

# WEST COAST NUT

JUNE 2019 ISSUE

## SPOTLIGHT:

Drip Irrigation Isn't  
Just for Young Hazelnut  
Orchards Anymore

SEE PAGE 4

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Use of Technology in  
Regulatory Functions

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AgTech Today, in  
the Future

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Central Valley

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JUNE 12, 2019

See page 60-61 for agenda details

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By the Industry, For the Industry

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### ***Drip Irrigation Isn't Just for Young Hazelnut Orchards Anymore***

The results are in: drip irrigation produces bigger hazelnut trees faster, more nuts sooner, and fuller, heavier kernels. With drip irrigation, hazelnut production is now possible in dry soils with low-clay content, instead of only in historically-used prime soils. "Drip irrigation is increasingly being adopted. It really has enhanced orchard establishment," said Nik Wiman, Assistant Professor, Orchard Crops Extension Specialist at Oregon State University (OSU) Wiman Lab. "Grows trees a lot faster. We're seeing nuts by year four."

See full article on page 4



# DRIP IRRIGATION

## ISN'T JUST FOR YOUNG HAZELNUT ORCHARDS ANYMORE

By DANITA CAHILL | Contributing Writer



Preparing for irrigation season, Jeff Newton unwraps a sand filtration system. All photos courtesy of Danita Cahill.

### THE RESULTS ARE IN: DRIP IRRIGATION

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### Benefits of Drip Irrigation on Established Trees

Jeff Newton, farm manager for Crimson West/Christensen Farms in McMinnville, Oregon, got in on the ground floor with hazelnut drip irrigation. He partnered with OSU extension service and Crop Production Services, and in 2011, installed a drip system into a 100-acre orchard of two-year-old Jefferson trees. Like Wiman, Newton sees a higher yield sooner with drip irrigation. Dryland trees in poor soil might take anywhere from five to seven years to produce their first crop. With drip irrigation, he’s seeing three-year-old trees in their fourth-leaf producing. Once the trees are yielding, there are additional benefits. “You double your nut crop. Fill your kernels up,” he said.

Not only does Newton champion drip irrigation, he’s also a firm believer in fertigation. His reasoning is logical: why just water the trees when you can also be feeding them? Using 250-gallon tanks and electric fertilizer injectors, he constantly injects fertilizer through his drip system. Amounts vary depending on factors such as the age of trees. A two-year-old orchard may require only seven gallons of fertilizer per acre. A seven-or-eight-year-old orchard is more likely to need 40-50 gallons per acre. The particular fertilizer cocktail Newton mixes depends on a wide range of variables: not only tree age, but the stage of growth and nut development, the season, the weather, the soil type and the variety. “Every variety has a different analysis of what they need or want,” he said.

### Pumping Water

As for their irrigation systems, Christensen Farm pumps water from the Yamhill River. With 3,000 acres in hazelnut production, they utilize several different systems to serve their many orchards. Included among those systems is a 100-horsepower, 48-inch pump, which pumps 750-gallons per minute to a 145-acre orchard (five gallons per acre per minute). A variable frequency drive (VFD) starts the pump and controls output. The river water is run through a sand filter and then piped through 10-inch underground mainlines to the orchard. A piece of flexible hose juts from the ground at the head of each row of trees, to which the drip line is attached. Either

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Jeff Newton inspects a flow meter.



Jeff Newton points to an emitter hole on a drip line.

five-eighths or three-quarter-inch lines are used, depending on how far the water is being pumped. The drip lines are pressure compensated and have emitter holes punched every three feet. Each emitter releases half-a-gallon of water per hour.

### Moisture-Measuring Tools

Newton irrigates during the Willamette Valley's dry months of June, July and August. He doesn't leave the systems running constantly, but turns them on and off depending on moisture readings.

Naturally curious and scientifically minded, Newton relies on observation and measurement to determine how much water and nutrients the trees need. The more water a tree expires through its leaves, the more water that tree must take up through its roots to continue robust growth. Newton has several different moisture-measuring tools in his arsenal. One of his favorites is a device that measures sap flow. Two probes are tapped into the tree to measure water flow up the trunk. He also uses various devices to measure leaf moisture and nutrient levels, and soil moisture.

### Irrigation Research Continues

More OSU research is underway. Some of those studies take place at Christensen Farms in the form of a specialized weather station installed each spring by students from the engineering department. The station measures things like solar flux to

discover how much water, exactly, a tree needs for optimum growth. Since hazelnuts are a fairly shallow-rooted plant without a large taproot, 80-percent of the water absorption comes from the top 18-inches of the soil layer, according to Newton. So, Newton is experimenting with spreading the water and

nutrients over a wider swath around the tree's base. To do that, he's using two, and even three, drip lines in the older orchards. "We've been doing this a lot of years, but what we learned last year doesn't apply because the trees are

*Continued on Page 6*

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Seed peas growing as a cover crop in young hazelnut orchard.



Drip irrigation in a young orchard.



Drip irrigation in a maturing orchard.

*Continued from Page 5*

bigger now,” he said.

As for measureable results, a 22-acre, drip-irrigated orchard of seventh-leaf trees produced 2,000 pounds of nuts last year. In two other nearby orchards, Newton invites farm visitors to compare the trees size and health. Both orchards were planted in the early 2000s with the

Lewis variety. One orchard is irrigated. The other is not. The irrigated trees are noticeably larger and healthier.

### Things to Consider Before Installing a Drip System

Before installing a drip system, there are several things to consider. It takes a significant initial outlay of money to reap the benefits of higher-weight yields down the road. Besides cost, other

factors are soil type, if you hold water rights, and maintenance of irrigation lines and equipment:

- If your soil is quick draining, such as in the southern Willamette Valley, a drip system may not be able to keep up. In that case, a micro-sprinkler irrigation system may be a better bet.

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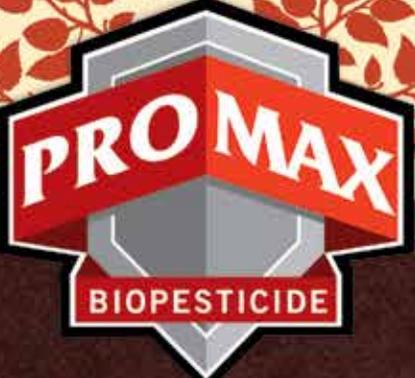


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Continued from Page 6

• You must hold state-granted water rights in order to pump water from a river, creek or irrigation well.

• As far as maintenance, Newton pulls the pumps and stores them before winter floods, and sets them up again around the first of June. Irrigation line is rolled up during months it's not in use and the rolls are hung out of the way in the hazelnut trees.

Sometimes lines have to be repaired or replaced. "Coyotes chew them," Newton said. "Flail choppers are hard on them," he added. Chemicals can clog the lines. Depending on type of water, minerals and debris can also clog the lines. A filtration system is good insurance, but adds additional expense.

What sort of system should a grower consider? That depends on budget and preferences. "You can get fancy and run it from your phone,"

Newton said, although he, personally, prefers a more hands-on approach. "I need to go out there and look. You need to see your trees every day, every week, every month—see what's going on."

### Hazelnut Drip System Costs

Costs can vary greatly, according to Anthony Tasselli of Ernst Irrigation in St. Paul, Oregon. "It depends on the amount of water you're moving at one time. Typically, growers are looking for 6-12 gallons per minute per acre."

Ernst Irrigation has installed systems for as low as \$250 per acre. That figure is for a single-button emitter per tree and one gallon of water per minute per acre. Costs can climb as high as \$1,100 per acre, which is for 12 gallons of water per minute per acre with emitter-line holes punched every 24 to 48 inches.

To break down some of those costs: for a 20-acre orchard, the price for a low-grade, 10-horse pump can start at a few hundred dollars. For an

ag-quality, 10-horse centrifugal pump, expect to pay around \$2,200.

For a 100-acre orchard, a 30-horse pump "at a useful pressure," of around 650-gallons per minute, or six-and-one-half-gallons per acre per minute, Tasselli said, would cost around \$4,100. There are some ancillary fittings needed, such as suction and discharge fittings to get the system up and running. Expect an additional expense of a couple thousand dollars for those. A variable frequency drive would add another \$7,500.

There are two types of filtration systems: disc systems and sand filters. For 300 gallons of flow per minute or more, either system would cost roughly the same, around \$2,200. Tasselli favors sand filtration.

As for the life expectancy of a system, Tasselli said growers can expect to get 15-20 years for the most reliable, long-term drip-irrigation infrastructure, if it's flushed and maintained.

If a grower wants to fertigate, a fertilizer injection pump for a 30-horse water pump system will cost from one thousand to a few thousand dollars.

When installing irrigation into young orchards, growers should consider the future water requirements needed as their trees grow and mature. More and more, Tasselli is seeing growers install drip irrigation into mature orchards.

"The ability to fertigate through the drip, I think, will be a huge benefit for those older trees," Tasselli said.

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Jeff Newton kicks aside debris to expose a flexible hose end to which a drip line attaches.

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# BEST MANAGEMENT PRACTICES FOR ALMOND YIELDS/BLOOM

By CECILIA PARSONS | Associate Editor

**H**OW CAN YOU BE SURE THAT most of the 6.5 million flowers on each of your almond trees will produce a 0.035 ounce kernel? By committing to a healthy long-term relationship with your trees, says Sebastian Saa, senior manager of agricultural research for Almond Board of California (ABC).

Saa, formerly with University of California (UC), Davis, and one of the developers of the nitrogen calculator tool for almond growers, was part of ABC's Orchard Workshop series and focused on maximizing sustainable almond yields.

## Successful Management of Almond Orchards

Managing almond orchards is a bit like marriage, in that it is a long-term relationship, Saa said. Management mistakes can cost production over a long time, but care and attention to detail will pay off over time.

Saa said one of the keys for successful long-term relationships with your almond trees is to understand how they produce a crop and what they need to produce sustainable yields each year.

His equation for maximizing sustainable yields:

**YIELD POTENTIAL = # OF FLOWERS X % FRUIT SET X KERNEL WEIGHT**

Implications of this equation are significant—especially if a grower or manager can figure out how to manipulate the variables, Saa said. The equation is meant to measure yield potential.

## At Bloom

At bloom time—the whiter an orchard, the better chances for good fruit set. More flowers are better, but it is not just the density of the bloom, but also the flower quality. Healthy and fertile flowers are more likely to set fruit. Flowers are just the beginning of

Equation for maximizing sustainable yields:

**YIELD POTENTIAL  
= # OF FLOWERS  
X % FRUIT SET X  
KERNEL WEIGHT**

the year's crop, Saa noted. Attention to orchards needs year round will determine yields.

The quality of the flowers depends on the level of orchard management the previous season. At the workshop, Saa took a branch from an almond tree and noted the spurs, the fundamental bearing structures. More than 80 percent of the almond crop is borne on the short, compact vegetative shoots. Each season only a portion of the spurs will bear fruit. Spur length is from a half inch to two inches and they grow in the prior season's wood. Some rest for a season and some produce fruit, Saa said.

## Key Driver for Healthy Flowers

A key driver of abundant, healthy flowers is the number and type of spurs on tree branches. Trees are constantly cycling through these fruit producing structures. Each year some spurs are just beginning to grow, some are 'resting' after producing fruit the previous year. Others are producing fruit and some are dying after producing fruit in previous seasons.

Spurs play an important role in supporting productivity and yield. Orchard maintenance of a healthy spur population contributes to the economic sustainability of an orchard.

Saa noted that the absence of new shoot growth in a given year means the tree is not developing enough new spurs. This could result in a yield reduction two years down the road. Irrigation and nutrient management play a large role in spur development.



Sebastian Saa, senior manager for agriculture research with Almond Board of California, explains almond spur development at an ABC In the Orchard Workshop April 17 in Wasco. This workshop focused on yield development, irrigation and nutrient management. All photos courtesy of Cecilia Parsons.

*Continued on Page 12*

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## Percentage of Fruit Set

The percent of fruit set is affected during and after bloom. The number one factor in a good fruit set is the number of bees flying in the orchard. That number is determined by the strength of individual hives and weather conditions each day during bloom.

The bee population in an orchard should be adequate for pollination, especially if weather limits flying time during bloom. Growers can place more hives per acre, Saa said, but there is a cost benefit to consider. There isn't much a grower can do to overcome poor weather conditions during bloom, but by making sure the hives in the orchard have the best possible bee strength when weather improves, pollination will occur. Hive strength makes a difference in years with fewer hours of flying time, Saa said, so hives with nine frames or better will ensure more flowers are covered. This is another

management decision for the grower. With all bases covered, a good fruit set is 28 percent.

The nutrients boron and zinc play key roles at this stage of nut production. Management to ensure demand is met will aid in crop development.

## Fruit Drop

Saa noted that fruit drop, the next event in almond production, happens in three distinct stages. The first drop occurs shortly after bloom when defective flowers fall from the tree. The second drop, or 'jacket fall,' occurs about a month later when pea-size flowers that are mostly unpollinated, fall to the ground. The third and final drop, commonly called the 'June drop' occurs six to seven weeks after bloom. This final drop is the result of competition for nutrients and demands on the tree. If bloom was poor, growers can expect higher levels of fruit drop in the first

and second drop stages. Saa said the tree decides who goes and who stays. More shoots versus fruit.

If the tree has had adequate nutrition during the past year, drop should be minimal. Trees rely on storage going into dormancy. If adequate levels of nutrition and water were provided the tree can maintain a new crop until the first irrigation of the season. There is some flexibility if both water and nutrients were managed well in the fall.

## Kernel Weight

The final piece of the production puzzle comes with kernel weight. Again, water and fertilization management are major players in delivering optimal kernel weights at harvest.

Saa said from March to May the nuts inflate much like a water balloon. Water management is critical to kernel size during that time. Temperatures and light interception by the tree also play roles in kernel development and size by helping with adequate carbohydrate supplies.

Following best orchard management practices, including irrigation and nutrient management, will allow for canopy development and maintenance of tree health. A balance between supporting excessive growth that promotes shading and modest growth that supports more spur development is important. Overlapping branches and dead wood should be removed to promote more light interception and promote spur survival.

If management is correct and variables such as weather conditions do not affect production, the 6.5 million flowers times 28 percent fruit set times 0.035 ounce kernels can equal a 4,000 pound to the acre harvest.

ABC's Optimal Yield Series can be a resource for improving production. Subscribe by contacting Almond Board of California. California Almond Board Sustainability Program includes nitrogen and irrigation calculators.

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# AN IPM APPROACH TO VERTEBRATE PESTS

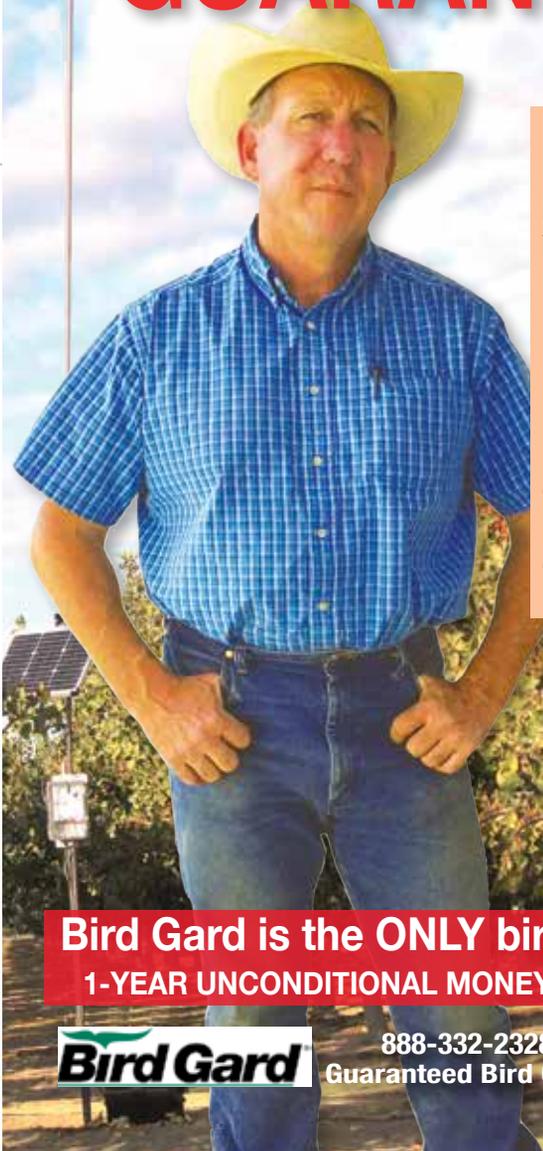
By CECILIA PARSONS | Associate Editor

**T**HEY DON'T LOOK THAT DESTRUCTIVE IN DISNEY MOVIES, BUT vertebrate pests in almond orchards can drive growers and managers nuts. Vertebrate pests run the gamut from coyotes to ground squirrels, to voles and even roof rats. Depending on the species, they can cause yield losses by feeding



Ground Squirrel Burrow. All photos courtesy of Roger Baldwin.

