Managing Agricultural Nitrogen
&
Fertilizer Research and Education Program

Asif Maan, Ph.D.
Environmental Program Manager II

Contents

- 22 Years of Fertilizer Research and Education Program (FREP)
- Nitrogen Management and FREP Initiatives
  1. Accessibility of FREP research
  2. Focused research on nitrogen management practices
  3. Technical education and outreach

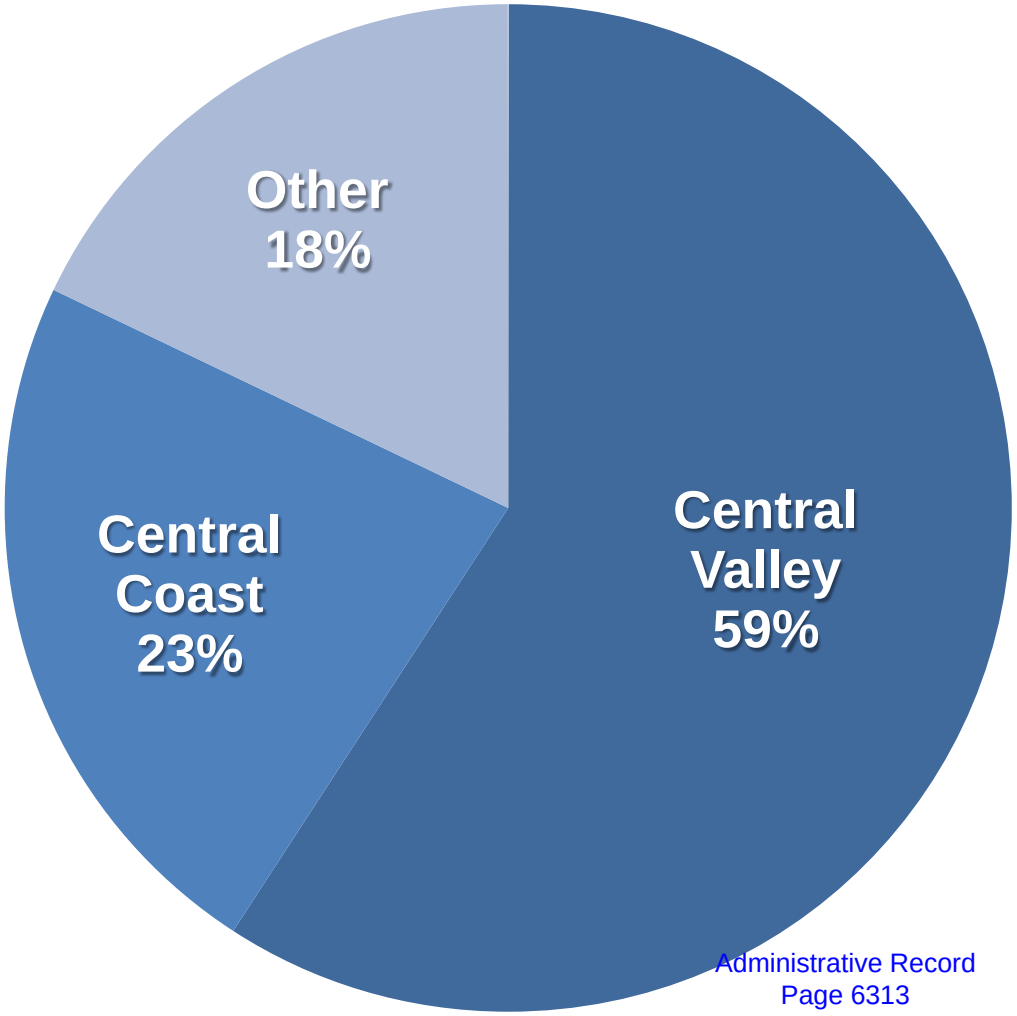
22 Years of FREP

1988 – CDFA Nitrate Working Group

- 1989 “Nitrate and Agriculture in California” Report
- Confirmed locations in the state where groundwater contained elevated levels of nitrate
- Fertilizer Research and Education Program (FREP) was established in 1990

22 Years of FREP

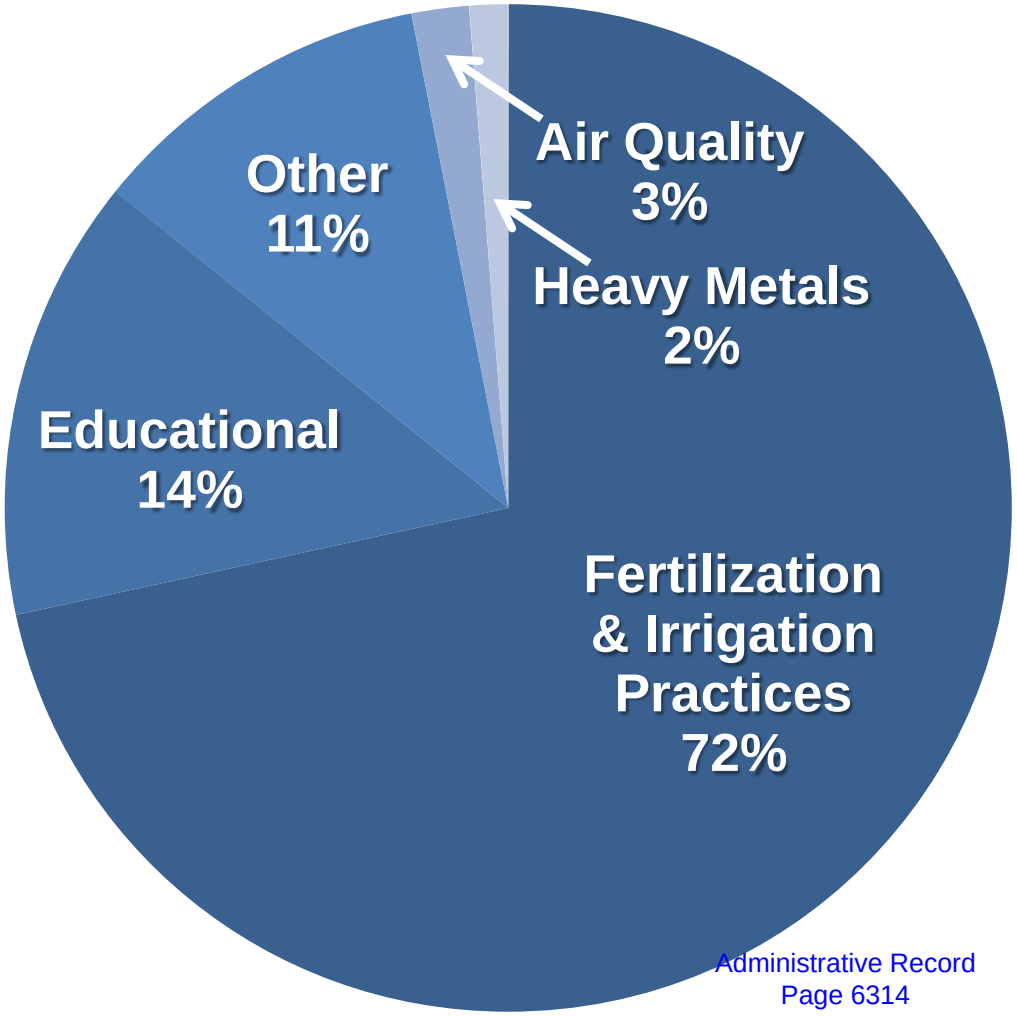
Over $12 million spent on 160 basic and practical research and education projects



