2018 | THE ALMOND CONFERENCE

ALMOND ORCHARD 2025: ZERO WASTE

ROOM 306-307 | DECEMBER 5, 2018

california almonds
Almond Board of California

growing ADVANTAGE
The Almond Conference

AGENDA

- **Karen Lapsley**, Almond Board of California, moderator
- **Caleb Gervase**, Van Duyn Farms, Inc., moderator
- **David Babson**, USDA, DC
- **Paul Thompson**, Select Harvest, Australia
- **Kelpie Wilson**, Wilson Biochar Associates, Oregon


water
harvest dust
ALMOND ORCHARD
2025 GOALS
pest management
zero waste


REDUCE THE AMOUNT OF **WATER** USED TO GROW A POUND OF ALMONDS BY **20%**
REDUCE **DUST** DURING ALMOND HARVEST BY **50%**
water
harvest dust
pest management
zero waste
ALMOND ORCHARD
2025 GOALS
Suterra
INCREASE ADOPTION OF **ENVIRONMENTALLY FRIENDLY PEST MANAGEMENT** TOOLS BY **25%**
ACHIEVE **ZERO WASTE** IN OUR ORCHARDS BY PUTTING **EVERYTHING WE GROW TO OPTIMAL USE**

ACHIEVE **ZERO WASTE** IN OUR ORCHARDS BY PUTTING **EVERYTHING WE GROW TO OPTIMAL USE**

Zero Waste and New Markets for the Almond Industry: Challenges, Opportunities, and the Advanced Bioeconomy

The Almond Conference

Sacramento, CA

05 December 2018

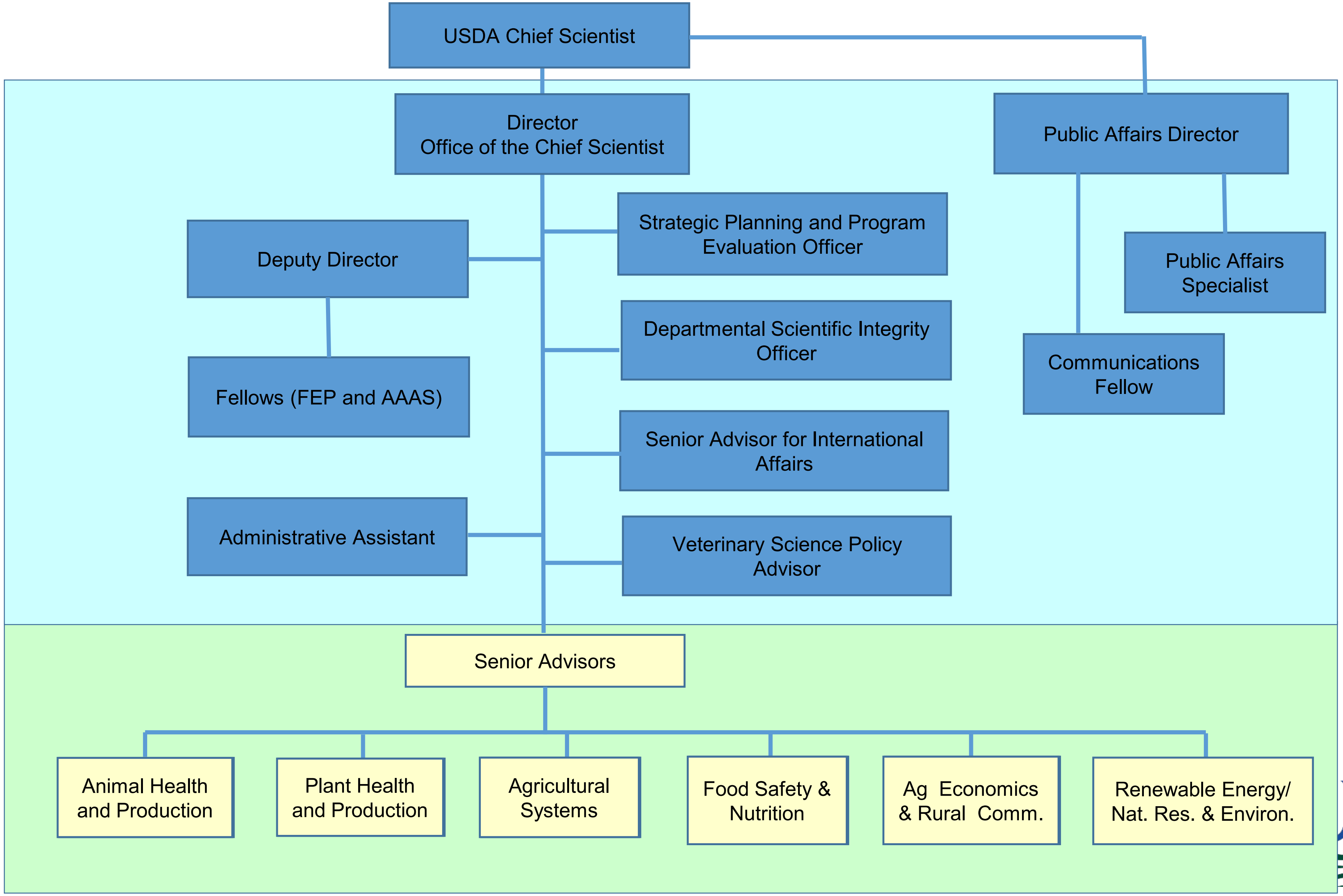
David M. Babson, Ph.D.

Senior Advisor

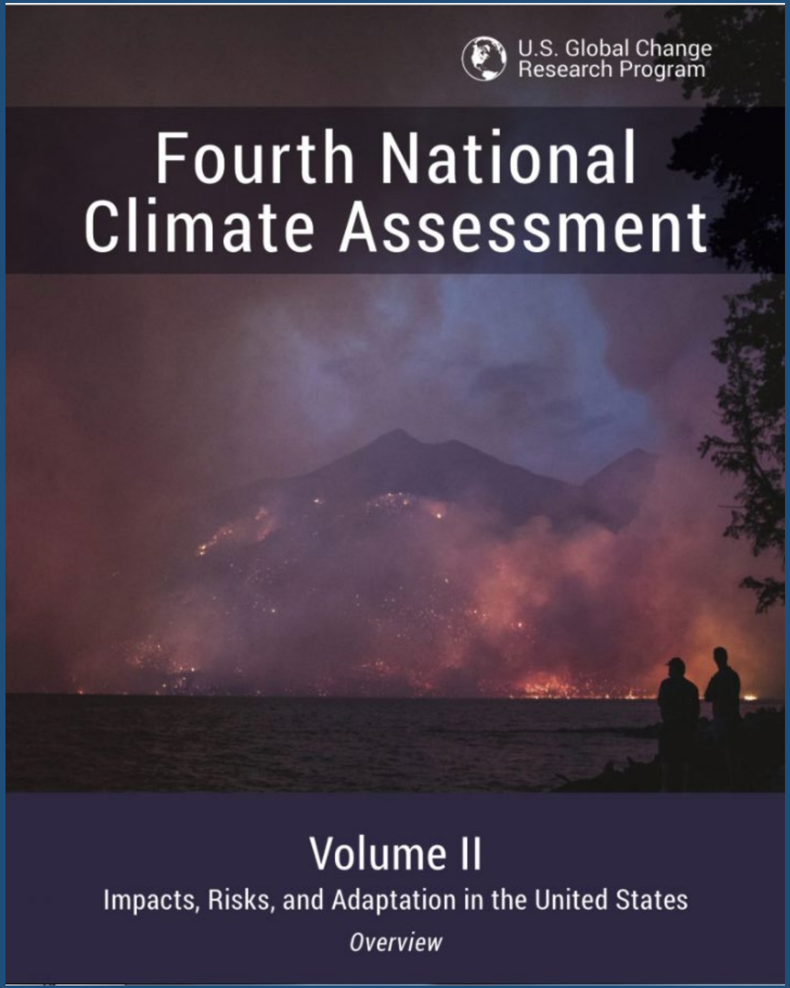
Renewable Energy, Natural Resources & Environment

U.S. Department of Agriculture

The USDA Office of the Chief Scientist

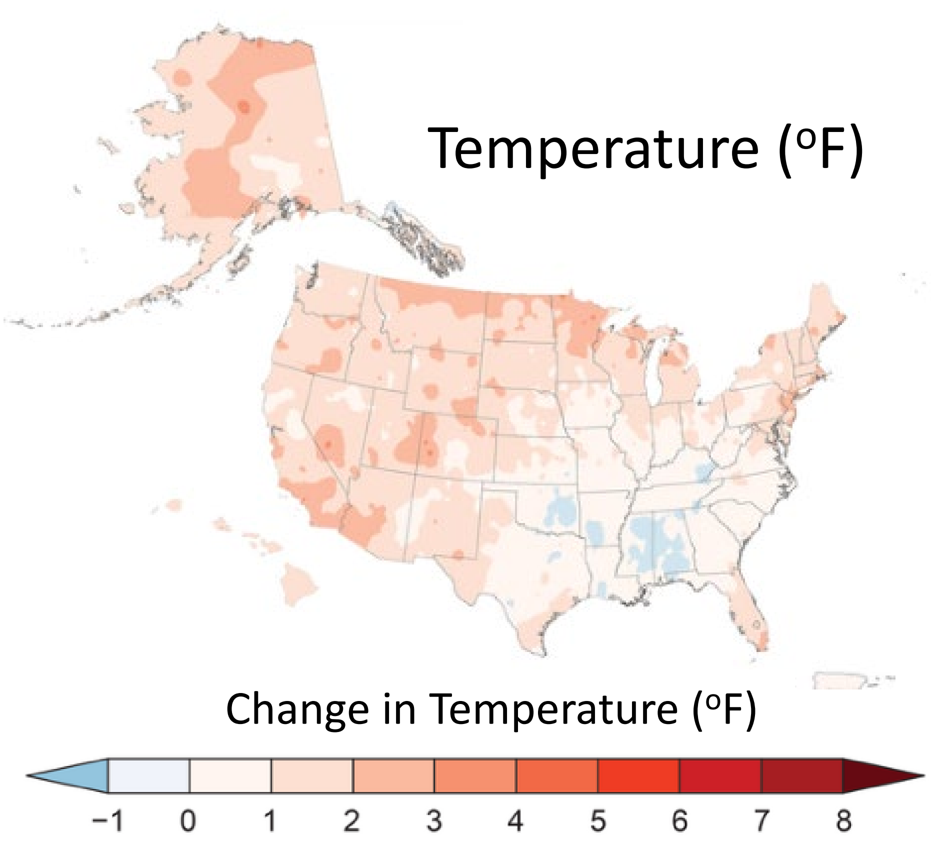


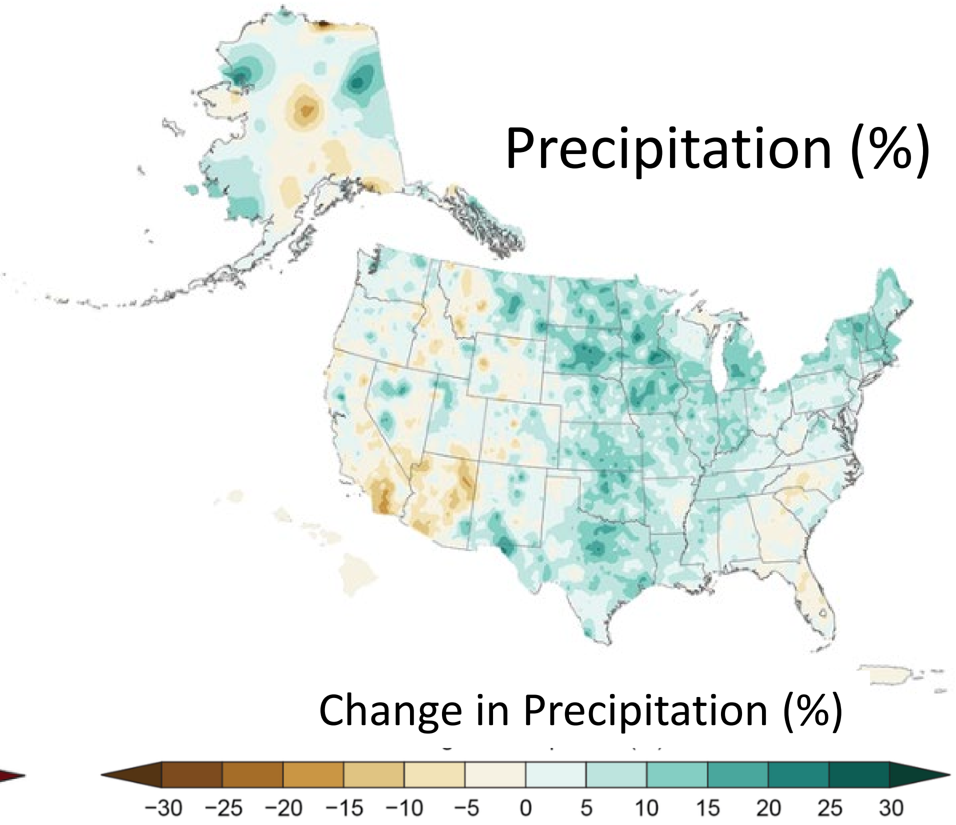
Three quick things about climate change from our new report



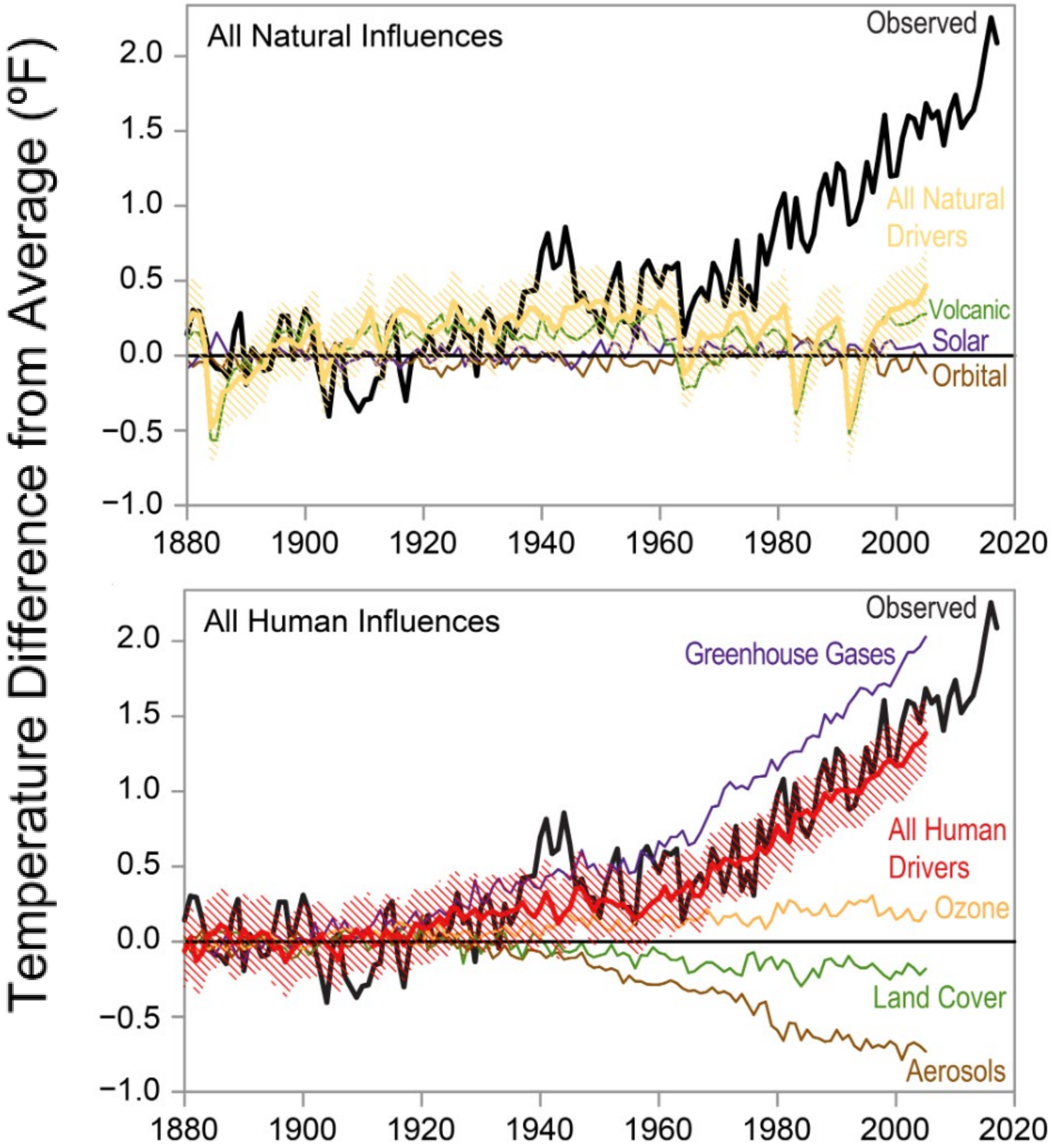
Climate change is real and its already a thing!

Changes ***already*** observed in just two specific measures

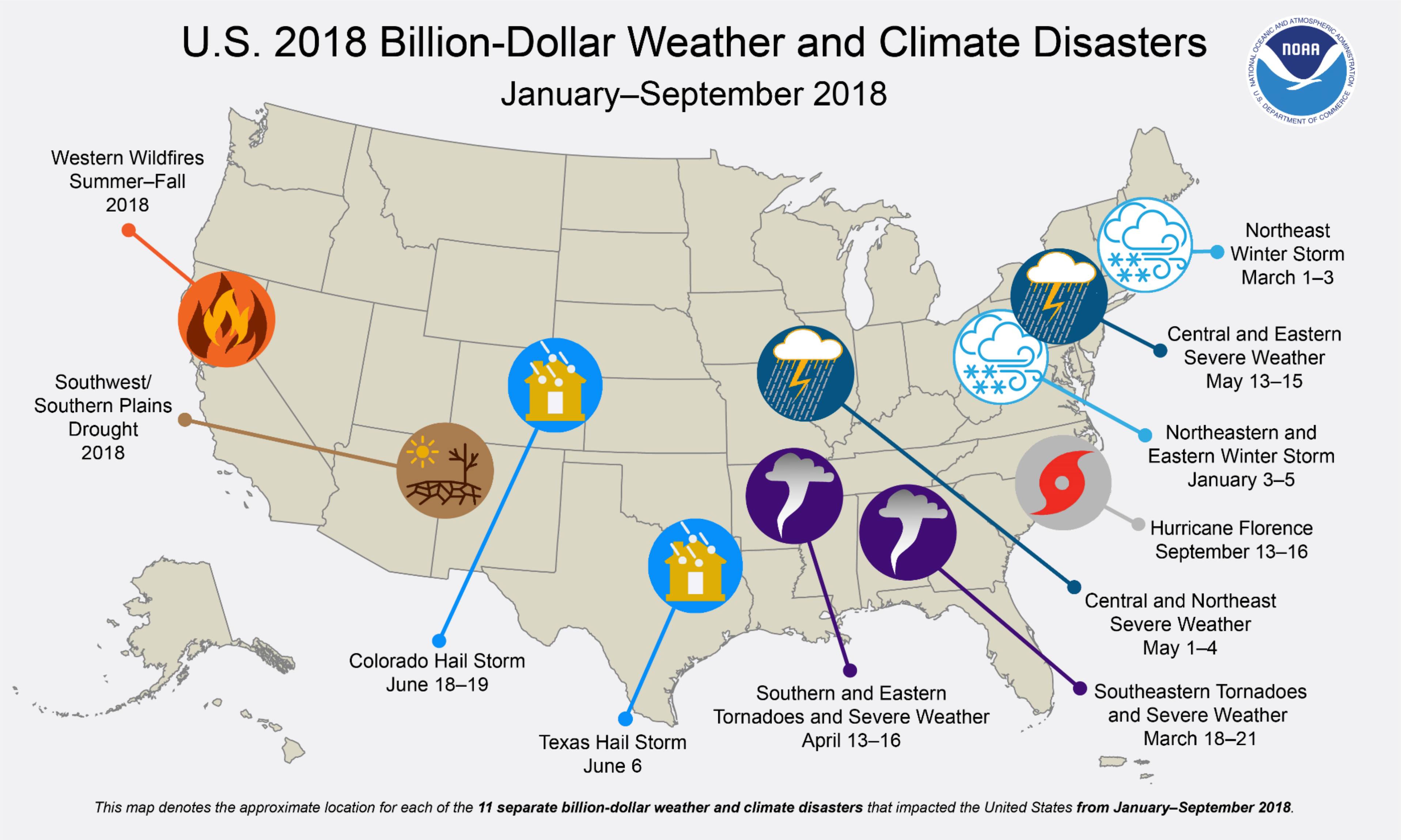




Humans are causing it!



