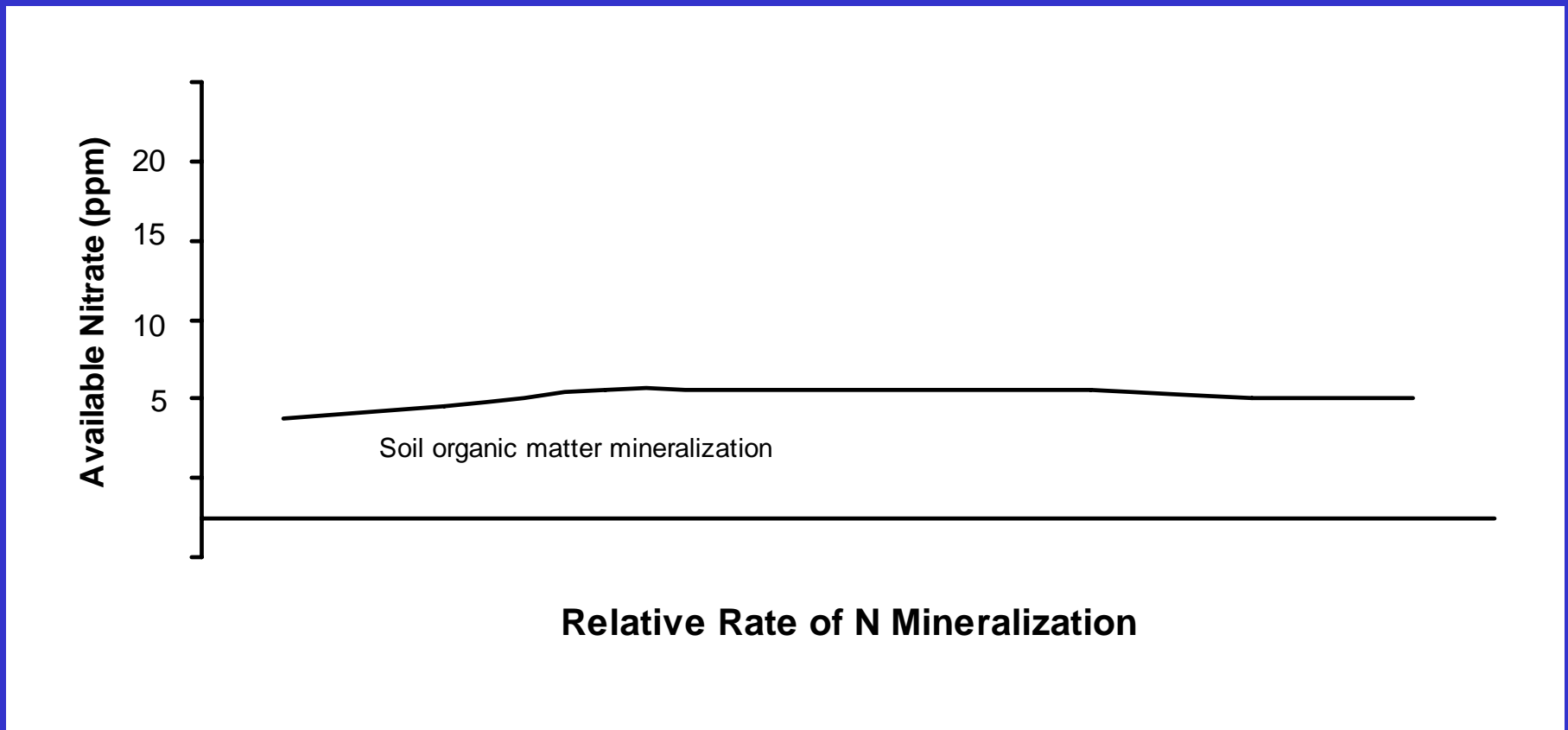
Cover Crop Nitrogen Synchrony

- **Achieving synchrony between crop uptake and N supplied by mineralization from cover crops, soil organic matter, and fertilizers is the challenge for managing N fertility of vegetables in organic systems**