FREP Projects by Geography

22 Years of FREP

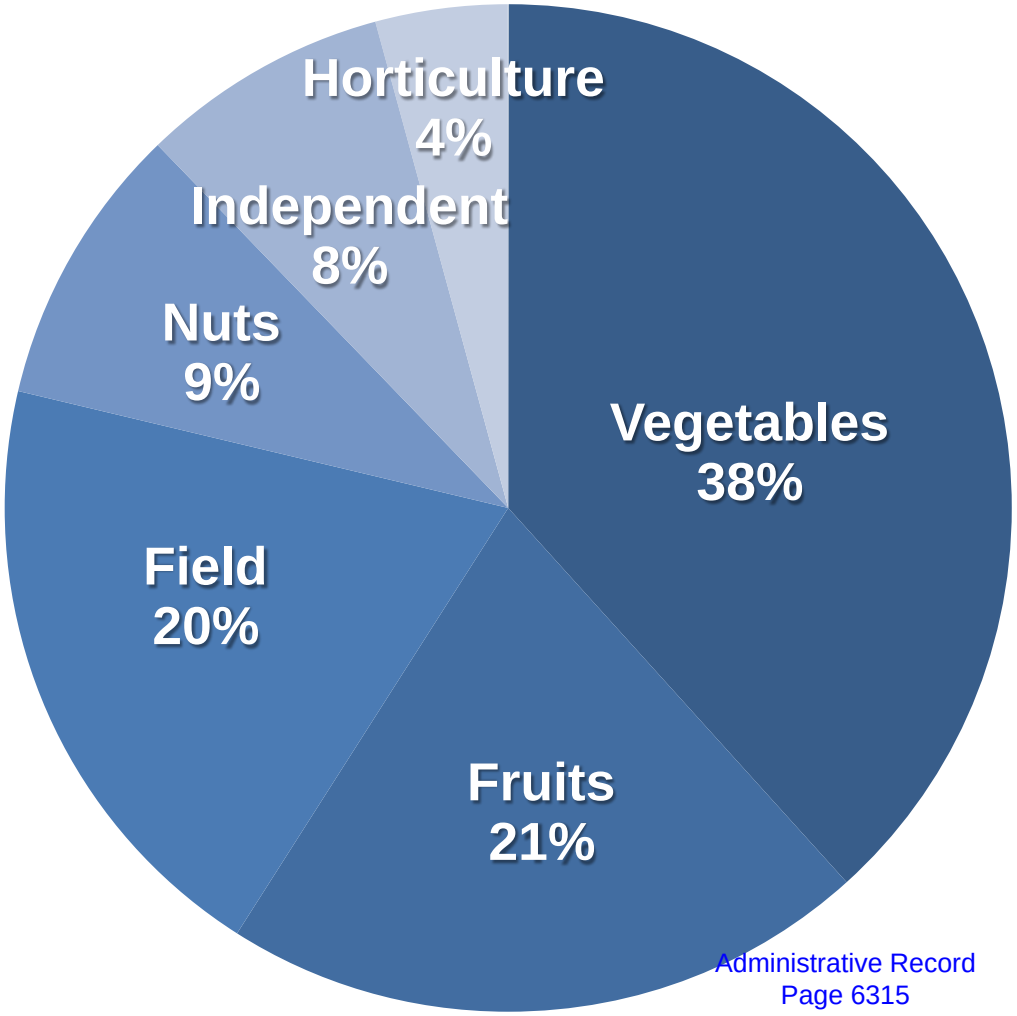
Over $12 million spent on 160 basic and practical research and education projects



FREP Projects by Discipline

22 Years of FREP

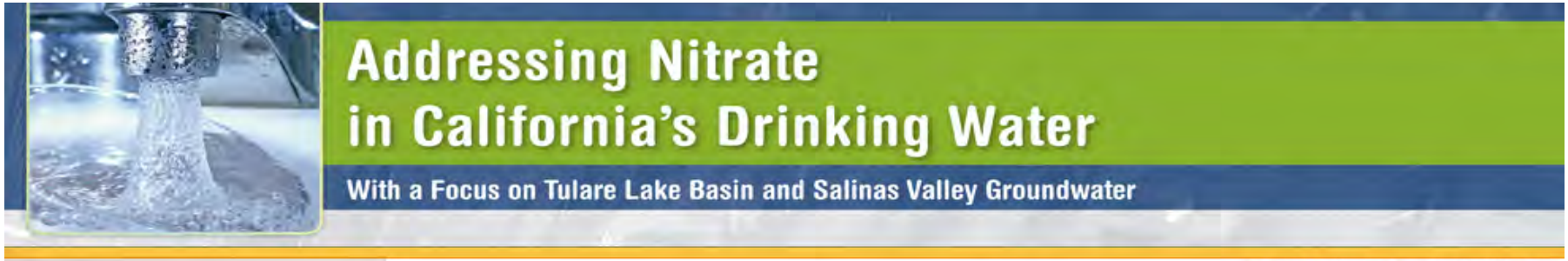
Over $12 million spent on 160 basic and practical research and education projects



FREP Projects by Commodity

22 Years of FREP

2012 SBX2 1 Report



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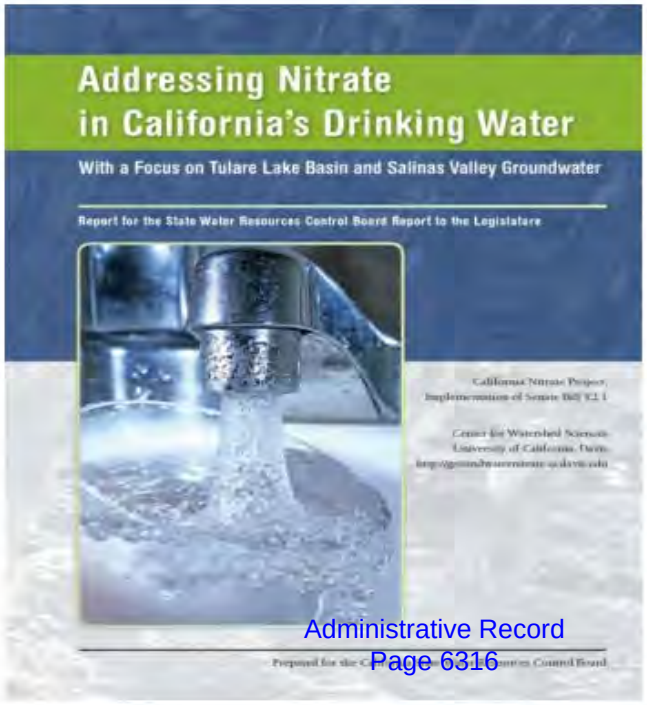
UC Davis Report for the SWRCB SBX2 1 Report to the Legislature



