54th Annual Report

A Summary of Research from 2022 to the California Rice Growers

Chairman's Report

California Rice Research Board Chairman

Drew Rudd

Welcome to the 54th annual report to the California Rice Growers. In the following pages, we report on grower funded research from 2022. The following pages will include summaries of the various projects that were funded, including rice breeding, variety trials, weed and disease management, cover crop studies, invertebrate pest management and insect monitoring as well as several others.

The drought conditions experienced over the past several years lead to a decrease in acreage that most of us have never seen in our time farming rice in California. Farm Service Agency reports show that there were 241,000 acres planted in 2022, which was 61% of the 2021 crop (a year of reduced water allocations). Despite the reduction in assessment funds generated, the Rice Research Board was able to fund the main projects for rice production and rice industry issues. The generous winter that came to California has filled our reservoirs and with that it is a pleasure to see rice acreage rebound to (near normal) levels within the state! This will help towards reversing the negative budget and the use of reserve funds we experienced with the very low acreage of the 2022 crop year, where the CRRB observed assessments covering less than 50% of the rice research projects at the Rice Research station, UC Davis, and the USDA.

Just below is a list of the projects in this report. I hope that you will look through the areas that interest you, and read the full reports, linked with the QR code, for further information. Full technical reports can also be found on the website www.carrb.com. Look under the tab "Annual Reports", select the 2022 year, the article will be under "Full Report Text" to the right of the title.

In spite of the challenges that we've faced, I'm happy to report that we are continuing to make good progress in the various projects funded by the rice industry. None of that happens without the ongoing support of the California growers through the Rice Research Board. Many thanks to you all. I wish you the best for a safe and productive year in rice country.

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Rice Breeding Program

Rice Experiment Station

Administration and Plant Breeding Staff

The California Cooperative Rice Research Foundation (CCRRF) is committed to the development and release of excellent high-yielding and high-quality rice varieties. The RES Breeding Program implements rice variety development for all market classes of long, medium, and short grains.

The focus of the RES rice breeding program is to develop improved rice varieties with high-yielding and superior-quality grain types and market classes that are commercially competitive in the world market for the benefit of California rice growers now and in the future.

The Rice Experiment Station is now up to full strength with the majority of positions filled. Dr. Harrell's leadership has brought progress and stability. This year features the release of two new varieties: The long awaited herbicide resistant Medium Grain with the ROXY® technology, released as M-521 and a Premium Quality Short Grain, Calhikari-203

Breeding Nurseries

Three breeding nurseries are established to accelerate breeding activities. The breeding nursery locations include: (1) Rice Experiment Station facility in Biggs, CA (77,552 lines), (2) the Hawaii Winter Nursery for generation advance and seed increase in Lihue, HI (8,203 lines), and (3) the San Joaquin Cold-Tolerance Nursery for cold-induced blanking screening (4,165 lines).

Each of these nurseries has a unique role in the California breeding program. The RES facility allows for the creation of new varieties and summer seed production and evaluation. The Hawaii facility allows for a winter generation to be produced, giving the breeders two generations per year. The San Joaquin nursery evaluates the cold tolerance of varieties, and is used in conjunction with refrigerated greenhouses at RES.

Medium Grain

M-521 (19Y4000)

Some have been following the progress of the herbicide tolerant ROXY® variety 19Y4000. The CCRRF Board approved the release of this variety and the new official name will be M-521. This line will be the first herbicide resistant, medium grain in California. The variety will have both oxyfluorfen and blast resistance. It was bred conventionally with the aid of marker-assisted selection (MAS) for Pi-b blast resistance and the ROXY® trait. The original cross was with M-210 (blast resistant) and the oxyfluorfen resistant discovery. Backcrossing with M-206 seven times has resulted in a variety 99.6% genetically similar to M-206.

Confidence in the productive ability of M-521 is high as it was evaluated in the UCCE State Wide (SW) Yield Tests for four years (2019-2022), for a total of 41 yield experiments. Based on the pooled four-year SW Yield Tests, field performance of M-521 was similar to M-206 and M-210 in all SW test locations beginning in 2019. It has very good seedling vigor, flowered at 87 days, with a plant height of 96cm, and a lodging potential like M-206 and M-210. Yield performance of M-521 in different zones or UCCE test locations is summarized in the table below. Location specific performance indicated 2-4% yield advantage of M-521 over M-206 and M-210 in San Joaquin and Biggs. In other locations, M-521 had an average of 2% lower yields than the two Calrose varieties.

Location (County)	Grain Yield (lb/A, 14% MC, 4 yrs			Yield over M-206	Yield over M-210
	M-206	M-210	M-521		
San Joaquin	9618	9502	9848	2%	4%
South Butte	9292	9578	9131	-2%	-5%
Glenn	9152	9487	8885	-3%	-6%
Colusa	9295	9178	9000	-3%	-2%
Sutter	9200	9246	8748	-5%	-5%
Yolo	9130	9067	8894	-3%	-2%
Biggs	8752	8733	9018	3%	3%
North Butte	8624	8982	8882	3%	-1%
Yuba	7860	7538	7334	-7%	-3%
MEAN	8907	8949	8839	-2%	-2%

Grain Characteristics and Milling Quality of M-521

The milled grains of M-521 were marginally lighter, slightly longer, and slightly narrower than the M-206, and M-210 varieties.

When cut at 22% moisture and above, M-206 had a head and total of 68/71, while M-210 and M-521 had 67/71. At 18-22% moisture, the milling yield of M-521 was slightly improved to 67/72, similar to M-210. As is typical, when harvested at moistures below 18%, all three entries tended to have reduced head rice as grains became drier.

RVA and Quality Evaluation of M-521

The average apparent amylose (20.66%) and protein content (5.96%) of M-521 was similar to M-206 and M-210. All three had low gel type typical of a Calrose-type medium grain. Based on the average of four-year RVA (rapid visco analysis) data, M-521 does not deviate significantly from the profile of M-206 or M-210. Results indicate that M-521 cooking characteristics are similar to M-206 and typical of a Calrose type rice.

Cold-induced Panicle Blanking and Disease Screening Tests

Cold tolerance screening is performed in San Joaquin and in the refrigerated greenhouse at RES from 2019 to 2022. Averaging the four-year results in San Joaquin shows that M-521 had blanking of 1.3%, compared to 1.5% for M-206 and 1.2% for M-210. Overall, in both San Joaquin and greenhouse testing, M-521 had a cold tolerance level similar to M-206 and M-210.

Based on the four-year stem rot resistance screening, M-521 had an average stem rot score of 3.38, which is moderately susceptible to stem rot disease. M-206 and M-210 were both susceptible to stem rot with scores of 3.77 and 3.45 respectively.

For blast resistance, screening is limited to the detection of incorporated blast genes using DNA markers detected by the RES Genetics Lab. M-521 and M-210 were both positive for the presence of the Pi-b blast gene, while M-206 was negative for the desired gene. Therefore, if a blast outbreak occurs, M-210 and M-521 are expected to show resistance.