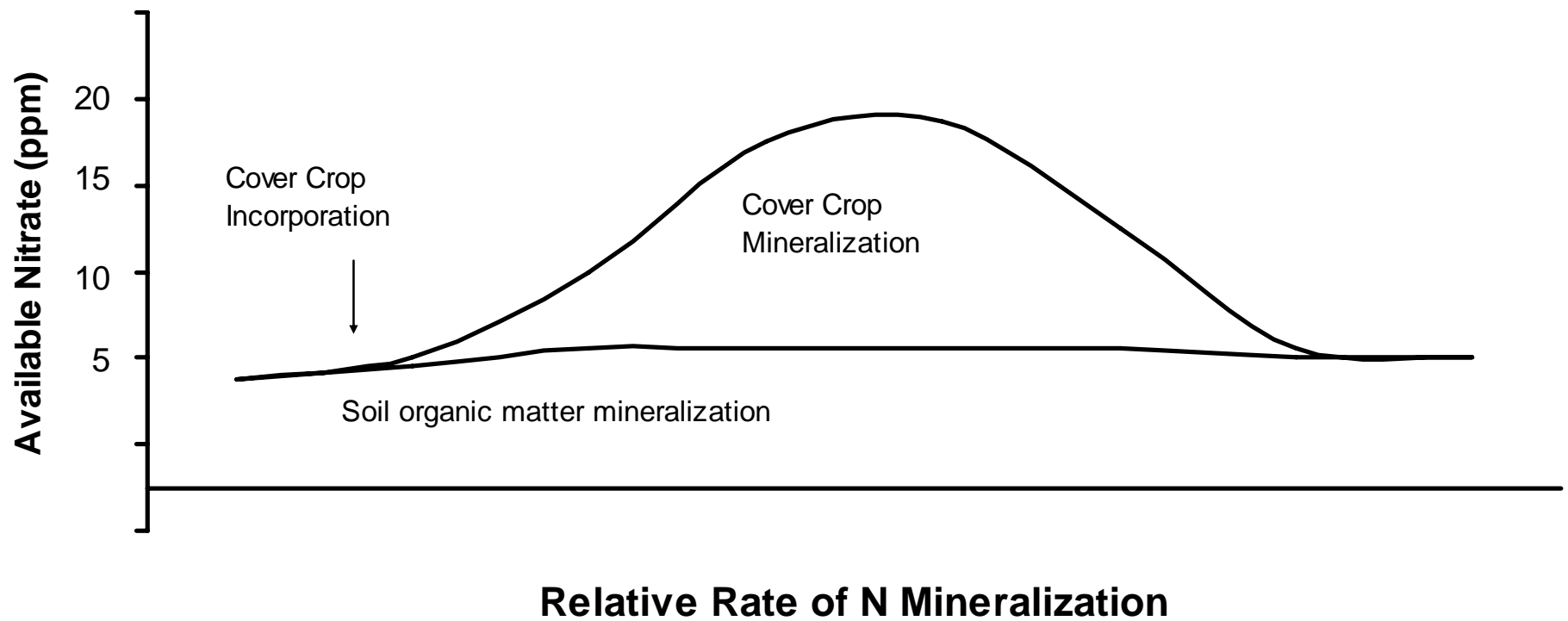
Impacts of Soil Building on Nitrogen Storage in the Soil

Soil Type	Management	N storage Lbs/A
Clay Loam	Organic	3400
Clay Loam	Conventional	2800
Loam	Organic	2800
Loam	Conventional	2200
Fine Sandy Loam	Organic	2400
Fine Sandy Loam	Conventional	1200

