2023

THE ALMOND CONFERENCE

Connecting the Dots

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Regenerative, Climate Smart, Organic: What These Mean for Growers and How They Can Add Value

Moderator: Josette Lewis (ABC)

Speakers: Amelie Gaudin (UC Davis), Tanya Gemperle-Goncalves (Gemperle Family Farms), Zac Ellis (ofi), Joe Gardiner (Gardiner Farms)

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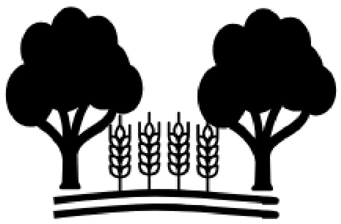
Regenerative / Climate Smart / Organic

What does this mean and how it can add value?

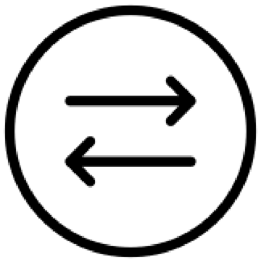
Dr. Amélie Gaudin
Department of Plant Sciences | UC Davis

Regenerative / Climate Smart / Organic



System re-designs

Modify orchard composition and structure to boost beneficial interactions



Substituting inputs

Focus on replacement of technologies and synthetic inputs

Gains in efficiencies

Better use of on-farm and input resources within existing system configurations

Common ground

- Managing for sustainability; beyond just productivity
- Management practices that can provide multiple environmental and public health benefits
- Systems approach
  - Management
  - Outcomes
- Flexibility in implementation, no recipe
- High likelihood of tradeoffs

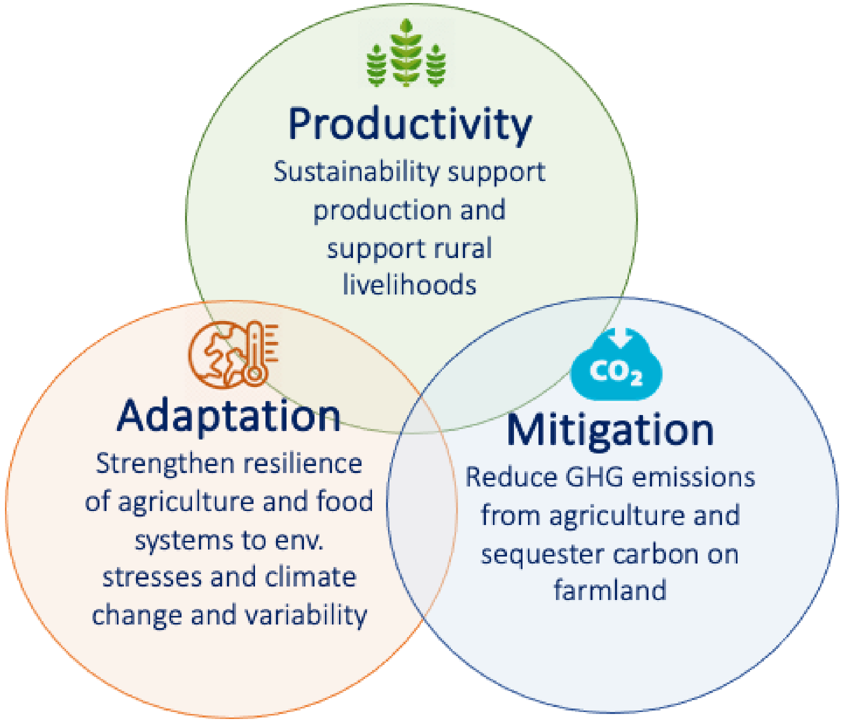
What does this mean?

Organic

- Pioneer, farmer led movement
- Ecological farming
- Regulated
- Set of approved production practices
- Premium, established markets and certifiers

What does this mean?

