California Wheat Commission Office
1240 Commerce Ave. Suite A,
Woodland, CA 95776

Research Committee Meeting April 16, 2018 (3:00 p.m.)

Conference Call Attendance

Access Number Participant: = +1 408-638-0968 (US Toll) or +1 646-558-8656 (US Toll)

Participant Passcode/Meeting ID: 466 870 1284

Join by Link: https://zoom.us/j/4668701284

		Call In	Attending
1.	Ron Rubin	Yes	
2.	Jim Parsons	Yes	
3.	Kirk Elholm	Yes	
4.	Larry Hunn	Yes	
5.	Lee Jackson		Yes
6.	Roy Motter	Yes	

Research Committee Meeting Notice

Sent and posted April 4, 2018

Via Teleconference Call

DATE:	**Monday, April 16, 2018**
TIME:	**03:00 P.M.**
ACCESS NUMBER:	+1 408 638 0968 (US Toll) or +1 646 558 8656 (US Toll)
PASSCODE/ Meeting ID:	466 870 1284
Or Join with the link:	https://zoom.us/j/4668701284
LOCATION:	1240 Commerce Ave. Suite A Woodland, CA 95776

Board Members wishing to participate in the meeting VIA TELECONFERENCE CALL must notify Crystal Sandoval via email to (csandoval@californiawheat.org) or by Fax to (530) 661-1332 at least 24 hours prior to the listed meeting. ***Failure to do so will disqualify you from participation.***

AGENDA

I. Call to order — Chairman Ron Rubin

II. Roll call

III. Approve agenda

IV. Financial Resources - FY 18/19 Budget Outlook

V. Funding Recommendations

VI. Future Challenges Funding UC Research - Recommendations

VII. Adjourn

All agenda items are subject to discussion and possible action. All interested parties are invited to attend the meeting. Time will be allowed for members of the public to make comments on each agenda item (up to 2 minutes). To make a request for more information, or to make a request regarding a disability-related modification or accommodations for the meeting, please contact Crystal Sandoval at 530-661-1292, or 1240 Commerce Ave., Ste. A Woodland, CA 95776, or via email at csandoval@californiawheat.org Requests for disability-related modification or accommodation for the meeting should be made at least 48 hours prior to the meeting time. This notice and agenda are available on the Internet at *www.californiawheat.org*

CALIFORNIA WHEAT COMMISSION
FY 17/18 Income / Expense as of 3/31/18

	FY 2016/17 ACTUAL $.075/cwt	FY 2017/18 APPROVED *8/30/2017* $.075/cwt	FY 2017/18 92% of FY *(as of 03/31/18)* $.075/cwt	% of Budget	FY 2017/18 PROJECTED *End of FY 17/18* $.075/cwt
INCOME:					
401. ASSESSMENTS	$765,850	$700,000	$569,490	81%	$600,000
402. INTEREST	$4,063	$4,000	$6,114	153%	$4,752
403. OTHER INCOME	$5,106	$100	$100	100%	$100
407. LABORATORY					
CROP QUALITY	$6,635	$8,000	$12,310	154%	$12,310
LABORATORY ANALYSIS (+Training)	$90,017	$135,000	$109,664	81%	$115,000
405. REFUNDS	$0	($20,000)	($15,064)	75%	($15,064)
TOTAL INCOME	**$871,671**	**$827,100**	**$682,615**	**83%**	**$717,098**
EXPENSES:					
GENERAL & ADMINISTRATIVE					
501. SALARIES	$192,299	$238,398	$201,302	84%	$238,398
502. STAFF EXPENSE	$2,772	$3,000	$3,121	104%	$3,121
503. OFFICE EXPENSE	$8,104	$11,600	$7,558	65%	$8,000
504. OFFICE SERVICES	$8,691	$10,700	$9,554	89%	$10,000
506. INSURANCE	$12,315	$16,520	$11,201	68%	$14,000
508. PROFESSIONAL SERVICES	$18,012	$19,000	$13,279	70%	$13,500
509. CDFA	$17,803	$19,000	$17,417	92%	$19,000
513. COMM MTGS	$4,847	$6,182	$4,466	72%	$6,000
516. CONDOMINIUM FEES	$4,047	$4,100	$3,710	90%	$4,100
521. Building Maintenance	$547	$10,000	$9,702	97%	$9,702
TOTAL G&A EXPENSES	**$269,435**	**$338,500**	**$281,310**	**83%**	**$325,821**
RESEARCH					
601.RESEARCH CONTRACTS	**$284,275**	**$330,000**	**$328,333**	**99%**	**$328,333**

CALIFORNIA WHEAT COMMISSION
FY 16/17 Income / Expense as of 3/31/17

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MARKET DEVELOPMENT/OUTREACH					
505. INFORMATION/MEMBERSHIP	$3,614	$3,550	$2,903	82%	$3,000
510. CAWG CONTRACT	$18,000	$20,000	$20,000	100%	$20,000
512. COMM EXPENSE	$6,570	$6,000	$6,415	107%	$6,500
600. TECHNICAL SERVICES	$3,269	$4,500	$4,749	106%	$4,749
602. PUBLICATIONS	$700	$1,500	$4,953	330%	$4,953
603. TRADE TEAMS	$815	$1,500	$1,394	93%	$1,394
604. MARKET DEVELOPMENT	$13,009	$10,000	$9,307	93%	$10,000
605. USWA	$25,638	$18,950	$19,950	105%	$19,950
621. WHEAT VARIETY SURVEY	$3,936	$4,000	$2,018	50%	$2,018
624. OUTREACH	$13,889	$10,000	$10,078	101%	$10,000
TOTAL MARKET DEVELOPMENT	**$89,440**	**$80,000**	**$81,766**	**102%**	**$82,564**
LABORATORY					
617. LABORATORY					
SALARIES	$143,027	$143,481	$123,790	86%	$135,000
OPERATING EXPENSE	$33,286	$38,500	$27,814	72%	$30,000
TOTAL LAB	**$176,314**	**$181,981**	**$151,605**	**83%**	**$165,000**
OTHER					
626. CAPITAL EXPENSE					
OFFICE	$0	$1,000	$0	0%	$0
LABORATORY	$0	$12,000	$8,043	67%	$8,043
TOTAL CAPITAL EXPENSE	$0	$13,000	$8,043	62%	$8,043
526. Reimbursed Expenses	($473)				
529. Bad Debt	$5,361				
525. Depreciation Expenses	$15,873				
TOTAL EXPENSES	**$840,225**	**$943,481**	**$851,057**	**90%**	**$909,761**
NET INCOME	**$31,447**	**($116,381)**	**($168,443)**	**145%**	($192,663)
Adjustments to reconcile Net Income					
Net Cash by Operating Activities	$35,870		($165,726)		
Net Cash by Investing Activities	$9,231		0		
Net Cash Increase for Period	$45,101		($165,726)		
Changes In Net position:					
Net Position, Beginning of Year	$821,628	$866,729	$866,729		$866,729
Net Position, End of Year	$866,729	$750,348	$701,003		$674,065