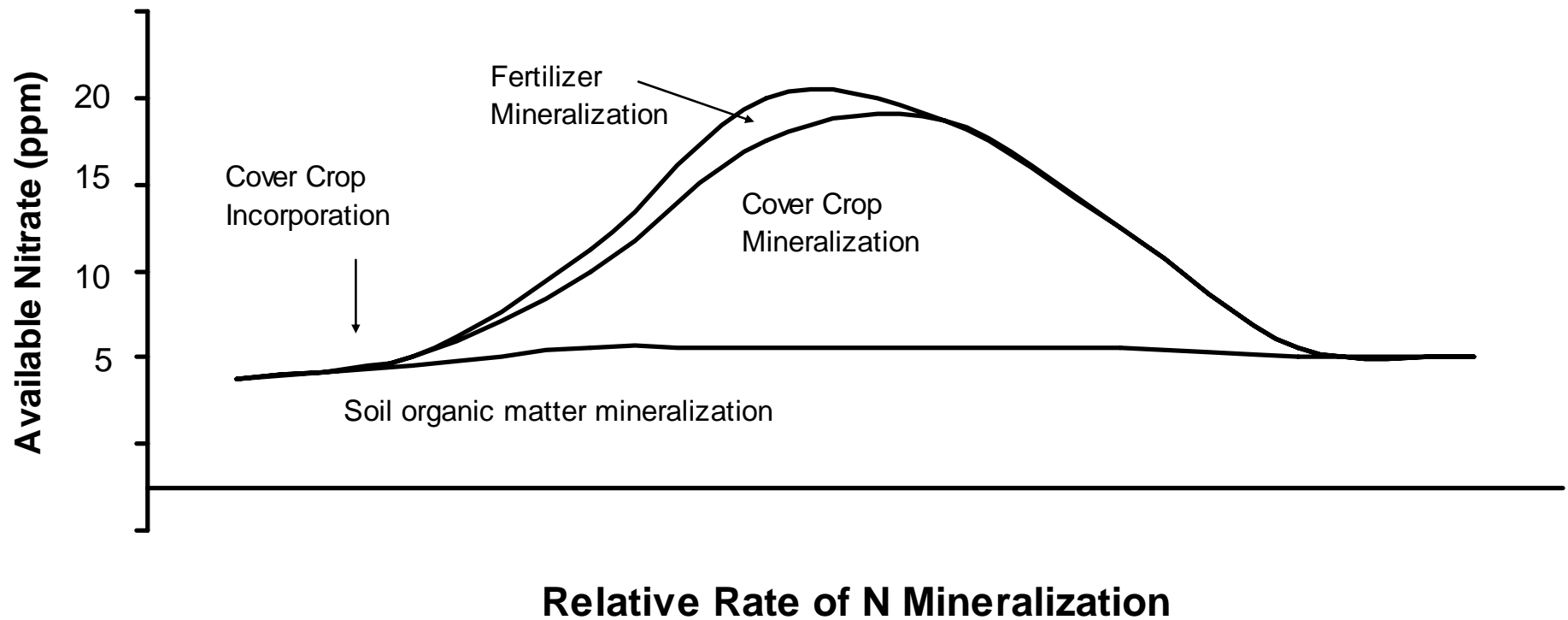
Nitrogen Release from Soil Organic Matter