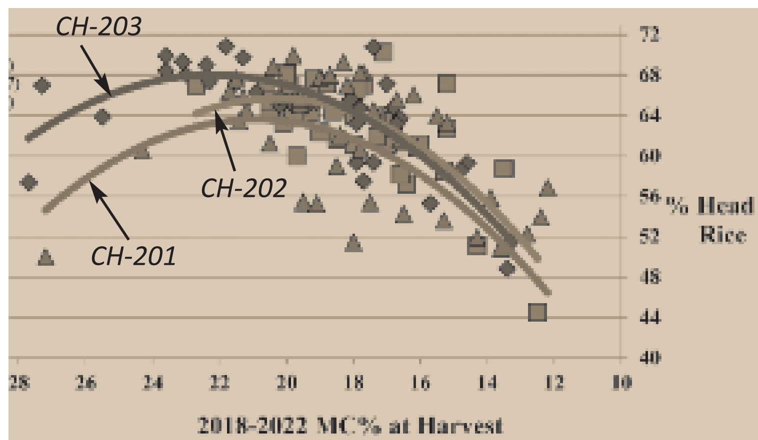
Calhikari-203 (17Y2087) Premium Quality Short Grain Rice

17Y2087 is a semidwarf, early maturing, high yielding premium quality short grain rice approved for release in 2023. The new variety will be named Calhikari-203 (CH-203). It has a 11-13% yield advantage over CH-202 and CH-201, averaging 9,050 lb/A yield based on five-year UCCE SW yield tests. CH-203 consistently showed higher lodging resistance of 33% vs. CH-202 at 65% and CH-201 at 61%. CH-203 has high milling quality. Test evaluations indicated the excellent grain appearance, cooking, and taste qualities of CH-203 for the premium quality short grain market. Taken together, the attributes of CH-203 make it suitable for comingling with existing premium quality short grains or a viable alternative to CH-202 or CH-201.

CH-203 Yield and Agronomic Performance

Compared to CH-202 and CH-201, CH-203 had a similar seedling vigor, it flowered at 89 days which is two days later than CH-202, one day later than CH-201. CH-203 is considered semidwarf like the older Calhikari varieties at 90 cm plant height. It also has excellent straw strength as shown by the low lodging potential.

Performance of CH-203 in the cooler areas of Sutter, Yuba, Yolo, and San Joaquin, showed it to be cold tolerant as indicated by yields exceeding 10,000 lb/A in Yolo and San Joaquin. In Sutter and South Yolo, CH-203 had a 5-8% yield advantage over CH-202 & CH-201. In the low yielding site of Yuba, CH-203 had a 16% yield advantage.



In summary, CH-203 had a superior grain yield over CH-202 or CH-201 in all SW test locations. It is adapted in all rice growing counties of California that makes it a viable alternative rice variety for commercial rice production.

RVA and Quality Evaluation for CH-203

All three Calhikari lines had apparent amylose content of 20% and low gel type grain, indicating similar softness when cooked. Low protein content is desirable because low protein content is correlated to high taste scores. Two-year protein analysis indicated that CH-203 had lower protein content than CH-202 or CH-201.

Overall, the CH-203 cooking profile was similar to CH-202 and CH-201. The amylographic profile also show that CH-203 more closely overlaps the cooking curve of Koshihikari. Internal and external blind evaluations for grain appearance, cooking and taste qualities by mills, rice handlers, market-

ing organizations, and some Japanese evaluators indicated the close similarity of CH-203 to Koshihikari and CH-202.

Short Grain Breeding

Promising SPQ

In 2022, two high yielding, SPQ entries were identified (21Y2031 and 22Y2119) as potential candidates for SW yield tests in 2023. For grain yield, 21Y2031 showed a 17% yield advantage over CH-202 and CH-201. When 21Y2031 is harvested between 18-22% moisture, the milling yield averages 66/73% head and total. Analysis for chalkiness revealed more chalky kernels (3.2%) for 21Y2031 than CH-202 (1.0%) and CH-201 (2.4%). Compared to CH-202, it also had a higher taste score due to its lower protein content.

Line 22Y2119 is another SPQ that had good grain yield and quality performance. It had a 16% yield advantage over CH-202 and CH-201. Its grains were slightly more chalky (1.5%) than CH-202 (1.0%), but less than CH-201 (2.4%). Lines 21Y2031 and 22Y2119 well be considered for SW yield test in 2023.

Promising Regular Short Grains (S)

Across the seven SW locations in 2022, 20Y2001 outyielded both S-102 and S-202. It averaged a yield advantage of 8% over S-202 and 28% over S-102. Compared to S-202 and S-102, line 20Y2001 was more adapted to different SW locations. Grain yield results show that it was the highest yielding line at six out of seven UCCE SW locations.

Milling yield of 20Y2001 was high compared to S-202 and had a similar percentage head rice to S-102 when harvested at 18-22% moisture. It is later flowering, shorter than its sister varieties, and lodges more (46% vs 37-40%). Chalky grain percentages fall between S-202 and S-102. Disease screening data from 2021 at RES revealed high stem rot resistance with a disease rating score of 1.8 for the line.

Some future lines to keep an eye on would be 20Y2008 and 20Y2072. Both lines outyielded the standard check varieties at RES.

Promising Sweet Short Grains (SWX)

A waxy short grain line included in the SW yield test has been designated 20Y2124. Results show that 20Y2124 had an average yield advantage of 5% for CM-203, and 25% over CM-101. Although the average yield advantage was only 5% greater than CM-203, it had wider adaptation than either of the older varieties. Cold-induced panicle blanking results from the San Joaquin cold tolerance nursery, show 20Y2124 is cold-tolerant like CM-203 and CM-101.

Genomic Selection

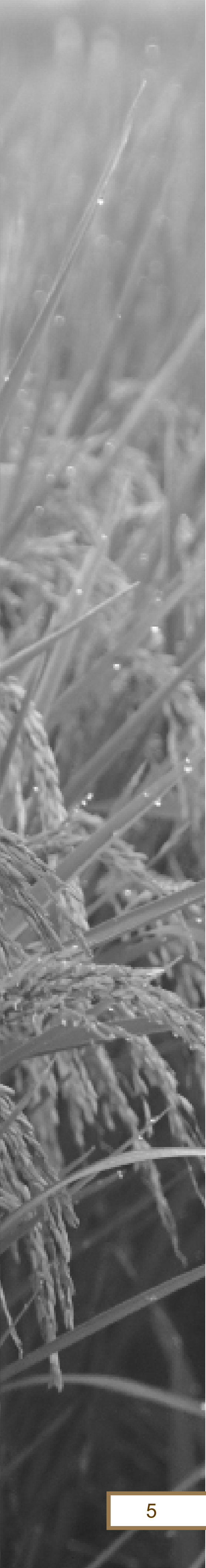
The Rice Experiment Station breeding program has successfully bred new and improved varieties for California growers using pedigree breeding method. The station also employs marker-assisted selection (MAS) for blast resistance, grain quality traits, and herbicide resistance. The whole variety development process takes about 10-12 years or longer, from the time the cross was made until variety release. While the pedigree method is proven effective, it is time-consuming, labor-intensive, and costly.

New breeding tools, such as genomic selection (GS), is emerging and may ensure complex traits are selected with improved accuracy and precision. GS, in principle, is another form of MAS. GS uses all markers spread across the genome to predict the performance of lines with genotypes only (organism's genetic information) without phenotypes (observable physical traits). Thus, selections can be made earlier that reduce the number of candidates to be examined in the field.

The goal of the project is to integrate GS, as a complementary breeding tool to MAS, into the RES breeding program. This efficiency gain has three major steps:

- A population, that represents the genetic diversity of the RES breeding program, was assembled and field tested since 2020.
- A suitable marker set, that is cost effective and can discriminate the RES germplasm, will be developed for routine use genotyping GS materials (training set and predictive set).
- Assess the prediction accuracy of the GS prediction model for selecting complex traits.

A total of 360 lines, consisting of advanced breeding lines and released cultivars of all grain types, were selected to be phenotyped for grain yield and agronomic traits. These same lines were genotyped to form a training population. Broad-sense heritability estimates, based on the phenotype, ranged from 0.64 for seedling vigor to 0.88 for days to 50% heading. This indicates good predictability for the agronomic traits. Grain yield data will be gathered in 2023. In addition to field evaluation, the population will be genotyped with genome-wide, single nucleotide polymorphism (SNP) markers to assess the potential of GS in the RES breeding program.