Climate – smart



- Policy driven
- Efficiencies – Substitutions , shorter term
- Emphasize agriculture as a climate solution - GHG
- Conventional / organic systems

Lewis et al 2019.Front. Sustain. Food Syst

What does this mean?

Regenerative

- “New”, farmer knowledge
- Redesigns, stacking of practices
- Low to no synthetic input
- Livestock re-integration
- Equity and food justice

1st level regenerative system - designed primarily to build soil health, cycle and sequester carbon

A deeper regenerative system – also optimizes for biodiversity and conservation

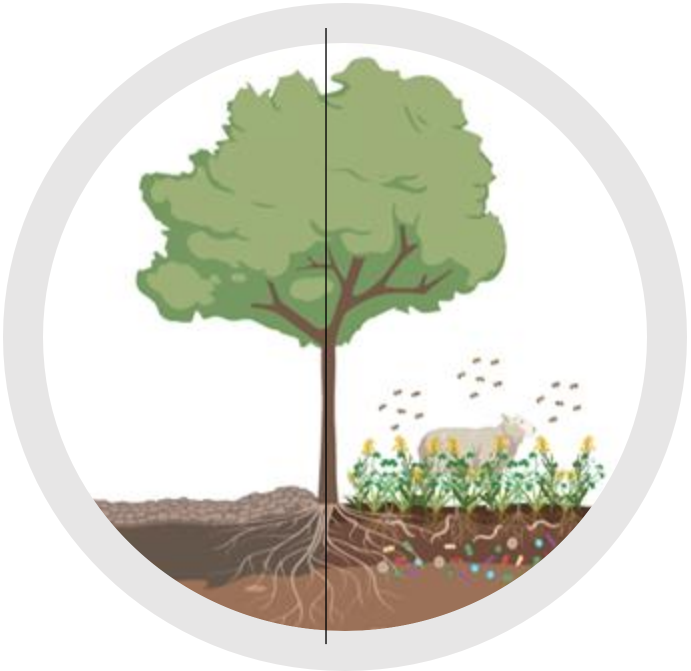
On its deepest level - supports individuals and communities and strives for equity, reversing decades of extractions

Newton et al 2020. Front. Sustain. Food Syst

Moving beyond definitions …

ECOLOGICAL PRINCIPLES

- Maximize biodiversity
- Maintain living roots
- Keep soil covered
- Frequent and diverse input of organic matter
- Strategic minimal disturbances
- Adaptation to landscape and communities



Rely on biodiversity
  - Time
  - Space
  - Above and belowground
- Living soil ecosystems
- Strategic and limited disturbances