California Wheat Commission
Cash Flow Statement
5/1/2017 to 3/31/2018

NET INCOME/EXPENSE	$	(168,442.52)

Adjustments to reconcile Net Income
to net cash provided:

By Operations:

Assessments Receivable	$	12,325.41
Customer Invoices (receivables)	$	4,884.19
Prepaid Contracts	$	(666.33)
Prepaid Expenses	$	12,099.49
Accounts Payable	$	(3,095.34)
Pension Payable	$	(22,830.97)

NET CASH INCREASE/DECREASE AS OF 3/31/17	$	(142,895.10)

(Net Income +/- adjustments)

The Cash Flow Statement accounts for actual cash flows in and out of CWC. If income or an expenditure is not accounted for on the *current* FY Income/Expense report, then adjustments are made on the Cash Flow Statement to account for changes in cash position.

BEGINNING CASH (as of 5/01/2017)

Edward Jones CD	$	560,000.00
Edward Jones MM	$	1,295.06
RVCTY-MM	$	153,267.78
Tri Counties Bank MM	$	150,567.86
Tri Counties Bank Checking	$	1,598.00

TOTAL OF BEGINNING CASH		$866,728.70

TOTAL CASH as of 11/30/2016	**$**	**701,002.63**

(Net cash provided by activities + beginning cash)

CASH ON HAND (as of 3/31/2017)

Edward Jones CD	$	513,000.00
Edward Jones MM	$	742.32
RVCTY-MM	$	153,463.80
Tri Counties Bank MM	$	26,060.07
Tri Counties Bank Checking	$	7,736.44

TOTAL CASH AND BANK ACCOUNTS	**$701,002.63**

CALIFORNIA WHEAT COMMISSION - FY 18/19 BUDGET PROPOSAL

	FY 2016/17 100% of FY $.075/cwt	FY 2017/18 APPROVED *8/30/2017* $.075/cwt	FY 2017/18 PROJECTED *End of FY 17/18* $.075/cwt	FY 2018/19 PROPOSED BUDGET $.075/cwt
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TOTAL LAB	**$176,314**	**$181,981**	**$165,000**	**$190,000**
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TOTAL CAPITAL EXPENSE	**$0**	**$13,000**	**$8,043**	**$9,500**
526. Reimbursed Expenses	($473)			
529. Bad Debt	$5,361			
525. Depreciation Expenses	$15,873			
TOTAL EXPENSES	**$840,225**	**$943,481**	**$909,761**	**$949,975**
NET INCOME	**$31,447**	**($116,381)**	**($192,663)**	**($220,875)**
Adjustments to reconcile Net Income				
Net Cash by Operating Activities	$35,870			
Net Cash by Investing Activities	$9,231			
Net Cash Increase for Period	$45,101			
Changes In Net position:				
Net Position, Beginning of Year	$821,628	$866,729	$866,729	$674,065
Net Position, End of Year	$866,729	$750,348	$674,065	$453,190

A. COVER PAGE

PROJECT TITLE

Development of wheat varieties for California 2017-2019

PRINCIPAL INVESTIGATOR

Jorge Dubcovsky

OTHER INVESTIGATORS

Oswaldo Chicaiza, Alicia del Blanco (50%), Xiaoqin Zhang (70%), and Marcelo Soria (20%).

SUMMARY:

The objective of the UC wheat-breeding program is to develop common and durum wheat varieties adapted to different California environments. The specific objectives are: 1) introduce new sources of disease resistance, improved yield and end-use quality characteristics; 2) create new segregating populations by hybridization and select the best lines using field based selection; 3) determine the genetic basis for grain yield and disease resistance and develop markers to accelerate the introduction of favorable alleles into breeding lines; and 4) produce Breeder's seed of lines targeted for variety release. The field-based selection program will be complemented by marker-assisted selection to accelerate the introgression of novel genes associated with increased yield and resistance to stripe rust and stem rust in common wheat. In both common and durum wheat, we will continue the introgression of the *gw-A2* mutation associated with increased grain weight and initiate the introgression of the *TmELF3* allele to increase number of grains per spike. In durum wheat we will continue the deployment of the low cadmium gene *Cdu1*, QTLs for improved pasta color, and mutations for increased resistant starch. In common wheat we will complete projects to map genes contributing to increased grain yield.

CALIFORNIA WHEAT COMMISSION

May 1, 2017 to April 30, 2019

B. OBJECTIVES

The overall objective of the UC Wheat Breeding Program is to develop common and durum wheat varieties adapted to different California environments. The main target traits include grain yield, disease resistance and quality, and the main market classes include white and red bread wheat and Desert Durum wheat. During the 2017-2018 funding cycle, we will emphasize the introgression of new gene variants to increase grain size and number in both durum and common wheat. For increasing grain-size, we will backcross the *gw-A2* mutation and for increasing grain number, we will introgress the *Elf3* allele from *T. monococcum* into both durum and common wheat. In durum wheat, we will continue our efforts to reduce cadmium levels and improve color and gluten strength. We will also continue our efforts to deploy slow rusting genes in combination with the race specific genes *Yr5* and *Yr15.* In the area of wheat nutritional value, we will continue the introgression of the mutations for resistant starch into different durum and common wheat backgrounds and the evaluation of their effects on agronomic and quality performance. The specific objectives for 2017-2018 growing season are:

Objective 1: Introduce new sources of disease resistance to stripe rust, stem rust, leaf rust and septoria tritici blotch and valuable alleles for grain yield components and end-use quality from wheat varieties from different parts of the world and from wild wheat relatives. We will also incorporate new alleles associated with increased grain size and number and with increased levels of resistant starch. We will incorporate the new stripe rust resistance genes *Yr77* and *Yr78* validate in 2016.

Objective 2: Create new variable populations of red and white bread wheat and durum wheat by hybridization, select the best lines from the segregating populations, and evaluate the selected progenies for quality and performance in different production areas of California.

Objective 3: Determine the genetic basis of wheat grain yield and resistance to diseases, develop molecular markers associated with these traits, and used them to accelerate gene deployment into adapted breeding lines.

Objective 4: Increase grains of new promising lines to perform extensive testing trials in multiple locations and for distribution to other breeding programs. Select pure seed of the best lines to produce Breeder's Seed, and send that seed to the Foundation Seed Program (FSP).