Long Grains

L-208 is the newest conventional long grain and was released in 2020. Agronomic characteristics, adaptation, milling, and cooking qualities of L-208 are similar to L-207.

Based on 2022 SW experiments, L-208 and L-207 had higher yield at locations outside of RES. The new variety, L-208, had approximately a 4.0% yield advantage over L-207 in 2022. It performed better and had higher yield in five out of seven SW experiments.

Promising Long Grain Lines

Three LG lines showed promise for future release: 19Y1018, 20Y1029, 20Y1008.

The advanced line 19Y1018 is a regular LG in the SW trials for a second time. It was planted in seven locations and out yielded L-208 and L-207 by 1.7% and 5.7%. Line 19Y1018 had less panicle blanking compared to Calaroma-201 in San Joaquin. Based on milling yield trends, the line showed stable head rice performance and can be harvested from 18-26% moisture content.

Genetics Lab

The main purpose of the RES Genetics Lab continues to be to provide the breeders with genetic marker information for the selection of potential and advanced lines as well as maintaining the purity of our released varieties. Throughout the year breeders submit leaf samples from F1, head rows, and ROXY® trait lines. Off-types that appear in RES or area producer's fields are also genetically identified through marker analysis. Results from this year are:

- 2,497 parental and F1 plants were analyzed to determine true crossing.
- Head row purity was verified in over 3,700 samples which included short, medium, long, and specialty lines.
- The presence of the oxyfluorfen herbicide tolerant trait (ROXY®) was determined for about 765 plants whose response to the herbicide was atypical.
- With the eventual release of a ROXY® rice variety, an efficient and repeatable assay to identify the presence of the trait was developed.

Overall, nearly 7,500 samples were processed, resulting in over 36,000 data points.

CRISPR technology

CRISPR technology has been used successfully in the lab to verify the oxyfuorfen resistant phenotype as well as to explore the targeting of other useful traits. An organism generated by CRISPR technology is considered a genetically edited organism and not a genetically modified organism. The difference is important in both consumer acceptance and government regulation. Genetically edited organisms do not have foreign DNA in their genome. A change in their phenotype is a result of a targeted change in their own DNA. This change could happen naturally and therefore is managed and regulated the same as conventionally bred organisms. The change in phenotype of genetically modified organisms is the result of the addition of DNA from another organism. This change could not happen naturally, so these organisms are managed and regulated in a stricter manner.

CRISPR technology is being developed and tested in the RES Genetics lab. No varieties are being released at this time. When CRISPR rice varieties are introduced in the future, it is hoped that RES will be able to enter the market in a timely manner.

Lab Improvements

In December 2020 CCRRF authorized the purchase of new analytical equipment for the RES Genetics lab. This will allow for the transition from SSR (simple sequence repeats) marker-based analysis to a SNP (single nucleotide polymorphisms) marker approach. The two techniques are similar in many ways which will result in a smooth transition. The difference is in the speed in which SNP maker results can be collected and analyzed. The running and identification of polymorphic alleles using SSR's averages 3.5 hours with the equipment available in the lab. Whit the purchase and use of the plate reader and SNP markers the average time to identify polymorphic alleles will be less than 30 seconds.

Rice Variety Trials

Project Leader:

Bruce A. Linquist, UCCE rice specialist, Department of Plant Sciences, UC Davis

It is easy to discuss the latest varietal advances coming out of RES, but no one would know how a new variety might perform in their growing region without this project. This project seeks to remove some of the uncertainty surrounding a new variety by comparing it to varieties already familiar to you.

Six on-farm rice variety evaluation trials were conducted throughout the rice growing region of California, with standard varieties compared to preliminary and advanced lines across a range of environments, cultural practices, and disease levels. One similar test was conducted at the RES in Biggs, CA. Average yield across varieties and locations in the four-replication advanced line tests was 8,300 lbs./acre. A second consecutive dry winter and water shortage allowed field preparation and planting to be completed in early May. All statewide tests were planted by May 21st. Several advanced lines in 2022 produced high yields as well as demonstrating important breeding goals aside from yield (disease resistance, grain quality, specialty types, etc.). Testing advanced and preliminary lines under a variety of conditions remains a critical aspect of releasing varieties adapted to changing cultural practices, markets, and pests.

You are encouraged to examine the full report linked to the QR code above and look over the data for the trial near you. The zones for the trials are described on pages 2-3, and the results start on page 5. These results allow you to compare how different varieties performed in an area similar to yours.

Project RM-2 was involved in the planting, sampling, and harvesting 9 trial sites throughout the rice growing area. This project was also involved in several educational activities including the winter rice grower meetings, the RES rice field day, fact sheets and publications, and updating of the UCCE rice website.

ROXY® Herbicide Tolerant Rice

The RES Rice Breeding Program initiated a special project in 2014 to bring non-GMO herbicide tolerant rice technology to California's rice growers. After a successful breeding effort and patenting of the trait, a "shared partnership" and commercial agreement has been reached between Albaugh LLC and CCRRF on the commercial development and launch of ROXY® RPS. Albaugh will sell the post patent herbicide ALB2023 and ALB2024 (oxyfluorfen) for the ROXY® RPS system. Milestones thus far:

- Submission to EPA for herbicide registration for rice was made by Albaugh in 2021.
- Albaugh has been conducting multi-location efficacy testing throughout the California rice growing regions with rice weed control research groups and the UC since 2020. Trials will continue to help position and educate the market on performance, establish BMP's and prepare the market for the 2024 launch of ROXY® RPS.
- Eight years of research involving multiple locations shows that ALB2023 applied preplant in a water-seeded system provides high levels of rice weed control with ROXY® rice.

ROXY® RPS offers several very attractive features for rice weed control:

- Oxyfluorfen provides a Group 14 (PPO) mode of action. This novel mode of action should help manage weed resistance to Group 1 (ACCase) and Group 2 (ALS) herbicides, which comprise three quarters of the herbicides registered on rice.
- ALB2023 in combination with the ROXY® trait provides early season control of yield robbing grass and broadleaf weeds, with activity on weed biotypes with proven resistance.
- Provides a new tool to broaden BMP's in rice production and is compatible with most currently registered post emergence rice herbicides.
- The risk of damage to neighboring fields is minimal since conventional rice varieties have tolerance to the herbicide at low rates.
- The preplant application system allows for use in sensitive areas with adjacent crops.

RES 2022 Efficacy Testing

In the RES ROXY® nursery, ALB2023 herbicide rate studies gave very good weed control. The delay in rice emergence increased with rising ALB2023 rates to 6 days at the highest rate. 50% heading was three days later at the 2 and 2.5 pts/A rate.

Improving Fertilizer Guidelines for California's Changing Rice Climate

Project Leader:

Bruce A. Linquist, UCCE rice specialist, Department of Plant Sciences, UC Davis

Rice production or its management can be influenced by many factors – drought, late rains, water sales, fallowing. This project explores how these factors can be managed to maximize the rice crop.

N Management After Fallow

Lack of water or the sale of water has recently put many fields into a fallow state. It is generally recognized that a better rice crop is produced by a field that has been fallow compared to a field that is continuous rice. What is not specifically known is why.

This project studied rice production after a fallow period and after continuous rice. Yields were higher in fallowed fields. Two reasons have come out over the last two years work. First, higher yields may be due to reduced disease. There was less stem rot in rice after fallow compared to continuous rice. Second, fertilizer N uptake was the same between treatments; however, the fallow had a greater late season N supply from the soil (after PI). From a management perspective, this suggests that less N needs to be applied for a field coming out of fallow – especially top-dress N.

