



IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

Barriers to Adoption of N Fertilizer Technology in Western North America

Rob Mikkelsen
Merced, CA

637
4
18

Better Crops

WITH PLANT FOOD

Feb.-Mar. 1933

10 Cents



Spring Fertilizer Number

UNIVERSITY OF CALIFORNIA
LIBRARY
BRANCH OF THE
COLLEGE OF AGRICULTURE

Not a new topic!

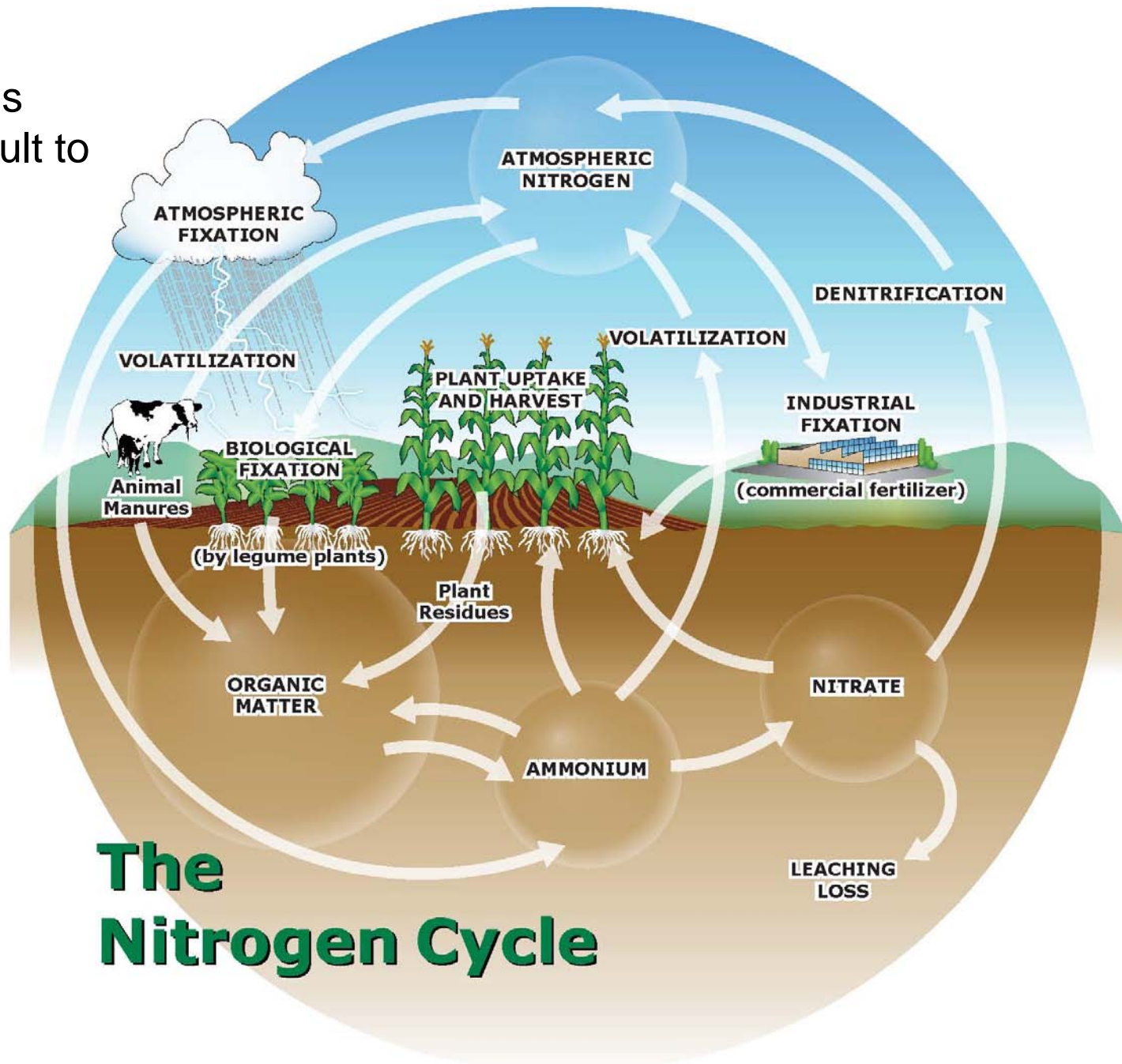
Barriers to “new” technology
have been discussed for
many generations!

75 years ago....

How to get farmers to understand
the importance of plant nutrition?



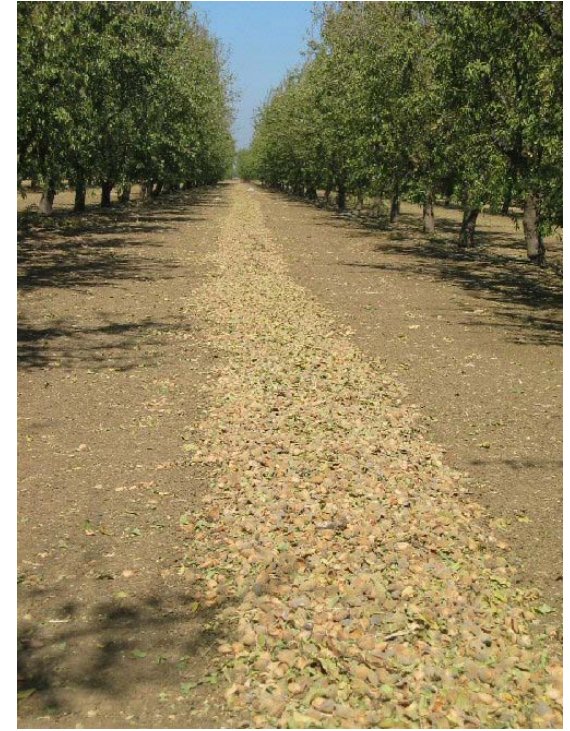
Nitrogen is very difficult to manage



The Nitrogen Cycle

Why Improve Nitrogen Use Efficiency?

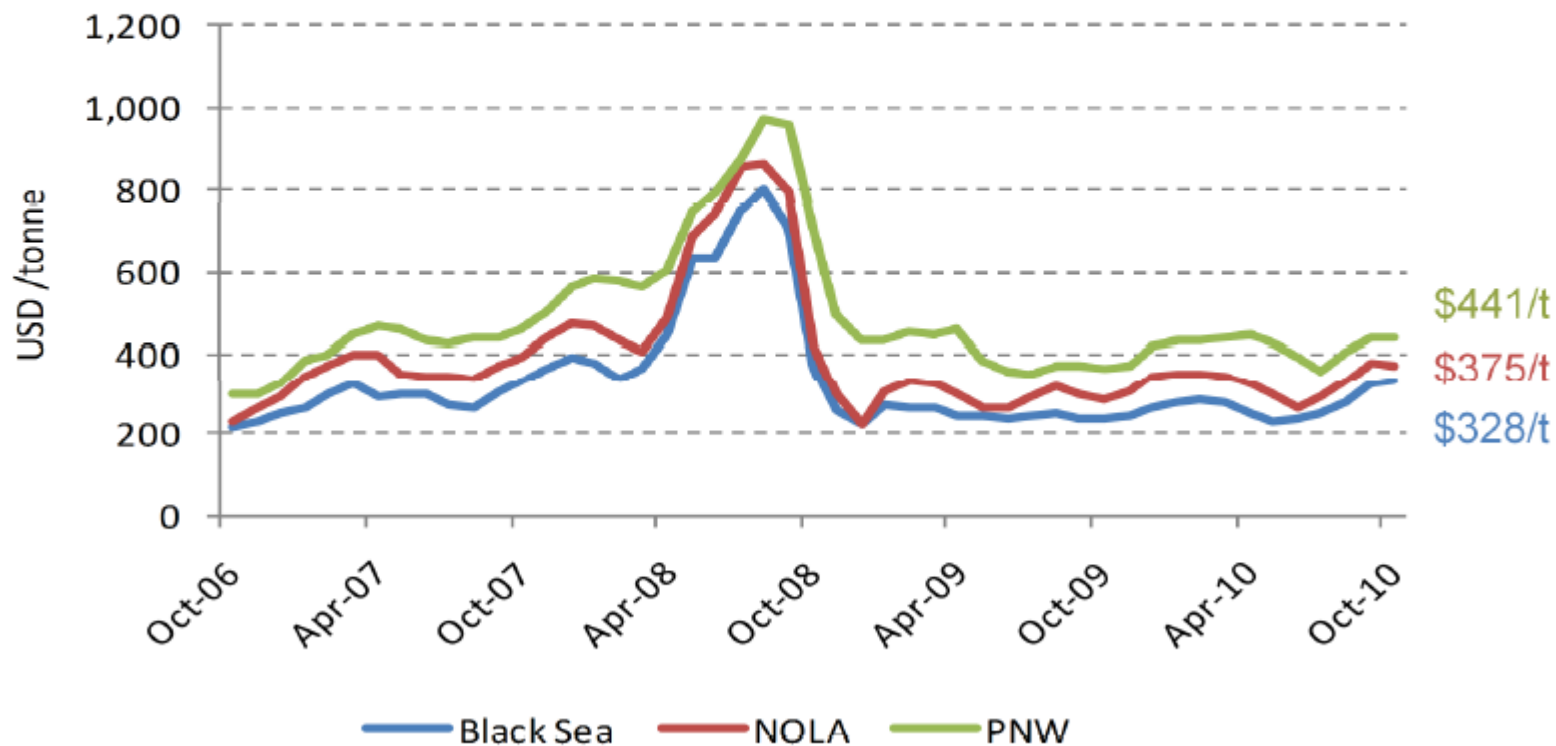
- **Economics**
- **Environmental impacts**
 - Nitrate in drinking water
 - Eutrophication & hypoxia
 - Biodiversity loss
 - Smog and PM_{2.5} from ammonia emission
 - Ozone depletion – N₂O
 - Greenhouse gases – N₂O and CO₂



Economic concerns

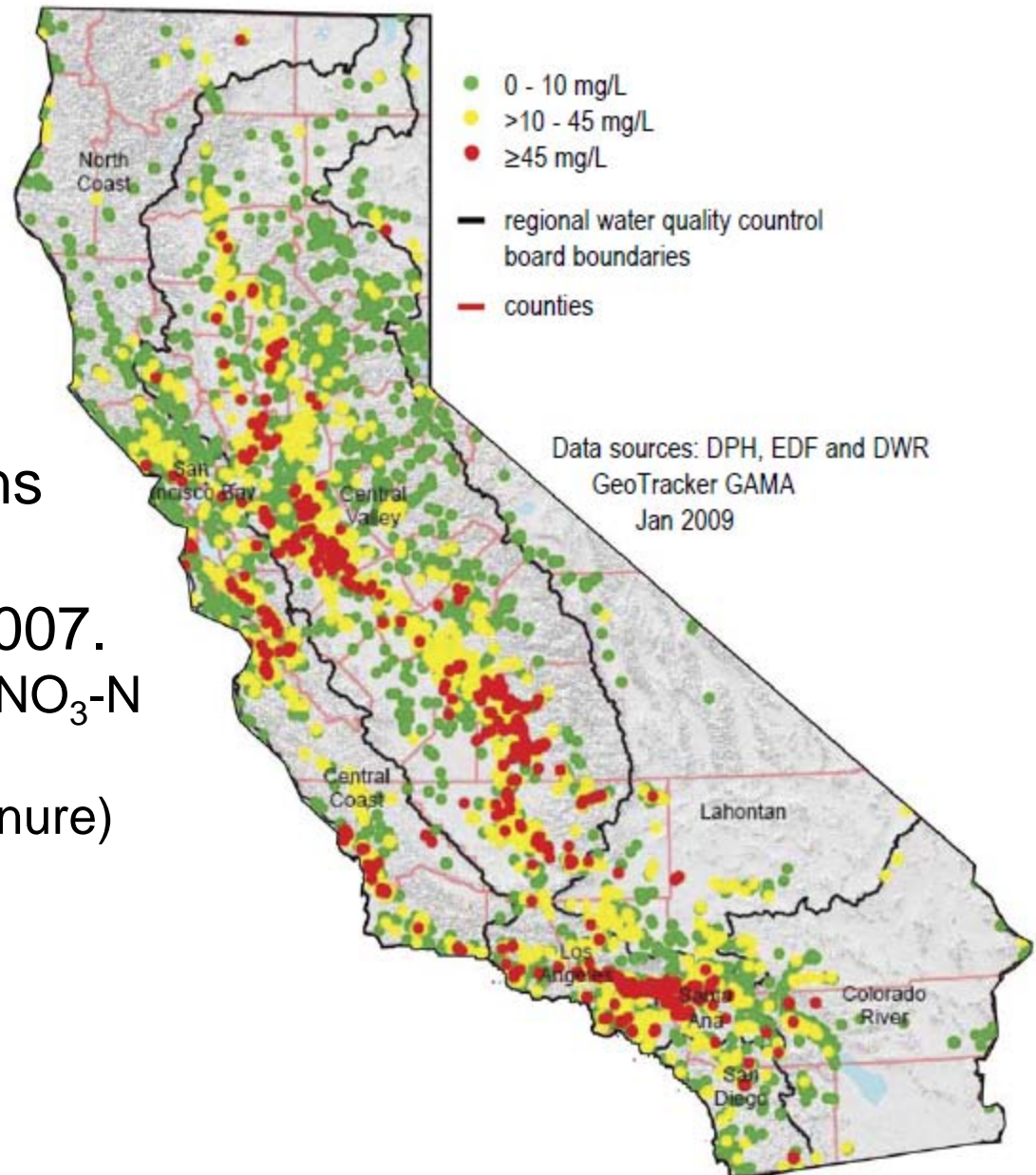
Black Sea Urea (per tonne)