C. PROCEDURES

PROCEDURES FOR OBJECTIVE 1

Incorporation of new genetic diversity: The incorporation of new sources of genetic diversity is a continuous objective of our breeding program. We will evaluate roughly 1,000 new advanced lines of common wheat and durum wheat in observation plots at Davis. These lines are received from CIMMYT, disease nurseries, and from different collaborating breeding programs around the world.

New sources of resistance to diseases are constantly required because of the ability of these pathogens to evolve and overcome current sources of resistance. The incorporation of different sources of stripe rust resistance is important to be prepared to a change in the current races of the pathogen. We will study the effect of combining different partial resistance genes in a single background to select the best combinations for our breeding program. A source of new resistance genes will be the lines carrying the adult plant resistance genes *Yr77* and *Yr78* identified in our recent survey of the NSGC core collection (validated in 2016). We will combine the *Yr15* and the strong gluten allele 7BxOE to be able to transfer both genes together. We will also introgressed the combined *Yr5* and low PPO allele in our durum wheat program.

We will devote some efforts to the preventive incorporation of stem rust resistance genes effective against UG99. This race has recently spread from Africa to Iran and, is a serious potential threat to the wheat industry. In hexaploid wheat we will incorporate the slow rusting gene *Sr2* and the *Sr35* resistance gene from *T. monococcum.* We have reduced the chromosome segment carrying *Sr35* and will continue its deployment into the program. In tetraploid wheat, we will incorporate the partial resistance gene *Sr13* from *T. turgidum* ssp. *dicoccon* that was recently identified in our lab.

For Septoria tritici blotch (STB) we will continue the crosses with "Milan" and its derivatives, which have shown good resistance to STB in field trials in California. Although STB epidemics do not occur every year, when they did they have produced devastating losses and we need to be prepared.

In the durum program, we will continue the introgression of the low cadmium allele *Cdu1* and combine it with the favorable QTL for increased yellow pigment and improved color stability identified in previous studies.

In both durum and common wheat, we will incorporate new genetic diversity generated from our mutant TILLING population including the *gw-A2* mutation associated with increased grain size, a mutant associated with increased grain number identified in hexaploid wheat, and the mutations in the *SbeIIa* and *SbeIIb* genes associated with increased levels of resistant starch.

PROCEDURES FOR OBJECTIVE 2

Approximately 150 crosses will be made in the greenhouse during the winter and planted at Tulelake to produce F_2 seeds in the summer. The new F_2 populations will be planted in the field in November at UC Davis. Individual heads from selected plants will be harvested and planted as F_3 families. The F_{4-6} families will be handled using the modified pedigree method. The best F_6 and F_7 lines will be harvested in bulk and advanced to a small observation plot.

Observation plots will be selected by agronomic characteristics and yield. The best lines will be analyzed for protein content and the selected lines will be tested for HMW-GS analysis to eliminate the poorest quality lines. Approximately 200 lines will be selected and advanced to preliminary yield trials. A preliminary screening of gluten strength will be performed at the CWC quality lab to eliminate lines with low gluten strength.

"Preliminary" and "Advanced" yield trials will be grown only at UC Davis. The best lines will be included in separate "Elite" experiments for common and durum wheats (4 replications) at Davis, and two other locations in the San Joaquin and Sacramento Valleys for common wheat and the San Joaquin and Imperial Valleys for durum wheat. Lines selected from the Elite trials

will be evaluated in the statewide regional trials for potential release. Selection of the more advanced yield trials will be complemented by quality tests performed at the CWC.

PROCEDURES FOR OBJECTIVE 3

To accelerate the incorporation of valuable traits, the traditional breeding effort will be complemented with a marker assisted selection program focused on the genes described below.

***Grain yield components*:** In 2016, we demonstrated that the incorporation of the *gw-A2* mutation is associated with significant increases in grain weight (published in 2016). We will use the perfect marker for this mutation to introgress it in both durum and common wheat top varieties and breeding lines. We will also combine this mutation with mutations in the homoeologs in *gw-B2* and *gw-D2*. Preliminary results from 2016 indicate that these additional mutations add a 2-3% increase to the 6% increase observed with the *gw-A2* mutation alone (total 9% increase). We have also identified two novel alleles that increase the number of spikelets in the grain and we will introgress those in the top durum and common wheat lines. The first one is a mutation in the *ELF3* gene introgressed from *T. monococcum* and the second one is a QTL on chromosome arm 7AL identified in two association studies and validated in a biparental population (2015-2016).

Increased resistant starch content in the grain: We will introgress the mutation in the different copies of the *SbeII* genes into new tetraploid and hexaploid lines and evaluate their positive effects on resistant starch and the negative pleiotropic effects on agronomic performance. We are trying to identify the best environments and genetic backgrounds to deploy the *SbeII* mutations associated with a 10-fold increase in resistant starch. We are intercrossing lines with the same *sbeII* mutations (but different genetic backgrounds) to identify chromosome regions that can be used to ameliorate the negative pleiotropic effects of the *sbeII* mutations on grain yield.

Low Cadmium: In durum wheat, we will use a perfect marker for the *Cdu1* low-Cd allele to continue its introgression in additional top yielding varieties. We will combine the low-Cd allele with other genes with positive effects on quality using MAS backcrossing. In addition, we will genotype ~1000 breeding lines with the *Cdu1* marker in collaboration with the high-throughput Genotyping Laboratory at WA Pullman to increase the frequency of the low cadmium allele in our breeding populations.

Quality genes: in durum wheat, we will continue the introgression of the *Glu-D1*$_{2+12}$ and the 7BxOE alleles to improve gluten strength and the *Gpc-B1* allele to increase grain protein content. To improve color we will introgress the 7BL *PSY-AB* allele for higher accumulation of lutein and the mutation in the lipoxygenase gene (*Lpx-B1.1*) that favors the stability of the yellow pigments during pasta production. For bread-making quality, we will combine the *Gpc-B1* allele with high- and low-molecular weight glutenin alleles for gluten strength.

Drought tolerance: In the area of drought tolerance, we will continue our efforts to identify the gene in the distal region of the 1RS arm from rye that is associated with longer roots and drought tolerance. This segment will be combined with the *Yr15* stripe rust resistance genes and with the strong gluten allele (7BxOE) to compensate for the lower gluten strength associated by the loss of the *Glu-B3* allele. All three genes are located on chromosome 1B.

***Stripe rust resistance genes*:** We will use molecular markers to introgres the new stripe rust resistance genes *Yr77, Yr78* and the *QYr.ucw.1BL* validated in 2016 into our susceptible breeding lines with good yield potential. Meanwhile, we will continue the incorporation of the partial

resistance genes *Yr18* and *Yr36* and the major genes *Yr5* (combined with the linked low-PPO allele) and *Yr15* (linked with the 7BxOE) into our top breeding lines.