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Center for Watershed Sciences • University of California, Davis
Groundwater Nitrate Project, Implementation of Senate Bill X2 1
Prepared for California State Water Resources Control Board • March 2012

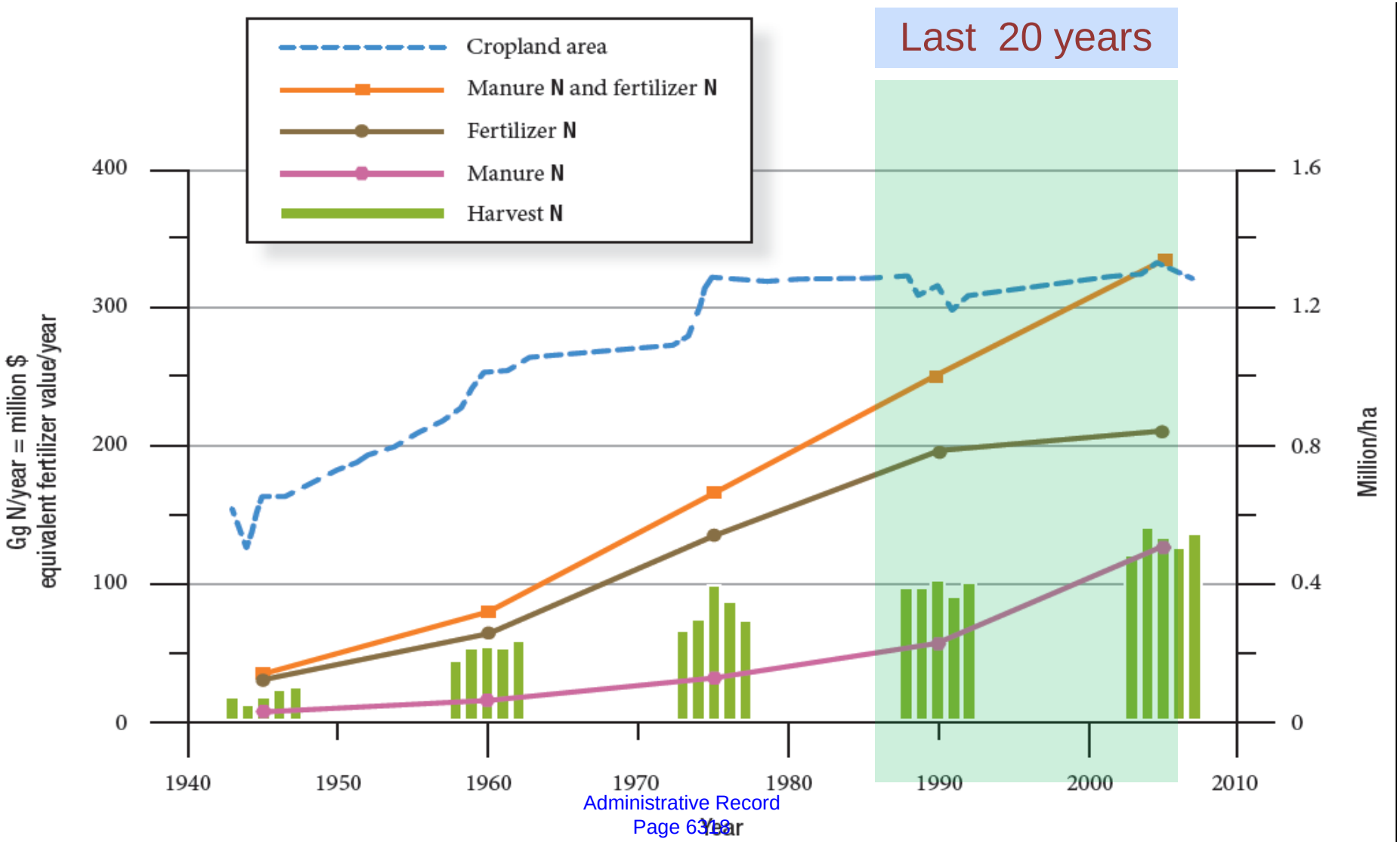
22 Years of FREP

2012 SBX2 1 Report Findings

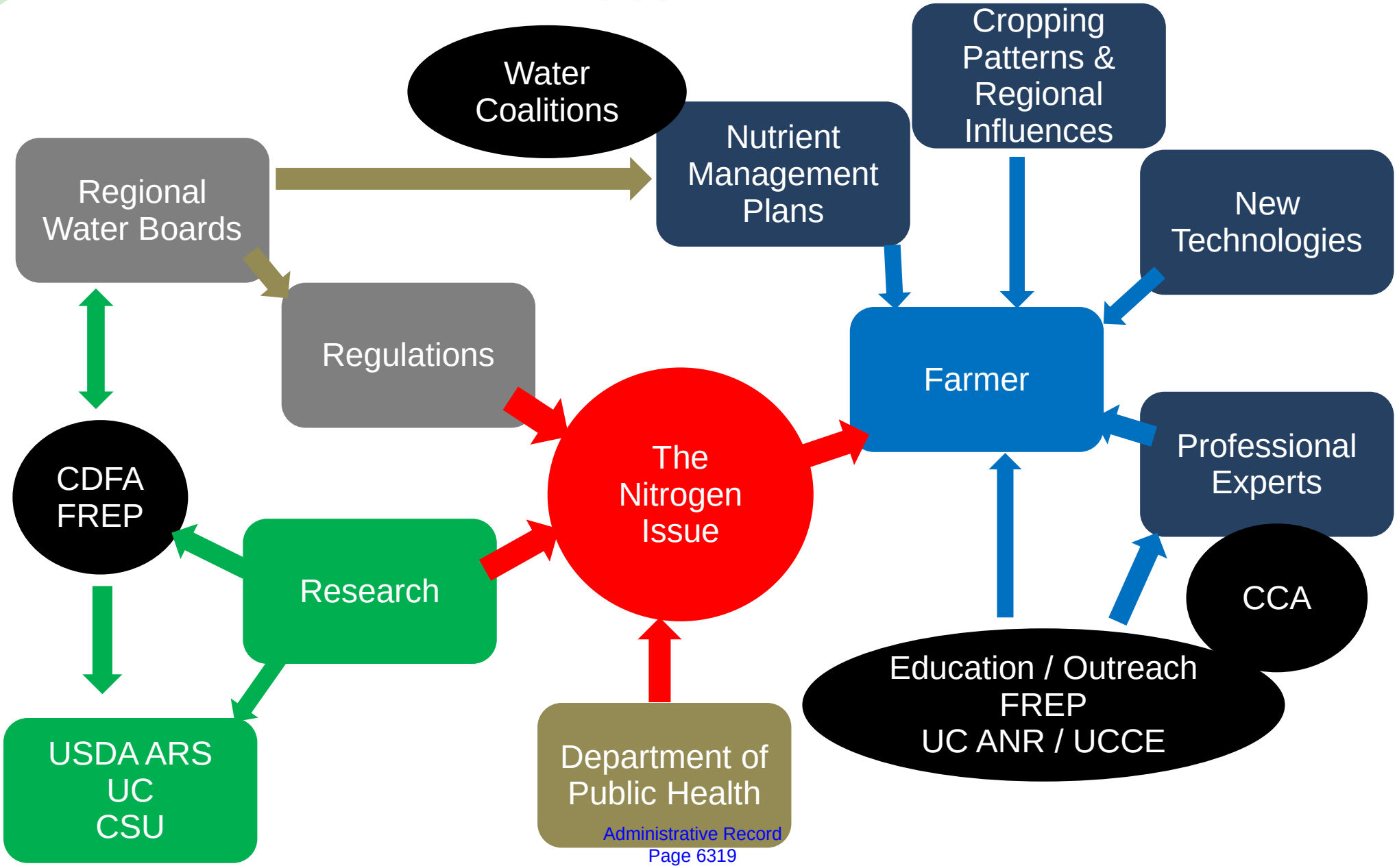
- Similar to the 1989 Nitrate Working Group report
- Agriculture is a large contributor to nitrate in ground water
- Proposed several promising options
- One of the most feasible, practical, and cost effective promising options is “pump and fertilize”

