Case Study: Successful approaches and lessons learned from dried fruit and nuts (almonds) in California

Fraser Shilling & Julian Fulton

UC Davis and California State University Sacramento

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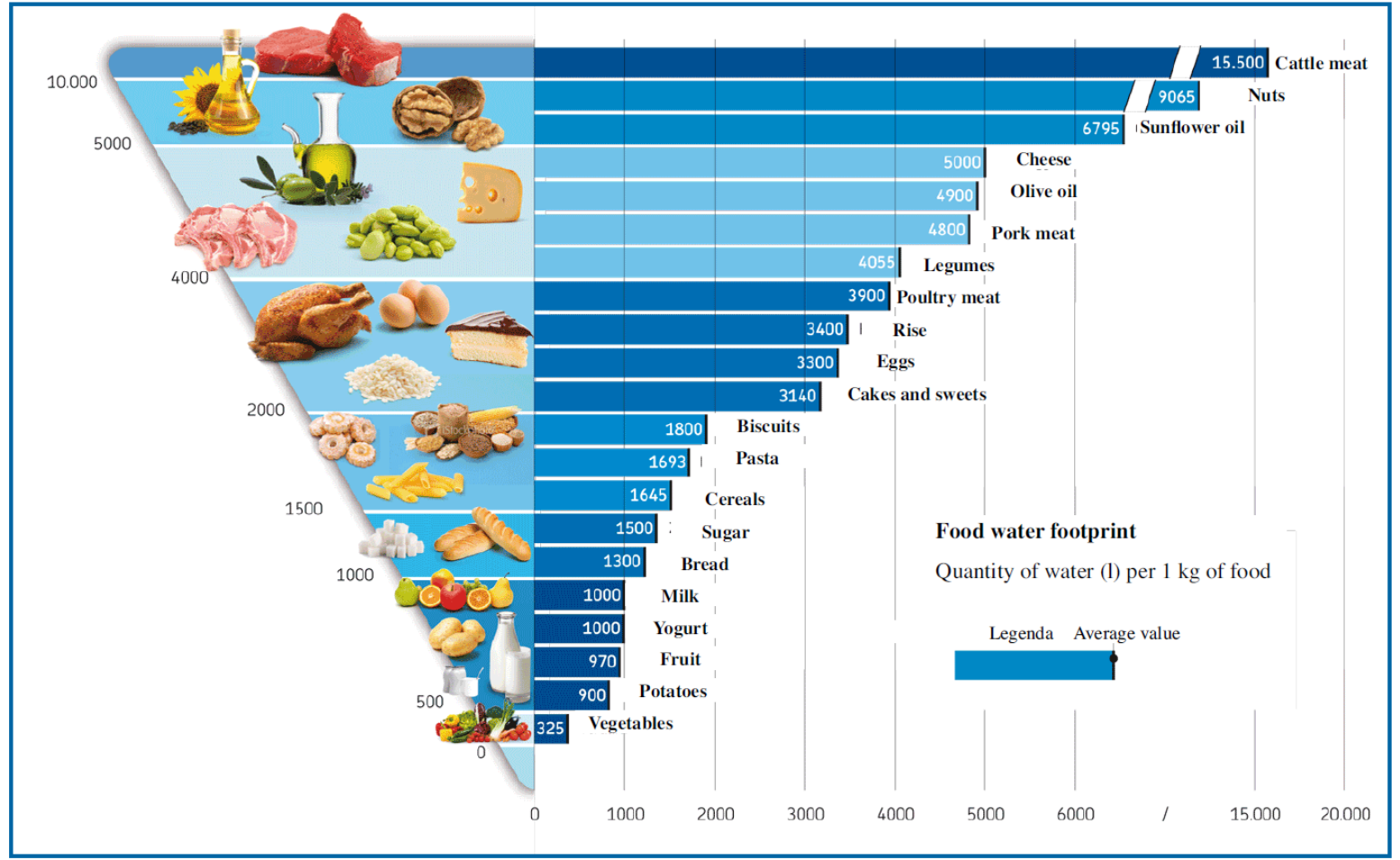