Stem rust resistance genes: We will introgress the UG99 resistance gene *Sr35* into our hexaploid wheat lines. *Sr35* confers near immunity to Ug99 and will be a useful preventive measure if the UG99 arrives to the US. We have reduced the chromosome segment from *T. monococcum* carrying this gene, and this reduced segment will be used for the introgression. In 2016, we identified *Sr13*, an additional resistance gene effective to Ug99. A survey of 452 durum lines from NSGC demonstrated that only 8.6% of the durum lines carry the *Sr13* resistance gene. We will expand the number of durum lines in our program carrying this resistance gene.

Septoria tritici blotch: We will continue our crosses with the septoria resistance variety Milan and the selection of resistant breeding lines.

PROCEDURES FOR OBJECTIVE 4

As lines are advanced in the breeding program through yield tests, each line is represented by few progeny rows that are also advanced by selection each year. Thus, when lines are selected for potential release there is a source of pure seed that can be used to produce breeder seeds. Seeds produced from head rows of varieties approved for release by the UC Genetic Release Committee are transferred to FSP for multiplication and distribution. We will seek PVP protection for all our released common and durum wheat varieties.

D. JUSTIFICATION

Continuous monitoring and breeding is needed to meet the challenges of changing and new pathogens and to increase the yield potential of wheat. The University's wheat breeding effort complements the private breeding effort by testing new sources of resistance genes and by incorporating them into adapted lines or varieties that can be efficiently used by the private sector. For the new genes to improve yield the UCD program is taking the risk of evaluating novel genes in the different CA environments. Once validated, we make these genes available to the private breeding companies working in CA. The UCD program is well equipped to incorporate new genes and technologies and to do preventive breeding programs (e.g. Ug99).

Because of the reduced profitability of wheat breeding, California wheat breeding companies cannot afford large germplasm screenings or large investments in biotechnology. Large companies also place limited breeding efforts on CA because of its relatively small acreage. The UC Davis wheat-breeding program has a long-term objective to improve wheat specifically for CA and has active collaborations with companies interested in breeding for CA in the area of Marker Assisted Selection: Arizona Grain Inc., Limagrain, and Syngenta. The UC wheat breeding program is a valuable back up for the private efforts, which are susceptible to market fluctuations. Reduced wheat profitability may result in the elimination of some private breeding programs. It is not possible to fund public breeding only during periods of inadequate private investment, because the process of developing and testing new varieties in self-pollinated species from new crosses takes several years. The UC wheat varieties have contributed for many years to sustain and improve wheat production in California.

E. COMBINED BUDGET BREEDING AND TESTING 2017-2018

Breeding Program	2017-18	2018-19	Sources of funding	2017-18	2018-19
Oswaldo Chicaiza. SRAIV (1 FTE)	$78,396	$80,748	CWC planned request	$ 195,000	$ 198,000
Benefits (51.8%)	$40,609	$41,827	CCIA request breeding	$ 81,000	$ 85,000
Marcelo Soria PGRI (0.15 FTE)	$ 8,431	$ 8,684	Royalties wheat varieties	$ 22,600	$ 22,600
Benefits (51.8%)	$ 4,367	$ 4,498	Reserves breeding	$ 9,300	$ 9,800
Xiaoqin Zhang Lab Assist. III (70%)	$36,490	$37,584	Private companies	$ 27,000	$ 27,000
Benefits (51.8%)	$18,902	$19,469	Total	$ 334,900	$ 342,400
Alicia Del Blanco Proj. Sci. (50%)	$32,400	$33,372			
Benefits (38.3%)	$12,409	$12,781			
Labor hours at DREC	$ 8,000	$ 8,240			
Labor hours at IREC	$ 3,000	$ 3,090			
Contract labor at UCD	$36,000	$37,080			
Total Salaries and Contract labor	**$279,004**	**$287,374**			
Truck ½ ton. One year	$ 7,000	$ 7,000			
Greenhouse space. One year	$ 6,000	$ 6,000			
Field operation	$13,000	$13,000			
Mark Lundy Reg. and Elite fees	$ 8,000	$ 8,000			
Field acreage recharge	$12,000	$12,000			
Travel to El Centro and Tulelake	$ 2,000	$ 2,000			
Expendables	$ 2,000	$ 2,000			
Supplies for lab tests	$ 1,000	$ 1,000			
Equipment repair and use fee	$ 4,000	$ 4,000			
Total supplies and equipment	**$55,000**	**$55,000**			
Total Breeding	$334,004	$342,400			

Budget justification

The budget for the wheat breeding program includes support for wheat breeders Oswaldo Chicaiza (100%) and Alicia del Blanco (50%). Alicia works 50% for the wheat breeding program and the other 50% is included in other barley and oat proposals. Support is also requested for Xiaoqin Zhang (70%) to provide MAS support to the breeding activities and for Marcelo Soria (15%) for database support. Contract labor for the breeding program is budgeted at $36,000. The 2017-2018 budget has a normal increase in salaries (~3%) and a similar increase was calculated for the 2018-2019 budget. Requests for supplies, equipment and field facilities are similar to previous years for both years. Since the testing program is now run independently of the testing program, we now pay the regular testing fees. These fees represent an additional $8,000 that are now transferred from my program to Mark Lundy's program.

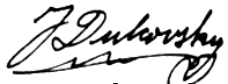
The total cost of the breeding and testing programs for 2017-2018 is $334,004 and for 2018-2019 $342,400. Funding requests for the breeding program from the CWC are $195,000 for 2017-

2018 and $198,000 for 2018-2019. The CCIA request is $81,000 from the CCIA for 2017-2018 and $85,000 for 2018-2019.

Based on the average of previous years, we estimate an income of $22,600 for our wheat varieties research fees. We also expect an income of $27,000 from collaborative agreements with Syngenta for growing their rows and yield trials at Davis. TO balance the budget we will add $9,300 in 2017-2018 and $9,800 in 2018-2019 from our reserves generated from returned overhead from our department.. In addition, to this funding, the University contributes the salaries of J. Dubcovsky and its laboratory space.

We are aware that the reduced acreage of wheat has taken a toll on the funding collected by the CWC so we have not make any increases beyond the annual salary increases and the new testing fees. We have been successful in obtaining new additional sources of funding for these difficult years and we have tried to reduce our requests from the CCIA and CWC as much as possible.