It will cost a lot of money!



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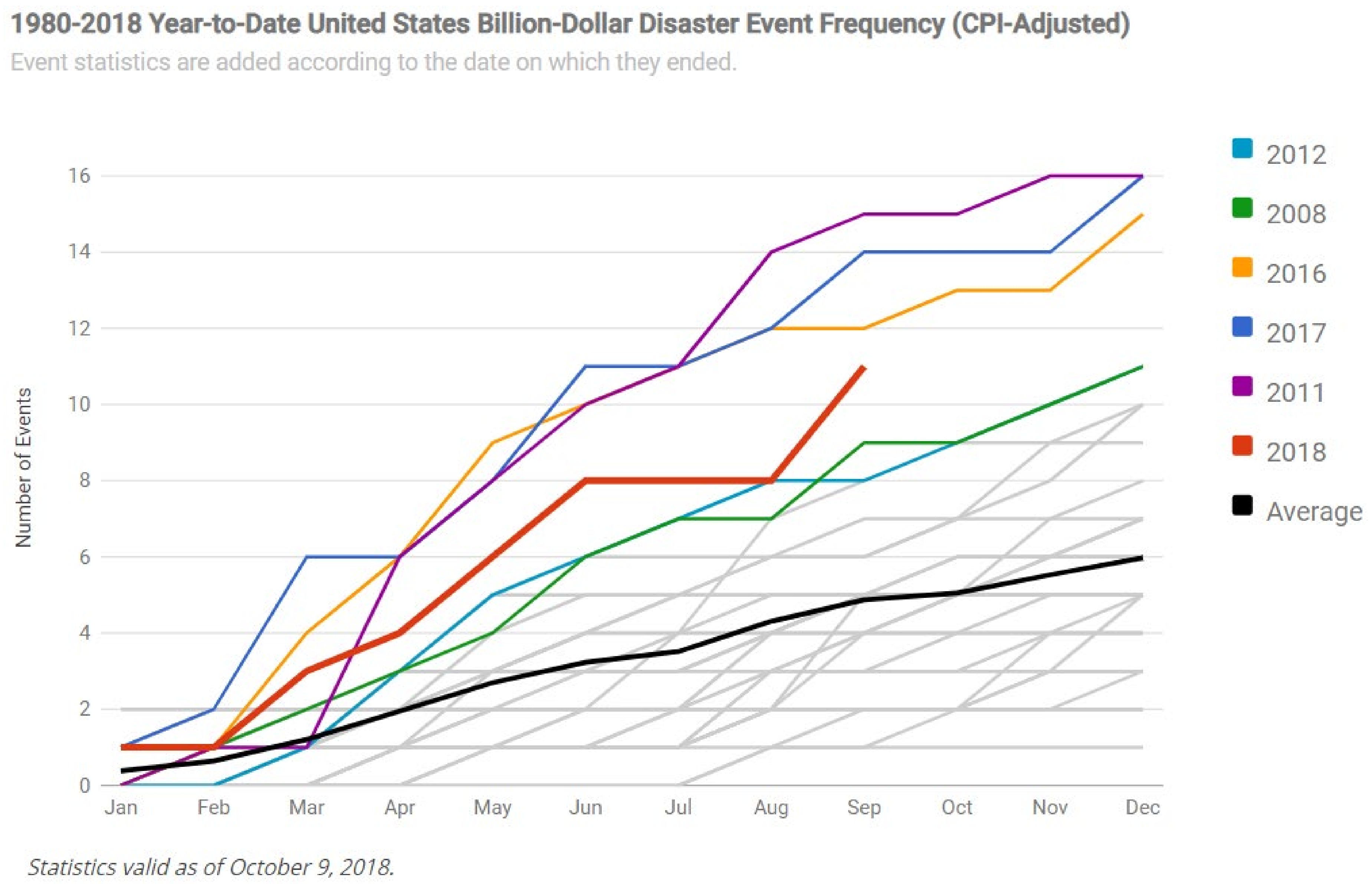
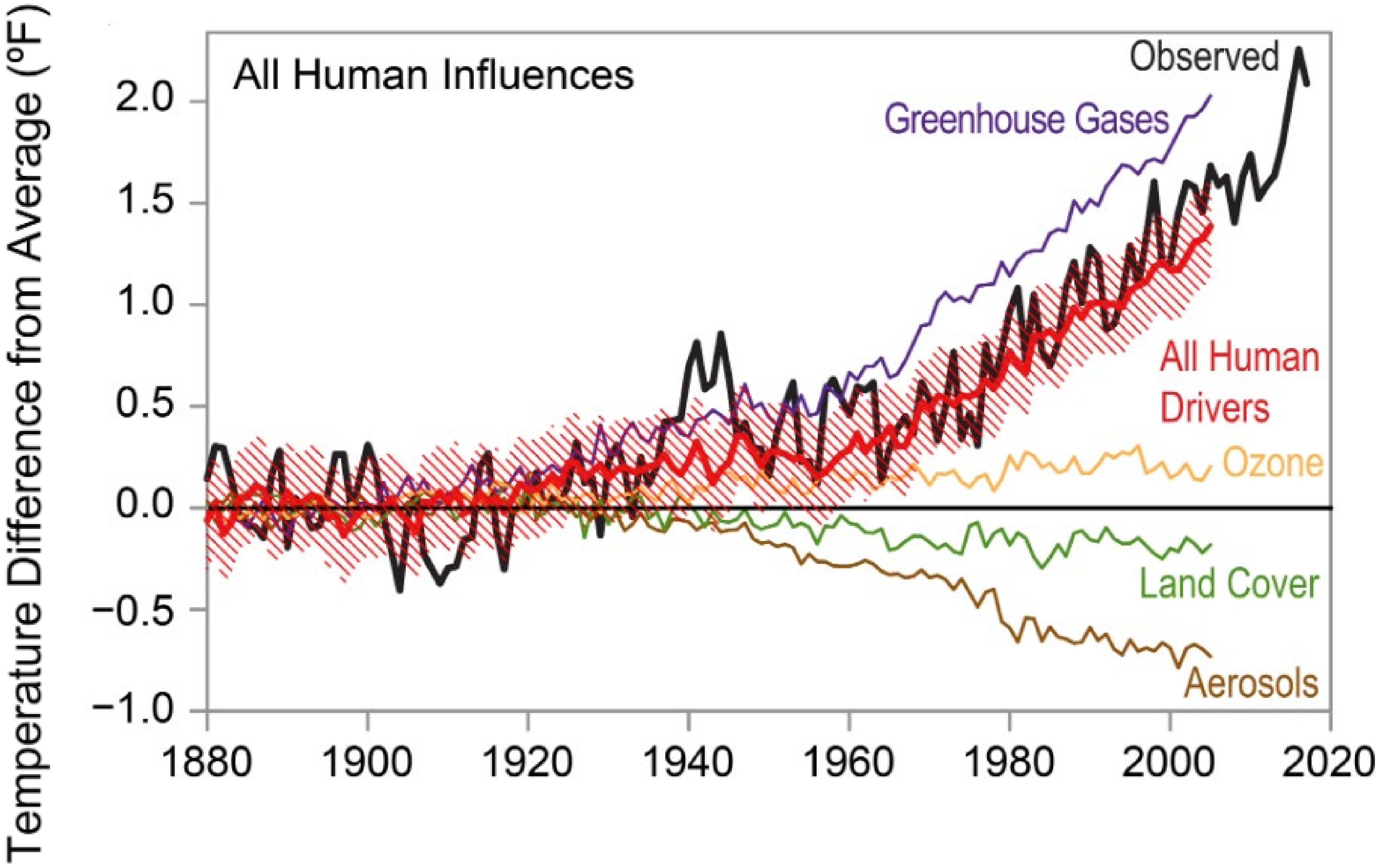
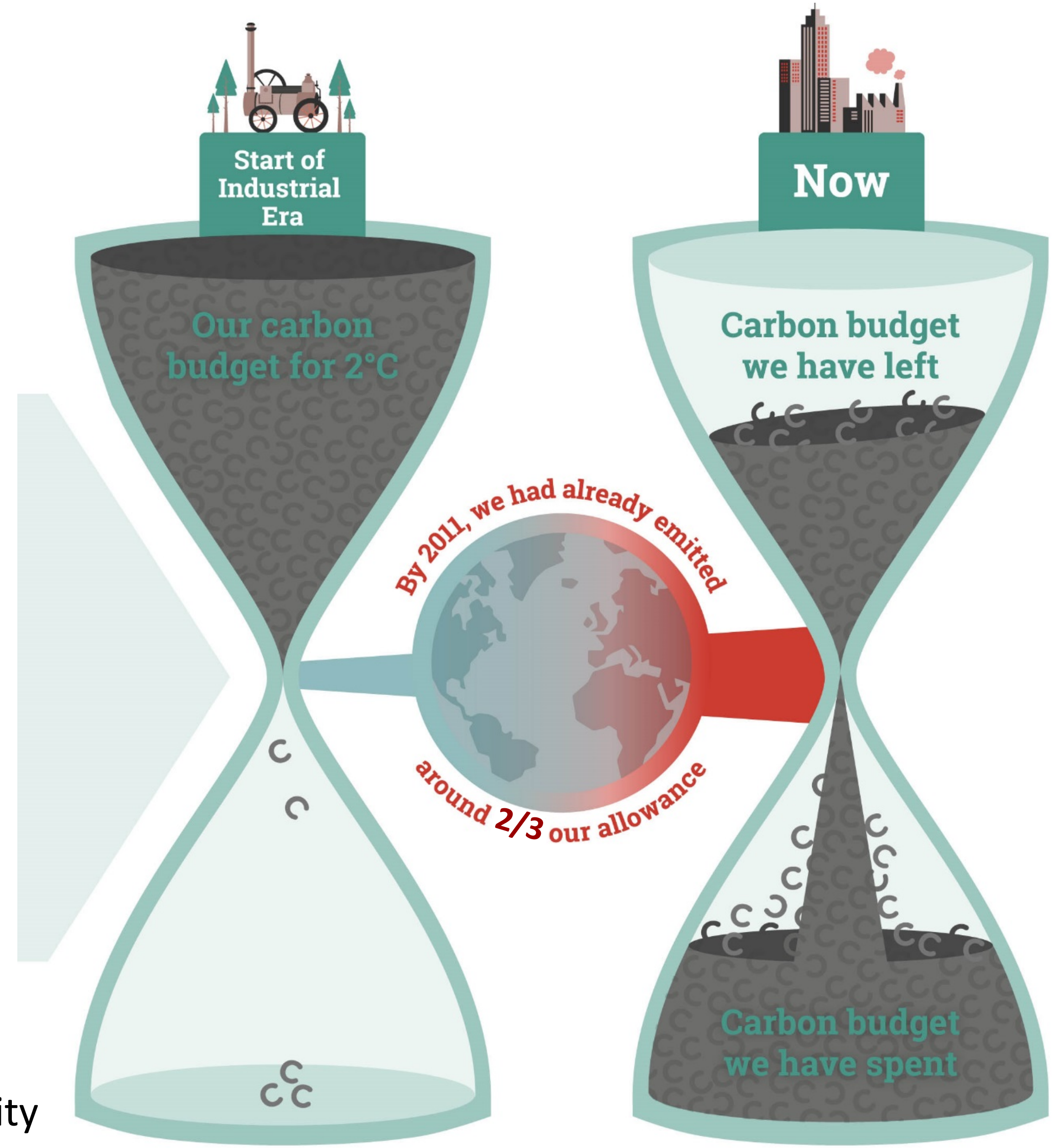


Recognize the fuss about carbon, but don't forget everything else!

