

University of California Cooperative Extension

Division of Agricultural and Natural Resources

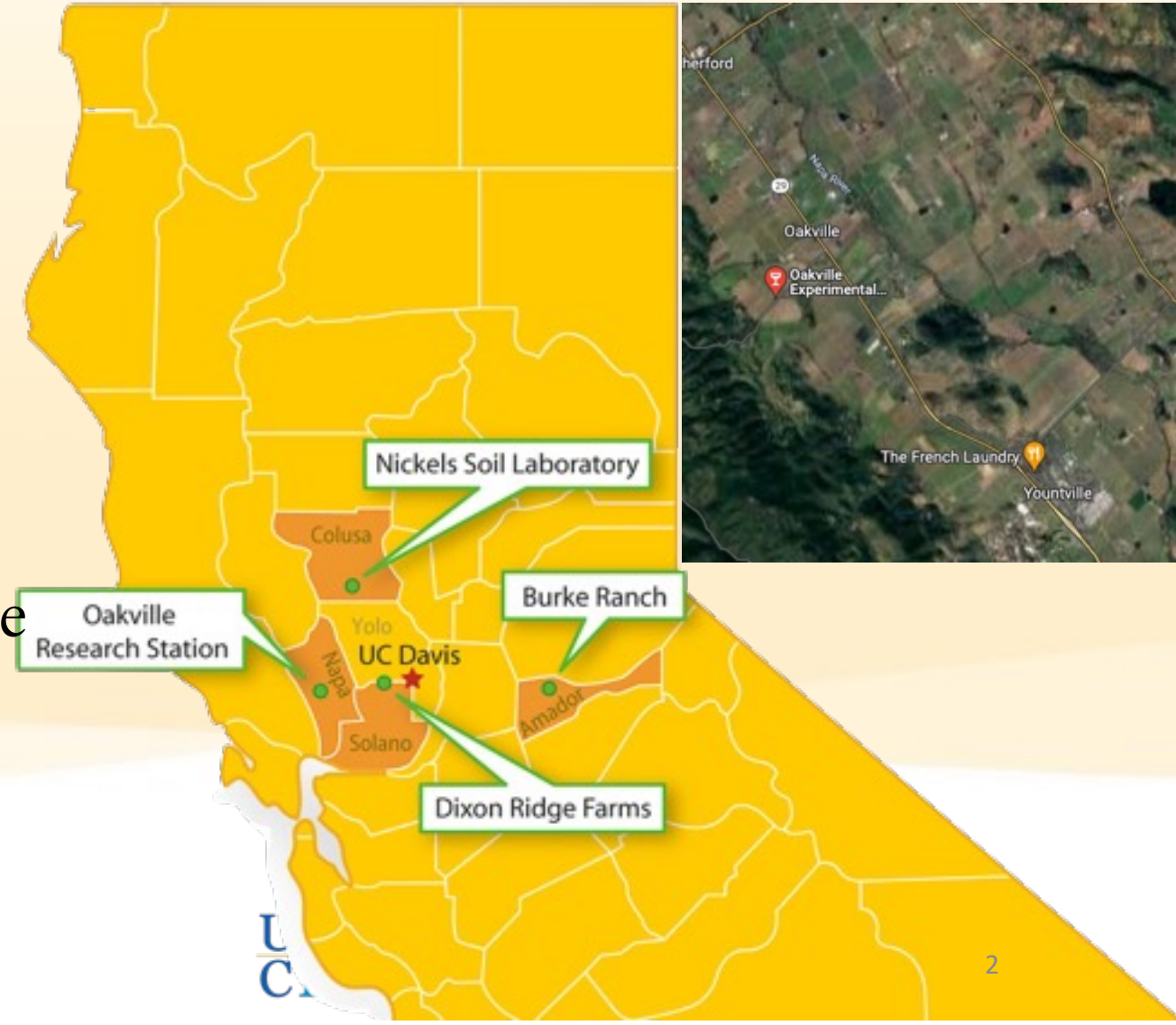
Christopher Chen, Ph.D.

UCCE – Integrated Vineyard Systems Advisor

North Coast

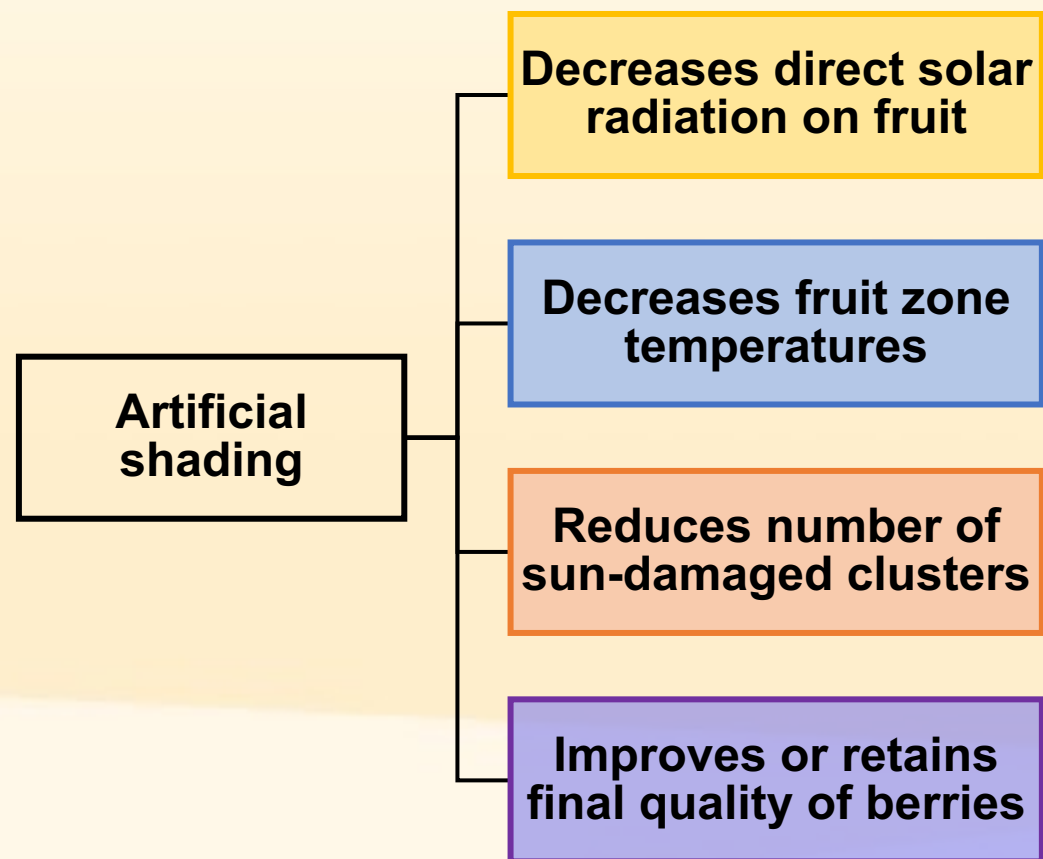
Master's Degree Project

- 2016-2018
- Project at the UC Davis Oakville Experimental Research Station in Napa Valley
- Focused on the impact of shade nets on the characteristics of Cabernet Sauvignon berries



M.S. Shade Nets Project

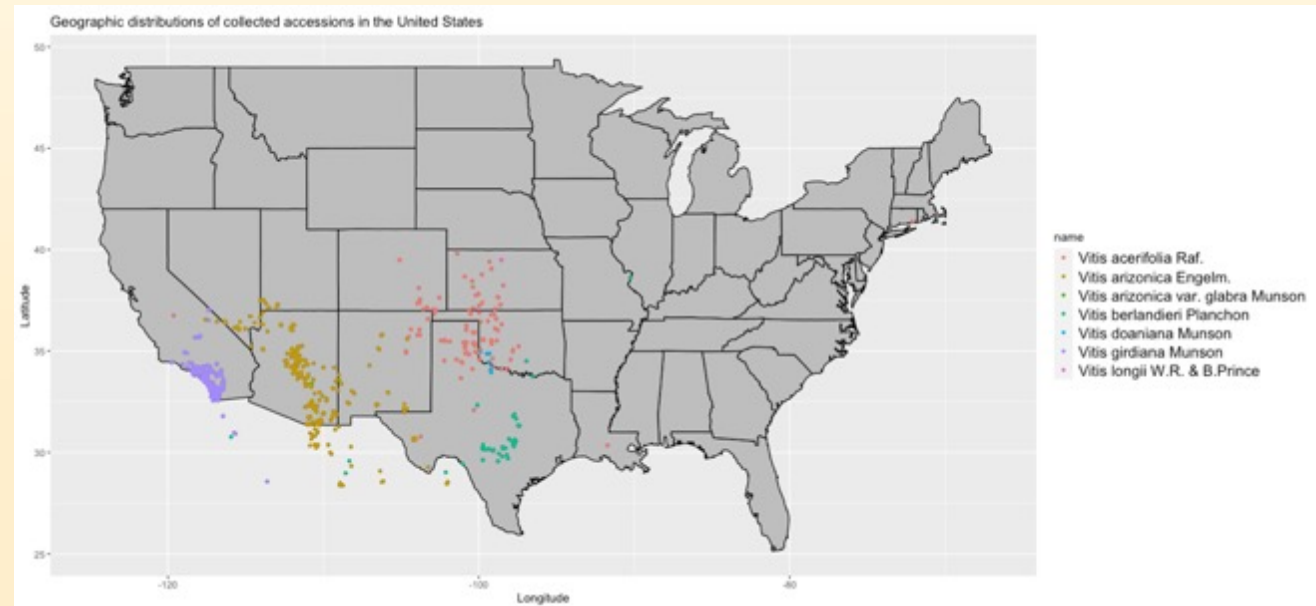
Shade netting



Different colored shade nets applied to Cabernet Sauvignon in Oakville, CA in 2017.

Ph.D. Salt-Tolerance Project

- Advisor = Andy Walker
- 2018-2021
- Conducted in a greenhouse at UC Davis
- Tested wild grapevines to look for tolerance to high-soil salinity



Ph.D. Salt-Tolerance Project

- Discovered some wild grapevines from my home desert, the Mojave, that are tolerant to salt
- Could tolerate up to 15% the average NaCl concentration in seawater
- Still working on this