Additional support to the breeding activities: We obtained a new grant from USDA for the next five years ($9.7M, 20 collaborators) that will help us fund must of the genetic research on yield genes. I also renewed my support from HHMI ($4.2 M) to generate novel genomics tools and for basic research in wheat. Additional research activities are covered by grants from USDA-NIFA, BARD and International Wheat Yield Partnership (IWYP). These additional sources of funding complement the industry support for the core breeding activities. The funding provided by the CCIA and CWC has been critical to leverage these additional grants, which multiply several fold the generous support from the CCIA and the California wheat growers.



Jorge Dubcovsky
Principal Investigator

PROJECT TITLE:

Evaluation of wheat varieties in California 2017-2019 (UC Small Grain Variety Testing Program)

PRINCIPAL INVESTIGATOR:

Mark Lundy

OTHER INVESTIGATORS:

Department of Plant Sciences UCD: J. Dubcovsky, Alicia del Blanco, O. Chicaiza, N. George; *UC Cooperative Extension-UCANR*: R. Wilson, D. Culp, S. Orloff, M. Leinfelder-Miles, S. Wright, B. Marsh, K. Mathesius, R. Hutmacher, R. Solorio, N. Clark, F. Maciel.

BUDGET REQUEST: $135,000 (2017-2018) & $137,000 (2018-2019)

A. SUMMARY:

The objective of this research is to test commercial and advanced wheat varieties across a wide range of environmental conditions in the state of California in order to determine genotypes with potential for economic productivity. The requested funding will be used to support common wheat and durum wheat trials in the major small grain producing areas of California. The UC Small Grain Variety Testing Program will include evaluation nurseries of advanced breeding lines and new and standard cultivars obtained from public and private breeding programs. Trials will be located at representative environments in the Sacramento, San Joaquin, Imperial, and northern Intermountain region and will be grown using production practices appropriate for each environment. The performance of the entries will be documented and summarized on the UC Small Grains Program website (http://smallgrains.ucanr.edu/Variety/). The resulting information will be used as supporting data for justifying the release of advanced breeding lines from both public and private breeding programs and to identify where and under which conditions cultivars are best adapted. The program will also manage elite germplasm nurseries for the UC wheat breeding program in two selected locations to help accelerate the development of public cultivars.

CALIFORNIA WHEAT COMMISSION

May 1, 2017 to April 30, 2019

B. OBJECTIVES: The overall objective of this research is to provide productivity information for new and existing small grain cultivars to growers in various regions of California as well as to public and private breeding programs. The performance (which includes yield, agronomic characteristics, diseases & pest reactions, and grain quality) of cultivars and advanced breeding lines from public and private breeding programs will be evaluated in representative environments throughout California. The UC Small Grain Variety Testing Program will cover the main grain-producing areas (including the Sacramento, San Joaquin, Imperial, and northern Intermountain Region) of California. The resulting information will be used to justify the release of advanced breeding lines from both public and private breeding programs and to identify where and under which conditions cultivars are best adapted.

Objective 1: Measure crop productivity, quality, disease resistance and agronomic characteristics for commercially available small grain varieties and advanced breeding lines across a range of environmental and management conditions that represent California agroecosystems.

Objective 2: In a subset of trial locations, directly manipulate crop water and nitrogen availability and measure variability in genotypic reactions to these varying management conditions.

Objective 3: Measure in-season changes and variety-specific differences in growth directly and via crop phenotyping platforms.

Objective 4: Apply multi-level statistical models to trial data to understand and communicate varietal differences due to genotypic, environmental and management effects.

Objective 5: Report results of the research and analysis on our program website, in extension meetings and other agricultural forums.

C. PROCEDURES

Objective 1: The following replicated yield tests are planned for the 2017-18 season:

Common wheat and triticale: The Regional fall-sown test (30-50 entries, predominantly HRS, but including HWS, HWW, HRW, triticale and other classes or subclasses made available by cooperating breeders) will be planted at 6-8 sites in the Central Valley and surrounding areas, and in the Imperial Valley.

The fall-sown elite nurseries established in collaboration with the UCD wheat breeding program

(20-30 entries, HWS and HRS) will be planted at two sites in the Central Valley.

The quality collaborators nursery, which includes 12-15 elite lines and new cultivars for the collaborative testing program, will be planted at 1-2 sites in the Sacramento and San Joaquin Valleys. This program involves domestic millers and bakers, grain dealers, and private breeding programs.

A fall-sown winter wheat test (approximately 40 entries) and a spring-sown wheat test (approximately 30 entries) will be planted at the UC IREC in Tulelake, CA in cooperation with Oregon State University.

Durum wheat: The Regional fall-sown test (30-50 entries) will be conducted in 3-4 sites in the Central Valley and one site in the Imperial Valley.

The fall-sown elite nursery conducted in collaboration with the UCD wheat breeding program (20-30 entries) will be planted at one site in the San Joaquin Valley.

A durum wheat quality nursery consisting of 6-12 elite lines and new cultivars will be planted to provide grain samples for quality analyses for the durum wheat collaborative testing program, at one site in the San Joaqauin Valley and one site at the Imperial Valley.

UC Elite nurseries: In order to accelerate the development and release of public cultivars, off-station testing of elite germplasm from the UC wheat breeding program will be conducted at key locations. Selected materials can then be more rapidly advanced to the UC Variety Testing Program nurseries. When combined with early generation quality testing, the time required for cultivar release can be shortened.

Quality Collaborators Trials: Elite germplasm (both common and durum wheat) from public and private breeding programs will be produced under optimum cultural conditions in the San Joaquin and Imperial Valleys for collaborative end-use (milling and baking) tests in cooperation with the California Wheat Commission and California's milling and baking industries.

Intermountain Region: For the Intermountain region of northern California, germplasm from both public and private small grain breeding programs operating in the Pacific Northwest will be evaluated at the UC Intermountain Research and Experiment Station in Tulelake in cooperation with Oregon State University and the USDA-ARS. This effort will help accelerate the development of cultivars for the Intermountain region of northern California.

Field methods: All small grain tests will be conducted on University of California research farms or grower fields under irrigated or rainfed conditions. Nurseries will be planted at seeding rates required to achieve plant densities of 1.0 million plants per acre for rainfed wheat tests and at 1.2 million plants per acre for irrigated wheat tests. Randomized complete block designs with 4 replications will be used, and individual plots will measure 15 to 20 feet in length and 6 to 9 drill rows (6-9" spacing) in width.

Data on yields, bushel weights, kernel weights, agronomic characteristics (plant height, lodging, dates of heading and maturity, shatter) and reactions to important diseases and pests will be recorded and analyzed. Seed samples from grain harvests at selected locations will be analyzed

for protein content and milling and baking performance (common and durum wheat tests).