Nitrogen Release Characteristics from Cover Crop

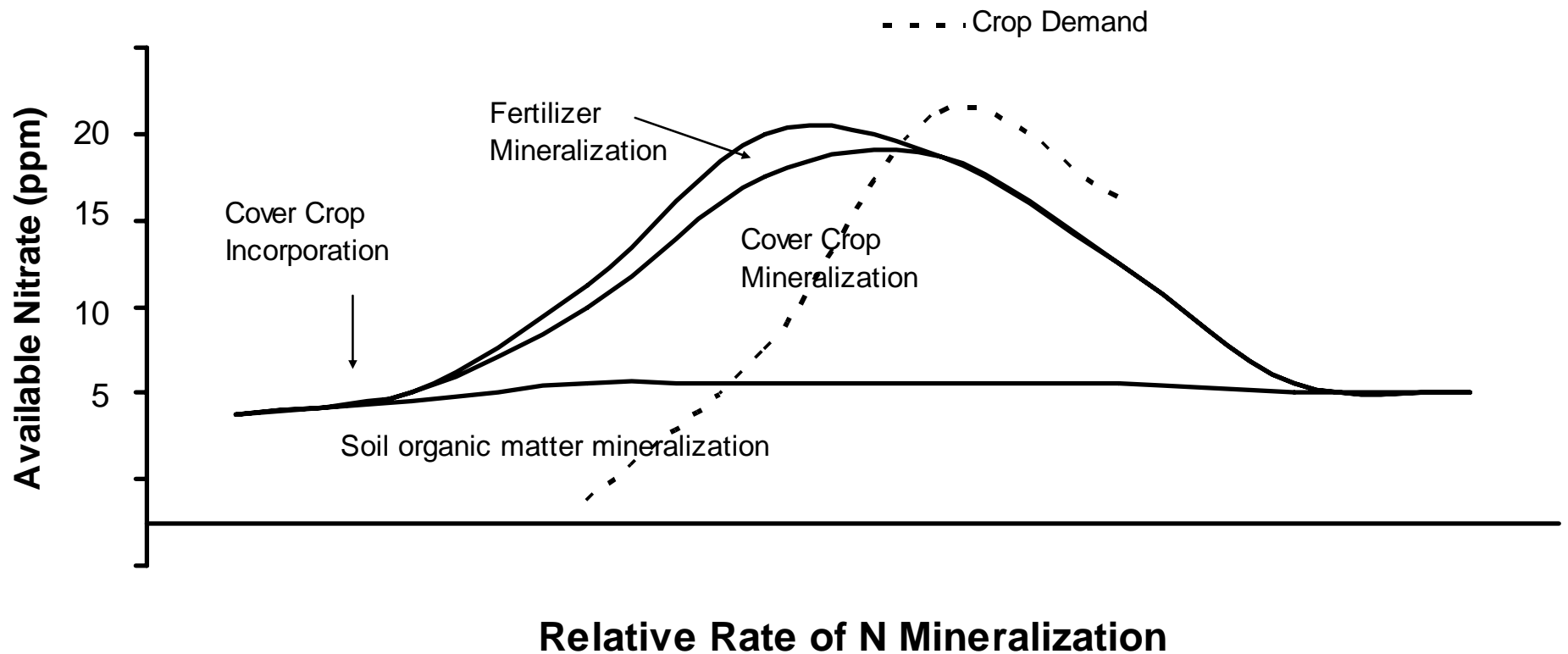


Nitrogen Release Characteristics