Water in California:
Example California Almonds

December 19, 2016

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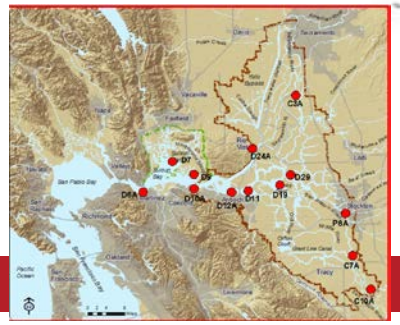
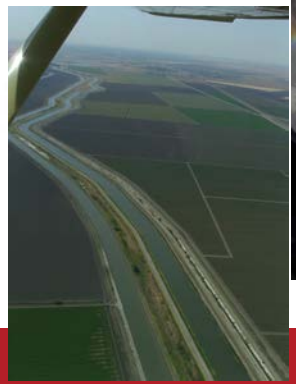
Almond Board of California

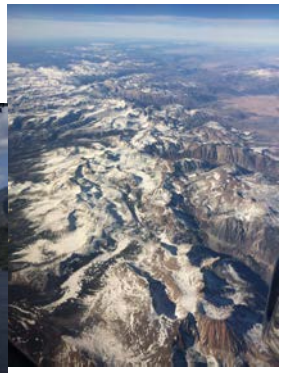
Basics of Water in California



- It rains/snows in winter and doesn't rain in summer (Mediterranean climate)
- System moves water from north to south and from winter to summer (snow pack)
- 75% of California's precipitation occurs north of Sacramento, and 75 percent of its water demand lies to the south.[1]
- In normal years, 70% of water is from surface and 30% from ground. In dry years, more from ground water.
- The snowpack supplies about 30 percent of California's water needs as it melts in the spring and early summer[2].
- Current system set up for 2/3 current population (16 mill to now 41 mill)
- Continued debate and efforts to diversify the water supply
- Droughts recur in Mediterranean Climates

Source:
1. PPIC
2. DWR press release about the snowpack survey





Water: Who decides in California?

California:

- *State Water Resources Control Board* (SWB) (part of CAL-EPA)

- Issues permits for surface water rights, specifying amounts, conditions for diversion and storage • Sets statewide policy for water quality • Regulates wastewater & storm water discharges to surface water and to groundwater • SGMA (ground water management) implementation

- *Department of Water Resources* (DWR) (part of CA Natural Resources Agency)

- Holds rights to State Water Project (SWP) water but must apply for water rights permits from SWB who can limit what DWR can provide • State Water Project (SWP) delivers water to 29 contractors who distribute to local water districts • Management and regulation of water usage: flood control, water supply, environmental mitigation, electricity generation • Dams: construct, operate, maintain 1200 jurisdictional dams • Water Transfers: DWR is involved when transfer involves use of State Water Project (SWP) or Central Valley Project (CVP) facilities for water transfer conveyance.

- *California Water Commission*

-Advises director of DWR and Secretary of Natural Resource Agency • Approves all rules and regulations of the DWR. • Selecting water storage projects for funding under the Safe, Clean, and Reliable Drinking Water Act of 2012.

Federal:

- Bureau of Reclamation (Dept of Interior)

- Manages federal water supplies (yellow)

- Federal Energy Regulatory Commission

- Relicenses dams every 50 years

- National Marine Fisheries Service (Dept of Commerce) & Fish & Wildlife Service (Dept of Interior)

- Both enforce Endangered Species Act

Regional/Local:

- City/Regional Water Management Agencies
- Irrigation Districts
- Groundwater Sustainability Agencies
- Irrigated Lands Regulatory Program Coalitions
- Regional Water Quality Control Boards

Etc, etc…..

The Scope of the California Almond Industry

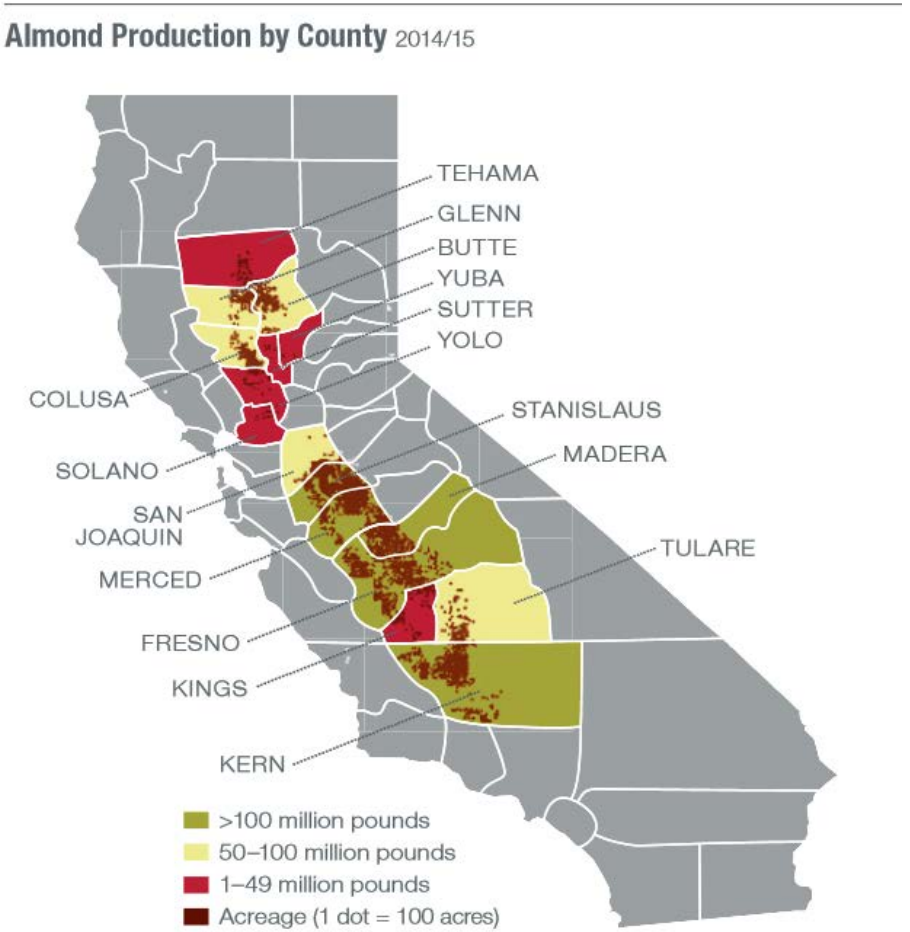
- Spanning 500 miles throughout the Central Valley
  - 1.1 mill acres (0.46 mill ha) total
  - 900,000 A bearing (375,000 ha)

- California grows **100%** of the almonds commercially produced in the U.S.
  - 82% of worldwide production
  - Shipments **66% export**; 34% domestic
  - U.S. is the largest single market

- $5.9 billion in farm value (2014)
  - 2nd most valuable California crop

- 2014 export value **$4.5 billion**
  - Top U.S. specialty export crop
  - California's #1 ag export***

- Almond industry generates about **104,000 jobs** statewide; *97,000 in the Central Valley*****
  - $21 billion in total economic output
  - About $11 billion to the state's GDP



Sources:
* USDA Agricultural Statistics Service, Pacific Region (NASS/PR)
**U.S. Department of Commerce, Foreign Trade Statistics
*** *Source: Economic Impacts of the California Almond Industry: UC Ag Issues Center*

Why California?

