California Almond Industry Searches for Innovative Solutions for Biomass

Dr. K. Lapsley & G. Huang

Almond Board of California

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The Scope of the California Almond Industry

- Spanning 500 miles throughout the Central Valley
- 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** 2014
  - 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

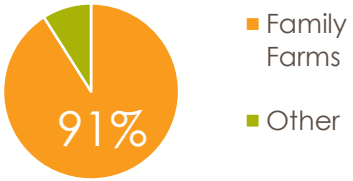
About Almond Farmers

Multigenerational, family farmers are the heart of California's Almond community.

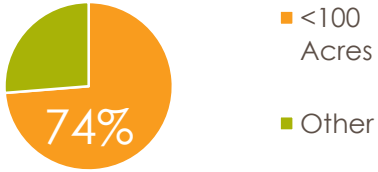
We recognize that in order to preserve our way of life for future generations, we must always farm responsibly.

More than 6,800 total farms

More than 90%
Family Farms



Nearly 3/4
Under 100 Acres

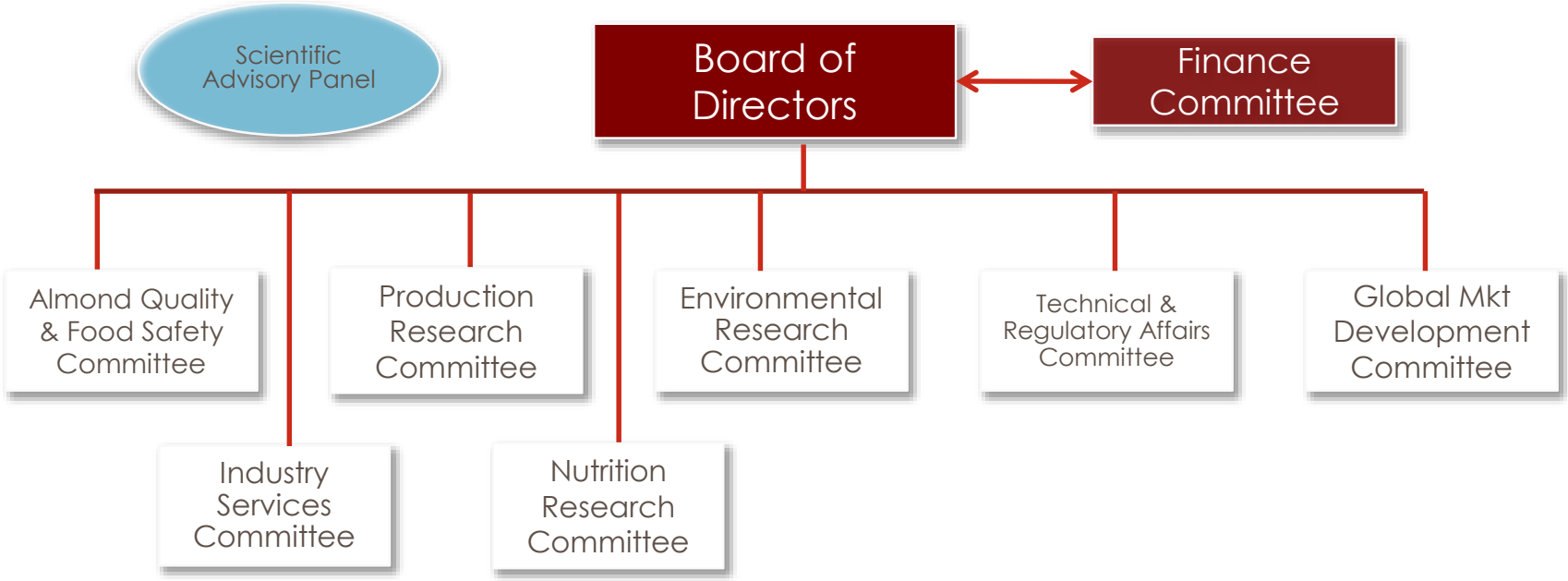


About the Almond Board of California

Almond Board of California (ABC) Organization

- Grower-enacted “Federal Marketing Order” established in 1950
  - Represents growers and handlers (processors)
  - “Quasi governmental”
  - Non-profit organization
- Under USDA supervision
- Funded by assessment $.03/lb
- Does not sell, set, track, or quote almond prices
- Broad-based program
  - Global Market Development
  - Scientific Research

Board/Committee Structure – All Volunteers!