It’s the carbon folks

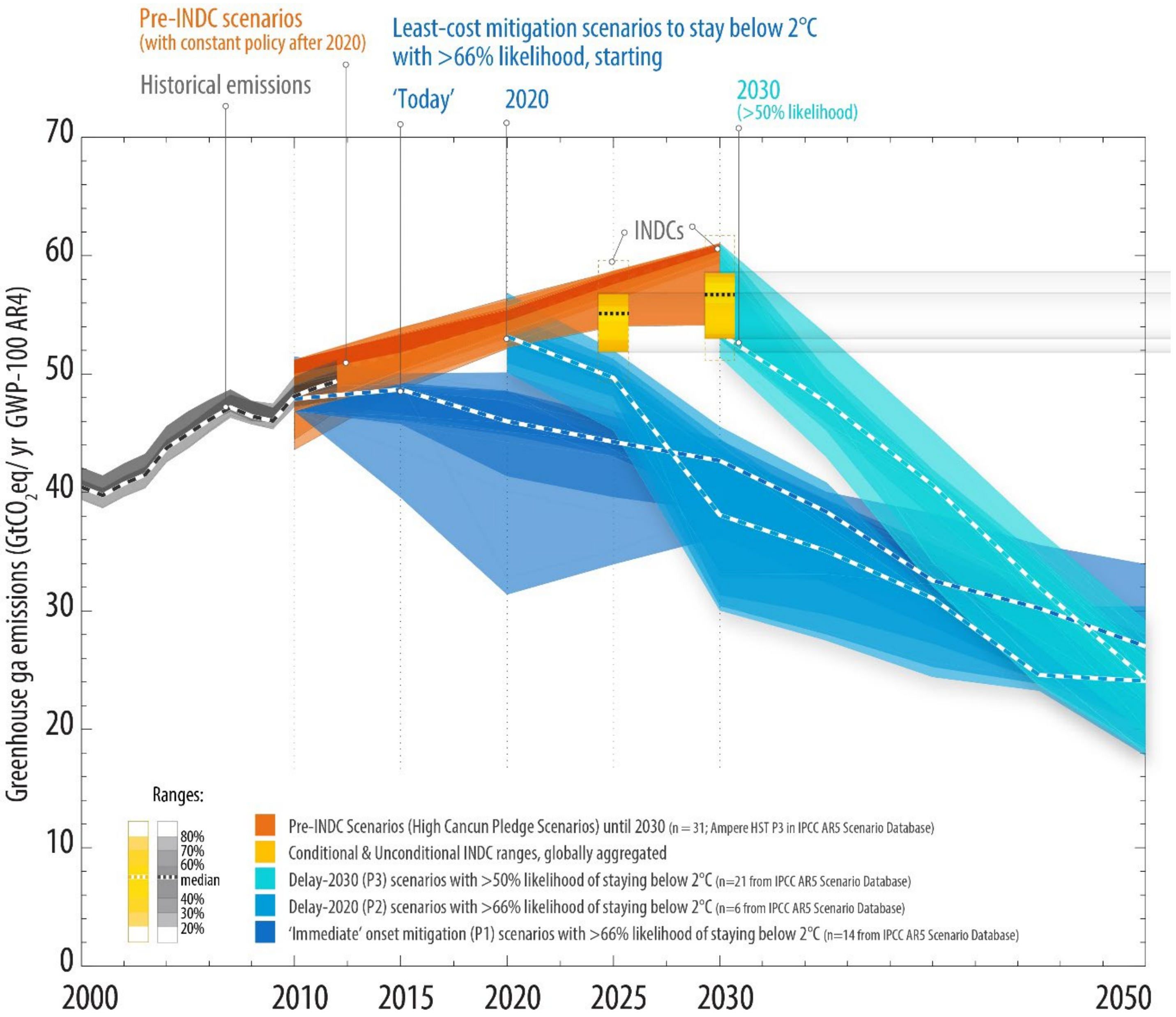


Carbon Budget

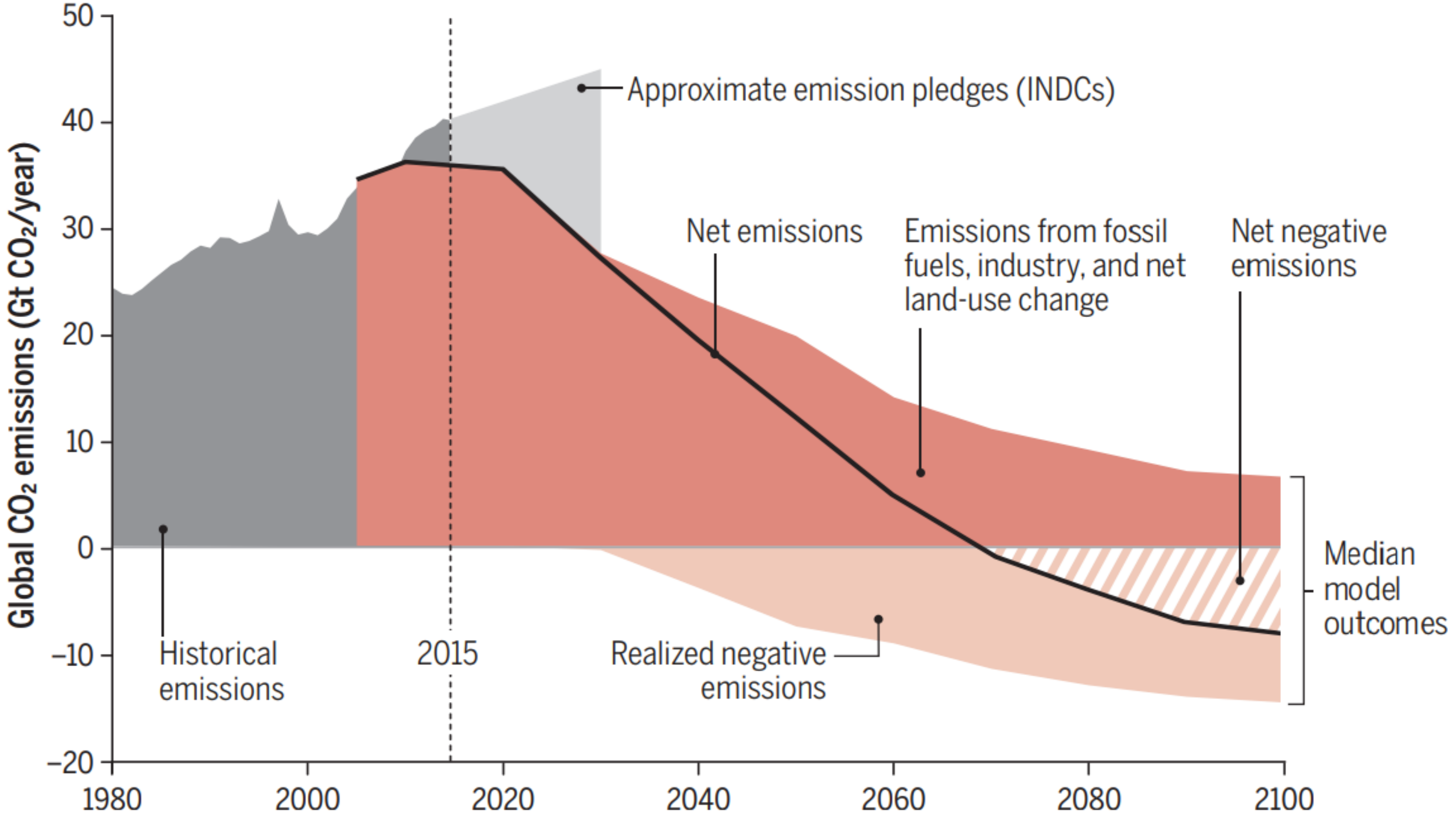


K.Mach
Stanford University

Emissions reductions are targets – are projections

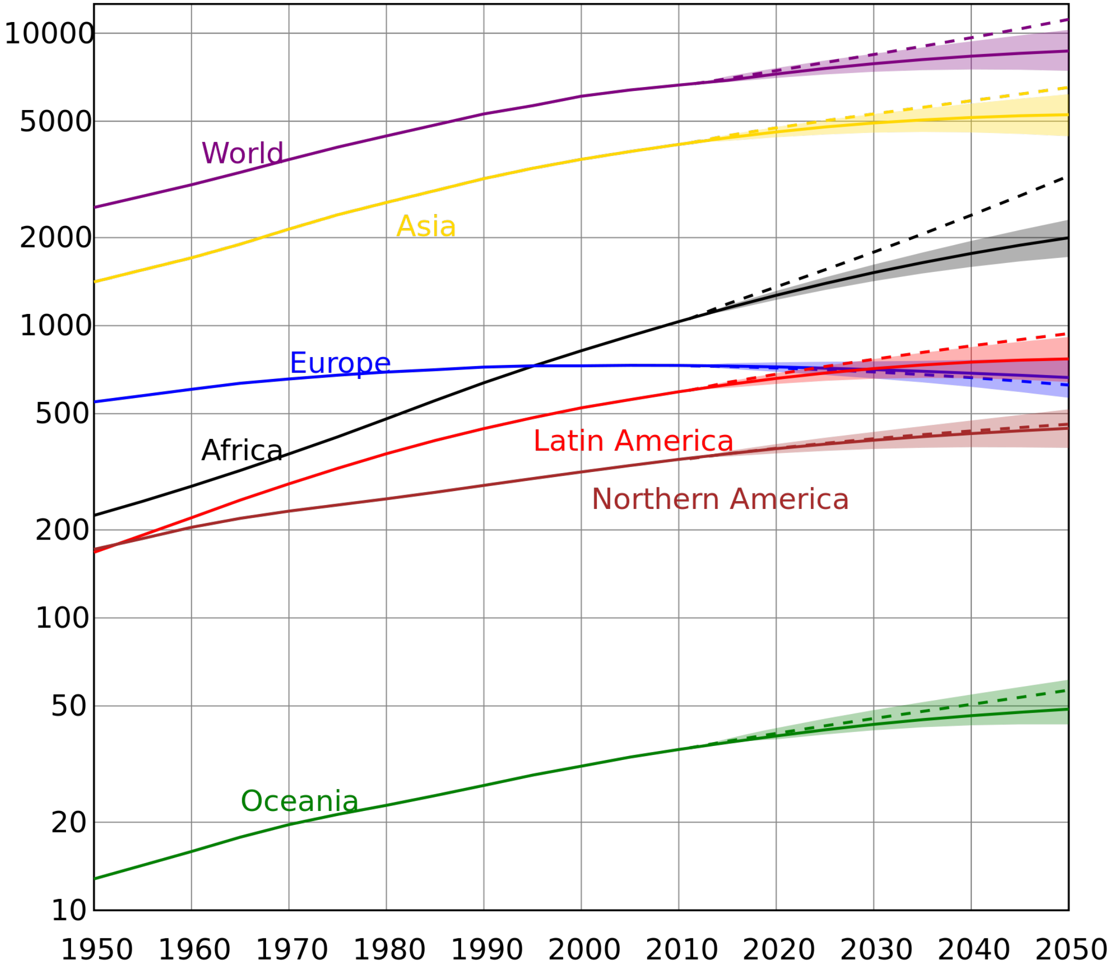


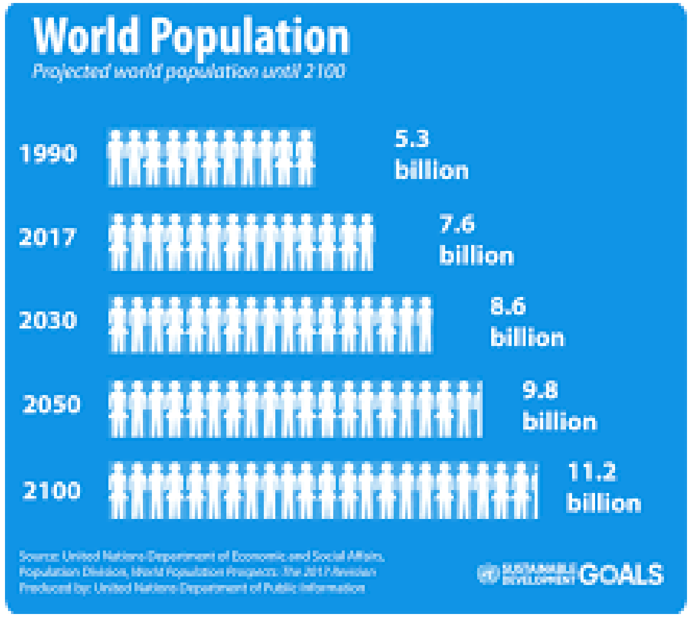
Commitments have a large reliance on negative emissions



It's not enough to just cut emissions – even to zero.
Carbon removal on a huge scale will be needed too.

Population growth





Global population to 9.7 billion by 2050

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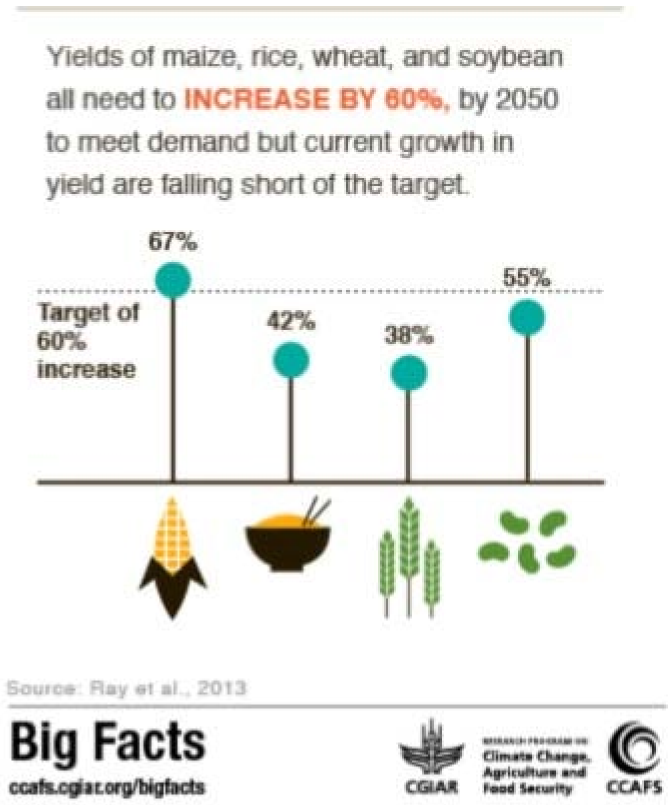
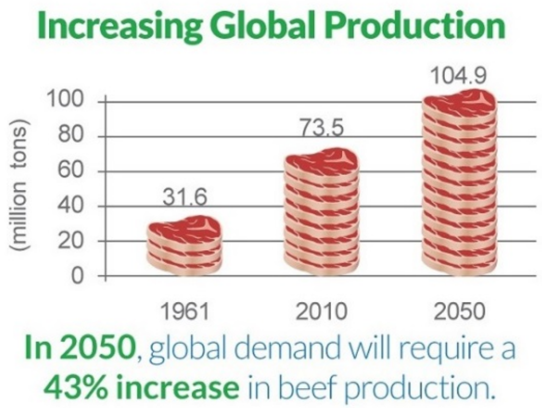
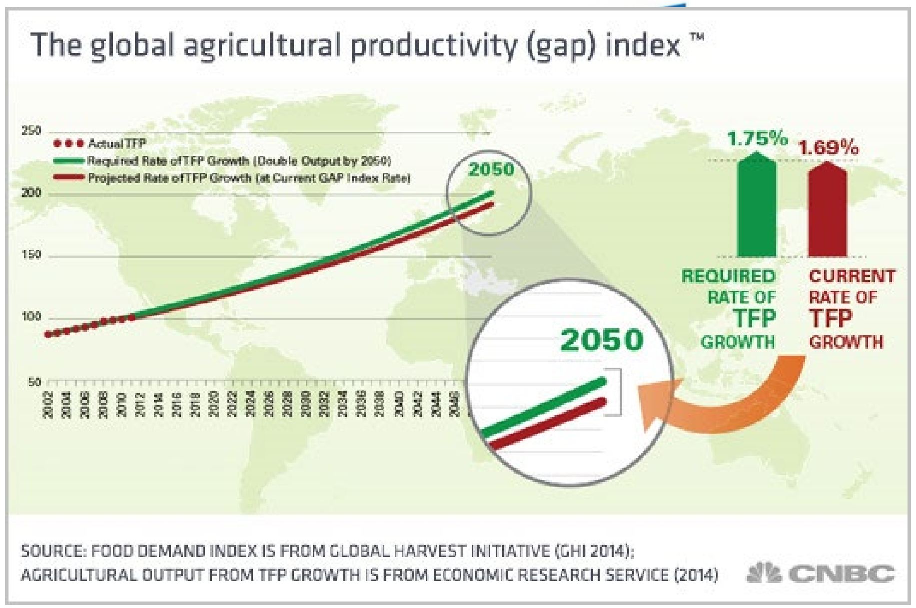
A more affluent population







With increased population and affluence comes increased food demands

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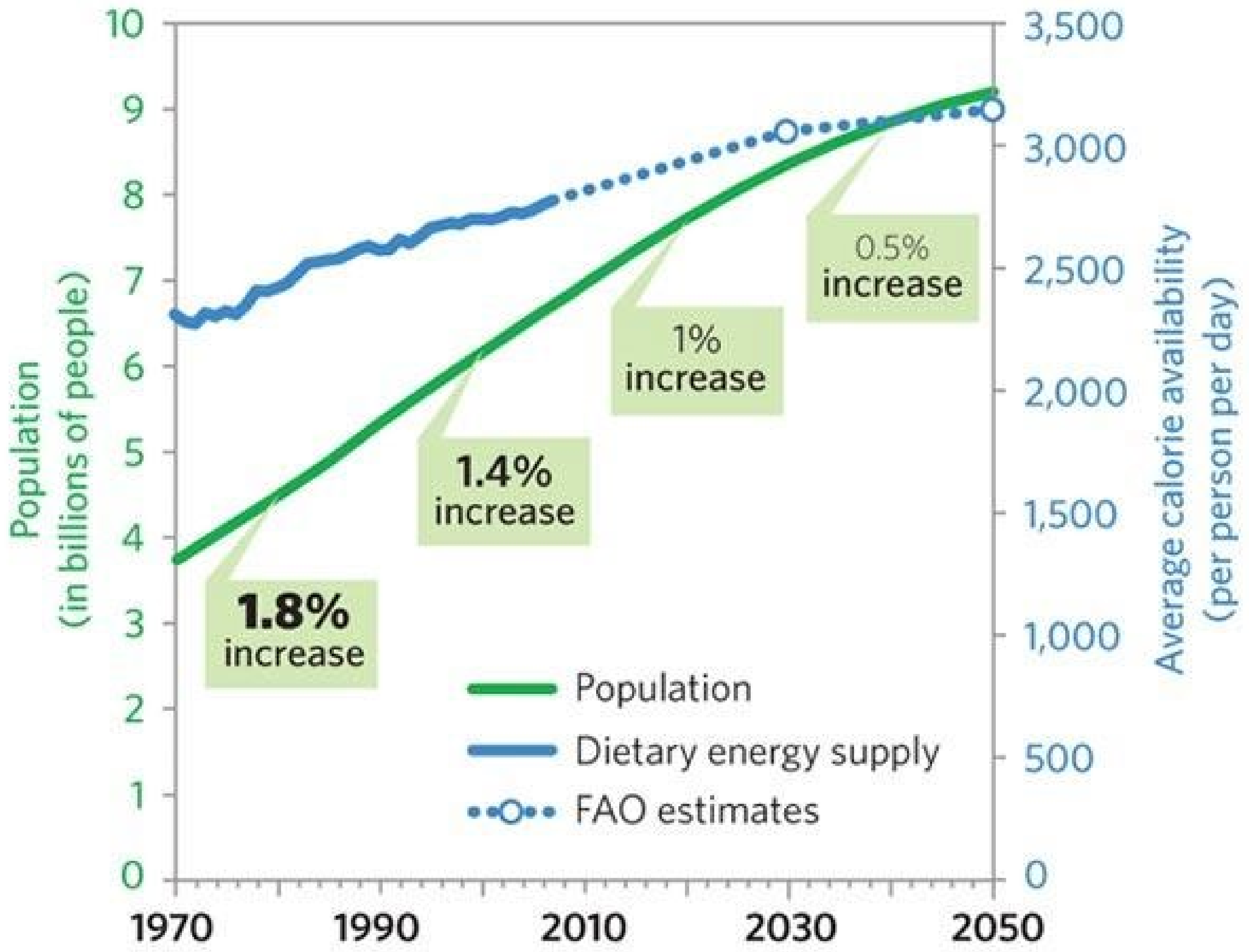
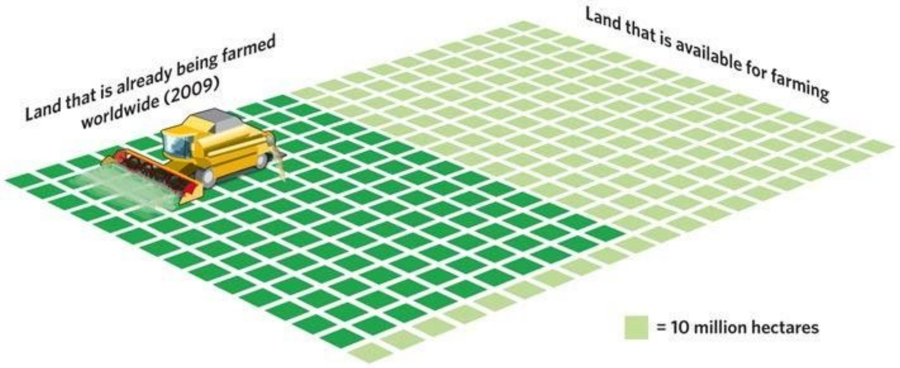
Threats to food security



Land and resource limitations

- An estimated 10^9 ha of new land will be required to feed global population in 2050
- This is an area 20% larger than Brazil



- An FAO outlook says that current cropland could be more than doubled by adding 1.6 billion hectares
- Consensus advises against substantial increases that could tax natural resources and harm ecosystems.

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The Bioeconomy
a.k.a
The New Carbon Economy

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The Carbon Based Economy

A carbon based economy is an opportunity. Engineering systems to use renewable carbon consistently and efficiently can enable an economy that functions as a tool to manage carbon on an industrial scale.

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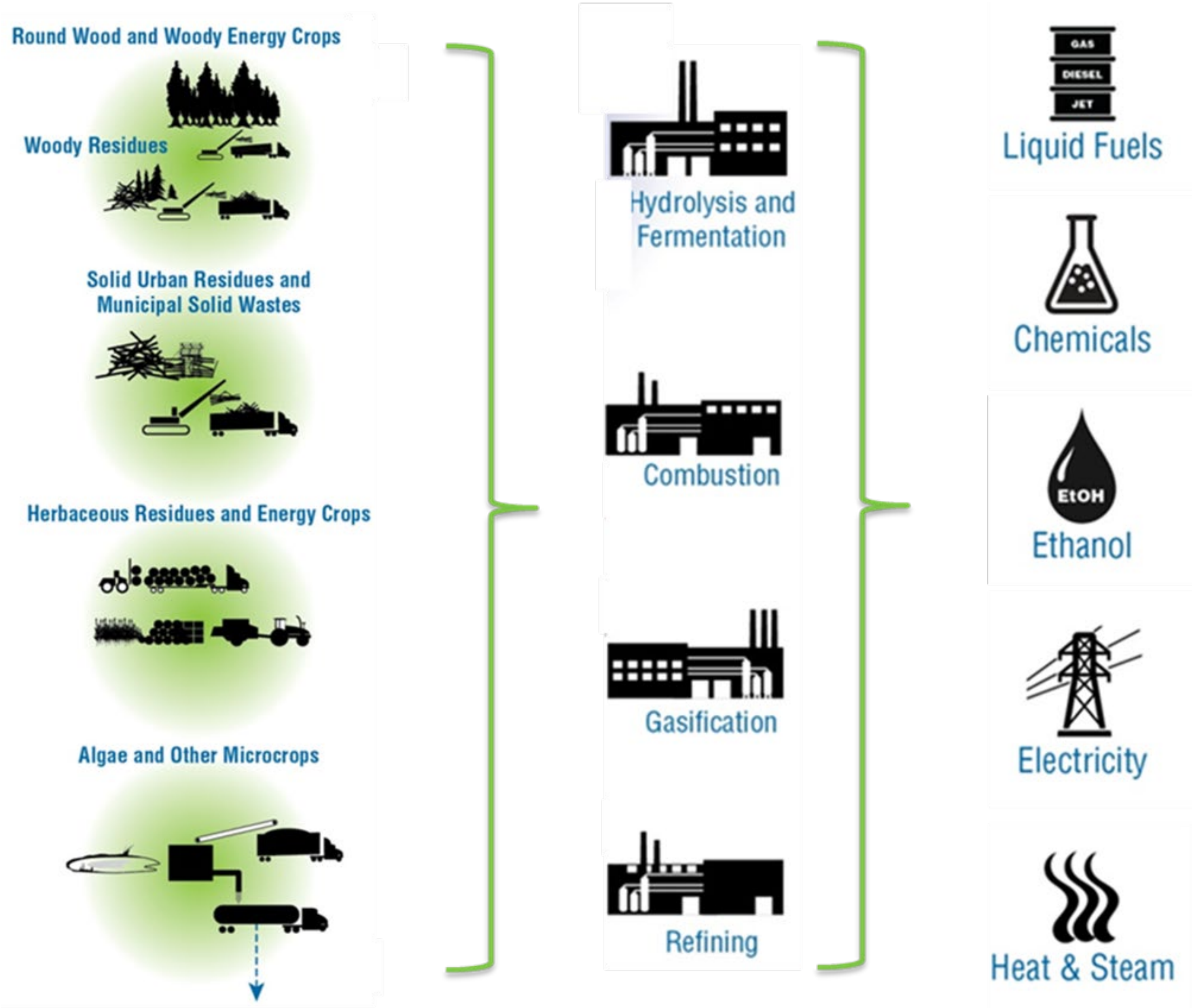
The Bioeconomy Concept



- Revenue and economic growth
- Broad spectrum of new jobs
- Rural development
- Advanced technologies and manufacturing
- Reduced emissions and Environmental Sustainability
- Export potential of technology and products
- Positive societal changes
- Investments and new infrastructure

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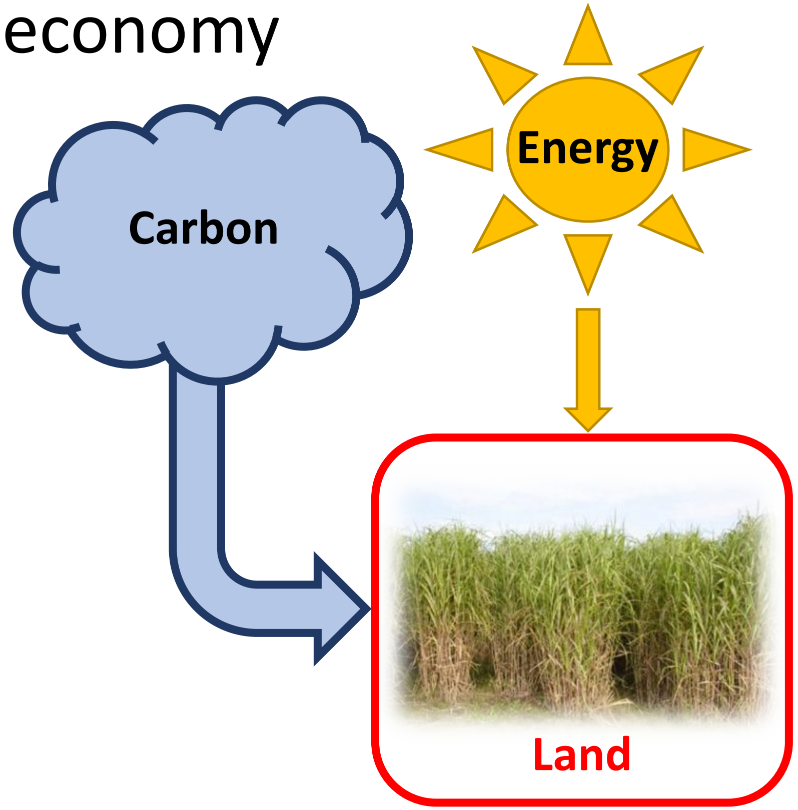
Bioeconomy and Land Intersections