No-till Planting after Fallow

When a field is fallowed, the farmer often takes advantage of the time to work and level the ground. This section of the project seeks to understand if it is possible to simply flood up these fields without any further tillage (NT). This NT approach was tested against conventional tillage (CT) on three commercial fields. Research showed that stand establishment was poorer in NT fields. Windy conditions in May probably contributed. Weed, pest and disease pressure were either similar or better in the NT treatments. Most importantly, yields were similar or higher in the NT treatments. More work will follow in this area.

Alternative N Management

2019 rains forced many growers to plant their rice before any fertilizer was applied. This was unexplored territory for growers, no recommendations were available. Research was conducted in 2020-21 and data analysis in 2022.

- Aqua ammonia or urea applied to dry soil before flooding resulted in the highest yields.
- If dry soil application is not possible, the next best scenario is to split the N application. A split application of 15-35-35-15% at 3-4-5-6 weeks after planting will likely give the best results. Total N rate may need to be increased compared to N applied before flooding.
- Using enhanced efficiency fertilizers such as Super U, Agrotain or Agrocote, had no benefit over applying urea alone.

Forward & Reverse Genetics for Rice Improvement

Project Leader:

Thomas H. Tai, Research Geneticist, USDA/ARS Crops Pathology and Genetics Research Unit, Department of Plant Sciences, UC Davis

During 2022, characterization of herbicide target gene and metalloid uptake/accumulation gene mutants could not be addressed due to problems with germinating seeds of the mutant lines. The primary focus for the year shifted to identifying a new field site for mutant population development and evaluation.

The feasibility of the UC Davis Plant Sciences Row Crop Facility (RCF) to support generation advance, seed increase, and trait evaluation was tested and the location was found to be suitable. Large, flooded paddies are not possible at RCF as they have been at other locations. The season was spent becoming familiar with the production practices at the RCF and identifying issues and planting/production solutions for next season. Seeds were produced from about 250 Kitaake M8 mutant families and a few varieties and lines for other projects.

Drone-based phenotyping was initiated, and multispectral imaging data was collected from the RCF site. Analysis of this data looking at various traits such as plant height and coloration is underway in preparation for more rigorous efforts in 2023.

Finally, remnant mutant populations derived from the variety Sabine were screened for resistance to the ACCase-inhibiting herbicide clethodim. Some reputedly resistant mutants were identified, although there were issues with the reliability of the screening. It is probable these plants will prove to be escapes rather than resistant. Nonetheless, the strategy and logistics for herbicide screening at the new site have been worked out. Additional screening to make use of thousands of remnant mutant lines before they lose viability, will be conducted if funding is available next year.

Cover Crop Variety Trial in Rice

Project Leader:

Whitney Brim-DeForest
UCCE farm advisor, Sutter, Yuba, Placer, and Sacramento counties

Previous research in California rice systems identified several benefits and challenges from cover cropping (Pettygrove and Williams, 1996). Adding nitrogen to the system is one potential benefit. Improving subsequent rice yields and long-term soil quality are examples of other benefits. Challenges may include difficulty with residue management that delays rice planting, increased greenhouse gas production in waterlogged soils, and increased management costs. Growers incur costs with cover cropping that may not be recovered with increased rice yield or reduced inputs in the short-term. For these reasons, it is important to identify cover crops that will perform well in rice production systems in order to optimize benefits

The overall purpose of this proposal is to start assembling information for California rice growers on cover crops that will survive the typically wet winters and water-logged soils found in most rice fields. If cover crops do not grow and produce sufficient biomass, they cannot confer the benefits that are typically associated with cover crops.

The Rice Cover Crop Variety trail will be conducted over two years from December 2022- December 2024. This trial is located across three sites, Butte (Rice Experiment Station) and Colusa County, and one in the Northern San Joaquin Delta region. Both the Rice Experiment Station (RES) and the Colusa site have dominantly clay soils. The site in the Northern San Joaquin, has a high organic matter soil.

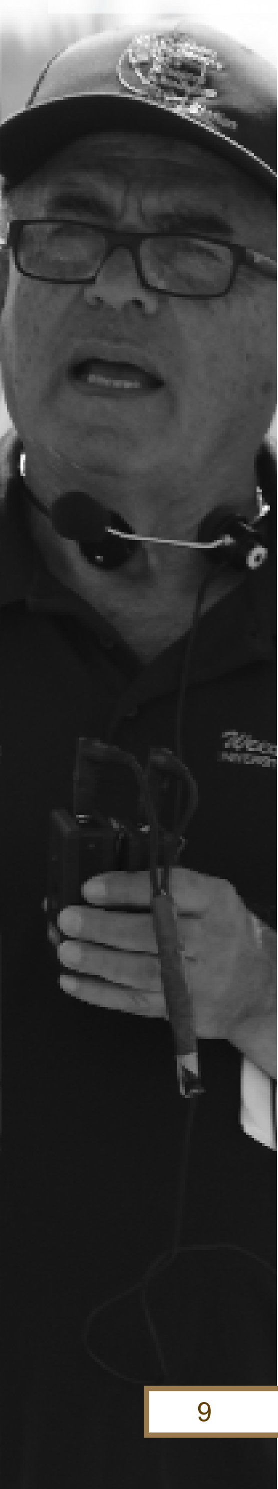
A total of 10 different cover crop species and 2 Cover Crop Mixtures were trialed. The species planted in a monoculture were: 1) Purple Vetch (*Vicia benghalensis* L.), 2) Woolypod Vetch (*Vicia villosa* ssp. *dasycarpa*, 3) Bell Bean (*Vicia faba*), 4) Balansa Clover (*Trifolium michelianum* Savi), 5) Field Pea (*Pisum sativum* ssp. *arvense*), 6) Yellow Mustard (*Brassica juncea* L.), 7) Purple Top Turnip (*Brassica rapa*), 8) Rye (*Secale cereale*), 9) Oats (*Avena sativa* L.), and 10) Biomaster Pea (*Pisum arvense*). Mixture 1 was a mixture of Purple Vetch, Bell Bean, Field Pea and Rye. Mixture 2 was Purple Vetch, Balansa Clover, Field Pea, Oats, and Radish (Sp.).

Germination counts of each species, and percent cover was measured in December and January. While current findings are preliminary, during the December months, the site in Colusa County had the greatest germination and percent cover compared to the other two. At the Rice Experiment Station site, rice straw may have hindered the development of a good seed bed, while at the San Joaquin site, late planting and minimal seed incorporation may have reduced germination success. However, high rainfall and flooding at each site greatly reduced cover crop success by January overall, even at the Colusa site. Within sites, there were certain species that appeared in the beginning to be performing better than others: Rye, Turnip and Mix 2 at Colusa, and Rye, Mix 1, Oats and Woolypod vetch at the Rice Experiment Station. However, there is limited data at this time to suggest any certain outcomes.

Weed Management in Rice

Project Leader:

Kassim Al-Khatib, Professor & UCCE Specialist, Weed Sciences, Department of Plant Sciences, UC Davis



Effective weed management programs in three rice cropping systems was the goal of this research, including continuous flooded rice, partially flooded rice (pinpoint) and drill seeded rice. Weed control programs in rice require early herbicide applications such as thiobencarb, clomazone, or Butte followed up by a postemergence herbicide. The efficacy of these programs would depend on herbicides in the program, time of application and water level.

Herbicide Research

Loyant

Research was conducted to determine the potential to incorporate new herbicides to manage weeds including herbicide resistant weeds. Field research showed that Loyant has a broad-spectrum weed control activity. It controls selected grasses sedges, and broadleaf weed species. Loyant has good control of smallflower umbrellasedge, a troublesome weed in California rice, when applied at early rice growth stages. Loyant is effective and safe to use late in the growing season up to 6-10" tall smallflower. Loyant applied at 1.33 and 2.66 pint/A rates did not cause significant grain blanking and was similar to blanking in nontreated control.

