Rice Notes
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University of California
Agriculture and Natural Resources | Cooperative Extension

In This Issue

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Sutter, Yuba, Sacramento and Placer Counties

Rice Crop Rotation Tool Launched

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Background

The UCCE Rice Team has launched a new decision-support tool, the "Rice Rotation Calculator", which can be found at https://rice-rotation-calculator.ipm.ucanr.edu/ (Figure 1). The tool was created through a partnership between UCCE, UC Davis, and the UC Integrated Pest Management program. It was funded by a grant from the Western IPM Center.

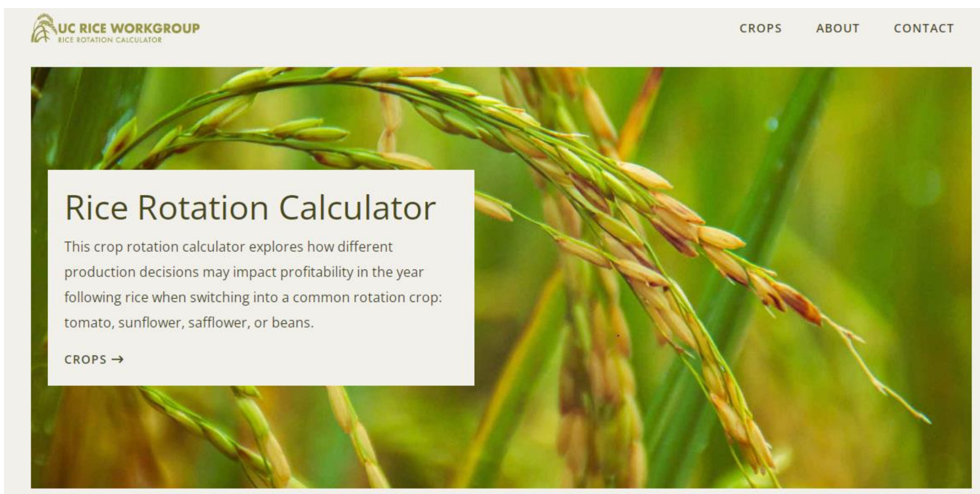


Figure 1. *The web page for the rice rotation calculator can be found at:* https://rice-rotation-calculator.ipm.ucanr.edu/

The idea for the calculator came about from a study conducted by UC Davis Graduate Student Sara Rosenberg, where she interviewed growers across the rice-growing region on their crop rotation practices, both growers who did and did not crop rotate. One of the large barriers that came out of the study was the economic uncertainty of switching out of rice, including the cost of switching as well as the overhead costs of a new crop, whether or not a new crop would be profitable, and the difficulty of finding markets. The tool provides the answer to the economic uncertainty question, as well as the overhead and profitability of the new crop.

The tool was developed via a series of data collection and feedback meetings over the course of the winter and summer of 2021. The initial Rice IPM Workgroup meeting (with about 20 attendees) provided some context for the regulatory requirements that would be involved with switching to a new crop, then the following small group meetings provided data and more context for switching to each of the proposed crops: sunflower, safflower, tomatoes, and dry beans. Additional data on costs were taken from the UC Davis Costs Studies for rice and each of the rotational crops, as well as USDA data.

Once the calculator was in a preliminary stage, feedback was solicited from Pest Control Advisors, growers, and industry members, to refine the calculator and make sure that it had all of the functionality that would be useful to rice growers thinking of potential rotations.

Tool Overview

The tool allows California rice growers to choose between four rotational options: safflower, sunflower, tomatoes, and dry beans. Growers can input data from their production systems and ranches for rice as well as the rotational crops. There are also default data values (averages) that the tool generates if the growers do not know the values or can not obtain them.

The output generates a constantly updating graph, which updates as the inputs and values are changed (Figure 2). The values are also outlined below the graph, for several cost categories: baseline information (your rice values), the opportunity cost of time learning the new crop and finding markets for the new crop, seed, equipment and implements, straw management, field reconstruction (i.e., levee deconstruction/formation or additional slope), labor, inputs, harvest, irrigation, extra expenses (which includes office expenses and compliance payments), crop loss, and rent.

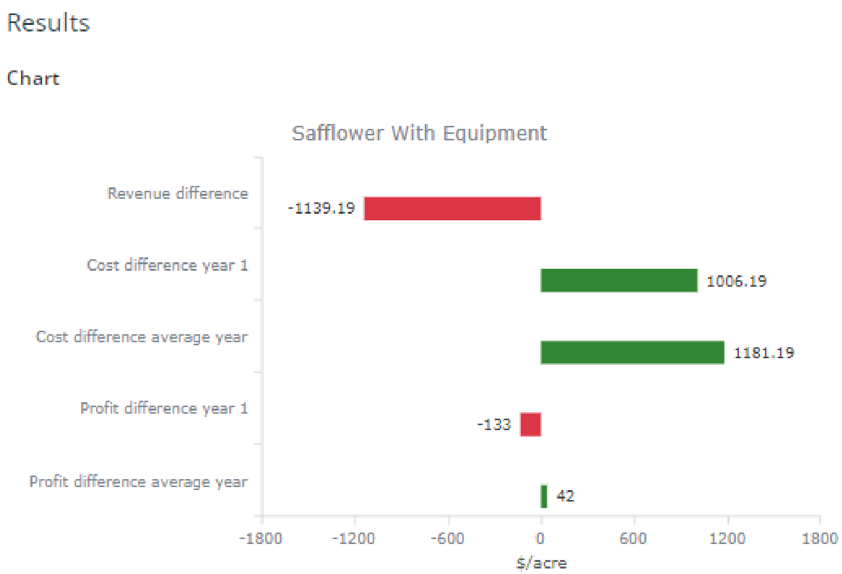


Figure 2. An example output chart from the calculator with safflower as a rotational crop. The calculator provides the overall revenue difference between safflower from rice, the cost difference between safflower and rice in the first year of switching out of rice as well as an average rice year, the profit difference between safflower and rice in the first year, and the profit difference on an average rice year.