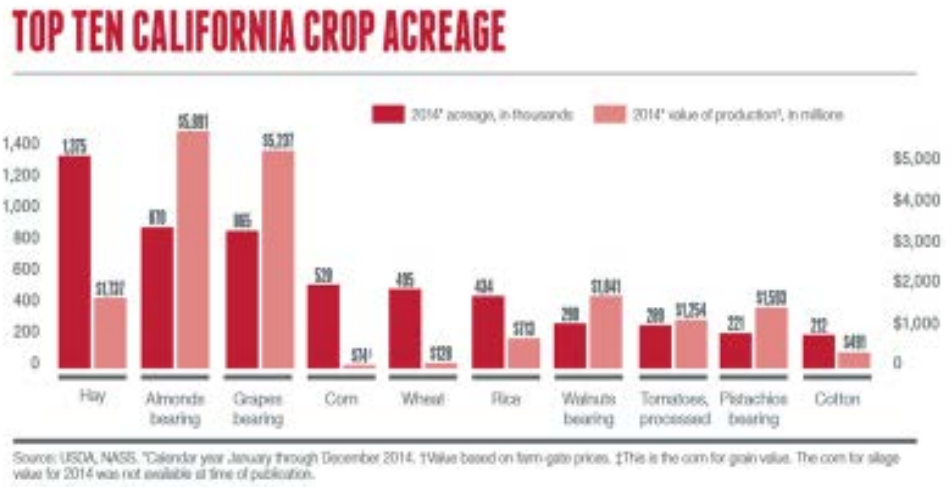
California is the most productive almond growing region in the world.

- Mediterranean climate ideal for growing almonds
- Central Valley's rich soils
- Water availability and infrastructure
- Highest standards for environmental, worker, and food safety
- Innovative technology and research

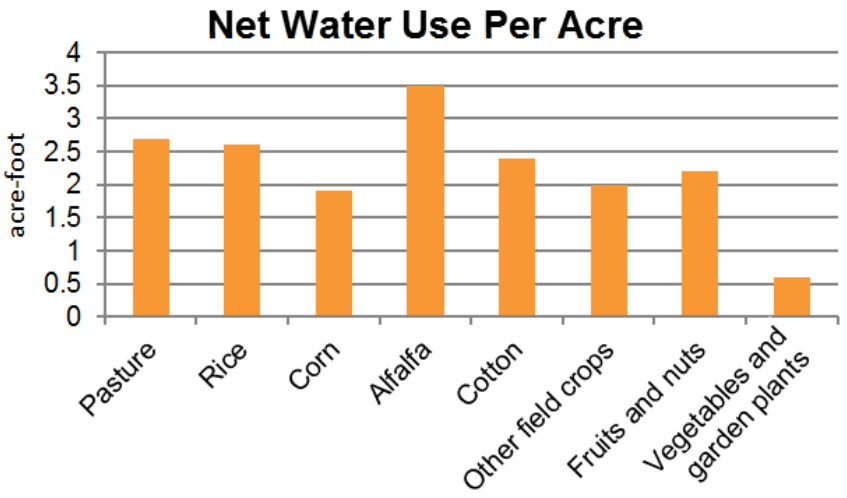
How Much Water to Grow Food?

All plants need water to grow.

- California produces 99% of the United States' almonds, artichokes, dates, figs, raisins, kiwifruit, olives, cling peaches, pistachios, dried plums, pomegranates, sweet rice, and walnuts.
- California's top ten acreage crops include hay, almonds, grapes, wheat, corn, rice, walnuts, cotton, processing tomatoes, and pistachios.
- California's fruits and nuts use 34% of the state's ag water and account for 45% of it's revenue.



Milk was valued at $9.4 billion in 2014



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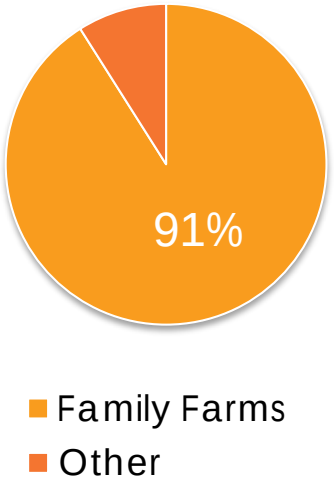
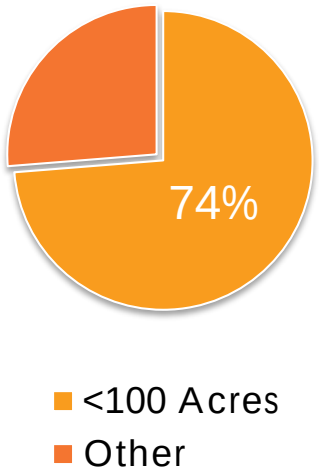
Family Farms

More than 6,800 total farms that grow almonds

More than 90% Family Farms



Nearly 3/4 Under 100 Acres (42 ha)

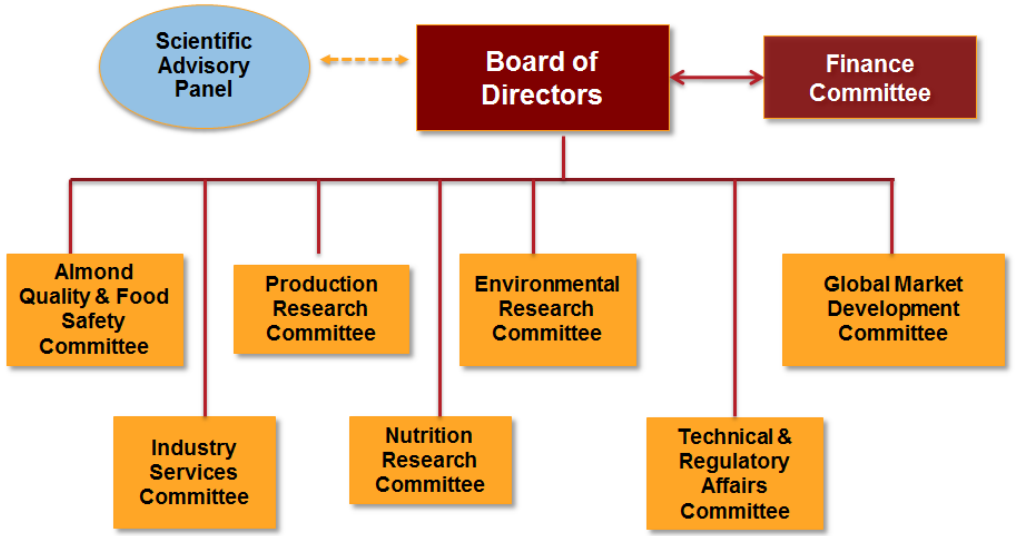


Source: USDA-NASS Census of Agriculture 2012

Almond Board of California (ABC) Organization

- Grower-enacted “Federal Marketing Order” established in 1950
  - Represents growers and handlers (processors)
  - “Quasi governmental”
- Under USDA supervision
- Funded by assessment $.03/lb
- Broad-based program
  - Global Market Development
  - Scientific Research
  - Industry Education
  - Quality and Food Safety
  - Regulatory Issues

2016 – 2017 Board of Directors - members



Research at the Almond Board of California

- Consistently funding and executing initiatives since 1973

- Total investment of more than **$50 million** to date.

