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UW-Madison Dairy Science Research . . . A Peek Behind the Curtain

Kent Weigel
Professor and Chair



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Outline

- A century of excellence in education and discovery
- Expectations of a new professor
- Staffing a project
- Securing funding
  - Internal programs
  - External competitions
- Acquiring biological materials
  - Experimental herd
  - Outside collaborators
- Anatomy of a major federal grant
- Today's challenge
- Future options and opportunities

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A Century of Excellence in Education and Discovery

L.H. Schultz, D.A. Wieckert, C.C. Olson, W.T. Howard, and D.P. Dickson

DISCOVERY

Nutrition

1898 First publication of Feeds and Feeding (Henry, later by Morrison)
1905 Salt requirement experiments
1924 Generation of Vitamin D activity in foods by irradiation
1940 NPN utilization by ruminants established
1940 Trace mineral salt experiments
1951 Low milk fat test related to changes in rumen acids
1951 Identification of rumen acids (acetic, propionic, butyric)
1951 Propionic acid shown to reduce ketosis
1971 Active forms of Vitamin D discovered
1974 Ammonia requirements for microbial protein production
1983 Use of forage particle length to calculate roughage indexes
1988 Limited hepatic lipoprotein secretion causes fatty liver
1993 Effectiveness of fiber in byproducts quantified
1998 Use of NIR for analysis of forage digestible fiber and degradable protein
2000 Effects of processing corn silage nutritive value
2000 Phosphorus management on dairy farms
2004 Use of choline to prevent fatty liver
2005 Incorporation of milk urea nitrogen analysis and use in management software

Management

1890 Babcock Test for milk fat introduced
1891 Round silo promoted
1906 First cow test association formed
1941 Initiation of dairy cattle housing and milking parlor research
1950 Research on environmental influences on production in 50 herds
1967 Dairy beef project initiated
1968 Shift from Babcock test to infra-red technology and automated milk analysis
1970 Post-milking teat dip experiment
1973 Computerized ration balancing made available
1975 AM-PM and test interval adjustment factors implemented
1981 Milk yield loss associated with subclinical mastitis as indicated by SCC
1991 Model for marginal increases in feed costs for milk, fat, protein, and lactose
2002 Development of "Milk Money" program to improve milk quality

Physiology

1895 First use of Tuberculin test
1917 First use of diagnostic test for Johne's Disease
1934 Brucellosis eradication program initiated
1939 2000 cows artificially inseminated in Wisconsin
1940 Egg-yolk buffer medium developed as semen extender
1949 Dicoumarol as cause of bleeding in cows fed spoiled sweet clover hay
1949 Research on embryo mortality
1959 Rate of milking studies
1963 Early breeding of heifers studies
1964 Wisconsin Mastitis Test developed
1970 Somatic Cell Test based on DNA developed and used in DHI laboratories
1978 Concept of estrogen receptors in the uterus developed
1982 Bovine placental lactogen isolated and characterized
1994 Development of Ovsynch program
2004 Increased steroid metabolism link in high milk production and reproduction

Animal Breeding and Genetics

1912 First genetics experiments conducted
1935 Sire proving program started
1940 Experimental bull stud established on campus
1953 Inbreeding, line breeding and out-crossing research at Emmons Blaine farm
1951 First successful embryo transplants in cattle
1957 Dairy Herd Improvement records computerized
1980 Non-surgical ova transfer procedure developed
1982 Scoring system for SCC with optimum statistical properties
1989 First sire evaluations for SCC
1991 Genetic markers for milk production identified
2004 Gene identification through crossbreeding experiments

EDUCATION

- about 1300 undergraduates degrees in Dairy Husbandry/Science since 1938
- approximately 350 Master of Science degrees granted since 1938
- nearly 200 Ph.D. degrees granted since 1938
- more than 16,000 students in Farm & Industry Short Course since 1886
- 9 National Dairy Shrine Student Recognition winners since 1969
- 9 National Championship Dairy Cattle Judging Teams since 1918
- 4 Platinum Award Dairy Challenge Teams since 2002
- 3 ADSA Purina Mills Teaching Award winning faculty since 1973
- 4 ADSA Delaval Extension Award winning faculty since 1951
- 12 UW CALS Outstanding Teaching Award faculty

EXCELLENCE

(L-R) I.W. Rupel (1963), R.P. Niedermeier (1977), L.H. Schultz (1983), B.R. Baumgardt (1985), N.A. Jorgensen (1991), L.D. Satter (1997)

- 6 American Dairy Science Association Presidents (pictured above)
- 4 ADSA Award of Honor Recipients
- 5 ADSA Distinguished Service Award Recipients
- 45 ADSA Faculty Awards