Zembu

The new herbicide Zembu (Pyraclonil) is good tool to control several grasses, smallflower sedge, and broadleaf weeds. Zembu needs to be used in a program to broaden its weed control spectrum. The herbicide programs of Zembu followed by Butte plus propanil; propanil plus Loyant; and Clincher plus Granite showed exceptional control of all weeds present in the field.

TVE29

A field study was conducted to evaluate crop injury and weed control of TVE29, a new grass control herbicide with novel mode of action. We have also evaluated the tolerance of six California rice varieties to TVE29. This herbicide was safe on all varieties tested. It also provided exceptional grass control. We think that TVE29 will have a positive impact on our weed control in rice.

ALB2023/2024

Research was conducted to determine the efficacy of ALB2023 and ALB2024 for use in ROXY Rice Production System® and ROXY trait rice for weed control and crop safety. The research continued to show that Roxy rice is an effective and promising technology. ALB2023 applied at different rates was safe on rice with excellent control of most grasses and broadleaf weeds. ALB2023, however, showed poor control of ricefield bulrush.

Vantek

Work continued on using Vantek herbicide, a new product from BASF, to control grasses on water seeded rice. Research showed the potential of using Vantek at the 3 to 5 rice leaf stage. Optimum usage of Vantek will be explored in the coming growing season.

Potential Herbicides

A new project has been initiated to study the potential to use two new herbicides in California water seeded rice, oxaziclomefone and GWN-10723. Preliminary research showed that these herbicides have good potential to control grasses in rice. Work will continue to improve the efficacy of these herbicides.

In the last four years, the Gowan company marketed benzobicyclon in combination with halosulfuron under the trade name Butte. In 2023 growing season, Gowan will market benzobicyclon alone under trade name Cliffhanger. Butte was sold as a granule formulation; however, Cliffhanger will be sold as liquid formulation. In 2022, we studied the efficacy of different rates and application timing for Cliffhanger. Our research showed that Cliffhanger provide slightly better control of grasses compared to Butte. Research will continue in 2023 to optimize the efficacy of Cliffhanger. We will study the efficacy of 10 and 12 oz/A of Cliffhanger. The label in 2023 may allow 10 oz/A, but in 2024 the label will increase the rate to 12 oz.

Weedy Rice

We continue to work to develop important data to help manage weedy rice. Weedy red rice is a problematic weed due to its phenotypic similarities with cultivated rice. Limited herbicide availability has driven a need for non-chemical control options for managing this pest. One pre-planting strategy that is being explored is the stale seedbed methodology which aims to maximize soil seedbank withdrawals via germination. This technique is adapted in rice by flooding a field, waiting for germination and emergence of weed seedlings, and completed with a mechanical or chemical control application. Optimization of this process is dependent on maximizing weed seed germination which is primarily influenced by both temperature and moisture availability.

This projects research aimed to determine the ability to germinate of California weedy rice accessions under various temperature and water potential treatments. Previously described weedy rice accessions 1, 2, 3, and 5 along with M-206, were exposed to temperatures from 10-40°C in combination with water abundance to water stress potentials until either germination or weed seed decay occurred. Research showed that germination reached 95% when seeds were exposed to temperatures between 20-35°C in combination with abundant water. Germination was lowest when seeds were water stressed, temperatures were colder than 20°C, or warmer than 35°C. These results could be utilized in the decision-making process for successfully implementing the stale seedbed methodology targeting weedy rice via maximizing germination. The results from this study and others will be combined to develop a thermal model for growth and development of the weedy rice that can be used to predict emergence and growth of weedy rice.

We have tested more than 36 samples of suspected herbicide resistant weed populations that were collected by growers and PCA including barnyardgrass, early and late watergrass, smallflower umbrella sedges, sprangletop, and redstem. Most of the samples tested showed resistance to at least one herbicide. We had several seed samples with multiple resistance. We provided each grower with extensive report that include photos of plant response to different herbicides and recommendations to select alternative herbicide to control their herbicide resistant weed. In 2022, both our field and lab program seek to assist California rice growers in their critical weed control issues of preventing and managing herbicide-resistant weeds, achieve economic and timely broad-spectrum control and comply with personal and environmental safety requirements.

Automotive Interior Part Made from Rice Straw

Project Leader:

Joseph Greene, Professor, Department of Mechanical & Mechatronic Engineering, CSU Chico

This project seeks to produce a sustainable, cost efficient, interior automotive part. Considerable progress was made in 2021, with this year's goal of producing a part to be tested by Ford Motor Company and meet their specifications. Currently, mined talc mineral is used as a filler in these parts.

Formulations of polypropylene (PP) from pure plastic to PP plus straw to PP plus straw plus additives were tried. One of the additives, maleic anhydride, is very promising. The tensile strength of PP, plus 10-30% straw by weight, plus maleic anhydride, is greater than PP alone. This seems to be related to maleic anhydride promoting more bonding between the PP and the straw fibers. Greater impact resistance also comes with this combination.

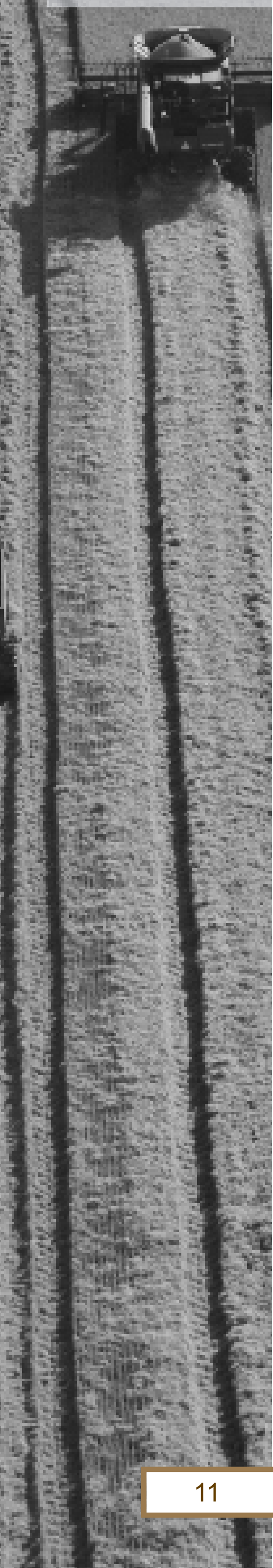
The rice straw infused plastic processed very well in the twin screw extruder used to make parts. This is important for consistent part production.

Unfortunately, in June of 2022 Ford Motor Company decided to end support for the project and end all research in natural fiber projects. As a result, the research was carried out by forming a sporting pigeon with the straw infused plastic instead of an interior panel.

Rice Disease Research and Management

Project Leader:

Luis Espino, UCCE Farm Advisor, Butte and Glenn counties



Managing disease in rice fields is the focus of this project. The focus of this project changes with time since different diseases pop up with varying conditions. This year the project focuses on :

- Determining the susceptibility of California varieties to stem rot, aggregate sheath spot, and kernel smut, and explore the effect of these diseases on yield and quality
- Investigate the relationship between disease ratings at drain time and disease ratings before heading for stem rot and aggregate sheath spot
- Investigate the effect on stem rot development when reducing water flow during heading and grain fill
- Monitor the response of blast resistant M-210 to blast epidemics in the field

Stem Rot

Two variety trials were conducted in fields with a history of stem rot and aggregate sheath spot (AGSS). Similar to 2021, varieties with longer periods of development showed lower levels of stem rot severity. This translates to varieties S-102, CM-101 ad M-105 having greater stem rot severity than the lower levels of M-209 and M-211. Application of azoxystrobin reduced stem rot severity by 20%. Yield was not increased, but head rice values increased by an average of 3%.