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on nuts, pose food safety issues in the orchard, and damage irrigation lines. Their burrows can slow harvest, damage equipment and pose safety hazards for workers and livestock. Some vertebrate species can also transmit diseases to humans.

### Vertebrate Pest Pressure

Roger Baldwin, a University of California Cooperative Extension (UCCE) specialist in the Department of Wildlife, Fish and Conservation Biology at UC Davis, said vertebrate pest pressure may depend on the growing region or local environmental conditions, but in general, ground squirrels are the primary culprits in orchards. Roof rats feeding in almond orchards are a recent issue in some areas. Orchards near riparian areas are most vulnerable and may also be invaded by raccoons.

Growers or orchard managers who find evidence of vertebrate pest feeding, burrows or mounds in orchards or holes in irrigation lines need to first identify the problem pest so it can be successfully managed.

### California Ground Squirrel

The California ground squirrel, found throughout most of the state, can invade and quickly colonize an orchard. Ground squirrels live in burrow systems where they sleep, eat, rear young and store food. The burrows are about four inches in diameter although sometimes substantially larger, and their length can vary from five to 30 feet. Most systems are

*Continued on Page 16*

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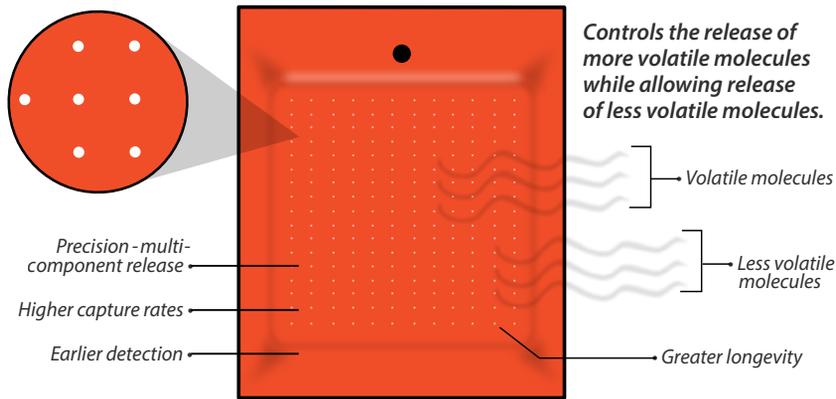
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*Continued from Page 14*

within two to three feet of the surface of the ground. The burrows alone are destructive as they can damage tree roots, are hazardous to machinery or workers and, at harvest time, can slow harvest and swallow up a significant number of nuts if the entrance is large.

Understanding the life cycle of this pest will help make management more effective.

Depending on weather and elevation squirrel reproduction can begin as early as late January. Males often emerge 10-14 days before females. Peak mating season is March-June. Gestation is 23-28 days. Females produce one litter per year.

Squirrels become inactive for two periods during the year. Estivation is the period of dormancy that takes place during extreme heat in July and August. Squirrels also hibernate during the colder months, but can emerge as early as January.

### Baiting

Squirrels feed on grasses or other plants in the spring and transition to seeds and nuts in the summer when they begin to store food. Baiting with treated grain works best after vegetation has dried.

There are two types of rodenticides used in baits and most are restricted use pesticides. Baldwin noted that it is important to follow the label for all products. First generation anti-coagulants are multiple feed materials, meaning the

targeted pest generally needs to ingest it over several days. It may take slightly longer to see results with the anti-coagulants, but there is typically less bait shyness and they are a safer product to use when concerned about direct consumption of bait by non-target animals. These anti-coagulants can be applied via spot treatments, placed around burrow openings; broadcast over wide areas or placed in bait stations where they are protected from the elements. Ground squirrels usually forage close to their burrows- within about a 75-yard radius.

Zinc phosphide is an acute toxicant and provides more rapid control. Less of the material is needed than with anti-coagulants, making it less expensive. Risks to non-target animals through direct consumption are higher and the bait is not always as acceptable due to odor and taste.

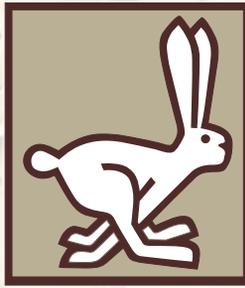
Pests killed by either of the products should be removed promptly as non-targeted wildlife can be poisoned if they feed on the carcasses. Carcasses of animals killed by zinc phosphide generally have low secondary toxicity risk, making it a preferred option where secondary toxicity is a substantial concern.

The UC website: [www.groundsquirrelbmp.com](http://www.groundsquirrelbmp.com) lists other control measures that have only moderate success. Those include trapping, shooting, repellants and burrow modification.

*Continued on Page 18*



Ground squirrel bait station in almonds.



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Ground Squirrel Drip Line Damage.

Continued from Page 16

### Irrigation Lines

Along with coyotes, ground squirrels are likely culprits when it comes to damaged irrigation lines. Baldwin said there is no evidence these pests are chewing to obtain drinking water. Rodents explore and chew on objects in their environment and the plastic lines are handy. Coyotes, and especially their young, are doing what many domestic dogs do—chew on things. The problem may be short term with coyotes as the pups grow and leave. Squirrel chewing is more of a constant issue, Baldwin said.

If coyotes are suspected in damage to plastic irrigation pipe, growers should look for evidence including tracks, scat or large tooth marks. Baldwin said the

chewing is rarely an ongoing issue and often ends when the young pups move on to live prey—which means they can help with the rodent issue. If damage becomes extensive, professional assistance is usually required to remove the responsible coyotes as selectively and as efficiently as possible.

### Pocket Gophers

Other burrowing vertebrates that may pose problems in a nut orchard are voles and gophers. Pocket gophers can be serious pests, feeding on bark of tree crowns and roots. They are active throughout the year and if uncontrolled and food is plentiful, can increase to 30 to 40 individuals per acre. In nut orchards they are more likely to damage a cover crop than to cause serious injury

to bark or roots of mature trees. They do regularly girdle and kill young trees though. Pocket gophers also chew on buried irrigation lines.

Pocket gophers remain active year-round. Surface activity decreases on hot, dry lowlands during summer and during and after heavy rains. Gnawing or girdling of young orchard trees is most likely to occur during late summer when the ground is dry and green vegetation is scarce.

Pocket gopher and mole mounds are often confused. Mole mounds are volcano or conical shape in appearance. Pocket gopher mounds are usually crescent or horseshoe shaped with a plug located toward the lower portion of one

Continued on Page 20

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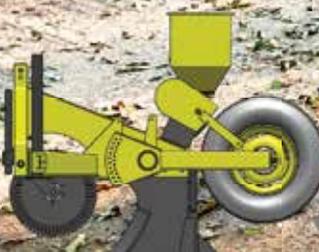




Photo by Wayne Lynch



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Continued from Page 18

side of the mound. It is important to note which species is invading the orchard as management options for each are different.

### Management

Pocket gopher management can be particularly effective in late fall through late winter when mounding activity is high. The UC Integrated Pest Management Vertebrate Pest Management Handbook advises that

the most effective long-term strategy for managing pocket gophers will require use of multiple approaches. Due to their inconsistent mound creation, a single treatment may miss part of the population, making multiple treatments necessary.

Burrow fumigation, trapping, and baiting appear to be the most effective control options. First generation anticoagulants such as chlorphacinone and diphacinone, zinc phosphide and strychnine are the primary toxic bait labeled for this pest. The handbook notes

that pocket gophers develop behavioral or physiological resistance to strychnine and it should only be used as part of an integrated pest management (IPM) program.

All pocket gopher bait is applied below ground. There are three primary methods for baiting: 1) hand baiting via the funnel and spoon method, 2) an all-in-one probe and bait dispenser, and 3) a mechanical burrow builder. Preventative perimeter treatments using burrow builders around orchard blocks or crop fields (up to three rows, 20-30 feet apart) made two to three times per year can reduce pocket gopher migration into crops BEFORE damage occurs.

### Voiles and Meadow Mice

Voiles, or meadow mice damage trees by chewing on bark and even girdling young trees. These mouse-like rodents spend more time above ground than gophers, but have underground burrows.

Removing vegetative cover can change their habitat enough so they seek more favorable conditions. If infestations are heavy, baiting with products similar to those for squirrels will work. Chlorphacinone is labeled for year-round crop border broadcast; most anticoagulants and zinc phosphide baits are labeled for broadcast in dormant orchards and for use in bait stations around the perimeter.

Burrow fumigants such as gas cartridges aren't effective for controlling voiles, because their burrow system is shallow and has numerous open holes. Electromagnetic or ultrasonic devices and flooding are also ineffective against voiles.

When it comes to disease transmission, the primary concerns are Hantavirus, Colorado tick fever and Leptospirosis. Ground squirrels, wood rats and mice can be hosts of Colorado tick fever and it is transmitted by a bite from an infected tick.

Leptospirosis is caused by bacteria that can be harbored in many rodent species that show no signs of illness. The bacteria can be spread to pets and humans via urine from an infected rodent.

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# VIEWS FROM ALMOND PROFESSIONALS ON **WHOLE-ORCHARD RECYCLING**

By AMBER KERR AND SONJA BRODT | UC Sustainable Agriculture Research and Education Program, Agricultural Sustainability Institute, University of California Davis, BRENT HOLTZ | University of California Cooperative Extension, San Joaquin County, AMELIE GAUDIN | Department of Plant Sciences, University of California Davis

**A**LMOND ORCHARD REMOVAL in California's Central Valley is more expensive and complicated than it used to be, due to closures of biomass energy plants and stricter regulations on open burning. In response, an increasing number of almond growers are trying whole-orchard recycling, the practice of chipping the old trees and incorporating the wood chips into the soil before replanting the new orchard. Research on whole-orchard recycling (WOR) began in 2009, but only in the last few years have enough growers tried the practice to give a clearer picture of its effectiveness in the real world. What do adopters and non-adopters think about WOR at this early point in its development?

Our team just completed a three-year field trial funded by the California Department of Food and Agriculture to investigate how whole-orchard recycling affects soil properties and tree growth. To guide creation of outreach materials for our new website, and to prioritize future user-driven research, we conducted a series of surveys and interviews with almond professionals around the

state. The results were informative in their own right, and we wanted to share them with a wider audience.

## Survey and Interview Methods

We surveyed California almond professionals in two ways: (1) Paper surveys handed out at two WOR-focused field days in October 2018; (2) An online survey that was advertised via paper flyers at the December 2018 Almond Conference and via email to readers of West Coast Nut magazine. Here, we will present quantitative results from the online survey, which had similar outcomes but a larger sample size than the paper surveys.

We also conducted 30 phone and in-person interviews with survey respondents who voluntarily identified themselves for follow-up (along with other almond professionals known to have relevant expertise). Insights from those in-depth conversations are reported after the quantitative survey results.



Almond wood chips on the floor of a recycled orchard in Stanislaus County (February 2019), ready to be incorporated before the orchard is replanted. All photos courtesy of Amber Kerr.

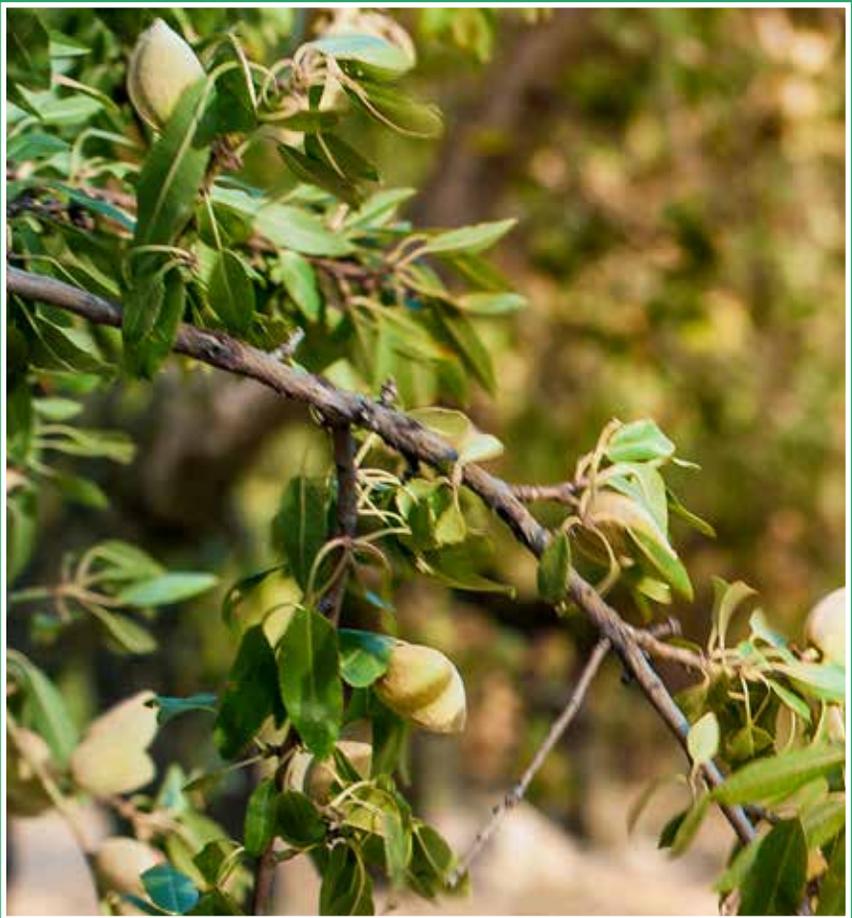


A newly replanted orchard in Stanislaus County (February 2019) that was recycled in Fall 2018. Some wood chips are still visible on soil surface.

## Online Survey Respondents

Our online survey received 125 valid responses, of whom the majority were WCN readers responding to an emailed survey link. They self-identified as 59 percent growers, 28 percent crop advisors or extension agents, 22 percent suppliers of farm products or services, 2 percent commodity board members, 2 percent researchers, and 13 percent other. (Each respondent could choose multiple categories if applicable, so percentages sum to more than 100 percent.)

Of these respondents, 27 percent had actually implemented whole-orchard recycling; 50 percent were familiar with how it worked but had never tried it; 18 percent had heard of it but did not know the details; and 6 percent had never heard of it before taking the survey. We note that WOR users are overrepresented in this survey; a random sample of almond growers and advisors would show much lower levels of experience with WOR. (Our best estimate,



*Continued on Page 24*

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according to informed guesses from orchard removal companies and crop advisors who work with large numbers of growers, is that the current adoption rate of WOR ranges between 5 percent and 10 percent in the San Joaquin Valley, whereas it is close to 0 percent in the Sacramento Valley.)

**Online Survey Results: Benefits**

We first asked respondents (n = 125) to choose all possible benefits of whole-orchard recycling from a list of options, and then we asked them to identify what they thought was the main benefit. When asked to “choose all that apply,” respondents spread their answers nearly equally across all the options, ranging from carbon sequestration to yield increases. But when asked to name only the “most important benefit,” respondents clearly focused on two factors (Figure 1a, see page 24): improving soil physical properties (chosen by 30 percent) and providing the most economical option to comply with air quality regulations (21 percent).

When we examined only the subset of respondents who had actually practiced WOR (n = 33), opinions shifted in an interesting way (Figure 1b, see page 24). Economical compliance with air quality regulations was their number one perceived benefit of WOR (27 percent), followed by soil physical properties (21 percent). Not a single one of these WOR adopters thought that soil nutrient status was the main benefit, perhaps due to their experience with higher nitrogen demand in recycled orchards. Three adopters (9 percent) said that the practice had no major benefits, indicating that not everyone had a positive experience with WOR.

**Online Survey Results: Drawbacks**

Similarly to the benefit questions, we asked respondents to choose all perceived drawbacks of WOR from a list, and we then asked them to select the single most important drawback. Answers to the “choose all” question (not shown) had a similar breakdown to the “single most important” question. Opinions on the most important drawback are shown for all respondents (Figure 2a, see page 25) and for WOR adopters only (Figure 2b, see page 25).

The most notable difference between all respondents versus only adopters was how they perceived the issue of disease in the replanted orchard. Disease risk was the number one concern for respondents in general, but for respondents who had actually tried WOR, disease dropped to a fourth-place tie. Our data cannot clarify the direction of cause and effect (growers may be more likely to try WOR if they have no major disease concerns), but it does seem that WOR adopters have not generally noticed increases in disease so far.