Sansavini, 2013

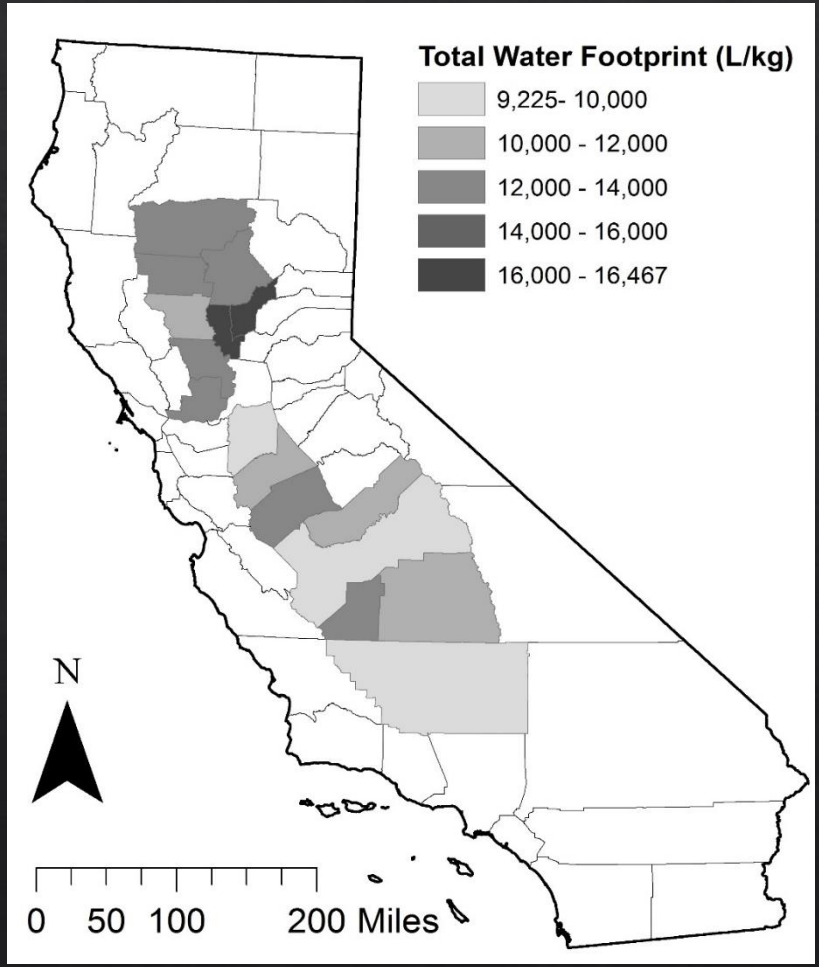
What is Water Footprint?

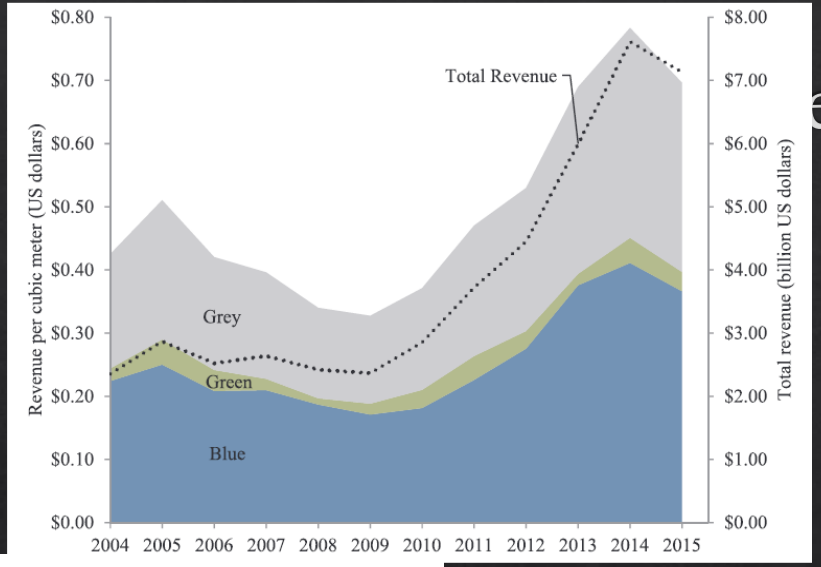
- Blue Water
- Green Water
- Gray Water

Green Water = Rainwater and soil moisture used directly

Blue water = Surface or ground water that is physically applied

Grey Water = Volume of water polluted by runoff and effluent





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Water-indexed benefits and impacts of California almonds