➔ Tradition of Continuous Improvement

Regulatory Issues Affecting California Almond Growing

- Water Availability
  - Sustainable Groundwater Management Act (SGMA)
  - Endangered Species Act
  - Delta restoration/ SJ River restoration
  - Dam relicensing/ unimpaired flows

- Water Quality
  - Porter Cologne Act
    - Irrigated Lands Regulatory Program
    - CV-SALTs
  - Clean Water Act (TMDLs)
  - Waters of the United States (WOTUS) (aka Clean Water Rule)

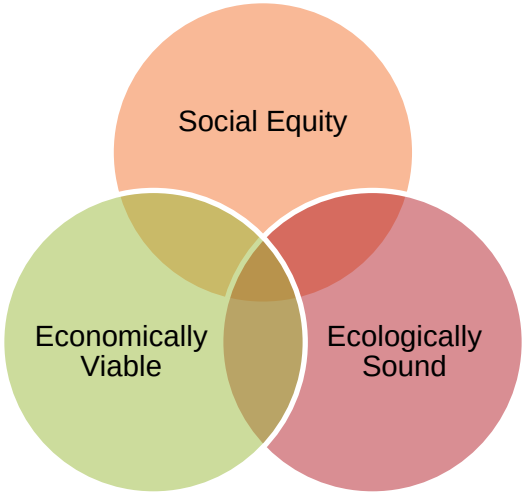
- Air Quality
  - Clean Air Act
    - PM2.5, PM10, Ozone (smog), Montreal Protocol (ozone layer depleting substances)
  - AB32 – reduction in Greenhouse Gases

- Pesticide Regulations
  - EPA
  - CDPR

California Almond Industry's Sustainability Definition

Sustainable almond farming utilizes production practices that are economically viable and are based upon scientific research, common sense and a respect for the environment, neighbors and employees.

The result is a plentiful, healthy and safe food product.

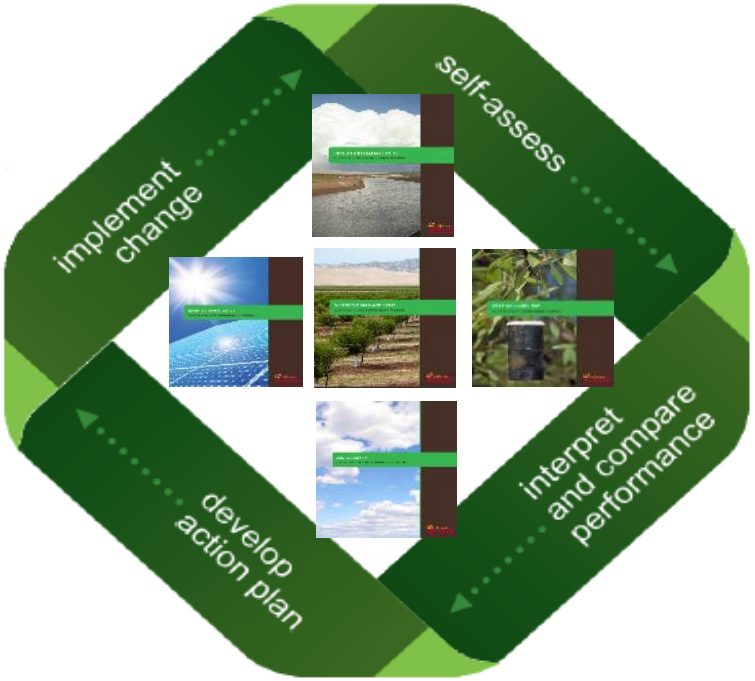


Definition developed using the 3 E's (or P's) and grower focus groups in 2005**.**

California Almond Sustainability Program (CASP)

- Established in 2009, CASP encourages almond grower and handler self-assessment surveys to track adoption of responsible farming practices
- Current CASP modules
  - Efficient irrigation management
  - Nutrient management
  - Air quality
  - Groundwater quality
  - Energy efficiency
  - Ecosystem
  - Financial management
  - Pest management
  - Workplace and communities
  - Pollinators