How do you use this Calculator?

Start by picking the rotation crop you wish to explore. You will then be taken to an interface with a drop-down menu. The drop-down menu will show you several crop cost categories. Each category will be accompanied by cost components that have associated values.

Click on the first category: Baseline Information. The calculator compares the costs and benefits associated with producing rice with a rotation crop. Under the Baseline Information category, you will enter your price and yield for your rice crop, your cost for water, and your cost for land (rent). You will also pick a yield value for your rotation crop in the baseline info section.

After you have entered your baseline information, continue to the next cost category, and change values as you see fit. The calculator values are defaulted to display an average cost based on current research. However, you can change these costs based on your circumstances by using the sliding bar or entering the value yourself. As you continue to enter the information and move through the cost categories, you will see how the costs start to accumulate. You may also see how savings start to accumulate. For example, perhaps you will not pay as much for fertilizers and pesticides for the rotational crop.

Feedback Appreciated

If you have suggestions for improvements to the tool, please feel free to contact us (Whitney Brim-DeForest at wbrimdeforest@ucanr.edu, or Sara Rosenberg at srosenberg@ucdavis.edu). There is also a plan already underway to make the data exportable from the tool so it can be downloaded and saved for future reference. We will notify everyone once that functionality goes live.

Acknowledgments

We would like to acknowledge other contributors to this research: Cameron Pittelkow, Ellen Bruno, Luis Espino, Bruce Linquist, Michelle Leinfelder-Miles, Kassim Al-Khatib, members of the UC IPM rice work group, and the California Rice growers who participated in the research.

Rosenberg S, Bruno E, Lam C, Tooyserkani B, Zorlu H, Martin T, Pittelkow C, Brim-DeForest W. (2022). UC IPM Crop Rotation in Rice Calculator. https://rice-rotation-calculator.ipm.ucanr.edu/

Looking back at 2022

Bruce Linquist, UCCE Rice Specialist

2022 was a year like no other we have seen in recent history. Following three years of drought with limited water supplies, rice acreage was down to a little over 250,000 acres - about half of a typical year. California rice acreage has not been this low since 1958. For the most part, unplanted rice acres were left to fallow. The impact was greatest on the west side of the valley (along the I5 corridor). For many rice growers, this was the first time in generations that they did not grow a rice crop. This reduction in acreage also had large effects on local economies and other industries that support the rice industry.

Due to a dry spring, planting started early and 50% of the rice was planted by May 5. The major source of irrigation water is runoff from the Sierra's, and while this was the case in 2022, many growers used additional ground water to supplement. For many, managing water during the season was a challenge and this led to weed problems for some. For those relying only on ground water, water quality was sometimes an issue, as well as having a hard time keeping a field flooded. Insect and disease problems were normal. While planting was early, May temperatures were low, which delayed crop progress. Low early season temperatures and planting more M-211 (a longer duration variety), contributed to a longer than average growing season. Half of the rice area was harvested by Oct 13, resulting in an average season length of 161 days which is about 10 days longer than normal.

Yields are expected to be a lower this year. This is in part due to the water problems mentioned earlier. However, from Sept 1 to Sept 9 the Sacramento Valley experienced historically high temperatures where maximum temperatures ranged from 103 to 116 ^{o}F and night time temperatures were often above 70 ^{o}F (data from Sacramento airport). This period coincided with flowering and early grain fill for much of the rice. Such temperatures during flowering are known to cause blanking and reduced yields. Also, high night time temperatures during grain fill can cause chalkiness and reduce milling quality. Early reports from grower's all support that yields and grain quality are down. Dr. Harrell will have a separate newsletter article discussing this further.

Following harvest, there has been a large amount of rice acreage where the rice straw has been bailed. This is in part due to the lack of winter water to flood fields for decomposition; however, with the drought, rice straw becomes more attractive as a livestock feed in the San Joaquin Valley. This fall some growers are getting a relatively good price for their rice straw.

There is a lot of uncertainty among growers about what next year holds. Certainly, a dry winter does not bode well for the rice industry. So, all eyes are on the weather.

High Nighttime Temperatures Partially to Blame for Increased Chalk and Decreased Milling

Dustin Harrell, California Cooperative Rice Research Foundation – Rice Experiment Station

California Calrose rice varieties are known worldwide for their high quality and often grade as a USDA No. 1. For milled medium grain rice to grade as a USDA No. 1, one of the major components considered is the chalk content. Milled medium grain rice must have a chalk content of 2% or less to grade as a USDA No. 1 and a USDA No. 2 must have 4% chalk or less. This year many loads of medium grain being delivered to mills are grading a USDA No. 2 and even some USDA No. 3, mainly due to a higher-than-normal chalk content observed this year across varieties. This is unprecedented in California and has many growers and millers searching for an explanation.

Rice kernels that have opaque or white regions in them that are more than one-half of the grain in size are considered chalky (Figure 1). Chalky rice grains are sometimes called "white belly", "white core", or "white back" depending on the area of the kernel that the chalk is found. Chalkiness of grain samples is evaluated by hand during grading.

Chalk in rice is formed when an increased packing rate of starch granules (amyloplasts) occurs during grain filling which causes air spaces in the endosperm of the kernels to form. This gives chalky rice that distinctive opaque or white color. Chalky rice also leads to decreased milling yields because the chalky areas tend to be weaker and more prone to breaking than translucent rice kernels. It should also be noted that immature kernels can also be considered chalky when mixed with mature translucent grains when rice is harvested too early (Figure 2).