22 Years of FREP

SBX2 1 Report Findings



Complexity and Opportunities



Opportunities

FREP Initiatives

1. Accessibility of FREP research
2. Focused research on nitrogen management practices
3. Technical education and outreach

1. Accessibility of FREP Research

Objective: To make FREP research data and findings readily available to growers and crop advisors.

- Cooperative FREP-UC Davis Project
- Developed web-based searchable database - CDFA-IT
- Synthesized key information from technical reports

1. Accessibility of FREP Research

Previous: List of Completed Projects

FIELD CROPS (1991 - 2008)

2008

- **Fertility Management in Rice**
  Project Leaders: Chris van Kessel and B. Linquist

2007

- **Effects of Cover Cropping and Conservation Tillage on Sediment and Nutrient Losses to Runoff in Conventional and Alternative Farming Systems**
  Project Leader: William R. Horwath
- **Practical Soil Test Methods for Predicting Net N Mineralization**
  Project Leader: William R. Horwath
- **Site-Specific Variable Rate Fertilizer Nitrogen Application in Cotton**
  Project Leader: Richard E. Plant, et. al.
- **Soil-Solution Partitioning of Trace Elements in Cropland Soils of California: Estimating the Plant Uptake Factors of As, Cd, and Pb**
  Project Leader: Andrew C. Chang

1. Accessibility of FREP Research

Previous: Final Reports

Effects of Cover Cropping and Conservation Tillage on Sediment and Nutrient Losses to Runoff in Conventional and Alternative Farming Systems

Project Leaders

William R. Horwath
Dept. of Land, Air, and Water Resources
University of California
Davis, CA

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University of California
Davis, CA

OBJECTIVES

1. Quantify discharge from research plots and grower fields to compare alternative management practices with conventional ones.
2. Quantify non-point source pollutions (NPSP) concentrations and loads in discharge.
3. Inform farmers, policymakers, and the general public about the usefulness of cover crops (CC) and conservation tillage (CT) in addressing nutrients losses.

40 Pages

1. Accessibility of FREP Research

Now: Searchable Database

FERTILIZER RESEARCH AND EDUCATION PROGRAM

1220 N Street, Sacramento, CA 95814 • 916-900-5022 • Fax: 916-900-5349 • frep@cdfa.ca.gov

INFORMATION ABOUT FREP

- 2012 FREP Conference Mailer
- 2012 FREP Conference Registration Form
  Use this PDF form to submit your conference registration by
- Searchable Database of FREP Research Projects
- FREP Fact Sheet

http://www.cdfa.ca.gov/is/frep/Default.aspx

- 2012 FREP Grant Outreach and Reporting Requirements
- 2011 CDFA/WPHA Conference November 16 & 17 Tulare, CA
- 2011 Conference CEU's

GENERAL INFO

- Our Mission
- Laws & Regulations
- Search Staff Directory
- FFLDRS Database

MORE RESOURCES

- The American Society of Agronomy - California Chapter
- Association of American Feed Control Officials
- Association of American Plant Food Control Officials
- CA Dept. of Health Services
- CA Dept. of Pesticide Regulation
- California Certified Crop Advisor Program
- California Fertilizer Association
- California Grain and Feed Association
- National Grain and Feed Association
- U. S. Department of Agriculture

1. Accessibility of FREP Research

Now: Searchable Database

CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

INSPECTION SERVICES DIVISION

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Meetings

CDFA Home > Inspection Services > FREP Database

FREP DATABASE

The Fertilizer Research and Education Program (FREP) funds and coordinates research to advance the environmentally safe and agronomically sound use and handling of fertilizer materials. Since 1990, FREP has funded research on many of California's important and environmentally sensitive cropping systems. This database aims to make the wealth of information contained in FREP research projects readily available, easily understandable, and convenient for growers to implement.

Please enter search criteria:

Keyword(s)