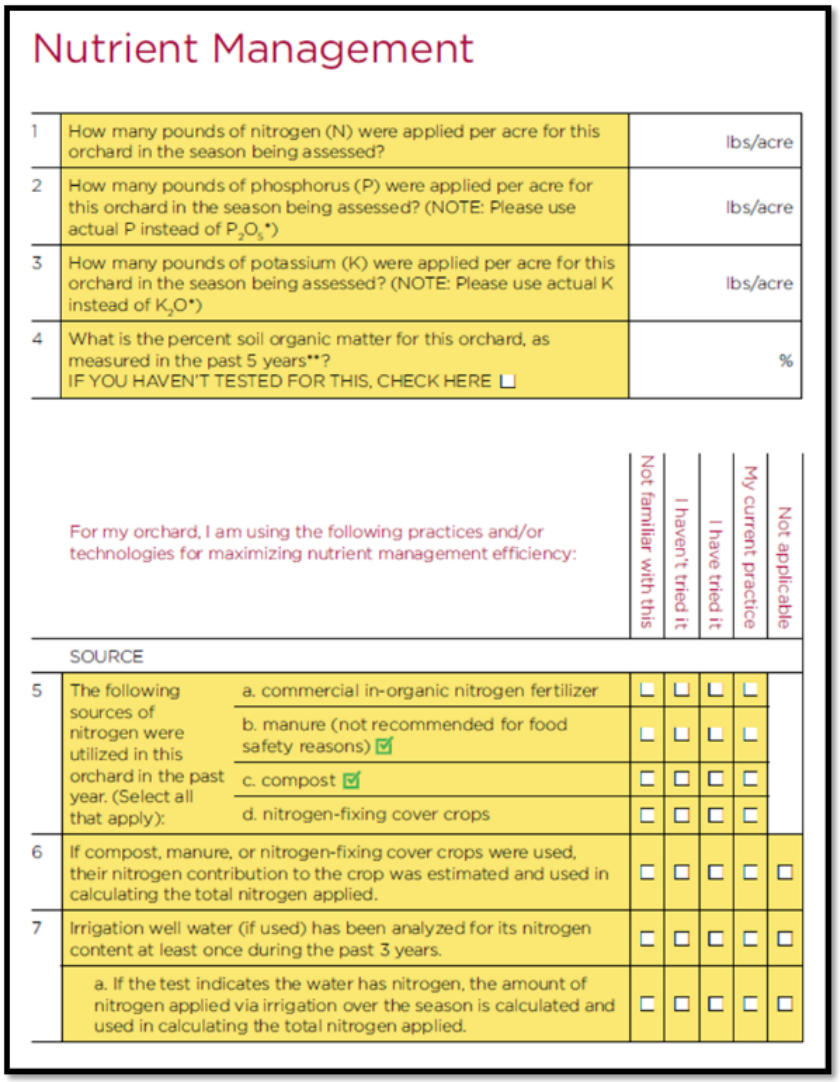
Cycle of Continuous Improvement



Format of Self-assessment

Use a practice: yes/no

Occasionally ask how much input is applied

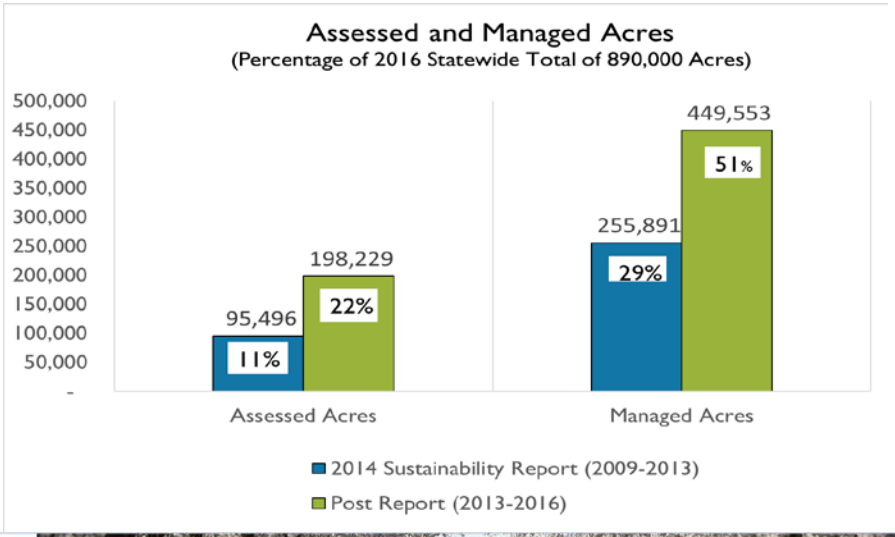


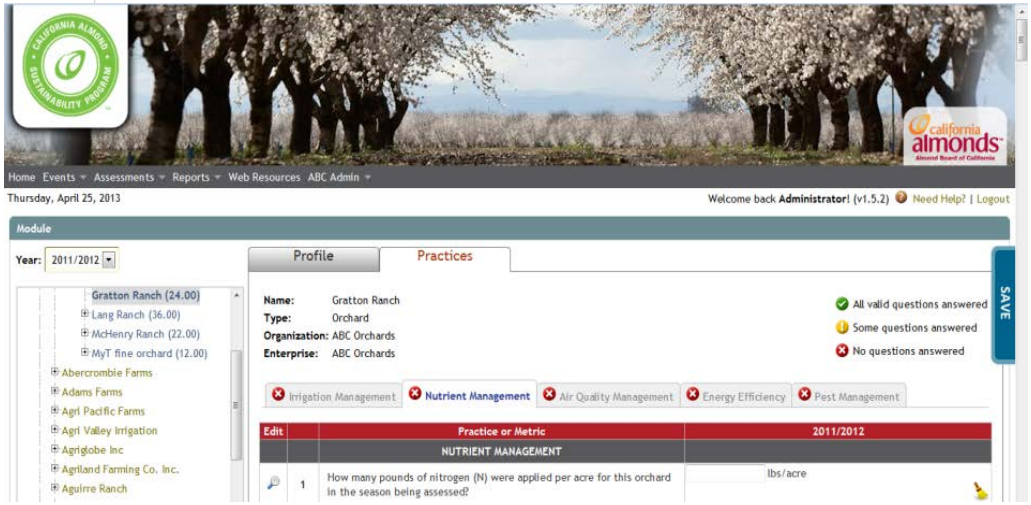
Nutrient Management

1	How many pounds of nitrogen (N) were applied per acre for this orchard in the season being assessed?	lbs/acre
2	How many pounds of phosphorus (P) were applied per acre for this orchard in the season being assessed? (NOTE: Please use actual P instead of P_2O_5*)	lbs/acre
3	How many pounds of potassium (K) were applied per acre for this orchard in the season being assessed? (NOTE: Please use actual K instead of K_2O*)	lbs/acre
4	What is the percent soil organic matter for this orchard, as measured in the past 5 years**? IF YOU HAVEN'T TESTED FOR THIS, CHECK HERE ☐	%

	For my orchard, I am using the following practices and/or technologies for maximizing nutrient management efficiency:		Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	SOURCE						
5	The following sources of nitrogen were utilized in this orchard in the past year. (Select all that apply):	a. commercial in-organic nitrogen fertilizer	☐	☐	☐	☐	
		b. manure (not recommended for food safety reasons) ☑	☐	☐	☐	☐	
		c. compost ☑	☐	☐	☐	☐	
		d. nitrogen-fixing cover crops	☐	☐	☐	☐	
6	If compost, manure, or nitrogen-fixing cover crops were used, their nitrogen contribution to the crop was estimated and used in calculating the total nitrogen applied.		☐	☐	☐	☐	☐
7	Irrigation well water (if used) has been analyzed for its nitrogen content at least once during the past 3 years.		☐	☐	☐	☐	☐
	a. If the test indicates the water has nitrogen, the amount of nitrogen applied via irrigation over the season is calculated and used in calculating the total nitrogen applied.		☐	☐	☐	☐	☐

Participation to Date (as of July, 2016)





Feedback to Grower (or Handler/Processor)

Report comparing grower to other participants

California Almond Sustainability Program — **2010**

	Practice or Metric	Your Selection	Use Statewide
	Irrigation Management Module		
	Orchard Establishment		
1	Were you involved in this orchard's establishment? *If No, click "No" and skip to question 16.*	Yes	85.6 %
2	Soil maps (e.g., NRCS soil series or web soil survey) were used to identify potential variations in soil texture, salinity, water holding capacity, or other factors.	Yes	69.7 %
3	Aerial or satellite photos (e.g., Google Earth) were used to identify potential variations in soil texture, salinity, or other factors.	Yes	54.5 %
4	Yield maps from the previous crop (almonds or another crop) were used to identify potential variations in soil texture, salinity, or other factors.	Yes	57.4 %
5	A GPS map of soil characteristics using sensing technology (e.g., EC, Veris® or SIS) was made and used to identify potential variations in soil texture, salinity, or other factors.		25.4 %
6	Backhoe pits were dug or deep auger/core samples were taken (guided by the above and other observed factors) in strategic places to determine:	Yes	
	6a. texture (percent sand, clay, silt) or saturation percentage	Yes	73.0 %
	6b. compaction layers or other soil stratification	Yes	77.5 %
	6c. salinity	Yes	72.3 %
	6d. pH	Yes	75.8 %
	6e. soil organic matter	Yes	66.1 %
7	Deep ripping, slip plowing, or tree hole backhoe pits were dug to address drainage and/or compaction issues (preferably after first testing for these problems).	Yes	90.7 %
8	If suggested by soil sampling, soils were amended to adjust pH, sodicity, salinity, etc. during orchard development.	Yes	80.1 %
9	Soils were amended with organic matter during orchard development.	Yes	44.1 %
10	All water sources were sampled and lab-evaluated for water quality/irrigation suitability.	Yes	76.6 %

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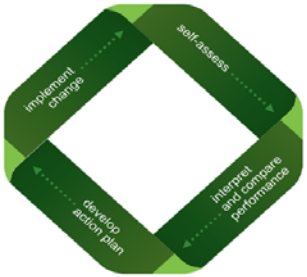
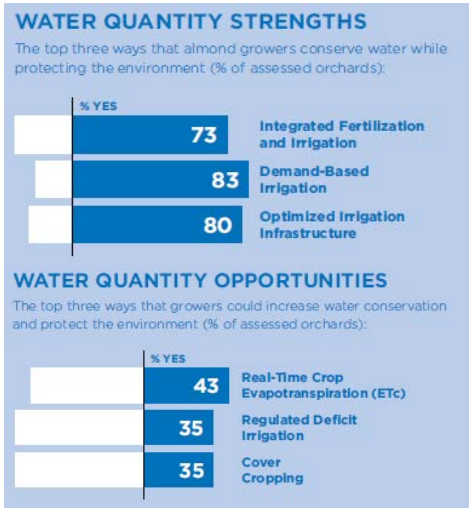
Cycle of Continuous Improvement



Reporting

2014 First Report Released

- Based on first 4 years
- Statistical Analysis re representativeness
- Calls out strengths and areas for improvement based on value analysis (which practices have widest impacts used/not used)
- Almond Board has used results for continuing education efforts
- Next report 2018? See what has changed
- **No Third Party Verification to date because of cost**
  - **Exploring validation and certification for components**
- **Currently no mechanism for a handler to know whether their growers participate in CASP**
  - **Exploring how to do that**