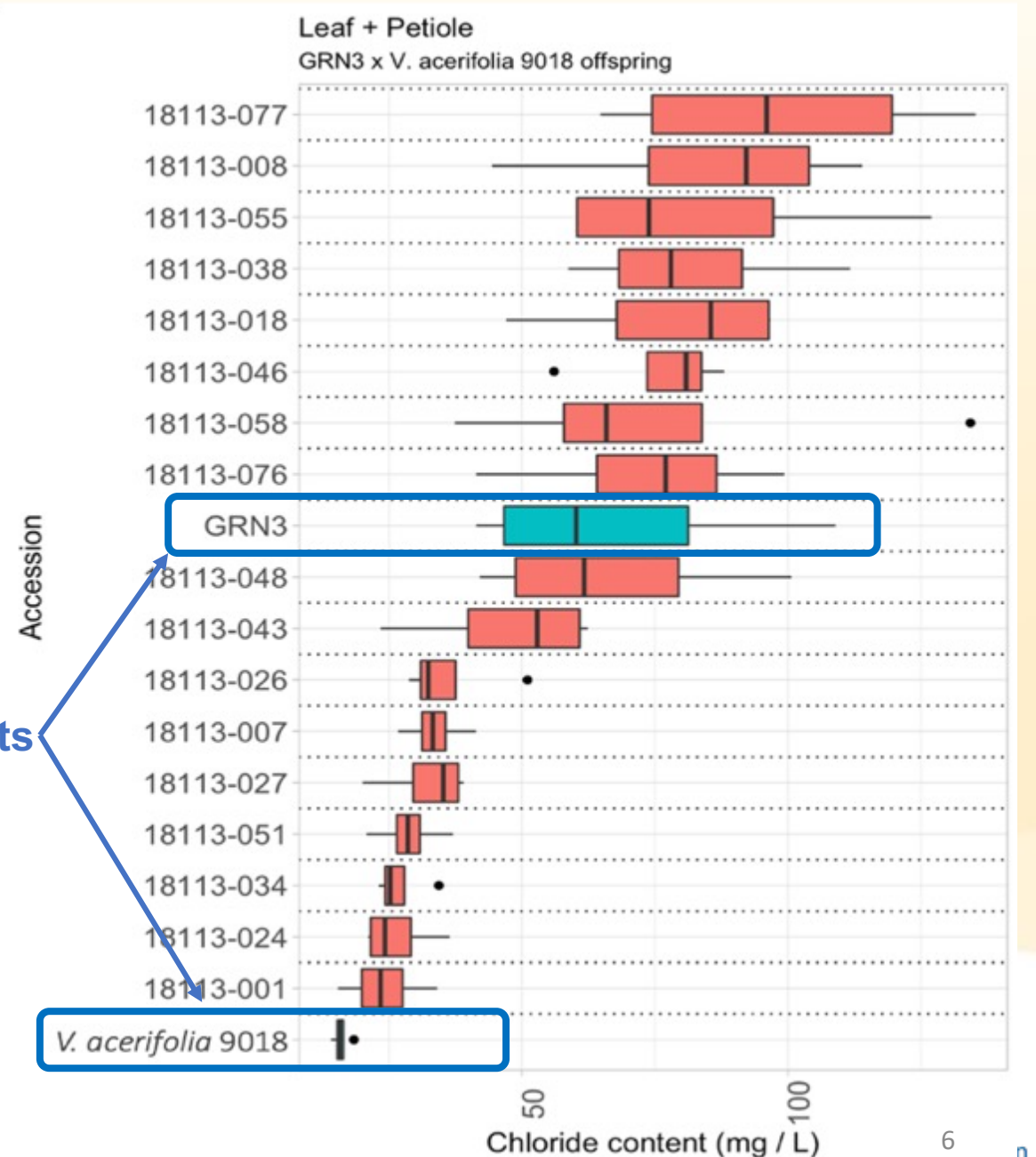


Salinity

Breeding new cultivars

- Long term solution
 - Can take decades
- Utilize wild grapevines
 - Huge gene pool
 - Potential for high salinity tolerance
 - Largely unexplored
- “Breed in” existing traits
 - Preserve other traits of existing rootstocks
 - Rootability, drought tolerance, vigor

Parents



Salinity

Unexpected problems

- Uneven ripening



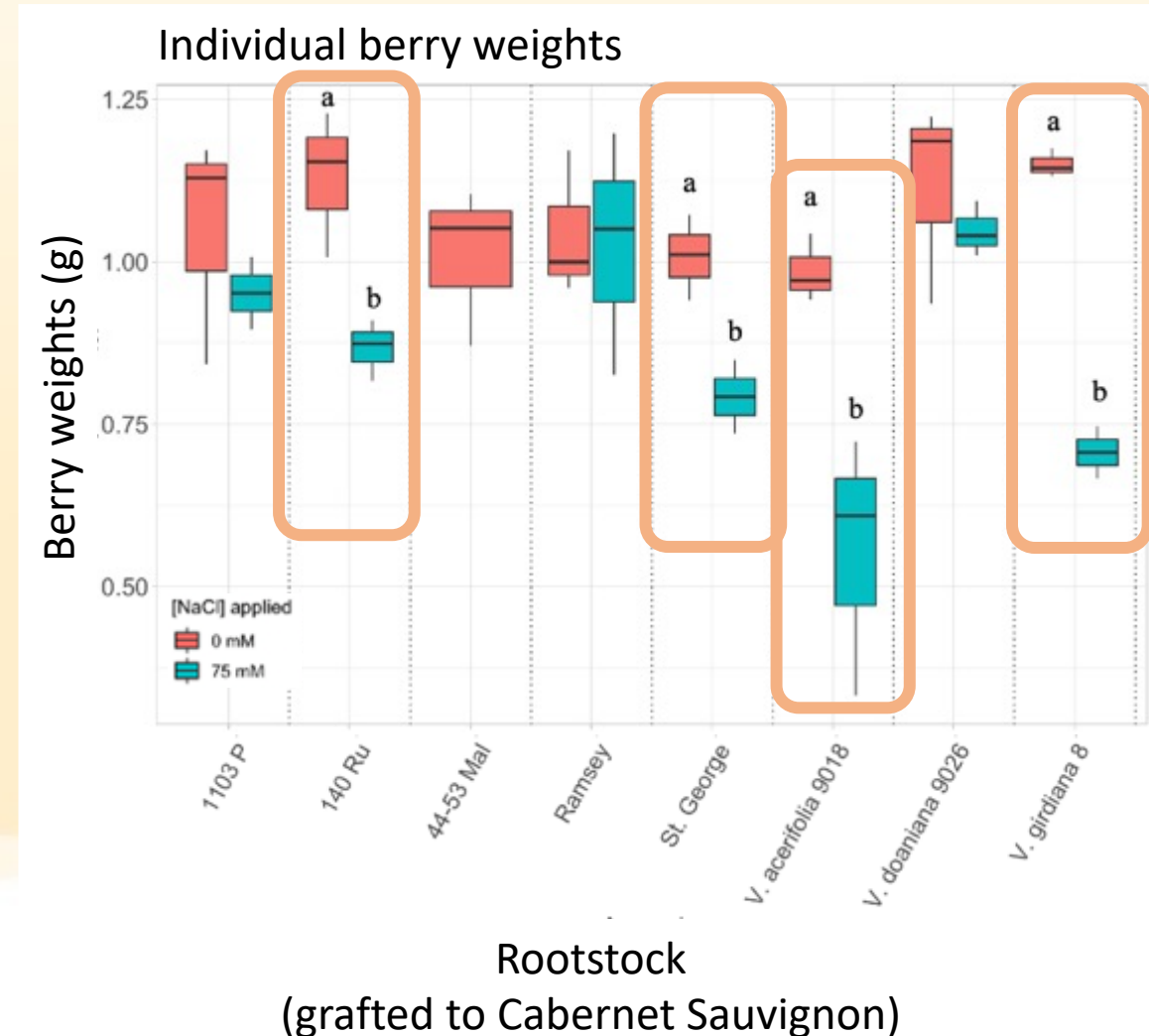
- Smaller berries



Salinity

Unexpected problems

- Uneven ripening
- **Smaller berries**
- Changing root allocation



Salinity

Unexpected problems

- Changing root allocation



Almonds

- I worked as a Post-Doctoral Researcher with Almonds
- For 2 months
- Then I got to work with grapes again (yay)





Integrated Vineyard Systems Advisor

- 2022 - Current
- University of California
 - Cooperative Extension
 - Agricultural and Natural Resources
- I cover three counties:
 1. Sonoma
 2. Mendocino
 3. Lake

Cooperative Extension

- Serves the public by supporting our communities and informing the public about current research in:
 1. Agriculture
 2. Home Economics
 3. 4-H
 4. Public Policy
 5. Economic Developments
- There is a Cooperative Extension program in all 50 states



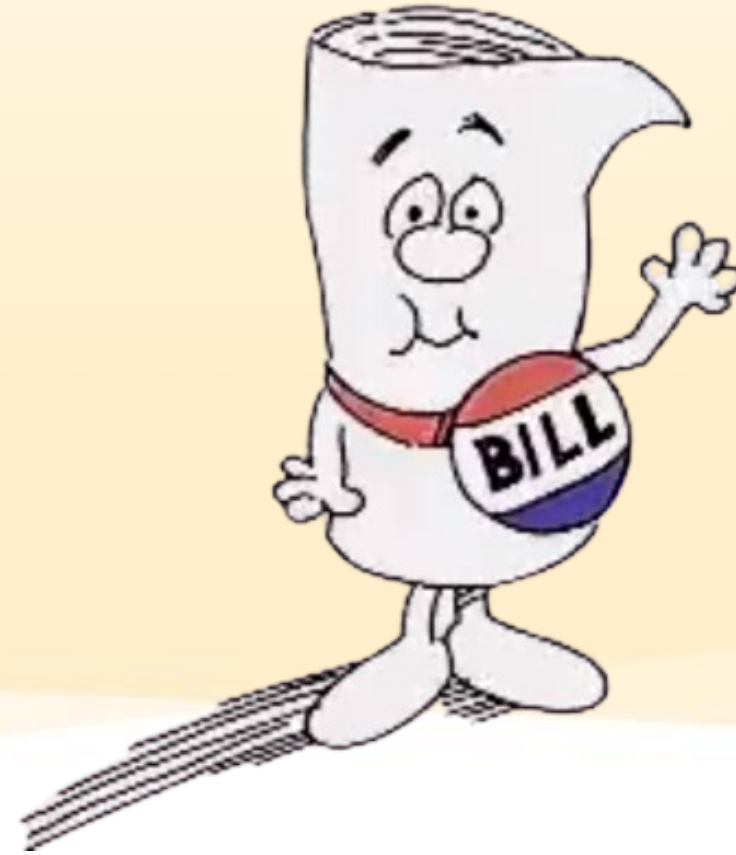


Land-Grant Colleges and Universities



Smith-Lever Act of 1914

- Established the CE programs nationwide
- CE programs operate out of land-grant universities
- Requires that there is instruction and demonstration in:
 - New agricultural techniques
 - Food preservation
 - Economics



Land-Grant Universities

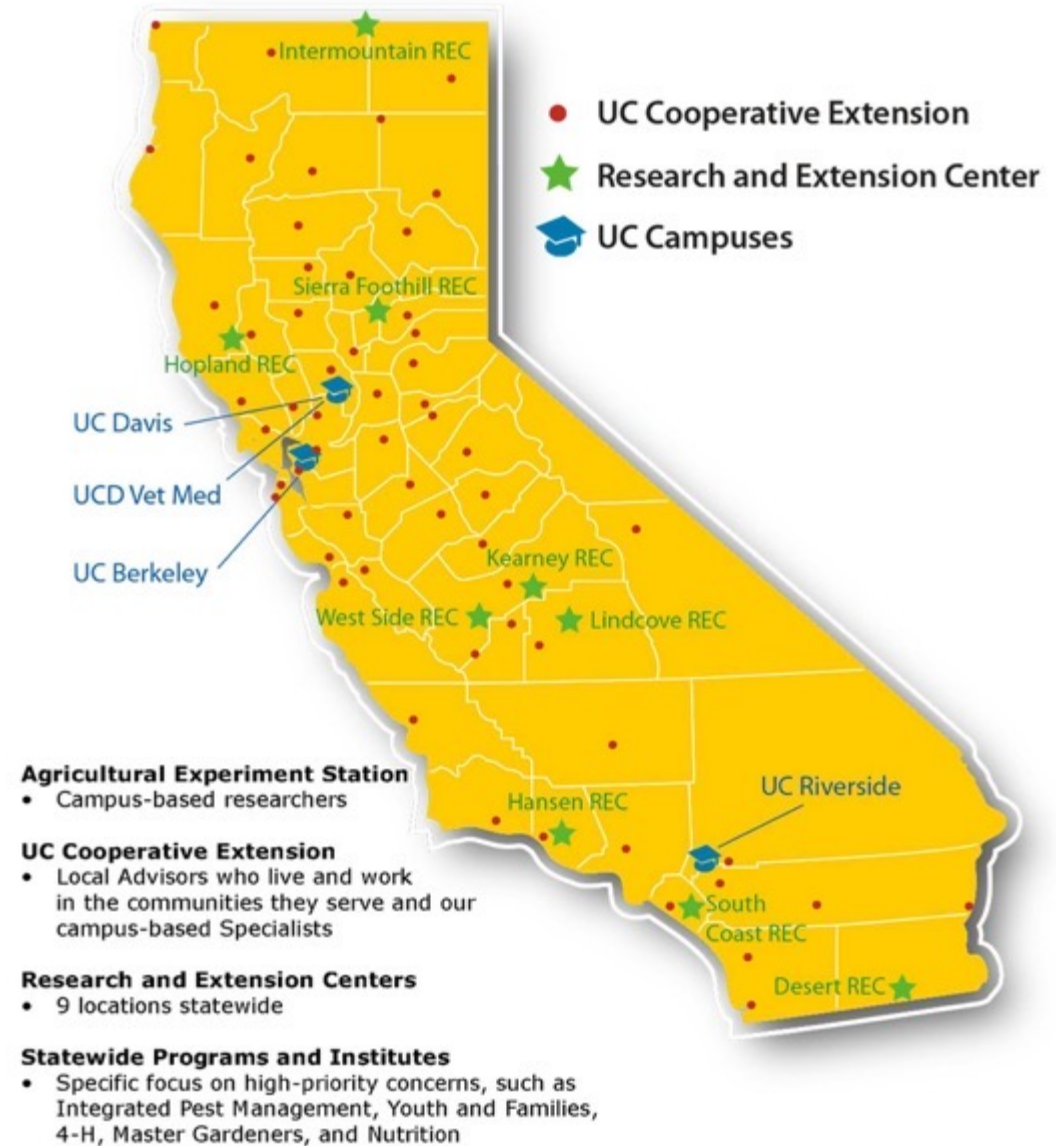
- Established by the Morrill Acts of 1862, 1890, and 1994
- Originally required to teach agriculture, military tactics, and the mechanic arts
- Land-grant universities receive several types of federal support
 - Federal land
 - Public funding
 - etc...