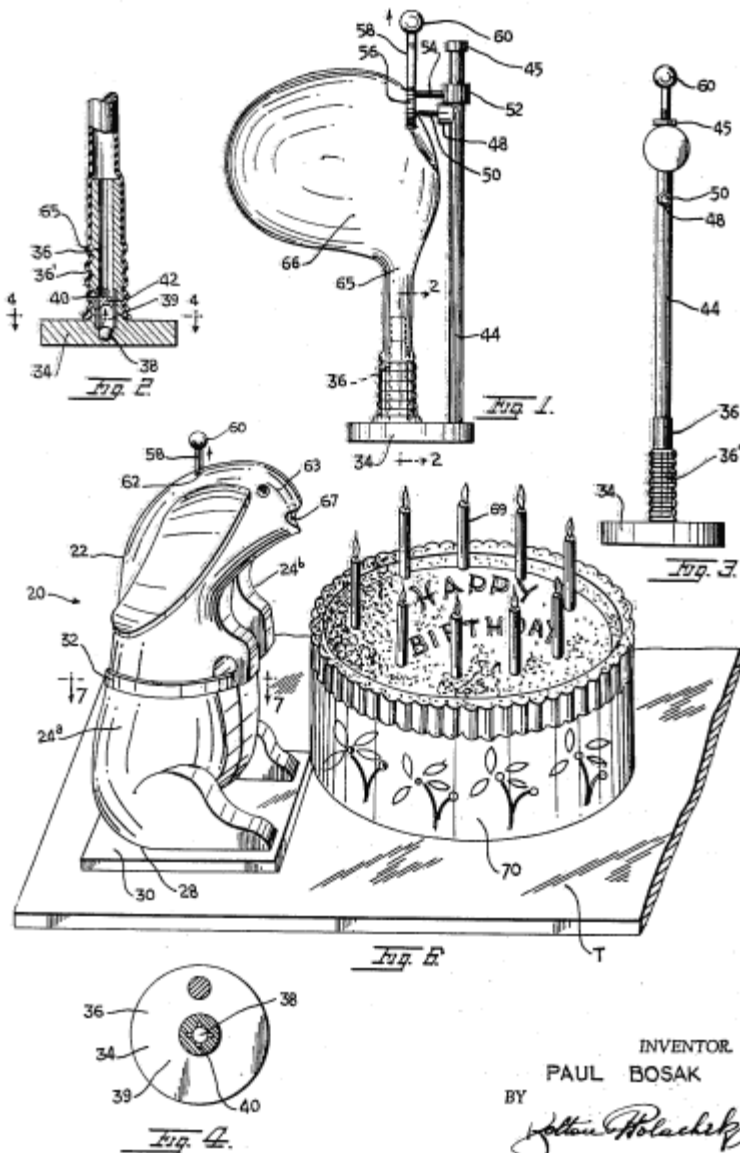
Avg. Oct 2010	\$	328
Avg. Oct 2009	\$	237
Avg. Oct 2003-2007	\$	221



Environmental concerns

Nitrate concentrations
in various California
wells measured in 2007.
 $44 \text{ mg/L NO}_3 = 10 \text{ mg/L NO}_3\text{-N}$
(some from animal manure)





INVENTOR
 PAUL BOSAK
 BY *John Holachek*
 ATTORNEY

Birthday cake candle extinguisher

[54] FORK WITH TIMER

Primary Examiner—Hwei Siu Payer

[76] Inventors: Nicole M. Dubus; Susan Springfield, both of 132 Castillion Ter., Santa Cruz, Calif. 95060

[57] ABSTRACT

A fork with timer comprising a fork having a head, a plurality of spaced tines extended from the head, and a handle extended from the head remote from the tines; timer circuitry connected to the handle of the fork and adapted for providing a cue after an elapsed period of time for indicating to user that another bite of food using the fork may be taken; a replaceable power source connected to the fork and coupled to the timer circuitry with the power source adapted for energizing the timer circuitry; and a switch connected to the fork and coupled between the power source and the timer circuitry with the switch having one orientation for energizing the timer circuitry and another orientation for de-energizing the timer circuitry.

[21] Appl. No.: 249,191

[22] Filed: May 26, 1994

[51] Int. Cl.⁶ A47J 43/28

[52] U.S. Cl. 30/142; 30/322

[58] Field of Search 30/123, 142, 324, 137, 30/147, 148, 149, 150, 322; 446/81, 175

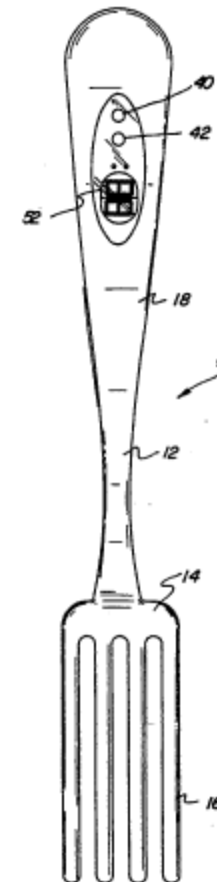
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4,914,819	4/1990	Ash	30/147
5,075,970	12/1991	Albert	30/123
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4 Claims, 3 Drawing Sheets

Not all new technology is a good idea!



Fork with a timer



US00D

United States Patent [19] Gravante

[11] Patent Num
[45] Date of Pa

[54] **NOVELTY SPORTS HAT** 2,958,156 11/1960 Sch
4,832,647 5/1989 Peri

[76] Inventor: **Louis J. Gravante, P.O. Box 32,
Camillus, N.Y. 13031**

[**] Term: **14 Years**

[21] Appl. No.: **741,155**

[22] Filed: **Aug. 7, 1991**

[52] U.S. Cl. **D2/248**

[58] **Field of Search** **D2/248, 251, 244, 513,
D2/250; 2/199, 185 R, 187; D21/59, 200, 209;
446/26, 27, 28; D28/41, 39, 42, 74, 75**

[56] **References Cited**

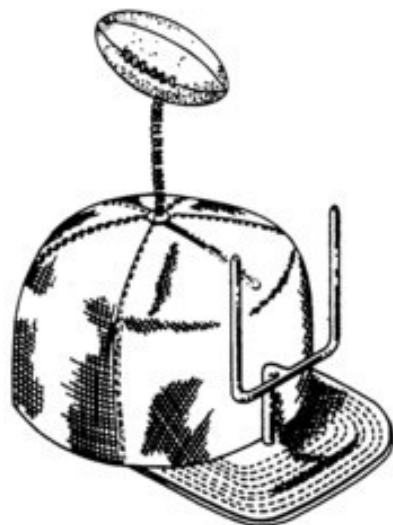
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D. 287,891 1/1987 Cavaliere D2/250 X R
D. 301,929 6/1989 Evans D21/200 X R
D. 311,089 10/1990 Guevara D2/250

Primary Examiner—A. Hu
Assistant Examiner—Paula
Attorney, Agent, or Firm—
[57] **Cl**
The ornamental design for
and described.

DESCI

FIG. 1 is a perspective v
showing my new design;
FIG. 2 is a front elevation
FIG. 3 is a side elevatona
ance being the same from
FIG. 4 is an rear elevation
FIG. 5 is a top plan view
FIG. 6 is a bottom plan v



Sports hat



US005830035A

United States Patent [19] Budreck

[11] Patent Number: **5,830,035**
[45] Date of Patent: **Nov. 3, 1998**

[54] **TOE PUPPET**

[76] Inventor: **David J. Budreck, 109 E. Woodruff
St., Port Washington, Wis. 53074**

[21] Appl. No.: **794,294**

[22] Filed: **Feb. 3, 1997**

3,911,618 10/1975 Gest .
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4,148,151 4/1979 Ulrich 446/367
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"Finger Fun", Washington Post, Mar. 22, 1959, p. c8.

Primary Examiner—Robert A. Hafer
Assistant Examiner—Jeffrey D. Carlson
Attorney, Agent, or Firm—Andrus, Scovales, Starke &
Sawall

Related U.S. Application Data

[63] Continuation of Ser. No. 553,885, Nov. 6, 1995, abandoned.

[51] **Int. Cl.⁶** **A63H 03/14**

[52] **U.S. Cl.** **446/366; 446/26; 446/327**

[58] **Field of Search** **446/26, 327, 328,
446/329, 486, 359, 365, 366, 367**

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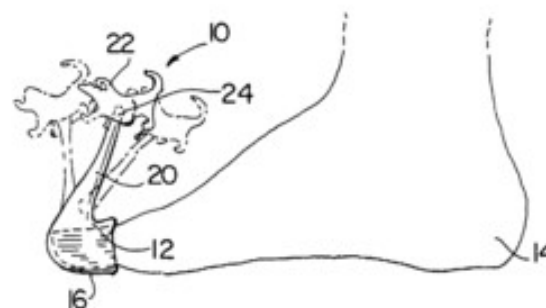
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ABSTRACT

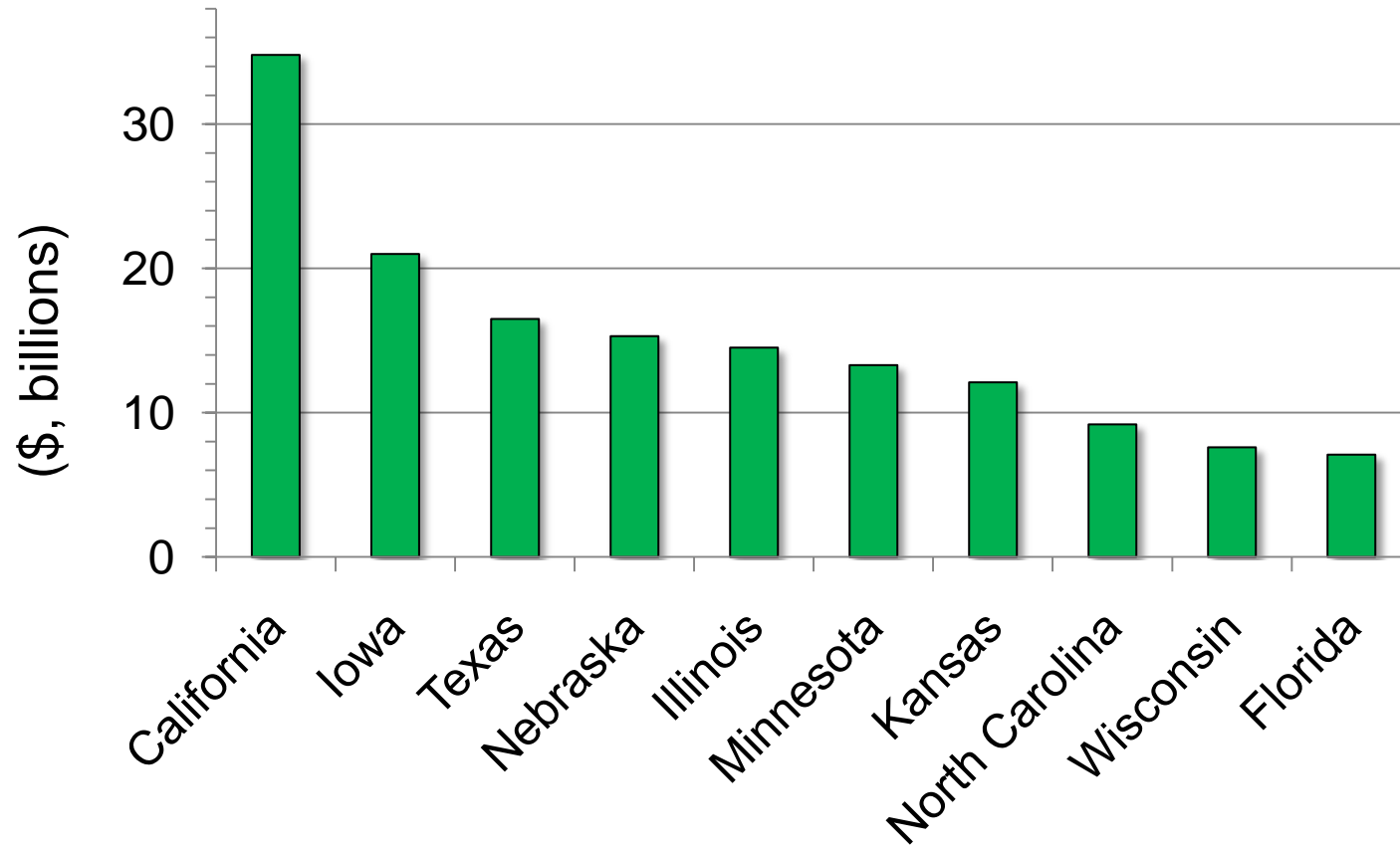
[57] A puppet is adapted to be mounted on a single human digit for providing animated motion of a figurine responsive to movement of the single human digit. The puppet comprises a hollow, elastic cap having an interior wall defining a cavity into which the single human digit is snugly received. The cap includes a resilient neck portion for supporting the figurine at a distance spaced from the single human digit such that movement of the single human digit causes the neck portion and the figurine to oscillate to and fro under the influence of the weight of the figurine.