Fertilizer Application



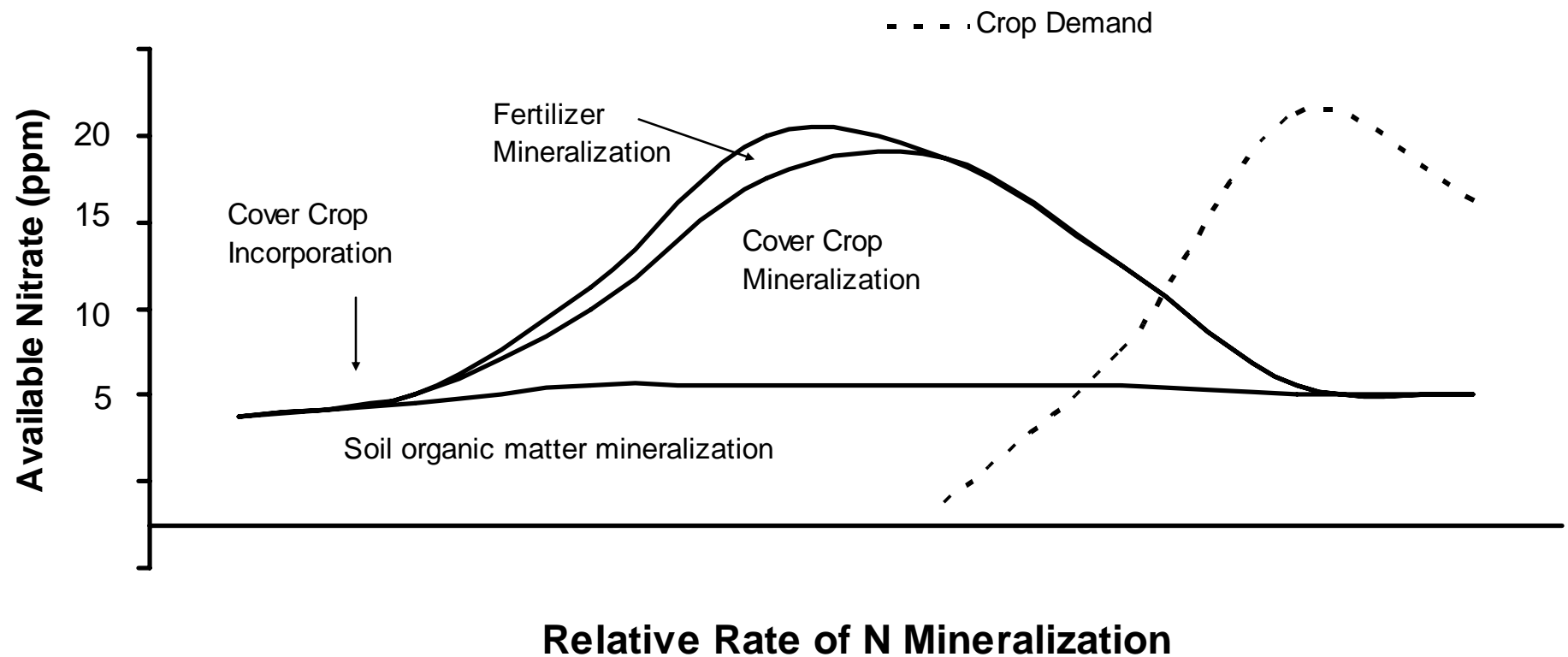
Nitrogen Release Characteristics of N From All Sources