Aggregate Sheath Spot

The long grain variety, L-208, showed significantly lower levels of AGSS, followed by M-105 and M-206. Azoxystrobin application reduced disease severity by 63% and resulted in a yield increase of 4%. Head rice yield was also increased by 6%. This treatment was effective across nearly all varieties and increased milling yield. The trials show that reducing AGSS levels by applying azoxystrobin resulted in a yield benefit even though disease levels are low.

Disease Ratings at Drain Time

Data on AGSS was not collected for this objective due to low disease levels. For stem rot, disease incidence taken at mid to late boot may predict disease incidence or severity at late maturity. Incidence and severity were related at each of the sampling times. For the mid to late boot stage, incidence and severity were linearly related, with incidence approaching 100% when disease severity was close to 1. At grain maturity, severity increased linearly with incidence until reaching a rating of 2.

Disease incidence and severity at maturity is linearly related to disease incidence at the boot stage – until it reaches 30%. At levels above 30%, prediction is variable and difficult. When disease incidence reaches 30% at boot, disease incidence and severity reach approximately 60% and 1.5, respectively.

Reduced Water Flow

Reduced water flow during the heading and grain filling stage did not increase the incidence or severity of stem rot. Holding water after heading, instead of maintaining a continuous water flow until drain time, may not result in increased stem rot levels. Water depth was not manipulated in this trial. Grower may increase their water level at heading and hold the water until it subsides, instead of draining the field. In this case, water depth will be larger and may affect water temperature and stem rot differently than in the trial.

Blast

During the season, there were no reports of blast in the Sacramento Valley. Blast was confirmed in two fields in the San Joaquin Valley. This is the first report of blast for rice in this area. Additionally, Nigrospora oryzae was identified causing panicle branch rot in one of the San Joaquin blast affected fields. This pathogen has been identified in 2022 causing collar blight in Butte County and in 2021 causing panicle discoloration in Yolo County. A bacterium, Pantoea ananatis was also identified in 2021 in the San Joaquin Valley. The industry needs to remain vigilant and monitor further developments of these pathogens.

Weedy Red Rice Control in Rice

Project Leader:

Whitney Brim-DeForest
UCCE farm advisor, Sutter, Yuba, Placer, and Sacramento counties

The overall goal of this research project is to continue to provide updated information on the spread, management, and identification of weedy rice in California.

Survey and Grower Interviews

Since the beginning of the 2016 season, the UCCE Rice Team has been working together with growers, PCA's, and County Agricultural Commissioner's offices to identify weedy rice infestations. Out of California's approximately 500,000 rice acres, weedy rice infestations have been found on only 0.4% of the acreage. See the weedy rice-specific website, www.caweedyrice.com for pictures.

In 2022, we had 6 samples submitted, none of which were weedy. We encouraged many growers to take out fields that had been previously infested with weedy rice, as a control measure.

In Season Field Trials

The project looked at fallow systems to manage weedy rice. Since many growers are using fallow or managed fallow to control weedy rice, this may yield more applicable and useful data for California growers than crop rotation. The treatments were as follows:

- Treatment 1: Fallow (no irrigation)
- Treatment 2: Managed fallow (1 irrigation flush, followed by spray of a non-selective herbicide)
- Treatment 3: Managed fallow (2 irrigation flushes, each followed by spray of a non-selective herbicide)

In the fallow treatment, no weeds of rice emerged. Under the managed fallow treatments (2x flush and 1x flush), no weeds of rice emerged except for weedy rice. The field does have a known population of barnyardgrass, but it did not emerge. Weedy rice emerged under the two managed fallow treatments. In the sprayed plots, most of the weedy rice was cleaned up in both fields. At a timing near heading (10/6/21-10/15/21), no weedy rice plants survived to produce seed. It indicates that the use of the managed fallow can effectively reduce weed seeds in the soil, without contributing weed seeds bank into the seedbank for the following season.

The treatment that was most effective at long-term control throughout the first season was Treatment 3 (2 flushes and 2 sprays). In 2022, no weedy rice emerged, and percent weed cover for non-rice weeds was much higher on average than in 2021.

Overwintering Experiment

Researchers are seeking to know what happens to the Weedy Rice seeds over the winter. Do they survive or do they die? To find out, Weedy Rice seeds of the four major biotypes are placed in mesh bags, then buried outdoors over the winter months. Each of the Weedy Rice types has a different best practice for control, so know what you have before you act.

One of the most interesting data points was the pre-emergence of weedy rice biotype 5, before removal from the soil in the control treatments. Because biotype 5 has little to no dormancy, this may indicate a non-flooded winter field may be the best treatment option, as opposed to flooding. In this scenario, since growers are doing field preparation in April/May using tillage, they would likely till under all of the pre-germinated weedy rice biotype 5. However, it is the only biotype that pre-germinated in large numbers, so it would be the only biotype for which this would be an effective control method.

It appears that shallowly buried seeds (seeds near the soil surface), had greater mortality than seeds that were buried. This applies across flooded and non-flooded treatments as well as across biotypes 1,2,3, and 5. Biotype 3 had the lowest mortality rate, which means that most of the seed was either viable or dormant. This correlates well with what we have seen of Biotype 3's persistence in the field (some fields have been infested for 10 or more years). For Biotype 1 and Biotype 5, non-flooded (ambient) conditions proved to be most effective at causing mortality, whereas, for the other types (Biotype 2 and 3), there were no large differences between the flooded and ambient treatments.

New biotypes

In 2018, we found Type 6, and in 2019, we found Type 7. In 2021, we found at minimum 3-4 other possible types (at least one of which appears to NOT have a red pericarp). In 2022, we tested 17 suspicious samples. Most samples were from one location only, meaning that they are likely low-acreage infestations at this time. All were tested against known weedy rice samples, California japonica varieties, and some specialty varieties. At this point, it appears that we have several likely new biotypes (8 out of the 17 tested), two of which are white-pericarped. In the next year, once we have completed the third replication, we will begin to disseminate information to growers, PCAs and other stakeholders regarding the new types, their identification, and distribution.

Refining Armyworm Monitoring using Pheromone Traps

Project Leader:

Luis Espino, UCCE Farm Advisor, Butte and Glenn counties

Seven commercial rice fields were monitored during the growing season with pheromone traps and weekly larval searches. Fields monitored have been observed for several years.

In 2022 the first armyworm peak was similar to previous years, occurring on week 6, (late June). Average moths counts were 38.8 moths/trap/day. The second armyworm peak was low compared to previous years, and the pear was reached on week 13 with an average of 2.8 moths/trap/day.

When relating the number of moths for each trap to the average number of moths around that trap, the best fit is obtained using the number of larvae one week later. So essentially, the numbers of moths captured (i.e. at the peak on week 6) will give you the best match to the larvae peak one week later (week 7).

Overall densities up to 7.5 larvae per square foot caused defoliation that remained below the economic threshold of 25%. Panicle injury was not observed at any of the locations monitored.

Fumigant Reduction Potential Using Wireless Smart Technology for Early Detection of Insect Activity in Rice During Storage

Project Leader:

Zhongli Pan, Department of Biological & Agricultural Engineering, UC Davis

For the last four years, the RRB has studied how to detect insects in stored rice. This project has developed a wireless probe that can detect insect infestations far earlier than typical human monitoring. A smart probe has been successfully designed, tested and demonstrated for insect detection in stored agricultural products. Up to this point the research has focused on inserting the probes into the top layer of rice. This has demonstrated excellent, rapid insect detection even when human monitors cannot detect any insects. What has not been determined was if the top layer of rice was sufficient for monitoring or if deeper monitoring was required.

