Presented by





Almonds: Food-Water-Energy Nexus

Guangwei Huang Almond Board of California



bearing _____total

Water: increased efficiency

- Reduced amount water used to grow 1 lb almonds by 33% since 1994
- Nearly 80% of almond orchards use efficient micro-irrigation systems, well above state average of 42%
- Over 85% of growers schedule irrigation based on soil, evapotranspiration or tree needs, rather than on fixed timing

Water: more to do

- Funded over 100 irrigation research projects over last 30 years
- Irrigation continuum: encourage growers to move toward more efficient scheduling, design, performance of irrigation systems
- Orchard 2025 Goal: reduce amount of water used to grow a pound of almonds by 20%
- Key: time water to plant needs to increase yield with same amount of water

Energy Expenditure for Almond Production Can Account for More Than 20% of Annual Costs of Culture Practices



Almond Sustainability Report 2014

California Almond Industry Produces More Than 3.1 mil. MT Biomass (DM) Annually



2017 California Almond Biomass (3.1 mil. MT DM)



Kernel:Hull:Shell :: 32:48:20 (DM)

Huang & Lapsley 2019: Integrated Processing Technologies for Food and Agricultural by-Products, 373-390

Energy + +

Projected Almond Biomass (2019-2025)



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Almond Woody Biomass Can be a Good Feedstock for Bioenergy Conversion

Table 2Heat Conversion Properties of Almond Tree Woods and Shells (%DM)		
Analyte	Wood chips (10)	Shells (9)
Moisture	7.3 ± 1.5	$8.1\pm\!3.0$
Ash	2.3 ± 0.2	3.8 ± 1.4
Volatile matter	79.6 ± 1.3	72.2 ± 11.2
Fixed carbon	18.2 ± 1.4	20.3 ± 0.3
MJ/kg (LHV)	17.5 ± 0.1	16.6 ± 0.7
MJ/kg (HHV)	18.8 ± 0.1	18.4 ± 0.4
Carbon	52.5 ± 0.3	47.2 ± 1.3
Hydrogen	5.6 ± 0.0	8.2 ± 2.5
Oxygen (by difference)	39.3 ± 0.5	49.3 ± 4.5
Nitrogen	0.2 ± 0.1	$0.3\!\pm\!0.2$

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REDUCE THE AMOUNT OF WATER USED TO GROW A POUND OF ALMONDS BY 20%



ALMOND ORCHARD 2025 GOALS

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INCREASE ADOPTION OF ENVIRONMENTALLY FRIENDLY PEST MANAGEMENT TOOLS BY 25% ACHIEVE ZERO WASTE IN OUR ORCHARDS BY PUTTING **EVERYTHING WE GROW TO**

ABC Is Searching for Value-added Solutions for Woody Biomass

- More than 4.5 billion pounds of woody biomass annually
- More co-gen plant closedown, open burning restriction, and the demand for dairy ranch bedding staggering
- ABC has:
 - funded projects on soil amendment of biochar and shells, application of torrefied shells in plastics
 - Collaborated with technology vendors
- ABC welcomes collaborative research opportunities in:
 - Installation of gasification, pyrolysis, and torrefaction system able to handle almond biomass



For more information 2018 Research Update on Almonds.com

Guangwei Huang

Associate Director, Food Research and Technology Almond Board of California ghuang@almondboard.com www.almonds.com