45 Employees based in Modesto, New Delhi, London, Shanghai

Research at the Almond Board…

- …is the foundation for continuous improvements in growing almonds productively, safely, and in a way that is environmentally responsible.

- Through ABC, California's almond community has been investing in research on topics related to almonds' sustainability since 1973 with a total investment of more than $50 million to date.

ALMOND ORCHARD OF THE FUTURE

Where can the almond industry and ABC make a difference?

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.

AIM: WATER MANAGEMENT AND EFFICIENCY

Focuses on accelerating the transition of growers up an irrigation improvement continuum with the adoption of more efficient irrigation and scheduling and management practices, resulting in the maximization of "crop per drop". Adopting more advanced water management technologies.

AIM: SUSTAINABLE WATER RESOURCES

Explores how best to leverage a unique strength of the industry, its acreage, for increasing groundwater recharge in aquifers, which collectively are California's largest water storage system. Working to recycle municipal waste water and other degraded water as a way of increasing overall water availability for farmers and all Californians.

Sustainable Conservation

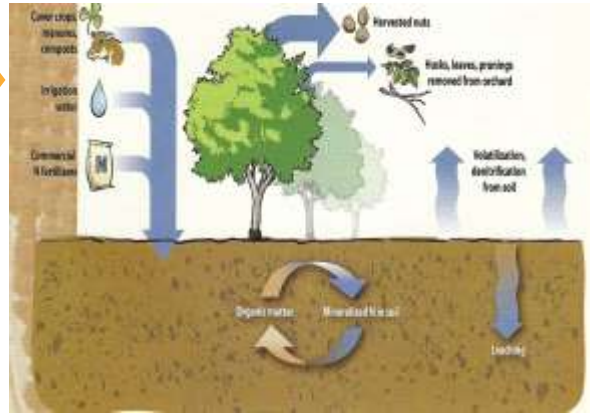
LAND IQ

UCDAVIS
UNIVERSITY OF CALIFORNIA

california almonds

AIM: AIR QUALITY

Nitrogen Management Tools

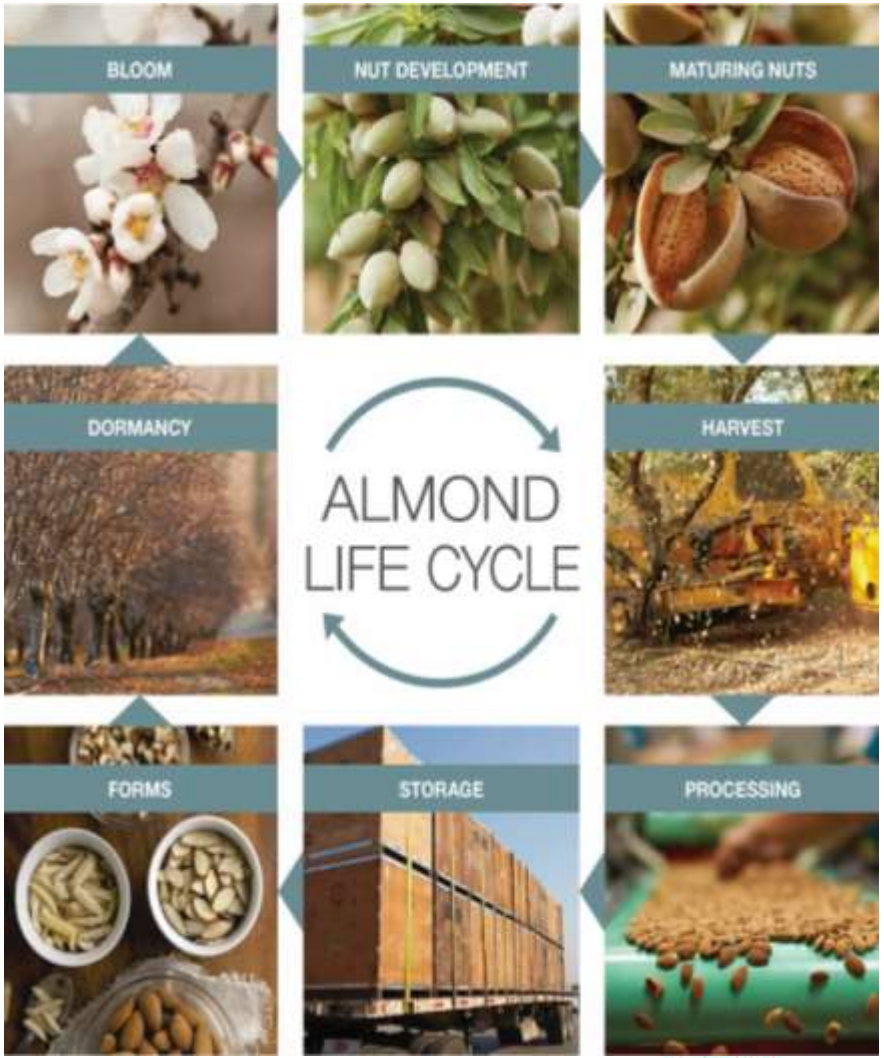


Kathy Kelley-Anderson et al: ANR Pub # 21623

Delving into the various ways almond production impacts air quality as well as evaluating options to decrease emissions.

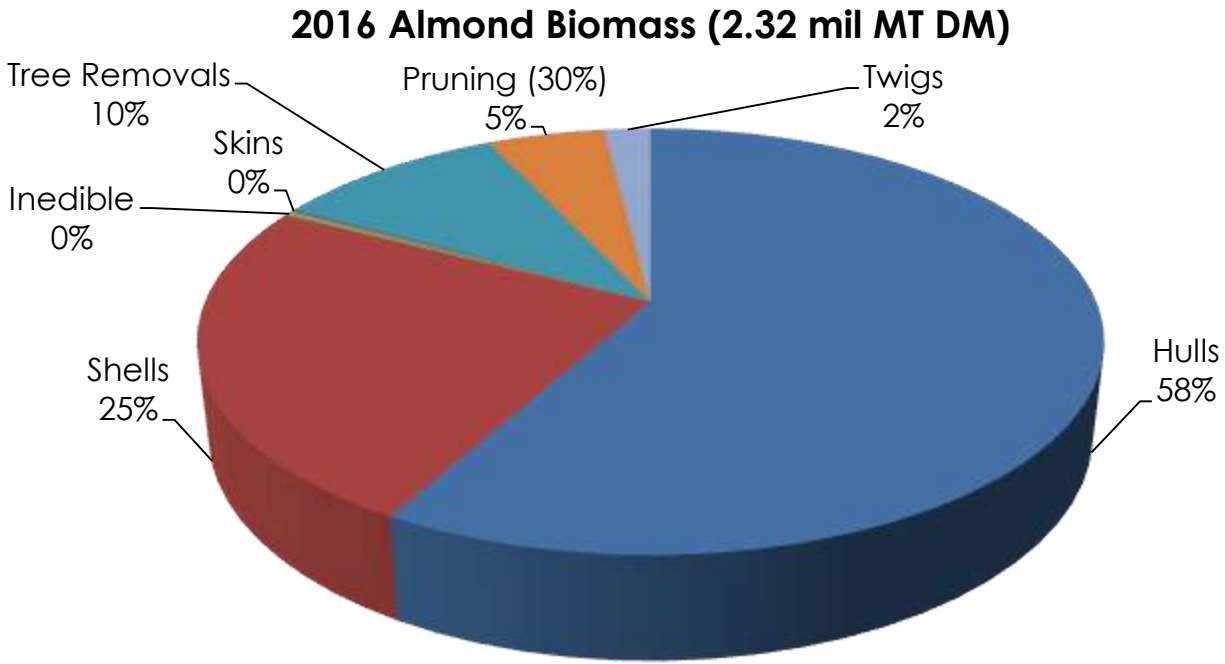
AIM: 22ND CENTURY AGRONOMICS

Recognizes that we need to better understand and then adopt the technologies that will lead California Almond farming into the 22nd century. Each component of almond farming will be considered, from land preparation and varietal development to equipment and processing.