(Growing) demands on the land

Land *could be* a limiting factor in a new carbon economy



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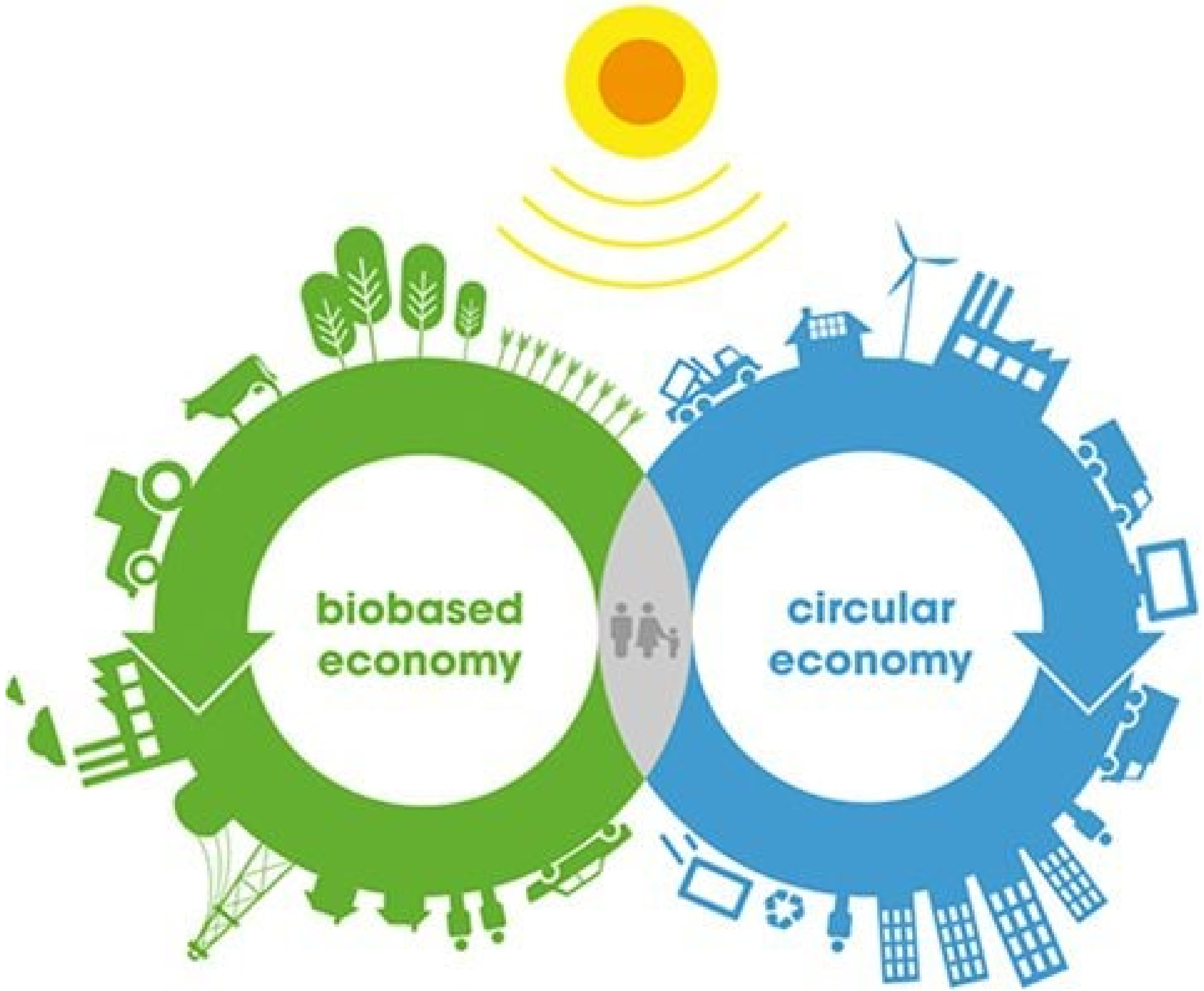
Do more and make more with less land



Almonds and the Advanced Bioeconomy

Along with the almond

Additional resources in the almond industry

<u>Gross biomass in the Central Valley</u>

(1000 BDT)	Almond	
	Shell	Orchard Removals & Prunings
Sac Valley	100	84
San Joaquin V.	528	351
Total	628	435*

Data courtesy of Jeff Welch, *Aemetis Feedstock Study*

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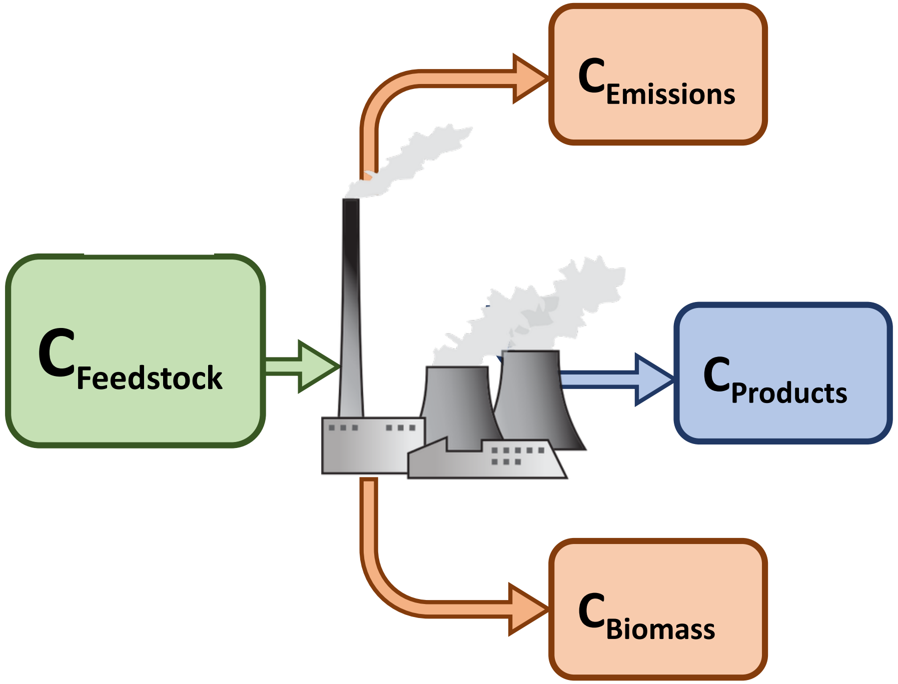
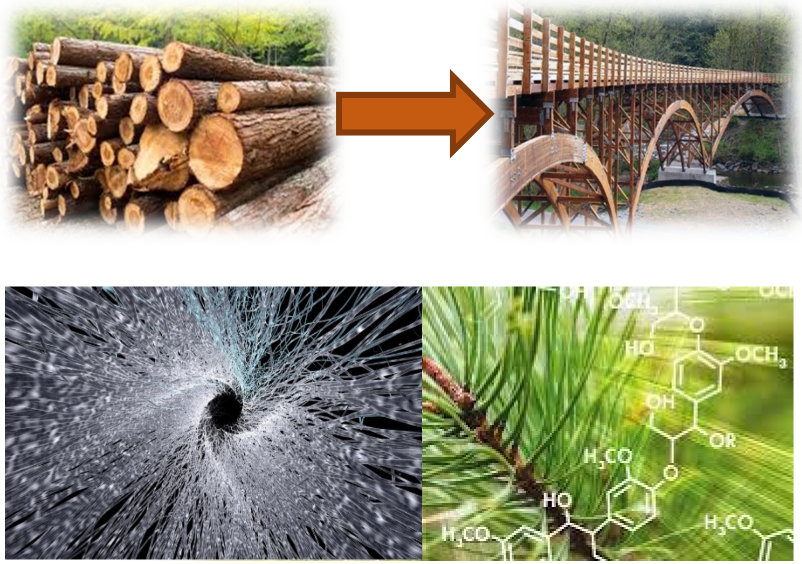
Carbon Efficiency vs. Biomass Efficiency

Carbon Efficiency



V.

Biomass Efficiency



- Carbon efficiency considers the carbon flux through the system.

Optimizing systems for carbon will require leveraging biomass properties in product functionality – biomass efficiency

- Biomass efficiency considers also inherent chemical and structural components of the biomass feedstock that confer an efficient utility for the feedstock.

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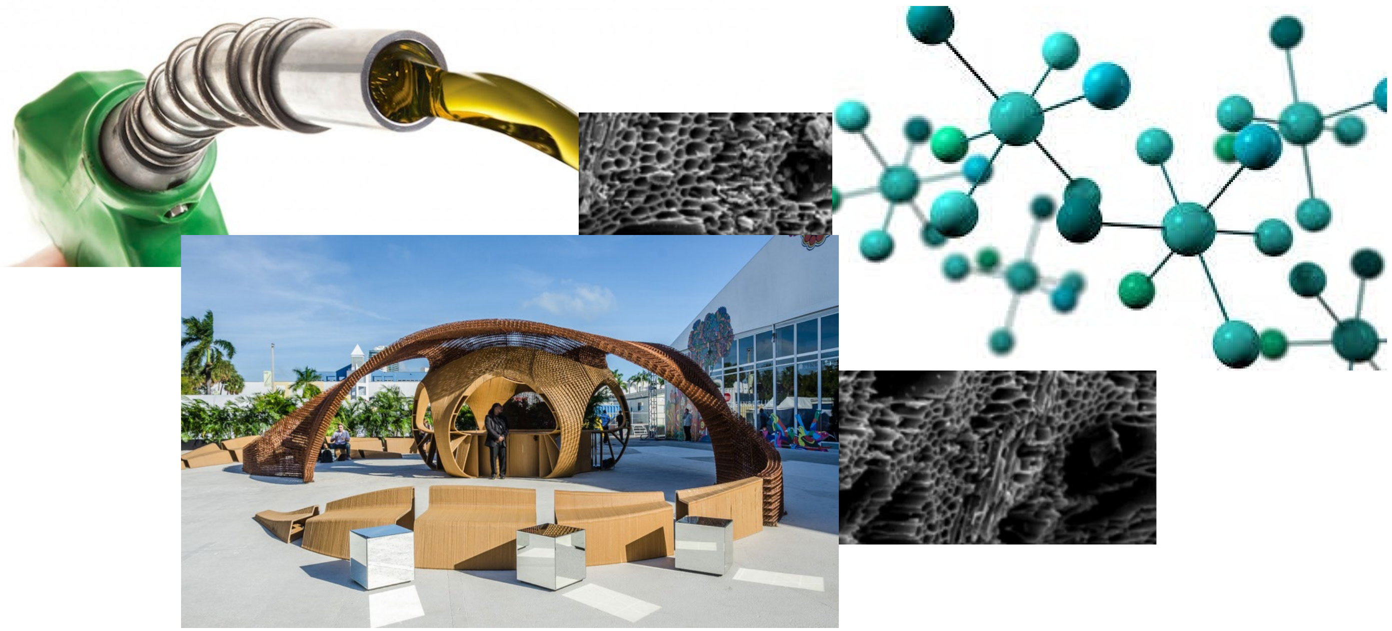
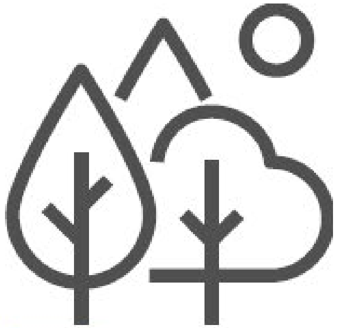
Additional resources in the almond industry





- These resources may not be technically “wasted” now, but efficiency matters and there are differences between down-cycling, recycling, and upcycling.

Aemetis Cellulosic Ethanol Approach

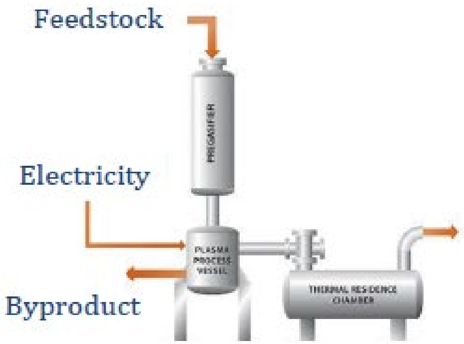


1

Feedstock

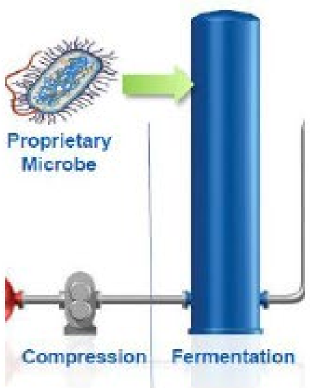
Biomass

- Orchard/Vineyard Wood Waste
- Orchard Byproducts
- Forest Wastes



2

Thermal Transformation



3

LanzaTech Fermentation

4

Ethanol Plant Integration

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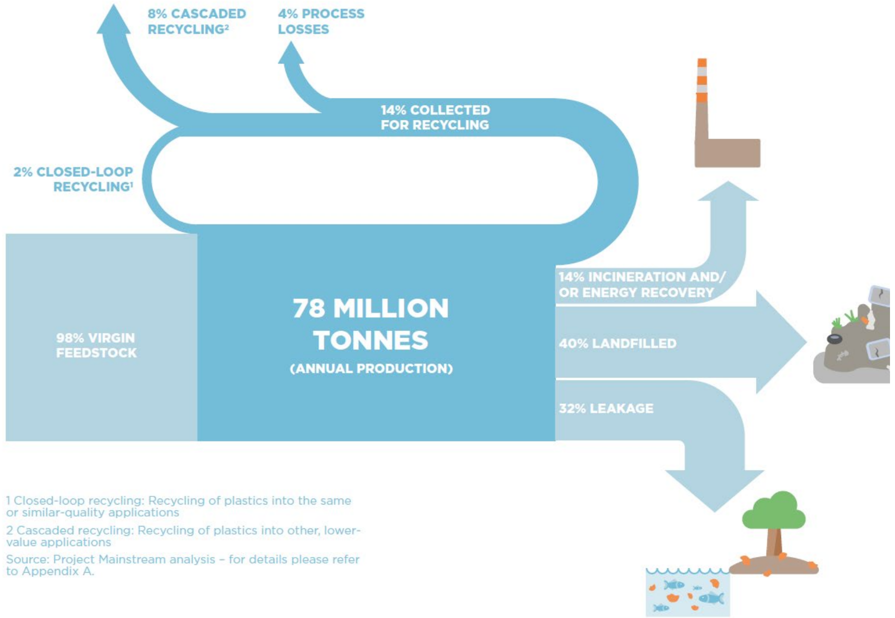
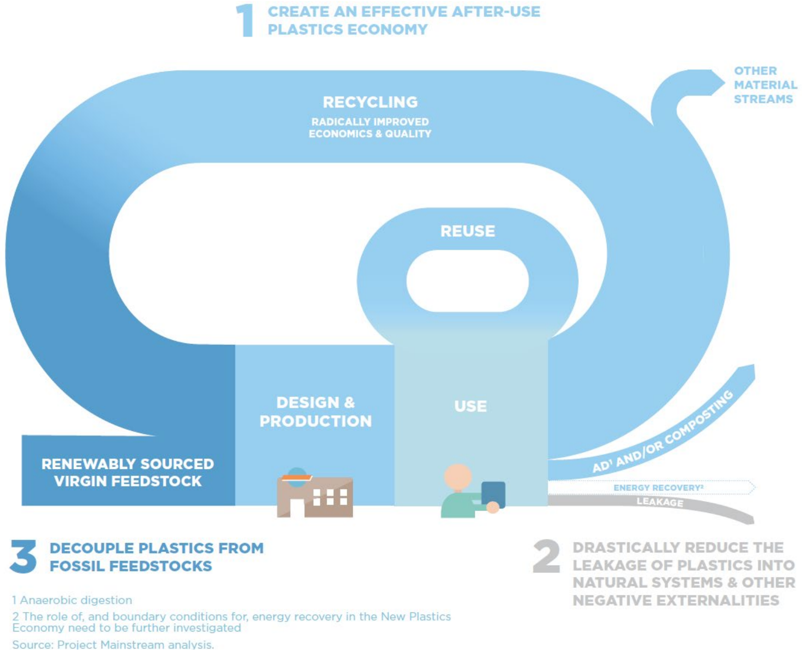
Designing plastics for the circular economy

Plastics are a hallmark of modern life and consumer use of plastics is projected to grow over the coming decades. According to the Ellen MacArthur Foundation, the projected growth in consumption would result in oceans that contain more plastics than fish (by weight) by 2050. Currently, only about 2% of plastics are recycled into the same or similar-quality applications. Modern plastics need to be designed with end-use, particularly their recyclability, in mind. Participants in this session will discuss challenges in designing plastics for a circular carbon economy.

LINEAR → CIRCULAR



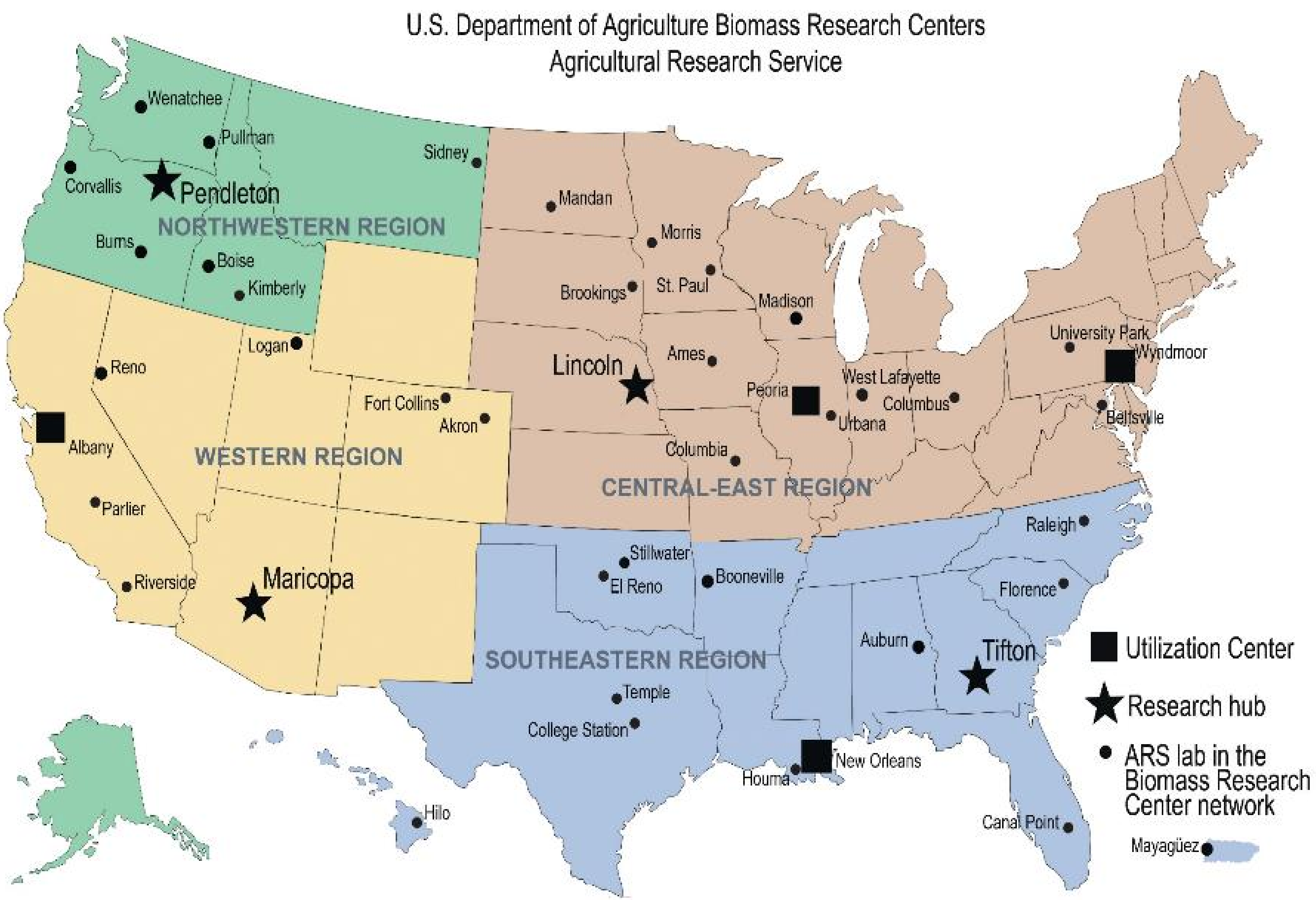


USDA Bioeconomy Research Focus Areas

Feedstocks

Conversion

Products and Markets


U.S. Department of Agriculture Biomass Research Centers
Agricultural Research Service
NORTHWESTERN REGION
WESTERN REGION
CENTRAL-EAST REGION
SOUTHEASTERN REGION
Wenatchee
Pullman
Sidney
Corvallis
Pendleton
Burns
Boise
Kimberly
Logan
Reno
Albany
Fort Collins
Akron
Parlier
Riverside
Maricopa
Hilo
Mandan
Morris
St. Paul
Brookings
Madison
Lincoln
Ames
Peoria
Urbana
West Lafayette
Columbus
University Park
Wyndmoor
Beltsville
Columbia
Raleigh
Stillwater
El Reno
Booneville
Florence
Auburn
Tifton
Temple
College Station
Houma
New Orleans
Canal Point
Mayagüez
Utilization Center
Research hub
ARS lab in the Biomass Research Center network

Biomass Conversion Centers

Conversion Technologies

- Hydrolysis
- Enzymatic (catalytic and non catalytic)
- Metal catalysis
- Pyrolysis and torrefication
- Microbial (bacterial, fungi and yeast)
- Anaerobic digestion

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Conversion: Microbial Platforms

New yeast strains:

1. with 90% ethanol conversion efficiency reduced costs by $0.35/gallon
2. that converts coffee waste into ethanol
3. that converts xylose into ethanol
4. Yarrowia strain with 3X more lipid production