Figure 1a. All respondents (n = 125)

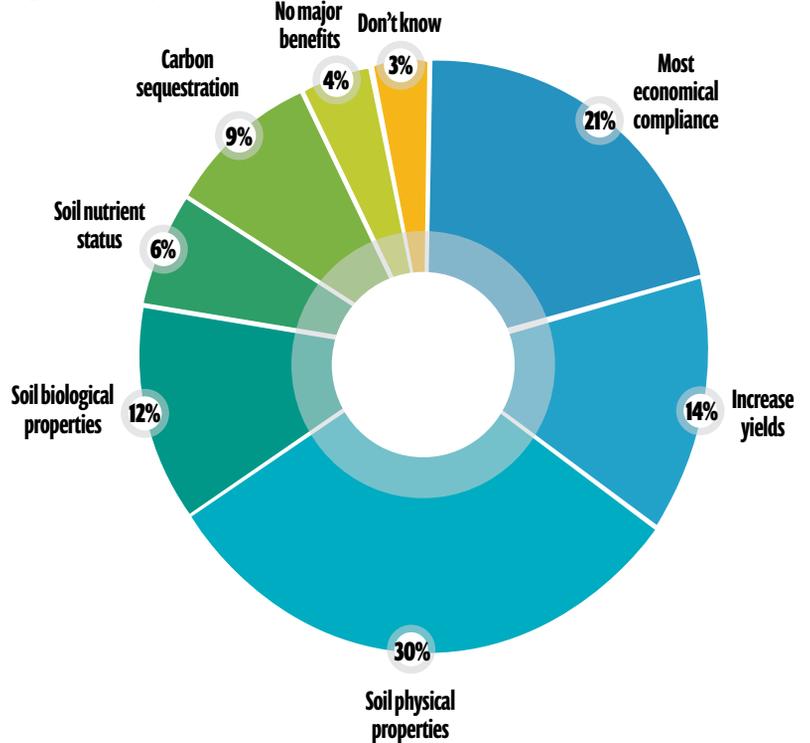


Figure 1b. WOR adopters only (n = 33)

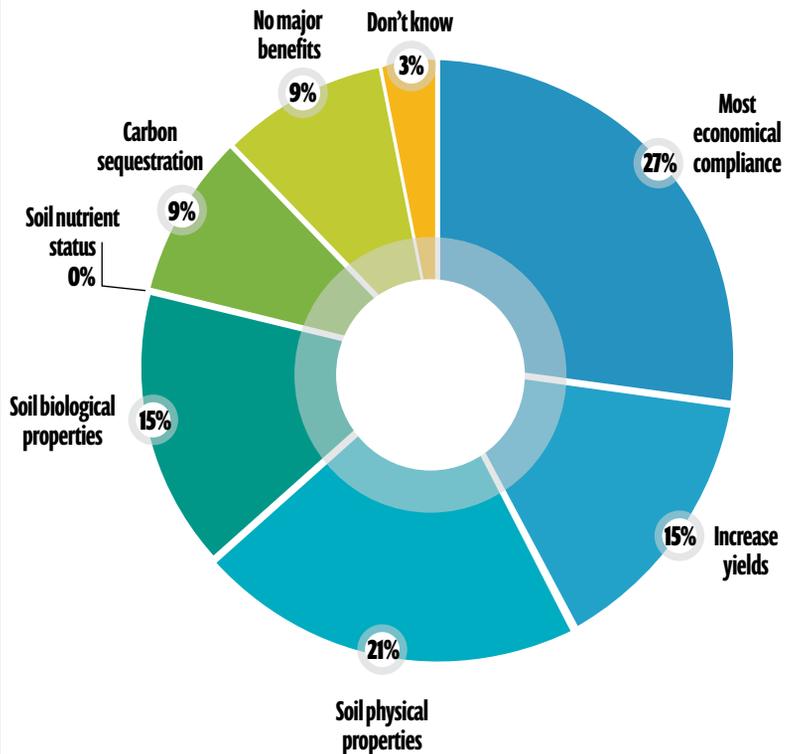


Figure 1. Most important benefit of whole-orchard recycling in almonds, according to online survey participants in December 2018. (Answers were mutually exclusive; respondents could only pick one)

Concerns about expense were common among all participants (22 percent named it as the top drawback). Among adopters, expense was an even bigger concern (27 percent) than among non-adopters. A variety of other drawbacks were consistently mentioned (woody debris; poor nitrogen (N) status; lack of equipment; etc.), and only

Figure 2a. All respondents (n = 125)

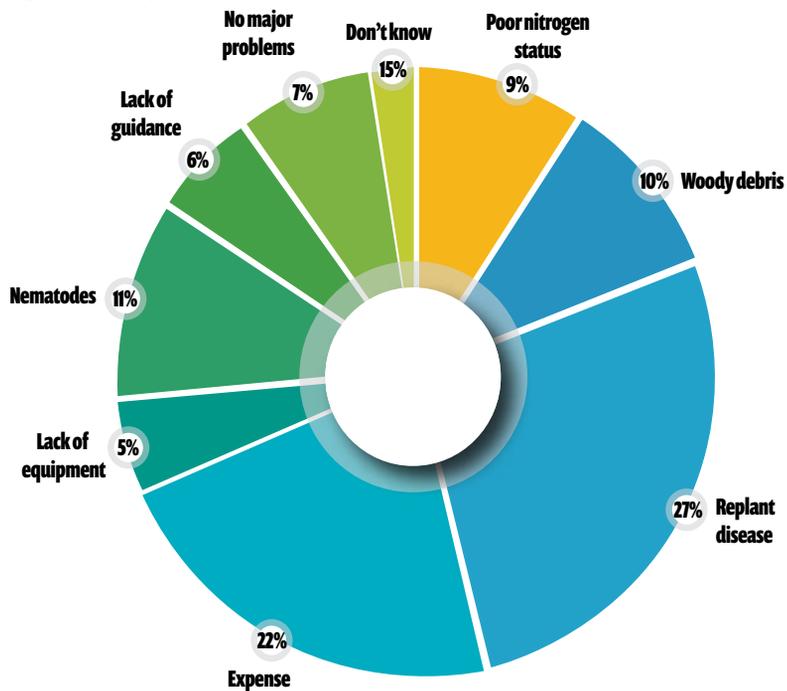


Figure 2b. WOR adopters only (n = 33)

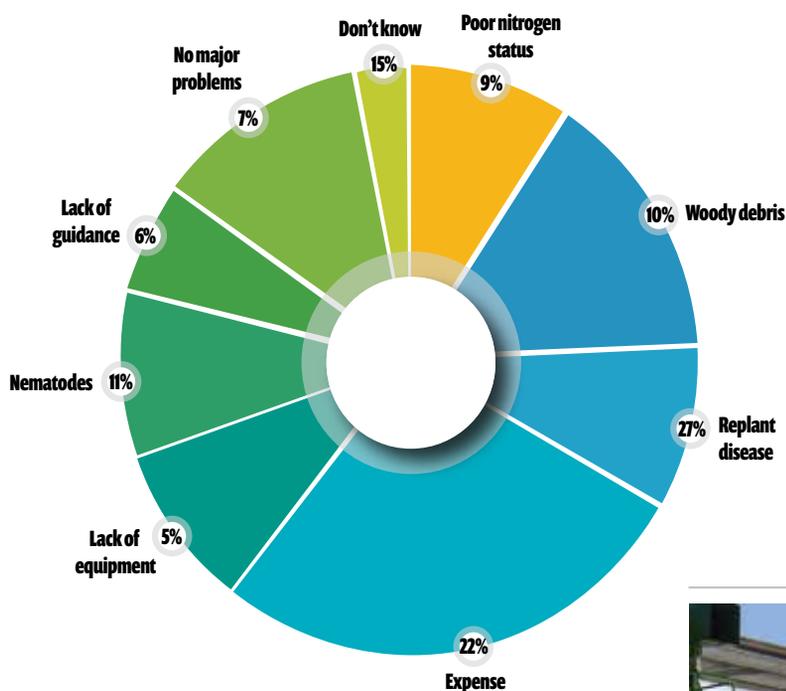


Figure 2. Most important drawback of whole-orchard recycling in almonds, according to online survey participants in December 2018. (Answers were mutually exclusive; respondents could only pick one.)

4/33 adopters (12 percent) said that they had no major problems with WOR. This ranking of benefits and drawbacks helped us focus our in-depth interviews by phone and in person.

## In Depth Interview Results

We wanted to learn how growers and crop advisors overcame the stumbling blocks of whole-orchard recycling and whether they were on track to see its theoretical benefits. The headings below correspond to the most frequently-asked questions from the write-in sections of our surveys. We answer these questions to the best of our ability on the basis of our field research and interviews with almond professionals in January to March 2019. These interviews comprised 30 practitioners (12 growers, 13 crop advisors, and 5 other professionals including nursery operators and almond processors).

### Is WOR too Expensive?

WOR has a higher upfront cost, but the extra cost depends on the baseline practice that it is being compared to. Where open burning of old orchards is still common and legal, that may still be the cheapest option, at least for now. WOR is similar in price to the grind-and-haul disposal method, except for the additional cost of spreading the chips (which our interviewees reported as being \$125-\$400 per acre). Subsequent land preparation (deep ripping, disking, leveling, floating; fumigating) is usually the same regardless of whether WOR is used, though some of our interviewees noted the need for more tillage and/or larger equipment to incorporate the chips properly.

Many interviewees mentioned that they would be more eager to try WOR if the additional cost could be offset by a subsidy. Although WOR is not yet eligible for CARB greenhouse gas offsets, nor is it yet on the list of funding-eligible

*Continued on Page 26*



Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP) practices, the San Joaquin Valley Air Pollution Control District now offers an incentive of \$600 per acre for grinding and incorporating wood chips (helping to offset the cost compared to burning).

### Does WOR Perpetuate Diseases?

Little empirical research has been done on this question. However, none of the growers and crop advisors in our interview sample who had done whole-orchard recycling ( $n = 13$ ) had noticed any disease concerns in the replant orchard. Theory suggests that once the chips are dried and incorporated into the soil, they do not tend to harbor viable pathogens from above-ground parts of the tree (twigs, branches, flowers). Nor do wood chips from WOR appear to affect fumigation efficacy, according to our interviewees.

Expert opinion differs on which almond diseases are incompatible with WOR. Two diseases of special concern are *Armillaria* (oak root fungus) and *Ganoderma adspersum* (a virulent butt rot fungus found from Madera County south), because they are known to survive in dead wood. Although there is no direct evidence that wood chips from these infected trees would increase disease pressure (beyond what already occurs from left-behind infected roots and soil), growers with heavy infestations of *Armillaria* or *Ganoderma* may want to err on the side of caution and dispose of old orchard wood offsite or by burning.

Research is also needed on whether crown gall (*Agrobacterium tumefaciens*) and band canker (*Botryosphaeria* sp.) can be transmitted via orchard recycling, as these pathogens may be able to persist in wood and/or soil. To reduce the risk of any disease organisms surviving the recycling process, we recommend grinding the wood with a 2 inch screen and letting the chips dry completely on the surface before incorporating them thoroughly.

### What Equipment is Needed?

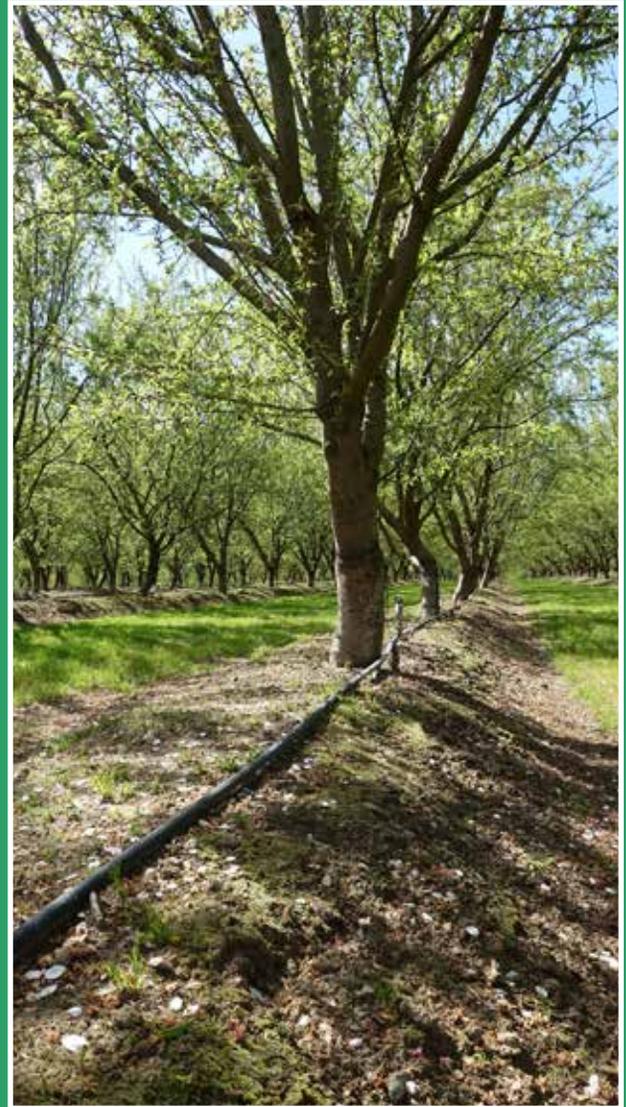
Most growers lack the specialized

equipment (usually, horizontal grinders and modified manure spreaders) to carry out WOR themselves, so finding a trusted contractor is crucial. Because demand for orchard removal services exceeds supply, and because WOR is a new practice, there is a risk of poor quality control. Many WOR adopters reported frustration due to orchard removal companies arriving weeks late, spreading the chips unevenly, and/or not incorporating the chips properly before they rushed off to the next job. A Stanislaus County grower reported that the first time “didn’t go very well” due to careless spreading, which left large wood chunks and uneven chip depth. She had to change contractors three times over the next three years and is now happy with the results.

For post-spreading land preparation, many interviewees reported good results from using a moldboard, Baker, or switch plow (in addition to deep ripping and stubble disking). Leaving the chips mostly in the top four to six inches of soil is not desirable, especially if the chip layer was more than three to four inches deep to begin with.

### How Fast do the Chips Decompose?

Most growers practicing WOR have no problem obtaining a clean orchard floor in time for the first harvest in year three or year four. “The chips disappear after one full season,” said a grower in Merced County who is on his sixth round of WOR. The few growers who did have problems with woody debris



No chips are visible on the floor of this fifth-leaf Nonpareil/Aldrich orchard, which was planted on a recycled orchard block in 2015. (Merced County, California, 3/2019)

generally used a large screen size (>4 inches), had excessive amounts of wood (>60 tons/acre), and/or lacked adequate equipment to incorporate the chips below four to six inch depth.

Growers have achieved better decomposition rates by letting the chips dry on the soil surface first, treating the chips with fertilizer, manure, or irrigation before the new orchard is planted, and maintaining native vegetation or planted cover crops in between the tree rows. Many growers who started out trying a larger chip size (four to six inches) say that next time they would spend the extra time and cost to obtain a smaller

Continued on Page 28



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chip size (two to four inches).

### Will the Replant Orchard be Stunted?

After some early setbacks with nitrogen-starved replant orchards, growers and researchers alike have learned that proactive extra fertilization is crucial for success following WOR. University of California Cooperative Extension advisors Brent Holtz and Mae Cullumber

summarized these findings in the February/2019 issue of WCN. In a nutshell, they recommend six to eight ounces of N per tree during the first year after WOR—a doubling of the standard amount. Our interviewees noted that the timing of this extra N is as important as the amount; the additional N demand kicks in surprisingly early, as soon as March. One WOR adopter in San Joaquin County made a habit of

checking on the leaf color of his replant orchard daily, using a pair of binoculars from his kitchen window. “It was fairly time-consuming working out that nitrogen issue,” he said.

### How Does WOR Benefit the Soil and the Trees?

Although it is too soon to generalize about yield increases under whole-orchard recycling, the original 2009 WOR trial at Kearney Ag Center has shown a consistent yield advantage of about 20 percent (215 kernel-lbs/acre) in the recycled plot compared to the burned control plot over the first seven bearing years. Only one of our interviewees had orchards that were of bearing age after WOR, so not enough farm-level data are available yet.

Data on soil physical properties is encouraging so far. The field trials in this experiment have shown that, over the first three years, WOR increases soil organic matter, water infiltration, soil microaggregate stability, and soil water-holding capacity, among other factors. We expect to see these effects translate into healthier, more water-efficient trees over the longer-term.

### Acknowledgements and More Information

Research on whole-orchard recycling is ongoing, and we want to hear from as many practitioners as possible. You can contact us via the new website [orchardrecycling.ucdavis.edu](http://orchardrecycling.ucdavis.edu), which also includes the latest research results, best-practice guidance, interviews with grower adopters, events, and publications.

PIs on this project were Amelie Gaudin (UC Davis), Brent Holtz (UCCE), Sonja Brodt (UC Davis), Greg Browne (USDA/ARS), and Andreas Westphal (UCR). We extend our sincere thanks to the 30 interviewees who gave so generously of their time, as well as to the 181 survey respondents who shared their thoughts for the benefit of the community.