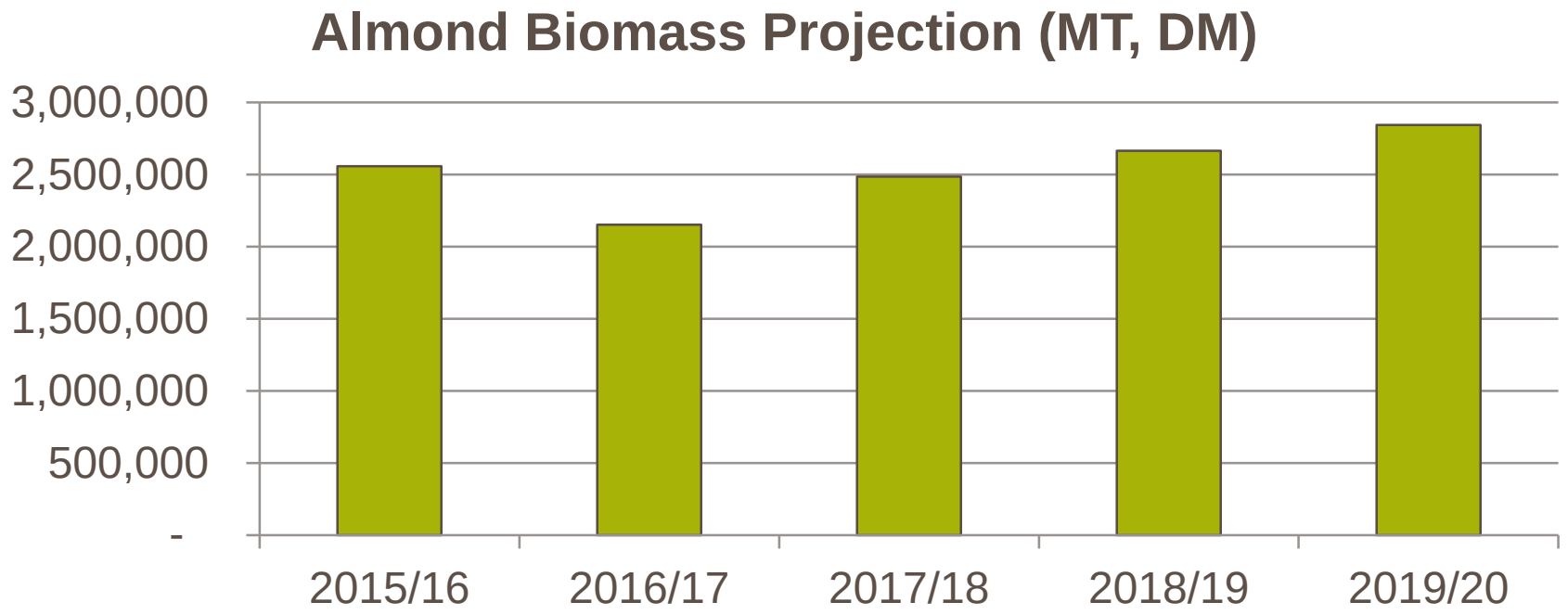


Almond Biomass

2016 Almond Biomass Estimation



Almond Biomass Estimation



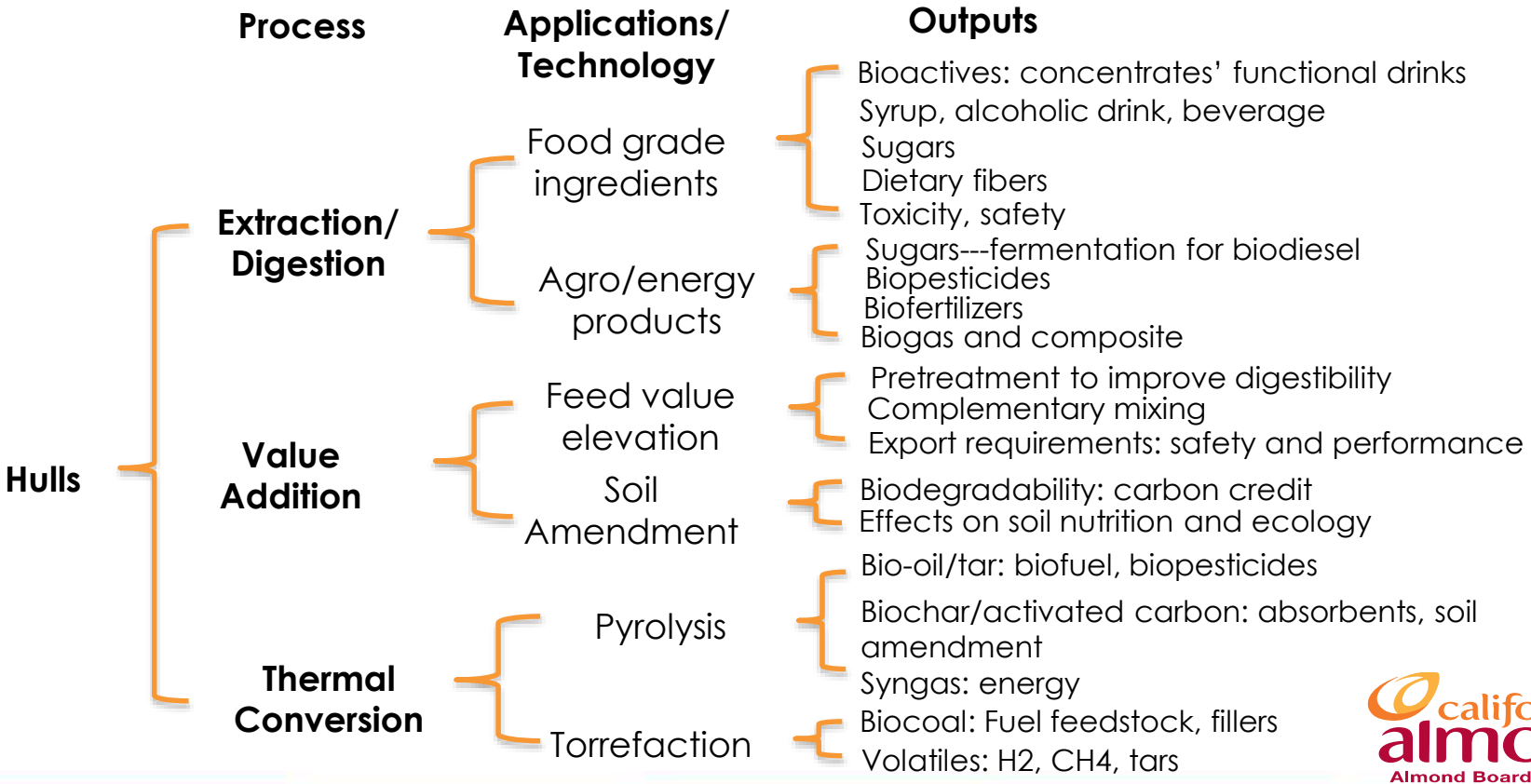
Biomass Generated by Almond Industry

Co-product	Grower	Huller/ Sheller	Handler	Current Outlets
Pruning	x			• 20% Controlled burning? • 80% Wood chipping
Tree Removal	x			• 80% Co-gen • 20% Wood chipping
Twigs	x	x		• 80% Grinding for soil amendment • 20% Co-gen
Hulls		x		• 100% Livestock feeds
Shells		x		• 90% Dairy bedding • 10% Co-gen • ? Export
Inedible			x	• 40% Oil for cosmetics • 60% Landfill
Skin			x	• 90% Livestock feeds • 10% High fiber bran