Agricultural Experimental Stations

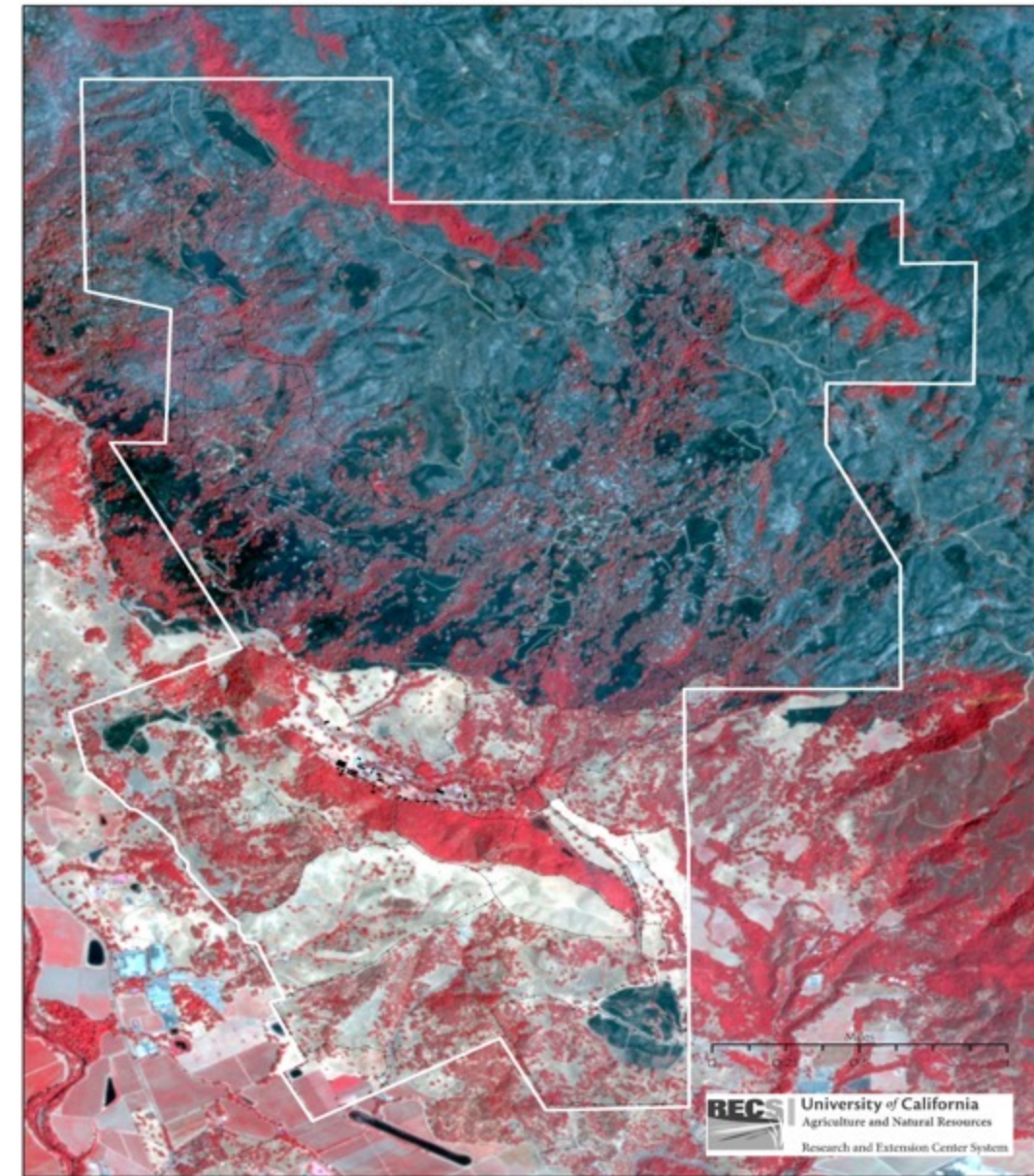
- Established by the Hatch Act of 1887
- Must be connected to a land-grant institution
- There are several in California
- Hopland Research and Extension Center (HREC) is the closest to us
- Funds must be matched by the state

University of California Agriculture and Natural Resources



Hopland REC

- 5,358 acres near Hopland, CA
- Promotes indigenous land access
- Hosts many research studies on natural systems and livestock management
- Lots of baby sheep right now
- Central hub for UCCE events



Center Boundary
Pastures

Cooperative Extension Offices

- UCCE operates directly out of county offices
- We are often in the same building as the Agricultural Department for the County or the Weights and Measures Office



California's Land Grant University

- University of California
 - 9 Teaching Campuses (14,114 acres)
 - 9 Research and Extension Centers (13,000 acres)
 - 58 County Offices (1/county)
 - 1 Cooperative Extension system (UC ANR)
- UC established – March 23, 1868



Comparing Roles in UC

UC Professors

- About 70% research
- About 30% teaching

UC Cooperative Extension

- About 70% teaching
- About 30% research



Types of UC Cooperative Extension Jobs

1. Cooperative Extension Advisors
 - Our goal is to provide resources to growers in a set region
 - Typically, we cover 1-4 counties each
2. Cooperative Extension Specialists
 - Conduct more research than advisors
 - Operate statewide
3. Professors of Cooperative Extension
 - Operate from a UC Campus
 - Act as a professor and extension specialist at the same time

UCCE
Advisor

Student

Professor



Why?

- Scientific results can be difficult to understand and implement
- Our job is to help make science more accessible to the people that would use it
- We also help create new knowledge through research



UCCE Advisors

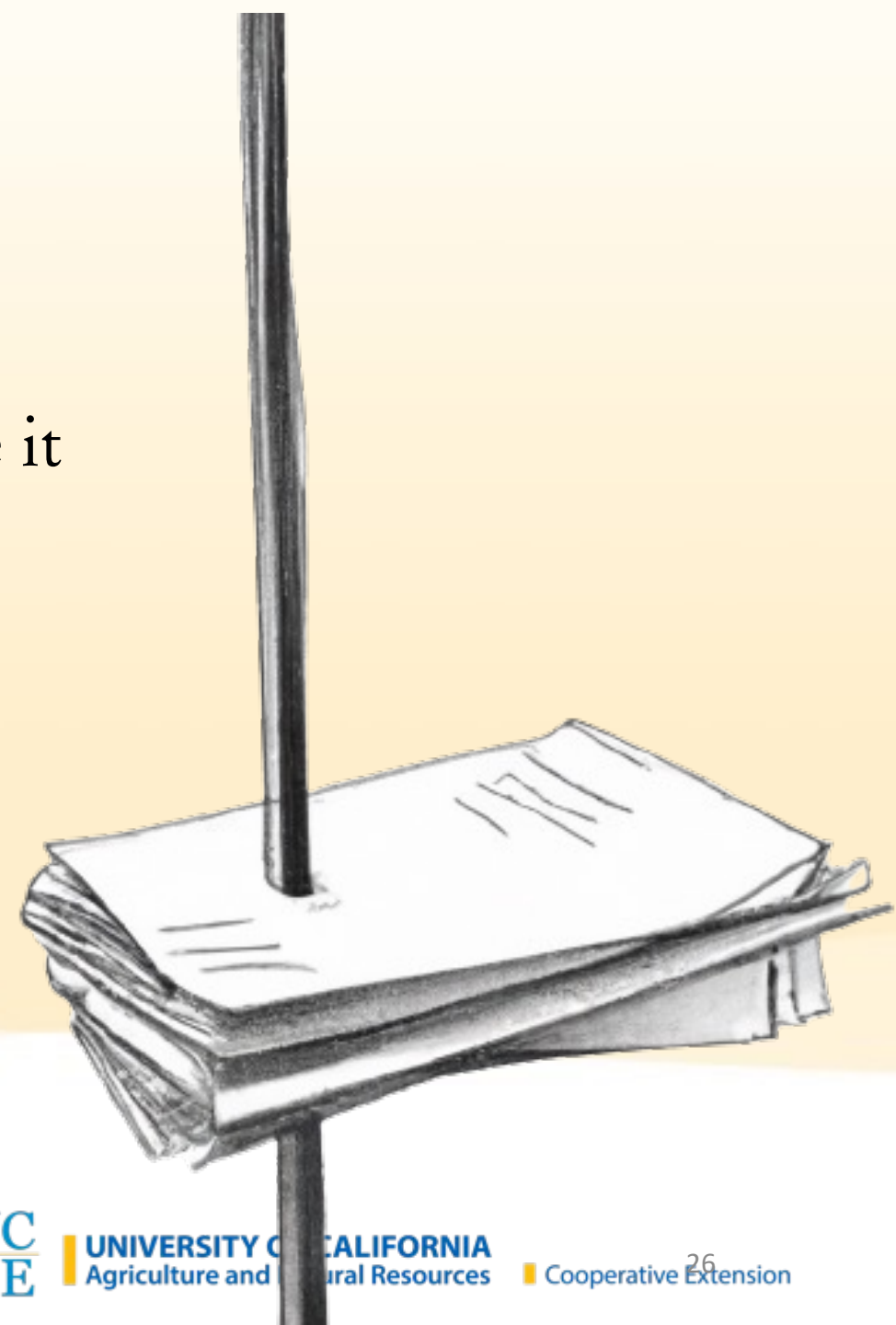
- We cover almost all major crops or livestock in California
- Types of Advisors in Sonoma Co.
 1. Viticulture Chris Chen (me)
 2. Specialty Crops Ellie Andrews
 3. Dairy Randy Black
 4. Livestock Stephanie Larson
 5. Integrated Pest Management Cindy Kron
 6. Forestry Mike Jones
 7. Fire Tori Norville
- And many more