To accomplish this deeper monitoring, four of the standard 20" probe sections were stacked one on top of another. Each section contained a camera and other data logging equipment. These 80" probes were pressed into the stored rice and monitored. It is believed that insect infestation generally starts from the top layer of rice and gradually moves down to the bottom when the population becomes large. If true, and insect populations can be detected early, then treatment can occur in only the top layer, thus saving treatment costs.

The deeper level, multi-segmented monitoring was conducted at two commercial rice storage facilities. Insect activities were observed and environmental conditions recorded. The results indicated that the insect infestation started at the top layer of rice and the insects intended to stay in the top layer. Based on the observed results of insect activity, a top-layer disinfestation treatment was conducted in the early stage of the infestation.

The top layer disinfestation treatment was performed instead of fumigating the entire product. The results showed that this limited, top layer treatment had only about 16% of the chemical cost this year compared to the typical treatment of fumigating all the rice in the facility.

It is concluded that the early detection of insect infestation coupled with top layer disinfestation treatment can significantly reduce the chemical use and related costs for pest management. This procedure should also avoid damage of the rice from insects.

Rice Protection from Invertebrate Pests

Project Leader:

Ian Grettenberger, CE Specialist, Department of Entomology & Nematology, UC Davis

Research activities for 2022 focused on tadpole shrimp and rice seed midge.

Management of Tadpole Shrimp

We evaluated a wide range of insecticides for tadpole shrimp management using several different study methodologies and varied rates and timings for a number of materials. We demonstrated that some materials hold promise as alternatives to pyrethroids. Our open ring and trash cans+rings trials did provide contrasting results for some materials, such as Pyganic 5.0. Some possibly odd results for the early post-flood timing will be interpreted cautiously. We also tested Vantacor, which is not currently labelled for rice in California, and which contains chlorantraniliprole (diamide). It was highly effective at both timings for the higher rate we tested, which was still a "lower" rate. We had fewer "other" treatments to test for tadpole shrimp this year because of the lack of efficacy demonstrated for candidate insecticides in prior years and few additional, "new" materials to try Evaluating additional materials will be imperative to help shift away from only pyrethroids.

Biological Control of Tadpole Shrimp

We tested biological control as a management tactic for tadpole shrimp this past year, using mosquito fish. In one of the two trials, the fish suppressed the shrimp when examining counts summed across the season. In the other trial, there was generally no effect of the fish treatments on tadpole shrimp abundance. We also did not see an effect of fish on plant measurements. While mosquitofish will clearly consume tadpole shrimp and suppress their populations, their effects may be inconsistent or it may require high stocking rates of fish to appreciably affect tadpole shrimp abundance. Getting fish into the fields quickly will be critical to make this a viable tactic.

Rice Seed Midge

In the first year for our team, and for the first time in a while in California, we tested the efficacy of various insecticides against rice seed midge. We built off the methods of prior trials and used delayed flooding and planting to create conditions conducive to rice seed midge populations. We found substantial variability among treatments in how they affected midge populations. Notably, management of tadpole shrimp and rice water weevil may run counter to management of rice seed midge. We saw that Warrior II may have even flared rice seed midge populations possibly by disrupting natural enemy control. Some rates of Belay and Dimilin, along with Vantacor, appear to be the most promising treatments of the ones we tested for managing rice seed midge.

The rice water weevil light trap at the RES has been catching very few weevils in the past several years. This past year appeared to be another low-pressure year for the industry.

We remained informed of possible new and invasive arthropod pests that could affect California rice. This includes continued monitoring of brown marmorated stink bug and the channeled apple snail. No new rice pests were found in California rice fields, and we hope that this trend continues into the future.

Quantifying Water Use of Cover Crops in Rotation with Rice

Project Leader:

Kosana Suvocarev, Dept. of Land, Air and Water Resources, UC Davis

This research seeks to create season habitat for the waterfowl breeding season in fallow rice fields. Cover crops can provide a winning solution for soil health and nesting habitat on agricultural lands. Cover crops in this context are rain fed and rely on soil water storage to get them through maturity.

After two years of experimental measurements, the project was extended for one more winter season. After two dry years, the 2022-23 season is very wet. New fields were selected in October 2022 and the equipment is running at two checks in a single field – one fallow, and one cover cropped. Measurements will be conducted November 2022 through July 2023.

Treatments to Improve Consistency in Properties of Rice Ash for Concrete & the Anticipated Costs

Project Leader:

Sabbie Miller, Department of Civil and Environmental Engineering, UC Davis

This project seeks to use rice straw/hull ash (RSA) as a mineral additive for concrete. It would replace fly ash, a by-product of coal burning power plants. It has been shown by this project in previous work, that RSA can be an effective substitute in concrete.

The focus of this cycle of research was to determine the economic and environmental impacts of key processes. Findings to date suggest that preparing rice straw for combustion to derive the ash as a mineral additivity for concrete has notable impact. From an economic perspective, both capital and operating costs are high. Our preliminary estimates put these at approximately $300,000 and $170,000, respectively, for rice straw ash recovery from a 200-acre rice farm. However, total revenue from ash and fertilizer that could be recovered was estimated at less than $10,000 annually for the same size farm. For greenhouse gas (GHG) emissions from producing rice straw ash, impact was just under break even with electricity and cement replacement.

Emerging Weed Issues in Rice

Project Leader:

Whitney Brim-DeForest UCCE farm advisor, Sutter, Yuba, Placer, and Sacramento counties

Over the past several years, there have been several new weed species identified. In 2017, at least 2 fields were identified with an unknown watergrass biotype. After extensive attempts at identification, we were unable to conclusively identify the species. Control methods have become the focus in the meantime.

The overall goal of this research is to continue to address emerging weed issues promptly. In 2019, we collected a survey of soil samples from across the rice-growing region, to establish a baseline of the weed species and biotypes present across the California rice region. In 2020 we finished the baseline survey, concluded the herbicide screening for the 2018 watergrass samples, and conducted a larger watergrass survey. In 2021, we conducted the herbicide screening for the 2020 watergrass samples, and the phenotyping of the same samples.

In 2022, we reanalyzed data from the herbicide screenings, sent reports to all 64 growers and PCAs, made contacts and connections to further our watergrass identification and studies, and finished the website hosting the ArcGIS maps for the 2019 rice weed survey.

Watergrass Identification

Brim-DeForest has been reaching out to scientists worldwide for assistance with the identification of the unknown watergrass species. Researchers in Texas, Japan, Turkey and Colorado are helping.

Since there has been no success identifying the new Echinochloa species, the team is working to refine the list of obvious and measurable traits of the watergrass species. These key characteristics make an identification key possible. Once finalized, the key will be published through UCANR and made widely available to the rice industry.

Online Mapping

In the fall of 2019, a comprehensive survey took place by soil sampling from fields in each major rice-growing county. The samples were collected after the rice harvest, from October to November. Each field was sampled four times, randomly throughout the field. Samples were then placed in pots and grown out in the Department of Plant Biology greenhouses in Davis using different types of irrigation.

Each soil sample was marked simply for the presence or absence of known weed species. Any unidentifiable or unknown species were grown to flowering and were identified by Advisor Brim-DeForest. Samples were averaged per field, and averages for all samples in each county are summarized and all maps have been loaded into ArcGIS. All of the data is available at: https://sites.google.com/ucdavis.edu/californiariceweedssurvey2019

Herbicide Testing

The majority of the watergrass samples of all species are resistant to all of the tested herbicides, with only SuperWham®/Stam® and Cerano® showing control of approximately 50% (or more) of the samples. Late watergrass is widely resistant to all of the herbicides tested, with only SuperWham®/Stam® showing some degree of control of roughly 50% of the samples. Surprisingly, 100% of samples tested were resistant to Bolero®, Butte®, Clincher®, Regiment®, and Granite GR®.