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# USE OF TECHNOLOGY IN REGULATORY FUNCTIONS

By TERRY BRASE | Director, Farm of the Future at West Hills Community College



**A** **S MORE AND MORE** technological devices and practices are developed, growers will continue to get and more sales pitches. A walk through any conference exhibit hall is a small look at the huge market that is ag technology. It is a very competitive market and these companies and developers are not only fighting for the investor's dollar, they are competing for the growers sales dollars. Developers and their marketers must provide justification to the grower for their products. If the market is to support the product, it must have a specific benefit to the grower.

## Benefits of Technology

The obvious benefit is the economic value. The grower and the investor, want to know that they will get a return on their investment. The investor wants a return along with interest and the grower wants to increase income and/or reduce costs within a two to three years span of time in which they have invested.

There are also intrinsic advantages such as comfort and ease of mind, which many growers consider when purchasing new technology. One grower invested in an autoguidance system and discovered it was far less stressful, so much so, he could have lunch in the tractor with his wife, and most importantly he was confident his employees could plant in straight rows. In speaking with him, not once did he mention how much money he saved, but that he actually enjoyed fieldwork again.

Environmental benefits that protect natural resources should be given consideration also. I believe that growers are naturally environmentalists, though many people don't see it that way. Many

of the tools that growers have used in the past have not been as environmentally friendly as hoped and one reason why they are "in the past". Balancing economic benefits and environmental benefits for the long term is what I have always considered to be the definition of sustainability.

## Technology for Regulatory Functions

Another benefit not often discussed, and thus the subject of this article, is the use of technology for regulatory functions. The US government has a long line of regulatory agencies. So the old cynical quote comes to mind, "I'm from the government and I'm here to help".

Governmental agencies don't make laws, but they do create the standards and regulations by which the laws are implemented. Agencies are also responsible for enforcing those standards and regulations. Most of the time we don't recognize these regulations as beneficial (and at times there may be valid arguments to this point), but they are in place for reasons of safety, fairness, and equity.

An example of a regulatory agency is the Occupational Safety and Health Administration (OSHA), which is responsible for the safety and the health of the workers in the US. A very noble and important purpose. Laws are passed on a regular basis dealing with safety issues, however Congress and the Senate do not provide the specific details of what is to be done and how to ensure safety and health. That is left up to OSHA to create the regulations that implement the laws. These regulations are usually criteria

or standards that must be met. In the case of OSHA, it involves safety devices and practices that employers must have for their employees.

The other role that agencies have is the enforcement of the regulations or laws. Enforcement is not usually in the form of an FBI agent or federal officer, it is something more dreaded... paperwork! It's called accountability and it provides the agency proof that the regulations are being followed. Again in the case of OSHA, there are annual reports due and every time somebody is injured a report is completed. These may not be required, but if a company does not have documentation of when, where and how accidents occurred, they may be subjected to penalties.

Another example of an agency is the Food Safety and Inspection Services (FSIS) which is a part of the United States Department of Agriculture (USDA). The Farm Bill from the federal government provides the laws concerning healthy foods and the FSIS is responsibility to develop the regulations and standards to ensure those laws can be implemented and enforced. In some cases the standards are the amount of residue or quality of products.



Enforcement comes in the form of inspectors that test residue on products and if it doesn't meet the standard they have the right to take the product off the retail marketplace.

States also take responsibility for the food products that are produced within their border. The state department of agriculture often has regulations to make sure that crop inputs are being properly applied. Regulation takes the form of certification tests for persons doing the application before being allowed to buy or apply products. Applicators are also required to complete paperwork and documentation of all environmental conditions when the product was applied.

### Accountability

Therefore along with regulations and various benefits provided by the government agencies comes accountability. Accountability is how an agency documents the compliance of its rules or the impact of the funds that it has expended. In what form does the government currently require accountability? Usually it is in the form of written reports that are completed by the public, people receiving the benefit, or government workers hired to collect data on compliance.

Using some of the previous examples, lets see how technology can be used to document regulatory compliance. These are not a summary or critique of current regulations, merely a reflection of how technology could be used.

### Using Technology to Document Regulatory Compliance

OSHA is concerned about safety of workers and documents injuries. Documentation is required that shows that safety gear is in place; personal protective equipment (PPE) is being worn; and injuries that occur in the workplace. Use of RFID (radio frequency ID) tags with a Bluetooth or Wifi on safety gear would allow an inspector to enter a building and get a complete list of safety gear and location on a handheld tablet. An electronic counter (similar to a FITBit) on PPE would provide documentation on its use. A proximity sensor on a first aid kit would record each time it was open with a time and

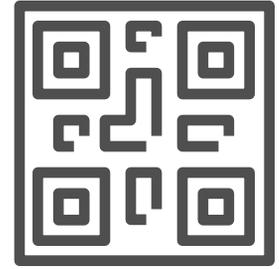
date stamp, to be checked against a log of injuries.

In a processing plant inspectors fill out a paper form with each lot or grouping of fruit that he takes a sample from, to document the level of residue or bacteria. Instead, a QR (quick response code) is attached to each lot of fruit as it comes out of the field. As it enters the processing plant a date/time stamp is attached to the database for the QR code. As it is tested for residue, that information is also attached to the database. Everything that is done to

that food item is automatically digitally entered into the QR database. A handheld data-logger could be used to scan a QR code for the lot of fruit for confirmation of compliance and checking of results.

Most animal production facilities

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have to get rid of a large amount of manure. A state's department of natural resources is usually responsible to make sure that it is spread someplace where it will not get into the groundwater or surface water. Animal production facilities are responsible for a Manure Management Plan that includes a map and how much manure was placed on each field. Growers have hand created maps and estimate the values in the past. A technological alternative is to use GIS (Graphics InterchangeFormat) to create a map of all the fields and GPS on the application equipment to document the time and location of all applications. If a flow meter is used, it will also document how much was applied. An as-applied map provides an accurate application rate throughout a field, knowing not only where but how much.

Applying restricted chemicals in the field requires not only a field location, but should also be time/date stamped, chemical information, and weather conditions including temperature, humidity and wind. This information is important because you are not only accountable to the government, but you are likely accountable to your neighbor. Using a GPS is a trustworthy source to document where and where the application occurred. To get weather data automatically, National Oceanic and Atmospheric Administration (NOAA) records this 24/7 and make the information available on the internet. Downloading and attaching to the application information provides

the documentation that the field was sprayed properly.

These examples are not at all futuristic; all of these technologies exist. Though I am not sure how many are actually being used for regulatory functions, some of them are being considered and researched. The example of the processing plant that identifies fruit going through the plant using a QR code to record all processes is known as Block Chain. It is something that will likely be expanded and adopted by more processors, not because the government requires it, but because the public wants it. People want to know where their food comes from and what has been done to it and how much energy it took to produce it. So in some cases it is not just the government demanding accountability, it is the public consumer that wants it.

### Technology Usage in the Future

Will technology be used for regulatory compliance? A likely and resounding yes. Anytime in the next 10 years; that is harder to predict. There are several issues that need to be considered.

Can the government require use of technology? Currently this unlikely because its use is not common enough that everybody would have access to it. Government agencies already make it an option as is the case with the manure management plans. The regulatory agency is not going to require the use of a GIS/GPS for manure management plans, but some consultants offer GIS and GPS services to create a plan and

then annually update it.

### Weighing the Pros and Cons

Another related concern... is Big Brother watching? The concept of the government watching our every move was originally created in the George Orwell book "1984". Do I really want OSHA to know every time I open the first aid kit to get a bandage for a paper-cut? I don't! How about a live video feed showing that you are indeed wearing your safety harness and safety glasses. Would you rather have a governmental inspector come out to your business or have data automatically sent to them?

Is it worth it? What would it cost to put a sensor on every first aid kit? This needs to be compared to the cost of hiring a person to travel to every job site to check and confirm compliance. This in turn needs to be compared to the cost of non-compliance, which is lack of data about accidents in the workplace and a missed chance to improve safety.

Use of technology for regulatory agencies for documentation of compliance does have advantages: automated data collection; accuracy and transfer of data; digital format that can be easier to summarize and analyze; and documentation of time/date/location with GPS. Concerns of privacy and costs need to be addressed.

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# DRONE ADOPTION GROWS AS Technology Rapidly Evolves

By BRIAN GERMAN | Contributing Writer

**B**EFORE DRONE TECHNOLOGY became available farmers would have to procure images of their operations from satellite services or through the use of manned aircraft. In a relatively short period of time the cost, quality and sophistication of aerial image capture changed significantly. What began as somewhat of a novelty has grown into a full-fledged industry that continues to become more advanced every year.

While drone technology initially developed outside of the agricultural

sector, it did not take long to realize that many of the features being utilized in other industries could be applied on farming operations. An increasing number of growers have been purchasing their own drones or employing drone services for a number of different applications on farms.

As the drones themselves continue to evolve, allowing for further applications and better functionality, so too does the software side of things. A common issue for growers in recent

years is that with increased adoption of data collecting technology the amount of information gathered can become overwhelming and ultimately useless if not interpreted and acted upon.

Mark Hull has been working with drones for over five years now, working with farmers in their agricultural operations as well as working with drone companies in testing and development. He noted that while drones have been around for quite a while, their usage in the agriculture industry has increased



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**DIGITAL WAYPOINTS HAVE ALSO MADE IT EASIER TO COMPARE DATA FROM ONE FLIGHT TO ALLOW FOR AN EXACT COMPARISON BETWEEN DIFFERENT POINTS IN TIME.**

considerably in recent years for a multitude of reasons.

### Affordability and Ease Of Use

Cost of production is on the forefront of every grower's mind when considering what types of new technology to adopt. Hull explained that the cost of quality drones has reached a point where the agriculture industry is more willing to try them.

"The idea of switching from manned aircraft, or satellite data, to drone data is becoming a little bit more feasible," said Hull. "It's very easy to become legally licensed to fly, so that's kind of changing things."

There are many drones on the market now that have the functionality that growers are looking for that are easy to use and within a reasonable price-point, Hull added.

"Kind of standard, what we would call consumer or maybe prosumer level drones, being used for photographing and videoing fields in natural color at any given time, documenting where things are at, where growth is at," said Hull.

Digital waypoints have also made it easier to compare data from one flight to allow for an exact comparison between different points in time. Hull added that mapping abilities have also become more simplified.

"The ability to stitch, or map with thermal imagery, is becoming a little bit easier and little more advanced," said Hull. "The most popular multi-spectral sensor for agriculture mapping has just made a model with a thermal camera in it."

Using thermal imaging data can allow

a grower to locate hot spots or issues with their irrigations system in real time through the deployment of a drone, saving a considerable amount of time compared to physically monitoring every row of their orchard.

Hull also said that the resources available to growers looking to hire a drone operator have progressed significantly in recent years.

"There's websites now that you can use to search for a drone pilot," said

Hull. "Now you can actually go on these sites and submit a job request. So, you can say, 'I want this work done, on this date, in this location,' and you can put in a budget and people won't respond unless they can afford to work for your budget."

Drone technology has progressed rapidly to become more user friendly and affordable and the industry

*Continued on Page 36*

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continues to innovate to better meet the needs of those interested in what they can accomplish.

### Where Drone Development is Heading

One of the drone developments on the horizon is what is known as a ‘drone in a box,’ which are more autonomous than current drones on the market.

“The theory of it landing and charging and dumping the data into the box so that the operator either could be the computer, or it could be someone from somewhere else,” said Hull. “That is a technology that people are watching for.”

While that technology is technically already here, Hull said that line-of-sight regulations will need to change to allow those types of drones to be deployed. “We are kind of waiting for that. We’re seeing FAA (Federal Aviation Administration) give more and more waivers for companies to test that,” said Hull.

”  
**ONE COMPANY CLAIMS THAT ITS DRONES CAN APPLY POLLEN IN ORCHARDS AND PRODUCE A 15 PERCENT BOOST IN FERTILITY.**  
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Improving camera resolution and quality of the imaging data that drones are capable of producing is another area Hull said will likely continue to be developed.

“What that allows us to do is either fly higher than you normally would, or just fly at any given height but get much higher resolution. We call it GSD, Ground Sampling Distance, which is just the size of the pixel,” said Hull. “So, the smaller we get that, then the easier it is to analyze where a nut is or an orange is.”

Hull noted a project he is working on involving a 100-megapixel camera and the opportunities it presents. “What that does is allows us to get much more like laser, you know, LiDAR (Light Detection and Ranging) type resolution data, so now you might be able to do even more with trees like looking at branch diameters and trunk diameter. The more information you can get, the more that you can do with it in post processing.”

There are countless companies currently working to develop drones for a multitude of uses in agriculture. One company claims that its drones can apply pollen in orchards and produce a 15 percent boost in fertility. There are also several different companies that are continuing to develop drones that are capable of efficiently and economically spraying various types of materials such as herbicides, insecticides, or fertilizers. In China, farmers are already employing drone operators using pre-programmed drones with the capability of flying without a pilot to deliver materials based on pest and disease information of individual plants.

*Continued on Page 38*

All photos courtesy of Mark Hull, All Drone Solutions.




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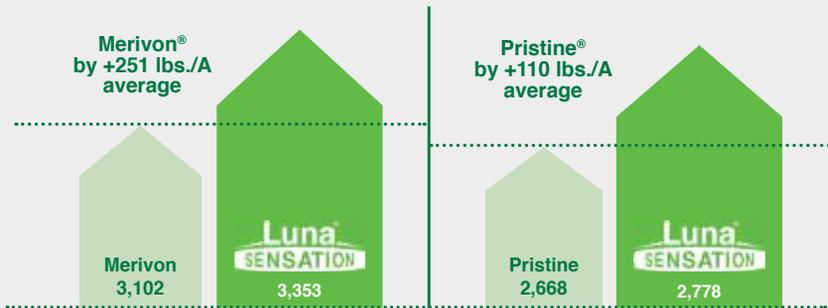
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*Continued from Page 36*

It is uncertain just how quickly the drone industry will continue to advance and improve, but as more farmers continue to use drone technology in their operations the more the drone industry will focus on addressing agricultural issues.

### Other Industries Driving Applications for Agriculture

Much of the functionality of drones

and how they are applied to farming originated through the needs of other industries. Hull highlighted developments with autonomous cars as helping to push continued improvements in collision avoidance technology and vision positioning systems that have been applied to drones.

The evolution of cell phones also helped to push significant development in technologies inherent in modern drones. Hull noted that the need for smaller processing components that are necessary for GPS played a sizable role in where drone technology is today.

Other industries will keep contributing to the further advancement of drone technology, Hull added, as drone applications continue to expand in construction, delivery and distribution, as well as search and rescue. Agriculture will likely benefit

as a result of additional improvement to what drones are capable of, both in terms of increased functionality as well as more affordable units to make investment more appealing to growers.

Technological breakthroughs in artificial intelligence and capacities for advanced decision-making computer processes will also become more engrained in drone capabilities as time moves on. The potential for a fully programmable fleet of autonomous drones with the ability to carry out detailed monitoring, make decisions regarding orchard issues and material applications, perform the necessary actions and return to their point of origin for charging may only be a few years away.

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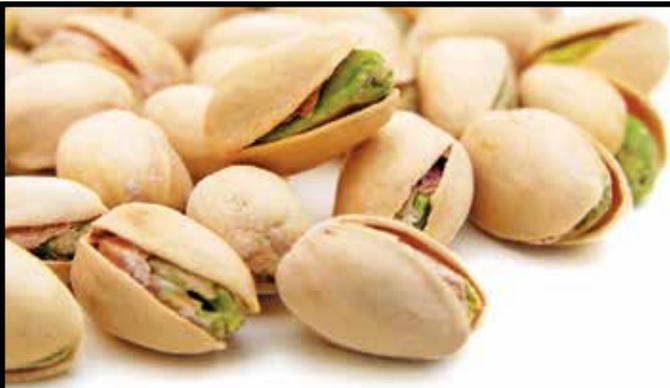
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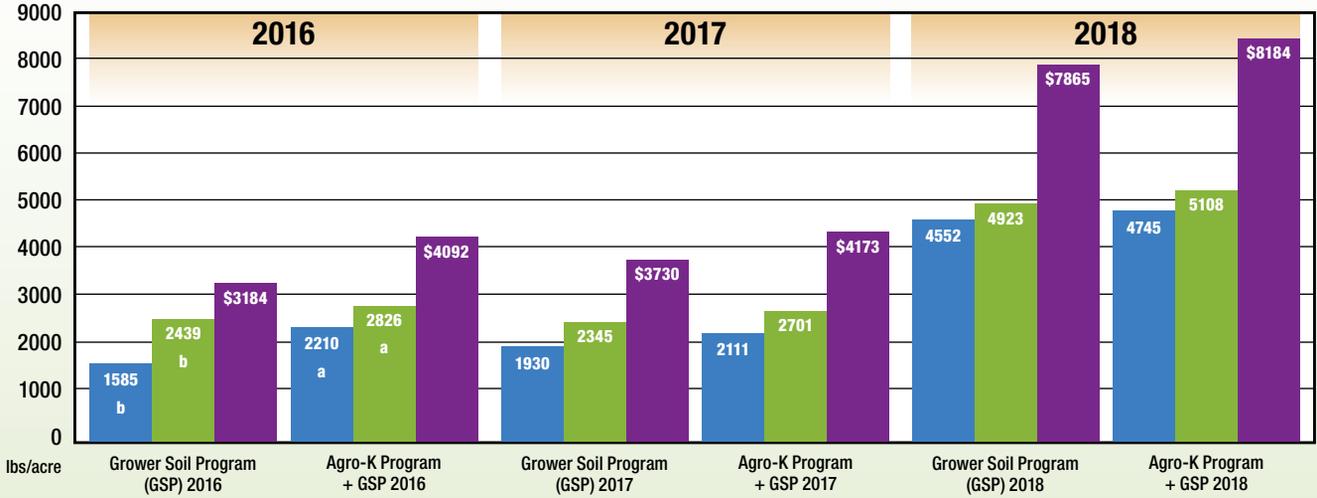


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# AGTECH TODAY, IN THE FUTURE

By JULIE R. JOHNSON | Contributing Writer

**P**RECISION AGRICULTURE IS more than just tools, it's a way of thinking, says Terry Brase, Farm of Future director in the Agriculture and Industrial Department at West Hills College, in Coalinga, California.