Type of Crop: View All

County: View All

Date Range: View All

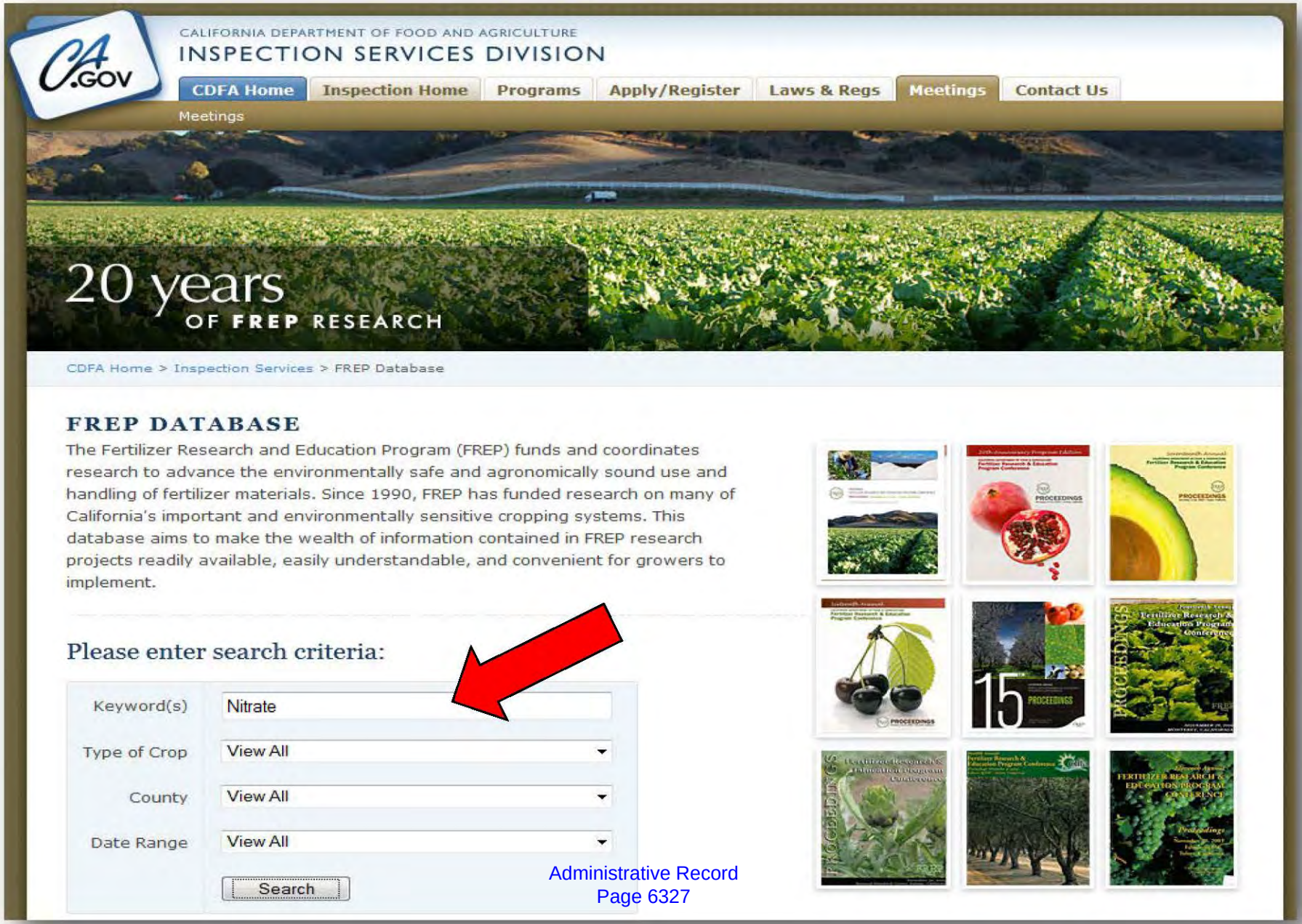
Search

1. Accessibility of FREP Research

Search Options

1. Accessibility of FREP Research

Search Options



1. Accessibility of FREP Research

Search Results

FREP DATABASE

Search results:

Study Title	ct County	Crop Type
Establishing Updated Guidelines for Cotton Nutrition	Merced, Madera, Fresno, Tulare, Kings, Kern	Cotton
Evaluating and Demonstrating the Effectiveness of In-Field Nitrate Testing for Drip and Sprinkler Irrigated Vegetables	Santa Clara	Lettuce, Pepper, Celery, Onion, Cabbage, Broccoli
Minimizing Nitrogen Runoff and Improving Use Efficiency in Containerized Woody Ornamentals through Management of Nitrate and Ammonium-Nitrogen	Yolo, Riverside	Nursery crops
New Standard for the Effectiveness of Foliar Fertilizers	Fresno	Clementine mandarin
Nitrogen Fertilizer Management to Reduce Groundwater Degradation	Stanislaus	Almond
Site-Specific Variable Rate Fertilizer Nitrogen Application in Cotton	Kings, Fresno	Cotton
Soil Testing to Optimize Nitrogen Management for Processing Tomatoes	Fresno	Tomato

1. Accessibility of FREP Research

Report Summary

STUDY RECORD

Establishing Updated Guidelines for Cotton Nutrition

Weir, B., University of California Cooperative Extension, Merced; Miller, R., University of California Diagnostic Laboratory, Davis; Hutmacher, R., USDA Water Management Research Laboratory, Fresno; Huffaker, R. and Travis, R., Department of Agronomy and Range Sciences, University of California, Davis; Vargas, R., University of California Cooperative Extension, Madera; Munk, D., University of California Cooperative Extension, Fresno; Wright, S., University of California Cooperative Extension, Visalia; Roberts, B., University of California Cooperative Extension, Hanford; Munier, D., University of California Cooperative Extension, Bakersfield

Highlights

- In a subsurface drip irrigation system, highest seed cotton yields were obtained with 120 lbs N/acre.
- A preplant application of 50 lbs N/acre slightly increased yield.
- Applying N by drip irrigation throughout the season resulted in lower yields than when all N was applied at the early square stage.
- A correlation exists between lint yield and the ammonium acetate as well as the Mehlich-3 extraction method for K.
- formed in Coastal Range alluvium do not fix K.

Introduction

The overall objective of this study was to establish updated guidelines for cotton nutrition, which take into account soil and plant tissue analysis.

Administrative Record
Page 6329

Methods/ management

Crop
Cotton

County
Merced, Madera, Fresno, Tulare, Kings, Kern

Years of study
1993-1996

Fertilization guidelines
- Cotton

FREP Article
Final Report

FREP Proceedings 1993: Page 51

FREP Proceedings 1995: Page 18

1. Accessibility of FREP Research

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Administrative Record
Page 6330