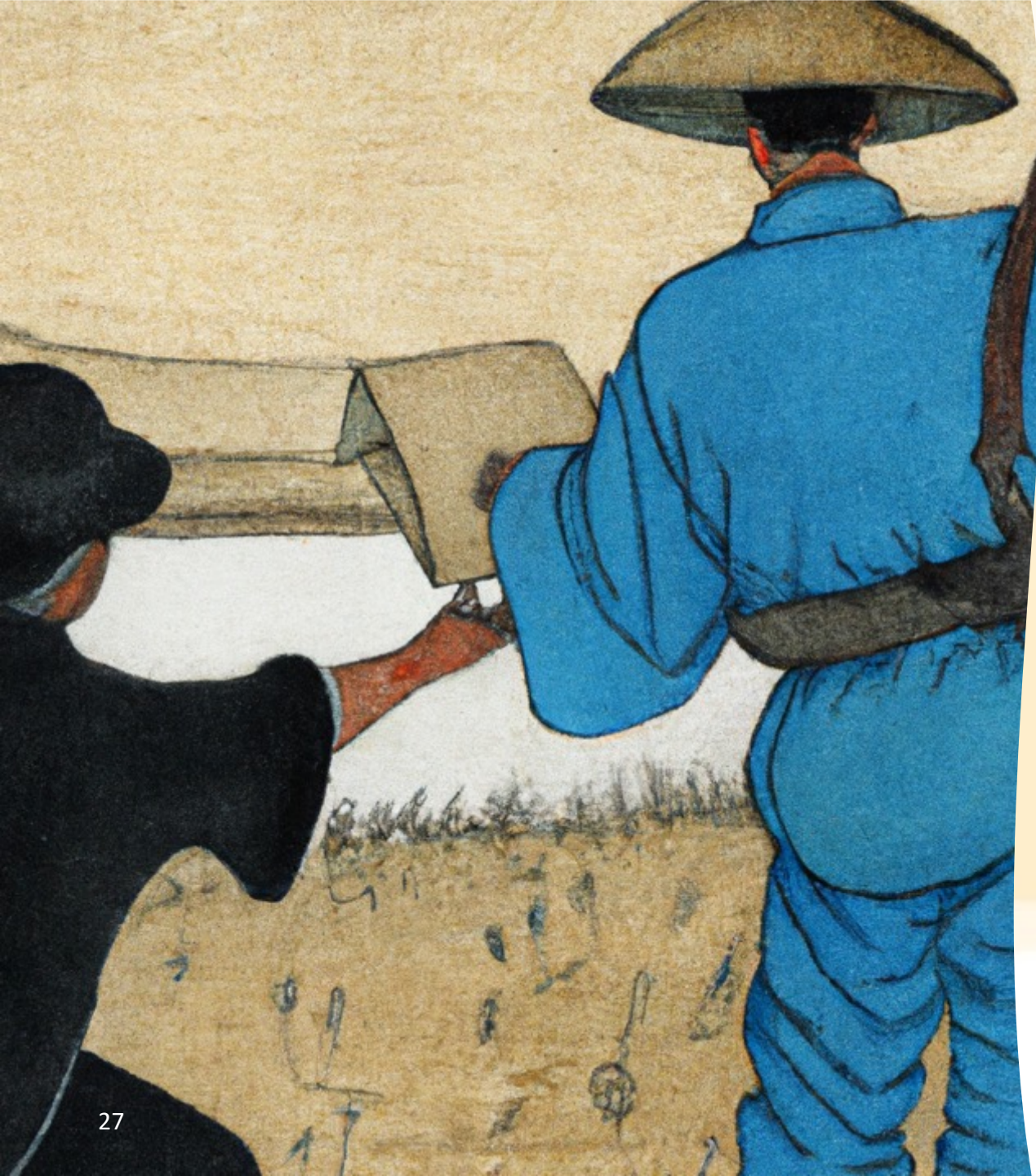
Resources Provided
by
University of California Cooperative Extension

Extension and Outreach

What is Extension?

- Extension is a process of *extending information* to the people who would use it
- Often, this takes the form of conveying results from the most recent scientific research
- It may also encompass
 - *Laws and regulations*
 - *Proper application of techniques,*
 - *Preliminary information about new risks*





What is Outreach?

- Taking the time to understand what our clients need
- Listening to the problems that are affecting growers
- Providing resources and events to address clientele needs

Forms of Extension and Outreach



Events

- Each of us host multiple events/year
- These events are tailored to our clientele
- Examples
 - Sonoma Grape Day (annual)
 - Ant Identification training (annual)
 - Small Vineyard Management classes
 - UC Davis *On-The-Road*
 - Vineyard Master Classes (w/ SCVTG)

Types of Events

1. Training Sessions
2. Research Dissemination
3. Socratic Discussions
4. Participatory Learning
5. Focus Groups



Upcoming Events

(Open to Students)

1. Ant Identification Workshop
 - Where – 133 Aviation Blvd
 - When – April 17 & 18
 - Cost – Free!!!
 - Food – No...sorry
(chance to win a free microscope though)
2. Sonoma Viticulture – Master Class
 - Where - Santa Rosa JC
 - When - May 23, 2023 (9am-2pm)
 - Cost – TBD (\approx \$15/student)
 - Food – Yes (probably tacos)



Consultation

- Most (not all) UCCE Advisors provide **free consultation** services
- Depending on your cropping system this could save a grower **hundreds of \$\$\$**
- Typically, **only for commercial producers** (not home gardeners unfortunately)



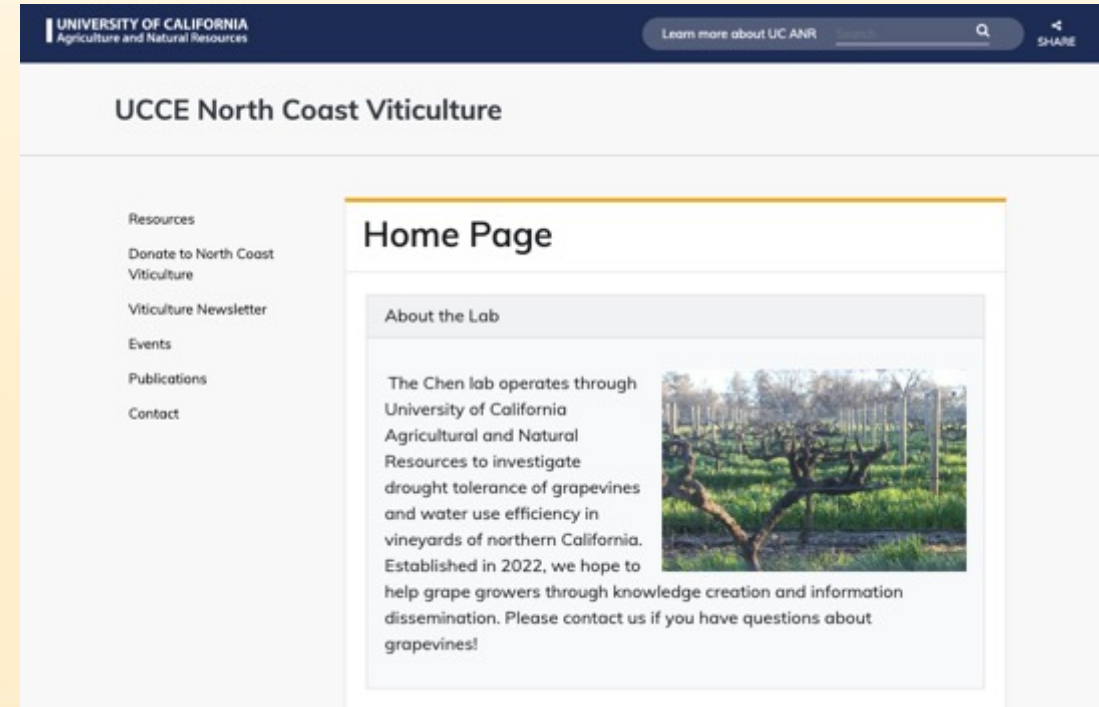
Consultation

- Reserved to within our region
- Helps us learn about the problems growers face
- Let's growers meet us



Resources & Information

- We maintain websites with useful information for our clients
- Examples
 - North Coast Viticulture webpage
 - Viticulture newsletters
 - Publicly-available research
 - Vineyard management tools
 - Soil and plant laboratories list
 - Tools for climate adaptation



Research

- UCCE contributes new research results to agricultural sciences on a continuous basis
- Research projects are often based on the needs of our clients and communities
- My research focuses on ‘climate-adaptive viticulture’ and how to help grape growers prepare for climate change



Study site vineyard in High Valley AVA



Temperature data loggers

Current Research from UCCE

1. Dairy Cows

- See if we can put more than one cow in a pen at a time

2. Integrated Pest Management

- What organic pesticides are useful in controlling leafhoppers
- How do we control Walnut-Husk Fly

3. Livestock

- How does grazing impact the natural ranges they occur on



Current Research from UCCE

4. Forestry & Fire

- How do we manage our forests better to reduce the risk of wildfire?

5. Viticulture

- What grape rootstocks are best for a changing climate?
- Where can we reduce water use in vineyards to protect endangered animals?



Past Research from UCCE

1. Livestock grazing in vineyards
 - Sheep grazing to control vineyard cover crops started with a UCCE study by McGourty and Harper
2. Benefits of cover crops in vineyards
 - Cover crops were more widely adopted due to a UCCE study in Mendocino County



Opportunities

- UCCE/UC ANR is hiring for many positions now
- These include positions like Agricultural Technicians, Advisors, Specialists, and Professors of Extension
- If interested, please check out: <https://ucanr.edu/About/Jobs/>



Climate-Adaptive Vineyards

UCCE North Cost Viticulture

Christopher Chen, Ph.D.