Both genetics and environment play a role in the formation of chalk in rice. Rice research has shown that some rice varieties tend to produce more chalk than others. In general, long grain varieties tend to be more susceptible to chalk formation than medium grains. However, medium grains are by no means immune to chalk formation. High nighttime air temperatures have been shown to be highly correlated with increased chalk formation in rice. Research has shown that increases in chalk formation can be observed when nighttime temperatures do not fall below 22^{o}C (71.6^{o}F). In the mid-south rice producing area the rule of thumb is that higher chalk and decreased milling yields are expected in years when nighttime temperatures did not fall below 75^{o}F at night (for at least a few hours) during grain filling.

The temperate climate of Sacramento Valley where California rice is predominately grown rarely has temperatures that do not fall below 75°F at night which would lead to increased chalk formation. In a normal year, nighttime temperatures that fall below 55°F are more worrisome for growers because the low temperatures can cause sterility and blanking. However, that was not the case in 2022. Figure 3 below shows the average daily day (red line) and nighttime (blue line) temperatures at the Sacramento airport weather station. Here you can see that the historic average nighttime temperatures from late August to mid-September ranges from around 60 to 58 degrees (Biggs averages 63 to 60 degrees), well below critical levels. Depending on the variety and planting date, this time typically coincides with the critical grain filling period most years. In 2022 you will notice that there are several days in early September that do not fall below 73 degrees and even one day that does not fall below 81 degrees at night. If rice was in the grain filling stages during this time period, there is a higher probability of having more chalk. How does this year compare to last year, you ask? Well, last year (Figure 4) there were no days where the nighttime temperatures did not exceed 69 degrees in Sacramento. Quite different from this year to say the least!

We are currently processing multiple Calrose varieties across research trial locations this year to determine which varieties may be more susceptible to increased chalk when exposed to higher nighttime temperatures. Early returns from the mill suggest that M-211 may be more susceptible. However, before we make that claim, we should also consider that M-211 is a later maturing variety and that grain filling on many fields may have coincided during the heat wave this year more often than earlier maturing varieties. We hope to know more soon.

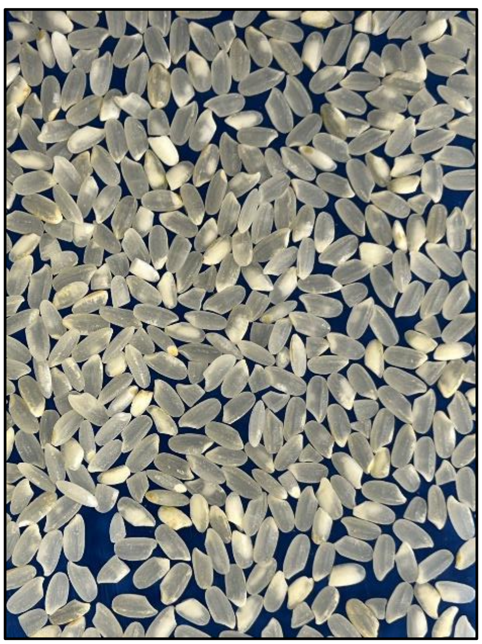


Figure 1. Sample of M-211 with high chalk content.

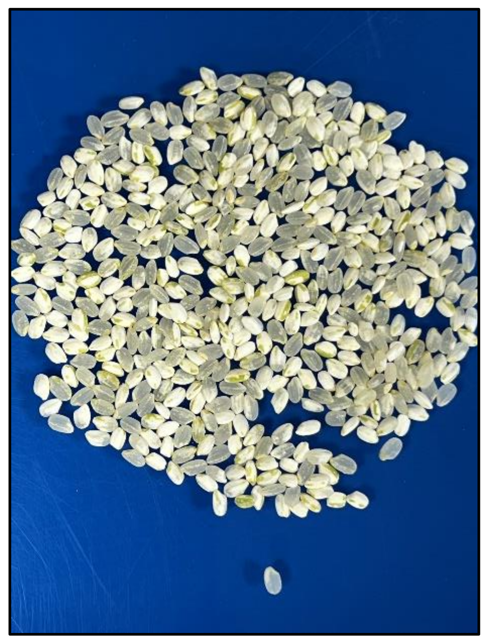


Figure 2. Experimental rice line with immature grains (high chalk) caused by harvesting at a high moisture content.

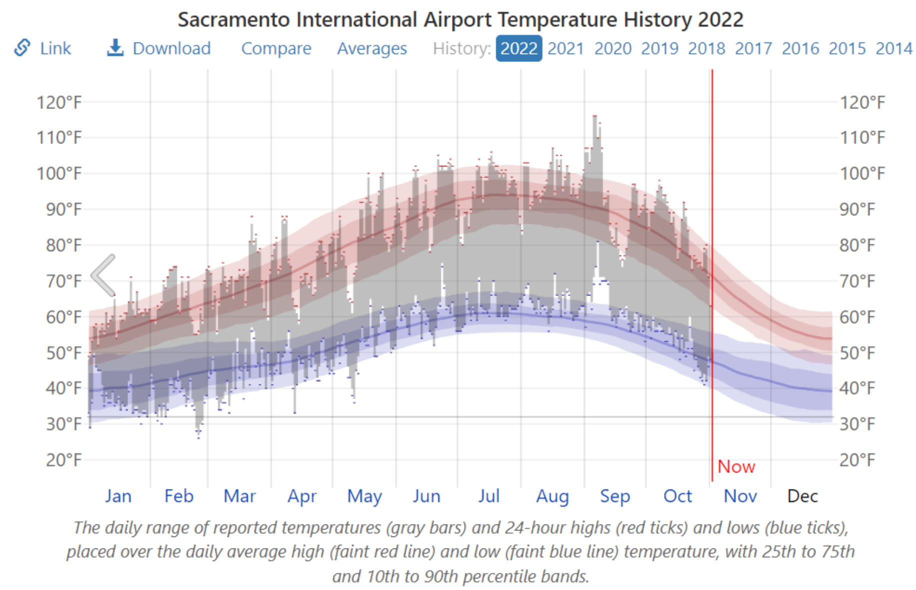


Figure 3. Historical average and daily high and low temperatures in Sacramento, CA in 2021.