11 Claims, 1 Drawing Sheet












Toe puppets

Cash Receipts for Farm Marketing (2009)



Washington

	Sweet Cherries	10,120 lbs per acre Worth \$10,423/acre
	Apples	32,900 lbs per acre Worth \$11,048/acre
	Wine Grapes	8,320 lbs per acre Worth \$3,972/acre
	Blueberries	8,000 lbs per acre Worth \$13,421/acre
	Non-Storage Onions	38,000 lbs per acre Worth \$12,350/acre
	Storage Onions	61,000 lbs per acre Worth \$1,977/acre
	Potatoes	58,000 lbs per acre Worth \$4,152/acre
	Wheat	3,774 lbs per acre Worth \$438/acre
	Fresh Sweet Corn	16,500 lbs per acre Worth \$4,604/acre
	Hops	2,058 lbs per acre Worth \$5,635/acre

TOP 40 COMMODITIES, 2007

Commodity	Value of Production
1. Apples	\$1,745,620,000
2. Milk	1,061,952,000
3. Wheat	974,516,000
4. Potatoes	685,063,000
5. Cattle & Calves	580,947,000
6. Hay	516,568,000
7. Nursery/Greenhouse	342,683,000
8. Cherries	327,118,000
9. Pears	178,224,000
10. Grapes	172,203,000
11. Hops	128,165,000
12. Farm Forest Products	119,000,000
13. Corn for Grain	114,660,000
14. Eggs	105,372,000
15. Aquaculture	87,042,000
16. Sweet Corn	85,088,000
17. Corn for Silage	81,608,000
18. Barley	68,580,000
19. Broilers	63,925,000
20. Onions	60,033,000
21. Mint Oil	58,815,000
22. Christmas Trees	51,000,000
23. Blueberries	49,656,000
24. Haylage	29,156,000
25. Dry Edible Beans	28,254,000
26. Red Raspberries	27,886,000
27. KY Bluegrass Seed	26,606,000
28. Other Grass Seed	26,040,000
29. Lentils	23,075,000
30. Mushrooms	not published
31. Processing Green Peas	20,993,000
32. Asparagus	17,802,000
33. Dry Edible Peas	15,815,000
34. Alfalfa Seed	15,075,000
35. Carrots for Processing	9,344,000
36. Peaches	8,873,000
37. Strawberries	7,982,000
38. Nectarines	7,266,000
39. Apricots	7,137,000
40. Wrinkled Seed Peas	not published

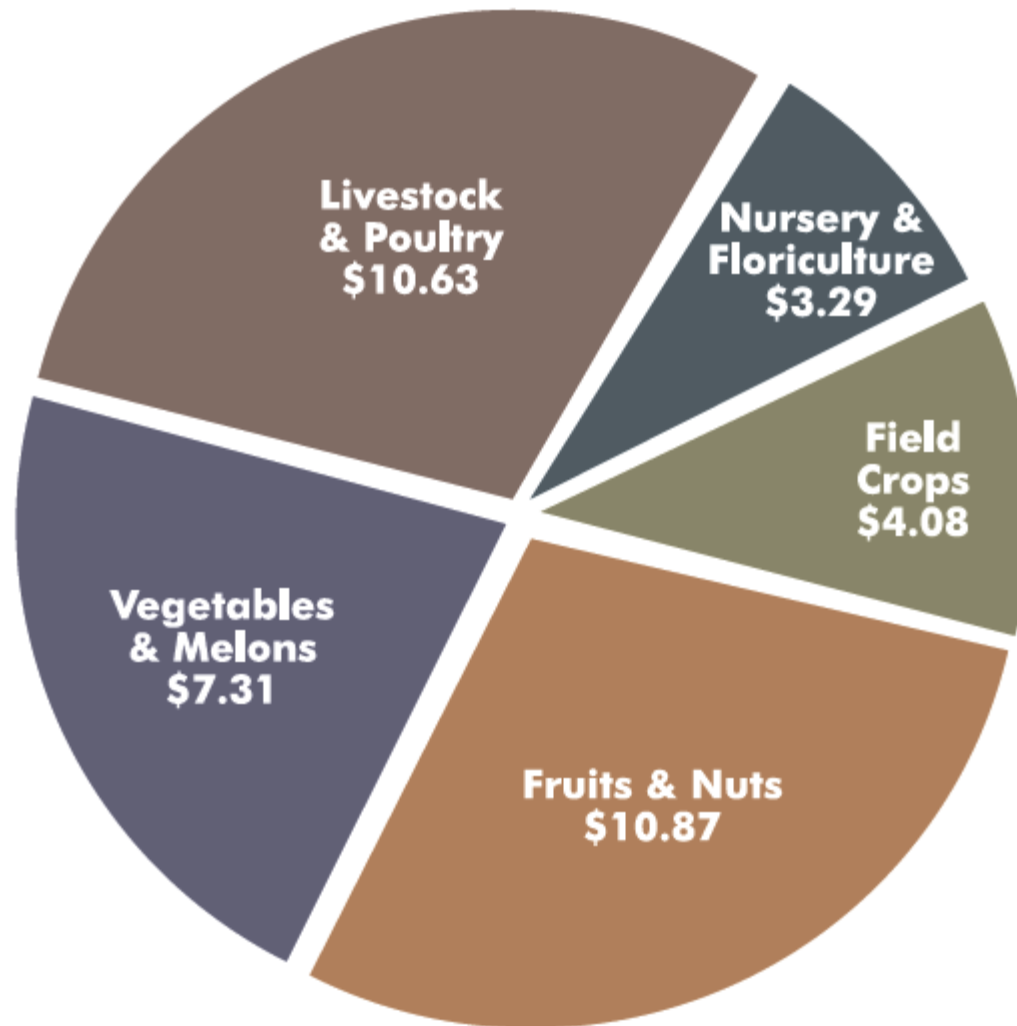
State of Washington: Top Crop Commodities

Crop	Production Value (Millions)			
1. Apples	\$ 1,756		11. Corn grain	\$ 115
2. Wheat	\$ 975		12. Sweet corn	\$ 85
3. Potatoes	\$ 685		13. Corn silage	\$ 82
4. Hay	\$ 516		14. Barley	\$ 66
5. Nursery/GH	\$ 342		15. Onions	\$ 60
6. Cherries	\$ 327		16. Mint oil	\$ 59
7. Pears	\$ 178		17. Grass seed	\$ 52
8. Grapes	\$ 172		18. Christmas trees	\$ 51
9. Hops	\$ 128		19. Blueberries	\$ 50
10. Farm Forest	\$ 119		20. Dry beans	\$ 28

California's Gross Cash Receipts, 2008

Total: \$36.2 Billion

Chart Values in Billions



State of California: Top Crop Commodities

Crop Production Value (Millions)

Grapes (all)	2,937		Flowers/Foliage	1,015
Almonds (shelled)	2,343		Broccoli	663
Nursery Products	2,273		Oranges	608
Alfalfa and other hay	1,797		Pistachio	569
Lettuce, (all)	1,580		Walnuts	558
Strawberries	1,578		Carrots	517
Tomatoes (all)	1,317		Lemons	473
Rice	1,183		Celery	354

Rose industry struggles with changing landscape

BY COURTENAY EDELHART, Californian staff writer

cedelhart@bakersfield.com | Tuesday, Oct 26 2010 03:41 PM



High-value crops
were once the
market for specialty
fertilizer products

Nursery Operator Hines Files for Bankruptcy, as Expected

By Jerry Sullivan

Wednesday, October 13, 2010

Irvine-based Consolidated Horticulture Group LLC, which operates Hines Horticulture Inc., has made an expected filing for bankruptcy protection.

Hines Horticulture grows and supplies plants, shrubs and other products to Home Depot Inc., Lowe's Cos., Wal-Mart Stores Inc. and other retailers.

The company runs eight nurseries in California, Arizona, Oregon and Texas and has 900 employees. Sales were \$123 million last year.



International Garden Products Files Chapter 11

Posted October 05, 2010 3:57PM PST

International Garden Products, a wholesale provider of plants and garden products, filed for Chapter 11 bankruptcy after some customers were unable to pay their bills.

The Damascus, Ore.-based nursery holding company said in a statement that the companies' finances had been damaged by issues unrelated to its own operations,

IGP and four of its affiliates, including Iseli and Weeks, filed voluntary petitions for Chapter 11 reorganization on Oct. 4, 2010.



WEDNESDAY, APRIL 22, 2009

B3

Resort, golf courses face foreclosure

Lender: No payments made since November

By Carrie Watters
THE ARIZONA REPUBLIC

An 80-year-old West Valley resort and two Biltmore golf courses face foreclosure with an auction scheduled in July, according to a filing with the Maricopa County Recorder's Office.

In jeopardy are the Wigwam

Golf Resort & Spa in Litchfield Park, as well as Arizona Biltmore Golf Club, which includes the Links and the Adobe, next to the separately owned historic Arizona Biltmore Resort & Spa.

Citigroup Global Markets Realty Corp. loaned \$65 million to Kabuto Arizona Properties, owner of the three properties, in June 2007, according to documents. The New York-based lender says Kabuto has not made payments since November.

"The Wigwam is going through tough times as are many golf resorts in Arizona," said Jon Reynolds, general counsel with Kabuto.

He said the company is negotiating with Citigroup to find a solution, although he declined further detail.

"We are in discussions with our bank right now, and it would not be constructive to comment on the nature of those discussions except to say that they are ongoing," Reynolds said.

A distinction between **invention**, an idea made manifest,



and **innovation**, ideas applied successfully

“incremental, radical, or revolutionary changes in thinking, products, processes, or organizations”

Stages in Decision Innovation Process

Knowledge: Exposed to innovation, but lacks information.
Not yet motivated to learn more

Persuasion: Interested in innovation and seeks information

Decision: Weigh advantages/disadvantages of innovation (Yes/No)

Implementation: Test innovation and determine usefulness

Confirmation: Finalize decision to continue using innovation

Five Groups of People

Innovators

Innovators are the first individuals to adopt an innovation.

Innovators are willing to take risks, youngest in age, have the highest social class, have great financial lucidity, very social and have closest contact to scientific sources and interaction with other innovators. Risk tolerance has them adopting technologies which may ultimately fail. Financial resources help absorb these failures.

Rogers, 1962

Early Adopters

This is the second fastest category of individuals who adopt an innovation. These individuals have the highest degree of opinion leadership among the other adopter categories. Early adopters are typically younger in age, have a higher social status, have more financial lucidity, advanced education, and are more socially forward than late adopters. More discrete in adoption choices than innovators. Realize judicious choice of adoption will help them maintain central communication position.

Early Majority

Individuals in this category adopt an innovation after a varying degree of time. This time of adoption is significantly longer than the innovators and early adopters. Early Majority tend to be slower in the adoption process, have above average social status, contact with early adopters, and seldom hold positions of opinion leadership in a system

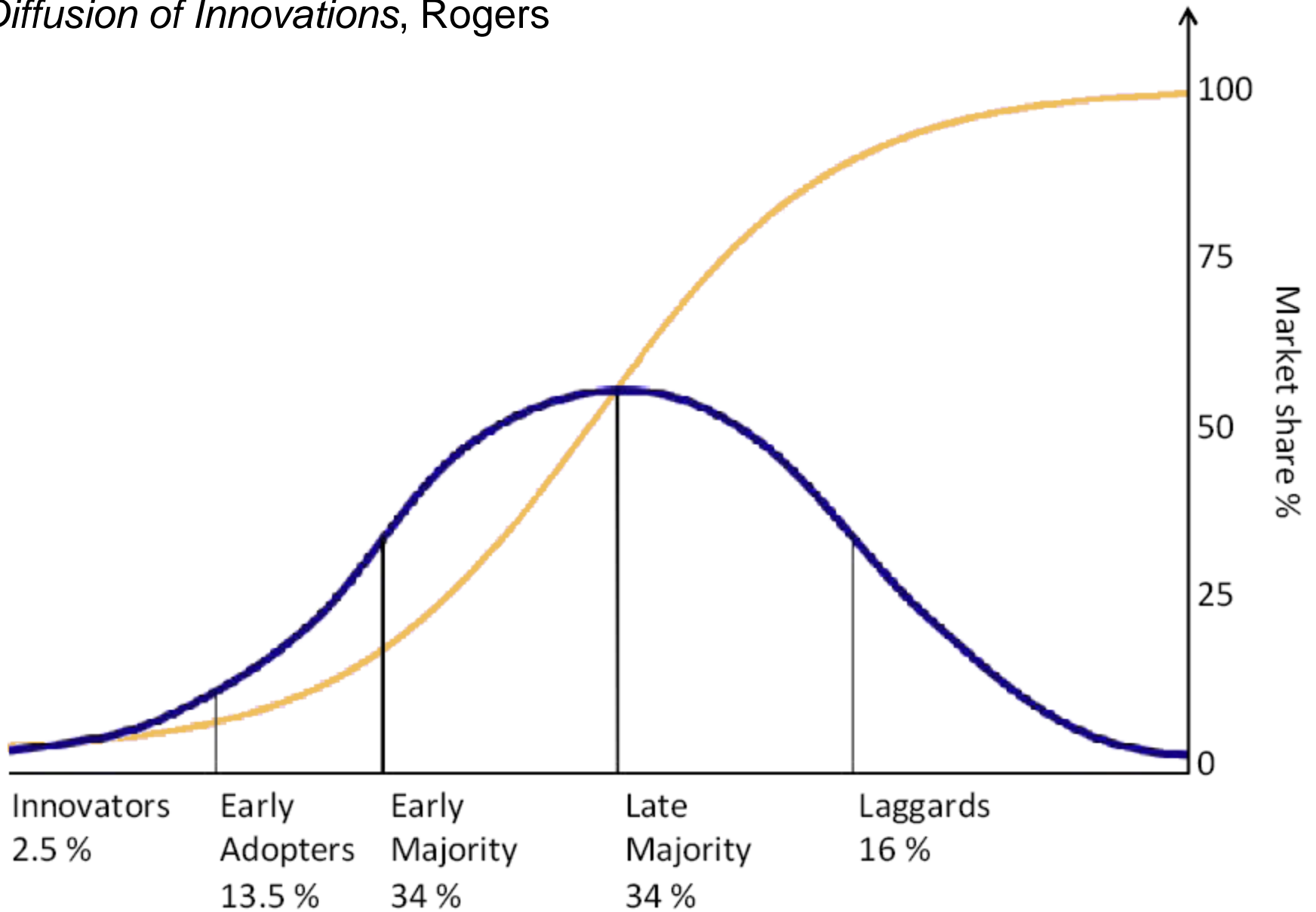
Late Majority

Individuals in this category will adopt an innovation after the average member of the society. These individuals approach an innovation with a high degree of skepticism and after the majority of society has adopted the innovation. Late Majority are typically skeptical about an innovation, have below average social status, very little financial lucidity, in contact with others in late majority and early majority, very little opinion leadership.

Laggards

Individuals in this category are the last to adopt an innovation. Unlike some of the previous categories, individuals in this category show little to no opinion leadership. These individuals typically have an aversion to change-agents and tend to be advanced in age. Laggards typically tend to be focused on “traditions”, have lowest social status, lowest financial fluidity, oldest of all other adopters, in contact with only family and close friends, very little to no opinion leadership.

Diffusion of Innovations, Rogers



Non adoption decisions are rational from their point of view

- Lack of total information
- External factors

This model assumes “voluntarism”....

a non-regulatory approach to resource management

“the desired outcome will always eventually occur”



Linda S. Adams,
Secretary for
Environmental Protection

California Regional Water Quality Control Board Central Coast Region

895 Aerovista Place, Suite 101, San Luis Obispo, California 93401-7906
(805) 549-3147 • Fax (805) 543-0397
<http://www.waterboards.ca.gov/centralcoast>



Arnold Schwarzenegger
Governor

59. The purpose of the nutrient management element of the Farm Plan is to eliminate or minimize nutrient discharges to groundwater and surface water to meet water quality standards using best practicable treatment or control, and to assure compliance with this Order. The nutrient management element of the Farm Plan must be certified by Appropriate Professional certification, such as Certified Crop Advisor to be protective of water quality...