The new watergrass biotype is best controlled with Cerano® (50% of samples) or SuperWham®/Stam® (76% of samples). Barnyardgrass is best controlled by SuperWham®/Stam® (90% of samples), and Cerano® (45% of samples).

Although the new biotype shows widespread resistance, its impact on yields is likely explained by more than just herbicide resistance and is likely due to its competitive ability as well.

California Ricelands Salmon Project - Phase 2

Project Leader:

Andrew Rypel, Department of Wildlife, Fish & Conservation Ecology, UC Davis

Prior work on this project resulted in a preliminary indication that salmon raised in rice field floodplain habitat are estimated to be four times more likely to make it to the Pacific Ocean than those that do not experience the floodplain habitat benefits.

The current project is largely funded by a major grant from NRCS. These funds must be matched by the California Rice Commission and its sponsors, including the RRB.

Testing/Refining New Practice

The goal is to develop a draft practice standard on full sized fields that will effectively help salmon safely grow in a field rearing habitat. In 2022 this involved three fields totaling about 350 acres and a four acre dryside field for research. Limited numbers of Juvenile Acoustic Telemetry system (JSATS) fish tagging will be used to evaluate outmigration success to the ocean.

Wild Fish Utilization of Rice Habitats

The tracking of salmon using JSATS receivers will help researchers determine volitional passage, residence time and use of ricelands floodplain areas. Information collected will document the importance of rice habitat to wild salmon populations in the Sacramento Valley. Data gathered will enable significant cost-benefit analysis modeling to quantify the beneficial impacts of practice standard implementation. This assessment relies on floodplain inundation.

Early 2022 did not have adequate rain to inundate the test plots with runoff water, so the fish were released early. This also meant that there were no natural origin salmon utilizing the fields. Large amounts of zooplankton favored by juvenile salon were observed in the grower flooded fields. Salmon growth rates were also comparable to previous years. Rice straw left in the field seemed to produce dissolved oxygen levels of concern, a problem which will be examined and likely alter the practice standard.

Audited Financial Statement

Combined Statement of Activities for the Year Ended August 31, 2022

Condensed financial statements were derived from audited financial statements and a full copy of the audited financial statements can be obtained by contacting the address on the back cover

	General Fund	Reserve Fund	Totals
REVENUE			
Assessments	$ 2,534,464	$ -	$ 2,534,464
Interest	-	68,685	68,685
United Tariff Rate Quota Management funds	-	520,785	520,785
Miscellaneous	21,438	-	21,438
Total Revenues without Donor Restrictions	2,555,902	589,470	3,145,372
EXPENDITURES			
Administrative:			
Administrative Services	264,752	-	264,752
Administrative Tax and Insurance	22,975	-	22,975
Annual Report	3,897	-	3,897
Audits	11,825	-	11,825
Insurance	2,778	-	2,778
Memberships	16,000	-	16,000
Miscellaneous	248		248
Newsletter	1,720	-	1,720
Office Facilities	3,652	-	3,652
Office Equipment	2,353		2,353
Office Services	5,800	-	5,800
Office Supplies	5,722	-	5,722
Postage	2,017	-	2,017
Telephone	578	-	578
Travel and Mileage	7,523	-	7,523
	351,840	-	351,840
Program:			
Research	2,736,817	500,000	3,236,817
Rice Research Trust Grant	-	500,000	500,000
	2,736,817	1,000,000	3,736,817
Departmental:			
Marketing Branch	51,623	-	51,623
Enforcement	7,500	-	7,500
	59,123	-	59,123
Total Expenditures	3,147,780	1,000,000	4,147,780
Increase (Decrease) in Net Assets	(591,878)	(410,530)	(1,002,408)
Net Assets at Beginning of Year	1,474,858	10,874,422	12,349,280
Net Assets at End of Year	$ 882,980	$ 10,463,892	$ 11,346,872

California Rice Research Board

Lacey Stogsdill, Manager
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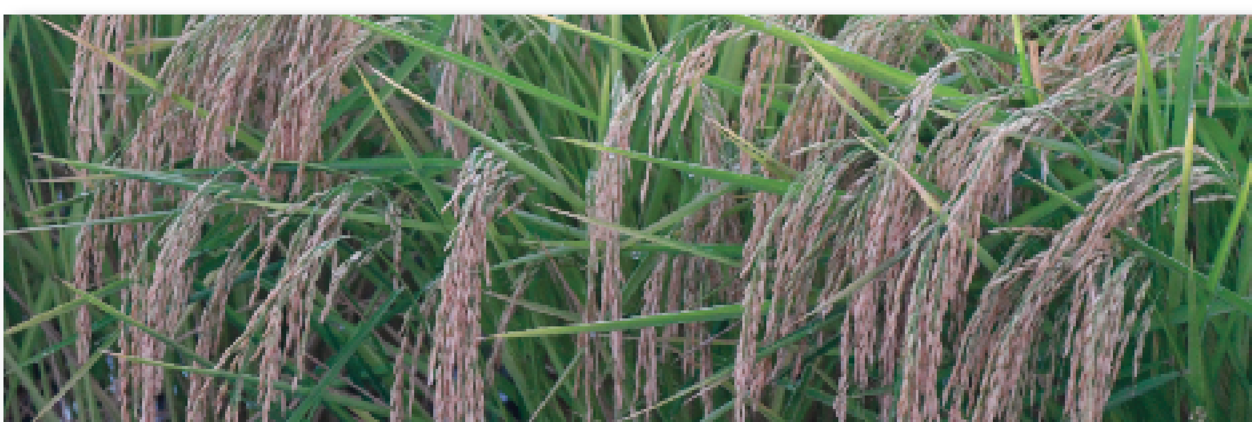
Members		District	Alternates	
Term of Office: August 1, 2021 through July 31, 2024				
Roy Holzapfel Willows	M: 530-521-4077	1	Jessica Lundberg Richvale	O: 530-882-4551
Alex Struckmeyer Arbuckle	M: 530-701-8151	2	Sarah Dennis Colusa	M: 530-760-7743
George Tibbitts Arbuckle	O: 530-437-2546	2	Kay Siller Yuba City	O: 530-437-2546
Term of Office: August 1, 2022 through July 31, 2025				
Andrew Rudd Gridley	M: 530-682-0929	1	Carter Knowles Chico	M: 530-680-4481
Christine Wylie Colusa	M: 530-458-4721	1	Chris Alves Glenn	M: 530-864-8549
William Warnock Nicolaus	M: 530-330-1828	2	Drew Dirks Maxwell	M: 530-330-2744
Bert Manuel Yuba City	M: 530-870-2137	2	Michael Bosworth Olivehurst	M: 530-632-6784
Term of Office: August 1, 2020 through July 31, 2023				
Imran Khan Chico	M: 530-517-2222	1	Vacant	
Jason Bowen Maxwell	M: 530-682-3489	2	Rob Van Dyke Pleasant Grove	M: 916-496-1656
Jared J. Gross Grimes	M: 530-434-9846	2	Brett Scheidel Nicolaus	M: 916-417-2282
Brian McKenzie Plumas Lake	M: 916-709-7884	3	Mike DeWit Davis	O: 530-756-5617
Public Member			**RES Liaison**	
Gilbert Stresser Yuba City	M: 530-701-9714		Steve Willey Nicolaus	M: 530-682-7832



California Rice Research Board

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