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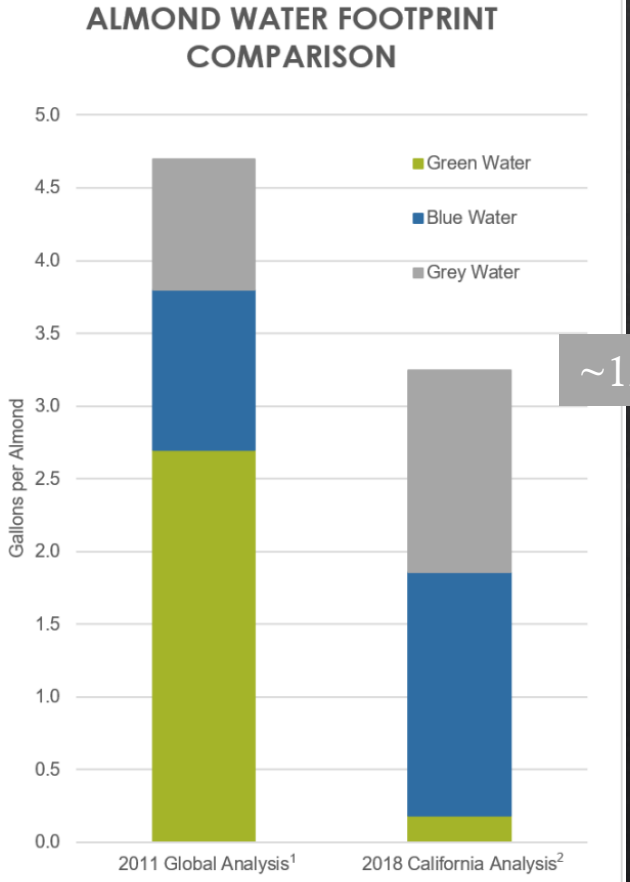
ABSTRACT

California almonds have been the focus of recent media scrutiny because of the large amount of water required to grow individual nuts and, by extension, for the industry as a whole. With almond orchard acreage doubling in the last two decades and becoming California's most extensive irrigated crop, the questions arise: what are the benefits and impacts derived from this use of scarce water? Can we use this information to make decisions about growing and consuming this particular crop? We first use a water footprint approach to estimate total impact on water per unit of almond production in California, including variation in the water footprint over time (2004–2015) and across the production area. We then compare almonds to a set of other foods and crops grown in California using water footprint values and three other dimensions: nutritional value, per-unit-weight economic value, and total economic value. The water footprint of California almonds averaged 10,240 liters per kilogram kernels (or, 121 liters per almond kernel), with substantial variation over the time period analyzed. Water footprint values also varied twofold across the production area, with the smallest water footprint being in the southern counties of California's Central Valley. In relation to dietary benefits, almonds were among the top three foods analyzed providing the greatest nutritional benefit per unit weights, however they had the highest water footprint value per unit weight. The direct economic benefits of almond production based on market sales were also greater than for any other major crop in California, however almonds again had the largest water footprint on a per-unit and aggregate basis. We find that nutritionally and economically indexed water footprint indicators provide information to better inform discussions on the benefits and impacts of growing almonds under California's limited water resources, relative to other crops. Such composite indices can be used in combi-