60. The nutrient management element of the Farm Plan must include...

- a. Average total crop nutrient demand and method(s) of determination per crop;
- b. Average total water demand per crop and total water applied per crop;
- c. Monthly record of fertilizer applications per crop, including fertilizer type and quantity applied (including but not limited to fertilizers, compost, manure, and humic acids);
- d. Nitrate concentration of irrigation source water;
- e. Timing of fertilizer application to maximize crop uptake,
- f. Estimation of the amount of fertilizer applied in excess of crop needs,
- g. Estimation of excess or residual fertilizer/nutrients in the root zone at the end of the crop growing season;
- h. Identification of planned nutrient management practices (such as irrigation efficiency, nutrient budgeting, and nutrient trapping) to eliminate or minimize nutrients in irrigation runoff or percolation to groundwater;
- i. Identification of planned management practices related to fertilizer handling, storage, disposal, and mgnt



Uncertainty leads to Insurance

Risk management used to protect against the possibility of uncertain loss

(uncommon, but severely devastating)

Insurance involves pooling funds from many to pay for potential damages

Is there a disconnect between insurance and the true cost?



Stabilization Wedges

A Concept and Game

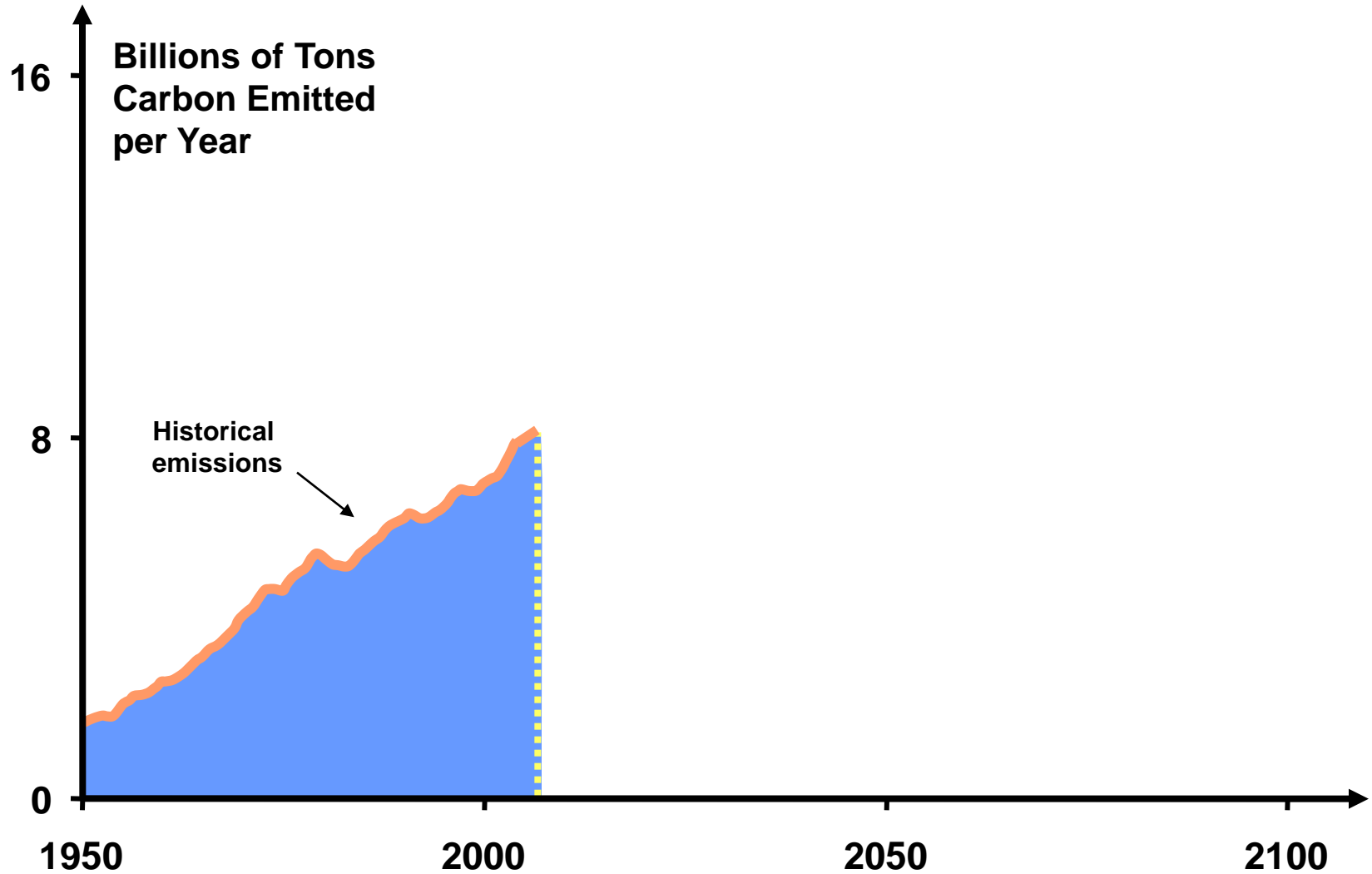
This presentation is based on the “Stabilization Wedges” concept first presented in

“Stabilization Wedges: Solving the Climate Problem for the next 50 Years with Current Technologies,” S. Pacala and R. Socolow, *Science*, August 13, 2004.

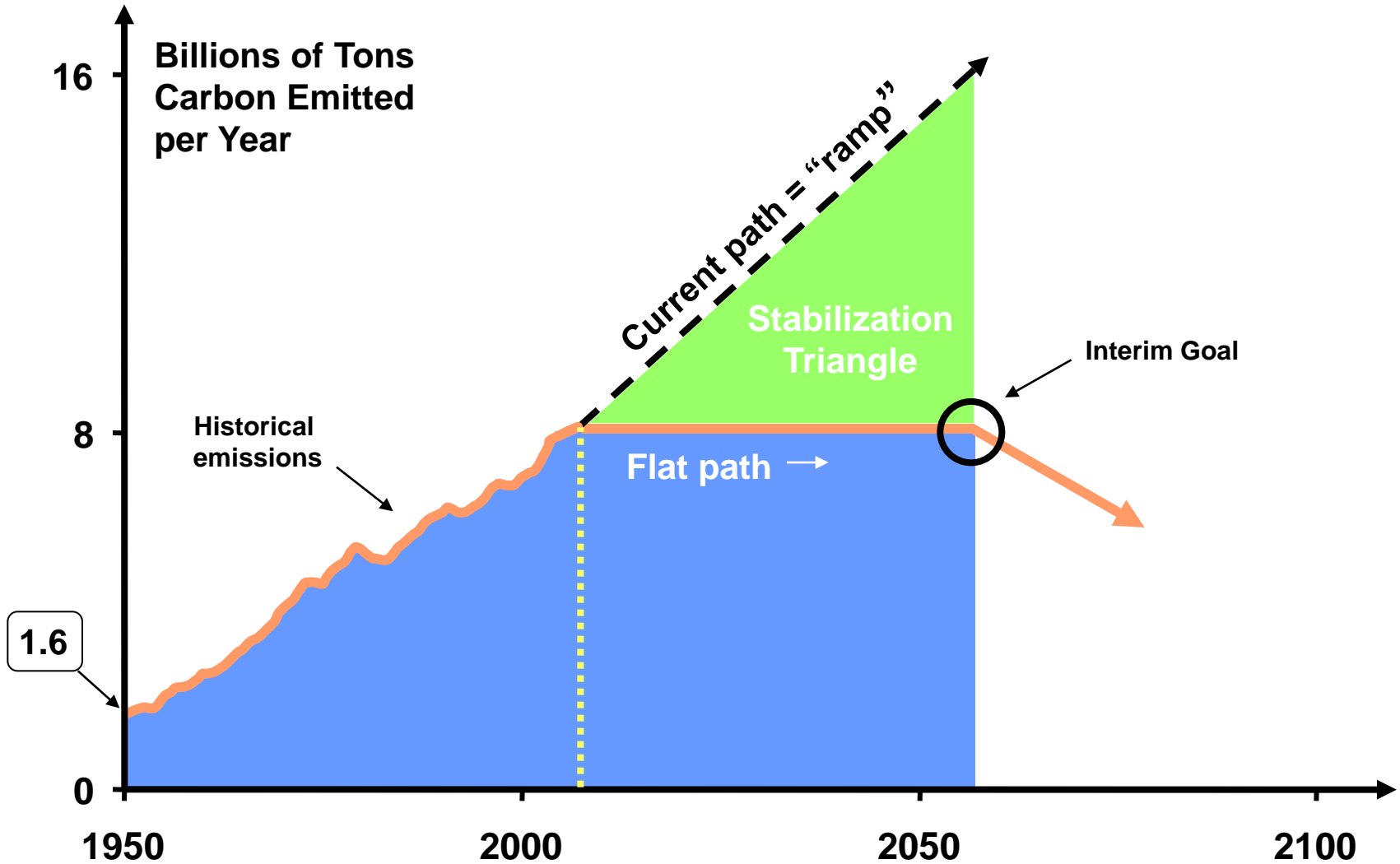


(adaption to N concepts: **Dr. Todd Rosenstock**, UCD)