Objective 2: At two trial locations, one in the Sacramento Valley and another in the San Joaquin Valley, the common wheat and triticale trial will be replicated three times. One trial will be conducted with water and N fertility delivered to optimize productivity. A second trial will be conducted where soil nitrogen availability limits crop growth and no N fertilizer is provided but water is not limiting within the season. A third trial will be conducted where water is managed to limit crop growth but N fertility is managed to avoid nitrogen deficiency. These 3 side-by-side trials, replicated in two locations and in forthcoming seasons, will create an opportunity to being to quantitatively differentiate the effects of N limitation, water limitation and unrelated environmental factors and measure how these management factors change the relative productivity of the common wheat and triticale varieties in the trial.

Objective 3: Cultural, management, and biological characteristics of test locations will be recorded, including soil coring for chemical and physical characterization, the deployment of in-field weather stations in areas poorly served by other weather monitoring equipment. Pre-plant and post-harvest soil moisture throughout the rooting zone will be measured in order to improve estimates of crop water availability and in-season use. In order to improve the understanding of environmental effects on crop growth and development at the diverse trial sites, in-season phenotypic measurements such as plot-specific Normalized Difference Vegetation Index (NDVI) and other forms of canopy spectral reflectance will be recorded at key phenological stages via drone-mounted multispectral cameras and other proximal sensing devices. This information will aid in the interpretation of variety trial results and improve our understanding of site-specific environmental interactions and their differential effects on cultivar performance. In addition, the identification of agro-ecological regions to which new cultivars are best adapted will be facilitated by this information. Information regarding the biophysical details of the production locations will also permit variety trial data to be used for validating computer-based crop production models that can then serve as new research and production tools for the California small grains industry.

Objective 4: In order to improve the understanding of genotype×environment patterns within the state, variety tests will be designed to more directly measure these patterns. Principle component analysis (PCA) and associated biplots will be used for classification and grouping of trials. Linear mixed models and least-squared means will be used for analyzing and summarizing trial data across multiple site-years. Together, these new methods will generate more precise, accurate, and useful variety performance estimates for the California small grains industry. The Agricultural Production Systems Simulator (APSIM) is a computer program that combines biophysical and management modules to simulate cropping systems and is widely used both for farm management and research in other parts of the world. The program can accurately simulate wheat production under a variety of production conditions. Trial data will be used to test the reliability of the model as a tool for simulating small grains production in California. Efforts will be made to begin integrating this modeling into the delivery of site-specific, real-time extension information.

Objective 5: Results of the analyses will be published online on the UC Small Grains website

(http://smallgrains.ucanr.edu/Variety/). Presentations of results of the research will be made at industry meetings, field days and other extension venues throughout the state each year.

D. JUSTIFICATION:

Advanced breeding lines that might become cultivars are evaluated first throughout California in the UC Small Grain Variety Testing Program. Areas where advanced breeding lines are best adapted are identified. Concurrently, the suitability of the germplasm from both agronomic and quality standpoints is determined, and forms the basis for variety recommendations. The UC Small Grain Variety Testing Program serves as the foundation for the small grains research program and is extremely important to California's small grains growers, advisors, seed companies, plant breeders, end-users and others in the industry.

Between 450 thousand and 750 million acres of various market classes of small grains (primarily wheat and barley, but also oat and triticale acreage for grain and forage) are grown each year in California, with some acreage in most counties. Production occurs under a wide range of environmental conditions and management practices, and supplies a variety of food, feed, and forage markets, for both domestic use and export. The acreage of individual cultivars changes from year to year as new cultivars are tested, approved, and released for commercial production to replace cultivars that have become susceptible to diseases or other pests or lack key characteristics. New cultivars should represent improvements in specific characteristics of the crop, meet specific needs of the grain industry, and decrease vulnerability to stresses resulting from diseases, pests, and unfavorable physical environments. In order to assure that new cultivars do represent such improvements, it is essential that advanced breeding lines are evaluated throughout California before they are released as cultivars. The evaluations result in the identification of regions where breeding lines are best adapted and, conversely, reveal which breeding lines are not adapted, have unacceptable characteristics, and should not be released as cultivars. Both public and private breeding programs use results from the UC Small Grain Variety Testing Program as supporting data for justifying the release of advanced breeding lines as cultivars. The UCD wheat breeding program also uses these data in the PVP applications for their varieties.

New cultivars that combine appropriate agronomic characteristics, specific end-use quality traits, resistance to multiple diseases, and high yield potential are needed for the economic survival of small grain growers in California. The continued appearance of new races of the pathogens that cause stripe rust, leaf rust, *Septoria tritici* leaf blotch, net blotch, and scald has made wheat and barley extremely vulnerable to disease epidemics and yield loss. Stripe rust remains the major threat. The regional testing program is an important component of the monitoring network required for early warning of new virulence.

The addition of more explicit measurement of the pre- and post-season soil water status at the sites along with in-season phenotypic measurements, such as plot-specific NDVI and canopy spectral reflectance at key phenological stages, will add important information to the trial data in the 2017-18 and 2018-19 cropping seasons. The increasing availability of relatively low-cost

measurement technology and computing platforms is fundamentally changing the way crop phenotyping is performed around the world. In order to remain relevant and competitive in the scientific landscape of the future, the statewide variety testing program must begin to integrate more ambitious measurements of the crop-soil environment into future research trials, and incorporate the analytical methods described previously.

In time, our goal is to transition the program toward more explicit in-season measurement of the crop environment and introduce more explicit management-related variability to a subset of these environments. This will allow us to develop a more direct, quantitative understanding of the contribution of repeatable biophysical management effects to overall genotype×environment effects. In this way, we will multiply the information created by the trials both for the purposes of more informed breeding and variety selection, and increase the crop management information that can be gleaned from the effort. For the 2017-18 season, drone-based crop phenotyping, site soil characteristics, and in-field data loggers represent the first step in this transition.

The likelihood of success in meeting the stated objectives is high if adequate funding is provided because of participation in the project by most plant breeders, both public and private, currently developing small grain cultivars for California. The information on the program website (http://smallgrains.ucanr.edu/Variety/CropType/) documents the extensive work done across all small grain growing areas in California. These results demonstrate the ability of the UC Small Grain Variety Testing Program to deliver relevant and in-depth information on small grain adaptability throughout California. We look forward to continuing this service for the California small grains industry.