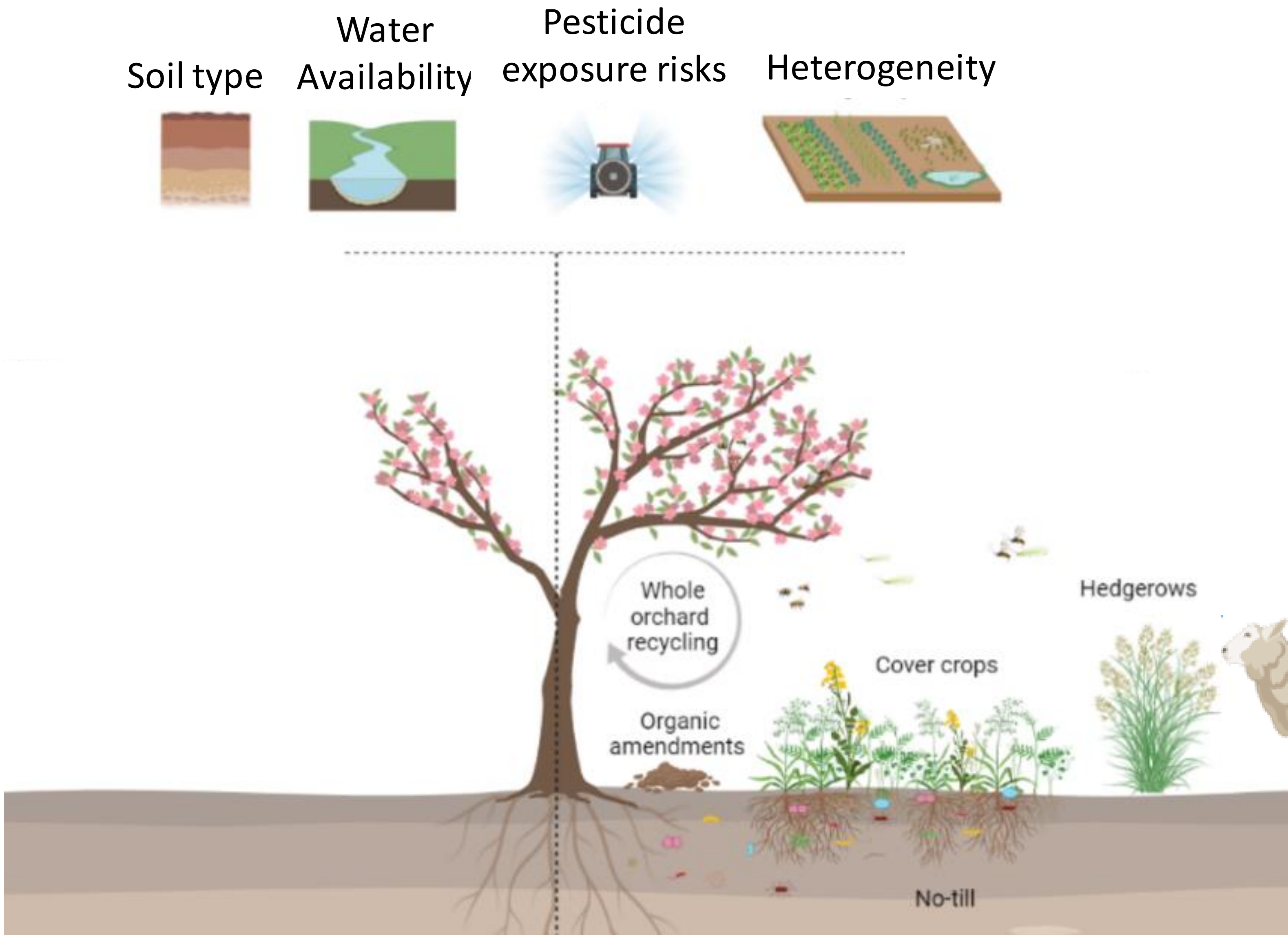
A very large number of papers in the ecology literature since the ~50s!

These systems already exist !

PRACTICES

- Field margin habitat
- Whole orchard recycling
- Organic amendments and composts
- Understory covers
- Chips/mulches hulls and shells
- Biochars
- Grazers

(...)



We have a very large unrealized potential in Almond systems

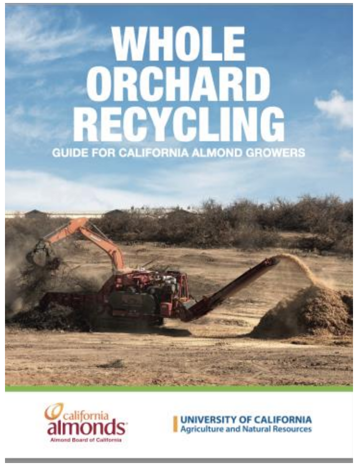
- No till for the most part
- Stable perennial habitat which sequesters carbon
- Multiple designs in space and time are feasible , distinct spatial and temporal niches
- Potential yield lags are minimal compared to annual systems; if well managed
- Cost, but high value specialty crop
- Unique context




How it can add value ?