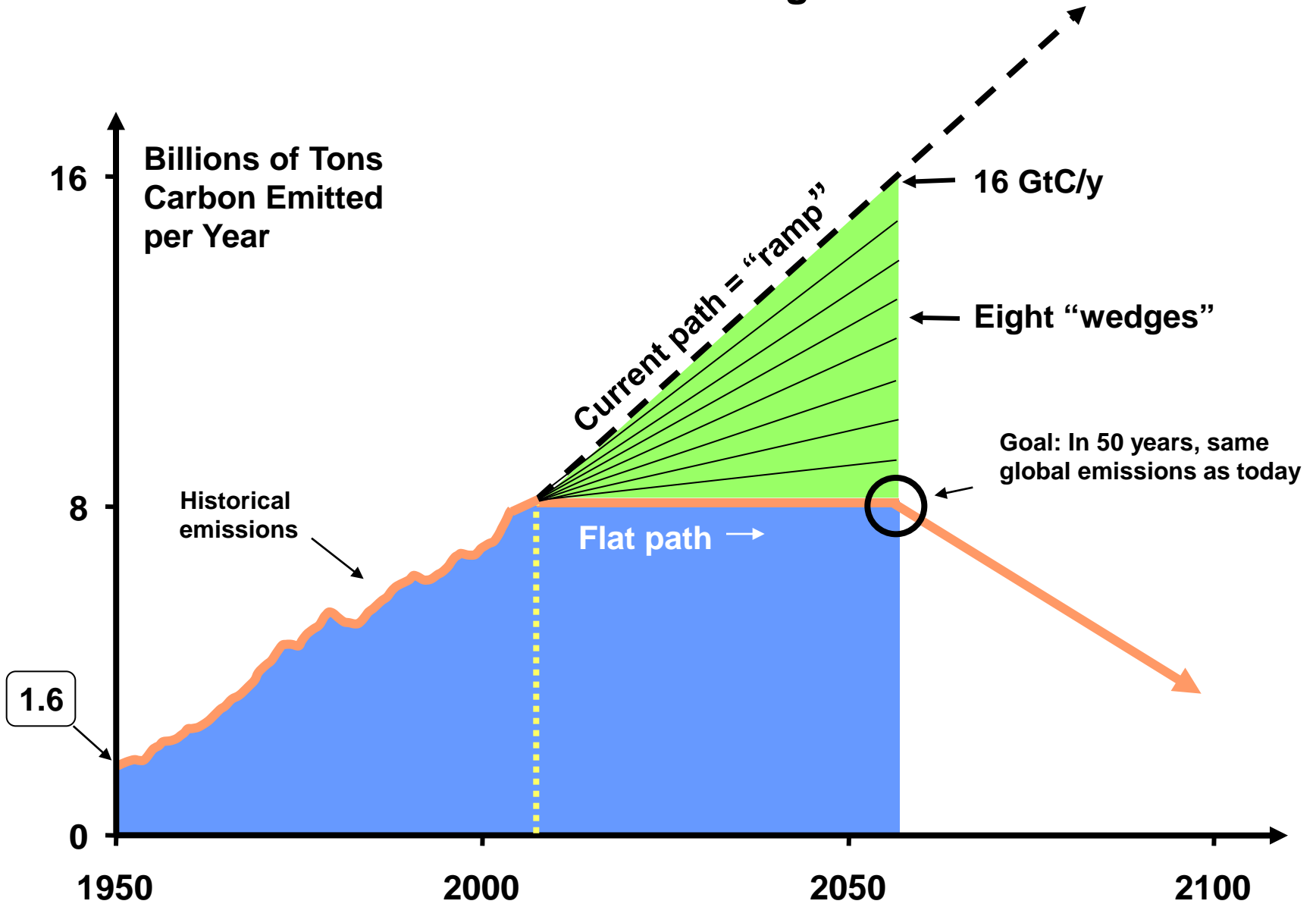
Historical Emissions



The Stabilization Triangle

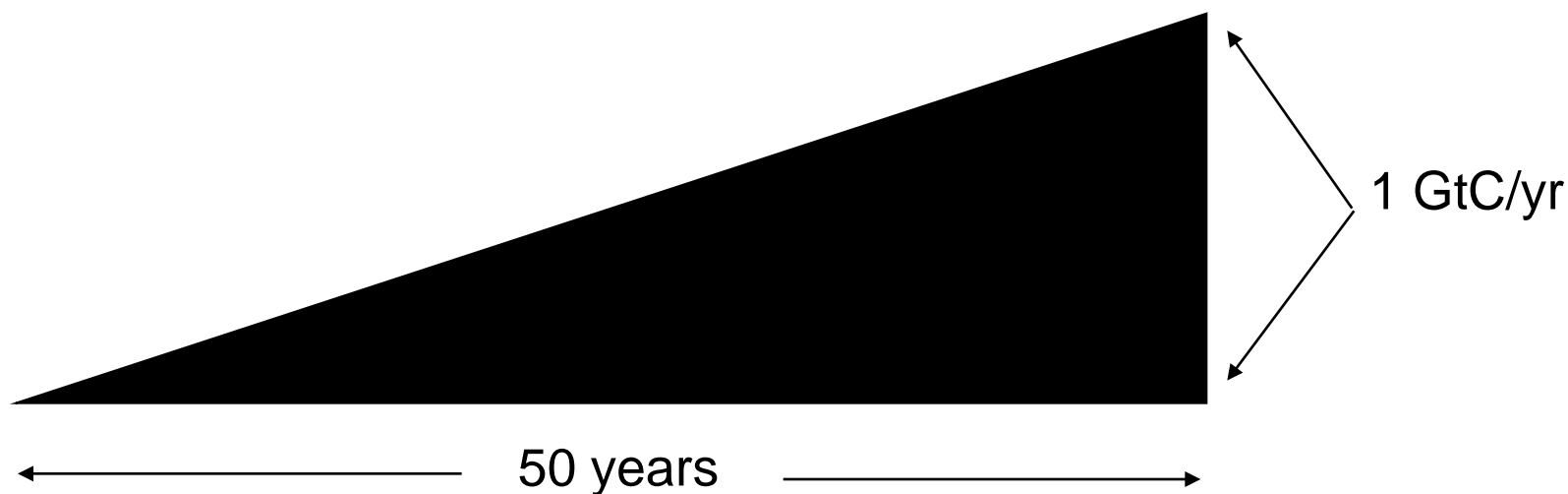


Stabilization Wedges



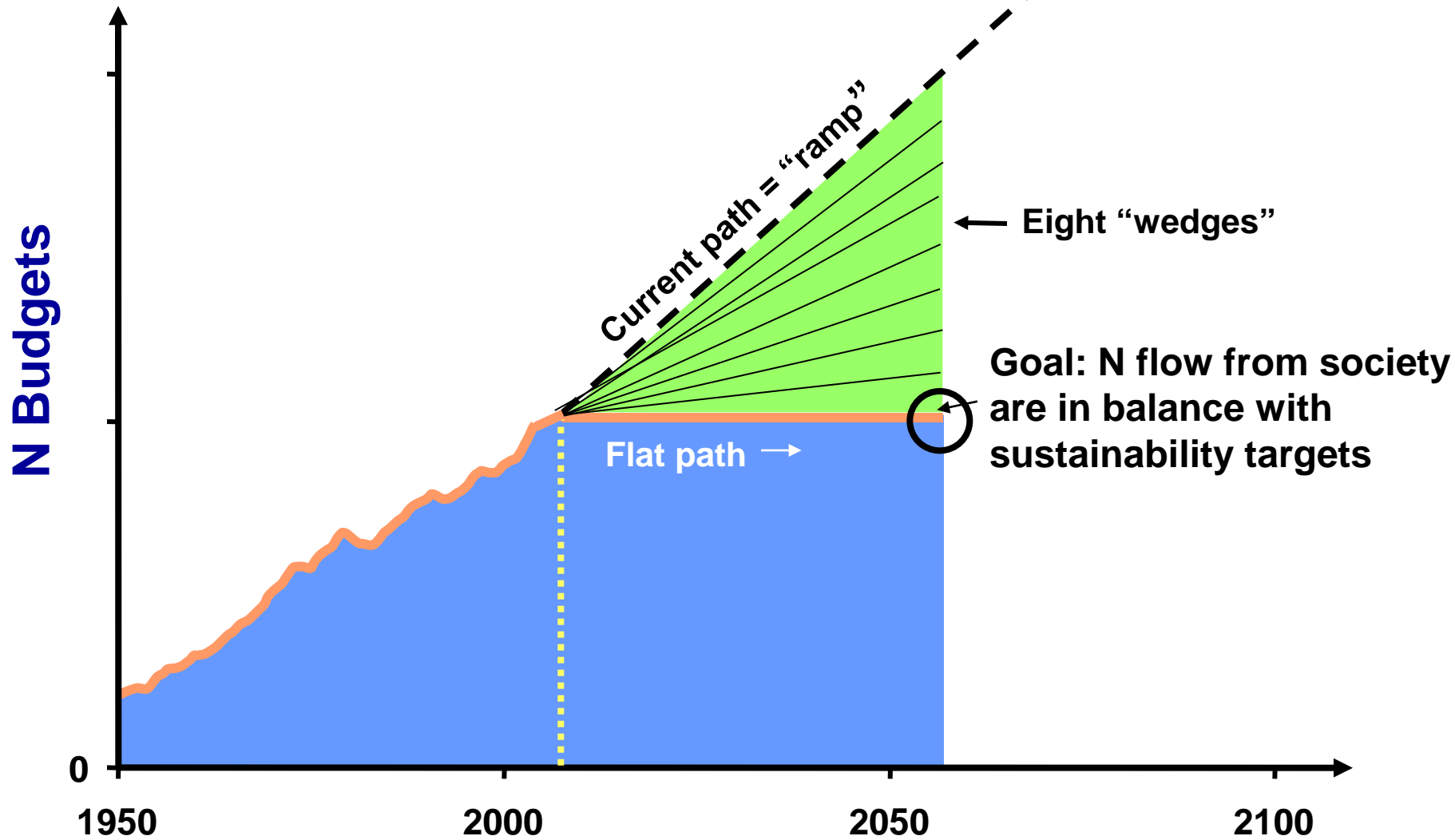
What is a “Wedge”?

A “wedge” is a strategy to reduce carbon emissions that grows in 50 years from zero to 1.0 GtC/yr. The strategy has already been commercialized at scale somewhere.



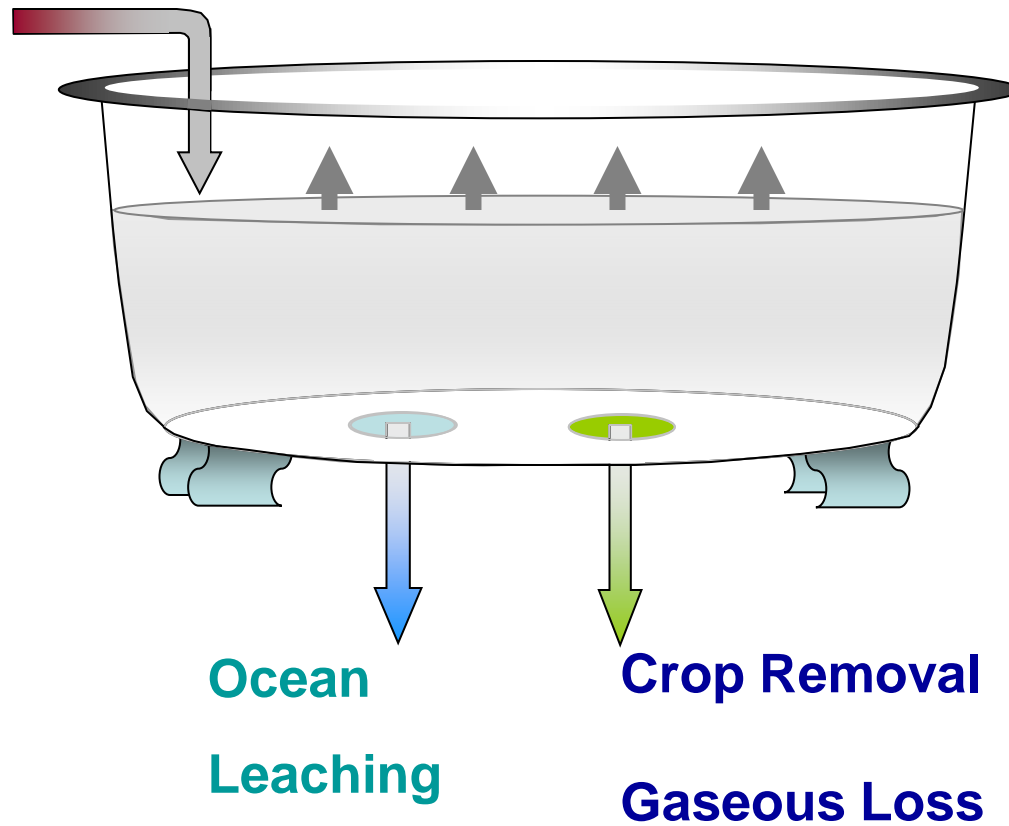
A “solution” to the CO₂ problem should provide at least one wedge.

Hypothetical Nitrogen Stabilization Wedges

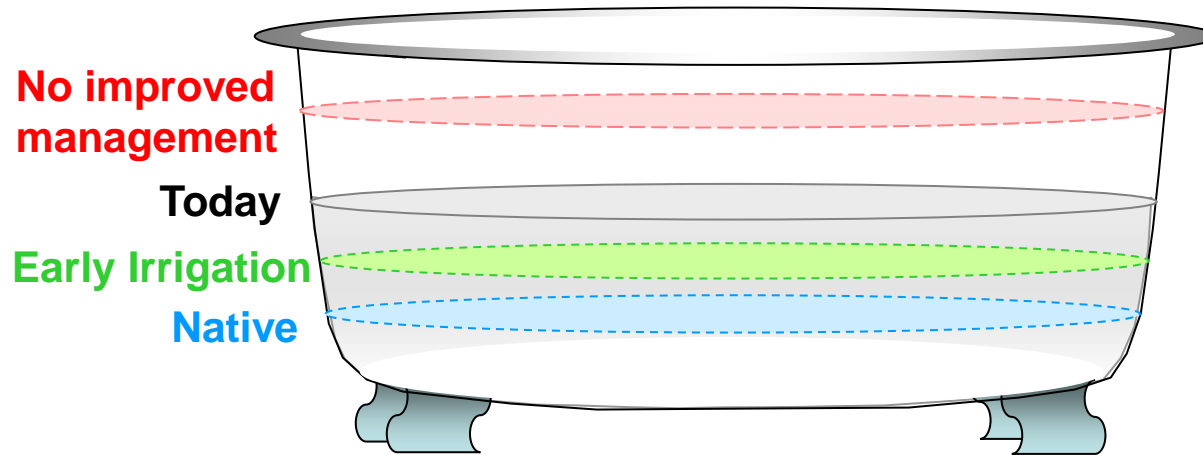


- Fertilizer
- Fixation
- Deposition
- Ag imports

Nitrogen Mass Balance



Past, Present, and Potential Future Nitrogen Budgets



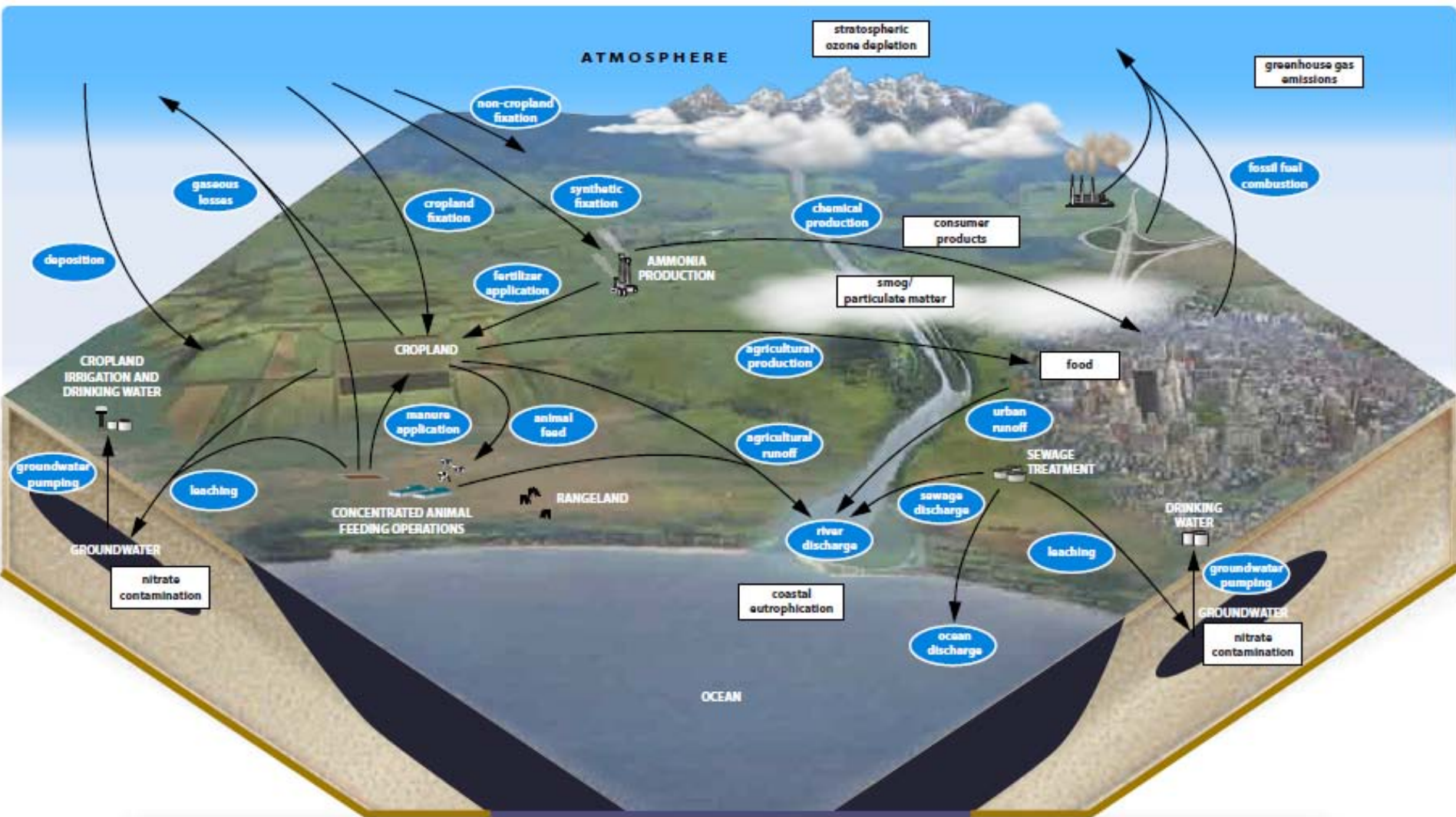
<http://nitrogen.ucdavis.edu>

THE CALIFORNIA NITROGEN ASSESSMENT



<http://igert.nspire.wsu.edu/>

**Nitrogen Systems: Policy-oriented
Integrated Research and Education
NSPIRE**



human health and environmental effects

The Nitrogen Cycle

UCD N Assessment

Dan Liptzin

Graphic adapted from The State of the Nation's Ecosystems 2008: Focus on Nitrogen: The H. John Heinz III Center for Science, Economics, and the Environment; graphic by Gabbhorn Studios. Some symbols are courtesy of the Integration and Application Network (ian.umces.edu/symbols), University of Maryland Center for Environmental Science.