This is just one of the many messages Brase shares as he talks about what the future holds for ag technology on the West Coast.

Brase has more than 23 years of

teaching experience and developing precision agriculture programs, and is considered one of the top experts in the field.

For much of Brase's teaching and research career he worked in the Midwest where he grew up in Iowa amongst the world of corn, soybeans, oats, alfalfa and pastureland.

Ready for a change, Brase says when West Hills College in the Central

California Valley had an opening in 2016, he jumped on the opportunity to work in "California's diverse agriculture."

Since coming to California, Brase has often heard growers say, "It's different here, that precision ag stuff that you do in the Midwest isn't going to work here."

"I understand those concerns," Brase said. "However, it's a matter of educating West Coast growers and showing them what technology has



Terry Brase, right, Farm of the Future director at West Hills College in Coalinga, works with a team on developing agriculture enabling technology. All photos courtesy of Terry Brase.

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Precision Farming is a specialty of Terry Brase, left, who is the director of the Farm of the Future at West Hills College in Coalinga where he is teaching students about agriculture technology.

Positioning Systems) we have on tractors that has been used since the 1990s,” he added. “Today, RTK (Real Time Kinematic) GPS is pretty mainstream.”

Another key geospatial technology, Brase said, is GIF (Graphics Interchange Format) which allows users to map spatial characteristics or objects, and more importantly the ability to map differences or variability within an area.

Drones are also used to collect geospatial data and imagery in an effort to understand an area’s elevation patterns, growth patterns, irrigation patterns, and more.

“Being able to identify patterns allows us to make educated decisions,” Brase said.

### Telemetry

Telemetry is another enabling technology, Brase explained, which taken by itself can be very valuable, but becomes even more so when used in combination with other technologies.

“Telemetry devices make it possible for a grower to be sitting in

*Continued on Page 42*

been developed and how it will work in California crops.”

Brase has had several opportunities to do just that, one of those occasions being earlier this year when he made a presentation at the Walnut Trade Show in Yuba City where he discussed, “What does the Future Hold for Ag Technology?”

Remi Schmaltz, CEO of Decisive Farming, describes ag technology, or precision ag, “is to think of it as everything that makes the practice of farming more accurate and controlled when it comes to the growing of crops and raising livestock.

“A key component of this farm management approach is the use of information technology and a wide array of items such as GPS guidance, control systems, sensors, robotics, drones, autonomous vehicles, variable rate technology, GPS-based soil sampling, automated hardware, telematics, and software.”

These “enabling technologies” are some of the topics Brase discussed in his Walnut Trade Show presentation.

“Enabling technologies are those technologies that when taken separate have value, but when used together create a system of data collection that can greatly enhance decision-making in farming,” he said.

### Geospatial

Brase said the geospatial technologies are used for a variety of reasons, but is only one part of any application we have in agriculture.

“Most people are familiar with geospatial known as GPS (Global



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The use of drones, seen here at West Hills College in Coalinga under the direction of Terry Brase, Farm of Future director in the Agriculture and Industrial Department, is becoming a very useful technology enabling tool for growers.

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an office while those devices are at work collecting data in the field which is fed through some type of network to the farmer sitting in the office,” he added. “So the farmer can be in the office but still be able to see what is happening in the field.”

Some of the telemetry devices may be automated, registering the data and transferring it, while other devices can be used to operate equipment which then sends the data in.

Other devices can be used in irrigation systems, transferring data on flow and pressure through the Internet which a grower can access on a smartphone.

“Telemetry refers to the transfer of data through wireless means and there are several systems out there for growers to choose from and utilize,” Brase said.

The “Internet of Things” is a program that sends information and data in to an Internet cloud allowing a grower to

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access that collection of data from just about anywhere at any time.

“The Internet of Things is really based on telemetry,” Brase said.

### Sensors

“Sensors enable us to do a lot of things working together with telemetry,” Brase explains.

Some examples of sensors include wheel sensors on tractors, inertial measurement units, LiDAR (Light Detection and Ranging), multi-spec cameras, sap-flow sensors, and soil-moisture probes.

“These are all examples of sensors that provide some type of data or information that by itself can be valuable, enabling technology, that collects data that we normally would not have,” Brase said.

### Control

Control technologies include such devices as automated valves or solenoid valves which can switch equipment on or off, or control equipment remotely.

One such device is the TWM valve which is able to convert electrical to hydraulic movement, “so it is actually like a hydraulic motor,” Brase said.

The Solenoid control device, which turns on and off to allow liquid to flow through it, is typically used in irrigation systems.

Another example of a control device Brase shared is the auto-guidance wheel installed in tractors which turns the steering wheel independently of the driver.

“Again, these control devices can be used independently, but can also be used in a data collecting system with other enabling technology to enhance a farmer’s decision making,” he added.

### Microcontrollers

“Microcontrollers can be used for a lot of different things, but in agriculture it is used for precision agriculture,” Brase said. “They can range from the basic components of robotics or an automated irrigation system.”

He said the ag industry is in great need of ag technicians to develop and install microcontroller systems.

“That is one of the reasons I am teaching at a community college in Coalinga

**“Telemetry devices make it possible for a grower to be sitting in an office while those devices are at work collecting data in the field which is fed through some type of network to the farmer sitting in the office”**

to develop a program to teach all of these concepts, such as microcontrollers and other enabling technology,” Brase explained.

Spatial analytics is tied to GIF, which allows the grower to create a map and its interpretation.

### Block chain

Block Chain is related to sensors and the Internet cloud.

“Basically what you are doing is

capturing data and then putting it into a cloud in a secure structure that can be accessed by those with the keys to do so,” Brase said. “As data is added it develops a block chain that is added to the chain of information.”

In agriculture this chain may include the date the crop was planted, the variety planted, the conditions it was planted in, products applied to

*Continued on Page 44*

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the crop, irrigation specifics, harvest and shipping data, and so forth.

“As time goes on, and more and more data is added to the block chain on each specific planting or crop, by the time the product goes to the grocery store it has a bar code on it that a consumer can access through their smartphone and get a complete history of that product,” Brase said.

## Biologics

Biologics is a new field of technology that deals with alternative methods to address pests and disease in crops, but is harmless to people and the product.

Another application of biologics, Brase said, is placing a certain biologic that is applied in the “soil that protects the organic matter there so it’s able to stick around and encourage the

micro-organisms to grow and speed soil health.”

He added, that biologics in agriculture is an idea of addressing not just the symptoms, but taking care of the actual problem in a way not harmful to the consumer, worker or product.

## Applying Enabling Technology

There are several mainstream ag enabling technologies used by growers on a regular basis, such as automated irrigation systems, soil moisture probes, and the use of GPS, telemetry, sensor and controls on tractors and other equipment.

“The term ag technology isn’t something for farmers and growers to shy away from,” Brase said. “It is something they are already using successfully.”

Adoption of new technologies comes in peaks and valleys, he explained.

The pattern, or hype cycle, of new ag technology starts with an introductory “trigger” during which the innovative farmer jumps on the wagon of excitement and expectation, followed by a peak of inflated expectation which often falls into a trough of disillusionment, then a slope on enlightenment and finally a plateau of productivity.

Bringing the world of agriculture and the world of technology together through education is something Brase is trying very hard to do.

“We have people out there who understand technology, but they don’t understand the farmer, and farmers who understand agriculture but not the technician and technology. We need to bring those two worlds together to move agriculture forward into a successful future,” Brase said. “That is why I do what I am doing.”

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# PECAN PRODUCTION IS MOVING UP

You could say Arizona pecan production is 'moving up.'

By CECILIA PARSONS | Associate Editor



## Arizona is Moving Up

**T**HIS SOUTHWESTERN STATE IS CURRENTLY ranked as the fourth largest pecan producer in the nation. Industry leaders are predicting growers could double pecan production in the next ten years, putting them in a solid third place behind Georgia and New Mexico and ahead of Texas for the first time.

According to the National Ag Statistics Service (NASS), over the last five years, pecan production in Arizona has increased by nearly 25 percent—from 22 to 28 million pounds produced per year. New Mexico has also seen gains in production, while the nation's leader in pecan production—Georgia, at over 100 million pounds—has seen crop set backs due to hurricane damage.



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The value of Arizona's pecan crop is rising due to production, but the average price per pound dropped in 2016, from \$2.71 per pound to \$2.50. Total value of the crop in 2017 was \$7 million.

Bruce Caris, executive vice president at Green Valley Farms, which has been in pecan production since 1965, said while the steady growth in acreage continues, growers realize water availability may be a limiting factor in the future. Growers, many coming to Arizona from California, are still actively planting pecans and pistachios in Arizona, but not at the pace seen four to eight years ago, he said. The San Simon area has seen marked growth over the last ten years with pecan acreage growing from 1,000 acres to 20,000 acres.

## Water

Growers are pumping groundwater to irrigate their trees and with the increase in acres, Caris said the water tables have lowered. Rainfall in the main pecan growing regions averages 10-14 inches per year, and helps supplement groundwater supplies. Caris said in his area, 80 percent of the rainfall comes at two times during the year: July-August and December-January.

There is increased awareness in Arizona of over-drafted groundwater supplies, he said and irrigation efficiency is a priority for growers to conserve water. Mature trees need about five to six acre-feet of water annually for commercial production; more than for pistachio and wine grape production.

Nearly all new orchards have micro-sprinklers or drip systems for irrigation. Growers no longer flood irrigate their orchards. With more precise irrigation methods, he said, growers are able to be more efficient with their water.

## Acreage

Josh Sherman, Commercial Horticulture Area Agent with the University of Arizona Cooperative Extension (UACE), most of Arizona's pecan acreage is in the southeastern part of the state. Of the 26,000 acres of pecans, about half are now producing and he expects acreage to increase. The San Simon, McNeal, and Bowie areas in the county have a sizeable portion of new plantings. At least four larger pecan growers have processing facilities on-site to sort, hull and dry the nuts.

Sherman said most of the new acreage is planted in the popular Wichita and Western Schley varieties, yet the newer Waco and Pawnee varieties are also being planted.

## Disease and Insects

The arid environment in Arizona causes less pressure from disease and insects, Sherman said, but cotton root rot can be an issue in some areas. In



Ponderosa Farms 2nd Leaf with Mountains and Clouds. Photo courtesy of Josh Sherman.

the last two years, research has shown a fungal growth inhibitor Flutriafol does reduce disease pressure, but at the cost of \$100 per acre for an application, growers may choose other cultural controls.

Aphids, particularly the black pecan aphid, are an ongoing challenge for pecan growers as densities increase and populations are lasting longer. Infestations of black pecan aphid can cause a reduction in chlorophyll, affecting nut quality. Yellow pecan aphid

complex feeding steals carbohydrates from the phloem stream, lowering kernel percentage. Environmental factors can affect insecticide efficacy and adequate spray coverage can be difficult in mature trees.

The pecan weevil and pecan case-bearer, Sherman stressed, are two serious pecan pests that are not in Arizona or California, but is an issue in all other pecan growing states east of New Mexico. Substantial damage, up to 80-90 percent crop loss, could occur if

these two insect pests were to become established. The pecan weevil has been identified in some parts of eastern New Mexico, although quarantined, and the Arizona Department of Agriculture is monitoring for the pest. The weevil can go undetected by private tree shakers and shellers as the weevil larvae are unseen inside the shell.

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# SPOTLIGHT— Growing Pecans with Ben King

By JENNY HOLTERMANN | Contributing Writer



Ben King. All photos courtesy of Jenny Holtermann.

**W**ALKING THROUGH BEN King's pecan orchard feels like being in a miniature oasis nestled into the Central Valley. You feel the cool breeze blowing through the 30-foot-tall trees and the temperature cools down at least ten degrees. Clover and native grasses flourish in the center of the orchard rows making a natural habitat for Monarch butterflies, bees and ladybugs. It's hard not to recognize the beauty of the environment that is so

abundant throughout the orchard. King farms 600 acres of pecans in McFarland, California. He splits his time between McFarland and the Northern California town of Colusa where he also farms pecans and almonds. A native to the Colusa area, his family started farming in the 1860's and King has continued on the farming tradition.

King purchased the McFarland property in 2013. He knew that some of the best water management in the state

was being done in the Southern San Joaquin Municipal Utility District and North Kern Water Storage District, of which the orchards belong to. King also knew these fields had great opportunity for groundwater recharge and water banking.

## Wet Feet

Growing up in Colusa, he is no stranger to pecans. Ben remembers growing up "I watched the old timers

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**“The California pecans are a real premium and we are working to differentiate ourselves to really stand out and showcase that.”**

plant pecans along the Sacramento River between the levees because they could handle the seepage. Pecans are adaptable to a lot of things, including wet feet.”

King explained “Pecans are like black walnuts; they just keep coming back.” He goes on to explain how they are not susceptible to phytophthora or nematodes as other tree nuts are. This makes them ideal for growing in wet conditions while focusing on groundwater recharge.

With more than 15 states now growing pecans across the nation, the American Pecan Growers Council was established just three years ago under a federal marketing order. The

self-proclaimed “America’s native nut” is grown on about 6,000 acres throughout California. Half of the production is near the Visalia area and the second half north of Sacramento. King’s ranches mirror this same production model.

**California Pecans**

King proclaims “The California pecans are a real premium and we are working to differentiate ourselves to really stand out and showcase that.” King discussed the difficulties with having to compete with the Mexican market. According to the International Nut and Dried Fruit Council, Mexico



Pecan Orchard.

*Continued on Page 50*

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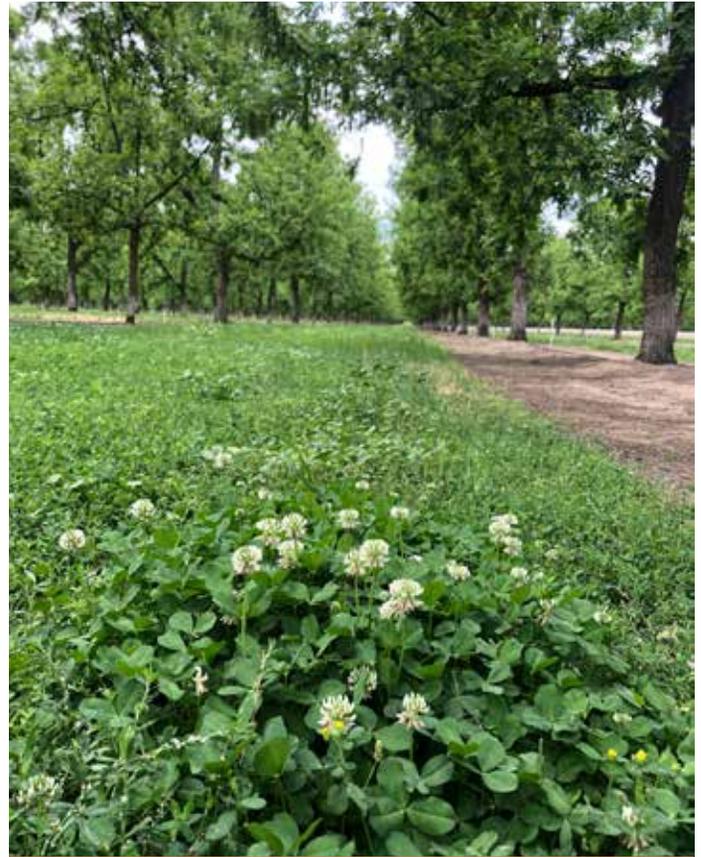
makes up 52 percent of the world production of pecans, followed by the United States with 40 percent.