~12 L/nut

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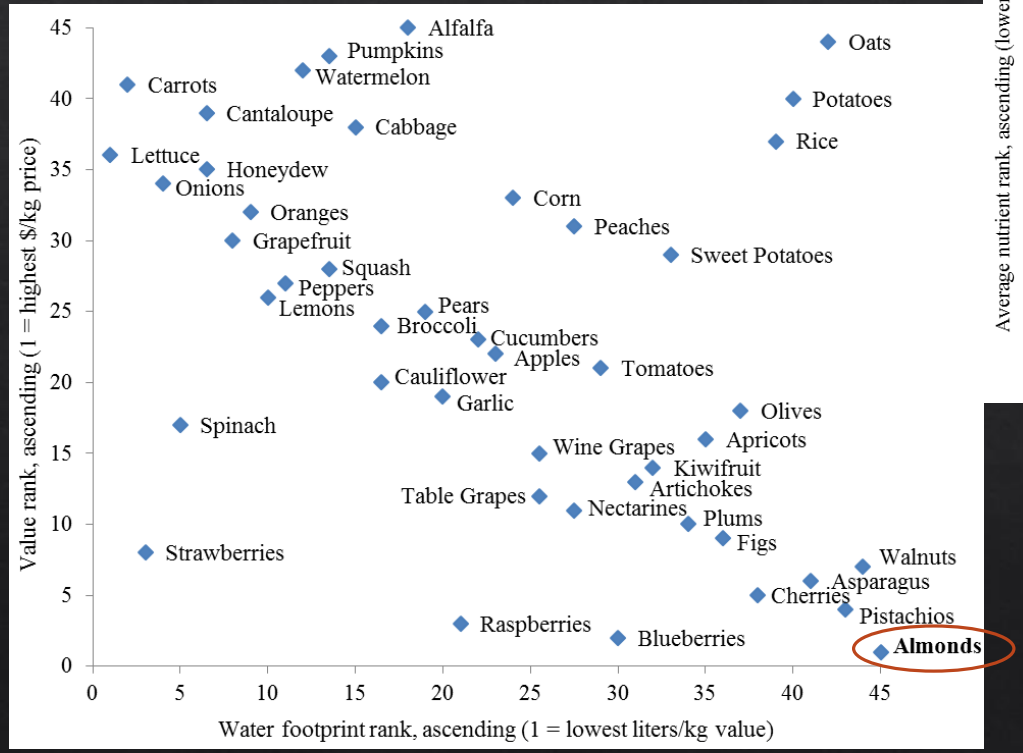
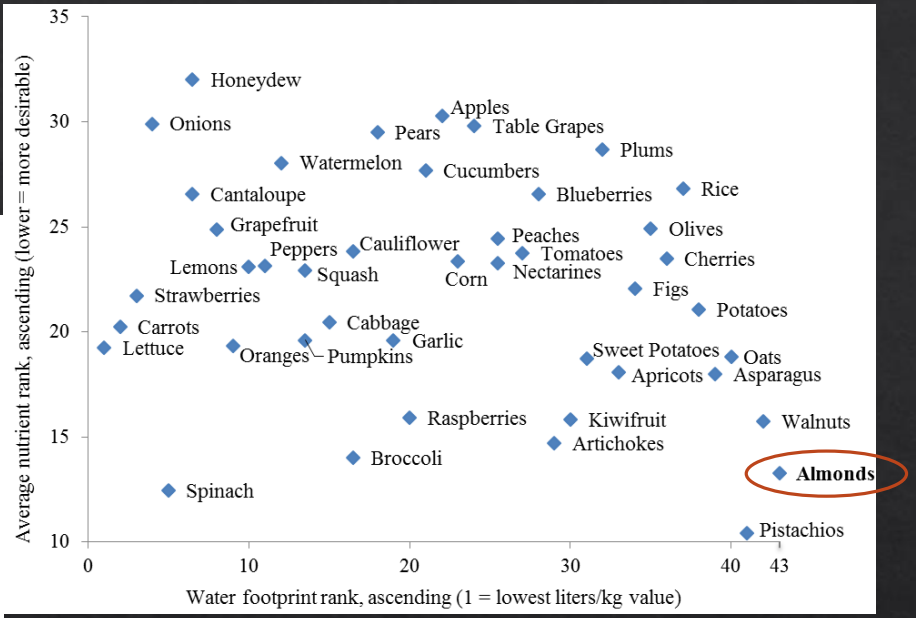
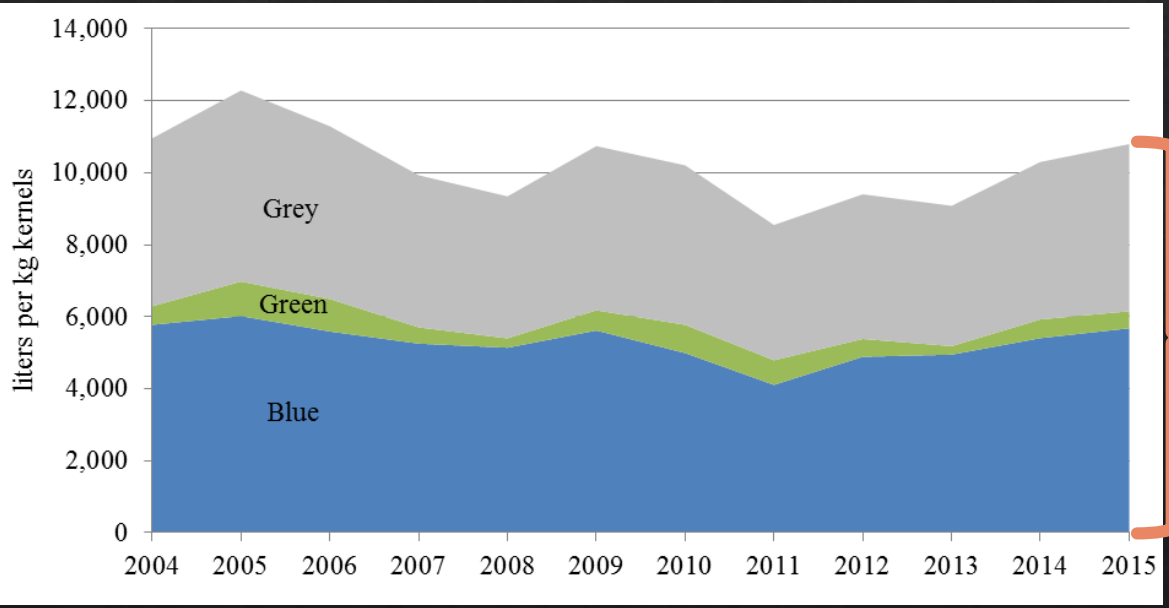
Almond vs other crops





Managing almond water footprints

What is actionable for growers?



estimate the off-setting value of sustainability actions relative to the calculated water footprint

95% of WF can be impacted by improved management

Managing almond water footprints

How can grower practices reduce the calculated blue, green, and grey WF?