Nitrate Concentration (Nitrate as NO₃) 2007

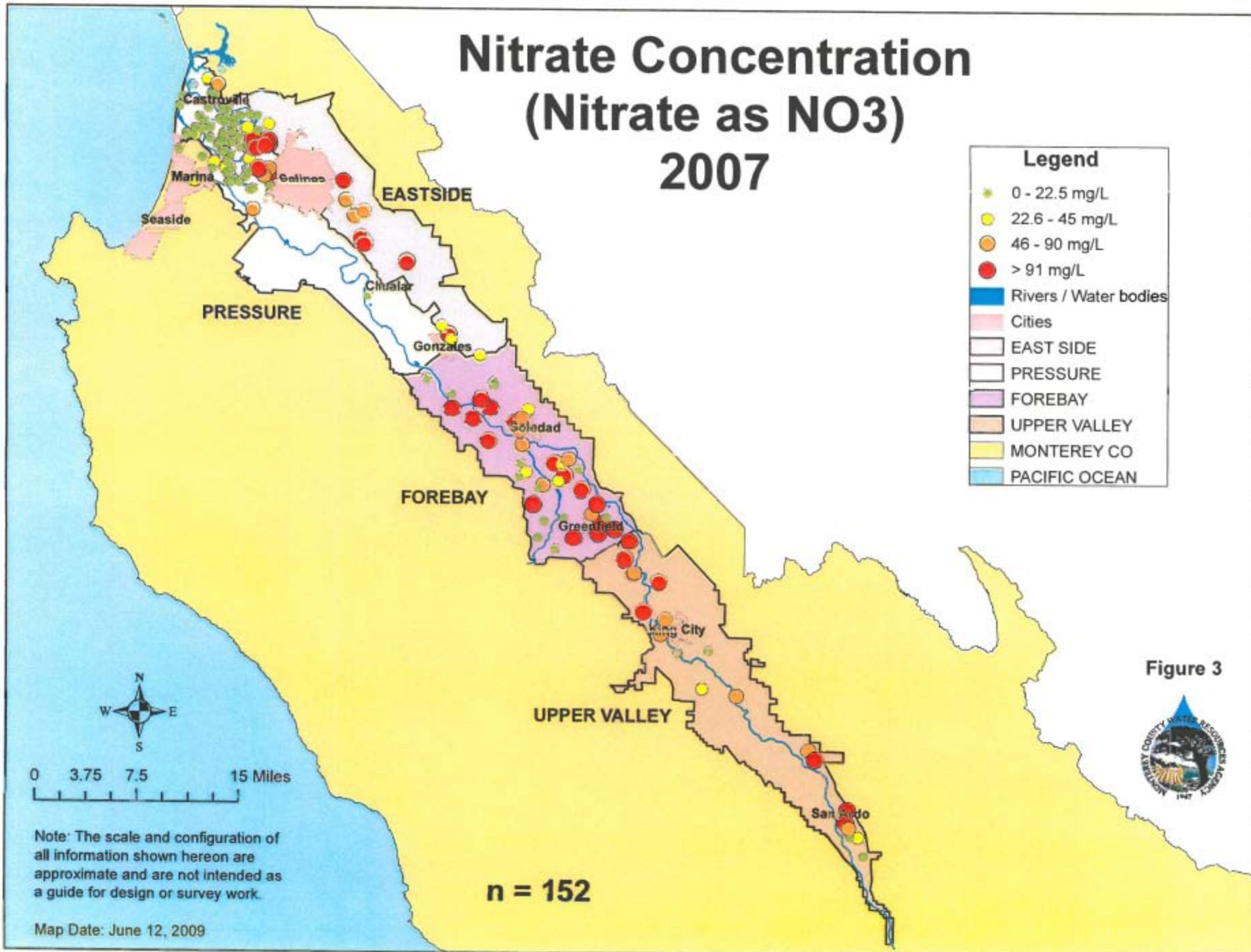


Figure 3



Note: The scale and configuration of all information shown hereon are approximate and are not intended as a guide for design or survey work.

Map Date: June 12, 2009

n = 152

Change in Nitrate Concentration 1993 to 2007 (Nitrate as NO₃)

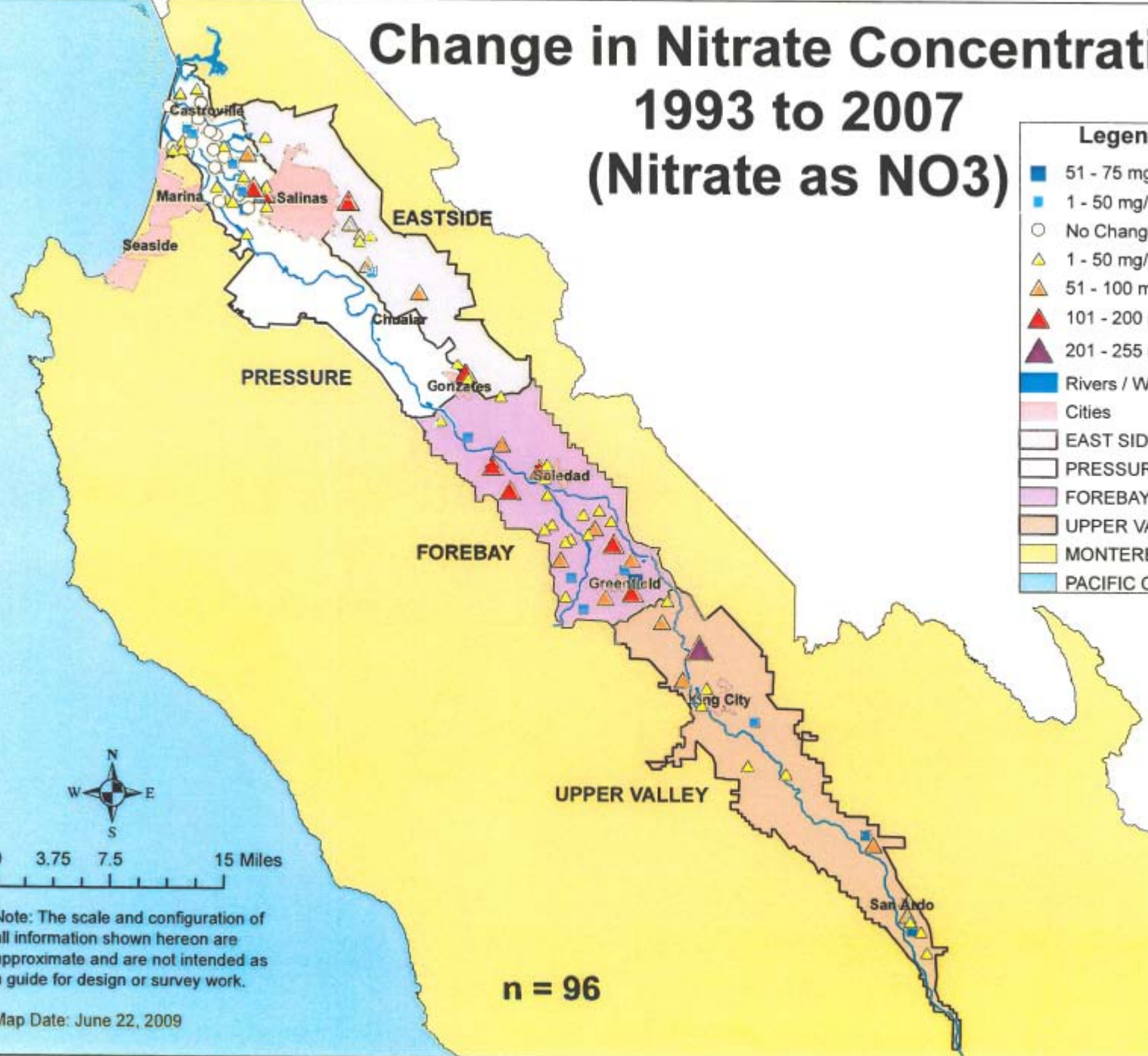
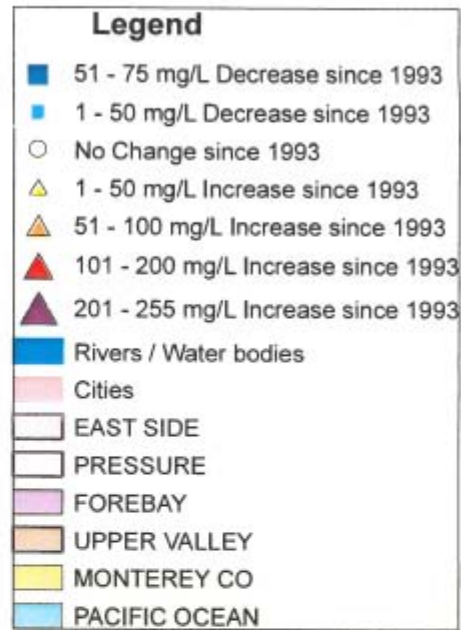
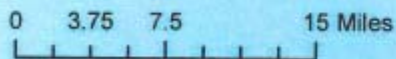


Figure 4



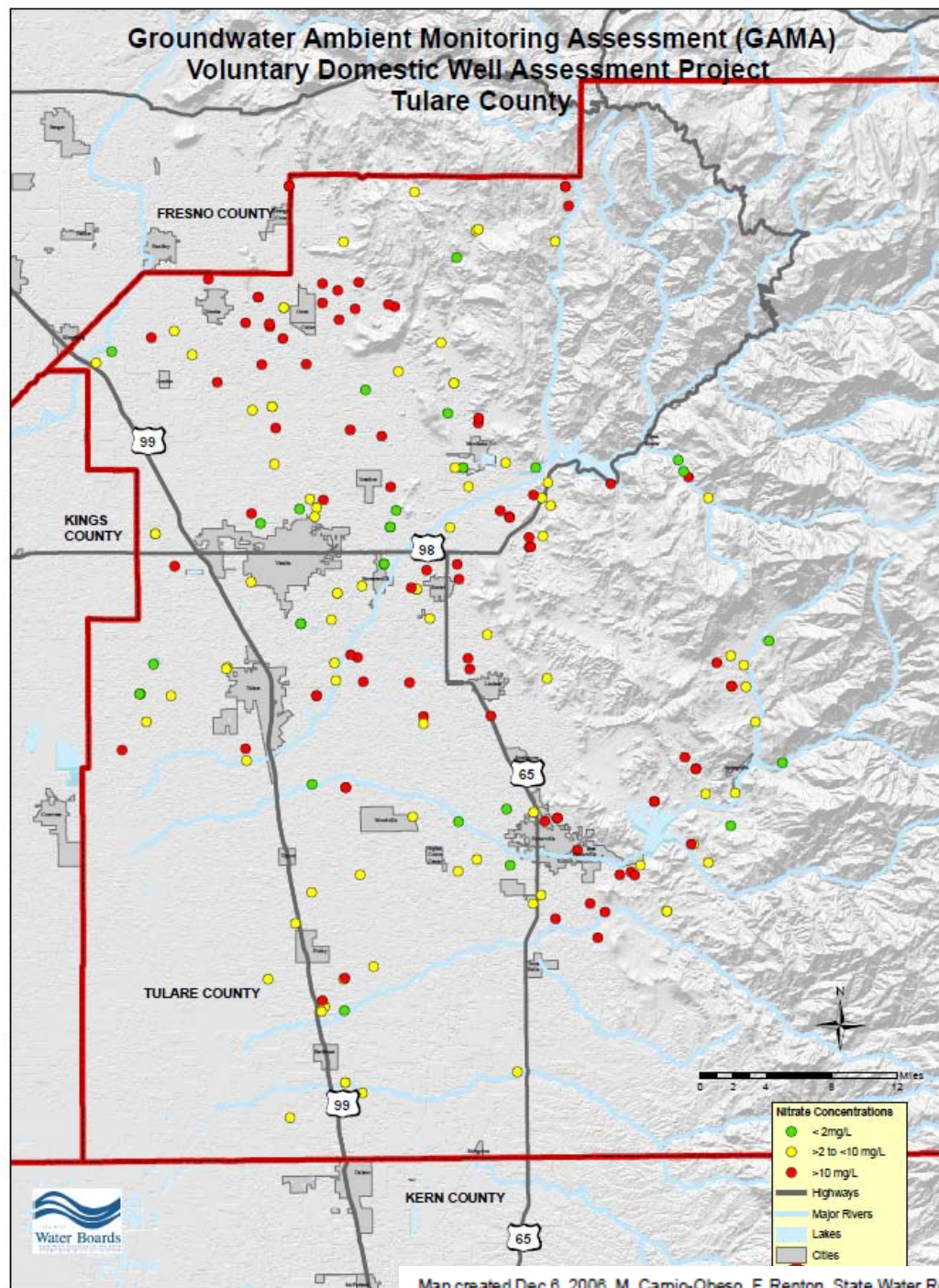
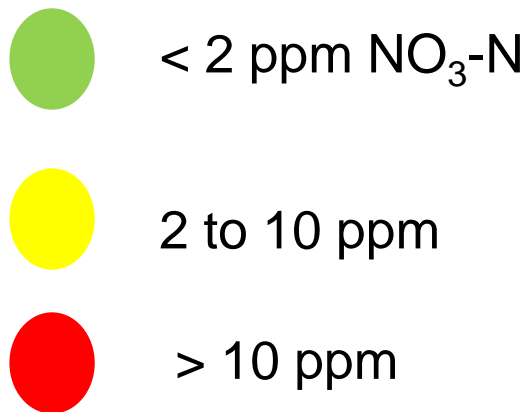
Note: The scale and configuration of all information shown hereon are approximate and are not intended as a guide for design or survey work.