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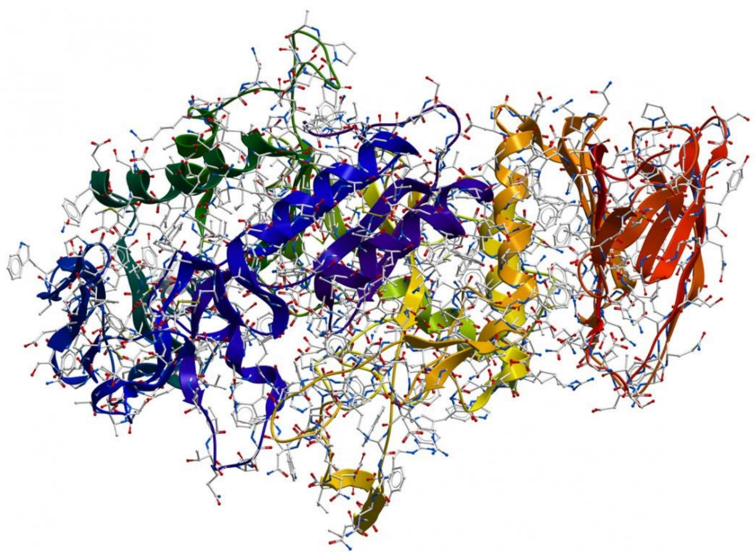
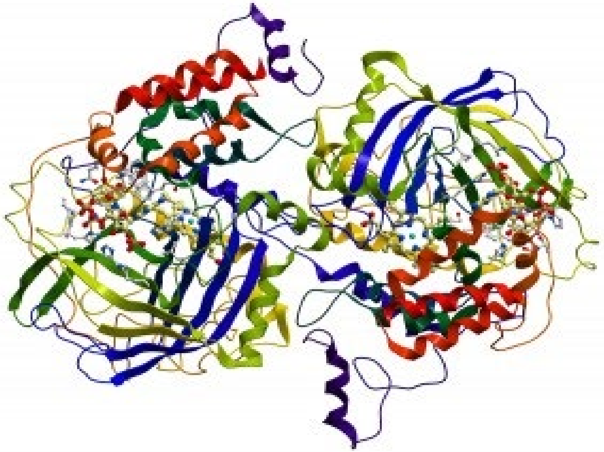
Conversion: Microbial Platforms

New enzyme technologies:

1. Antibacterial lytic enzymes reduce lactic acid bacteria 1000X increase ethanol yield 10X

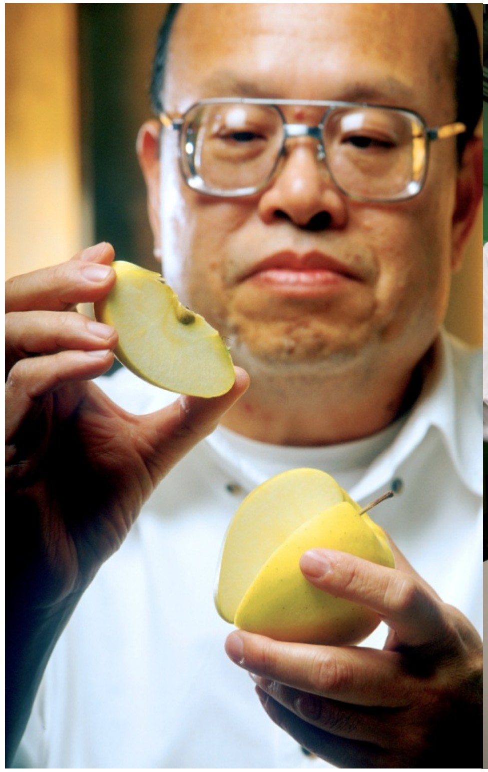


2. ‘Enzyme-ladder’ linking multiple enzymes improves biofuel production by 70X



New products and advances

Partnering with the USDA to create bioproducts that meet market needs.

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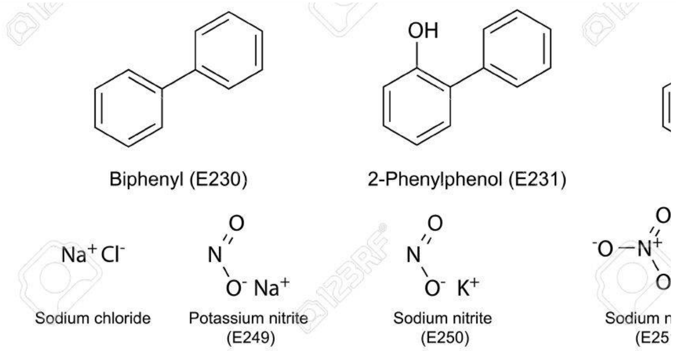
Engineering better products



Relevant policies and trends in the bioeconomy

Renewable and low carbon fuels

- Fuels are a HUGE market and are tricky to "decarbonize"
  - It's why they dominate the focus in the bioeconomy
  - It's why they have unique policies and environmental credit values

Process	Almond Wood
Transport	1.45
Avoided Burning (CH_4, N_2O, CO, VOC)	-16.29
Avoided Burning (CO_2)	-29.85
Feedstock Production	-44.70
Gasification & LanzaTech Process	0.62
O_2 Plant	-
Utilities	4.95
Biogas Co-product credit	-3.33
Co-product credit (Fish feed)	-7.57
Ethanol Production	-5.32
Denaturant	5.38
Tank-to-Wheel	1.93
Total CI, g/MJ	-42.70

Data courtesy of Jeff Welch, *Aemetis*

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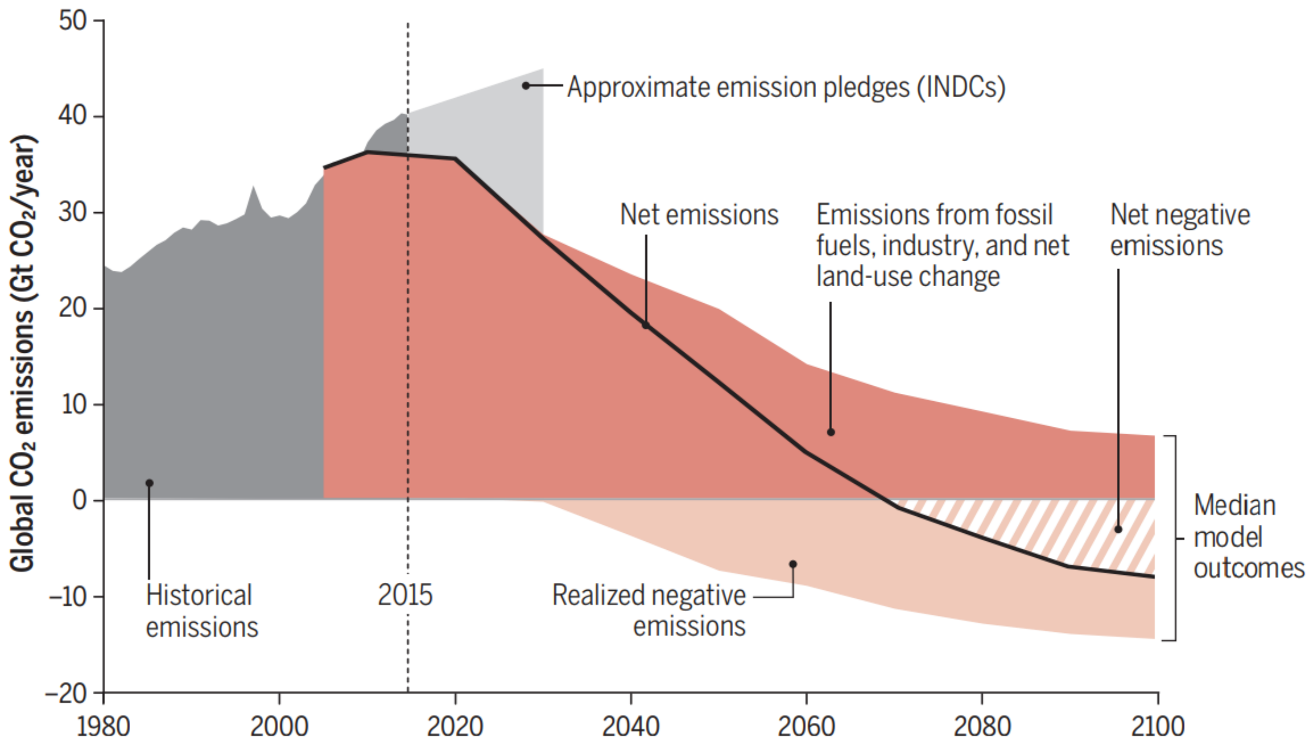
Carbon management

- Carbon management is a potentially VERY HUGE market
  - It's why I focus on it
  - It's why there is a lot of new policies being developed to establish unique environmental credit values



This implies that the future value propositions for "carbon management" will be real and increasing.

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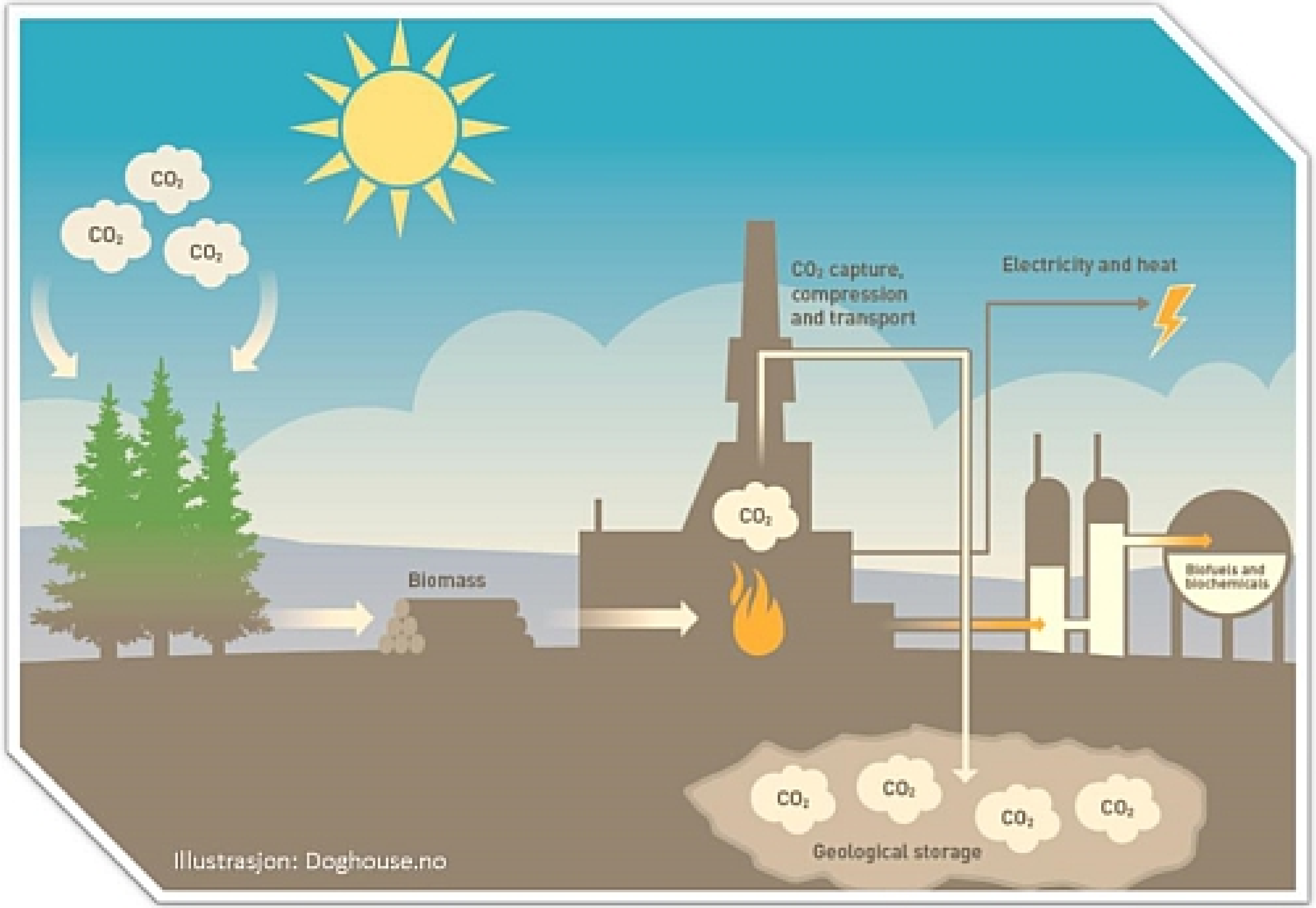
Can you spot the difference?

Can you spot the difference?

Bioenergy carbon capture and storage (BECCS)



BECCS

Carbon storage in products and materials

3D Printed biomass

Bio-based plastics

Carbon fiber

Biochar

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Summary

- Addressing climate change, natural resource limitations, energy and food security, and environmental risks, will present challenges, but offer opportunities.

- Realizing the vision for an advanced bioeconomy (or new carbon economy) will serve to minimize waste and maximize efficiency while creating new product supply chains, jobs, and markets.

- Opportunities for profiting from zero waste in the almond industry go beyond products and extend to ecosystem services and carbon management.

- Continued support for advanced biomass research should be supported to realize the new carbon economy.

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Thank you!

Contact me:

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U.S. Department of Agriculture

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SELECT HARVESTS

High quality natural products

Select Harvests Limited (“SHV”)

California Almond Conference

5 December 2018

Paul Thompson - Managing Director

Disclaimer & Basis of Preparation

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Certain statements contained in this presentation may constitute forward-looking statements or statements about future matters that are based upon information known and assumptions made as of the date of this presentation. These statements are subject to risks and uncertainties. Actual results may differ materially from any future results or performance expressed, predicted or implied by the statements contained in this presentation.

The Select Harvests Limited financial statements are prepared in accordance with Australian Accounting Standards, other authoritative pronouncements of the Australian Accounting Standards Board, Urgent Issues Group Interpretations and the Corporations Act 2001. This includes application of AASB 141 Agriculture in accounting for the current year almond crop, which is classified as a biological asset. In applying this standard to determine the value of the current year crop, the Company makes various assumptions at the balance date as the selling price of the crop can only be estimated and the actual crop yield will not be known until it is completely processed and sold. The resulting accounting estimates will, by definition, seldom equal the related actual results, and have a risk of causing a material adjustment to the carrying amounts of assets and liabilities within the next financial year.

Agenda

Select Harvests Overview

Project H2E – Hull to Energy

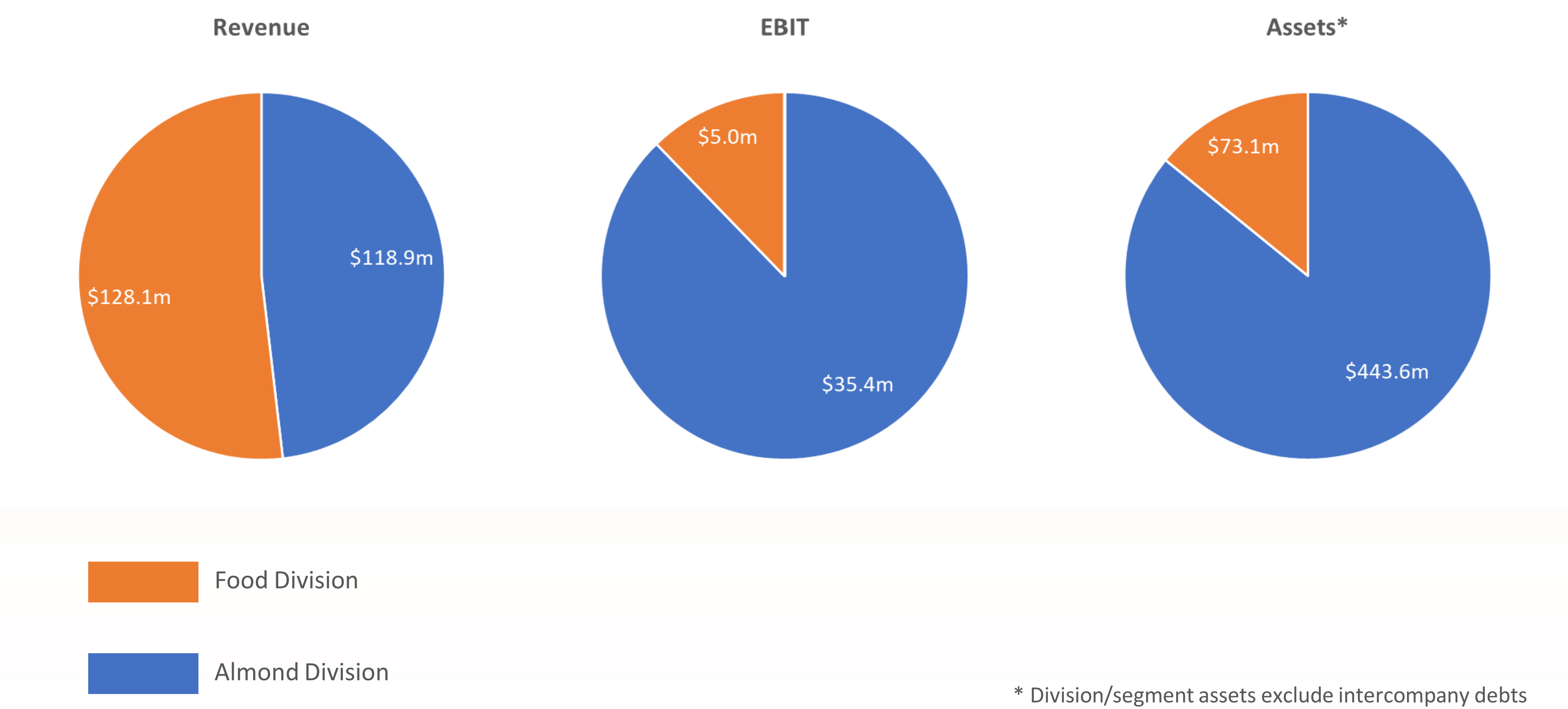
Composting Bio Ash

Select Harvests

- **Overview**
  - Listed on the ASX (SHV), with a Market Capitailisation of A$541m (9 November 2018) and 558 employees
  - Assets in the states of Victoria, New South Wales and South Australia
- **One of the largest almond growers globally**
  - 7,677 planted hectares of Australian almond orchards in Vic, SA and NSW
  - 36% of our planted orchards are currently immature, underpinning future growth
  - State-of-the-art almond processing facility at Carina West, North West Victoria. Capabilities include Hulling and Shelling, final stage value adding and stand alone Biomass plant.
- **Diversified 'better for you' branded plant food portfolio**
  - Market leading brands: Lucky, NuVitality, Sunsol, and Allinga Farms supplying wholesalers, manufacturers and retailers in both domestic and export markets
  - Value-added processing facility in the Northern Suburbs of Melbourne: snacking and cooking nuts, seeds, health mixes and muesli
- **Export focused business, with Asia the key target market**
  - Exclusive Lucky brand Trademark License & Distribution Agreement with PepsiCo Foods (China) Co. Ltd
  - Separate to the PepsiCo agreement, secured distribution for our Sunsol brand in Sam's Club China stores
  - Our Industrial Division seeing strong demand from Asian food processors, esp. the baking industry

We supply the world with a growing volume of high quality, plant based food products

FY 2018 Divisional Performance



* Division/segment assets exclude intercompany debts

An FY18 independent valuation of selected assets put their value approx. $100m above carrying value