Methods/ management

Crop
Cotton

County
Merced, Madera, Fresno, Tulare, Kings, Kern

Years of study
1993-1996

Fertilization guidelines
- Cotton

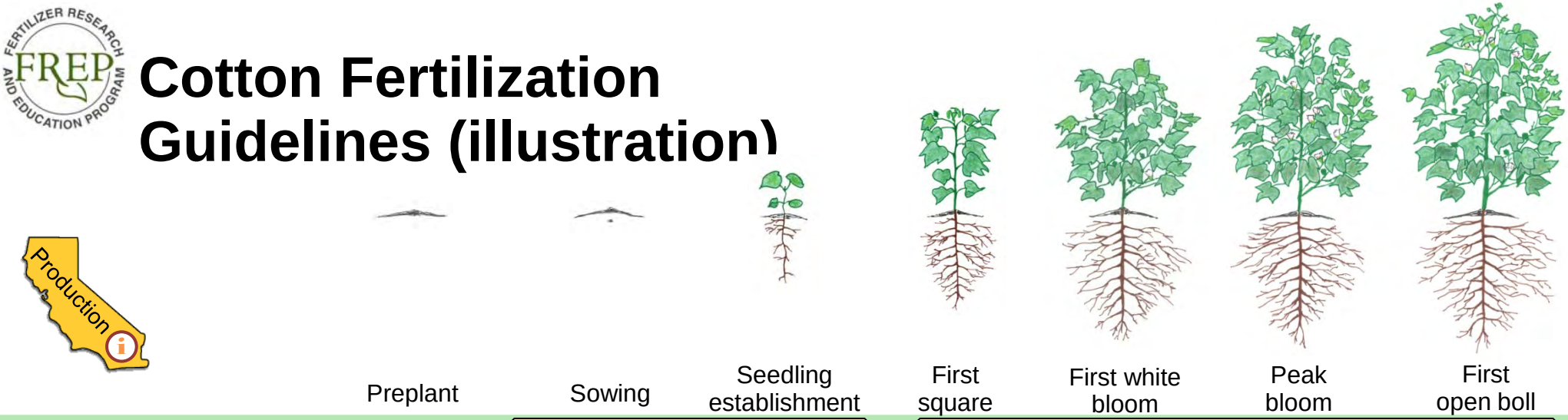
Future link

FREP Article
Final Report

FREP Proceedings 1993: Page 51

FREP Proceedings 1995: Page 18

Cotton Fertilization Guidelines (illustration)

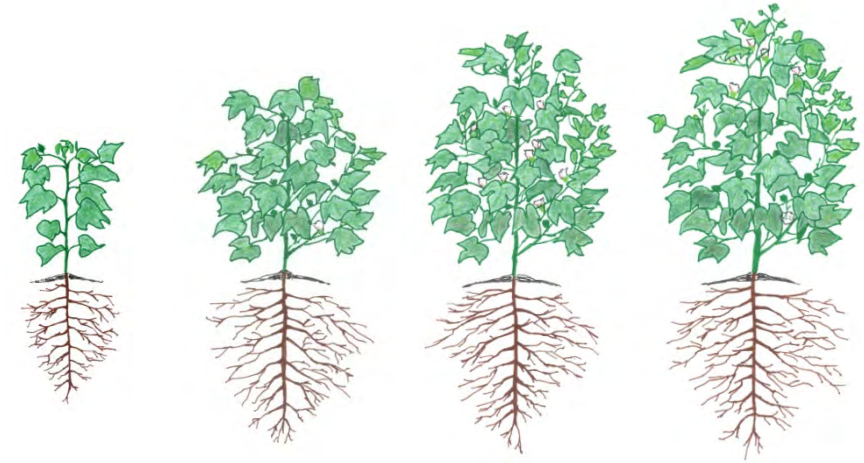


List of references

Links:

- University of California Cotton Production Information
- National Cotton Council of America
- The Cotton Pickin' Web
- California Cotton Ginners and Growers Associations (CCGGA)

Cotton Fertilization Guidelines (illustration)



Production

ng
ment

First square | First white bloom | Peak bloom | First open boll

Nitrogen (N

Petiole analysis

Side dress N | Foliar N

Potassium

Petiole analysis

Side dress K | Foliar K

Side dress Nitrogen

Application Rate

N requirement of cotton strongly depends on the yield level. The N fertilization rates for different cotton yield levels grown in soils with nitrate-N levels below 50 lbs/acre are listed below [43]. Approaches to determine a realistic yield goal are discussed here.

Yield goal (bales/acre)	Yield goal (lbs lint/ acre)	N fertilization (lbs N/acre)
1.5	750	55
2	1000	115
2.5	1250	170
3	1500	200
3.5	1750	200

Adapted from [43].

Another factor that needs to be taken into account is the type of cotton grown. In general, N application rates to Pima cotton are lower compared to Acala cotton due to slightly lower yields and the sensitivity of Pima cotton to excess N [37]. A 2-year study in the San Joaquin Valley found no increase in Pima cotton yield when the available N (residual soil nitrate-N plus fertilizer N) exceeded 150 lbs/acre [4, 15].

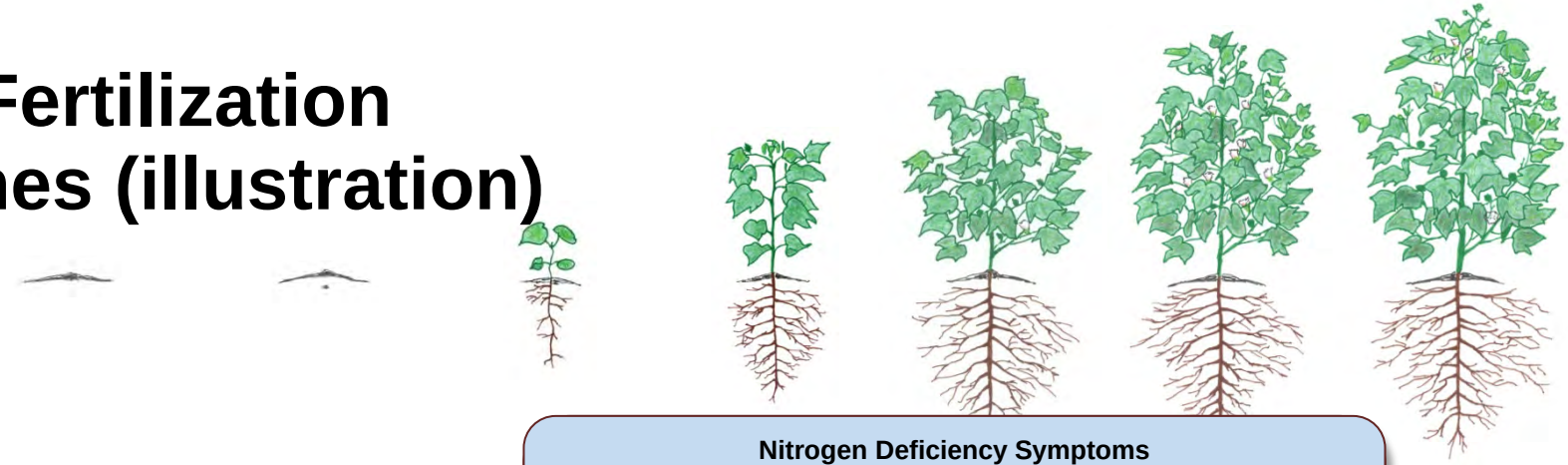
The optimal fertilizer rate also depends on the fertilizer application costs relative to the price of cotton that can be realized. The maximum yield is generally not the most profitable yield, as the yield increase diminishes with each additional pound of N added. Therefore, the economically optimal yield may be considerably below the maximum yield.

Mode of Application

Fertilizer Type

Time of Application

Cotton Fertilization Guidelines (illustration)



Preplant | Sowing | Se estab | First open boll

Nitrogen (N)

- Soil test
- Pre-plant N
- Starter N

Potassium (K_2O)

- Soil test
- Pre-plant K
- Starter K

Nitrogen Deficiency Symptoms

Nitrogen deficiency results in pale green leaves (see picture). The symptoms first appear on the older leaves. In addition, growth of the plant is stunted and the development of vegetative branches reduced. Bolls may be shed soon after flowering. When N deficiency occurs later in the season, leafs may turn purple, and bolls at late fruiting positions may be shed [43].