Single practices (few out of many…)

Whole Orchard Recycling

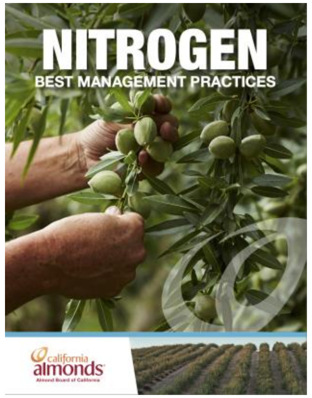


After 9 years, compared to burned

- Greater water holding capacity (+32% Field capacity)
- Improved infiltration rate : 2 folds
- Reduced soil compaction (-%14)
- Improved soil aggregation (+%19)
- Maintain higher tree water status and water use efficiency
- + 20% yield benefits under deficit irrigation
- Reduces nitrate leaching potential by 52%

- No yield tradeoffs if follow fertilization guidelines
- Low pest/disease potential

Jahanzad et al_2020, Jahanzad et al_2022, Holtz et al_2017
https://orchardrecycling.ucdavis.edu



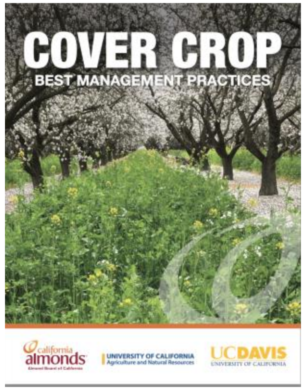
Compost, hulls and shells

After 2-3 years, compared to unamended

- Short term soil fertility
- Relevant sources of nutrients
  - N/P Nutrient management guidelines
  - Hulls and shells = Potassium
- Increases in soil organic carbon
- Associated benefits (CEC, topsoil volumetric water content – stem water potential)
- More biological activity
- Hulls and Shells mulch effect : lower soil evaporation; higher water infiltration

Leptch et al_2019, Villa et al_202, Khalsa et al_2021
Andrews et al_2023; Andrews et al_submitted

Winter planted cover crops



After 4 years, compared to bare soil

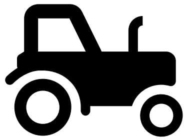
- Forage for pollinators
- Weed suppression
- Reduce spring emergence and NOW egg deposition
- Living roots and soil cover
  - In season increases in water infiltration
  - Aggregation (+22%),
  - Compaction (-41%)
  - Labile C and N pools
  - More biological activity , more diverse soil ecosystem
  - No increases in SOM or SOC

Wauters et al_2023, DeVincentis et al_2020, Wilson et al_2023, **Wauters et al_2024** in prep

How it can add value ?

Stacking in complex systems

12 organic Almond orchards, Similar soil type and texture (Yolo silt loam)
Along a management gradient
None, few or stacked adoption of soil health and diversification principles

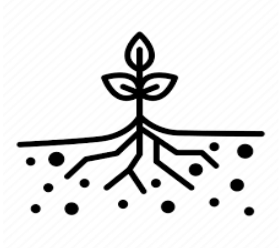


Disturbance

- Till
- No till

Soil cover

- None
- Partial
- Full

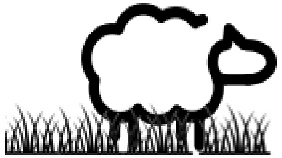


Living plants / roots

- Bare
- Winter
- Continuous

Organic matter inputs

- None
- 1
- 2 +



Diversification

- None
- Plants
- Plant + grazing

Marshall et al_under review_Applied Soil Ecology

Soil health data indicates 3 main groups

Cluster A


- Bare soil
- Recycled almond shell amendment
- Winter planted living cover and compost

Cluster B


- Winter living cover of resident vegetation
- Continuous living cover with mixture of planted and resident vegetation

Cluster C


- Planted winter living cover with animal grazing + compost
- Continuous living cover with animal grazing