E. BUDGET FOR REGIONAL TESTING 2017-2019

Regional Testing program	2017-2018	2018-2019
Staff Salaries (N. George, M. Rodriguez)	$106,854	$111,128
Staff Benefits ((N. George, M. Rodriguez))	$43,810	$45,562
Part time labor (UCD student interns)	$16,000	$17,000
Total Salaries and Contract labor	**$166,664**	**$173,690**
UCCE Advisor Collaborator reimbursement	$8,000	$8,000
Acreage Rental/Recharge (UD Davis)	$12,000	$12,000
Research and Extension Center labor and service charges (UCANR)	$26,000	$30,000
Total UC collaborator funding	**$46,000**	**$50,000**
Seasonal truck rental x 2	$16,800	$17,136
Box truck rental (harvest)	$1,500	$1,530
Statewide Travel	$4,000	$4,000
Equipment maintenance, repair, use and replacement	$7,500	$7,500
Consumable supplies and materials	$3,000	$3,000
Total supplies and equipment	**$32,800**	**$33,166**
Total Regional Testing Program	**$245,464**	**$256,856**

Sources of funding	2017-2018	2018-2019
CWC-Regional testing request	**$135,000**	**$137,000**
Quality Collaborators Program	$5,000	$5,000
CCIA-Regional testing request	$54,000	$56,500
Statewide testing fees	$15,000	$15,000
Elite-line testing	$15,000	$15,000
Testing program reserve funding	$21,464	$28,356
Total	**$245,464**	**$256,856**

Budget justification

The budget for the regional testing program includes support for UC Davis Department of Plant Science staff members, who are essential for implementing the field research, communicating with the various collaborators, curating the trial data and seed stocks, maintaining the equipment, and producing written and web-based summaries associated with the research. In addition to the full-time staff, part-time labor is a necessary supplement for tasks such as weighing entries, preparing seeds for planting, and recording the necessary in-season and post-harvest measurements associated with the experiment. The increase in budget between 2017-18 and 2018-19 reflects anticipated 4% increases in salary and benefits rates and a 6% increase in wage rates for hourly workers.

Relative to previous years, the proposed budget devotes a larger proportion of the requested funds to collaborators within UC Cooperative Extension. In recent years, new Agronomy Advisors have been hired in the San Joaquin and Sacramento Valleys. The contributions to the trials from the UC Advisors are invaluable to the integrity of the overall experiment, and UCCE Advisors make important contributions due to their more nuanced understanding of the particular variables of importance in a given region. The program has actively sought more explicit involvement from the UCCE Advisors in these trials in the past season and the budget includes money to reimburse the participating Advisors for trial-related expenses. This small investment to ensure the buy-in from current, new and future CE Advisors will provide manifold benefits in terms of the quality and quantity of the data produced and the information communicated from the trials across the state.

In a similar vein, the proposed budget devotes more resources to labor and service charges at the Research and Extension Centers where 4 trials are conducted annually. As mentioned above, over the next several seasons the program will begin to more explicitly measure and manipulate agronomic variables to develop a more quantitative understanding of the contribution of management effects to overall genotype×environment effects. To successfully control and integrate management variables, such as nitrogen and water, we will need to rent larger portions of the acres at the REC sites so that we can grow rotational crops in the non-trial areas in order to prepare and control the ground for effective measurement of key variables during the trial period. Control over the rotation on a 2-3 year timescale is essential to producing high-quality management data, but it will result in greater rental and labor costs at these sites. Independent of these increases, UCANR has proposed dramatic rate increases at the Research and Extension Centers (RECs). While we are actively opposing these increases through appropriate organizational channels, it does appear likely that the overall cost for our use of these resources will increase over the next two seasons. Nevertheless, we anticipate that this investment, over the medium-term, will multiply the information produced by the trials, bringing novel information into the breeding and variety selection efforts and adding valuable management information to the experimental outputs that are not currently within the scope of the trial. It may also provide leverage to more effectively supplement these efforts with other outside funding.

The budget also reflects an increase in costs related to vehicle rentals. It includes the rental of 2 fleet trucks from UCDavis Fleet Services and a box truck during the harvest season. Previous budgets included a larger truck that is required to pull our heavy-equipment trailer around the state and is double the cost of a light-truck rental. We have added a light-truck rental because it is necessary for participation in fieldwork by students who have no independent transportation to the trial location, and we frequently have multiple needs for vehicles on the same day. Because we have begun to measure protein content on three experimental replications, it is more efficient to subsample our grain in the field where it is being harvested. The box truck enables us to bring these larger quantities of grain back to UCDavis for processing. We have reduced the overall travel expenditures to reflect a decrease in the use of personal vehicles and travel expenses. For example, when working in the San Joaquin Valley overnight, our group now stays at WSREC in the dormitories rather than incurring hotel rental expenses as was the previous practice.

The budget reflects an overall deficit requiring $49,820 from other program resources over the 2017-19 seasons. This is in addition to the CE Specialist salary and benefits covered by UC ANR for M. Lundy.

We are aware that the drought, low grain prices and increasing competition for wheat acres from higher-value crops have taken a toll on the funding collected by the California Wheat Commission. As such, the 3.8% and 1.5% year-over-year increases in funding requests from the California Wheat Commission for the 2017-18 and 2018-19 budget years, are less than half of the 8% and 4% year-over-year increases in costs we anticipate. We are actively exploring options for broadening the base of funding for applied grain cropping system research through new grants and collection mechanisms. We believe that the proposed changes to the trial structure will gradually enable us to multiply the outputs from the existing effort and thereby increase its value to a broader range of funding sources. We are hopeful that these efforts will be successful in the medium-term. Regardless, we appreciate and depend on the basic support of this program that the California Wheat Commission generously provides.

Sincerely,

Mark Lundy

Mark Lundy
Assistant CE Specialist
Grain Cropping Systems
Department of Plant Sciences
University of California, Davis

Herbicide resistant Ryegrass management

Principal investigator: Mariano Galla, UCCE Agronomy & Weed Science Advisor, Glenn, Butte and Tehama counties

Collaborators Mark Lundy, UCCE Small Grains Specialist.

Italian ryegrass (*Lolium perenne spp. Multiflorum),* is an annual grass common in Sacramento Valley orchard and field crops. This species germinates and matures approximately at the same time as winter cereals and is highly competitive for soil nutrients especially during the time when wheat is tillering. It can also interfere with harvest and it has been reported that Italian ryegrass can cause up to 80% reduction in winter wheat grain yield due to competition for nutrients and water (Liu et al. 2016). Cases of Italian Ryegrass populations resistant to one or more herbicide modes of action have been reported in California and in other states. Brunharo and Hanson (2017) reported a population of Italian Ryegrass from Hamilton City resistant to Gramoxone, Envoy and Osprey. In Oregon, Liu et al. (2016) found a ryegrass population resistant to pinoxaden, the active ingredient of Axial. In the Sacramento Valley, the short rotation interval already limits the availability of effective herbicides because of safety concerns for the next crop. The spread of herbicide resistant ryegrass could further reduce our viable options.