A healthy (left) and a nitrogen deficient cotton leaf (right; photo provided by the International Plant Nutrition Institute; www.ipni.net).

While insufficient N reduces crop growth and lint yield, excessive N can cause difficulties in defoliation, harvest, and may reduce lint yield [22]. Furthermore, high N application rates may increase aphid populations. In a FREP-funded study carried out in the San Joaquin Valley, Godfrey and Hutmacher found that cotton aphid infestations were more severe with 200 lbs N/acre than with lower N application rates [1]. Aphid levels were especially high in plots where high N rates and the pyrethroid insecticide Capture (to control lygus bug populations) were applied.

Cotton Fertilization Guidelines (illustration)

	Preplant	Sowing	Seedling establishment	First square	First white bloom	Peak bloom	First open boll
Nitrogen (N)	Pre-plant N	Starter N	Soil test	Petiole analysis	Sidedress N	Foliar N	
Potassium (K_2O)	Soil test	Pre-plant K	Starter K	Sidedress K	Petiole analysis	Foliar K	

Soil Nitrate Test

Soil samples for nitrate analysis should be taken near planting time or at least 3 weeks after the last N application [43]. As cotton is a deep rooting crop, samples should be taken to a depth of at least two feet. The distribution of nitrate in the soil profile is very variable. For this reason, the estimation of the potentially available N is improved by taking samples deeper than 2 feet [2]. The Cotton Production Manual recommends taking samples from the top 3 feet of soil [43]. Due to the variability of nitrate in the soil, care must be taken that the sample is representative for the field (see Sampling for Soil Nitrate Determination).

The soil nitrate test measures the plant available N at the time of sampling. Its level depends on a number of factors (see Factors Affecting Soil Nitrate Concentrations in Spring). Therefore, the test result is field specific and needs to be determined every year.

In a study with FREP support carried out in the San Joaquin Valley between 1996 and 2000, Hutmacher and collaborators found that the residual nitrate–N level in spring can be fully subtracted from the crop N requirements to determine the amount of fertilizer N that needs to be applied [2].

Additional Information

Sampling for Soil Nitrate Determination

Daniel Geisseler

Time of sampling

- Soil samples for nitrate are either collected near planting time (generally referred to pre-plant nitrate test; PPNT), or just before the main N application is due (pre-sidedress nitrate test; PSNT).
- In both cases, samples should be taken at least 3 weeks after the last nitrogen (N) application.

Taking a representative sample

- When soil properties or plant development differ within a field, the field should be divided into different management areas with similar characteristics and a sample from each area should be taken [5].
- A convenient way to check for differences in soil properties is to use the interactive application SoilWeb (available at http://casoilresource.lawr.ucdavis.edu/soilweb/). For figure 1, the application was used for a field near Davis. For this field, separate samples should be taken from the area with Brentwood silty clay loam (BrA) and from the area with Myers loam (Ms). The central and right section of the field should be sampled separately if their management differs.
- If it is not clear whether textural changes or

Figure 1: Soil sampling plan for a representative sample from a field or management area. The

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2. Focused Research

Special RFP: "pump and fertilize" proof of concept

cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

FERTILIZER RESEARCH AND EDUCATION PROGRAM FREP

California Department of Food and Agriculture

FERTILIZER RESEARCH AND EDUCATION PROGRAM

SPECIAL REQUEST FOR FULL PROPOSALS

2012 SPECIAL REQUEST FOR FULL PROPOSALS

The Fertilizer Research and Education Program (FREP) within the California Department of Food and Agriculture's (CDFA) Division of Inspection Services is currently accepting full proposals to address the issue of nitrates in groundwater in environmentally sensitive areas of California. A recent report from the University of California suggests a "pump and fertilize" approach for making beneficial use of nitrates in irrigation groundwater as a source of plant nutrition. This method accounts for nitrates in groundwater before the groundwater is used as irrigation water. Subsequently, the applied nitrogen fertilizer is reduced based on the nitrates available in the groundwater used for crop irrigation. However, the value of nitrates in irrigation water as a plant nutrient source is influenced by crop, environmental, soil, irrigation, and other management factors. Therefore, this technique of reducing nitrates in groundwater is a key factor in nitrogen management plans or nitrogen budget worksheets. The full proposal should focus on research that utilizes the "pump and fertilize" method in concert with nitrogen budget worksheets to show proof-of-concept.

2. Focused Research

Special RFP: "pump and fertilize" proof of concept

- Six project proposals
- FREP-TASC and peer reviews
- Two proposals have been selected for funding of over $700,000
- Three years field level research in Tulare Lake Basin and Salinas Valley
- Both proposals are from UC

2. Focused Research

2013 RFP – Research Priorities

- **Demonstrating agronomically sound use** of fertilizing materials at the field scale
- **Managing agricultural nitrogen**
  - Minimizing nitrate movement below the root zone
  - Evaluating strategies to increase crop N use efficiency
  - Minimizing nitrous oxide emissions related to fertilizer use
- **Developing Best Management Practices**
- **Development of educational materials** to increase awareness of agronomically sound use of fertilizing materials

3. Technical Education

"Managing Agricultural Nitrogen" Forums

Collaboration with UC-ANR

University of California

Managing Agricultural Nitrogen

UC Agriculture and Natural Resources

- Home
- June 11 Forum
- June 18 Forum

EMAIL | PRINT

Forums offered - June 2012

Sponsored by:
UC ANR California Institute for Water Resources (CIWR) and CDFA Fertilizer Research and Education Program (FREP)

June 11 at the California Farm Bureau Federation, Sacramento
Please note: The June 11 Forum was rescheduled from June 12. Please note the date and location change.

June 18 at the UC Cooperative Extension Office, Tulare

Who should attend?
Growers, dairy operators, agency representatives, agricultural commissioners, policymakers and other concerned community members. The events are free and open to the public. ***Preregistration is required.***

Objective is to:

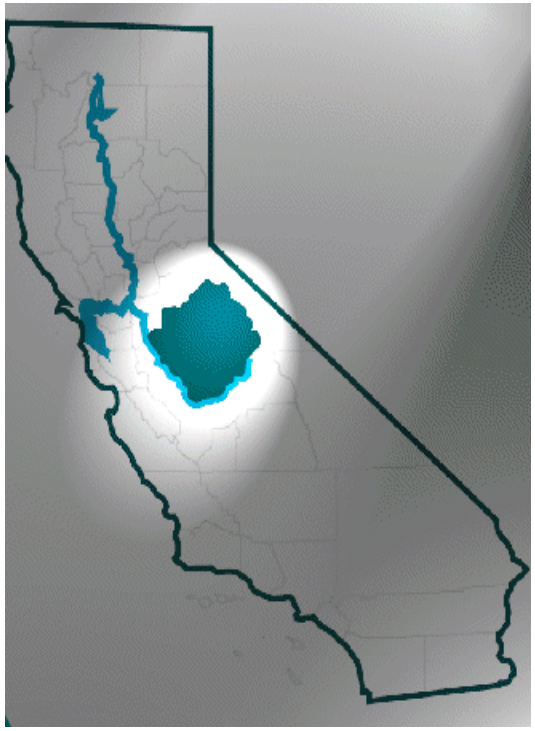
- Provide an educational forum on nitrogen use and management in agriculture
- Discuss management of agricultural nitrogen and gain an understanding of how management of agricultural nitrogen is proceeding
- Discuss the role of policy in nitrogen management
- Explore solutions to nitrate in groundwater
- Explore the need for additional research and education