Ideal Scenario



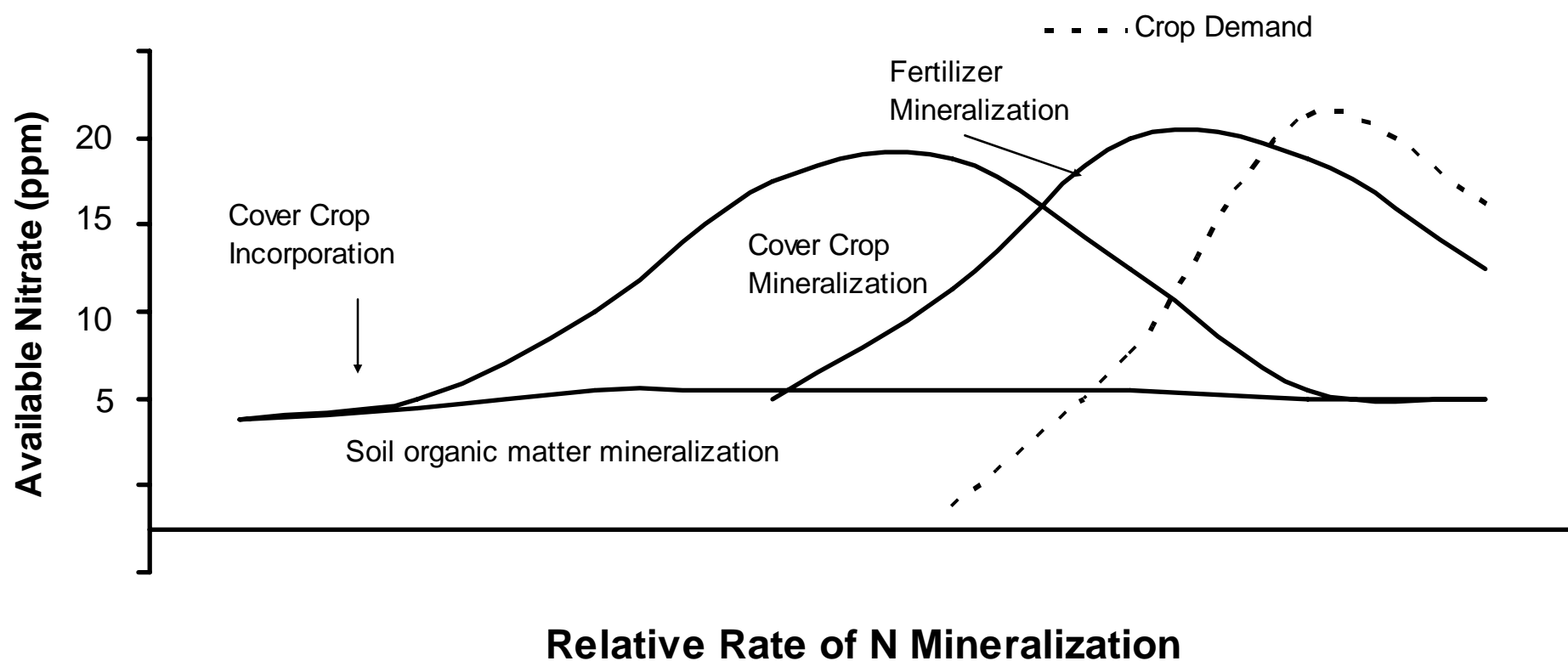
Nitrogen Release Characteristics of N From All Sources