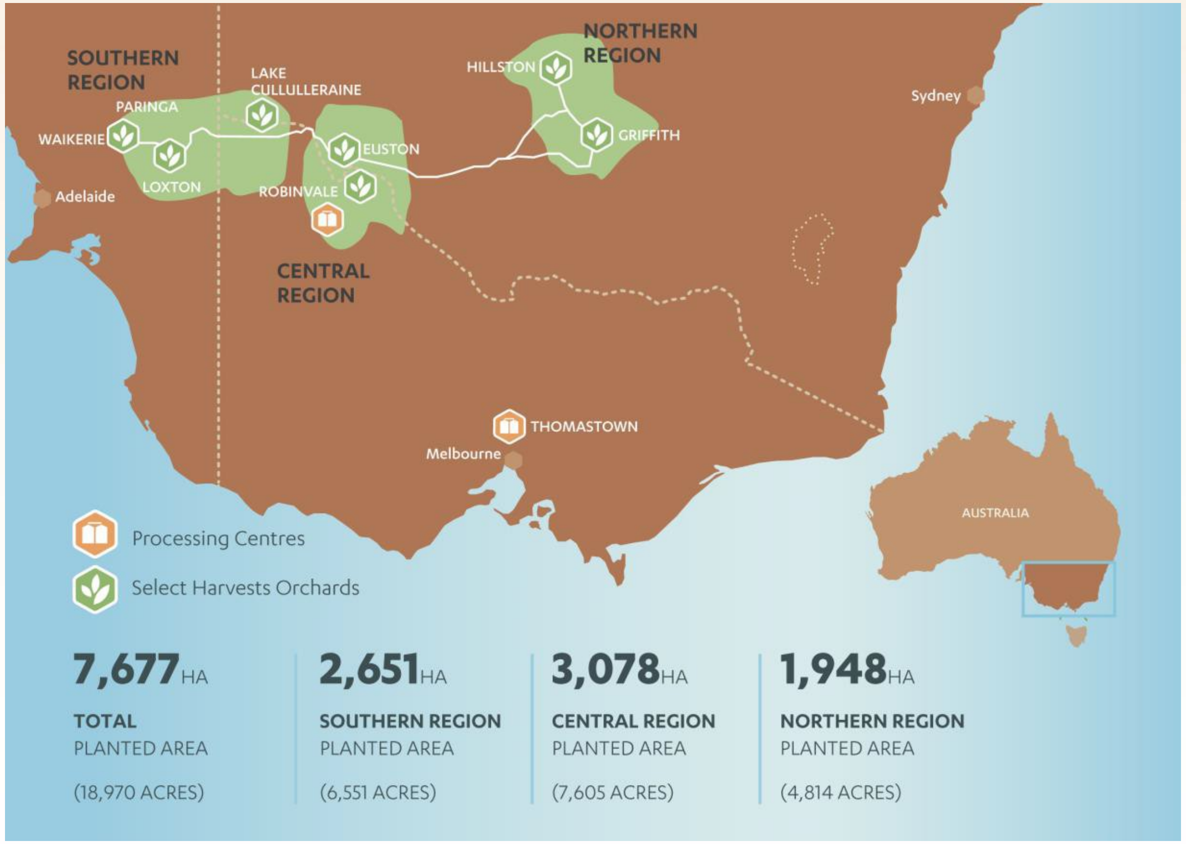
Almond Orchards – Our productive foundation

Geographic diversity limits exposure to:

- Weather
- Disease spread
- Insect infestation

Enables sequential progression of harvest period across regions:

- Better farm equipment utilisation
- Better processing utilisation
- Better labour utilisation



Secure access to diverse water sources:

- River Water
- Aquifers

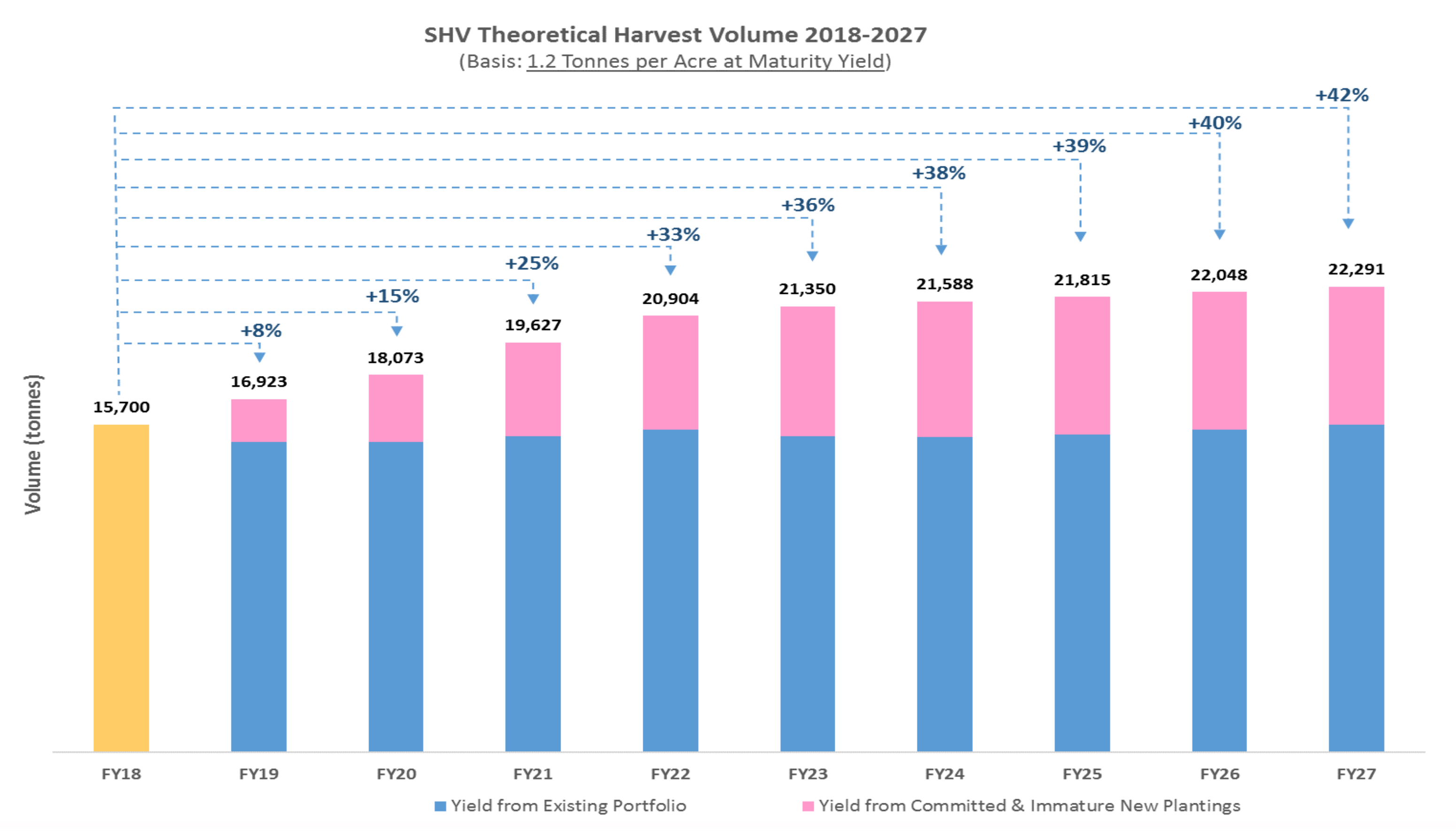
Positions the company to maximise harvest volume & reduce variance.

Building world class properties and a globally competitive low cost business.

Select Harvests has a global scale - planted almond orchard portfolio of 7,677 hectares

SELECT HARVESTS

Organic Volume Growth



Investment in almond orchards ensures underlying organic earnings growth

Agenda

Select Harvests Overview

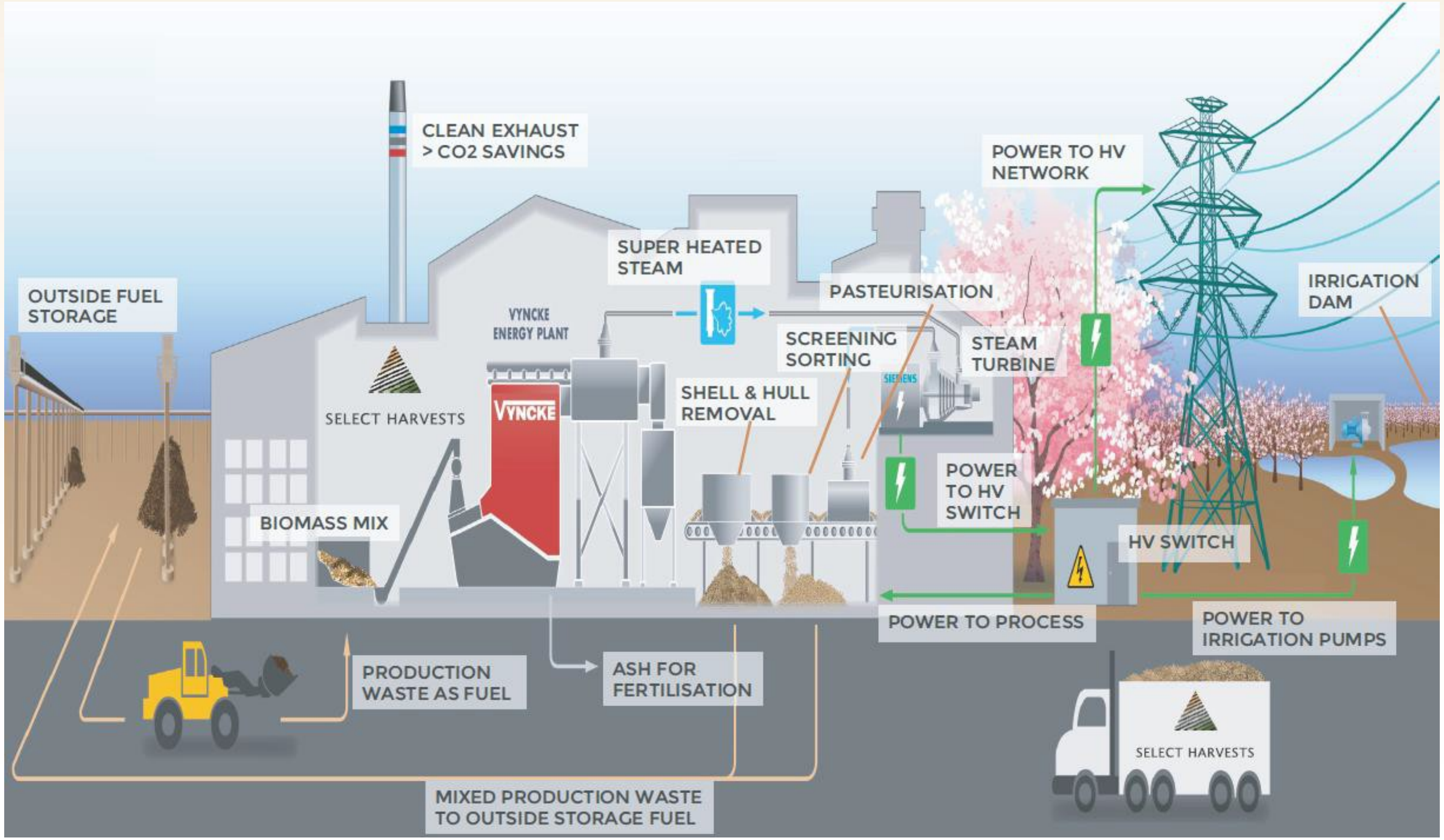
Project H2E – Hull to Energy

Composting Bio Ash

Project H2E – Hull to Energy

- Project H2E is a biomass boiler and steam turbine, fuelled by almond hull and shell and orchard waste and converting it to heat and power
- Project H2E is a world first with the utilisation of almond hull and shell as an energy source for generating electricity and steam directly to a manufacturing site
- H2E is providing power to our Carina West almond processing facility and exporting power to the grid
- As a result of the Project H2E, all farm waste produced from our harvest operations will be recycled
  - Organic matter and wood waste will be burnt through the H2E boiler to produce steam for power generation
  - Soil waste will be combined with the pot ash produced by the combustion process and will be used in the orchard as fertiliser
- Another initiative to reduce waste is the installation of a 50,000 litre worm farm will convert our almond waste into liquid fertiliser.
  - The bi-product from the worm farm will be used to support the facility gardens and grey water systems.
  - The worm farm has the theoretical capacity to consume the daily food waste of 1,400 people.

Project H2E – Hull to Energy



Benefits of H2E

Best long term economic use of our increasing hull and shell volume

- Almond hull and shell in Australia is fed largely to dairy cattle
- The long term hull price in Australia has averaged US$ 27/MT (ex. factory), with the nearest dairy stockfeed 4 hours away from our processing plant ($US 45/MT transport cost)
- The current Californian hull price is higher (US$ 36 to 45/MT) and transport costs lower (US$ 9 to 14/MT) than Australia
- Given the relatively low long term average price and transport costs to the nearest dairy, it is economical for SHV to use its increasing amount of hull and shell in our Biomass Boiler

Reduces our overall energy costs and allows us to avoid 'peak' energy pricing

- H2E allows us to better manage our energy needs and avoid peak prices
- Average energy costs (electricity and fuel) have been increasing in Australia. The average cost across our orchards and Carina West processing facility in Victoria is approximately US¢ 15.0/kWh vs. a US¢ 11.6/kWh retail cost for Northern California[1]
- Peak pricing can add another +10% to electricity costs on average
- We have budgeted to sell 20% of the energy produced by H2E to the grid

[1] US Energy Information Administration (EIA). Currency converted at 1.33 USD/AUD

The benefits of a biomass plant will depend on location, costs and prices (esp. hull and electricity)

Project H2E – Specifications & Operational Highlights

Specifications

- Vyncke 17MW thermal biomass boiler
- Siemens 3.1MWe SST-110 turbine
- Fuel feed system – moving floor type
- Emission control – multi cyclone
- Flue gas stack – 25m carbon steel

Operational Highlights

- Fuel source: almond hull & shell and field prunings
- Fuel consumed: 3.66T/hr – 30,000T/yr
- Power delivered direct to CW Processing Plant & Carina Dams
- Excess power delivered into local grid
- Operational Hours: 24hr x 7 days x 48 weeks
- Operators Employed: 13

Potash being composted and returned to our orchards

Agenda

Select Harvests Overview

Project H2E – Hull to Energy

Composting Bio Ash

SELECT HARVESTS

Composting of Bio Ash Project

- H2E will produce ~1,800 tonnes of potash p.a from 30,000 tonnes of hull and shell
- We current have a project is place that is turning this potash into potassium to be used on our orchards as part of a compost mix
- 34,000 tonnes of composted material will be applied to our orchards over a 12 month period, starting in winter 2019. Benefits include:
  - Better overall soil structure and health
  - Improved balance of nutrients in our fertilizer program
  - Cost neutral to our overall fertilizer program

Positive results from initial composting trail

Compost Row – Jan 2018

Non Compost Row – Jan 2018

Initial trail of composting in January 2018 showed very positive results for kernel size and weight

Video of Bio Ash Program

https://vimeo.com/303210589

Summary

- Select Harvests is the second largest almond farmer in Australia with 7,677 planted hectares
- Select Harvests aims to be an employer of choice and be recognised as one of Australia's most respected agri-food businesses
- We believe that safe and sustainable business practices are critical to gaining this recognition and for the long-term viability of the business
- One largest sustainability project is Project H2E – our biomass electricity co-generation plant which consumes almond by-products including hulls, shells and orchard waste
- Now operational, the Project will eventually generate enough electricity to power our Carina West Processing Facility as well as nearby pumps for the Carina farm orchard
- Benefits of the H2E project include: the best long term economic use of our increasing hull and shell volume; and a reduction in our overall energy costs
- The composting of Bio Ash produced by H2E has shown initial positive results and we intend to roll out the program across our orchards in 2019

WHAT IS BIOCHAR?

WHAT HAPPENS WHEN YOU ADD BIOCHAR TO SOIL?
CAN ALMOND GROWERS MAKE THEIR OWN BIOCHAR?

Kelpie Wilson
Wilson Biochar Associates

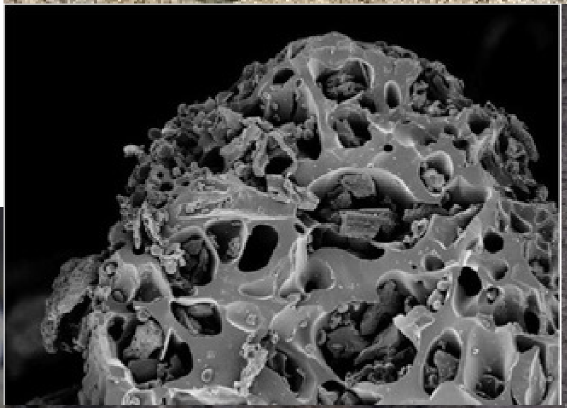
Outline

1. What is biochar?
2. How does it work in soil?
3. How can farmers make their own biochar?
    a) NRCS Biochar and Manure Conservation Innovation Grant
    b) Biochar Technology for On-Farm Biochar Production
4. Almond Biochar
5. Next Steps

1. WHAT IS BIOCHAR?

Biochar is charcoal that you can add to soil*



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**Biochar: A solid material obtained from thermochemical conversion of biomass in an oxygen-limited environment. (IBI, 2012)*

Terra Preta – human-created soils in the Amazon are 500 -6,000 years old.

Native rainforest soil – highly leached, acid

Terra Preta soil – rich and fertile

Charcoal retains nutrients that rain would otherwise leach from soil

Iowa soils – 50% of soil carbon is charcoal

- Iowa soils – some of the most fertile in the world
- Why? Natural biochar from prairie fires
- Helped by Native American burning practices
- Thick stems exclude oxygen, producing char, not ash

Multiple “Wins” of Biochar – for Almonds

Confirmed Biochar Benefits	Helpful to Almond Culture?
Adds long-lasting carbon to soil	Yes – biochar does not break down and can accumulate with annual applications, building soil carbon
Helps conserve water	Yes – increases soil water-holding capacity
Prevents nutrient leaching	Yes – holds on to nutrients and controls reactive nitrogen
Buffers soil pH	Yes – where soils are acid or neutral
Promotes soil microbial life	Yes – especially beneficial to legume cover crops and nitrogen-fixing bacteria
Promotes root growth and mycorrhizae	Yes – especially if used in nursery stock
Has disease suppressive effects	Yes – Can alleviate phytopthora and other soil fungal diseases & may alleviate orchard replant disease
Buffers soil salinity	Yes - biochar sorbs salts and prevents plant tissue desiccation
Sorbs pesticides	Yes – could help to protect bees and other pollinators

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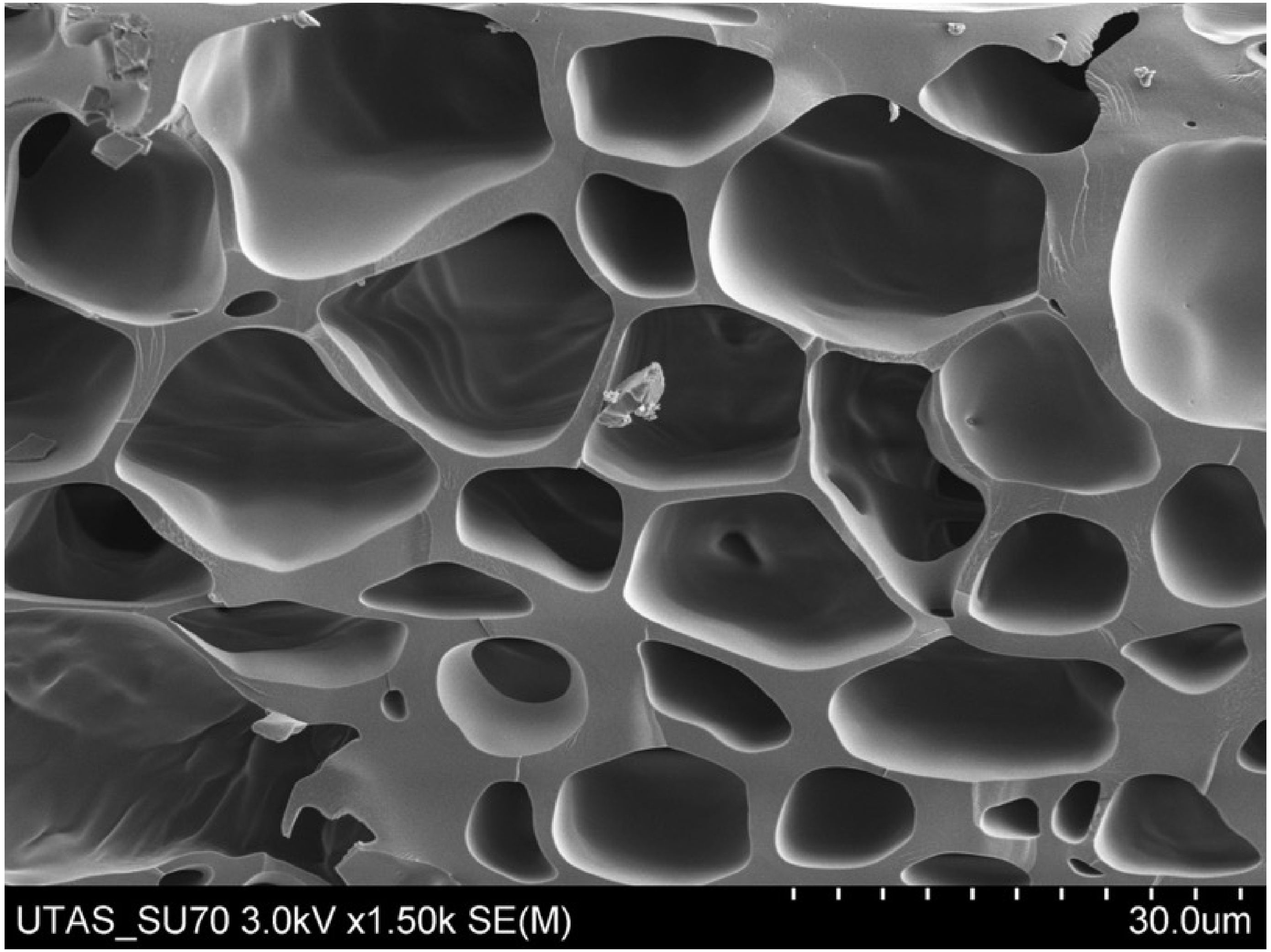
2. HOW DOES BIOCHAR WORK?