A percentage King sees the U.S. being able to surpass with a focus on California production. “California has the potential of being the standard in which pecans should be grown and marketed.”

King adds, “There is a chance for California to lead and support ‘America’s Original Super Nut’...people want and need to know where their food is grown and this can be how we differentiate the premium crop. California consumers need the opportunity to support California pecans.”

### Groundwater Recharge

King, in partnership with the University of California (UC) extension office, water districts and Specialty Block Grant funding is focusing on groundwater recharge in his McFarland pecan orchards. With King’s innovative direction he is leading this project to be a pilot for others. Ben King’s thesis is simple; By using late season flows and flooding his pecan fields, he is recharging his groundwater basin and growing a crop. King’s current experiment will keep his pecan fields saturated with runoff from the Sierra starting in the beginning of May through June. He understands he may be sacrificing some of the cultural practices by not being able to get into his fields, but that is a risk King is



Natural grasses are abundant throughout the pecan orchard.

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willing to make for science. “Rather than having to fallow land to recharge the basin, we are doing the same thing but growing something on it.”

A true environmental steward, King is able to do this experiment because of the turf management and groundcover he keeps on his orchard floors. The clover and natural grasses are abundant and King prides himself in the environmentally sustainable habitat he is building. Not just for the home he is making for the monarch butterflies but for the soil that he is rebuilding and the percolation rates he is increasing. The groundcover is also ideal for beneficial insects habitat, helping with pest management.

Pecans also need ample light penetration into the trees and orchard rows. With such tall and wide trees, this can sometimes be challenging. King rotates hedging his pecan rows every other year to allow more light into the orchard. The prunings are then chipped and naturally worked into the soil, ensuring the nutrients are not leaving the field.

**“If California could grow its pecan acreage to the 15,000 range, pecans could be the high-end Mercedes of the specialty crop.”**

## Harvest

Those same natural grasses that are home to the butterflies all spring and summer, help to dry out the fields fast during the fall to prepare for harvest. In his McFarland fields, the Wichita variety will be harvested in November followed by his pollinator varieties Cheyenne and Western. The first harvest shakes off about 60 percent of the crop, but they come back through a second time to harvest off the remaining crop. With a late season harvest, the ground cover plays an important role in ensuring the orchard rows are dry enough and enable harvest equipment to do an effective job.

King notes the fields in the Sacramento Valley generally use an earlier variety and try to harvest in the October timeframe. Northern California's fall and early winter rains make a later harvest extremely difficult, so variety planning is very important, especially since pecan trees have a 100-year-old life. King notes the investment into the crop is really a commitment for yourself and the future generations.

## Increasing Pecan Acreage

Seasonal demand is highest at Thanksgiving timing and Chinese New Year. The fall harvested crop is at high demand for these seasonal markets. "We need solid buyers in the US to ensure US product and not buy from Mexico just to get product." Mixing in Mexican product Kings says, adds to the fluctuating quality of pecans and doesn't help to create an American superior product. "With the creation of the federal marketing order, it will aid us to set standards for American pecans," King hopes.

"If California could grow its pecan acreage to the 15,000 range, pecans could be the high-end Mercedes of the specialty crop." King envisions, if just a small portion of walnut growers convert a small percentage of their fields along flood zones there is real recharge potential for the San Joaquin Valley or the Sacramento Valley. "If there are old trees coming out planted on black walnut rootstock with soil issues or if a grower has marginal soil," King says it would be ideal for growers to switch

to pecans. King's McFarland fields were originally planted for just that in the 1970's because of its close proximity to Poso Creek and its high flood zones. They grew pecans where nothing else would grow during the wet winters when the creek flooded.

Pecan's adaptability to different soil types enable them to grow well in the southern states, the deserts of New Mexico or Arizona as well as the flood zones or recharge potential regions of California. While incorporating King's soil health techniques and environmental stewardship practices, pecans could very well help California maintain its specialty crop production while recharging our basins and being sustainably focused.



Chipped hedge prunings.

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# A SYSTEMS APPROACH TO ORCHARD MANAGEMENT

By CECILIA PARSONS | Associate Editor

All photos courtesy of Cecilia Parsons.

**IS AN ALMOND ORCHARD** more than just trees growing in dirt?

Five Madera area almond growers can answer that question with a resounding YES!

Tom and Dan Rogers believe the microbial activity in their soil strengthens their production system.

Juggy Samran describes his orchard as an ecosystem.

Rob Schuh and Andrew Carroll say they are managing the surface area of their orchards to capture energy to produce nuts.

During a bus tour of almond orchards hosted by California Ag Solutions, each grower spoke about their implementation of a systems

approach to orchard management with a goal of reducing inputs and producing more crop.

Protecting their trees—their long term investment—means focusing more on overall tree health than just delivering the standard amounts of water and nutrition.

## Maximizing Water Use

Tom and Dan Rogers, like many almond growers, first farmed row crops. Crop choice shifted, Tom Rogers said, when they realized there was more money to be made farming almonds than cotton.

But, watering the trees to runoff and applying the usual amounts of nitrogen each year wasn't producing the trees they wanted. In a Monterey/

Nonpareil orchard planted in 2005, they were using micro sprinklers and seeing dieback in the lower canopies of their trees.

“We were struggling to find a better program. We were overwatering some areas and under watering some. When we had problems with our irrigation well, we knew we had to maximize our water use,” Tom Rogers said.

Changes in their irrigation system were incremental. Double line drip was installed. Automation helped them move to pulse irrigation—shorter sets, multiple irrigations. They found that 36 inches of applied water still produced a 3,000 pound crop.

“We weren't brave enough to go lower

*Continued on Page 54*

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than that,” Tom Rogers said. They did go a step further and buried their drip lines four inches deep.

Nitrogen (N) use in the orchard also dropped. Sixty to 80 units of actual N plus compost applications were used.

With the shorter sets, Tom Rogers said the irrigation water spread over a larger area rather than flowing deeper into the soil. Adding the compost improved water infiltration. Tom

Rogers said the compost material did not remain on the orchard floor, but broke down well with January rains. Another result of the compost was increased worm activity in the soil—an indication that microbial activity was moving in the right direction to improve soil health.

Although it was a chore for them to bury the drip lines, Dan Rogers noted that they lost less water to evaporation and there is never standing water on the orchard floor and lower humidity levels in the orchard.

## Orchard Management Changes

As a result of their orchard management changes over the past four years, Tom Rogers said they have seen improved tree health, including more fruiting spurs in the lower canopies. They have also eliminated fungicide applications.

His next step, Tom Rogers said, will be to plant cover crops and eliminate pre-emergent herbicide applications.

## Hybrid Model of Orchard Management

Samran’s transition to a ‘hybrid model’ of orchard management has been a deliberate choice.

Like the Rogers’ brothers, he was dissatisfied with the water and nutrition schedule in his almond orchards and sought some small changes to improve tree health and productivity.

Concern that his young trees were not attaining proper growth, he chose to investigate improving soil health, and due to his medical training, he said he sees many similarities between soil health and human health.

Healthy soil, with nutrients available for trees, will help them tolerate stress, much like healthy humans can endure stress, Samran said. Building an ecosystem in an orchard that meets the need of the trees will promote productivity.

One of Samran’s first goals was to reduce the length of his irrigation sets and use more pulse feeding of nutrients. Previously using 24-hour sets, they are now at 12 hours. His soil variability was a challenge for even water distribution and he found the shorter sets helped manage water use. Samran said his focus with irrigation is not so much on managing the water, but being mindful of the trees’ oxygen needs.

In a block of fourth leaf almonds, Samran and California Ag Solution’s Silas Rossow looked at the spur development on the trees and what that meant in terms of productivity in the future.

“We are not really farming trees,” Samran said, “we are farming spurs.”

Feeding the spurs with foliar applied nutrition will help increase the probability of fruiting on spurs. Applied Zinc is critical to fruiting, Rossow said.

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Almond nut fill late April in a Madera area orchard.

### Cover Crops

Planting cover crops in his almond orchards, Rob Schuh said, helped improve water penetration and reduced pest pressure in an orchard that was in failing health.

Six years ago he made plans to pull the 22-year-old trees. Instead, he said he decided to try to restore the soil. Years of keeping the ground bare and smooth had led to soil compaction. If he could improve water infiltration, Schuh reasoned, he could get a few more years of production out of the trees.

Schuh and his son-in-law Andrew Carroll said a compost application was the first step—at eight tons to the acre, reduced to five after the first year. After seeing positive results, planting a cover crop was next to add more soil tilth and microbial diversity. The seed mix of legumes, grasses and brassicas did not take up water or nutrients meant for the trees, Carroll said, and it allowed them to reduce their UN 32 applications.

The mix of seeds is important, Schuh said, because depending on weather conditions, one type of plant may not grow. Timing of planting is important. The first year they tried, they found that planting in January is too late to get a good stand. October is the best time frame, they found, as the plants will flower before the trees bloom and provide food for pollinators. Having a cover crop does not pose a risk of freeze damage. Rossow said bare ground will be slightly warmer at the surface, but there is no temperature variability at the canopy height.

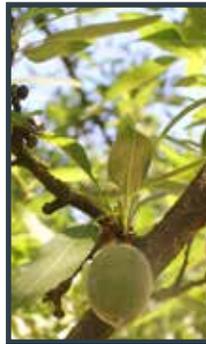
Schuh said they plan to leave the cover crop in the orchard as long as possible before harvest. After harvest they will burn down, and plant their next crop by the end of October. That cover crop, he said, will be planted in a wider strip to aid water penetration.

One of the bonuses from the green and flowering crop, Schuh said, was the population of beneficial insects in the orchard. Hot spots of mite activity were normal each summer, prior to the cover crop, but the beneficials have been keeping mites in check.

*Comments about this article? We want to hear from you. Feel free to email us at [article@jcsmarketinginc.com](mailto:article@jcsmarketinginc.com)*



Madera area almond grower Rob Schuh shows the biomass accumulated on his orchard floor due to his cover crop program.



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# USING SUN AND AGRICULTURAL RESIDUE TO CONTROL PESTS

Biosolarization shows promise for conventional and organic farmers

By DIANE NELSON | UC Davis AND STEVE ELLIOTT | Western SARE

**N**UT GROWERS SPEND A LOT of time and money controlling weeds and other pests, and often have to turn to chemical fumigants to keep destructive soilborne pests at bay. They also have to deal with low-value byproducts of production, like hulls.

But what if those agricultural waste streams could generate alternatives to chemical fumigants and make farming more productive, profitable and environmentally friendly?

Maybe they can. Researchers at the University of California, Davis, are



Professor Chris Simmons is testing biosolarization on 10-acres of almonds in Chico. All photos courtesy of UC Davis.

encouraged by early results in almond orchards and other sites experimenting with “biosolarization,” a process that combines the sun’s heat with soil amendments to manage weeds and other soil-borne pests.

“It looks promising,” said food science and technology professor Chris Simmons. “We still have a lot of work to do, but biosolarization is showing real potential as a safe, sustainable way to control pests while improving crop quality and yield.”

## Strengthening Solar Power

Some growers, especially organic producers, already use soil solarization as a pest and weed-control tactic. Plastic sheeting traps solar radiation and heats the soil enough to kill weed seeds and other soil-borne pests. It’s effective but can take four to six weeks.

Biosolarization can accelerate and improve the process. Simmons and his team are adding organic amendments like grape and tomato skins or ground nut shells to the soil before they tarp it, which promotes the growth of beneficial bacteria. The helpful microorganisms compete with pests and temporarily make the soil more acidic and less hospitable to weeds and other pests. Together, the soil heating and microbial activity can reduce the treatment time to days, not weeks.

“And by improving the beneficial microbes in the soil, biosolarization has the potential to improve crop quality and yield,” Simmons explained.

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“WE STILL HAVE A LOT OF WORK TO DO, BUT BIOSOLARIZATION IS SHOWING REAL POTENTIAL AS A SAFE, SUSTAINABLE WAY TO CONTROL PESTS WHILE IMPROVING CROP QUALITY AND YIELD.”

### Orchard Testing Under Commercial Conditions

In Chico, California, Simmons and his team are collaborating with almond grower Rory Crowley at Nicolaus Nut Company. They are three years into a 25-year experiment to see if almond-processing residue and the sun can boost soil health and reduce weeds and other soilborne pests. So far, Crowley is impressed.

“It’s been great for the soil,” Crowley said. “Using biosolarization and a mustard cover crop, we’ve increased organic matter by 1.25 to 1.75 percent, which is a huge jump. That’s good for carbon sequestration and the overall health of the soil.”

It’s too soon to tell if the soil improvements will translate to greater crop yield, but Crowley thinks biosolarization could become a good pest-management tool and a valuable use for what would otherwise be agricultural waste.

“We need to find a home for the co-products of almond processing, so why not see if we can use them to improve soil health while controlling pests?” Crowley asks.

### Field Test in Other Crops, Too

Simmons and his team are testing biosolarization on several annual and cover crops in plots on the UC Davis campus using agricultural waste streams from tomato and wine processing. Soon they will begin tests with strawberries, which are commonly treated with chemical fumigants each season as farmers plant anew.

“Fumigants are broad spectrum, which means they kill beneficial microorganisms along with the pests,” Simmons said. “Biosolarization is more targeted at specific pests.”

But in order for farmers to adopt biosolarization as an alternative to chemical fumigants, the treatment must to be effective, predictable and economical. So, the team is testing biosolarization with a wide variety of crops, amendments and soils against different pests in various locations at commercial scale throughout the state.

Simmons’ goal: To ensure farmers that biosolarization can be effective and economical under a wide range of

conditions against a broad number of pests.

“We’re making significant ground,” he said. “We’re hopeful biosolarization can help farmers return food and agricultural waste back into the system to control pests and improve crop production.”

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# Irrigation Management for Fertigation

By RICH KREPS | Contributing Writer

**D**IALING IN YOUR NUTRITION FOLLOWING THE four R's; right rate, right time, right source and right place is always much easier said than done. Soil types, base saturation percentages, soil saturation levels, soil pH, ECw (electrical conductivity water) and ET's (evapotranspiration) play a major role in determining whether that nutrition is actually absorbed and assimilated into your trees. Paying closer attention to the details of how you are applying your nutrition will go a long way to getting more bang for your buck. Nothing in farming is cheap. Increasing your odds of getting what you paid for into your crop, priceless.

## Dialing in the Plant Needs

Applying water and dialing in the plant needs with your

water source can be a logistical nightmare. Ordering surface water can be downright impossible if your acres don't match the delivery system of your irrigation district. It can be tough to get a small amount of water to run a six hour fertigation set as opposed to a 48 hour deep irrigation set. Smaller growers needing district water with canal deliveries can be forced with a "take it or leave it proposition". Larger growers throwing valves on multiple blocks and multiple delivery systems can make it very difficult to get around the entire acreage with short sets. Controlling smaller irrigation events evenly becomes labor intensive. "Well, farming is easy"...said no one, who had ever tried to make a living at it, ever.

## Best Methods

I get (and ask) questions often about which methods are the best. "Do I apply my nutrition in the first part of the irrigation set when the trees are thirsty, and uptake may be greater? If I apply the nutrition later in the last half of an irrigation set and leave it up high in the profile where the feeder roots are, will I have a better chance of assimilating more nutrition?"

After years of talking to other growers, pest control advisors (PCAs), certified crop consultants (CCAs), sustainability specialists, irrigators, agronomists, soil scientists and biologists, I have to come to the conclusive determination that the answer is...wait for it...both. Trees will take in a lot of nutrition with the soil solution early. However, it can only drink so much. Leaving it in the last half will hopefully ensure more is in the feeder root zone as the soil dries down. Definitely, don't go early with a big slug followed by a ton of water.

Think of it this way. You go to a nice steakhouse, order a T-bone, salad, mashed potatoes, sautéed veggies and crème brûlée to top it off. Dinner comes, you take your first bite, and it's delicious. You cut your second piece of steak right as the waiter turns your table over and dumps all your food on the floor. You were given enough food, but not enough time to eat it. And now it's all at your feet, a long way from your mouth. Many nutrients like nitrate, sulfate, boron and potassium end up with the same fate, below the feeding root zone and down at the tree's feet. But hey,



  
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at least with your dinner, the water is free and abundant; bon appétit.