Grower Outreach

Sustainability Areas Addressed by CASP Compared with 3 Other Well-known Programs

Sustainability Areas Covered by Practices and/or Metrics in Each Program	CASP Self-Assessment Program	Global GAP	Rainforest Alliance - SAN	SCS Certified Sustainably Grown
Land: Soil Management	Yes	Yes	Yes	Yes
Land: Nutrient Management	Yes	Yes	Yes	Yes
Land: Conversion/Degradation	Yes		Yes	Yes
Atmosphere: GHGs	Yes		Yes	
Atmosphere: Air Quality	Yes			
Water: Use	Yes	Yes	Yes	Yes
Water: Quality	Yes	Yes	Yes	Yes
Integrated Pest Management	Yes	Yes	Yes	Yes
Biodiversity	Yes	Yes	Yes	Yes
Energy Use	Yes	Yes	Yes	Yes
Packaging				Yes
Waste Reduction & Disposal	Yes	Yes	Yes	Yes
People: Human Resources	Yes	Yes	Yes	Yes
People: Communities	Yes		Yes	Yes
Increase Revenue	Yes			Yes
Food Safety	Yes	Yes		Yes
Total No. of Areas Covered	15	10	12	14
% Total No. of Areas Covered	94%	63%	75%	88%

LEADERSHIP:
WE MUST USE OUR TALENT AND TREASURE FOR THE BETTERMENT OF OUR INDUSTRY AND CALIFORNIA AGRICULTURE

ALMOND ORCHARD OF THE FUTURE

AIM Initiatives: Where can the almond community and ABC make a difference?

Water Management and Efficiency
Irrigation continuum development and outreach to accelerate transition of growers ➔ adoption of more efficient irrigation and scheduling and management practices, maximizing “crop per drop”

Sustainable Conservation

BERKELEY LAB
Bringing Science Solutions to the World

22nd Century Agronomics
From mapping orchards and the LCA update to assessing all phases of the almond production cycle – then adopt the technologies that will lead California Almond farming into the 22nd century

Sustainable Water Resources
Leverage almond orchards for increasing groundwater recharge in aquifers. Also opportunities to recycle municipal waste water and other degraded water as a way of increasing overall water availability

EDF ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

Air Quality
Assessing ways almond production practices can play a role in carbon sequestration and carbon credits

SureHarvest

LAND IQ

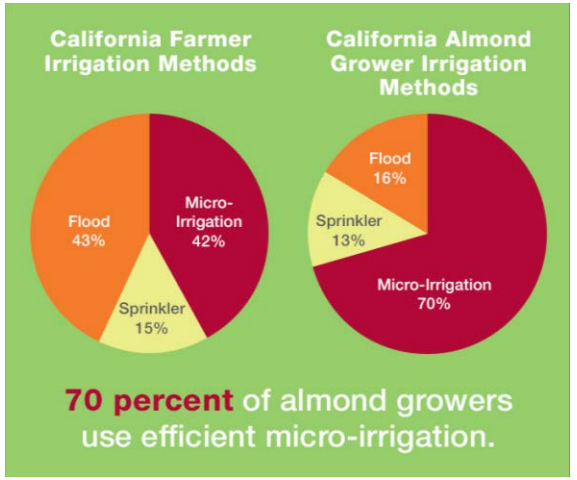
ALMOND ORCHARD OF THE FUTURE

AIM Initiatives:
Where can the almond community and ABC make a difference?

Almond Water Use Efficiency- Achieved to date:

Through Almond Board research programs, almond farmers have been funding **water efficiency research since 1982** with over **90 projects** funded to date.

- Over the past 20 years, almond growers have improved their **water use efficiency by 33%,** producing **more crop per drop.**
- **70% of almond orchards use micro-irrigation**, applying water directly in the root zone, and allowing for precise timing and rate of irrigation.
- **83% of growers practice demand-based irrigation** using a combination of weather data, tree demand data, and/or soil moisture data



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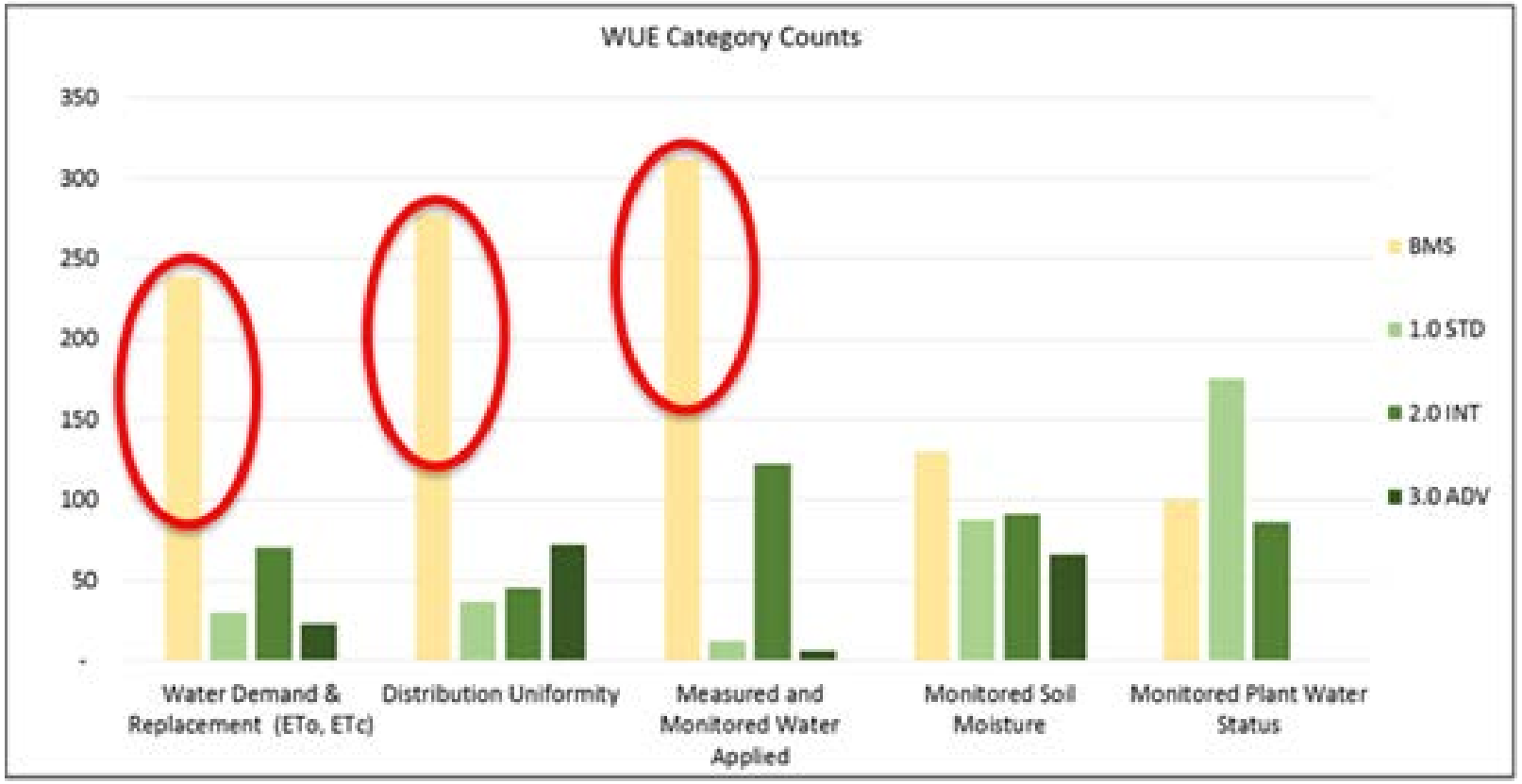
Almond Irrigation Improvement Continuum