Map Date: June 22, 2009

n = 96

Domestic Well Assessment Program

Tulare County, 2006



**What are some of the wedges for N?
(excellent exercise for farmers)**

**What are some of barriers impeding
enhanced adoption?**

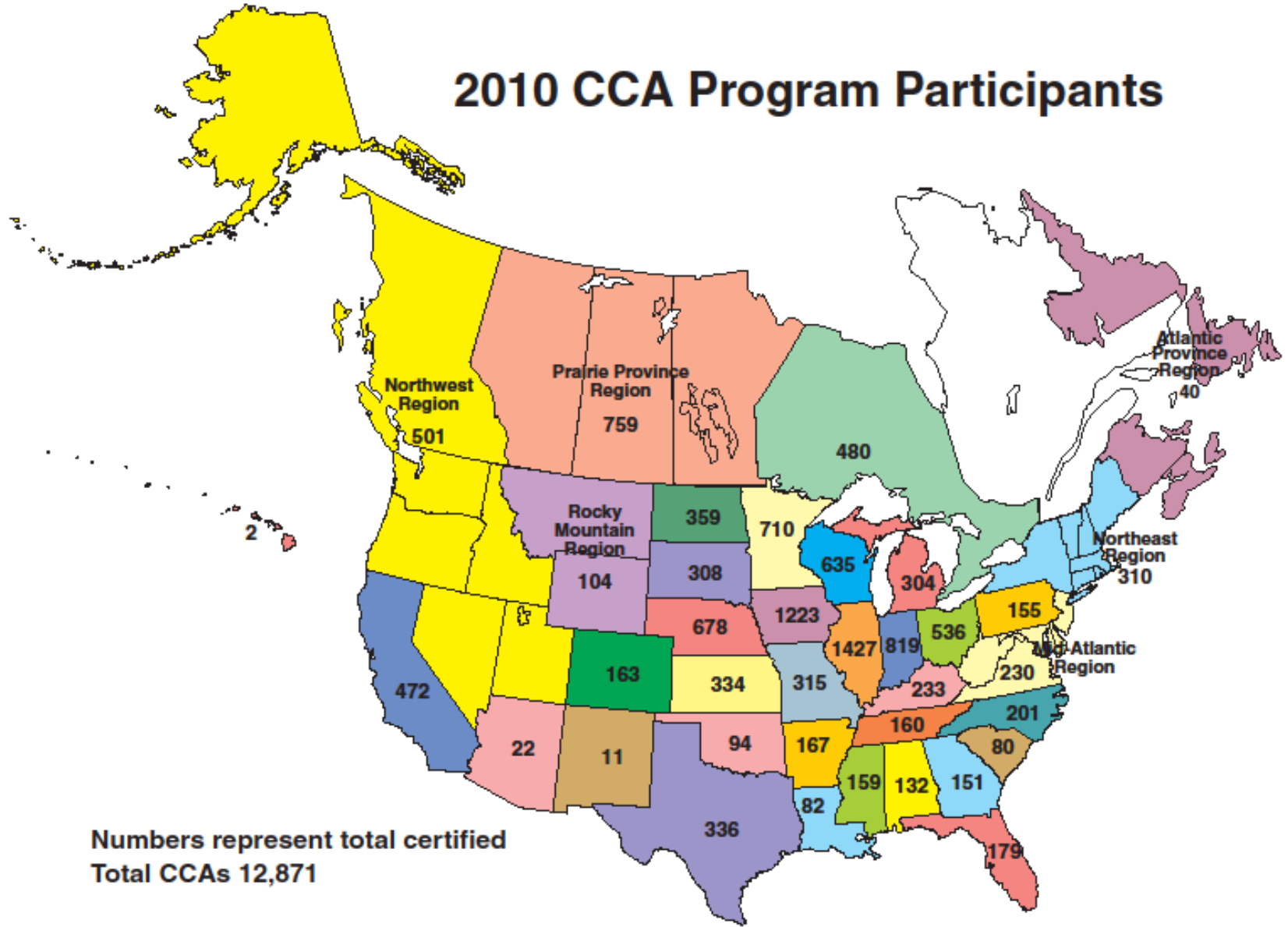


Barriers from Industry

Agronomic education of crop advisors



2010 CCA Program Participants



Numbers represent total certified
Total CCAs 12,871

Barriers from Industry

Pest control adviser workforce aging, dwindling (Western Farm Press, Oct. 2006)

Terry Stark, executive director of the California Association of Pest Control Advisers, said a survey 3,100 members revealed that :

40% of its members are over 55 years old
35% are 45 to 55
17% are 44 or younger

Barriers from Industry

Not a simple business transaction...
but a social/community exchange



Barriers from Industry

Profitability required at all levels
(not well appreciated by public sector)

Understanding of situational applicability
of products, technology, and packages
(nothing works everywhere!)

Proprietary competition between companies

Barriers from Industry



Example:
How to handle
specialty products?

Barriers from Industry

Technology can advance faster than our capacity to manage complex spatial and temporal variability



Perception of Academia by some farmers...



Ever learning, and never able to come to the knowledge of the truth...

Barriers from Academia

Limited resources - personnel, budgets, and incentive for applied research

Multi-year studies not always appropriate for market development (can't wait that long)

Scientific knowledge may not translate immediately to competitiveness- not well appreciated

One farmer noted: "I'd go out of business following university recommendations"

Barriers from Academia

Inappropriate use of statistics?

- using mean separation for rate studies
- insisting on 95% confidence levels

Accept 3rd –party private research?

(where does industry turn to if University not interested?)

Technology adoption by academia often
lags industry advances

Barriers from Growers

Tradition is comfortable, esp. with older people

Costs vs Return

easy to measure costs, returns take effort

Reliability is important...

complex and variable cropping

Barriers from Growers

Risk is a barrier to change

“The Produce Broker calls the shots”

(underestimating N results in zero marketable yield)

More precise water management is complicated
excellent ET prediction available
automated soil water monitoring common

(but managing many fields and soils make things difficult)

Barriers from Government

Competing environmental goals

California examples:

Global Warming Solutions Act: Focus on nitrous oxide emissions

Regional Water Boards: Focus on nitrate in groundwater

Barriers from Government

Competing environmental goals

Methane from dairies to be regulated... encourage methane digesters

Air Resources Board: Prohibit methane combustion from bioenergy without NOx scrubbing