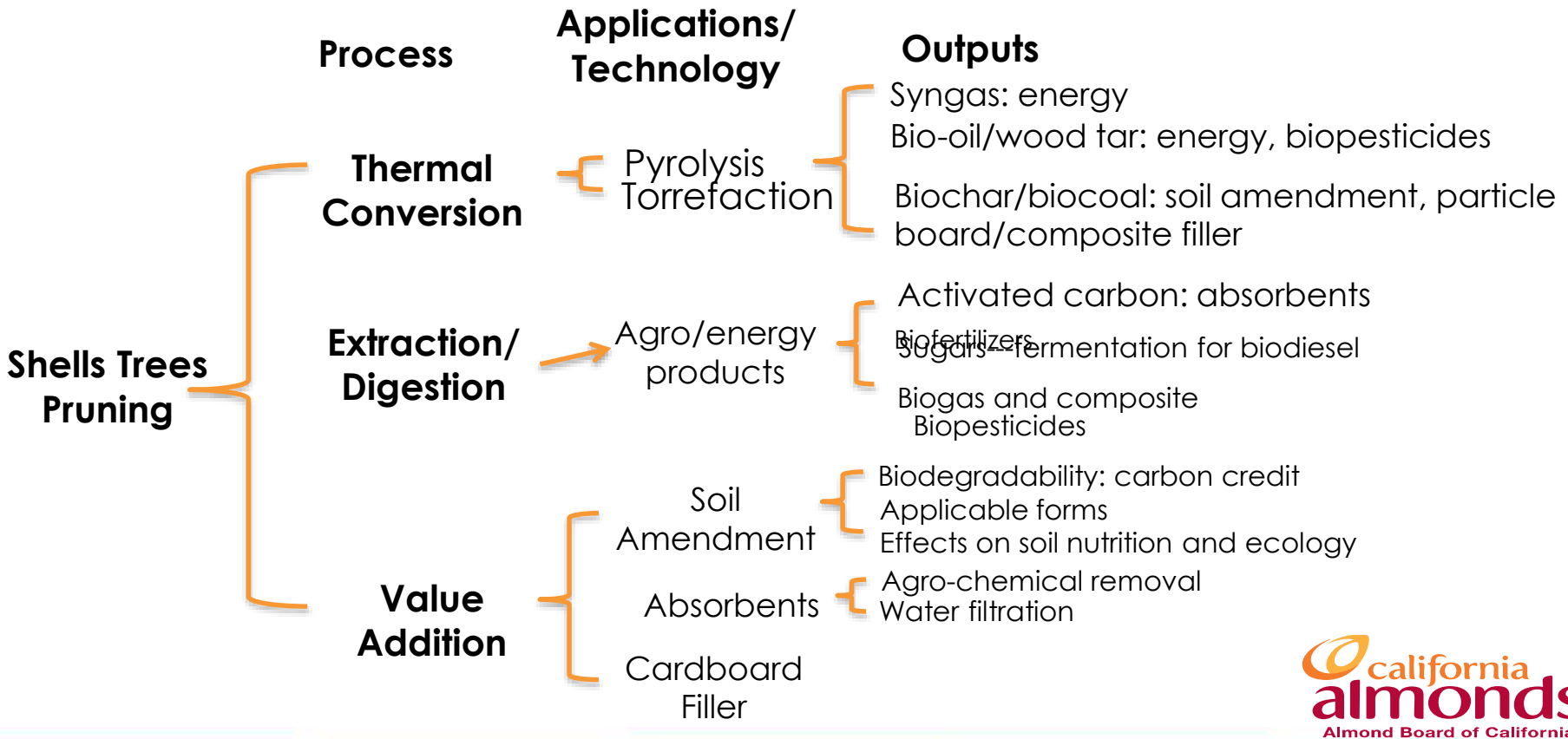
Published Papers on Utilization of Almond Biomass

Application	Hulls	Shells	Pruning	Skins	Twigs & Trees
Feed Value	++				-
Soil Amendment	+	+			+
Sugar Extraction/Digestion	+	+	+		-
Bioactives	++	+	+	+++	-
Absorbents	+	+			-
Combustion Products		+	+		-
Gasification		+	+		-
Pyrolysis/biopesticides		++	+		-
Torrefaction/composite filler		+			-
Activated Carbon/Biochar		++++	+		-
Particleboard Filler		+		+	-
Others (culture media, wood chipping, colorants, fibers, nanopaper, etc.)	+	+	+		+

Potential Research Directions for Hulls??



Potential Research Directions for Shells and Woody Material?



Thank You!