Measurement	1.0 Minimum	2.0 Intermediate	3.0 Advanced
Irrigation System Performance	Evaluate irrigation system for pressure variation and average application rate at least once every 3 years. Correct any diagnosed system performance problems.	Assess distribution uniformity and average application rate by measuring water volume at least every 3 years. Correct any diagnosed system performance problems.	Assess distribution uniformity and average application rate by measuring water volume at least every 2 years. Correct any diagnosed system performance problems.
Applied water	Use application rate and duration of irrigation to determine water applied.	Use water meters to determine flow rate and water applied.	Use water meters to determine applied water and compare to crop water use (ETc, evapotranspiration) to determine irrigation efficiency.
Orchard Water Requirements	Estimate orchard water requirements using "normal year" regional ETc to estimate irrigation demand on a monthly time step.	Estimate orchard water requirements using "normal year" regional ETc – adjusting for current weather and cover crop use on a bi-weekly time step.	Estimate orchard water requirements using "normal year" regional ETc to plan irrigations then use real time ETc data to correct the schedule on a weekly time step.
Soil Moisture	Evaluate soil moisture based upon feel and appearance by augering to at least 3-5 feet. Monitor on a monthly time step.	Use manually operated soil moisture sensors to at least 3-5 feet and monitor on a bi-weekly time step. Use information to ensure calculated water is not over/under irrigating trees.	Use automated moisture sensors that store data over time. Review weekly to ensure calculated water is not over/under irrigating trees.
Plant Water Status	Evaluate orchard water status using visual plant cues just prior to irrigation or on a bi-weekly time step.	Use pressure chamber to measure midday stem water potential just prior to irrigation on a monthly time step. Ensure calculated water applications are not over/under irrigating trees.	Use pressure chamber to measure midday stem water potential prior to irrigation on a weekly time step. Ensure calculated water applications are not over/under irrigating trees. Use it to assess when to start irrigating.
Management			
Integrating Approaches	Combine irrigation system performance data with "normal year" regional ETc estimates to schedule irrigations. Check soil moisture status with auger occasionally.	Use irrigation system performance data with regional estimates of "normal year" ETc to schedule irrigations and adjust based on feedback from monitoring soil moisture or crop water status.	Develop an irrigation schedule based on predicted "normal year" demand, monitor status using soil and plant based methods. Adjust irrigation schedule with real-time ETc as the season progresses.

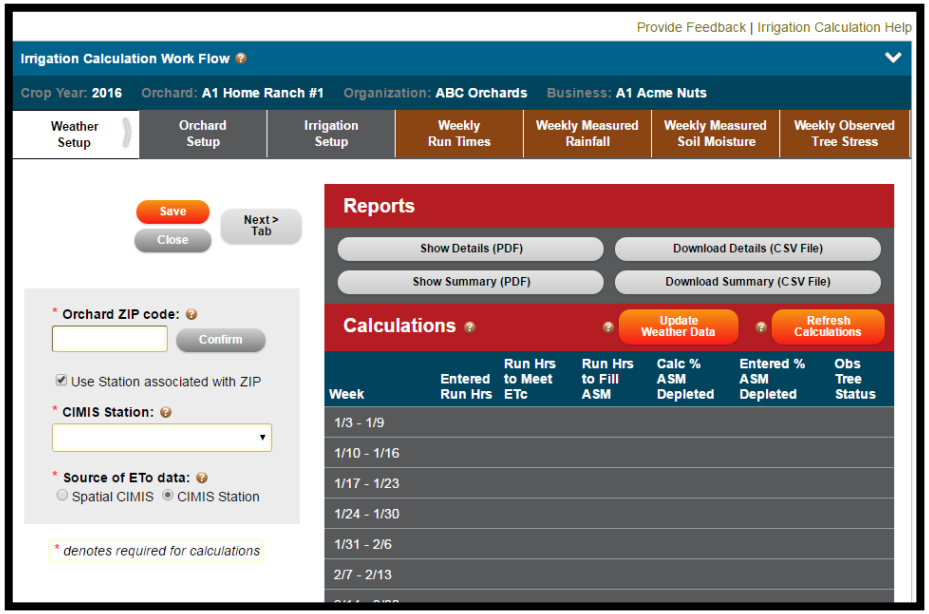
*The web version of this continuum, available on Almonds.com/ Growers,will feature a "More Information and Guidance" link in each square explaining how that step can be achieved.

Data Mining the California Almond Sustainability Program (CASP)

Matched practices in CASP to the Irrigation Continuum to see where we are:



Almond Irrigation Improvement Continuum: Implementation



http://www.almonds.com/sites/default/files/misc/grower/almond_irrigation_improvement_continuum_1.0.pdf

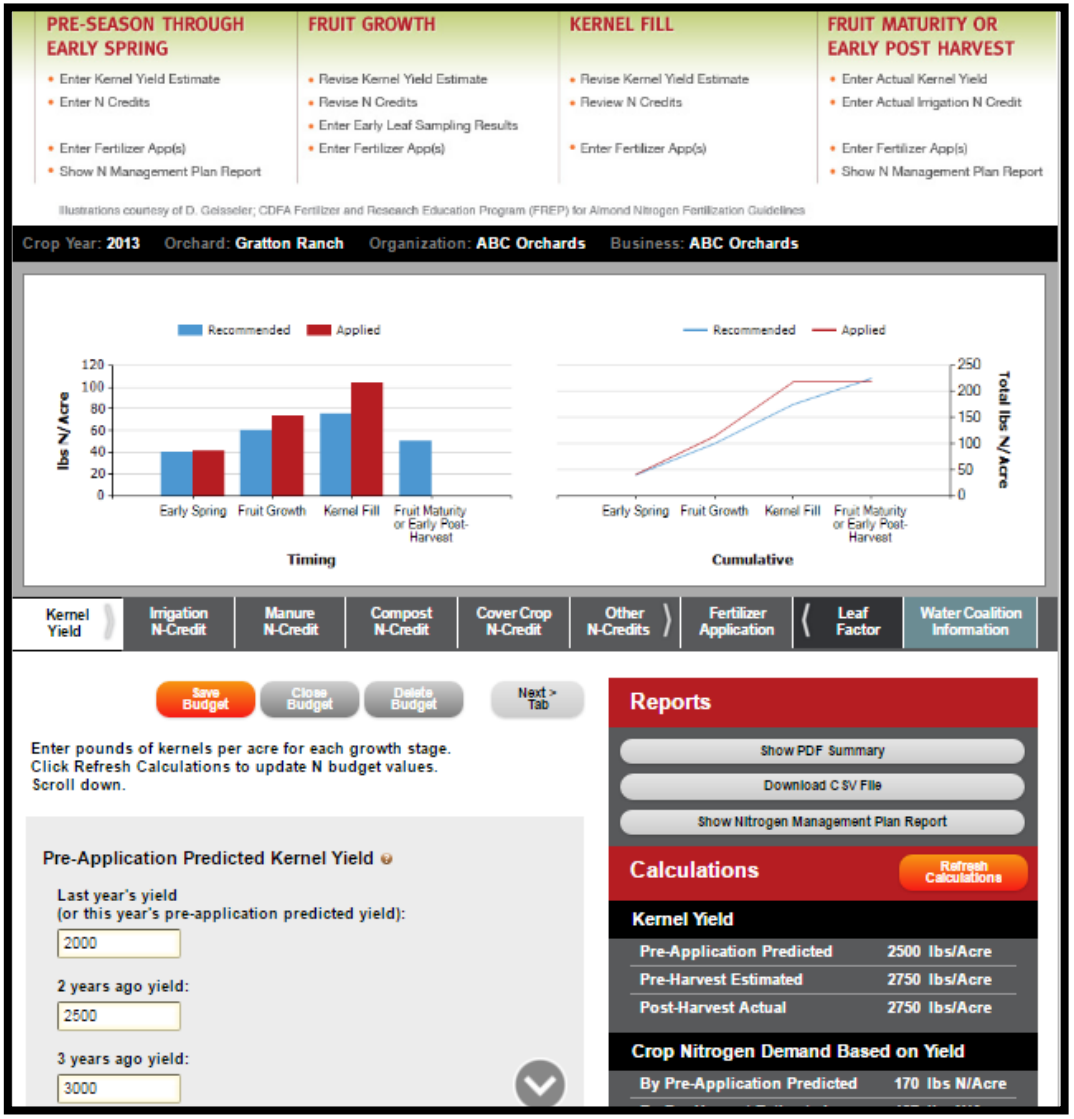
- Outreach via Sustainability/UC extension events to growers
- Developed On-line Irrigation Calculator – to help with basic water demand calculations.
- Developing comprehensive one-stop-shop website with UC Extension (Level 1.0 guide now on ABC website)
- Hired Irrigation Specialist to work with growers on implementation
- Measure via Sustainability Program