### So What's the Solution?

So now what? Hedge your bet. If you typically run a 48 hour irrigation set in a week, run a 24 hour set to fill the profile. Follow it up in three days with an 8 hour fertigation event applying your nutrition in the last 6 hours. Leave just enough time to flush the lines and turn the pumps off. Follow that three days later with a 16 hour set and you've matched your ET's. However, you've left your nutrition in the root zone for a longer period of time. The third pulse shot will keep more nutrition in soil solution. Pulsing your irrigation, if plausible, will also keep your soils more active. The soil microbiology now spends less time in anaerobic conditions and you get another bonus;

biological nutrition assimilation. Many fertilizers have to go through biological transformation to become plant ready. By not drowning out your good soil biology it can use the fertilizer and turn nutrients not immediately available, into plant ready material. There is also another benefit, less puddling. You create a more active soil. Application more closely matches percolation.

### Altering Irrigation Schedules

We often find when growers actually alter their irrigation schedules with shorter fertigation events, they use less fertilizer. And the tissues still show adequate levels of plant nutrient uptake. That obviously saves you money. Now couple that with potentially higher yields, and you get even more bang for your buck. Put it into actual monetary terms: A grower spending

10 percent less on nutrition on a \$600 per acre annual budget just saved \$60/acre. Increasing yields by 10 percent on a 2000 lb. almond crop just added 200 more pounds at \$2.50/lb. \$560/acre extra profit goes a long way to easing the stress of the effort expended micro-managing your crop. We see this often when growers take a more active approach to nutrient management. Decrease your inputs while increasing your yield. Create another twist on the 4R's: right time in the root zone, right feeding schedule, right water management and real rewards. That'll go a long way to buying another steak and actually getting to enjoy it!

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7:00 AM

### Registration

7:30 AM

### Trade Show

CE Credits: 30 Minutes; Other

### SEMINARS

### WORKSHOPS

8:00 AM

#### What Almond Growers Need to Know About the Sterile Insect Program

Houston Wilson, UC Riverside Cooperative Extension Specialist  
CE Credits: 30 Minutes; Other

#### The Ins & Outs of The Sustainable Groundwater Act (SGMA)

Aaron FuKuda, Tulare Irrigation District, General Manager

8:40 AM

#### Best Strategies for Controlling Mites at Hull-Split

Kris Tollerup, Kearney Agricultural Research Cooperative Extension Advisor, IPM  
CE Credits: 30 Minutes; Other

#### Root Health and Moisture Management for Pre-harvest

Devin Clarke, Crop Manager, Tree Nuts, Yara North America  
Rich Kreps, CCA

9:20 AM

#### The Latest on Canker Diseases and New Management Practices

Themis J Michailides Ph.D., Plant Pathologist UC Kearney Agricultural Research Cooperative  
CE Credits: 30 Minutes; Other

#### Supplemental Pollination

Elizabeth Fichtner, UC Farm Advisor Tulare County

10:00 AM

### Break

10:30 AM

### Trade Show

CE Credits: 30 Minutes; Other

11:00 AM

#### The Best Management Practices and Treatments for Hull Rot in Almonds

Mohammad Yaghmour Area Orchard Systems Advisor, Cooperative Extension Kern County  
CE Credits: 30 Minutes; Other

#### Best Methods for Dust Control

California Almond Board

11:30 AM

#### Understanding the Latest Laws and Regulations for Almond Pre-harvest

John Susoeff, Ag Standard Specialist Fresno County Ag Commissioners Office  
CE Credits: 30 Minutes; Laws & Regulations

12:00 PM

### Lunch

12:30 PM

#### NOW-Benefits of Mating Disruption

Brad Higbee, Field Research and Development Manager for Trécé Inc.  
CE Credits: 30 Minutes; Other

1:00 PM

### Adjourn

# WHAT DOES THE WALNUT RESEARCH BOARD DO FOR YOU?



THIS ARTICLE IS SPONSORED BY:



By CECILIA PARSONS | Associate Editor

**A** STOUNDING ADVANCES IN BREEDING NEW VARIETIES AND rootstocks, disease control and cultural practices over the past 50 years have resulted in a vibrant and resilient walnut industry in California.

## CWB Research Investments

Walnut grower assessments over the years have provided funding to more than 200 research projects in breeding and genomics, orchard management, plant pathology and pest management. In return, University of California (UC) walnut breeding programs have provided improved varieties and rootstocks adding disease resistance and a wider harvest window. University of California researchers have developed pest, disease, and orchard management strategies for efficient use of nutrients and irrigation.

Investment in research by the walnut industry over the past 50 years has topped \$23 million.

Joe Grant, Research Director with the California Walnut Research Board (CWB) said there are two parallel paths with walnut research: short term projects to deal with current production challenges and long term projects to ensure the next generation of walnut growers are successful. The Production Research Committee, consisting of grower members of the CWB, tries to strike a balance between short term needs and research projects which may take many years, but are aimed at securing the industry's future.

## Walnut Breeding

The 70-year-old breeding program at UC Davis, known as the Walnut Improvement Program, was started with the recognition that crop yields and disease resistance needed to be addressed to grow the walnut industry. Early breeding work by Luther Burbank resulted in the hybrid rootstock Paradox that delivered root vigor and disease resistance. Cultivar selection work emphasized traits that increased yields and improved shell and kernel quality. Breeders also added a later leaf-out trait to help with the bacterial disease walnut blight.

Through the Walnut Endowment at UC Davis an additional \$2 million has been invested in the walnut breeding program now under the leadership of Dr. Pat J. Brown.

One of the most notable contributions of this long-term breeding program has been the Chandler variety, which now makes up 50 percent of walnut acres in California. Since the rise of Chandler, more recent breeding program efforts have been focused on—among other traits—the development early and mid-season selections with excellent productivity and kernel quality. Recent releases include Ivanhoe, a very early harvesting, high yielding variety, and Solano and Durham, mid-season varieties with large light colored kernels and excellent shell appearance. Others are in the breeding pipeline and nearing commercial release.

*Continued on Page 64*

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*Continued from Page 62*

On the rootstock side, two clonal Paradox rootstock releases, RX1 and VX211, are now in common commercial use, five clonal Paradox rootstocks with superior resistance to Phytophthora, crown gall, or lesion nematode are in commercial scale field trials, and additional selections with resistance to multiple pests are expected to follow soon.

### **Genome Sequence**

With the first genome sequence of a commercial walnut variety at UC Davis in 2016 and the more recent sequencing of the first rootstock genome, the rate of variety and rootstock improvement is accelerating. The slow process of variety selection is changing with marker-assisted breeding. This new technology speeds up the process by allowing breeders to determine, at the seedling stage, if a new selection possesses the desired traits. Markers for genes that control traits such as yield, disease resistance, kernel color and shell strength are beginning to be used to make breeding selections.

### **Walnut Diseases**

Walnut blight disease remains a serious and ongoing concern for growers, especially though not exclusively in the state's central and northern growing regions. Discovery and field evaluation of new bactericides is an ongoing effort for researchers. A major focus has been to identify effective alternatives to copper+mancozeb treatments that will aid in slowing the development of copper resistance in blight bacteria and reduce the use of copper to control blight. Funded research is also looking at additional new compounds to enhance copper activity by allowing more of it to enter bacterial cells. Other new compounds are also in the research pipeline.

Genetic resistance to walnut blight has also become a focus of variety breeding at UC Davis. To breed for blight resistance, nut inoculation procedures are needed to rapidly screen new selections for blight susceptibility. Several new genotypes with superior resistance have been identified and

are being used in making breeding crosses that will result in improved varieties that are high yielding, good quality and resistance to walnut blight.

Grant said UC researcher Themis Michailides' work on canker causing Botryosphaeria and Phomopsis fungi has provided growers with an understanding of the biology of these pathogens and management strategies for reducing disease losses. Research has helped identify effective fungicides and spray timings reduce fruit, spur, and branch infection by these species. Cultural practices including pruning to remove dead and dying diseased branches in summer and fall reduces spore inoculum levels and slows the spread of these diseases in infected orchards.

### **Orchard Management**

On the orchard management side, research into orchard and canopy management using no- and minimal-pruning practices continues to show promise for reducing pruning costs and increasing productivity of developing orchards.

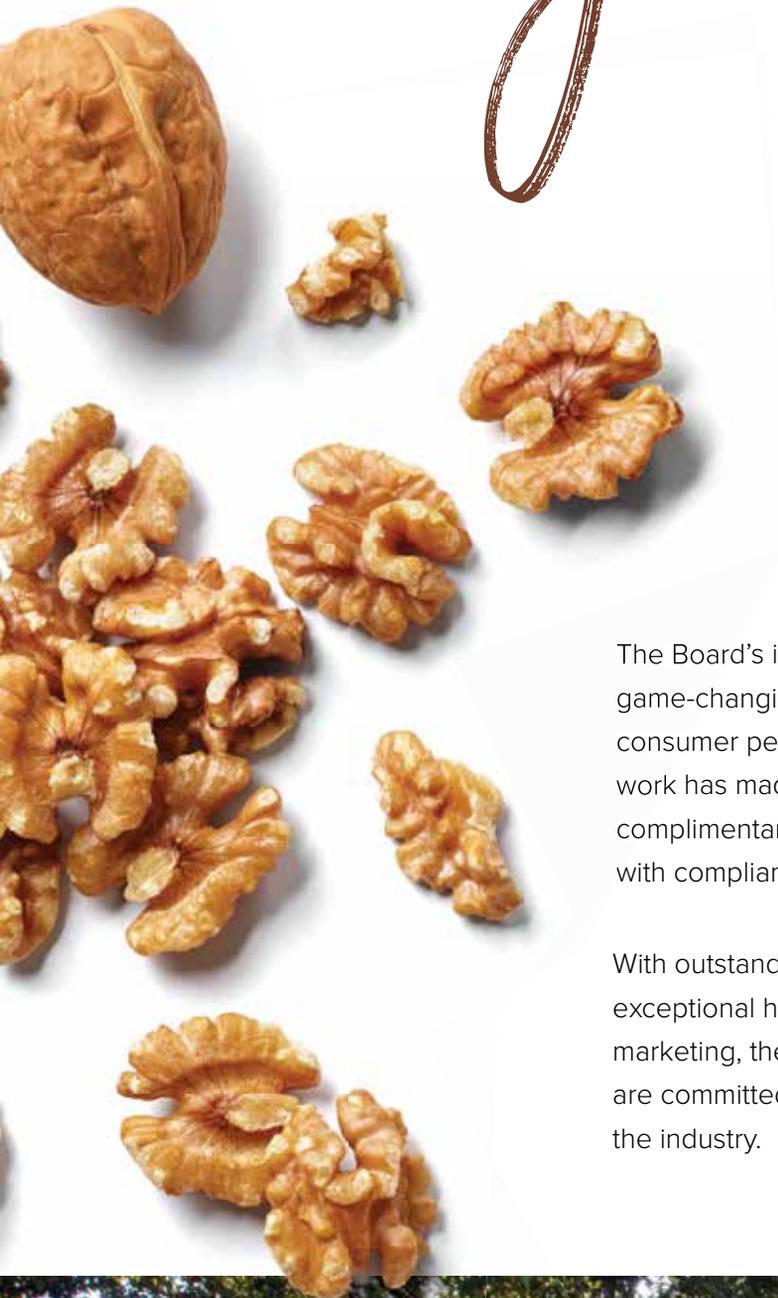
Irrigation scheduling work by Dr. Ken Shackel has demonstrated the feasibility of achieving significant water savings without impacting yields by delaying the start of early season irrigations, Grant said. This work was initially conducted at a northern Sacramento Valley orchard site, and work is underway to refine and validate the concept in other soil types and growing regions.

### **Recent Research**

Thanks to recent research efforts, walnut growers are now in a position to better manage their nitrogen fertilizer applications for maximum efficiency and reduce the risk of potential groundwater contamination from over fertilizing. With new information on in-season tree nitrogen uptake, growers can predict orchard nitrogen needs and match fertilizer applications and timing to the needs of the developing crop.

*Continued on Page 66*

# WORKING FOR you



The California Walnut industry has grown in the last decade, with production nearly doubling since 2007. While tariffs and other economic factors have been an industry challenge, the Board and Commission continue to work on your behalf through:

- ▶ Integrated marketing programs to increase awareness and drive retail purchase
- ▶ Concept development of innovative new products and shelf life testing
- ▶ Promotions featuring walnuts with restaurants such as Sizzler® and Wendy's
- ▶ Defending against burdensome industry regulations and federal and state tariff/non-tariff trade barriers
- ▶ Advocating for industry through USDA's food purchase and distribution program
- ▶ Securing USDA grants to bolster export market promotions through MAP and ATP funding

The Board's investment in production research has resulted in new game-changing varieties. The Commission's health research has shifted consumer perceptions about the health benefits of walnuts. Regulatory work has made great strides on behalf of growers. And we continue complimentary FSMA food safety training for growers to help with compliance.

With outstanding production research, exceptional health research, and strong marketing, the Board and Commission are committed to a resilient future for the industry.



[walnuts.org/working-for-you](http://walnuts.org/working-for-you)



Continued from Page 64

Research into orchard insect and mite management has also paid dividends in improved grower returns and orchard sustainability. While walnut husk fly remains a stubborn pest, research to evaluate new products and low volume sprays have helped growers keep pace with this destructive pest. Additional work showed that food grade molasses, which is less costly than conventional baits, increases feeding time and mortality of adult flies. A degree-day model developed for walnut husk fly helps predict emergence of overwintered flies and improve spray timing and effectiveness.

Resistance to husk fly attack has become the subject of breeding efforts. Traits like trichome density (the small hairs that grow from the epidermis of the nut) and production of certain volatiles have been shown to be related to differences in walnut husk fly susceptibility among varieties. Finding genetic markers for such traits could accelerate

the development of new varieties with greater resistance to husk fly.

Jerry Moore, Visalia area walnut grower and chairman of the Walnut Board's research committee is a believer in the value of focused research for the walnut industry.

He can cite several industry-funded research projects that had a positive impact on his walnut production.

"I was looking for a new variety to plant that would be an early, heavy producer and Ivanhoe, developed by the UC Walnut Breeding program was exactly what I wanted."

Moore added that the research to find chemistries to combat walnut blight have benefitted many walnut growers. In the future, he said, genomics will play a role in developing new rootstocks that have resistance to many diseases including crown gall, phytophthora and nematodes.

"We need to stay ahead of the game and tackle problems with pests and diseases quickly and keep improving our product," he said.



Close-up of a walnut. Photo courtesy of the California Walnut Board.

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# Almond Growers no Longer Expected to Meet Any Produce Safety Regulation Requirements

By THE ALMOND BOARD OF CALIFORNIA



To date, almonds are the only tree nut with a mandatory pasteurization program and defined performance criteria accepted by Food and Drug Administration (FDA). From 2007 to 2017, ABC invested more than \$5 million in food quality and safety research and education. This research has been translated into toolkits, online tools and shared at workshops. Photo courtesy of the Almond Board of California.

**F**OR THE PAST THREE YEARS, California almond producers have been striving to meet the demands of the Food and Drug Administration's (FDA) Produce Safety Rule, which was finalized in 2016 as part of the Food Safety Modernization Act (FSMA). Since the rule's passing, the Almond Board of California (ABC), the Almond Alliance of California and other groups have walked alongside almond growers and huller/shellers to help them determine how the Produce Safety Rule applies to them, provide resources, and host training workshops where growers could learn more about what they needed to do to be in compliance.

Then, on March 27, 2019, FDA issued a final Guidance Document, announcing the use of enforcement discretion for certain commodities covered under the Produce Safety Rule—including almonds. In the Guidance Document, FDA states, "We will not expect entities growing, harvesting, packing, or holding these commodities to meet any of

the Produce Safety Regulation requirements." In simple terms, as long as the Enforcement Discretion remains in effect, almond growers and huller/shellers are no longer subject to Produce Safety requirements. FDA has indicated that they will explore this topic further and consider pursuing rulemaking to address the unique circumstances of almonds.

The ramifications of this Guidance and use of Enforcement Discretion for almonds are immense.

"This is big deal for almonds. The notice effectively tables the Produce Safety Rule's requirements for almonds while FDA considers additional rulemaking, taking into consideration our long history of food safety and controls already in place" said Tim Birmingham, director of Quality Assurance and Industry Services at the Almond Board.

"This is a monumental achievement for our industry and a tribute to the extensive investments in food safety that the almond industry has made that started long before the enactment of FSMA. With this recent announcement

by FDA, our industry can now remain focused on the food safety issues that are most relevant without unnecessarily spending our valuable resources to just comply with a regulation," said Brian Dunning, chair of ABC's Almond Quality and Food Safety committee.

## How We Got Here: ABC, Others' Work with FDA

During the rulemaking process, ABC remained engaged with FDA, educating on industry practices and providing comments on draft rules along the way. When the final Produce Safety Rule was published, ABC was concerned that the rule did not take into account the fact that almonds were already subject to controls for pathogens such as Salmonella. Recognizing this, ABC continued to work with FDA, hosting and participating in a number of meetings and tours to educate FDA on industry food safety practices, including the mandatory pasteurization program.