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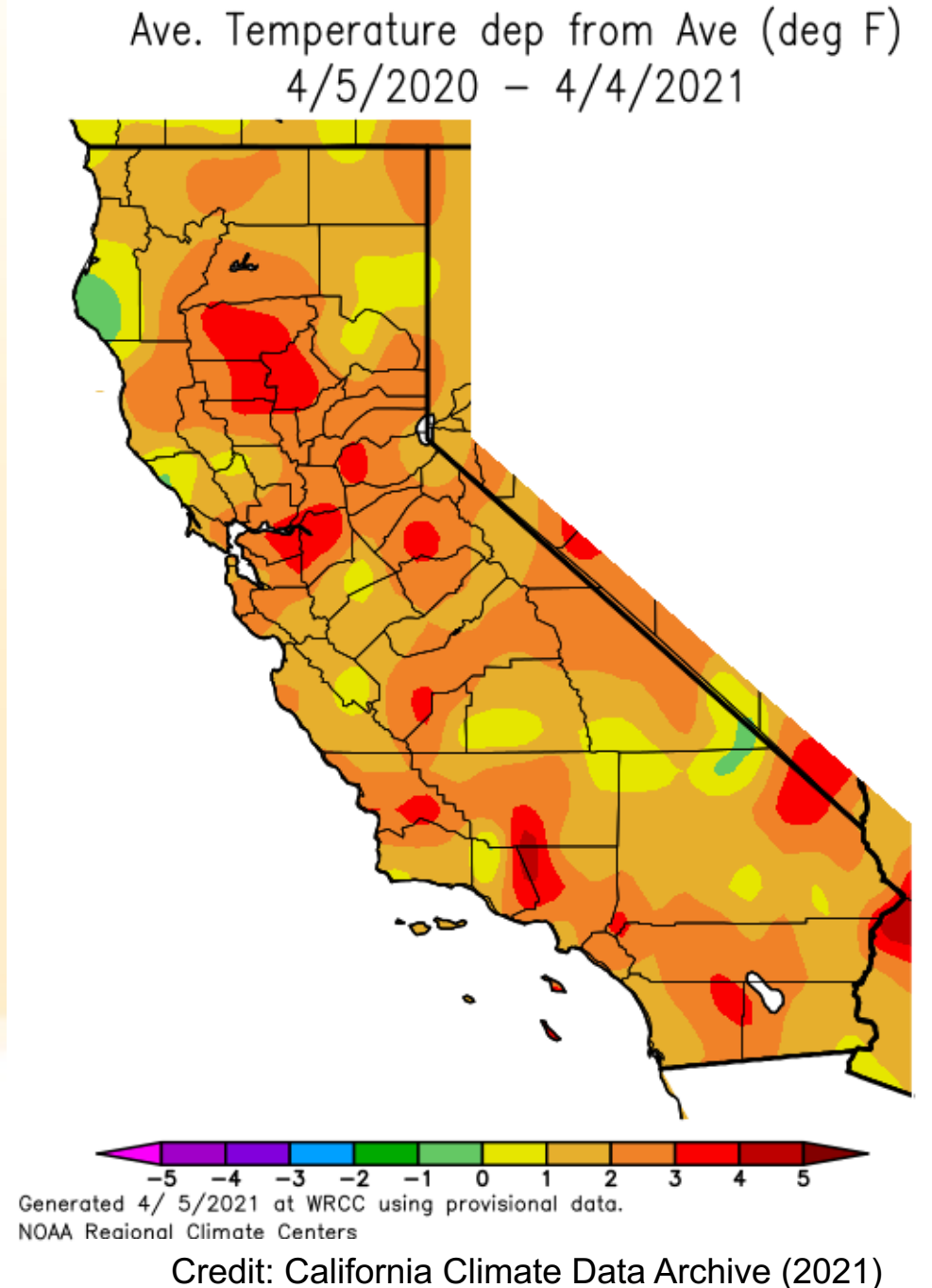
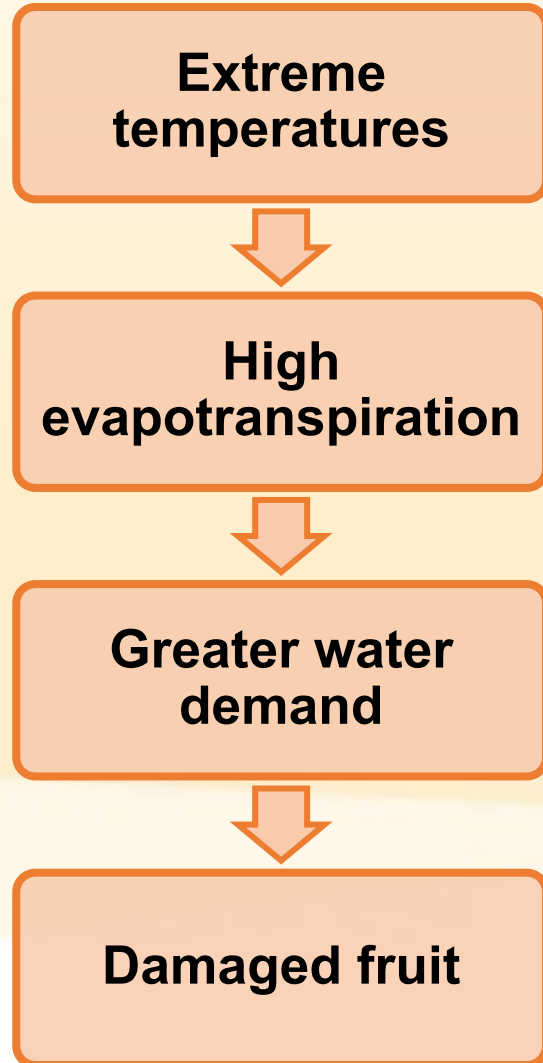
North Coast



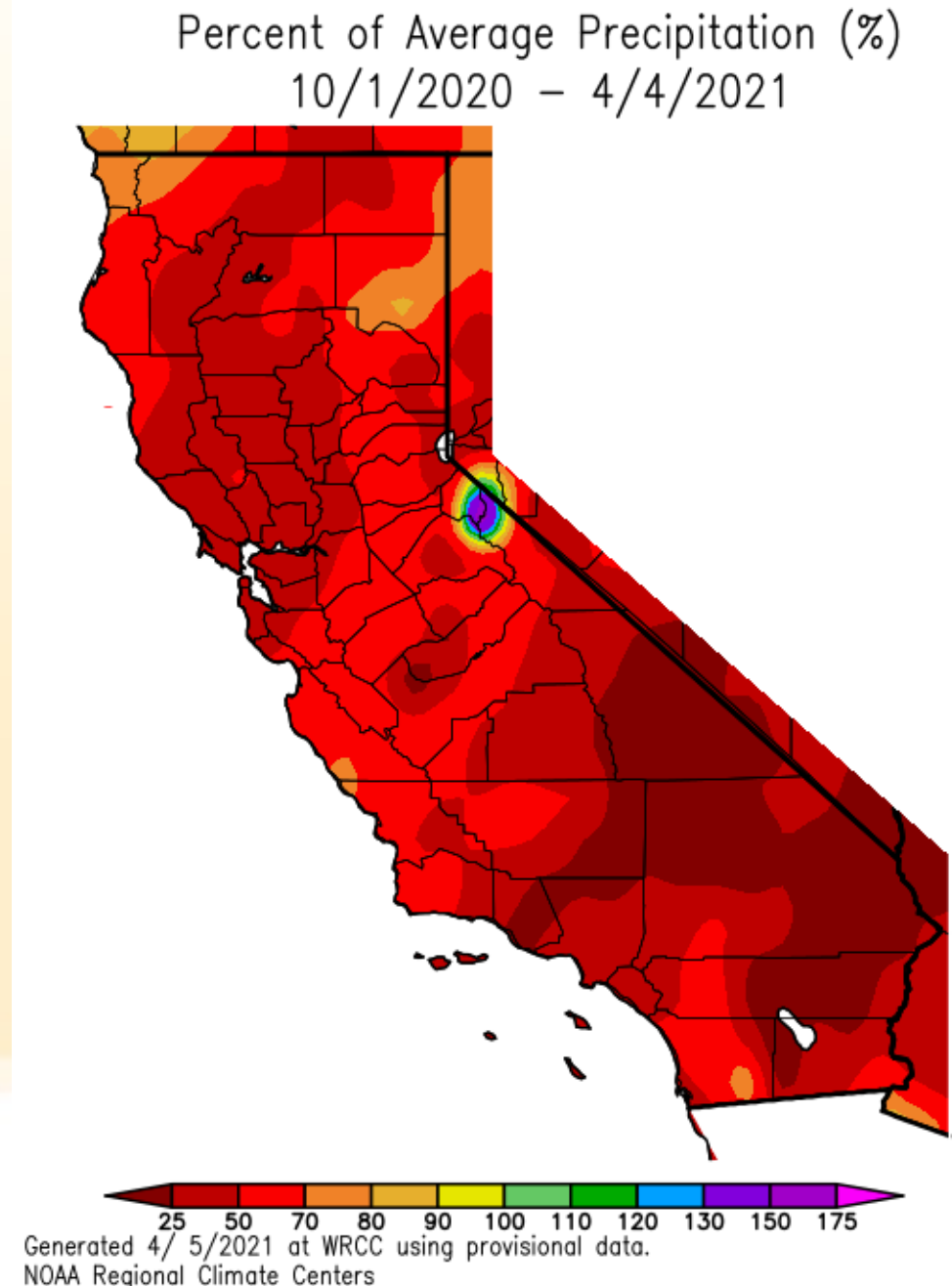
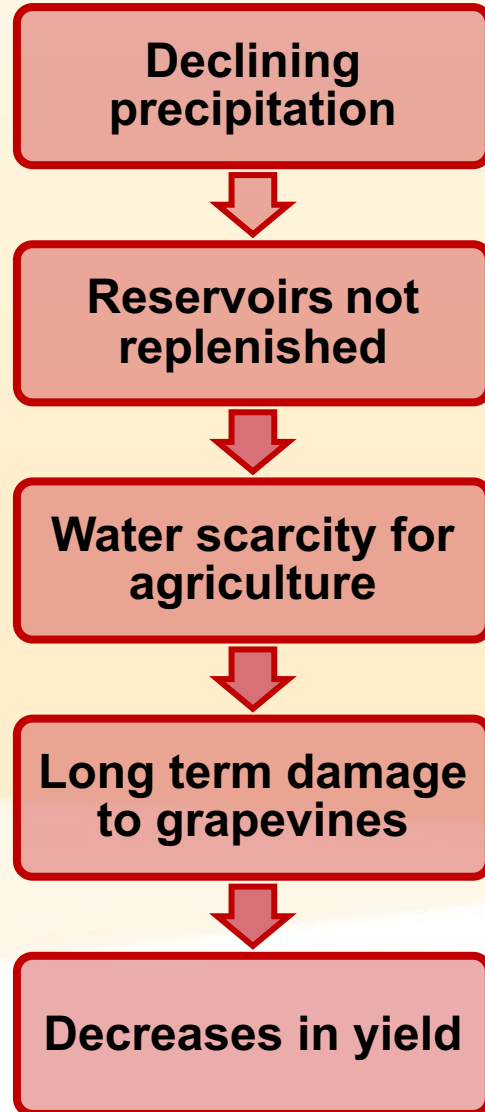
‘Climate Change’

- Used to be a somewhat-taboo term
- Now most people have accepted it as fact
- The climate around ‘climate change’ has changed

Extreme Heat

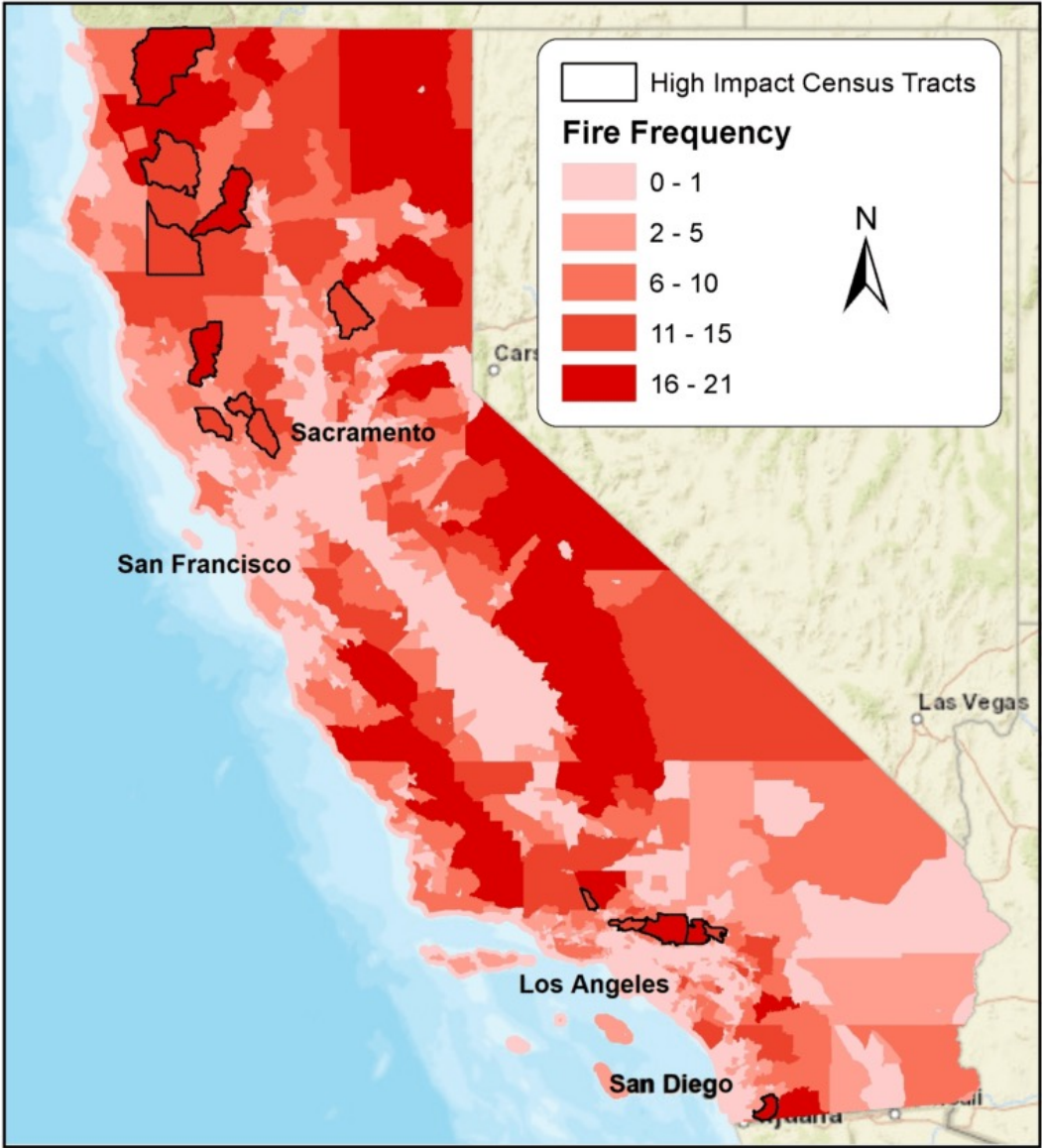


Drought



California drought conditions through the years





Credit: UC Irvine (2021)