Suboptimal – mineralization too early



Nitrogen Release Characteristics of N From All Sources

Adjusting fertilization for lack of synchrony from cover crop N release



Summary of Nitrogen Impacts of Cover Crops on Crop Production

- **Cover crops mineralize useful amounts of nitrogen that can be an important source for subsequent crops**
- **For high yield and quality, supplemental applications of N are needed for long-season crops**
- **Over a period of years, as the soil organic matter levels build up from the use of cover crops and compost, the amounts of supplemental nitrogen fertilizer needed for high yields may decline**

2. Pest Management Impacts of Cover Crops

- Insects**
- Disease**
- Weeds**

Soilborne Disease Impacts

- **Mustards**

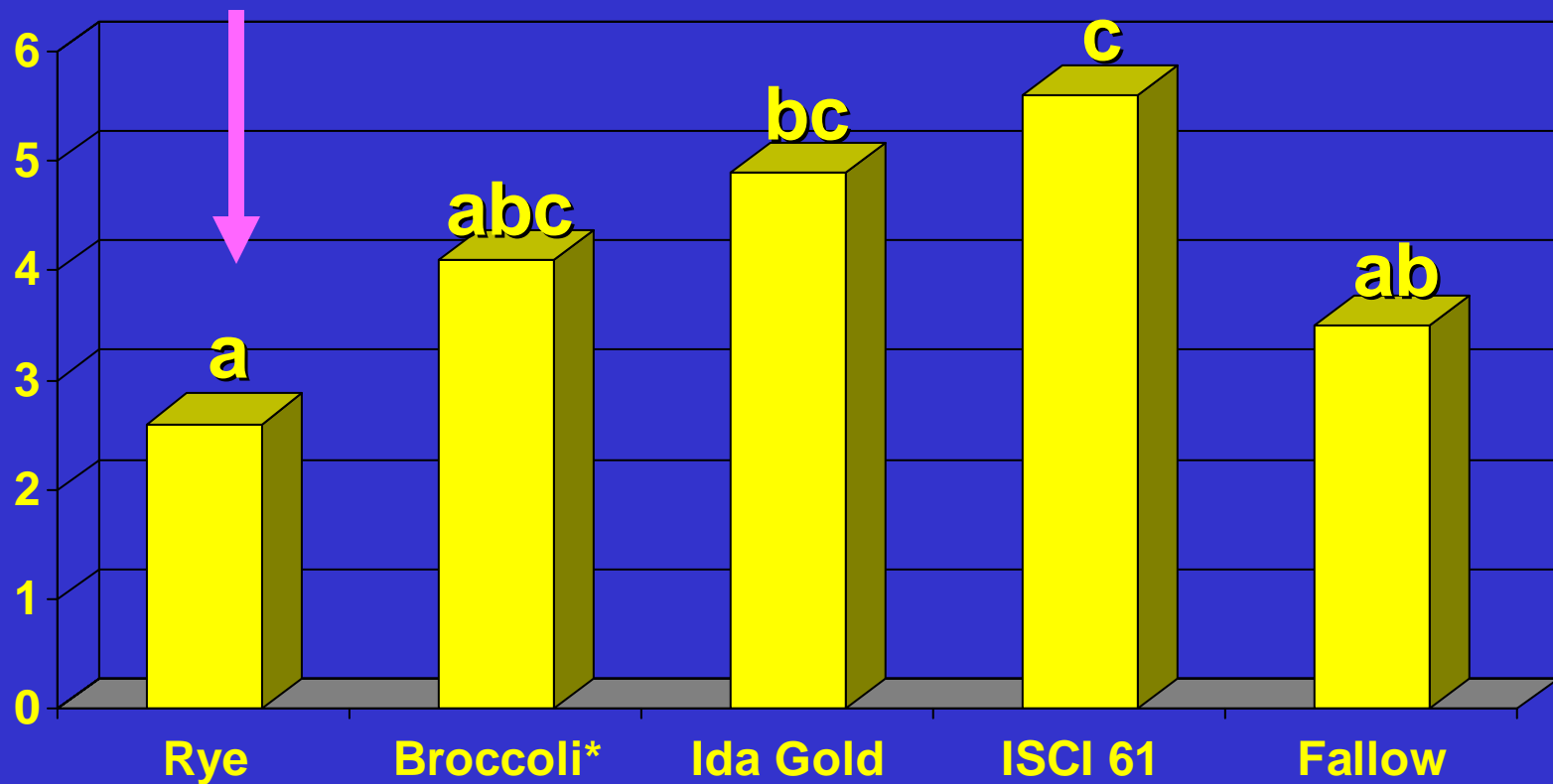
Why Mustard Cover Crops

- Produce a class of chemicals known as glucosinolates
- These materials break down enzymatically to isothiocyanates, thiocyanates, nitriles and isonitriles in the soil which are toxic to nematodes, fungi and weed seeds – biofumigation
- There may also be soil microbiological effects as well

Mustard Cover Crop Trials



Percent Infection by *S. minor* on Summer Lettuce Crop, 2005 (after two cover crop cycles and 4 lettuce cycles)



* Did not grow normally

Cover Crop Impacts on Disease

- **Biofumigation by cover crops has been a disappointment for disease control**
- **However, positive impacts have been demonstrated for nematode control**
- **Benefits from cover crops for disease control may be due to impact of adding organic matter and its affect on stimulating beneficial microorganisms**

Weed Impacts

- **During the cover crop growth cycle they can allow weeds to grow and set seed undetected**
- **In a sense, cover crops can act as a nurse crop to weeds**



Weed Growth In the Cover Crop

A photograph showing four individual weed plants of varying heights and a blue pen for scale. The plants are arranged from left to right, with the tallest on the far left and the shortest on the far right. The pen is positioned vertically to the right of the shortest plant. The background is a plain, light-colored surface.

**Legume
Mix** **Oats** **Rye** **Mustard**

Weed Seed Production While Cover Crop Was Growing

Cover Crop	Percent ground cover 28 days after planting	Burning Nettle Seed production Viable seeds per square meter	
		Year 1	Year 2
Legume/oats Mix	18	13,622	4,282
Mustard Blend	78	1,283	14
'Cayuse' Oats	30	6,010	1,861
'Merced' Rye	46	----	275