And that hard work finally paid off.

In an FDA release from March 27, FDA Commissioner Scott Gottlieb,

*Continued on Page 70*

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M.D., said, “We’ve worked closely with food producers to implement FSMA’s Produce Safety Rule... As part of this collaborative process, we’ve received important feedback on the application of this rule from stakeholders of certain commodities, including hops, wine grapes, pulse crops and almonds. Given the nature of these specific commodities, and the low risk that these products pose because of the way that they’re processed and consumed, we do not expect producers of these commodities to comply with the Produce Safety Rule.”

Put simply, FDA recognized the unique situation of almonds in relation to the Produce Safety Rule and is considering pursuing rulemaking to address for the long term, according to Birmingham.

### **Almond Board Pasteurization Program: 12 Years, 0 Salmonella Outbreaks**

In 2001 and 2004, Salmonella outbreaks were intensifying across the food industry and raising concerns about food quality and safety. One of the biggest questions for the California almond industry during this uneasy time was determining the true level of risk associated with the product. The easy answer seemed to be that risk should be low: conventional wisdom suggested that low moisture foods, such as nuts and seeds, did not pose a threat since the microorganisms of concern could not grow in these products. But conventional wisdom was not enough—hard evidence was needed to prove a low level of risk.

The Almond Board engaged food safety experts, United States Department of Agriculture (USDA) and research partners to take a holistic approach to the problem and identify potential risks and develop strategies to control and prevent outbreaks. This collaboration among experts ultimately resulted in the creation of the Almond Board’s mandatory pasteurization program for Salmonella reduction. To date, almonds are the only tree nut with a mandatory pasteurization program



and defined performance criteria accepted by FDA.

“The health and wellbeing of almond consumers matters deeply to everyone in the California almond industry. We’re not afraid to tackle food safety challenges head-on, aided by the expertise of our partners, and we’re proud of our pioneering best practices,” said Birmingham.

Extensive discussions with industry, university and government experts also lead to the implementation of best practices, including the Good Agricultural Practices (GAPs) for growers and Good Manufacturing Practices (GMPs) for processors, as well as updated Hazard Analysis and Critical Control Points (HACCP) guidelines and Pathogen Environmental Monitoring (PEM) resources.

Today, because of the Almond Board’s forward-thinking approach to food safety, drive to get ahead of potential problems and hard work in creating resources to help the industry produce the greatest possible product, the California almond industry has now gone 12 years without any Salmonella recalls and outbreaks.

ABC’s mandatory pasteurization program did well in positioning the California almond industry to comply with FSMA standards because it proactively, voluntarily created and implemented many programs that are already in line with FSMA requirements. Today, those programs are the reason that almond growers and handlers can breathe a little easier when considering FDA’s food safety regulations.

“FDA’s recent Guidance Document is a great win for the industry, and the fact that almonds are specifically called out and listed in the notice indicates that FDA has confidence in our systems and recognizes the effectiveness of the almond pasteurization program,” said Birmingham.

### **Building on Past Successes for Future Challenges**

From 2007 to 2017, ABC invested more than \$5 million in food quality and safety research and education. This research has been translated into toolkits, online tools and shared at workshops, and the Almond Board will continue to provide the industry with resources to understand and comply with food safety standards.

“We will continue to be proactive in the food quality space, evaluating the industry’s current practices and engaging in research to improve how we understand and threats to food safety,” said Birmingham.

If you have further questions about FDA’s March 2019 Guidance Document, please contact Tim Birmingham at [tbirmingham@almondboard.com](mailto:tbirmingham@almondboard.com). You are also encouraged to attend the Almond Board’s Almond Quality and Food Safety Symposium on Wednesday, June 12, where you’ll hear from top food safety and regulatory experts on issues impacting your operation. Learn more at [Almonds.com/UpcomingEvents](http://Almonds.com/UpcomingEvents).

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# GANODERMA ADSPERSUM CAUSES DAMAGE TO ALMOND TREES

By KATHY COATNEY | Editor

**G**ANODERMA IS A GENUS OF fungi with about 80 known species. It is generally considered a forest pest in the United States, but *Ganoderma brownii* has been in almonds for a long time. This fungus doesn't appear to impact tree production, and the only outward sign is development of large shelf-like mushrooms on the trunks called conks.

Bob Johnson, PhD student in the Rizzo Lab at University of California Davis, said, “*Ganoderma* is a genius of wood decay fungus and it infects trees.”

*Ganoderma* is referred to as a butt rot pathogen, Johnson continued. The butt of the tree is the underground portion of the stem where all the roots attach to

become the trunk, he added.

## New Species of *Ganoderma*

*Ganoderma* is a very broad genus, and the species, *Ganoderma brownii*, is commonly found in older almond orchards. It has a wide host range, from the coastal forests in southern California all the way to Oregon, and also in the Central Valley, but this species doesn't overcome tree defenses, Johnson said.

“The trees can live a long time with it (*Ganoderma brownii*) and not fall down,” Johnson said.

Historically wood decay has been thought of as a problem of old trees, but the newcomer to the block,

*Ganoderma adspersum*, is more aggressive than the other *Ganodermas*, and it hasn't been seen in North America or California before, Johnson said.

Johnson is getting more and more reports of trees in the 9-12-year-old range with *Ganoderma adspersum*. What happens is, one year a couple of trees are lost. The next year three percent, the year after that eight percent, and then the orchard is removed, he said.

## Rootstocks

There are close to 50 orchards in the five southern counties confirmed to have *Ganoderma adspersum*, Johnson said, and there are indications that



*Ganoderma* symptoms in an almond tree. Photos courtesy of Bob Johnson.



*Ganoderma adspersum* is rootstock related.

All of the orchards with *Ganoderma adspersum* have been on Nemaguard rootstock, Johnson said.

Rootstock research is currently being conducted on potted trees. “We’ve done some decay trials—just with blocks of these different rootstock wood.

So we’re working on it, it’s just slow,” Johnson said.

### Symptoms

Wood decay is the slowest growing of the pathogens, and even more challenging is that the disease may never be seen until the tree falls down, Johnson said.

The disease never really moves above ground because most of the infections start below the soil. Spores that land on the soil surface percolate down into the soil via water or irrigation, Johnson said.

Once the disease comes into contact with the wounds, then it eats straight to the butt of the tree, Johnson continued.

“Sometimes the trees look perfectly healthy until they fall down. You might not ever see it (the disease),” Johnson said.

There are some symptoms found on the trunk that are associated with *Ganoderma adspersum*, but they generally aren’t seen until the disease is already well established.

A flat strip may be seen running up the side of the tree. “If you look on the trunk, you’ll see where a portion of

*Continued on Page 74*

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the trunk hasn't grown and it still looks young," Johnson said. "Unless you know exactly what you're looking for, you don't really see any disease until the day your trees start falling down."

Another symptom are conks, but once they are seen on the tree, it is essentially dying from the inside out, Johnson said.

The conks release spores that are picked up by wind and water, moving them through the orchard and into neighboring orchards. It's nearly to impossible to stop the spread, Johnson said.

The first orchard where *Ganoderma adspersum* was found was in three 40 acre blocks.

"There were some beginnings of fruiting bodies, but there were no discernable fruiting bodies. Nobody other than somebody that knew what they were looking for would be able to find fruiting bodies," Johnson said, so the disease was basically invisible until all the trees begin to fail.

There is no treatment for *Ganoderma adspersum*—growers basically wait for the trees fail, Johnson said.

### Spread of the Disease

"It's likely that when the orchard becomes infected, lots of trees become infected all at the same time," Johnson said, adding as to the geographic spread, he can't say.

"Nobody has ever delineated the existing geography yet, but that's something we're working on," Johnson said.

As news of *Ganoderma adspersum* spreads, the disease appears to be creeping further and further north, Johnson said.

"We've got one site now that's about 25 miles north of Madera, and that's the northern most site, but I'm not saying it's not north of it. It's just the only one that's been reported," Johnson said.

As far as Johnson knows, *Ganoderma adspersum* hasn't moved north of Madera County—yet—and it hasn't moved into Merced County, he said.

"It could be, but the orchards that we sampled in Merced County were all *Ganoderma brownii*," Johnson said.

Johnson has surveyed trees in the Sacramento Valley, and they have *Ganoderma brownii*. *Ganoderma adspersum* was not there, he said, but he thinks it will eventually move into the Sacramento Valley.

"It's current distribution is related to where it was introduced," Johnson said.

Judging by the speed at which the fungus actually eats a tree, and how long it takes to make a fruiting body to spread it's spores, it's estimated the disease has been in the San Joaquin Valley for 15-20 years.

"It's just taken a long time to increase and for the epidemic to become an epidemic," Johnson said.

### Sanitation

Sanitation to prevent the spread of the disease is always a good thing, Johnson said, but with a wood decay fungus it may not be practical.

"It's biology is quite a bit different than the foliar pathogens and the trunk canker. Those are all in a different group of fungi, so they make spores very quickly, whereas *Ganoderma*, in order for it to make spores, it has to make this big fruiting body which takes a long time and it doesn't fruit on deadwood," Johnson said.

For the disease to become established, it requires a wound somewhere in the lower trunk or the roots. The way almonds are harvested is the perfect method for spreading *Ganoderma adspersum*, Johnson said.

Every year, every almond tree is shaken, and most trees twice for winter sanitation. The shaking can cause wounds that can't be seen, Johnson said.

Immediately after shaking the trees, the blowers and sweepers come in, and in essence, the spore load is spread across the valley every year, Johnson said.

"Every time we shake and blow, we're increasing the spread of the inoculum, and increasing the number of infected trees," Johnson said.

So, how do you sanitize that? You don't, Johnson said, but efforts to reduce dust at harvest could help reduce the spread of the disease.

"I think any reductions in dust will reduce the spread because if you think about it, the spores are basically dust biological particles. So they're moving with the dust," Johnson said.

"Keeping the dust on the orchard floor and keeping the dust out of the air is going to slow down the larger geographic spread," Johnson said.

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# CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE TO CONSIDER LISTING FOUR SPECIES OF BUMBLEBEES AS ENDANGERED

By ROGER A. ISOM | President/CEO Western Agricultural Processors Association

**IN RESPONSE TO A PETITION** by the Xerces Society, Defenders of Wildlife and the Center for Food Safety, to the Fish and Game Commission list four (4) species of bumblebees as endangered under the California Endangered Species Act (CESA), the California Department of Fish and Wildlife (CDFW) has prepared an evaluation report (Petition Evaluation) for the Petition. The Commission referred the petition to CDFW. The four species include

Crotch bumble bee, Franklin bumble bee, Western bumble bee, and Suckley cuckoo bumble bee. The Petition Evaluation assesses the scientific information discussed and cited in the Petition in relation to other relevant and available scientific information possessed or received by the Department during the evaluation period. The Department's recommendation as to whether to make any of the four bumble bee species a candidate for listing under CESA is based on an assessment of

whether the scientific information in the Petition is sufficient under criteria prescribed by CESA to consider listing the species as endangered or threatened.

## Review of the Petition

After reviewing the Petition and other relevant information, the Department found that "the Petition provides sufficient scientific information to indicate the petitioned action may be warranted. Therefore, the Department recommends the Commission accept the Petition for further consideration under CESA."

## Two-Step Process

The Commission has the authority to list certain "species" or "subspecies" as threatened or endangered under CESA. CESA sets forth a two-step process for listing a species as threatened or endangered. First, the Commission determines whether to designate a species as a candidate for listing by evaluating whether the petition provides "sufficient information to indicate that the petitioned action may be warranted." If the petition is accepted for consideration, the second step first requires the Department to produce, within 12 months of the Commission's

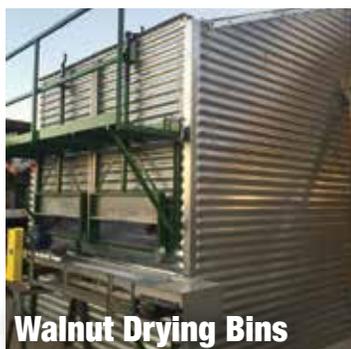


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acceptance of the petition, a peer reviewed report based upon the best scientific information available that advises the Commission whether the petitioned action is warranted. Finally, the Commission, based on that report and other information in the administrative record, then determines whether or not the petitioned action to list the species as threatened or endangered is warranted. A petition to list a species under CESA must include “information regarding the population trend, range, distribution, abundance, and life history of a species, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, the impact of existing management efforts, suggestions for future management, and the availability and sources of information.

**The Report**

The report cites several factors or threats affecting the ability of all the petitioned species to survive and reproduce and they fall into four main categories:

- Present or threatened modification or destruction of their habitat
- Competition
- Disease

•Other natural and human-related factors, including pesticide use, genetic factors, and climate change.

Within these categories, agriculture is highlighted many times as posing a threat. Under habitat destruction, agricultural conversion of lands is cited as a contributor to loss of habitat. Within the category of competition,

*Continued on Page 78*

The four species include  
**Crotch bumble bee,**  
**Franklin bumble bee,**  
**Western bumble bee, and**  
**Suckley cuckoo bumble bee.**



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EVALUATION OF THE PETITION FROM THE XERCES SOCIETY, DEFENDERS OF WILDLIFE, AND THE CENTER FOR FOOD SAFETY TO LIST FOUR SPECIES OF BUMBLE BEES AS ENDANGERED UNDER THE CALIFORNIA ENDANGERED SPECIES ACT



Prepared by  
California Department of Fish and Wildlife

April 4, 2019



*Continued from Page 77*

the report highlights threats from other species of bees, “particularly of other bee species imported and managed to pollinate crops or produce honey” as a direct threat by reducing pollen and nectar resources. Under “other factors” the report specifically highlights the use of herbicides and pesticides as having “several negative impacts on native bumble bees, including degrading habitat and removing floral resources, causing direct mortality and sublethal effects, reducing population success and survival rates, and increasing disease risk.

Herbicide use has contributed to the loss of bumble bee habitat resulting in indirect impacts to bumble bees. It reduces floral resources for all bumble bees, nesting habitat for bumble bees that nest above ground, and could cause a decline in bumble bee reproductive success and/or survival rates. Pesticide use, including various types of insecticides and fungicides, could directly impact bumble bees through mortality and sublethal effects. The use of insecticides, of which neonicotinoids are addressed in detail, is most likely to directly harm bumble bees since they are broadly toxic to insects and thus could kill or otherwise harm exposed bumble bees. The Petition also identifies threats from climate change and indicates changes in temperature and precipitation pose a significant threat to bumble bees by decreasing the availability of floral and overwintering resources, increasing pathogen pressure, and decreasing available nesting habitat.

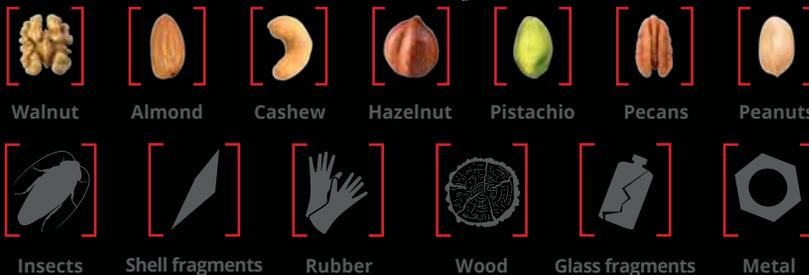
**What Does This Mean?**

What does all this mean? While the outcome is not yet determined, there is a high likelihood that some, if not all, of these species of bumblebees could be listed as “endangered”. This will put even more pressure on the use of pesticides and herbicides in agricultural settings should bumblebees become listed as endangered. This will have to be closely monitored over the next several months.

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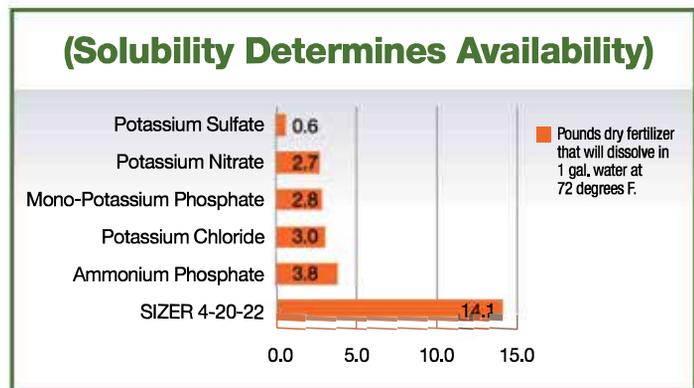


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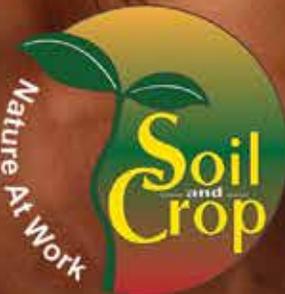
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