On-Farm Practice	Blue WF	Green WF	Grey WF
Site selection		X	
Soil preparation		X	X
Energy management	X		
Soil management	X	X	X
Irrigation management	X		X
Nutrient management			X
Bare-surface management	X	X	X
Waste management			X
Biochar	X	X	X

Source: Fulton and Shilling, forthcoming

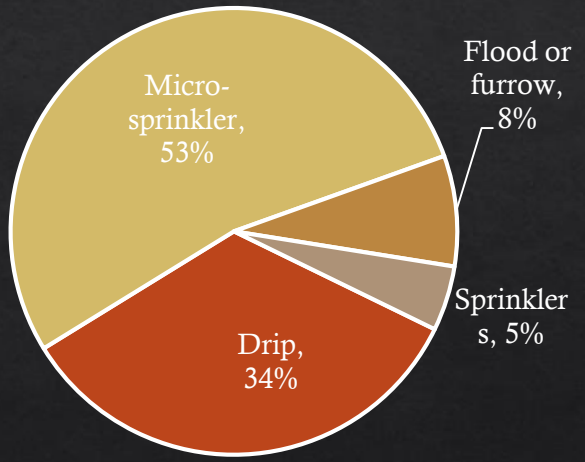
CALIFORNIA ALMOND SUSTAINABILITY PROGRAM™

www.sustainablealmondgrowing.org

Actions: Blue WF Reduction

Examine practices that contribute to reduced WF and extend WF quantification to specific recommendations and sustainability metrics

Blue WF



Irrigation technologies used (A) (N=212) reported in almond grower self-assessments (SureHarvest, 2017).

Actions: Gray WF Reduction

Examine practices that contribute to reduced WF and extend WF quantification to specific recommendations and sustainability metrics

Gray WF

nutrient budgeting techniques (98%, n=119)
recommended timing of fertilizer applications (100%, n=75)
fertigation (93%, n=107)

Nutrient management module from almond grower self-assessments (SureHarvest, 2017).

Actions: Green WF Reduction

Examine practices that contribute to reduced WF and extend WF quantification to specific recommendations and sustainability metrics

Green WF

Soil moisture monitoring (90%, n=88)
Soil amendments for water retention (37%, n=132)

Irrigation and nutrient management modules from almond grower self-assessments (SureHarvest, 2017).

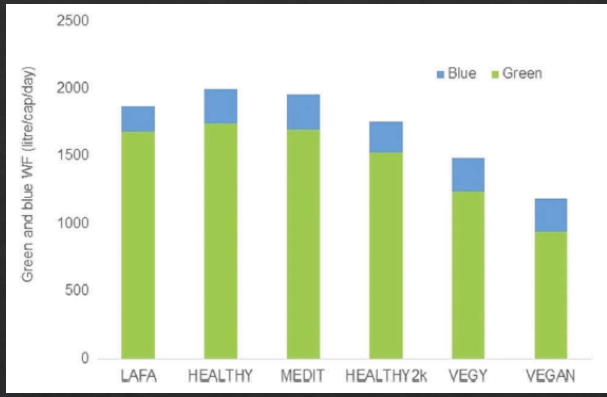
Actions: Offsets

Quantify practices that could be considered offsetting for WF

- Groundwater recharge
- Biomass to energy
- Biomass to biochar
- Biomass to livestock feed

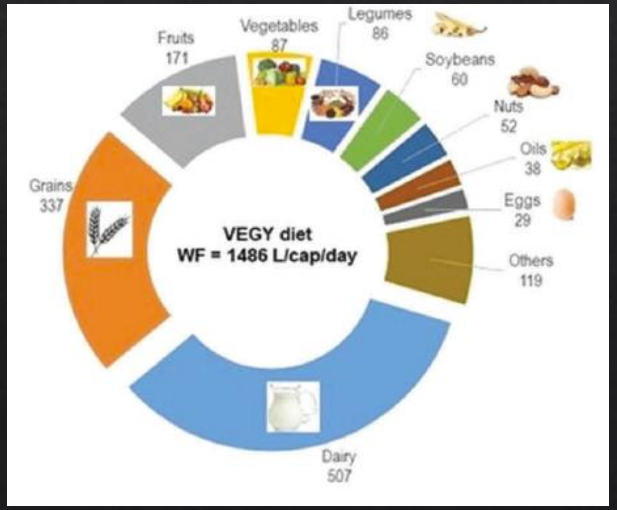
(Aric Crabb/Bay Area News Group)