Climate Concerns

- Global average temperatures have risen by at least 3 °F since the start of the 20th century
- Drought persists in the West Coast
- Extreme weather events have become more frequent
 1. Large wildfires
 2. Prolonged heatwaves
 3. Unexpected freeze events
 4. Drought or excessive precipitation

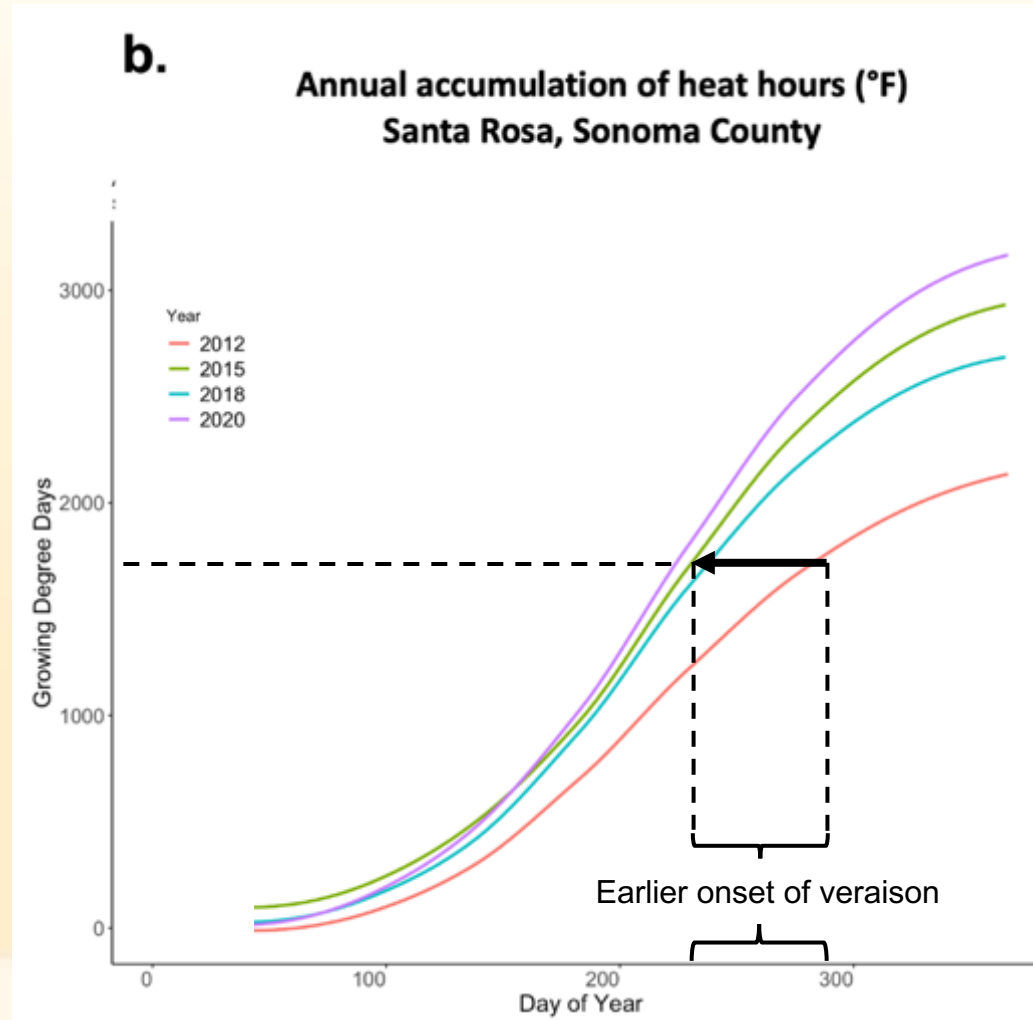


Climate Concerns with Agriculture

- Climate conditions impact many aspects of agriculture
 1. Resource availability
 2. Extreme and sudden weather events
 3. Biotic and Abiotic stressors
 4. Pest/disease success and survival
 5. Phenological timing of crops
 6. Yields
 7. Plant health



Shifting Phenology



Cumulative heat accumulation in Santa Rosa, California in 2012, 2015, 2018, and 2020; linear model. (Data from <https://cimis.water.ca.gov>)



Changes in Phenological Timing

In Central Europe the impact of warming climates has been documented in Bernáth et al. 2022 (pre-print)

Between 1985 and 2018

- Budbreak: 5-7 days earlier
- Flowering: 7-10 days earlier
- Berry maturity: 18 days earlier
- Harvest: 8-10 days earlier

Vineyard Asynchrony

- Both the pest and host can respond to changing climates in unpredictable ways
- Changes in temperature and atmospheric CO₂ levels have impacted the timing of generational cycles of insect species in vineyards
 - Resulting in some asynchrony between pest and predator/parasatoid







The unpredictable nature of climate change

We know what to expect, but not when and where to expect it

- e.g., Spring frost damage as far south as Fresno in April 2022

Extreme events are occurring more frequently and unexpectedly, with long-term weather forecasts are becoming less reliable.

Impact of such events like heatwaves are more noticeable in regions unaccustomed to them (i.e., coastal heatwave impacts > inland heatwaves)

Stressors in Vineyards

Abiotic stressors

- Frost damage
- Heat
- Drought

Biotic stressors

- Animal Pests
- Plant Pests (weeds)
- Diseases



Vine health \sim available resources + (abiotic stress) + (biotic stress)

Stressors

No natural immune system

- Additive resistance
- Defense compound synthesis
- Abiotic stressors redirect resources

Can tolerate many stressors, but there are limits to what a vine can handle



Availability of Essential Resources

- Water
 - Drought is the limiting factor
 - More frost-events = more water use
 - More heatwaves = more water use
- Fertilizers and Pesticides
 - Availability depends on world market
 - Climate concerns may lead to supply instability
- Skilled labor
 - More expensive and less available
- Wineries / Processing Facilities
 - Warning from other cropping systems
 - Pear processors shut down





Damage from extreme events

- Wildfires
 - Vineyards hailed as ‘fire breaks’
 - Burned vineyard has no production for 3-5 years after damaged
 - Smoke-taint damage to fruit
- Late-spring or early-fall frosts
 - Occurring more often and further south
 - Shortens the growing season
- Multi-year drought
 - Acts as a persistent abiotic stressor
 - Leaves vines more susceptible to other stressors

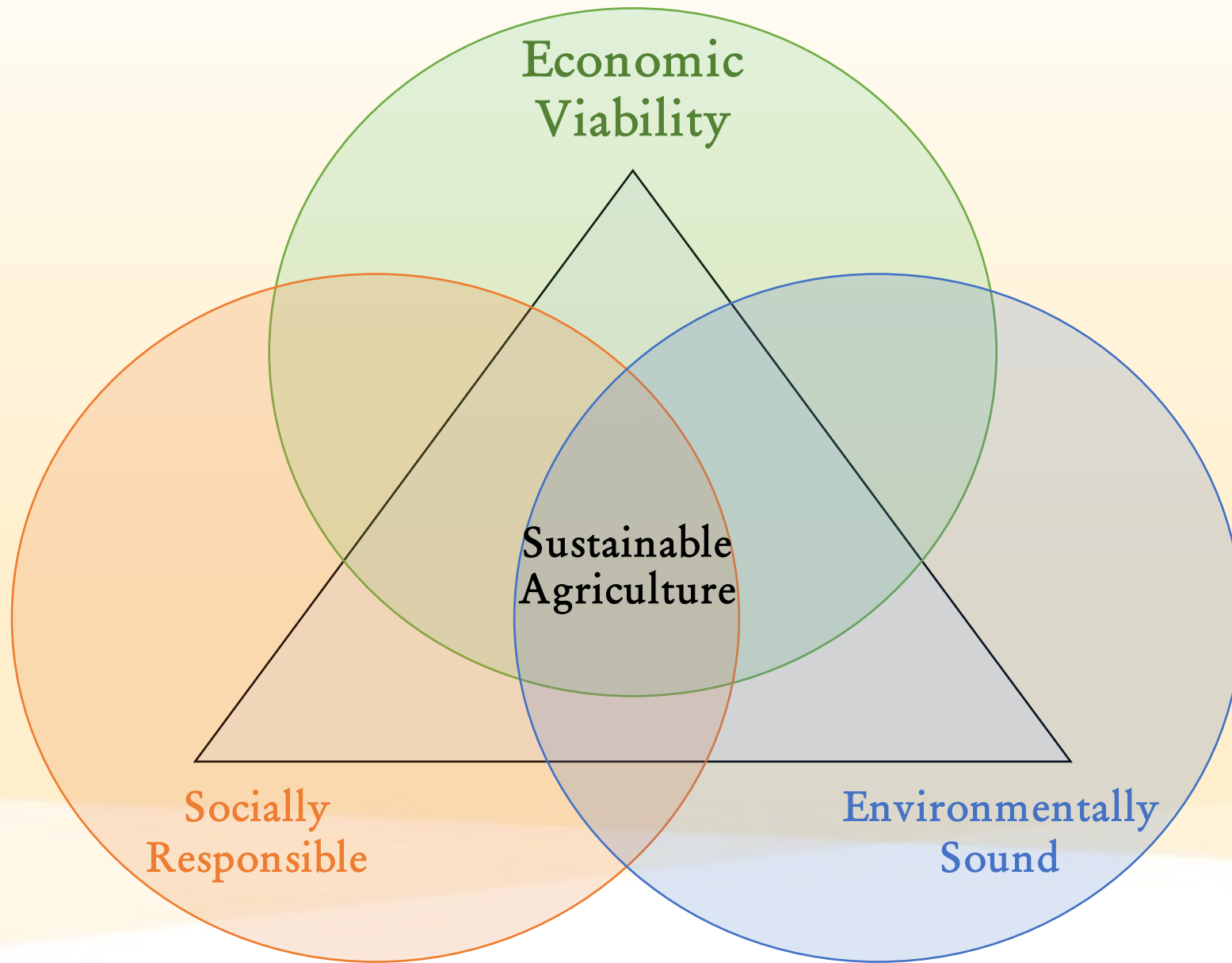


Conserving Agricultural Land

- As farming becomes more difficult due to climate change, we are at risk of losing agricultural land
- With the decrease in farming, land use zoning is often converted from agricultural to housing
- Keep farming to keep farmland