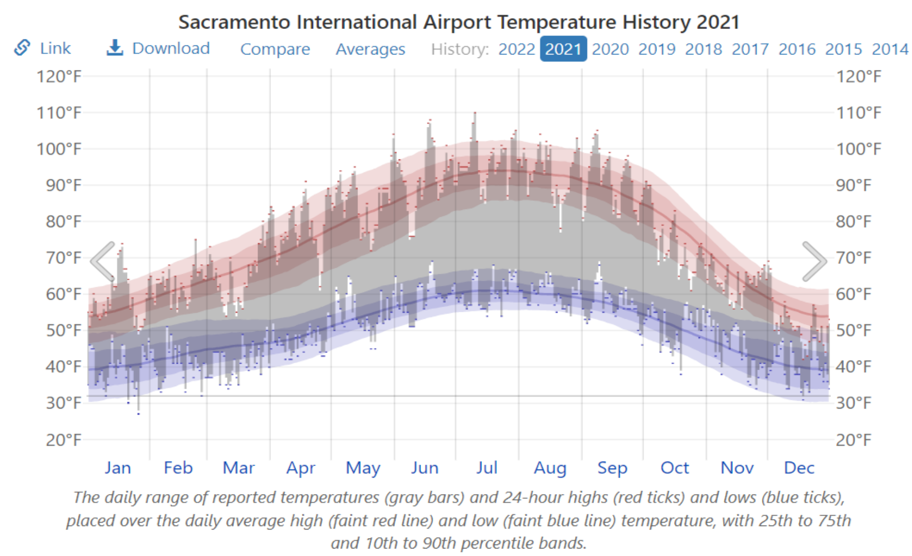


Figure 4. Historical average and daily high and low temperatures in Sacramento, CA in 2022.

New smart insect pest detection technology for agricultural and food products

Zhongli Pan and Ragab Khir, Dept of Biological and Agricultural Engineering, UC Davis

With the continued support from the California Rice Research Board, Almond Board of California and their members, Dr. Zhongli Pan and his research team have successfully developed a smart insect pest detection and control technology (patent pending) and demonstrated its effectiveness in detecting the insects in early stage of insect infestation in and agricultural and food products. The entire system has three components: a detector, a cloud server, and a user interface (Figure 1). The detector captures insects when they emerge and takes their photos periodically or on demand at any time through an APP on mobile devices or a computer. It also measures and records temperature and relative humidity which are closely related to insect activities, product quality and food safety. The insect images and temperature and relative humidity data are sent to a cloud server. A computer program is then used to analyze the images and data, and then send the insect count, temperature and relative humidity data to the user interface or APP to be viewed remotely at any time. Alert notice can also be automatically sent to the managers for taking necessary pest management and control actions.

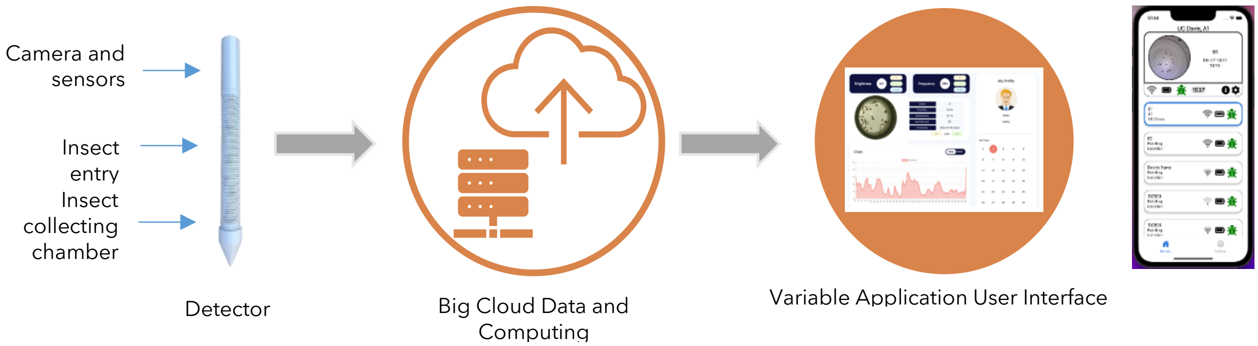


Figure 1. Smart insect pest detection technology

The SIPD technology recently received the AE50 Outstanding Innovation Award from the American Society of Agricultural and Biological Engineers for the innovation, significant engineering advancement, and impact on the market served. The SIPD system is now commercially available from AIVision Food Inc.

SIPD technology demonstration results: During the last four years, the SIPD was systematically developed and tested. Last year, it was successfully demonstrated at nine commercial rice warehouses, three commercial almond processors, and one walnut processing facility in California. The demonstration included products in stockpiles, metal silos, flat concrete storage, bins and boxes. The most important finding was that insects were quickly detected by the new technology when insects were present or emerged, but were not detected by human inspection.

For rice, the new SIPD technology was able to detect insect activities in all tested storage facilities in April, which was not expected. The typical human inspection starts to check and may find insects in June or July when the weather is warm. As examples, the SIPD device detected the first insect in the next day after installation in the tested storage facilities. All the installed detectors detected insects within 18 days. The number of insects increased during the test period. However, the human inspection in all tested storage facilities did not find any insects during the entire test period. This demonstrated the effectiveness of the SIPD technology for early detection. Additionally, the SIPD devices were able to catch and detect different types of insects. The early detection also allowed for just the top-dressing treatment by only treating the top layer of the product, which reduced the chemical treatment costs by up to 70% based on the estimate from this year's results. The SIPD technology achieved real-time monitoring, early detection, and automatic notification of insect activity, temperature and relative humidity in rice storages.