Barriers from Government

Safety and efficacy hurdles

NSN not sold in California

DMPP (*Entec*) nitrification inhibitor-
available globally except North America

Knowledge and Management Barriers

Plant

Soil

Water

Environmental fate

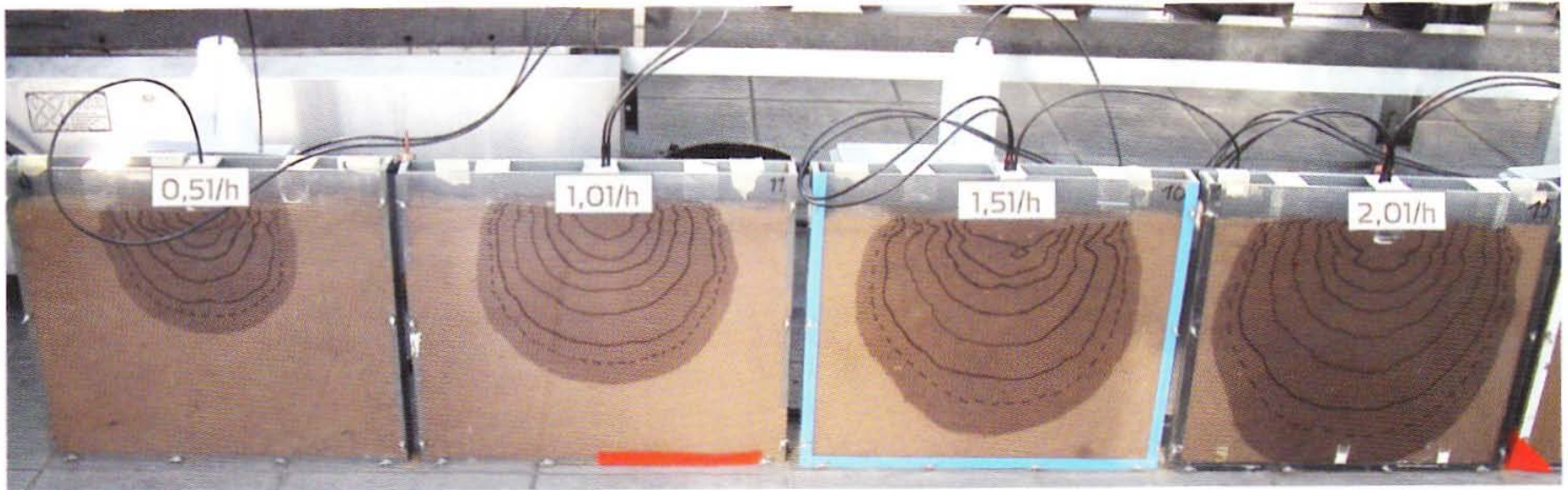
Management package



Water Management is Key to Nitrogen Management



Rate of water delivery determines the volume of wetted soil



emitter flow rate

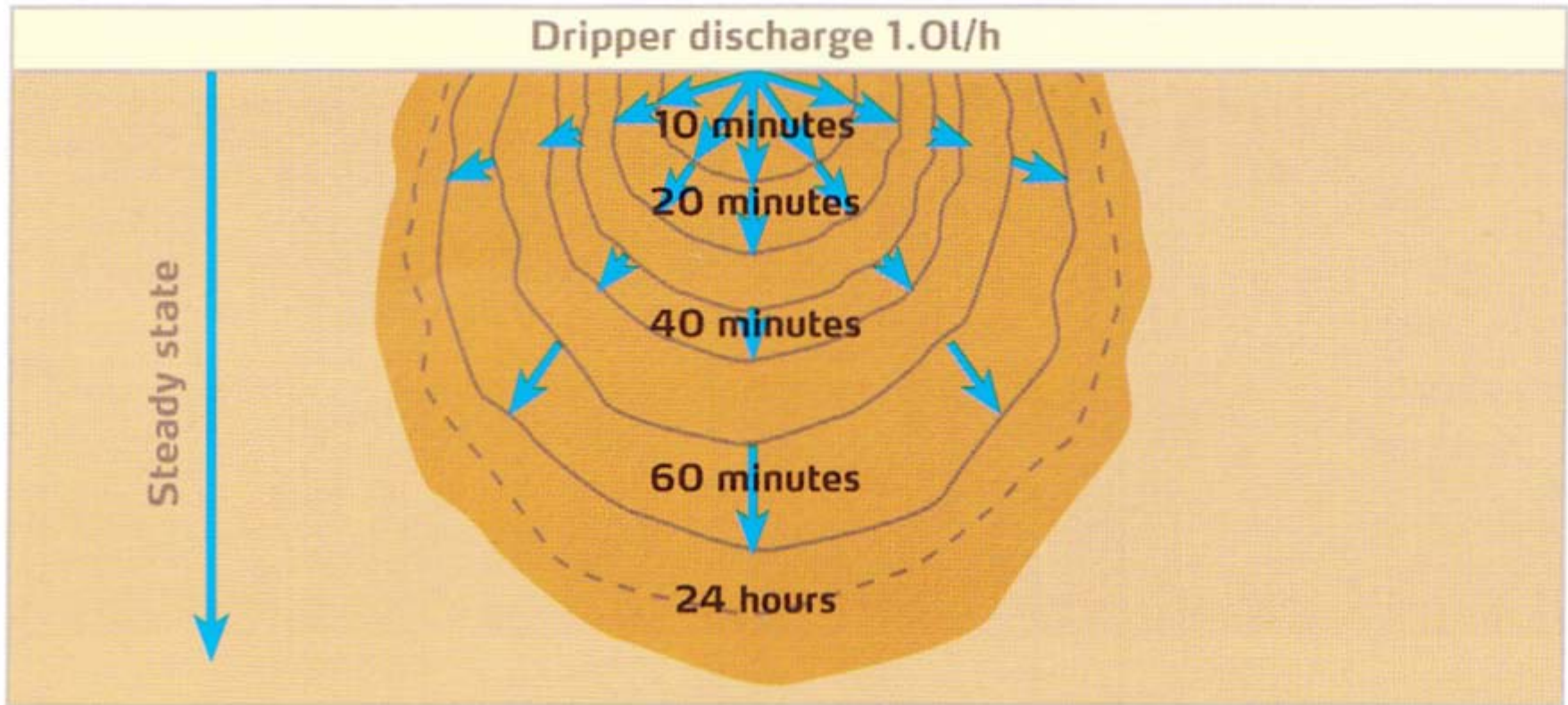
0.5 L/hr

1 L/hr

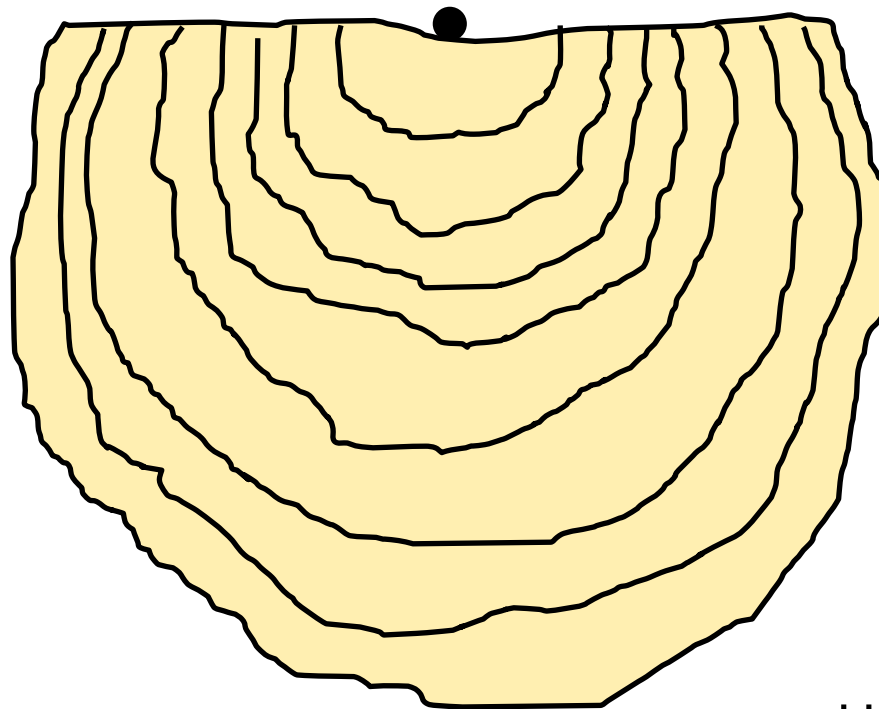
1.5 L/hr

2L/hr

Typical wetted soil volume following a one-hour irrigation

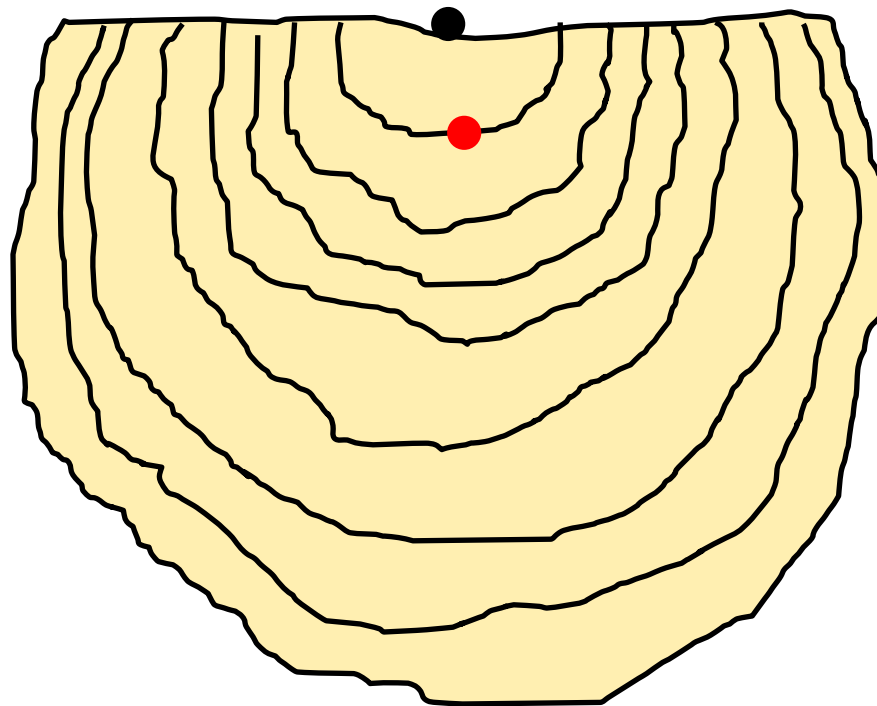


Urea: $\text{CO}(\text{NH}_2)_2$

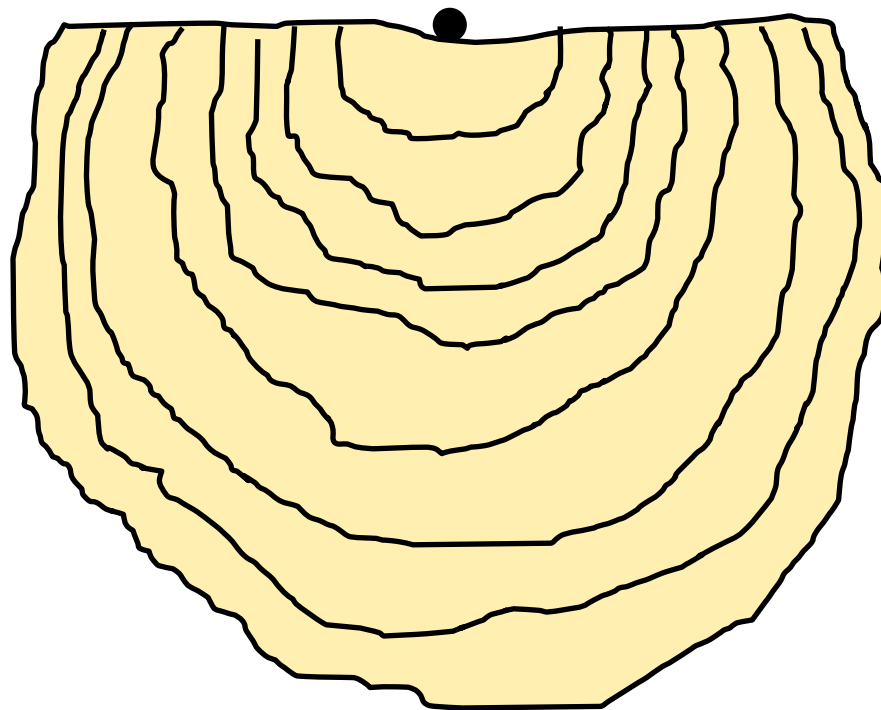


Urea \rightarrow 2NH_4^+

Ammonium: NH_4^+



Nitrate: NO_3^-



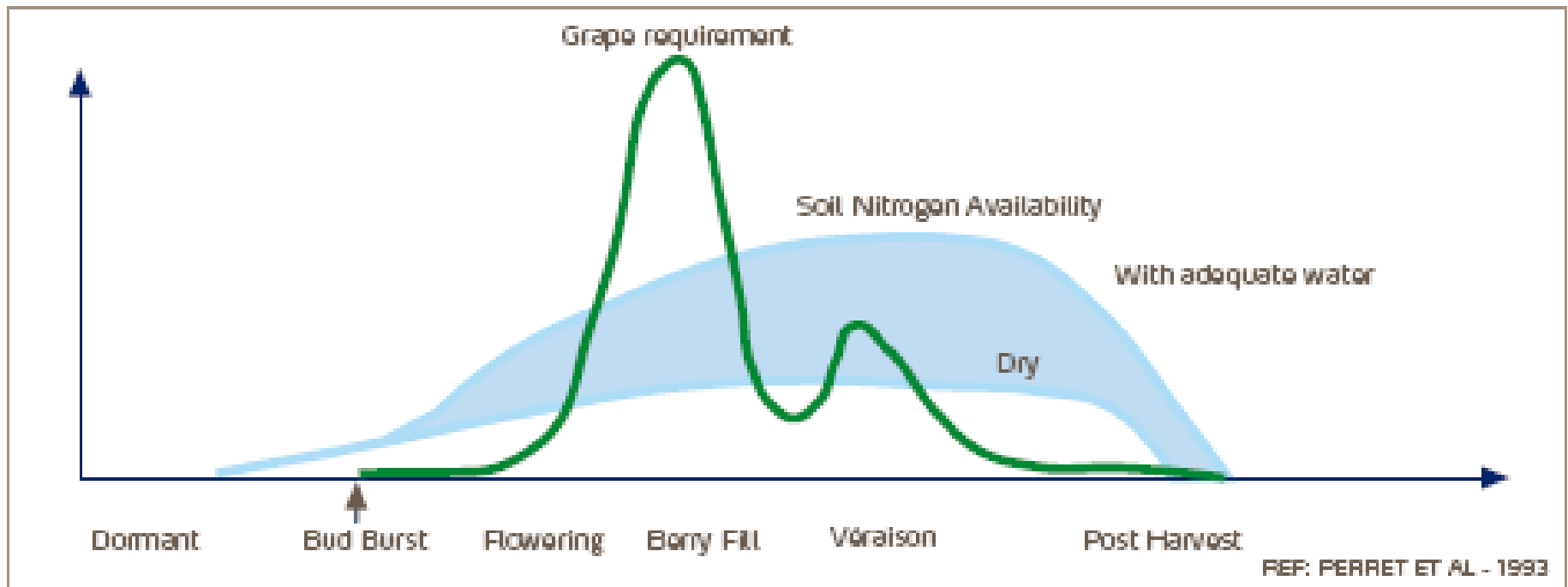
Where are the roots?

How to manage 200 to 300 lb N/A
for a crop with a 6-inch rooting depth?



Grape Phenology & Nutrient Uptake

General Nitrogen Requirement of Grapevine



YARA

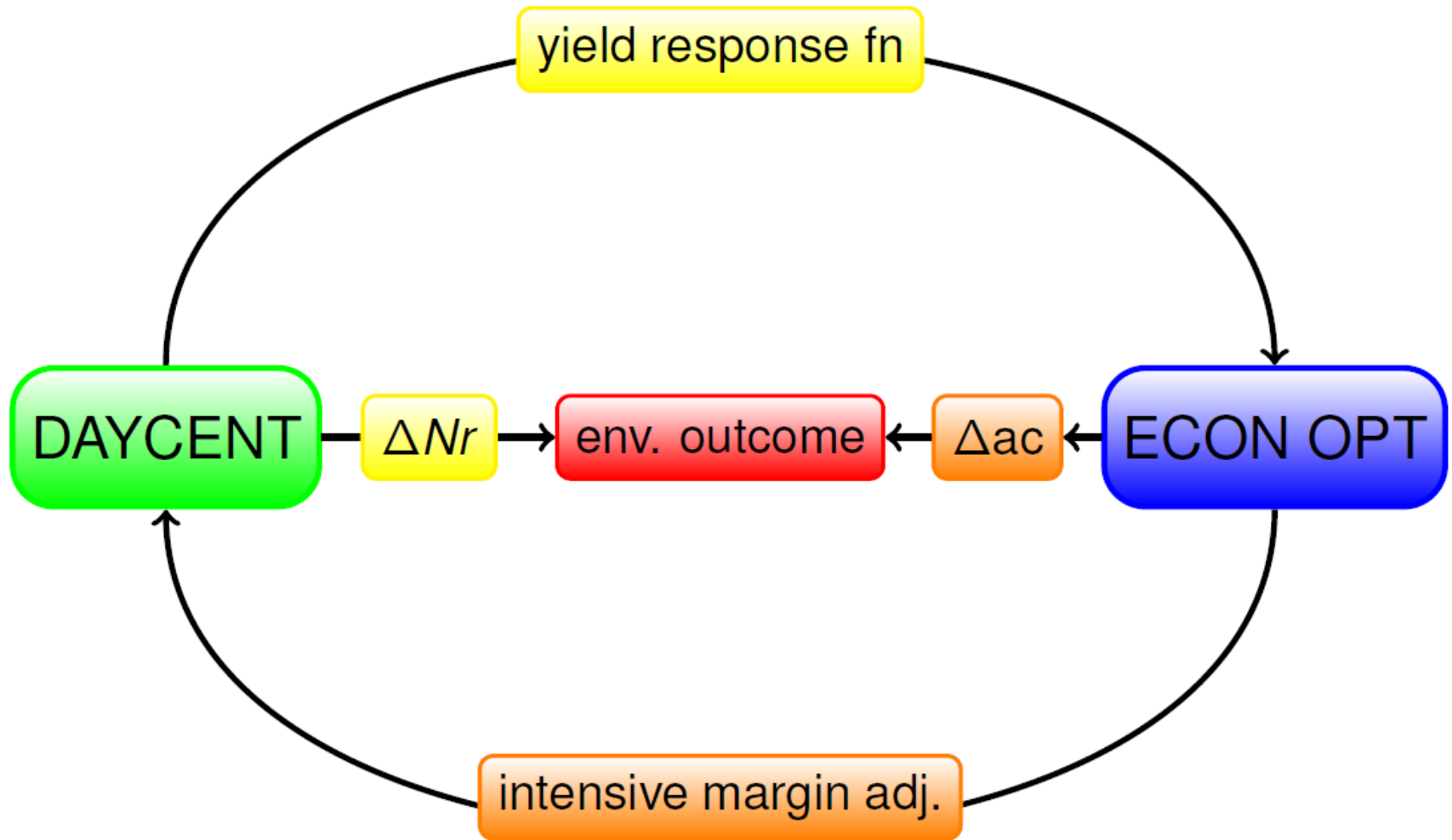
An example of linking fertilizer practices with environmental impacts

A regional economic model of nitrogen use Linking a biophysical model to an economic optimization model

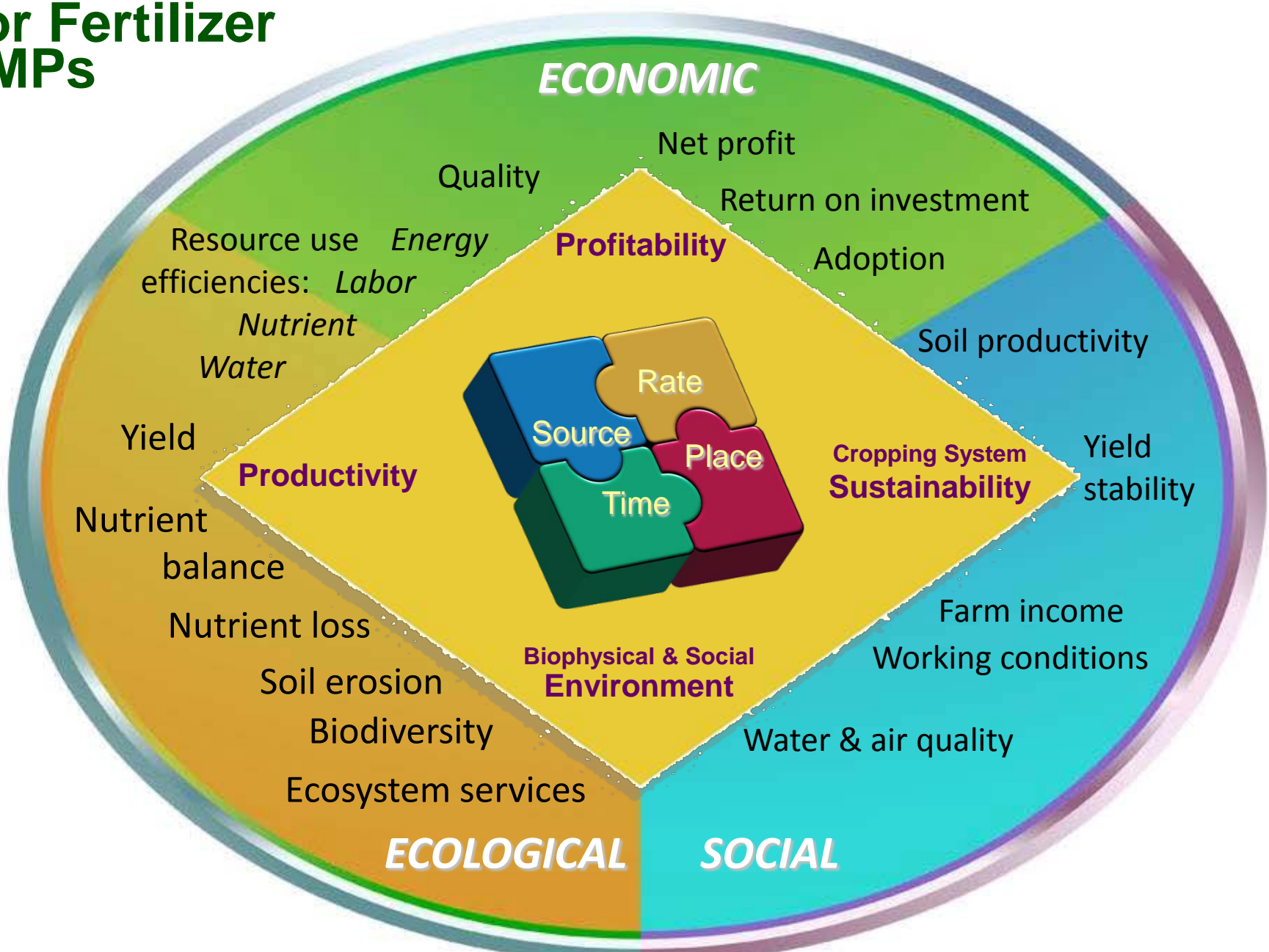
P. Mérel¹, S. Bucaram¹, J. Lee² and Johan Six²

Univ. Calif. Davis

Overview



Global Framework For Fertilizer BMPs







IPNI

INTERNATIONAL

PLANT NUTRITION

INSTITUTE

Additional information on
plant nutrient production
and management are
available from the IPNI website:

www.ipni.net



International Plant Nutrition Institute
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Norcross, Georgia 30092
USA

www.ipni.net