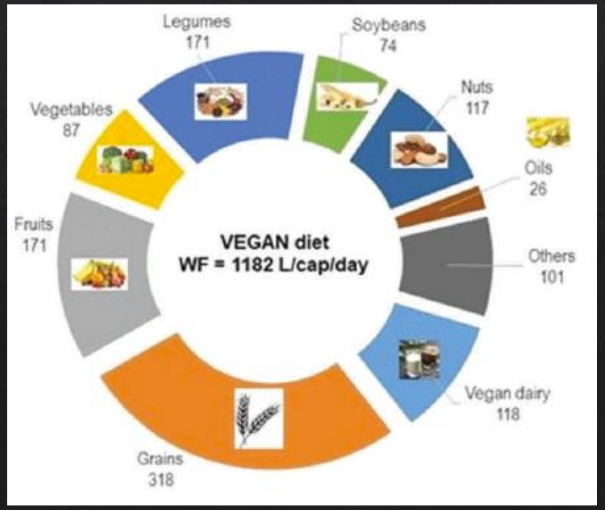
Diet Modification Can Reduce Demand



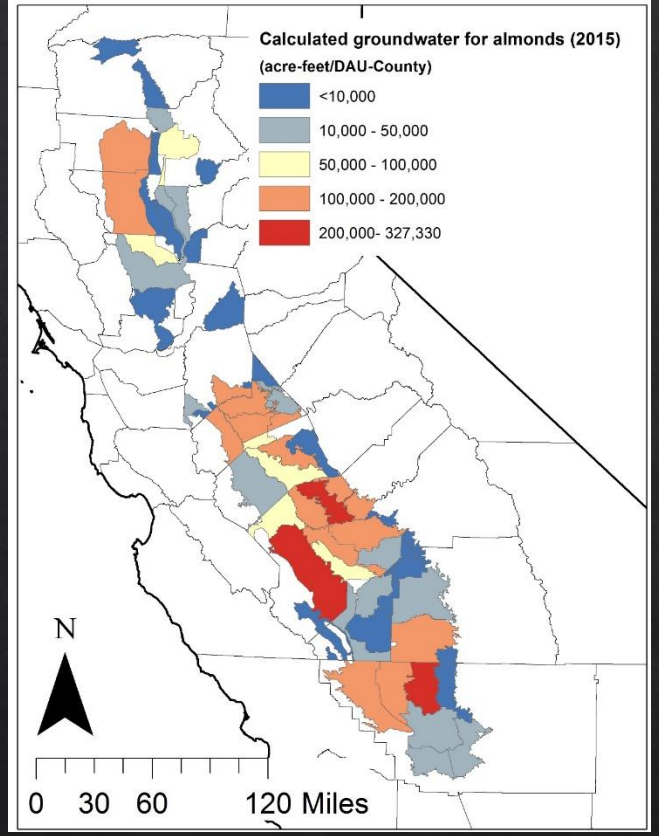
Mesfin M. Mekonnen & Julian Fulton (2018) The effect of diet changes and food loss reduction in reducing the water footprint of an average American, Water International, 43:6, 860-870, DOI: 10.1080/02508060.2018.1515571

Transitioning away from meat/animal products to vegan reduces individual and societal WF

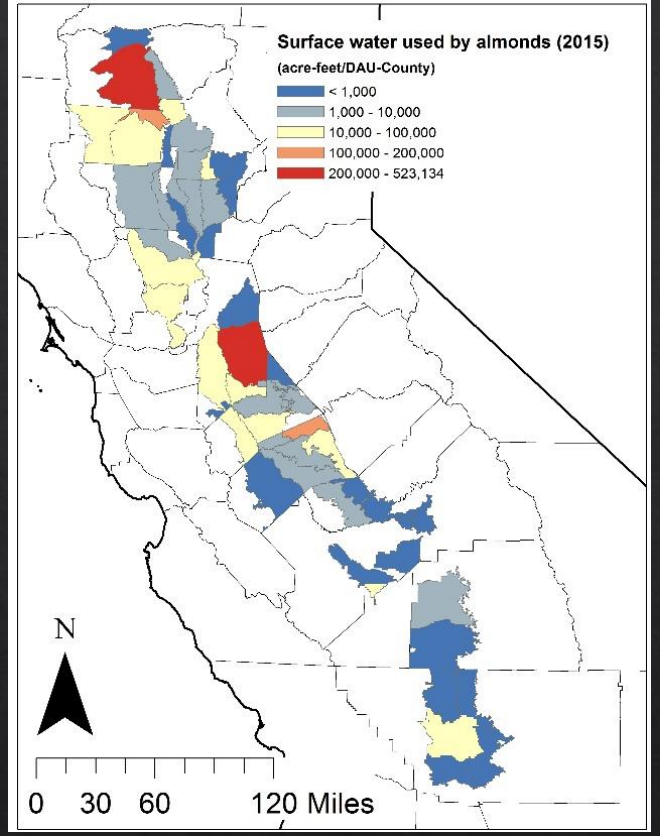




Water Supply Stress



Almond groundwater demand/use per County, total = 3.2 million acre-feet and 65% of estimated total demand*