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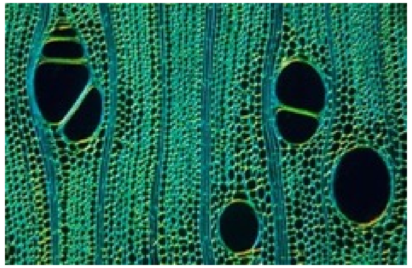
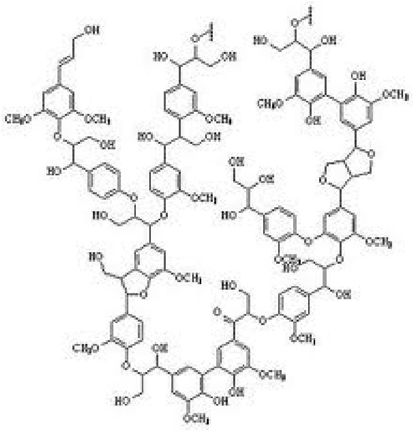
Biochar is formed by heat



Wood:
- Has cellular structure

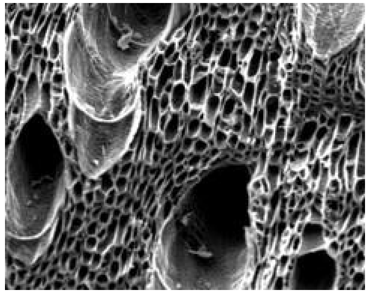


Lignin molecule:
- Has many carbon rings already

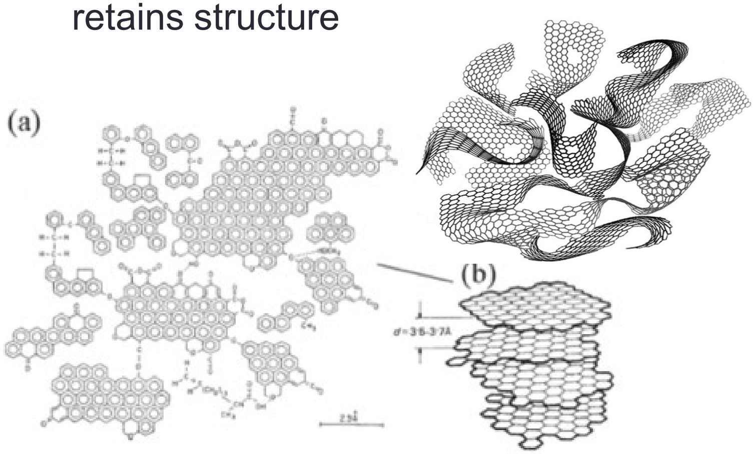
Cellular Micro-scale

HEAT

Molecular Nano-scale



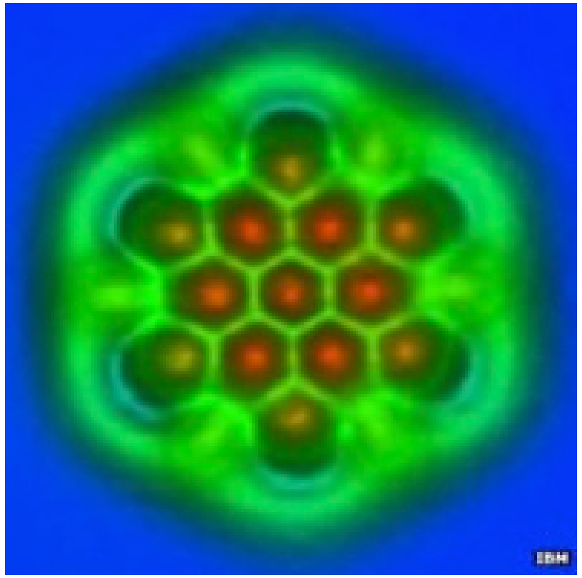
Biochar:
- Biomass shrinks but retains structure

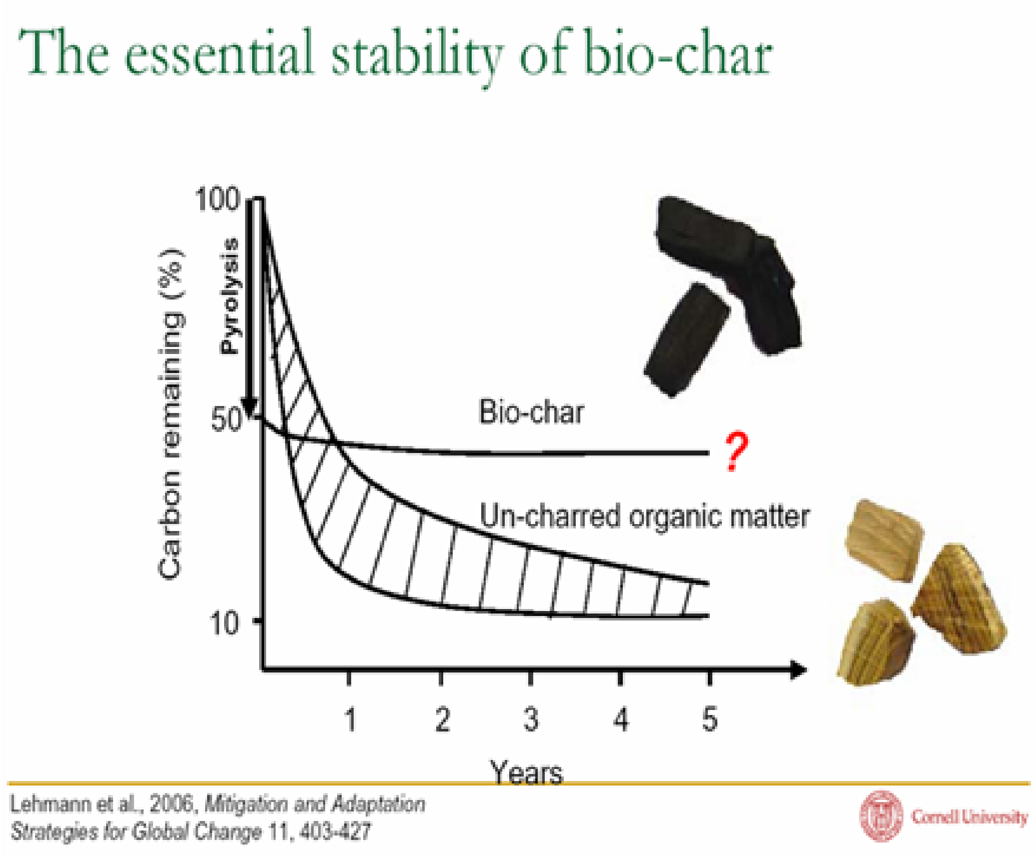


Biochar:
- Carbon rings fuse and condense

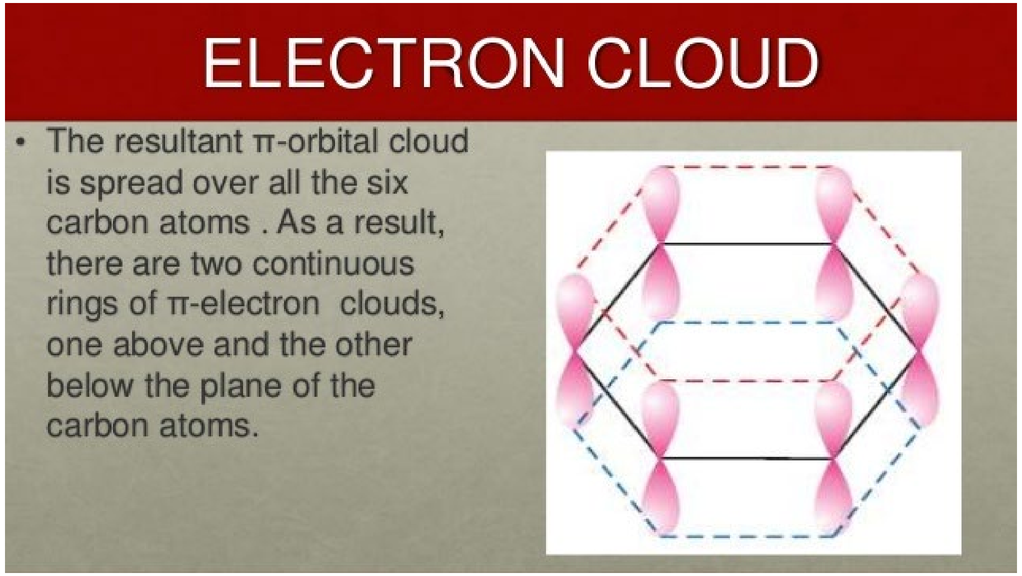
Result: porosity at multiple scales, high specific surface area

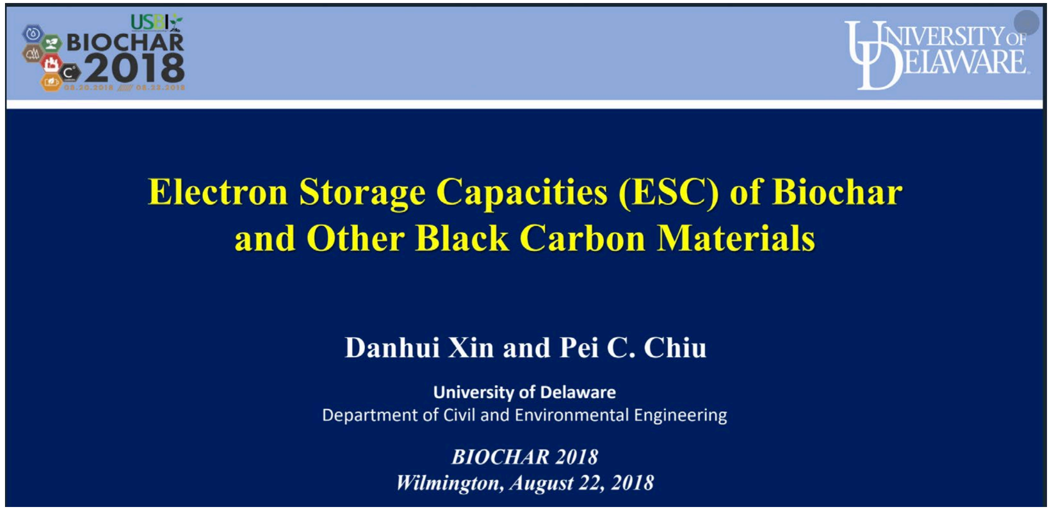
Fused carbon rings are not easily consumed by microbes

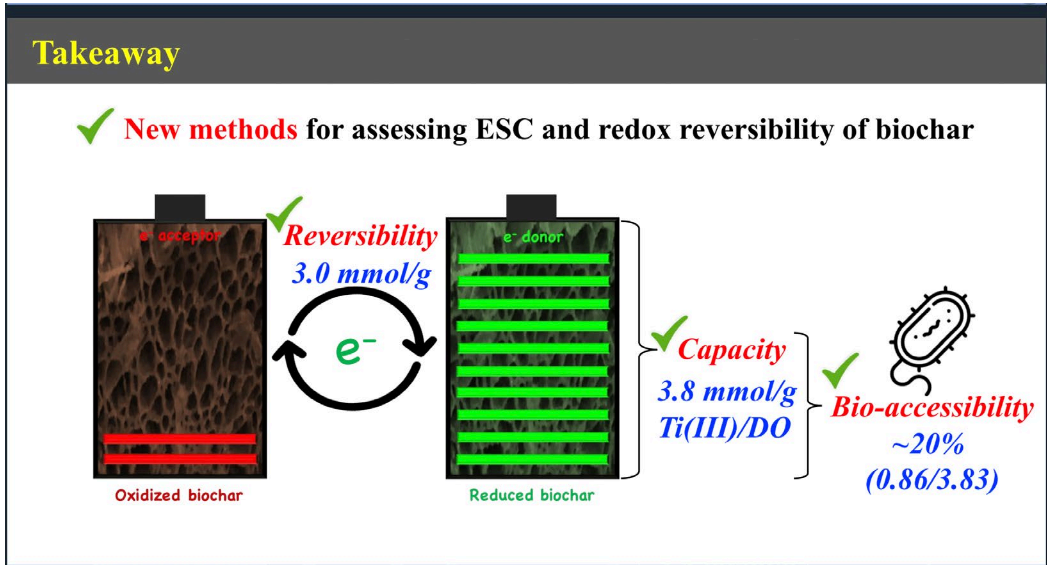




Biochar has electrical properties – like a battery in soil

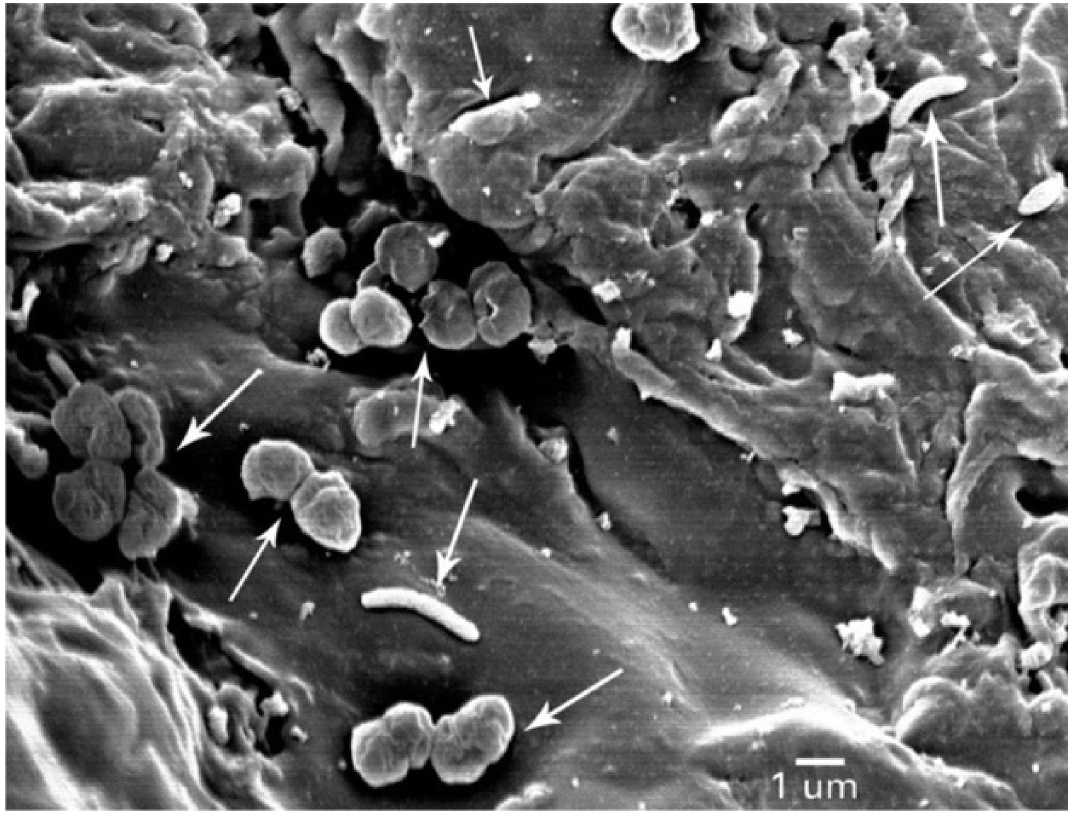






Soil Microbes Inhabit Biochar

Biochar holds electrons promoting interspecies electron transfer, more efficient metabolism, and a more robust microbial ecosystem



Picture from: *Chen, Shanshan, et al.* "***Promoting interspecies electron transfer with biochar.***" *Scientific reports 4 (2014).*

Biochar is like a luxury condo for microbes

Included:

- Electric
- Water
- Food

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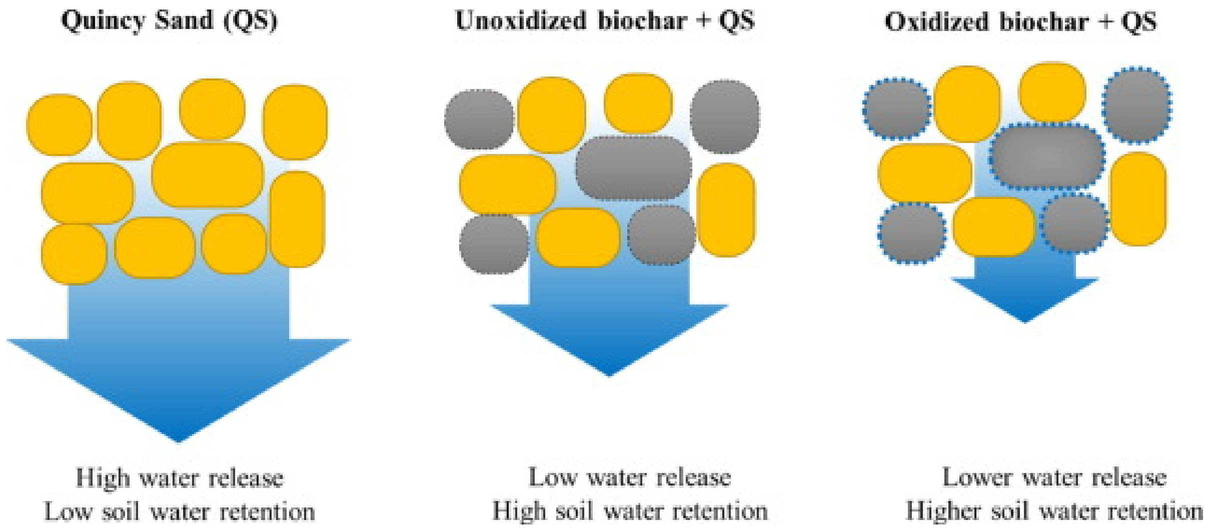
Biochar water-holding capacity



Suliman, Waled, et al. "The role of biochar porosity and surface functionality in augmenting hydrologic properties of a sandy soil." *Science of The Total Environment* 574 (2017): 139-147.