Nitrogen Management Tool:

Based on Patrick Brown's Research (funding: ABC, Yara, CDFA-FREP, USDA-SCRI)

- 4 R's
- Estimate N need based on yield estimates
- Timing of applications

Added incentive for growers: provide N Management Plan needed for ILRP.



ALMOND ORCHARD OF THE FUTURE

AIM Initiatives:
Where can the almond community and ABC make a difference?

AIM: Sustainable Water Resources or How to diversify the Central Valley's Water Supply?

Options include:

- Groundwater recharge
- Recycling of urban waste water/ storm water/ oil produced water
- Conservation (improvements to irrigation water supply systems/ irrigation mgmt)
- Desalinization of saline waste/ ground water

Groundwater Recharge Project:

Assess whether almonds (other crops) can be used to recharge GW with flood waters)

Almond Board of California funding
Sustainable Conservation,
UC-Davis,
Lawrence Berkeley Lab
LandIQ

- Assess impact on trees
- Assess impact on GW quality/amount
- Assess where feasible geologically/ hydrologically

UC DAVIS
UNIVERSITY OF CALIFORNIA

BERKELEY LAB
Bringing Science Solutions to the World

Sustainable Conservation

Stormwater floods Modesto almond orchard in experiment to restore aquifer

By Lisa M. Krieger lkrieger@mercurynews.com

POSTED: 01/20/2016 06:52:08 AM PST | UPDATED: 7 DAYS AGO 0 COMMENTS

Almond trees are flooded on Tuesday, Jan. 19, 2016, in Modesto, Calif. Scientists from UC Davis are flooding the almond orchard

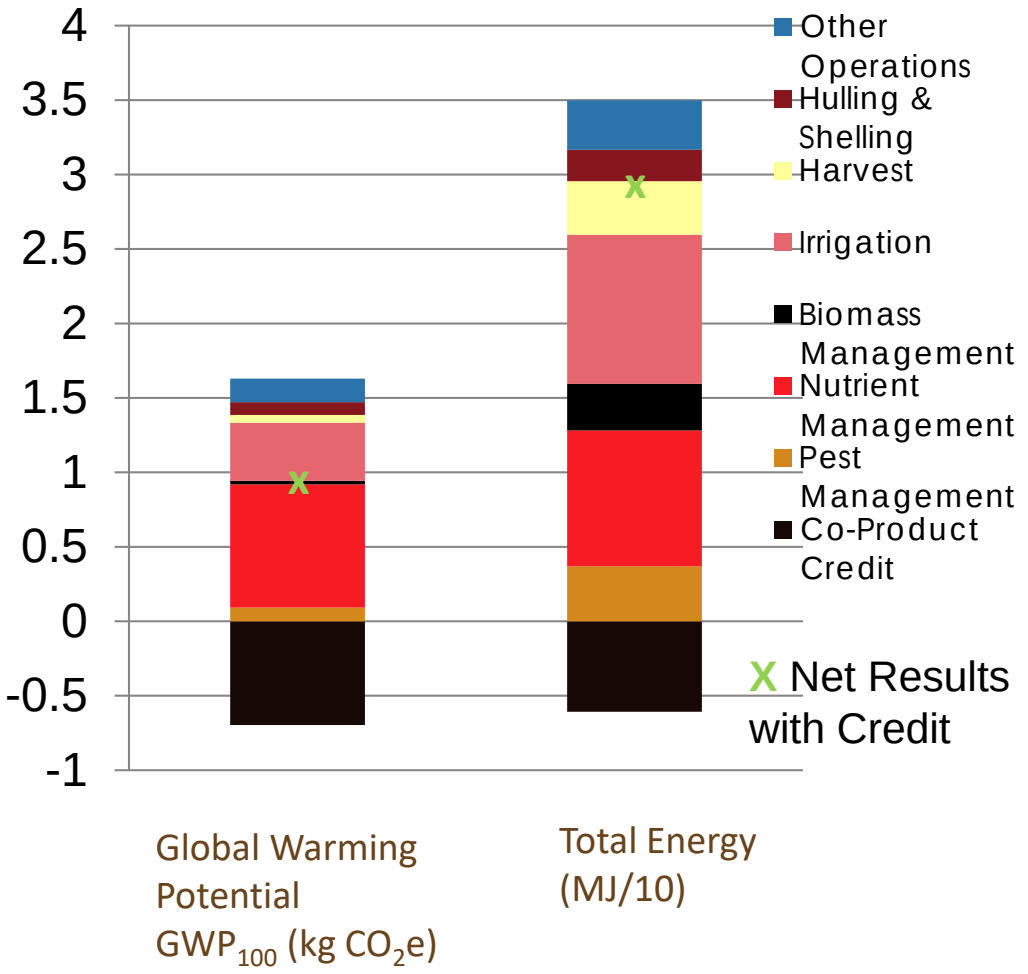
california almonds
Almond Board of California

ALMOND ORCHARD OF THE FUTURE

AIM Initiatives: Where can the almond community and ABC make a difference?

Lifecycle Assessment (LCA)

- LCA of energy used/ produced and greenhouse gases emitted/ sequestered/ avoided
- Study funded by the Almond Board of California and the CA Department of Food and Agriculture Specialty Crops Block Grant Program
- Two studies have been published to date based on almond LCA research
- **At baseline, our industry is offsetting about 50% of its carbon**
- We're now researching ways to further this via improved management of inputs and outputs



ALMOND ORCHARD OF THE FUTURE

AIM Initiatives:
Where can the almond community and ABC make a difference?

OPTIMIZING ALMOND BOARD RESEARCH PROGRAMS

While AIM enables the almond industry to accelerate innovation, it is underpinned with substantive goals that support advancement in **research**, **outreach**, **education** and **policy** across several key areas.