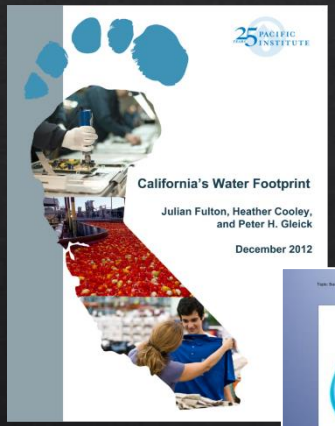
Estimated surface water use for almond production in 2015, per County. Total = 1.7 million acre-feet

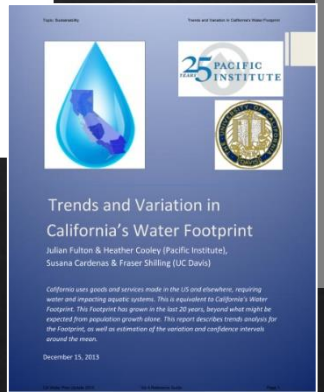
Threats to Supply

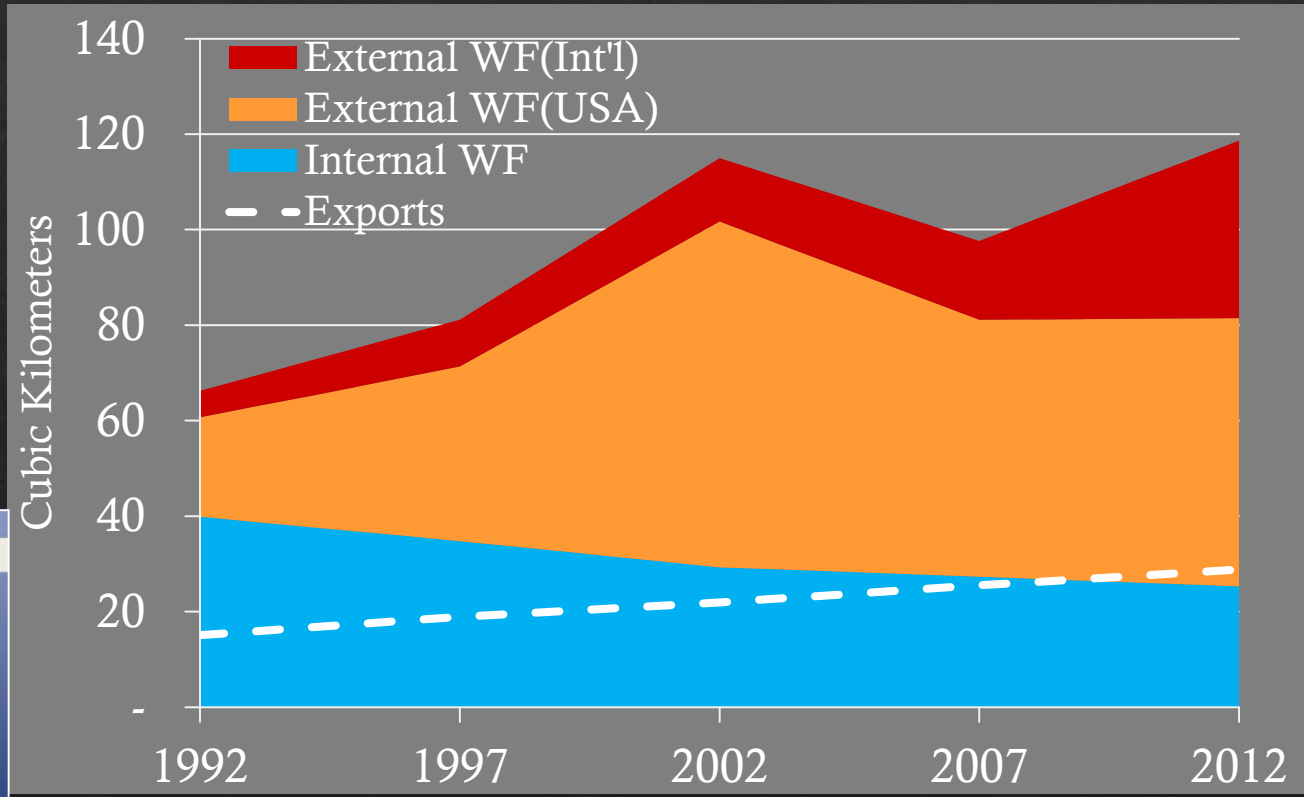
- Sustainable Groundwater Management Act (SGMA) -- >90% of almond production is within priority basins under SGMA

- Surface water supplies are expected to decline as snowpack and total precipitation declines with climate change, will lead to increased competition for increasingly rare resource