Subset of indicators -- Alley (0-30 cm) --

Service	Indicator	Cluster A	Cluster B	Cluster C
Lower compaction	Bulk density (g/cm^3)	1.71a	1.62ab	1.56b
Store C	Total soil C (g C/kg dry soil)	8.78a	13.43b	17.47b
Nutrient cycling	Respiration (mg CO_2/g dry soil)	0.29a	0.39ab	0.53b
	Soil proteins (mg N/g dry soil)	1.81a	2.01a	5.89b
Nutrient availability	Total N (g N/kg dry soil)	0.85a	1.27a	1.63b
	Available P (ppm)	4.64a	20.12b	57.59c
Conserve water	Water Holding Capacity (gH2O. g soil)	0.23a	0.26a	0.23a

frontiers in Sustainable Food Systems

ORIGINAL RESEARCH
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Check for updates

Regenerative Almond Production Systems Improve Soil Health, Biodiversity, and Profit

Tommy L. D. Fenster[1,2], *Patricia Y. Oikawa*[2] *and Jonathan G. Lundgren*[1*]

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ELSEVIER

Ecosystem Services
Volume 38, August 2019, 100948

Agroecological management improves ecosystem services in almond orchards within one year

Vincent De Leijster[a], Maria João Santos[a b], Martin J. Wassen[a], Maria Eugenia Ramos-Font[c], Ana Belén Robles[c], Mario Díaz[a], Maartje Staal[a], Pita A. Verweij[a]

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https://doi.org/10.1016/j.ecoser.2019.100948

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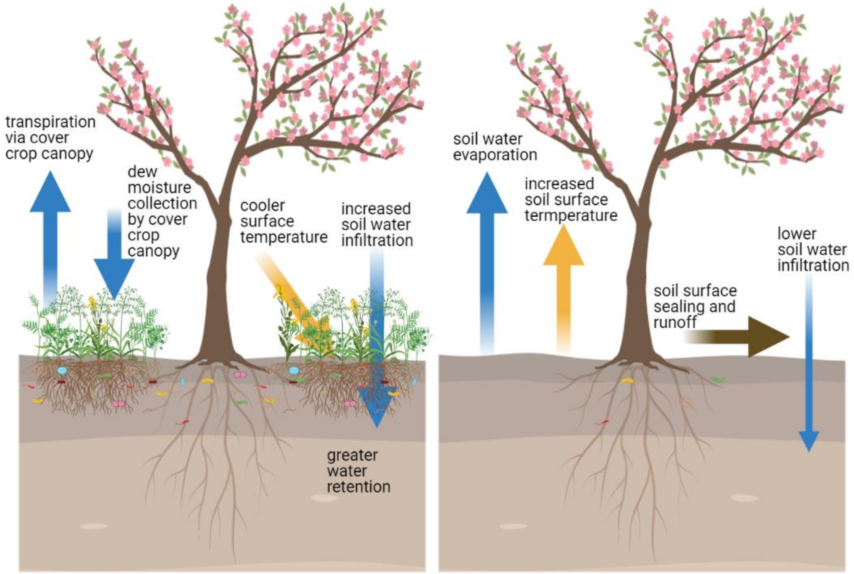
Key knowledge gaps

- Food safety (A. Pires et al)
- Water cycling and footprint (K. Suvokarev et al)
    - Preliminary study , 5 orchards
    - No significant differences in ET
- Re optimizing management/designs



Key enabling technologies

Off ground harvesting
Groundwater recharge

- Research on commercial farms / trials
- Successful models in the Valley , co-learnings
  - Can help tackle some common production challenges (infiltration, salinity…)
  - Uncertainties in timing of benefits to growers
  - Science: 5 years *vs* 20+ years
  - Complex and need to assist growers
- Costs/benefits: support in transitioning
  - What is the cost of not doing anything?
  - Long term vision for management , so are trees !

Gardiner Farms

The Almond Project


Valuing growers experience and knowledge
california almonds
Almond Board of California
Thank you