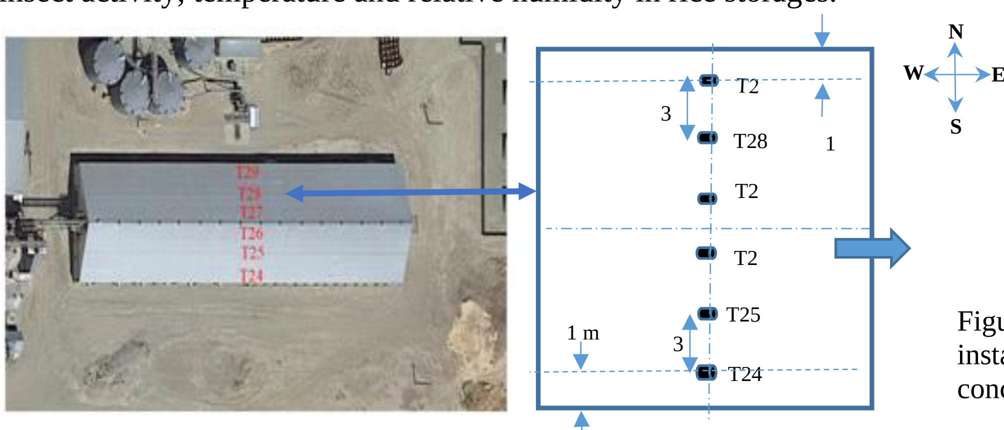
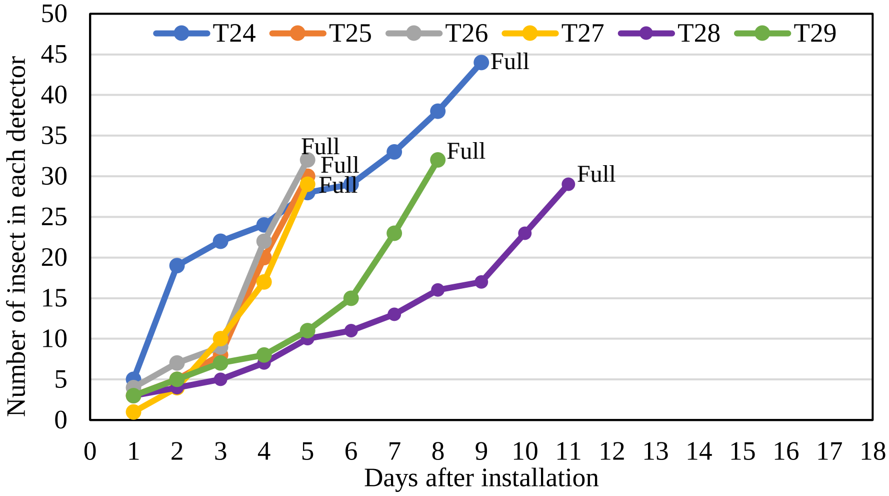


Figure 2. SIPD devices installed in rice in a flat concrete storage facility



Insects detected in detector # T29 after 8 days of installation

Figure 3. Number of insects detected in rice in a flat concrete storage facility

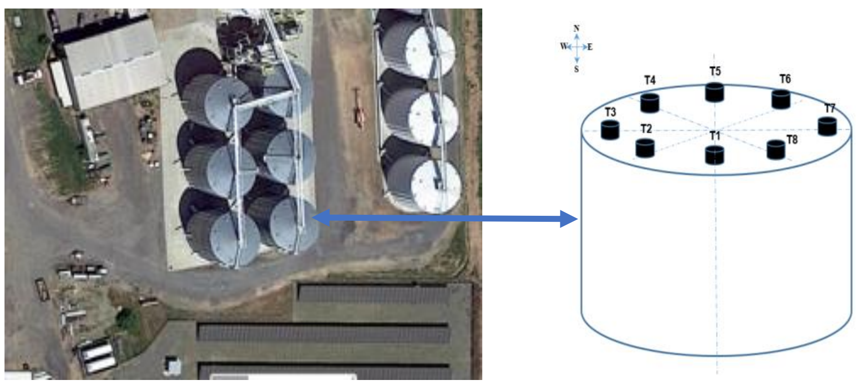
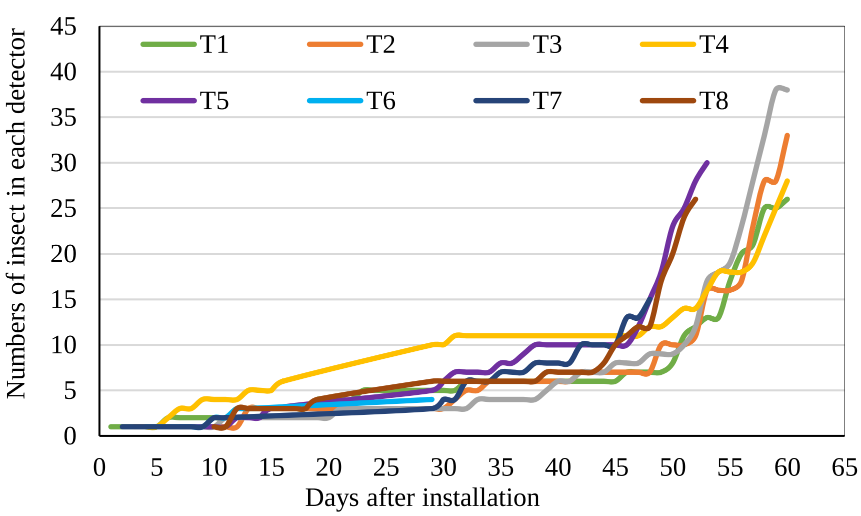