1. Irrigation and Nutrients
2. Orchard, Tree, Rootstock
3. Harvesting
4. Almond Biomass, Co-Products, Energy
5. Soil Health Management
6. Pest Management
7. Food Safety
8. Pollination
9. Sustainability

+

RESEARCH

OUTREACH

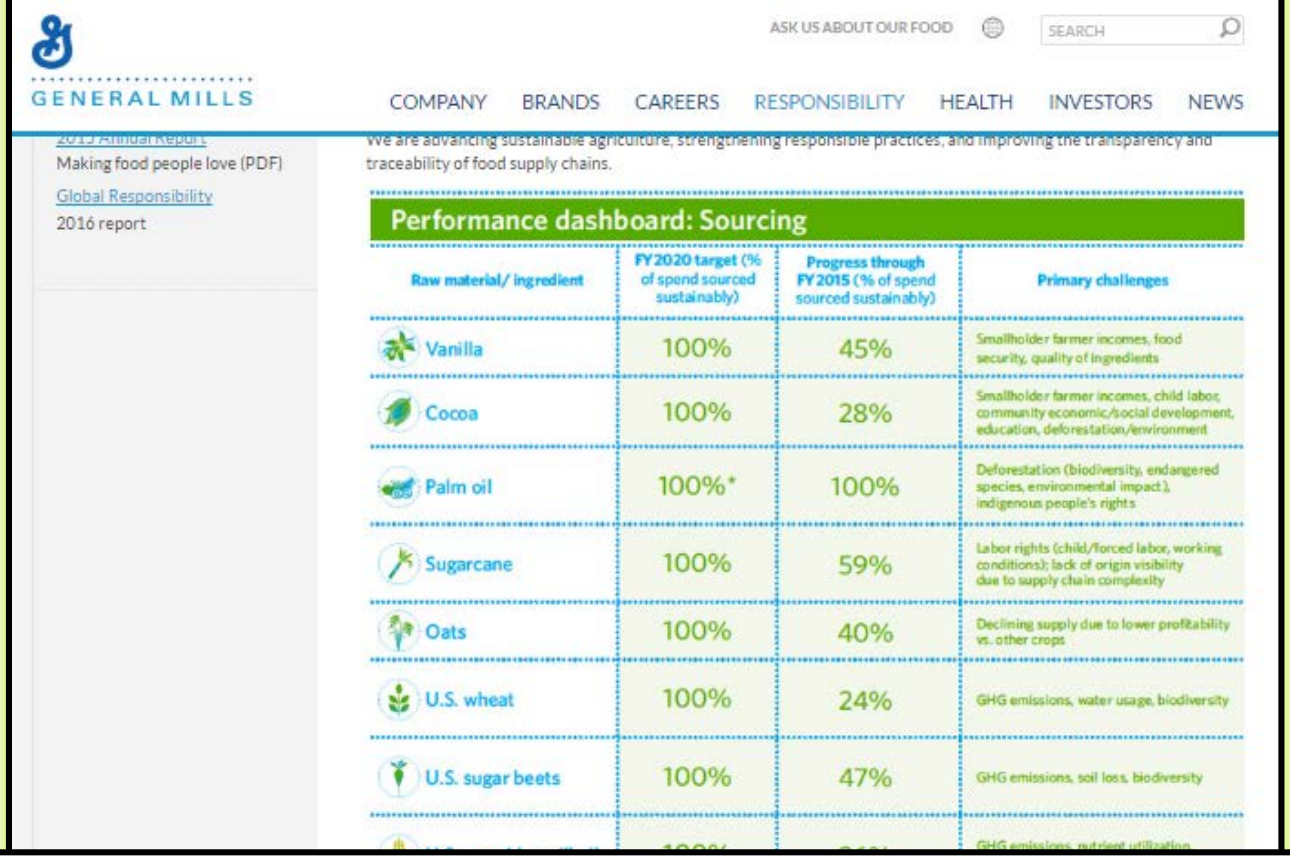
EDUCATION

POLICY

Private (Company) Standards

In response to consumers, to increase efficiencies

Who gets to decide what is sustainable?



GENERAL MILLS

ASK US ABOUT OUR FOOD

SEARCH

COMPANY BRANDS CAREERS RESPONSIBILITY HEALTH INVESTORS NEWS

2015 Annual Report
Making food people love (PDF)
Global Responsibility
2016 report

We are advancing sustainable agriculture, strengthening responsible practices, and improving the transparency and traceability of food supply chains.

Performance dashboard: Sourcing

Raw material/ ingredient	FY2020 target (% of spend sourced sustainably)	Progress through FY2015 (% of spend sourced sustainably)	Primary challenges
Vanilla	100%	45%	Smallholder farmer incomes, food security, quality of ingredients
Cocoa	100%	28%	Smallholder farmer incomes, child labor, community economic/social development, education, deforestation/environment
Palm oil	100%*	100%	Deforestation (biodiversity, endangered species, environmental impact), indigenous people's rights
Sugarcane	100%	59%	Labor rights (child/forced labor, working conditions); lack of origin visibility due to supply chain complexity
Oats	100%	40%	Declining supply due to lower profitability vs. other crops
U.S. wheat	100%	24%	GHG emissions, water usage, biodiversity
U.S. sugar beets	100%	47%	GHG emissions, soil loss, biodiversity

MARS

TOMATOES

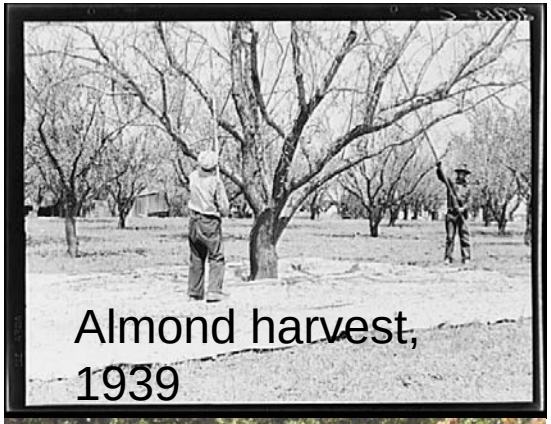
Tomatoes are the second most-used raw material after rice at Mars Food. Though we use less than one percent of the global tomato supply, we're keenly aware of the impact of our sourcing. We work with suppliers like Conessa, Ingomar, Kagome and Solana to make sure we're doing things right.

Tomatoes are a summer crop, typically grown in warm, temperate regions using irrigation. Ensuring a secure supply of irrigation water is hugely important — that's why we try to source from areas that use highly efficient drip irrigation. Research suggests that improved tomato varieties and farming practices could increase yields and further reduce irrigation and water content in the fruit.

Some of our Associates are currently looking at other areas in the world where we could source tomatoes. We carefully examine

What Encourages a Grower to Change his/her Practice(s)?

- **Easy:** when it helps improve yield or quality and/or saves/earns money.
- **Moderate**: when with additional inputs such as investment in technology can improve yield or quality and/or save on inputs
- **Difficult:** when no economic benefit or risky for the grower to change their practice

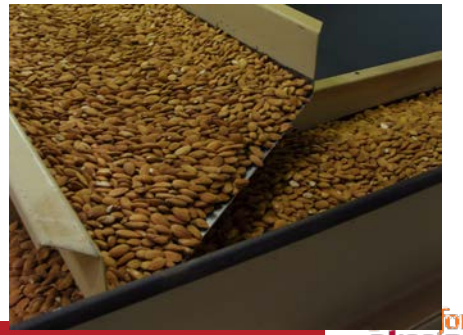

Almond harvest, 1939


Almond harvest, 2010

Growers are constantly managing risk in a variable environment.

Growers constantly innovate

However, you are buying from a processor, not individual almond growers!



Thank you!

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