Climate-Adaptive Viticulture

Challenges to implementing change



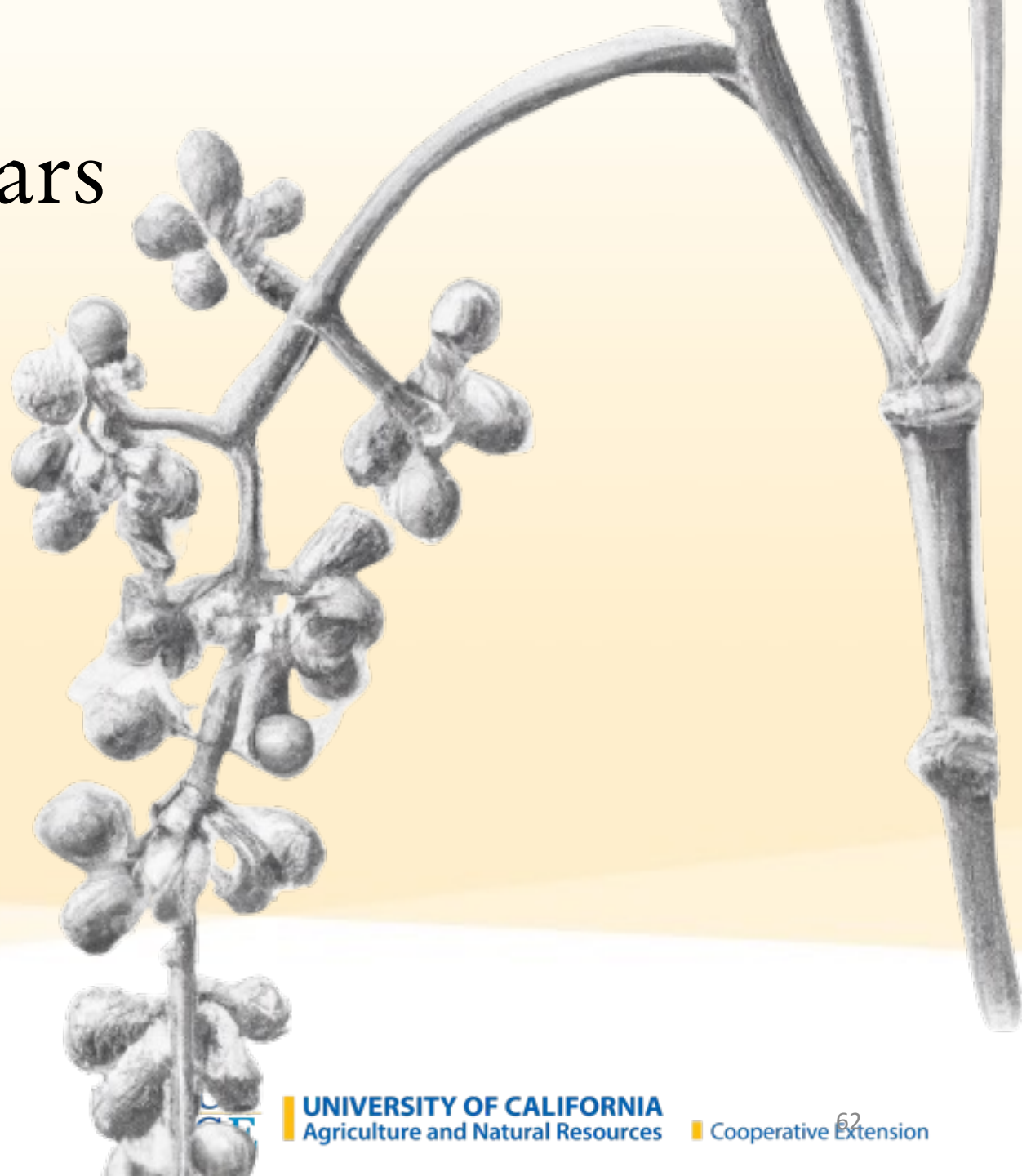


Grower Adoption

- New tools are always slow to be adopted
- Economic concerns limit adoption
- We should be trying tested methods and techniques now
- Climates won't wait for us
- Can't tell growers they need to take large personal risks either

Developing new cultivars

- Need new cultivars tolerant to unique climate conditions
- Do the trait exist in the genetic profiles of cultivars we have?
- Time to new cultivar release \geq 20 years
- Time to grower adoption \approx ???





Resistant Cultivars

Rootstocks have long been used as a method of tolerance to both biotic and abiotic stressors. ⁽²²⁾

- GRN rootstocks for nematode tolerance

Scions are also being developed to help impart tolerance to specific pests and/or diseases ⁽²³⁾

- Pierce's Disease resistant scions

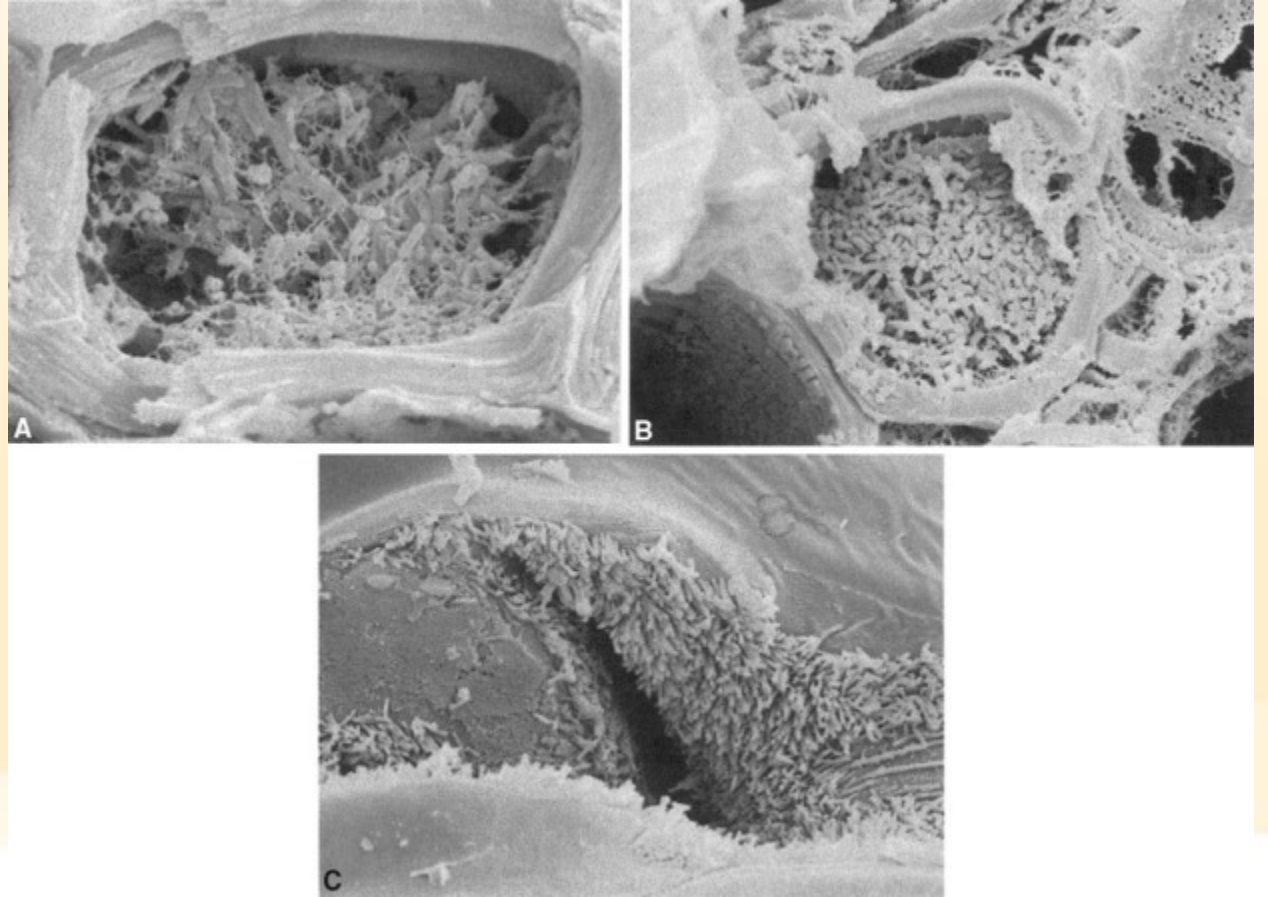
22. M. Mumtaz Khan, Muhammad Tahir Akram, Rashad Waseem Khan zQadri, and Rashid Al-Yahyai. Role of grapevine rootstocks in mitigating environmental stresses: A review. *Journal of Agricultural and Marine Sciences [JAMS]*, 25(2):1–12, Sep. 2020.

23. A. F. Krivanek and M. A. Walker. *ii* resistance to pierce's disease is characterized by differential *ii* populations in stems and leaves. *Phytopathology*, 95:44–52, 1 2005. ISSN 0031-949X. doi: 10.1094/PHYTO-95-0044.

Finding a PD-resistant Scion

Xylella fastidiosa clogs the xylem vessels in grapevines by colonizing the vessels

To find a 'resistant cultivar' would be to find one where vascular hydraulic conductivity does not fail under *X. fastidiosa* infections



PD resistant scions – the ‘Walkers’

Over 20 years of development led to the release of five grape scions with inherent resistant to *X. fastidiosa*

Developed by the Walker Lab at UC Davis

Meant to mimic the most popular cultivars in California



Cultivars by Climate

Winkler index

Region/class	*F units	*C units	General ripening capability and wine style
Region Ia	1500–2000	850–1111	Only very early ripening varieties achieve high quality, mostly hybrid grape varieties and some <i>V. vinifera</i> .
Region Ib	2001–2500	1111–1389	Only early ripening varieties achieve high quality, some hybrid grape varieties but mostly <i>V. vinifera</i> .
Region II	2501–3000	1389–1667	Early and mid-season table wine varieties will produce good quality wines.
Region III	3001–3500	1668–1944	Favorable for high production of standard to good quality table wines.
Region IV	3501–4000	1945–2222	Favorable for high production, but acceptable table wine quality at best.
Region V	4001–4900	2223–2700	Typically only suitable for extremely high production, fair quality table wine or table grape varieties destined for early season consumption are grown.

Variety	Region	Climate	Vigor	Yields
Chardonnay	I, II	Cold	Moderate	Moderate
Sauvignon blanc	I, II, III	Cool	High	High
Riesling	I, II, III	Cool	Moderate	Moderate
Gewürztraminer	I, II	Cool	Moderate	Low
Sémillon	II, III	Warm Coasts	Moderate	High (clonal 8-10)
Melon	I, II	Cold	Moderate	Moderate
Pinot blanc/gris	I, II	Cool	Low	Low-Moderate
Viognier	III, IV	Warm-Hot	Moderate	Low
Colombard	II, III, IV	Warm	High	High
Chenin blanc	II, III	Cool-Warm	High	High
Emerald Riesling	II, III	Cool-Warm	High	High
Burger/Monbadon	III, IV, V	Warm-Hot	High	High
Palomino/Listan	IV, V	Hot	High	High
Muscat blanc	II, III, IV	Warm	Low-Moderate	Low-Moderate
Malvasia bianca	II, III, IV	Warm	Moderate	Moderate
Cabernet sauvignon	I, II, III	Cool	High	Moderate
Merlot	I, II, III	Cool	High	Moderate
Cabernet franc	I, II, III	Cool	High	Moderate
Malbec/Cot	II, III	Cool-Warm	High	Moderate
Petite Verdot	I, II, III	Cool	Moderate	Low
Zinfandel	II, III, IV, V	Cool-Hot	Moderate	High
Mourvedre	II, III, IV	Warm	High	Moderate
Pinot noir	I, II	Cool	Low	Low
Syrah/Shiraz	II, III, IV, V	Cool-Hot	High	Moderate
Sangiovese	III, IV, V	Warm-Hot	Moderate	High
Petite Sirah/Durif	II, III	Cool-Warm	Moderate	Moderate
Valdiguie/Napa Gamay	III	Warm	Low	High
Carignane	III, IV	Warm-Hot	High	High
Grenache	III, IV	Warm-Hot	High	High
Tempranillo	II, III, IV	Warm	High	High
Barbera	III, IV	Warm-Hot	Moderate	Moderate
Ruby Cabernet	III, IV	Warm-Hot	Moderate	Moderate
Carnelian	IV, V	Hot	High	High
Mission	IV, V	Hot	High	High
Rubired	IV, V	Hot	High	High
Alicante Bouschet	IV, V	Hot	High	High