Figure 4. Detectors installed in rice in a metal storage silo



Insects detected in device # T4 after 7 days of installation

Figure 5. Number of insects detected in rice in a metal storage silo

Figure 6. Detectors and insects detected after installation in rejected almond kernels

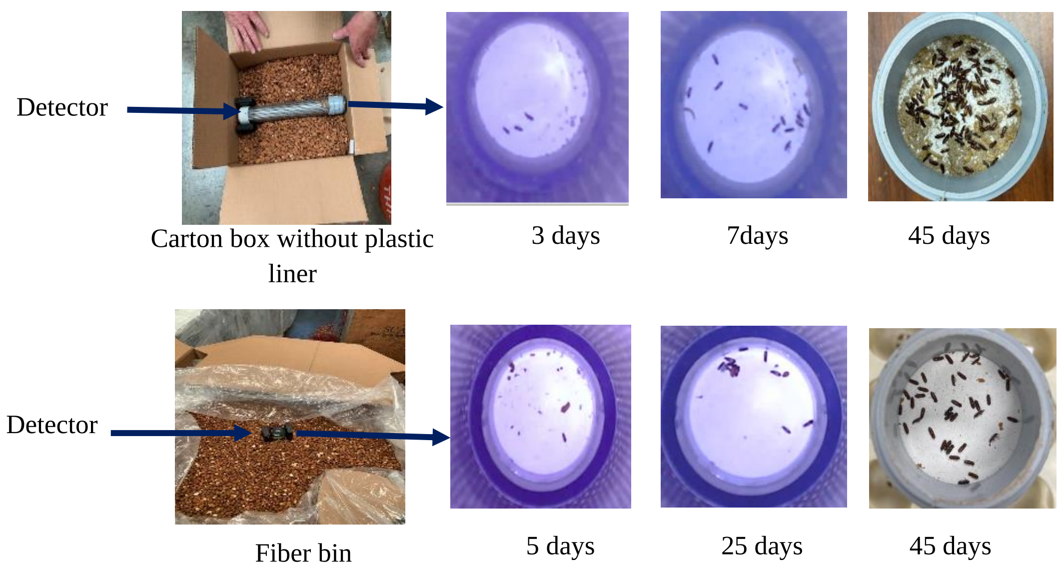


Figure 7. Insects detected after installation in final almond kernels packed in a carton box

Figure 8. Insects detected in stockpiled almonds

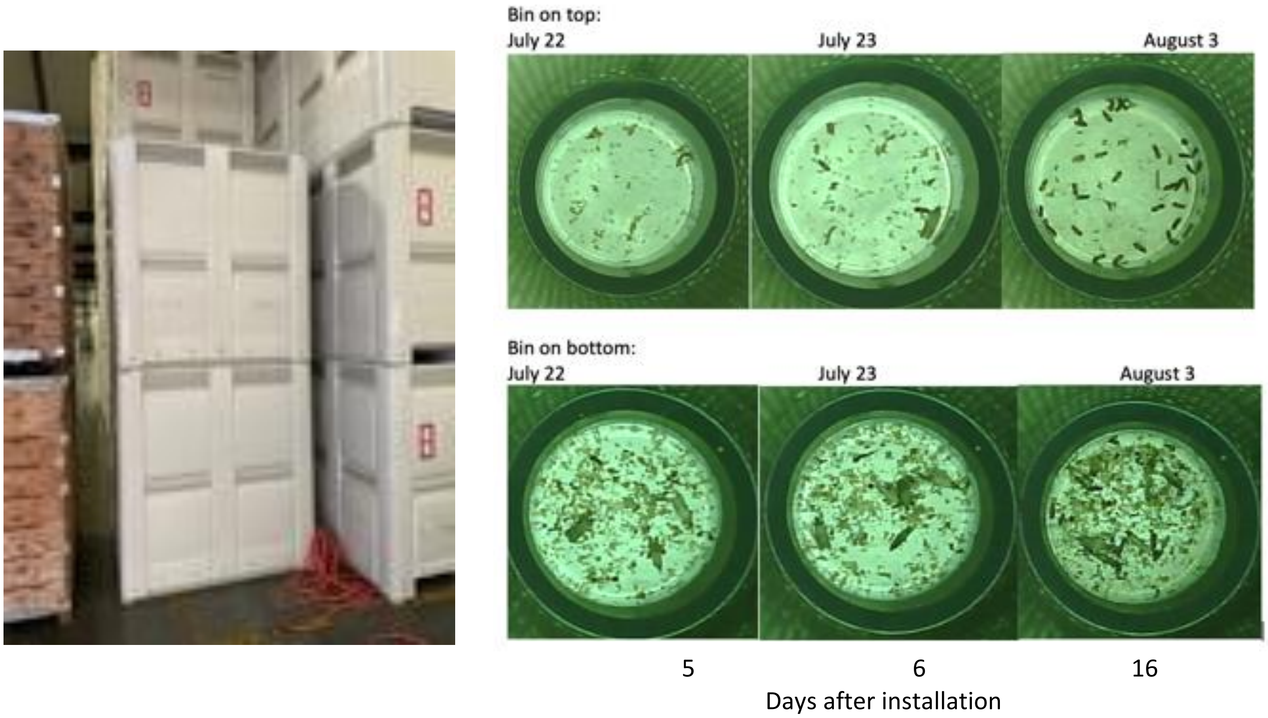


Figure 9. Insects detected walnut kernels in bins in a processing facility

Metal storage silos for walnuts

Installing detectors in walnuts in metal storage silo

Insects detected after 2 days of installation

Figure 10. Detectors and insects detected in in-shell walnuts in a metal storage silo

Applications and Benefits of SIDP

- SIDP is the only fully demonstrated smart technology and available for commercial applications that achieve early insect pest detection, monitoring storage conditions, and providing notification.
- It can be used to for various food and agricultural products during storage, processing, handling, and transportation/shipping.
- The detectors can be placed in product in packages, bins, shipping containers, warehouse storage, and bulk products. They can also be placed in processing and storage facilities to replace insect traps, eliminating the cost of human inspection and associated risks.
- The early insect detection and notification avoid or minimize the loss in products and quality, allow new pest management methods with reduced chemical use, cost, and negative impacts on food safety, workers, and environment.