CA Exported WF Increasing







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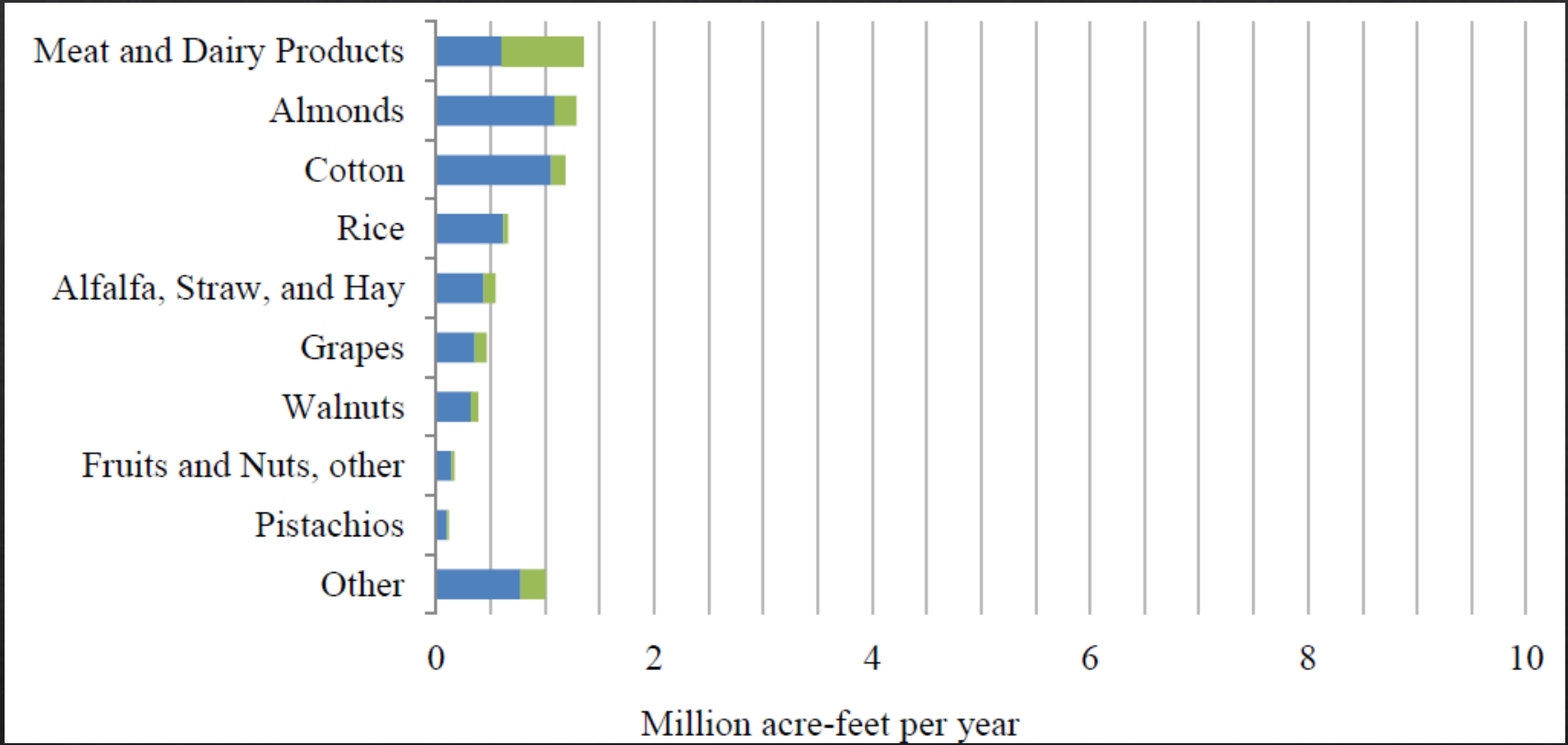
Blue and Green Water Footprints

Consumptive use factors for agricultural products from the California Simulation Evaporation of Applied Water (Cal-SIMETAW) model (Orang et al. 2013), which reconstructs seasonal crop evapotranspiration (ETc) estimates (in units of acre-feet per acre) for 20 crop categories from 1992 – 2009 using recorded weather and cropping pattern data. ETc values were further divided between evapotranspiration of applied water (ETaw) and effective precipitation (EP). ETaw values were used as blue water factors to calculate the blue water footprint of agricultural products. Green water factors were calculated as EP plus residual soil moisture (in other words, ETc minus ETaw). These factors were available at the combined Detailed Analysis Unit-County level (DAU-Co)

(Fulton, Cooley, & Gleick, 2012)



Blue and green water footprints of goods produced in California and exported internationally (Fulton et al., 2012)