In a preliminary test conducted in a wheat field near Willows CA, axial, osprey, simplicity and glyphosate failed to control Italian Ryegrass. The objective of the proposed research is to evaluate possible alternatives for the management of herbicide resistant ryegrass. Particular attention will be given to possible use of pre-emergent herbicides, an option not commonly adopted by California growers. A minimum of two field experiments (depending on cooperators availability) will be established. Data collection will include herbicide efficacy, crop safety and yield.

Funding Request: $4,000 (For 2 locations, $2,000 per location)

FY 17/18 Valuation of Non-Billed CWC Laboratory Services Provided for Research

UC Breeding and Field Trials (Research)

UC Regional Trials (Durum) 112 samples @$200	$	22,400.00
UC Regional Trials (Common Wheat) 446 X $150	$	66,900.00
J Dubcovsky Breeding Program (Durum) 154 x $200	$	30,800.00
J Dubcovsky Breeding Program (Common Wheat) 116 x $150	$	17,400.00
Subtotal UC Programs	**$**	**137,500.00**

Collaborator Meeting (Research)

Collaborator Mtg testing from CWC lab (Durum) 8 @ $200	$	1,600.00
Collaborator Mtg (Common Wheat) 59 @ $150	$	8,850.00
Subtotal Collaborator Meeting	**$**	**10,450.00**

Pacific Northwest Wheat Quality Council (Research)

11 samples @ $150 (Complete Test)	**$**	**1,650.00**

Crop Quality Samples (Market Development)

CA Desert Durum Crop Quality (75% of 14 samples @ $200)	$	2,100.00
CA Desert Durum Crop Quality (75% of 14 samples @ $30.00)	$	315.00
CA Desert Durum Crop Quality (75% of 14 samples @ $10.00)	$	105.00
Composite CA Desert Durum CQ (75% of 4 samples @ $200)	$	600.00
Composite CA Desert Durum CQ (75% of 4 samples @ $30)	$	90.00
Composite CA Desert Durum CQ (75% of 4 samples @ $10)	$	30.00
CA Desert Durum Crop Quality (75% of 4 samples @ $80)	$	240.00
HRW Crop Quality (*75% of 131 samples @ $150)	$	14,737.50
HRW Crop Quality (*75% of 131 samples Sedementation @ $10)	$	982.50
HRW Crop Quality (*75% of 22 samples SRC @ $60)	$	990.00
HRW Crop Quality (*75% of 22 samples SRC @ $50)	$	825.00
HRW Crop Quality (*75% of 22 samples SRC @ $5)	$	82.50
Lab Analysis (used outside services)	$	390.00
2 samples - Amylograph, Extensograph, Starch Damage, Vomitoxin		
Subtotal Crop Quality Samples	**$**	**21,487.50**

Total: **$ 171,087.50**

last year: $91,555

Research	**$**	**149,600.00**	**87%**
Market Development	**$**	**21,487.50**	**13%**

* US Wheat reimburses CWC 25% for the use of CA crop quality data in their USW CQ report. (The reimbursement (and other indirect costs) show up on the Income statement: Lab/Crop quality, so are not included here).

AZ durum samples are totally reimbursed: 75% from AGRPC and 25% from U.S. Wheat.

Additional Information

Figure. Historical California wheat acres planted vs harvested acres from 1982-2016

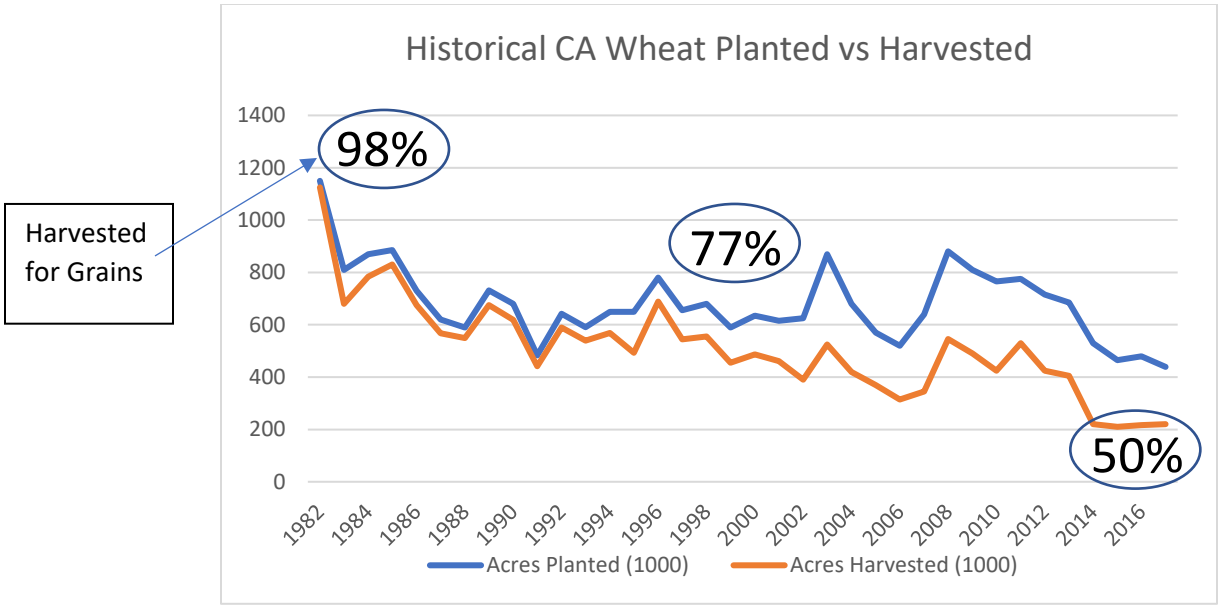


Table. Research Funding, FY Income/Deficit, and reserves at the beginning of each FY for the last 10 years.

	Research Funding	FY Income/Deficit	Reserves at Beginning of FY
2009/10	$ 218,000	$ 300,719	$ 1,048,043
2010/11	$ 284,130	$ 159,067	$ 1,190,698
2011/12	$ 336,493	$ 190,060	$ 1,430,964
2012/13	$ 395,000	$ (174,899)	$ 1,600,062
2013/14	$ 356,000	$ (253,380)	$ 1,477,211
2014/15	$ 325,000	$ (419,679)	$ 1,230,018
2015/16	$ 325,000	$ (1,358)	$ 838,853
2016/17	$ 310,000	$ 31,447	$ 821,628
2017/18	$ 330,000	$ (192,663)	$ 866,729
2018/19	$ 335,000	$ (220,825)	$ 674,066