- The application of SIDP technology can prevent unnecessary fumigation treatment, eliminating the guess in fumigation time or late fumigation causing product loss. It is an effective tool for determining the appropriate dosages of fumigants and assessing the effectiveness of fumigation.
- The monitoring of environmental conditions of products provides important information for avoiding product quality deteriorations and concerns in microbial growth.

2022 Pest Review

Luis Espino, Rice Farm Advisor, Butte and Glenn Counties

As mentioned in other articles, 2022 was a very different and difficult year for rice. In the area of pest management, insect and disease problems were average; however, there are some observations of interest.

Armyworms were heavy in some areas of Butte County. Is this because acreage was concentrated there? Possibly. In Glenn County fields that were isolated and with no other rice around, I saw fewer moths and worms than in Butte County fields that were surrounded by rice. For the last couple of years I have also monitored moth populations in fallow fields. This may seem obvious, but traps in fallow fields catch very few moths compared to fields with rice. This shows that rice acts as an attractant for moths and this plays a role in the armyworm cycle. The fact that we cannot find armyworm eggs in rice is puzzling.

I was able to set up an insecticide trial in a commercial field with a heavy armyworm infestation. Again, Intrepid 2F came out on top, followed closely by Dimilin. They both give good control of armyworms but Intrepid seems to kill the worms a little faster than Dimilin. Over the years I have tested pyrethroids, carbaryl, and *Bt*s. Unfortunately, these products do not work very well in our system.

Stem rot and aggregate sheath spot problems were average. In my trials I noticed stem rot severity was not reduced as much with azoxystrobin (the active ingredient in Quadris) as in previous years. On the other hand, I had very good control of aggregate sheath spot which resulted in a yield increase of 4% and even a little bit better head rice yield.

Blast was not a problem this year. There were a couple of blast reports during the season, but after visiting the fields and sending samples to the lab, those turned out not to be blast. A report of blast from the Delta is still being investigated. Rice in the San Joaquin Delta would be a very unusual occurrence. Kernel smut was not a problem. In fact, since the epidemic of 2018, kernel smut levels have been decreasing.

I did find more bakanae this year, but I don't think the incidence levels I saw would have resulted in an economic impact. It seems bakanae incidence has been on the increase for the past three or four years. The seed bleach treatment is very effective against bakanae, so I suspect some of these cases of higher incidence may be in fields seeded with untreated seed; however, even treated seed can develop some bakanae if the seed sits in the truck for too long before seeding.

2022 Delta Rice Recap

Michelle Leinfelder-Miles, UCCE Delta Farm Advisor

In 2022, I estimate rice acreage in the Delta, south of the Yolo Bypass, was at least 8,000 acres. Most Delta rice is grown in San Joaquin County, but there is some acreage in Sacramento County. While Delta rice acreage is relatively small compared to that in the Sacramento Valley, it has been steadily increasing over the last several years (Table 1).

San Joaquin County Rice						
	2022	2021	2020	2019	2018	2017
Acreage	8000 (est.)	7070	4990	4360	3620	3060
Average Yield (cwt/ac)	Not available	95	88	81	86	82

Table 1. Rice acreage and yield according to the San Joaquin County Agricultural Commissioner's crop reports. County rice production is predominantly in the Delta region.

Given the increasing interest in rice production among Delta growers, and the differences in production practices from the Sacramento Valley, UC Cooperative Extension and UC Davis will be releasing a cost of production report specifically for Delta rice later this year or in early 2023. A Delta rice cost study was last produced in 2007, so updating the study was long-overdue. I want to thank all the growers who participated in a focus group to update the study.

Cool temperatures can make the Delta a challenging place to grow rice. Low night-time temperatures can cause blanking, which results in empty grains. Growers are limited to using only very-early and early maturing varieties. Most of the Delta acreage was planted with variety M-206, but some growers also planted a portion of their acreage with M-105. In 2022, we continued the UCCE Delta variety trial, which will help to identify and advance cold-tolerant varieties. The Delta trial is part of a statewide network of trials, led by UC Rice Extension Specialist, Bruce Linquist, and coordinated by Staff Researcher, Ray Stogsdill. I anticipate that the statewide results will be ready in time for the February Field Notes newsletter.

This year, I worked with growers and consultants on a handful of pests. Weed management is always top-of-mind for rice growers. There are limited practices and products that can control problematic weeds, and in some circumstances, the weeds may develop resistance to the herbicides that are available. If herbicide resistance is suspected, please contact me so that we can submit weed seeds for testing. We would collect the seeds in the late summer or early fall when they have matured but have not shattered. Resistance testing is overseen by UC Weed Science Extension Specialist, Kassim Al-Khatib, and takes place in greenhouses during the winter. By the following spring, we provide the grower with information on which herbicides are still working and which are not.