Weed Impacts

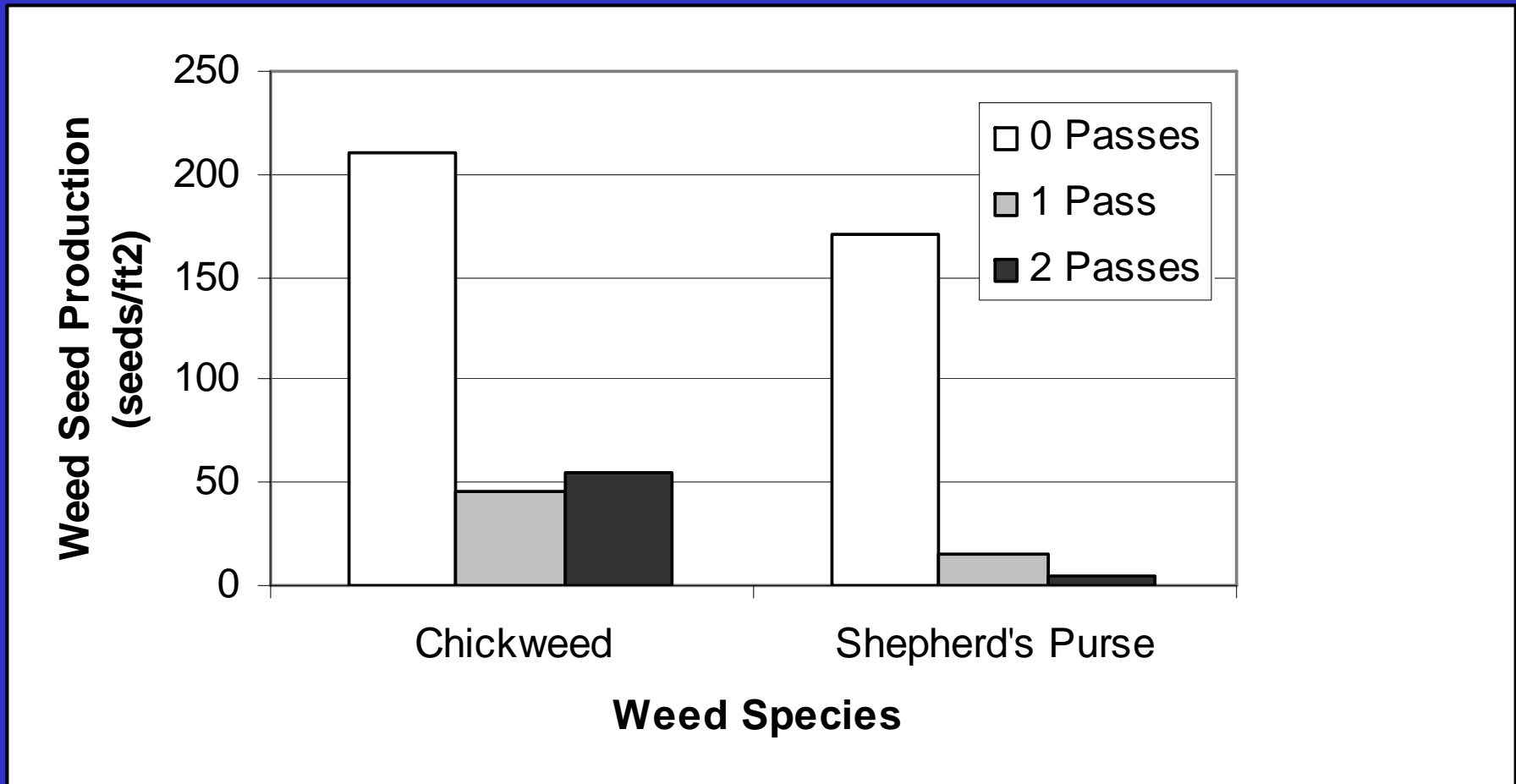
- **The negative impacts of slow growing legume mixes on weeds can be offset by higher seeding rates (i.e. 200 lbs/A)**

Rotary Hoe Which Can Kill Weeds in Cover Crops



Used when weeds are at
the white thread stage

Impact of Rotary Hoe on Weed Seed Production



Boyd and Brennan, 2006

3. Soil Quality Impacts of Cover Crops

- Additions of organic amendments to agricultural soils is important because they are key to improving the quality of soils for crop production**
- Cover crops are an economical method of adding organic matter to soils**

Impacts of Soil Building on Nitrogen Storage in the Soil

Soil Type	Management	Organic Matter %
Clay Loam	Organic	2.24
Clay Loam	Conventional	1.78
Loam	Organic	1.74
Loam	Conventional	1.37
Fine Sandy Loam	Organic	1.31
Fine Sandy Loam	Conventional	0.66

Soil Quality Impacts of Cover Crops

- **Cover crops are important in providing a rotation for cash crops**
- **Improve soil tilth and aggregate stability**
- **Increase water infiltration**
- **Provides the basic food for the soil food web**
 - **Increases the health of soil**
 - **May suppress soilborne diseases and nematodes**



Cover crops have many benefits in vegetable production systems

- We have to figure out ways to include them on high value vegetable ground**



Bedtop/killed



**Conservation
Tillage**



**Furrow
Bottom**

Resources

- **Soil Fertility Management for Organic Crops (UCDANR 7249)**
 - Google CEMonterey and go to publications then free publications
- **Weed 'em and Reap (Part 2)**
 - Available from www.weedemandreap.org