3. Technical Education

"Nitrogen Management Training"

Background

- Waste discharge requirements to manage agricultural use of nitrogen
- East San Joaquin Water Quality Coalition is working with CDFA to develop nitrogen management worksheet / plan
- Professional expertise needed to implement nitrogen management plans



3. Technical Education

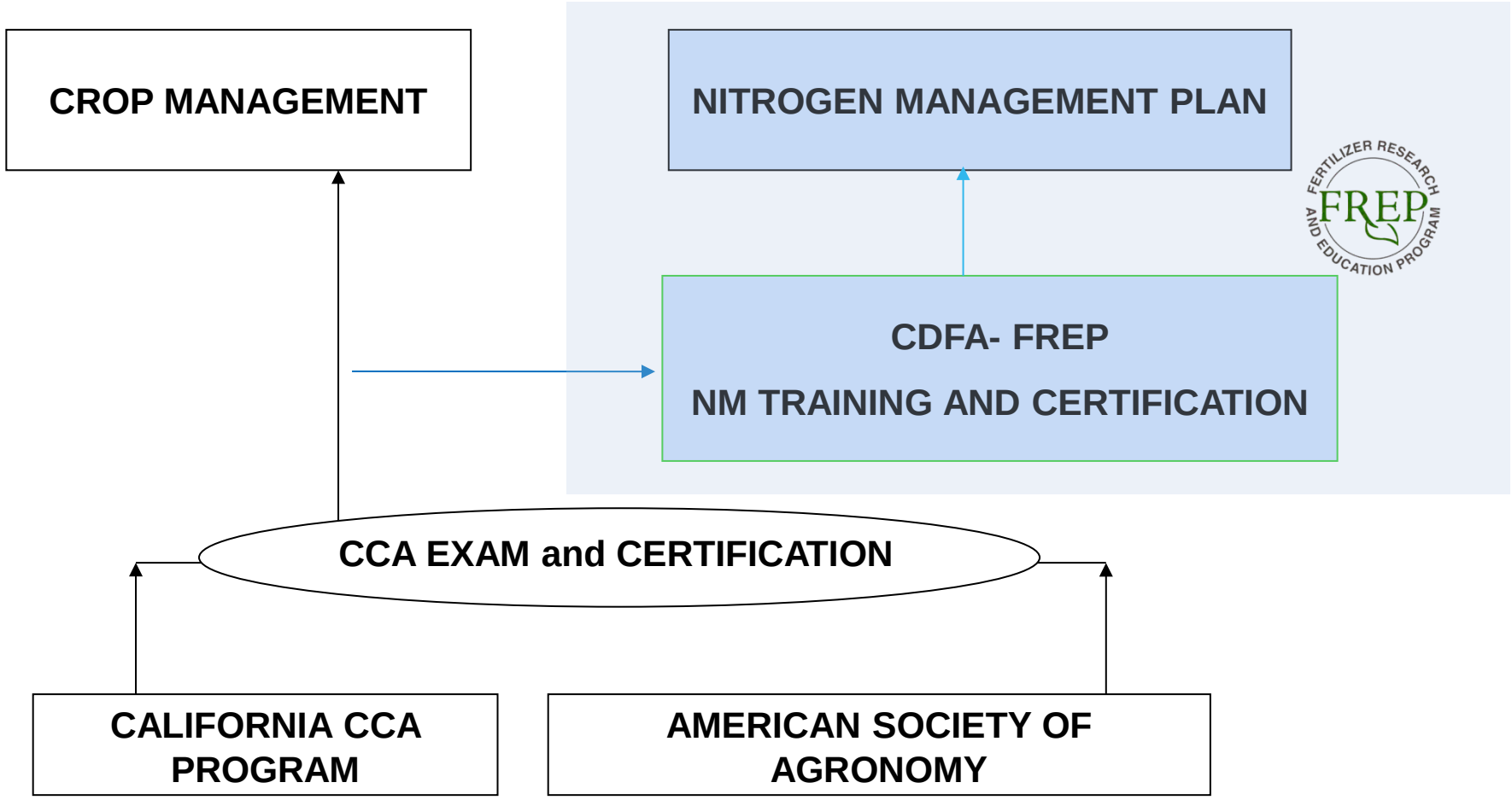
"Nitrogen Management Training"

Professional assistance

- CA Certified Crop Advisors (CCAs) have been identified as a good resource to assist growers implement NMPs
- Certified through the American Society of Agronomy
- Qualified to make nutrient recommendations
- However, would need training specific to nitrogen management

3. Technical Education

"Nitrogen Management Training"



CERTIFIED CROP ADVISER

3. Technical Education

"Nitrogen Management Training"

CCA NM Training and Certification Program

- Fertilizer Inspection Advisory Board, and CA CCA Board of Directors are very supportive
- Drafted course outline in consultation with CCA Board of Directors
- Presented the proposal to the UC President's Advisory Commission
- Working with UC-ANR for curriculum development

3. Technical Education

"Nitrogen Management Training"

DRAFT Outline of Training Modules

1. Environmental and economic benefits of nutrient management planning
2. Nitrogen fertilization
3. Interaction between irrigation and nitrate leaching
4. Regional influences
5. California crops and their nutrient requirements
6. Behavior and value of cover crops
7. Value of testing
8. How to develop a nitrogen budget worksheet

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3. Technical Education

"Nitrogen Management Training"

Process of Implementation

Concept Development	Curriculum Development	Stakeholder Feedback	Implementation
• FIAB • Secretary Ross • CCA Board • CVRWQCB • ESJWQC • CCA Annual Conference • UC PAC • UC Extension Conference	• CCA Board Subcommittee • Draft Training Modules • UC ANR – Curriculum • Training – who when, where, how • CEU • Ongoing	• Contact • Participation • February/March 2013? • Adjust	• By December 2013 • Training 2014 • Tracking • CEU

Summary

- CDFA is actively engaged with the water quality regulatory agencies, and other stakeholders
- FREP research data is available at: http://www.cdfa.ca.gov/is/frep/Default.aspx
- Focused research to develop practical tools to manage agricultural nitrogen
- CCA NM training and certification program – implement by December 2013
- Enhanced collaboration

Thank You