Over the last several years, I have conducted trials to evaluate the efficacy of a new herbicide product, Loyant (florpyrauxifen-benzyl; Corteva Agriscience), on grasses and sedges in the Delta drill-seeded system. (See https://ucanr.edu/sites/deltacrops/files/361256.pdf for project reports.) Loyant is now registered and will be available for the 2023 season. This year, I collaborated with graduate student, Deniz Inci, and Kassim Al-Khatib to evaluate product efficacy on cattails. With only one year of data, we cannot make too many conclusions, but it appeared that Loyant had efficacy on small cattails (less than three feet tall, Figure 1). The results were promising, and we will continue our investigation next year to see what more we can learn.

I have been trapping armyworms in the Delta since 2016 (Figure 2), in collaboration with fellow farm advisor, Luis Espino. The traps catch true armyworm moths. They were deployed on three ranches and monitored weekly. In 2022, we recovered the highest moth counts since 2017, and the peak flight occurred about one week earlier than in 2017. This is important information for management because, based on the armyworm life cycle, we know that peak worm populations occur approximately two weeks after peak moth flight. In other words, growers can make informed decisions based on the monitoring data and adapt their management to the field conditions. Trap monitoring is one part of an integrated pest management program for armyworms, which also includes scouting for feeding damage and the worms themselves. Over the years, I have observed armyworms in riparian and wetland vegetation that neighbor rice fields, so it is important to scout those areas, too. More information about Delta armyworm trapping is available on my website (https://ucanr.edu/sites/deltacrops/Rice/Armyworms/).

I observed a couple important diseases this year – stem rot and rice blast. In recent years, we have observed stem rot on certain ranches at harvest. As fields were getting drained, the plants turned brown instead of golden, and grains hadn't filled (Figure 3). We developed post-harvest straw management programs that included burying the residue to try to break down the fungal inoculum. This year, we noticed the problem in some locations early enough to make treatment decisions. We walked the fields at late-tillering and early-heading and found black lesions on the stems at the water line (Figure 4). We submitted samples to UC Plant Pathology Extension Specialist, Cassandra Swett, and confirmed stem rot. Treatment timing is critical for managing stem rot, and treatment at early-heading has been observed to be most effective. There is a tendency for stem rot to be more severe on low potassium soils, and many Delta soils are naturally low in potassium. A potassium fertility program may help mitigate disease severity, but management should include a multi-pronged approach that also includes post-harvest straw management and possibly fungicide applications. Currently, there is no varietal resistance to the disease. The rice blast that was confirmed was in one field. We observed lesions below the panicle ("neck blast") that caused blanking. Blast spores can move by air, are favored by warm, wet conditions, and can be exacerbated by excess nitrogen. Fungicides are registered and are most effective at early-heading. For more information on both of these diseases, see the fact sheets written by Luis Espino (https://rice.ucanr.edu/FactSheets/Rice/), or give me a call.

We should continue to keep weedy rice on our radars because we have seen it in the Delta in the past. Where we have observed light infestations, it appears that keen management – including in-season rogueing, post-harvest management that includes straw chopping but not incorporation, and winter flooding – can reduce, if not eliminate the pest. These are our management tools until a herbicide is approved for spot-spraying. Growers should also pay attention to equipment sanitation – harvesting weedy rice fields last (if possible) and thoroughly cleaning out equipment after harvesting fields where weedy rice has been observed.
Finally, I will be starting new projects this winter, in collaboration with fellow farm advisor, Whitney Brim-DeForest, and graduate student, Sara Rosenberg, to evaluate winter cover cropping between rice crops. Our objectives are to evaluate carbon and nitrogen cycling and variety survivability during the cool, wet (we hope!) winter conditions. These projects are supported by the CDFA Healthy Soils Program and the CA Rice Research Board. I look forward to sharing results in the years to come.

I am grateful to work with a great team of UC colleagues on these rice projects. I am also grateful for all the growers who have collaborated with us. I wish everyone a good end to the year, and I look forward to working with you again in 2023.

Figure 1. The herbicide, Loyant, was trialed on cattails in the Delta in 2022.
We will continue these investigations next year.

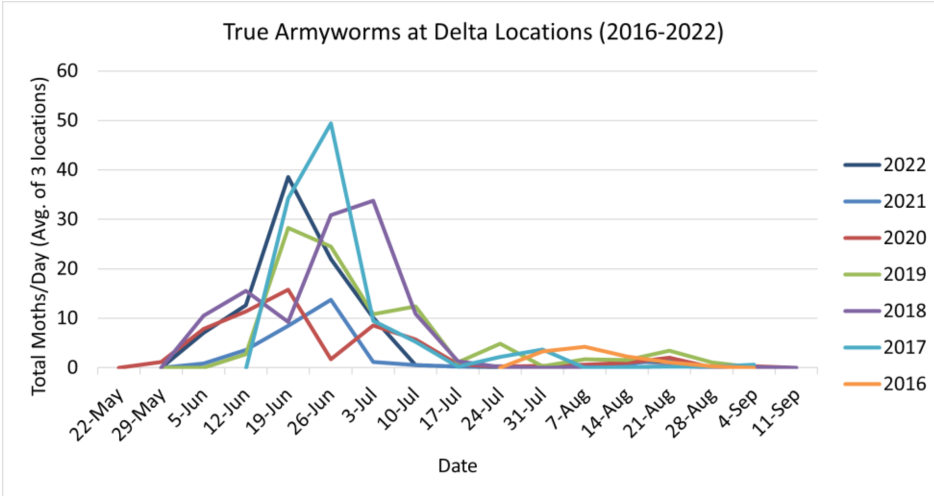


Figure 2. Delta true armyworm trap counts, 2016-2022. In 2022, trap counts were the highest since 2017 and the peak flight occurred about one week earlier than in 2017.

Figure 3. Plants with stem rot turn brown instead of golden when fields are drained, and grains may not fill.

Figure 4. Monitoring for stem rot should happen at late-tillering. Black lesions form on the stems at the water line. Fungicide treatment is most effective when applied at early-heading.