Water is held in pores and also by electrostatic adsorption to surfaces

Nutrients Stick to Biochar

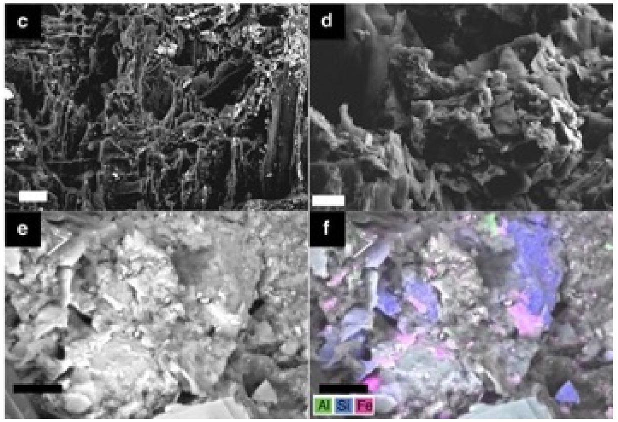
Organic Coating – best achieved by composting or using biochar to manage manure

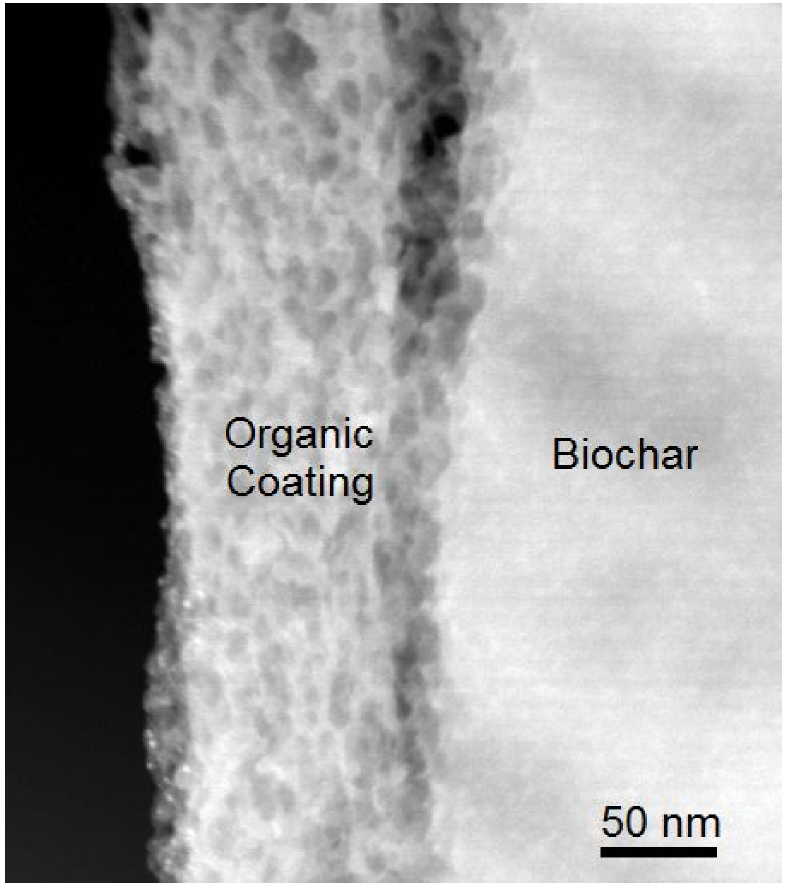
Cations
- Ammonium
- Calcium
- Magnesium

Organic compounds
- Organic functional groups
- Humic acid

Anions
- Phosphate
- Nitrate
- Sulfate

Minerals
- Metals
- Clay

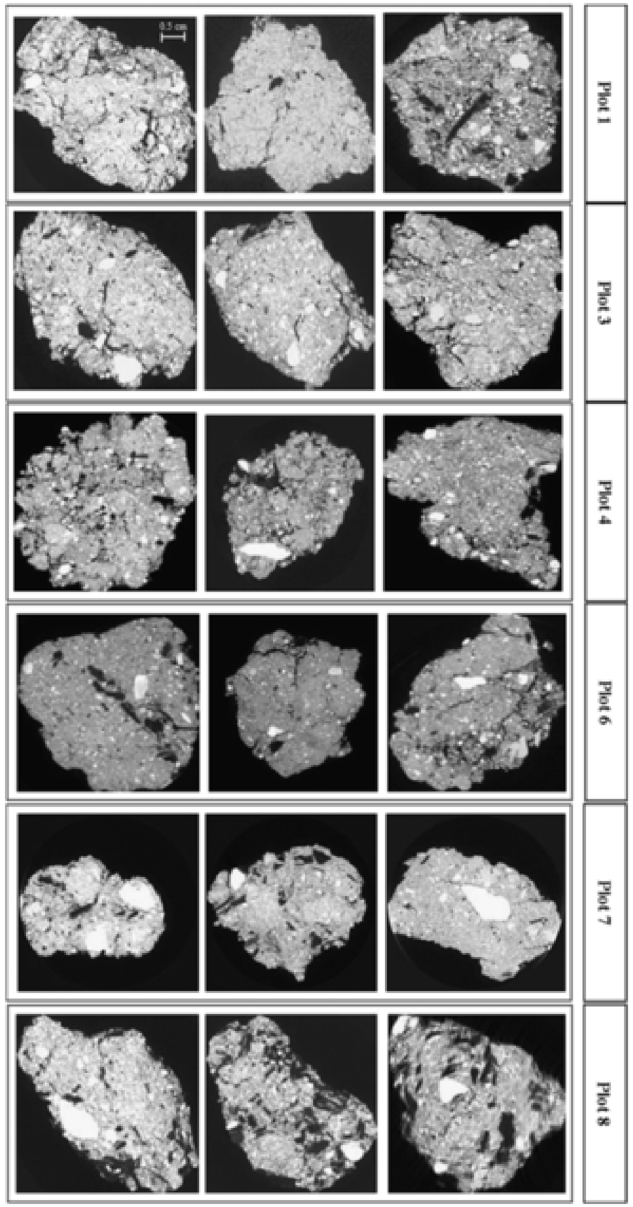




Hagemann, Nikolas, et al. "Organic coating on biochar explains its nutrient retention and stimulation of soil fertility." *Nature communications* 8.1 (2017): 1089.

Biochar improves soil aggregates

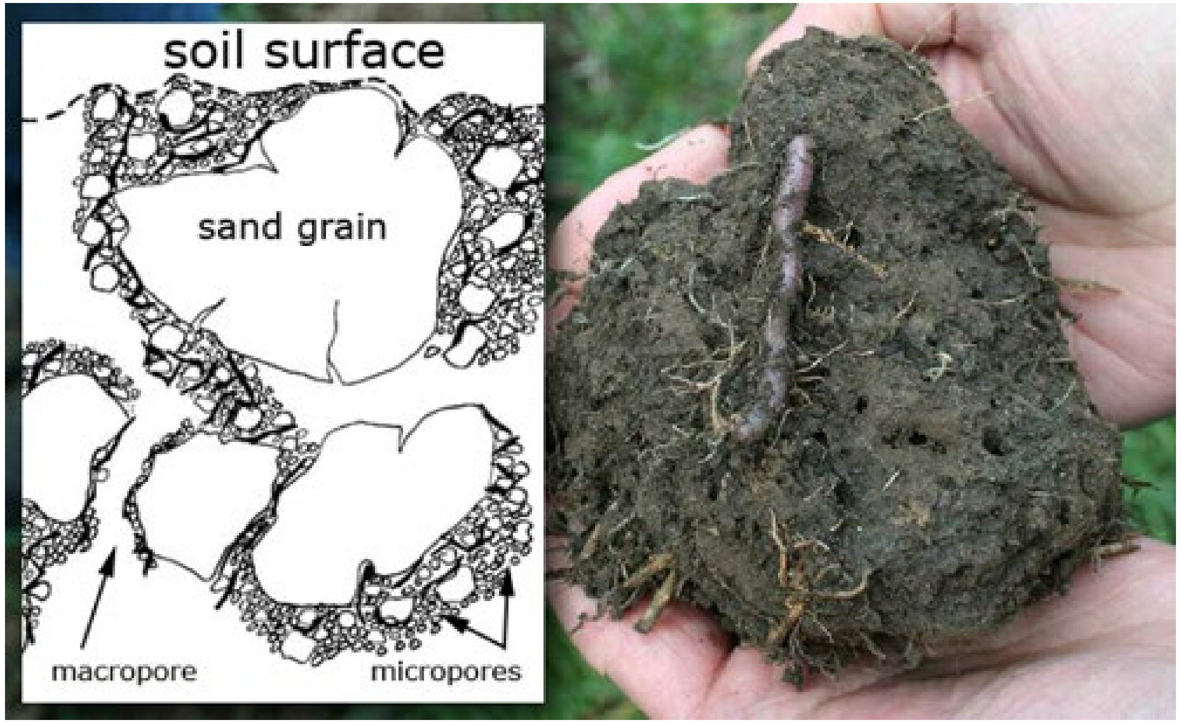
- Generally, the biochar application was able to increase the aggregate stability … of larger aggregates (4–8 mm and 8–16 mm) …



Khademalrasoul, A., Naveed, M., Heckrath, G., Kumari, K. G. I. D., de Jonge, L. W., Elsgaard, L., ... & Iversen, B. V. (2014). Biochar effects on soil aggregate properties under no-till maize. *Soil Science*, *179*(6), 273-283.

Build it and they will come…

- Biochar provides luxury accommodation for microbes
- Biochar is stable and won't degrade over time
- Soil life binds soil particles together
- Water and nutrients are held in soil
- Plant roots are happy!



Improved soil aggregates are the #1 measure of good soil

Trees Love Biochar

Carbon Gold planted cacao trees in Belize with and without biochar. Biochar-amended trees yielded cacao pods several years earlier than trees that had been planted without biochar.

Ponderosa Pine seedlings at Cal-Forest Nurseries in Etna, CA. Vermiculite soil blend (control) on the left and Rogue Biochar™ soil blend (test) on the right.

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3. How Can Farmers Make Biochar?

- NRCS Conservation Innovation Grant (2015)
- Farmers in Oregon often have forest land and forestry residue that they burn for disposal
- Farmers with livestock have manure that can be a problem to handle
- Combine two waste steams to create value

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Willow Witt Ranch – Goat Dairy

Two buckets of biochar sprinkled once a week in the goat barn keeps odors down.

No more ammonia smell!

- Healthier animals
- Better compost

"We were very impressed by the odor reducing power of biochar. It sure has improved our barns. When you dig into the floor, it looks like it's composting really well. Instead of the plate of waste hay and alfalfa and pee and poop, it's nice compost."

- Suzanne Willow

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Help for Acid Pasture Soils – Michaels Ranch

- Biochar in winter feed barn
- Biochar-manure spread on pasture

"It appears that it is definitely worthwhile and more effective to add the biochar in the floor of the barn and have the animals mix and deposit on it. The increase in nitrate should be really beneficial." - Troy Michaels

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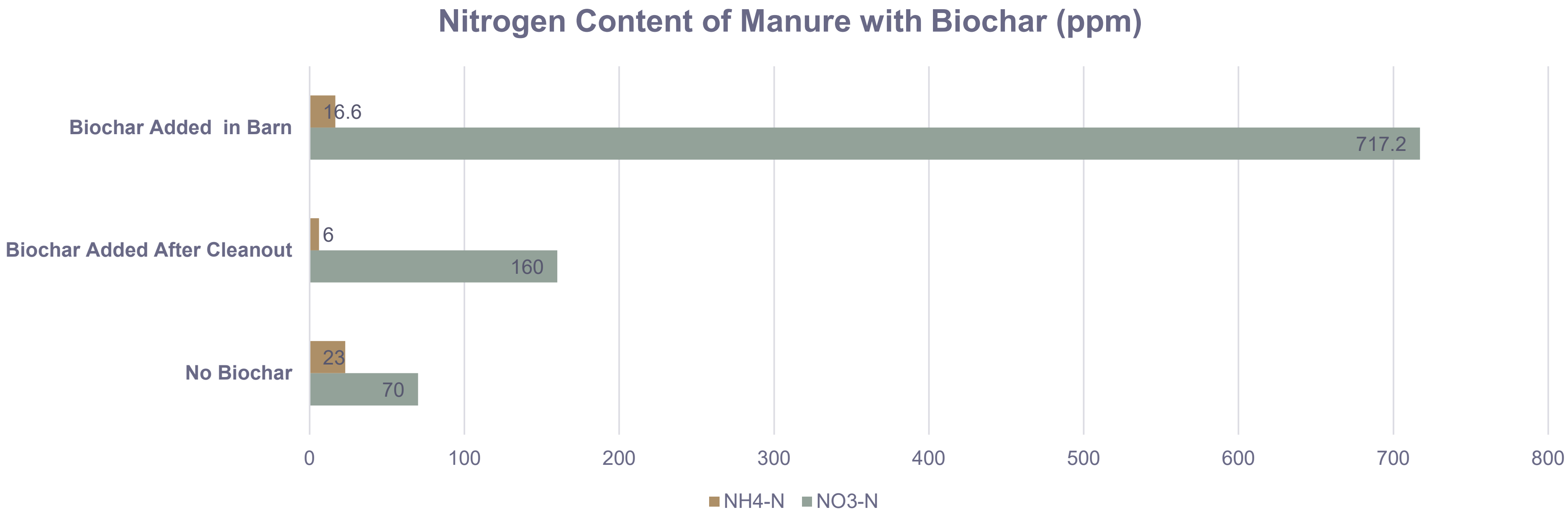
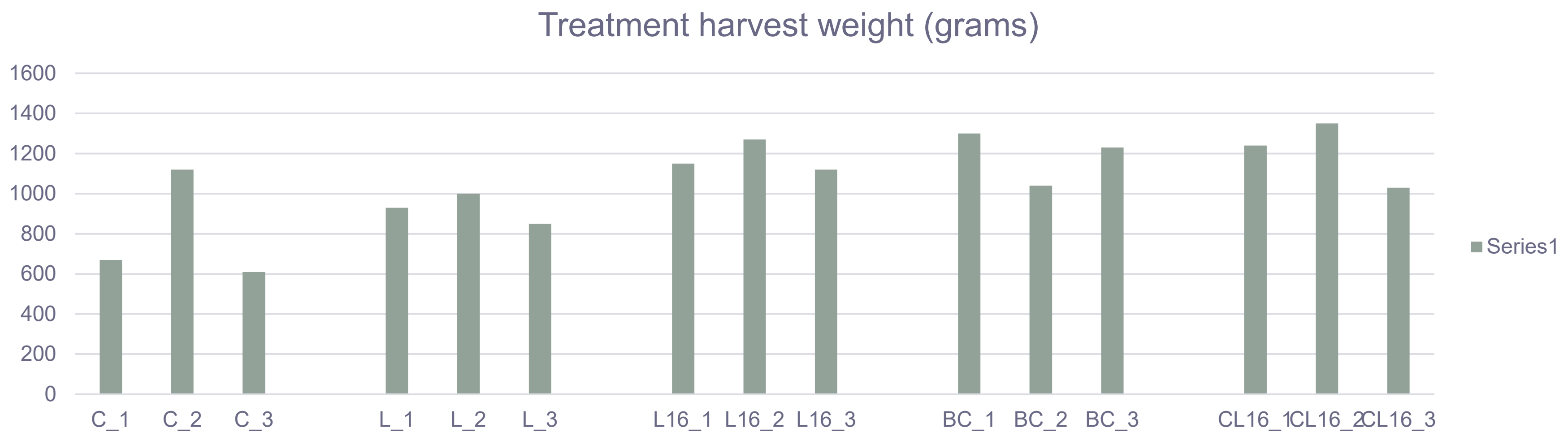
For best results, mix biochar with manure as it is generated



Biochar added in barn absorbed far more N than biochar added after cleanout

Biochar compost is equal to NPK fertilizer



Composted biochar, biochar +triple 16, and lime + triple 16 all did equally well

Biochar Technology – Conventional Slash Burning

Conventional Burn vs. Biochar Burn

- Conventional Burn: Flame under cold biomass makes smoke
- Biochar Burn: Light on top – heat transfers to pile by radiation
- **Flame on top burns smoke**

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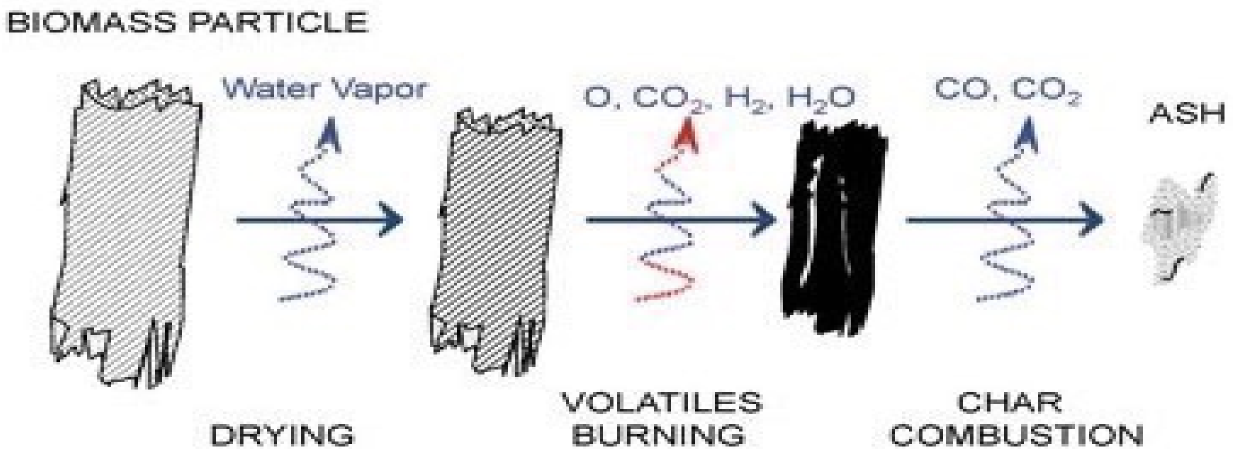
Technology: Flame Carbonization



- Biomass burns in 3 stages
- To make char, stop the process before it goes to ash
- Just another form of gasification
- **For more info see my webinar, Biochar in the Woods – Ecology, Technology and Logistics @ wilsonbiochar.com**

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Add a container to improve efficiency

The Flame Cap Kiln – Bonfire Biochar






- We made 70 cubic yards of biochar
- Worth $8,750 ($125/yard)


Growing Number of Projects and Partners

- NRCS
- USFS
- Oregon Department of Forestry
- North Dakota Forest Service
- Nebraska Forest Service
- Kansas Forest Service
- Utah State University Extension
- Oregon State University Extension
- Long Tom Restoration Council
- Yew Creek Land Alliance
- Illinois Valley Community Development Organization
- South Umpqua Rural Community Partnership

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Charring Pinyon-Juniper in Utah

NRCS CSP Biochar Activity

USDA

United States Department of Agriculture

CONSERVATION ENHANCEMENT ACTIVITY

E384135Z

CONSERVATION STEWARDSHIP PROGRAM

Biochar production from woody residue

Conservation Practice 384: Woody Residue Treatment

APPLICABLE LAND USE: Forest, Associated Ag Land

RESOURCE CONCERN ADDRESSED: Degraded Plant Condition

ENHANCEMENT LIFE SPAN: 10 years

Enhancement Description

Uses woody debris remaining after fuel reduction harvests or wildfires to create biochar. Biochar stores carbon and is a useful soil amendment that improves Soil Organic Matter (SOM) and water-holding capacity.

- Supports conversion of woody debris to biochar
- Per-acre payment

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Scaling Up – Big Box Biochar at Yew Creek Land Alliance, Nov. 2018

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Can almond growers carbonize prunings, twigs and dead trees in bins like this?

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Use What You've Got

- Tanks
- Shipping Containers
- Grain Bin Bottoms
- Rail Cars
- Dumpsters
- ???????

4. Almond Biochar

Hulls & Shells

Twigs

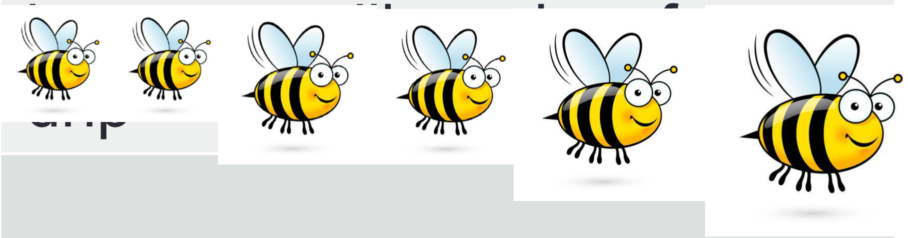
- Hulls & shells were difficult to carbonize without a fan for air
- Twigs might work better in a gasifier than in a flame kiln

Almond Biochar Test Results

Biochar Tests Comparison											
Biochar Sample	Moisture % at time of analysis	pH	EC dS/m	N %	ash %	Volatile Matter %	Carbon %	Neutralizing value (% $CaCO_3$)	H:C stability measure (0.7 max)	Surface Area (m2/g)	Dry Bulk Density (lb/cu ft)
OBS Rogue Biochar (wood biomass boiler)		10.5	1.212	0.94	8.7	25.3	83.6	11.1	0.25	456	4.9
Almond hulls & shells - WBA	81.7	12.45	8.65	0.82	14.2	26.4	58.8	17.7	0.66	271	5.8
Almond twigs - WBA	65.2	10.19	0.269	1.1	9.3	22.9	71.6	12.3	0.54	207	12.2
Almond shells by pyrolysis (75% shells + 25% sawdust)		7.8	3.2		19	30.7					
Almond shells by gasification (100% shells)		10.1	27.2		55.4	28.2					

- Processing conditions (temperature, residence time) determine ash and carbon content
- Feedstock properties (mineral content, density) influence EC, pH, surface area
- Feedstock pre-processing (particle size) impacts thermal processing conditions

What is the value of on-farm almond biochar?

Sustainability	Cash Flow
Builds soil health and disease resistance	Increases yields, but slowly
Uses on-farm inputs	Requires farm labor to produce biochar
Prevents loss of nutrients	Saves money on fertilizers
Conserves & retains water in root zone	Compare to infrastructure 
Protects pollinators	

5. Next Steps

Biochar2018.org

Look to USBI conferences and biochar industry directory for help with equipment, consulting, information: **Biochar-US.org**

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Thank You!

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Wilson Biochar Associates specializes in biochar technology and market development. We provide strategic advice and services to businesses and organizations.

- Technology Assessment
- Research and Analysis
- Project Development

More info at: WilsonBiochar.com

Thank you!

What's Next

Research Poster Session at 3:00 p.m.

Almond Stage Presentation at 3:00 p.m.

- Electronic Sensing of Larvae and Adult Insect Moths, presented by Sensor Development Corporation

Sensor Development Corporation

3:30 p.m. – 5:30 p.m. Social Hour is sponsored by Mulch Master

MulchMaster
Conserving Water Beautifully

What’s Next

Almond Stage Presentation at 3:30 p.m.

- Best Practices in Nut Butter Milling, presented by AC Horn

Almond Stage Presentation at 4:00 p.m.

- In-Canopy Sensors & Micro-Climate Models for Navel Orangeworm Management, presented by Semios

Almond Stage Presentation at 4:30 p.m.

- Smart Pest and Disease Scouting for Almond Trees, presented by Aerobotics