140 Ru



140 Ru – deep rooted

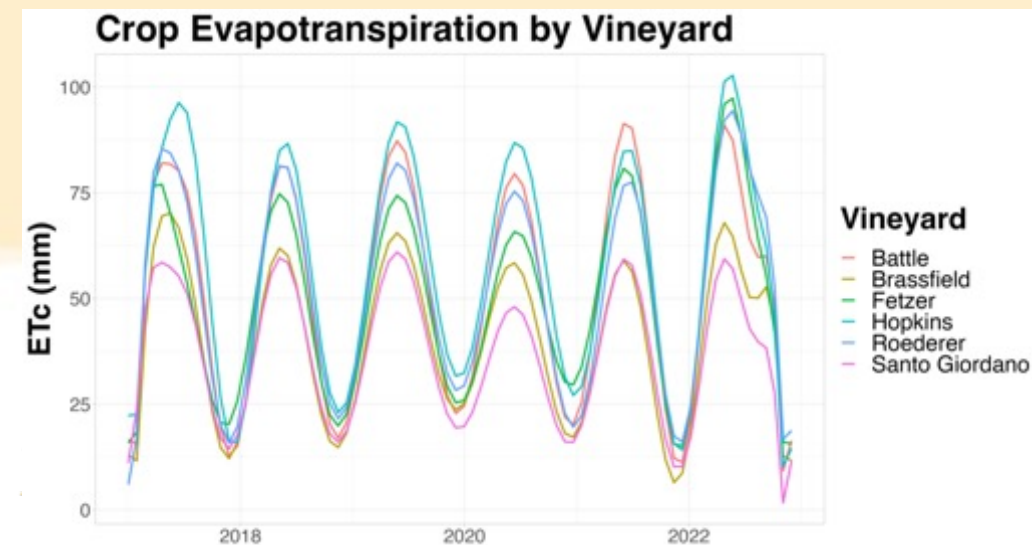
101-14 mgt



101-14 mgt – shallow rooted

Climate-Adaptive Rootstocks Study

- Identifying unique mesoclimates in California where grapes are grown
- Identifying the most common rootstock cultivars in California
- Analysis of their performance under drought
- Classification of each rootstock's drought tolerance in unique mesoclimates



The Climate-Adaptive Vineyard

The Climate-Adaptive Vineyard

1. Water Use Efficiency

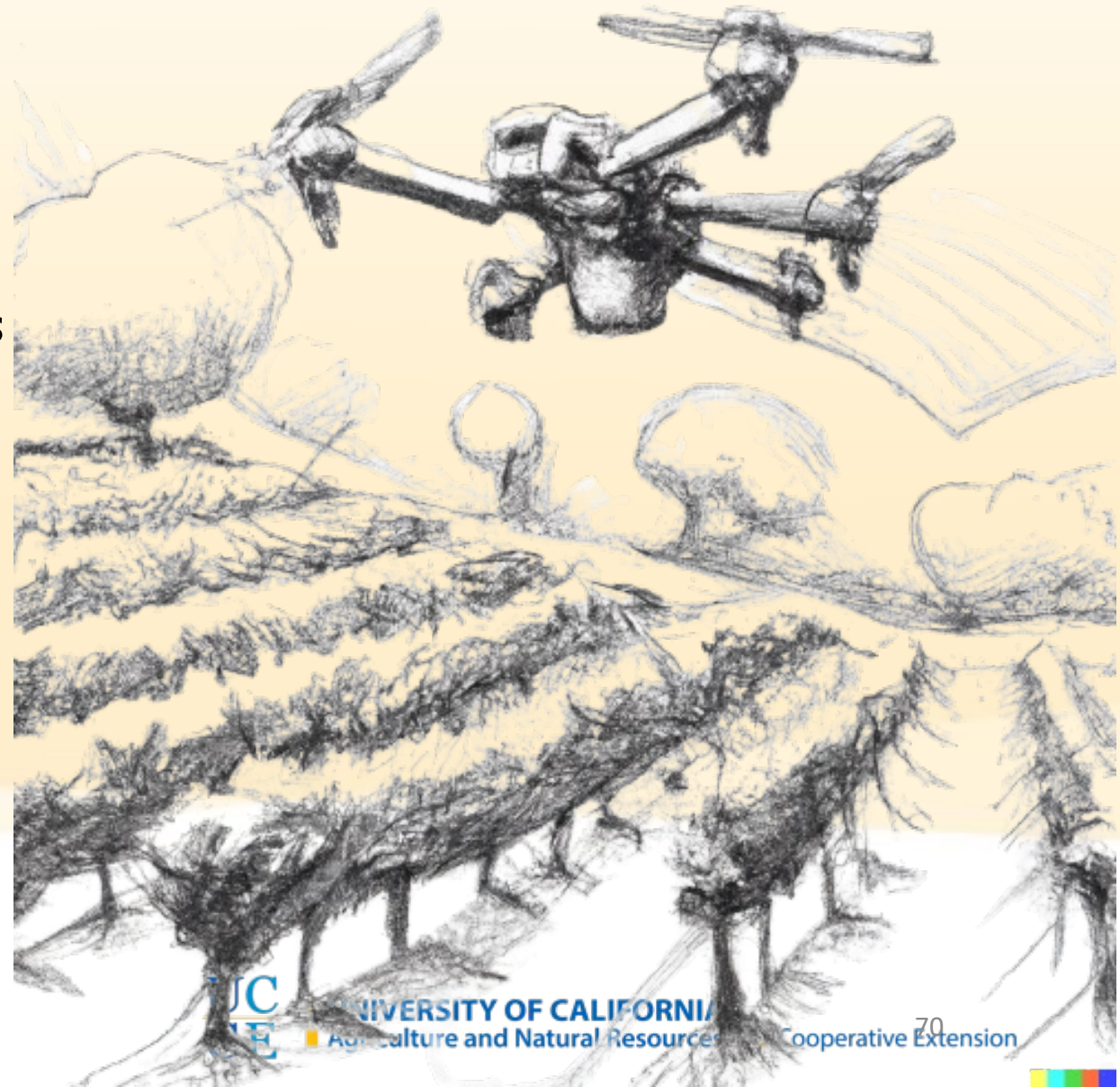
- Drought tolerant cultivars
- Precision irrigation methods
- Water-efficient cultural practices
- Better soil-water dynamics

2. Heat/Drought tolerant varieties

- Research and testing
- Available and adopted

3. Pest-tolerant rootstocks

- Identify future pest risks
- Research and testing
- Available and adopted



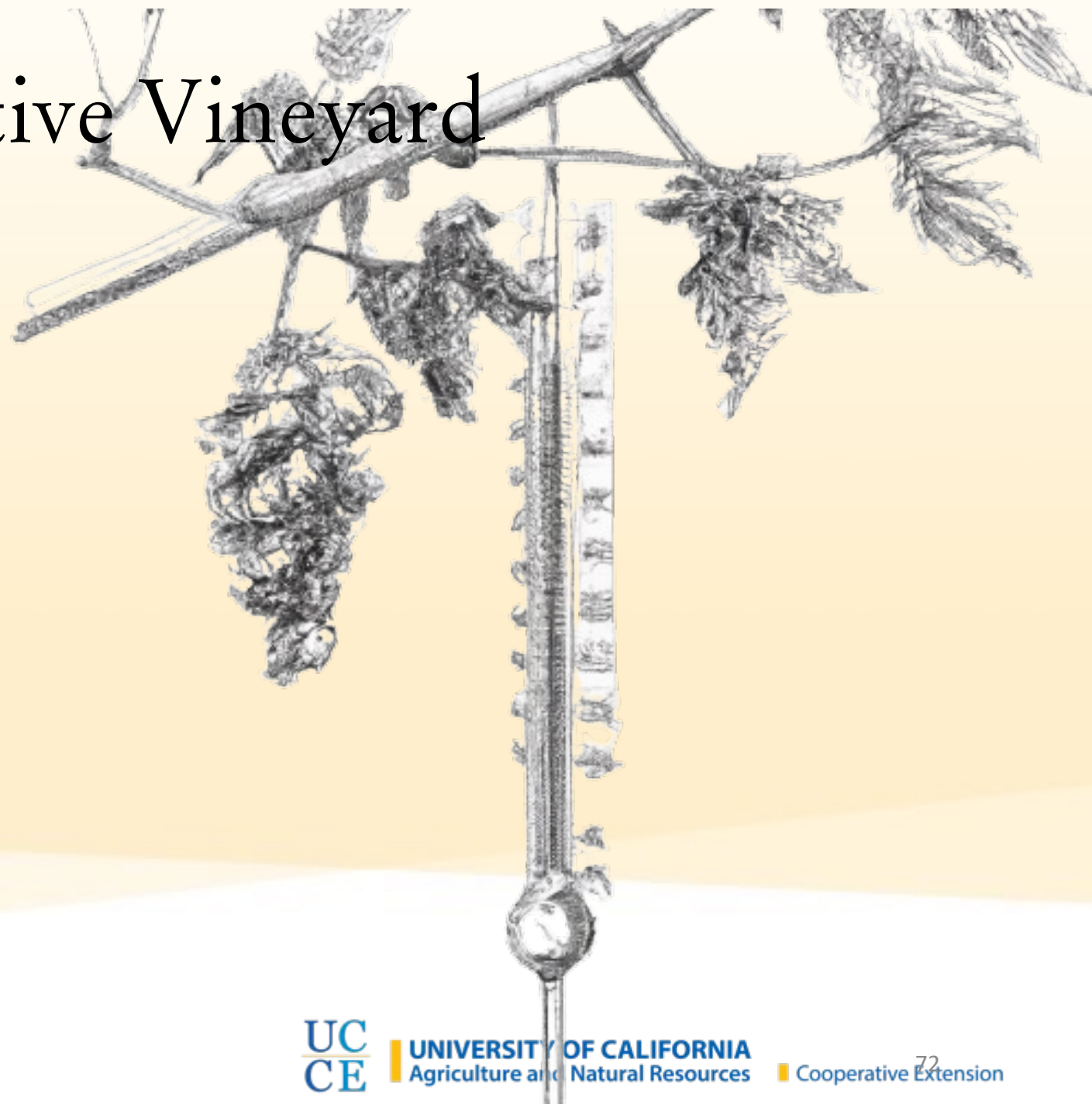
The Climate-Adaptive Vineyard

4. Efficient management practices
 - Precision irrigation
 - Optimize canopy design
5. Improving soil health
 - Increasing water infiltration
 - Improve water retention
 - Improve nutrient retention
 - Promote mycorrhizae health
6. Desirable employment
 - Make jobs desirable
 - Improve employee retention and well-being
 - Keep skilled-labor



The Climate-Adaptive Vineyard

7. Consistent monitoring
 - Look out for new issues
 - Observe and record patterns and trends
 - Get ahead of challenges before they become costly
8. Ready adoption of new practices
 - Growers willing to try out new concepts and practices
 - Increase our climate-resilience greatly



Supporting Research

Funding and agricultural land

- Always need more funding for research
- Also need funding for **implementation and grower education/outreach**
- University of California only owns and operates three vineyards
 - Two for research purposes
 - One for teaching purposes
 - **None** for outreach and grower education



UCCE ~ Private Vineyard Collaboration

- Vineyards are expensive to install, manage, and maintain
- Progress in climate-adaptive research relies on collaboration with private vineyard owners
- Very lucky in the North Coast to have a grower community interested in and supportive of viticulture research
- Need more collaborators in unique mesoclimates



Participate in UC Cooperative Extension

- Tell UC Cooperative Extension Advisors what research you want to see be pursued
 - We are here to address grower-facing problems
 - Our job is to listen to what our clientele needs and pursue answers
- Attend events we organize
 - This is how we make new research accessible
 - Provides an opportunity to have face-to-face conversations
- Ask us for resources
 - We will create them if we don't already have them prepared for public use



Thanks for Listening



Contact me: codchen@ucanr.edu