LANDMARK EVENTS

1883 Wisconsin legislature appropriates funding for establishment of an agricultural experiment station
1885 W.D. Hoard publishes first Hoard's Dairyman magazine
1886 First Short Course in Agriculture established
1887 Dean W.A. Henry hires S.M. Babcock
1890 Establishment of the "First Dairy School in the World"
1898 Campus dairy barn and teaching center completed
1938 Dairy Husbandry Department formed (Heizer, Chair)
1954 Dairy Cattle Instruction and Research Center constructed on campus
1955 Sale of Hill Farm research facility results in purchase of Arlington research farm and expansion of research herd
1972 Animal Science building constructed
1981 US Dairy Forage Research Center established on UW campus
2003 Construction of Integrated Dairy Facilities initiated

Historic Moments

Under the guidance of the first professor of agriculture, William A. Henry, the University of Wisconsin provided scientific research to expand the state's dairy industry in the late 19th century. Using the university farm and the newly created experimental station, Henry promoted the use of round silos for storing feed for cattle during the winter. In 1887 Henry hired Stephen Babcock who developed the first test for butterfat content of milk. This simple test enabled cheese makers to give farmers a fair price for their milk. It also allowed high quality butter and cheese to be manufactured consistently. The College of Agriculture also pioneered testing for bacteria leading to practical methods of milk pasteurization.

Working with fellow New Yorker William D. Hoard, Henry helped establish the powerful and progressive Wisconsin Dairyman's Association in Watertown in 1872. The Dairyman's Association provided education in new dairying methods through its publications and meetings even though its primary function was to help farmers market their dairy products.

In 1886 the university offered its first winter agricultural "short course". Stephen Babcock established the first "Dairy School" in the nation in 1890. Created with support from the legislature, these schools were significant in moving farmers from wheat production to dairying. University sponsored "Farmers Institute held across the state brought farmers and scientists together to share ideas.

In 1895, Dean Russell proved to farmers that the recently developed Tuberculin test was accurate. Twenty-eight normal appearing dairy animals from the UW herd that had tested positive for TB were slaughtered before a large crowd of farmers on campus. Russell's dramatic demonstration proved the TB test was effective and reliable. All of the sacrificed animals were infected.

In 1907 UW scientists S.M. Babcock and E.B. Hart set the stage for the discovery of vitamins and essential trace minerals by feeding diets of single grains to 16 dairy heifers. These experiments proved that micro-components other than fats, proteins, carbohydrates, and salts were necessary for life and reproduction. These results changed forever the way scientists look at the diets of animals and humans.

In 1933 a farmer brought a bucket of blood to the UW from a cow that had died for no apparent reason. Professor K.P. Linn determined the cause of death was internal bleeding due to the presence of dicoumarol, a blood thinner, found in moldy sweet clover hay. Dicoumarol continues to have extensive use as a rat poison and a blood thinner in humans.

In the mid-1930's, Wisconsin dairy breed organizations petitioned Agriculture Dean C.C. Christensen to establish a Department of Dairy Husbandry at the University of Wisconsin. With the full support of the state legislature, Christensen moved several extension faculty members specializing in dairy from Animal Husbandry to create the new department in 1938. Dr. E.E. Heizer, a Holstein specialist, moved from Ohio to Wisconsin to become the first Chairman of Dairy Husbandry. One of his early decisions was to improve the research and teaching herds by importing two carloads of registered Holstein heifers from Colony Farms in British Columbia. The name of the department was changed to Dairy Science in 1962.

The National Dairy Cattle Congress in Waterloo, Iowa, began experiencing financial difficulties in the mid-1960's. Dr. James W. Crowley, working with several prominent dairy cattle breeders from Wisconsin, made plans to establish a World Dairy Expo in Madison. CALS Dean Glenn Pound wholeheartedly supported the project and offered the services of UW Dairy Science faculty and staff to assist in conducting the show. The first show, held in 1968, and every subsequent World Dairy Expo has had the full support of CALS. Dairy Science faculty, staff, and members of the Badger Dairy Club continue to provide valuable assistance in the operation of the premier dairy exposition in the world.



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Expectations of a New Professor

- As a new tenure-track assistant professor, you get . . .
- Appointment with primary and secondary missions
  - 60-70% Research / 30-40% Teaching (always 9-month)
  - 60-70% Extension / 30-40% Research (mostly 12-month, for now)
- Physical space
  - Furnished office with computer
  - Laboratory with equipment left by previous scientist
  - Shared laboratory manager (e.g., physiology group, nutrition group)
- Funding
  - $175,000-200,000 in flexible research funds
  - $125,000-175,000 in graduate student assistantships (about 4 student-years)
  - 1st year summer salary (if applicable)



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Expectations of a New Professor

- As a new tenure-track assistant professor, you must. . .
- Show excellence in primary mission (e.g., research)
  - Secure extramural funding
    - Equipment, supplies, travel, publication costs
    - Graduate student assistantships, undergraduate hourlies, summer salary
  - Generate research results
    - Peer-reviewed publications
    - Patents, invited lectures, oral abstracts, poster presentations
  - Train graduate students effectively
- Show significant accomplishment in secondary mission (e.g., teaching)
- Do this within a 3-year probationary period and 6-year tenure clock



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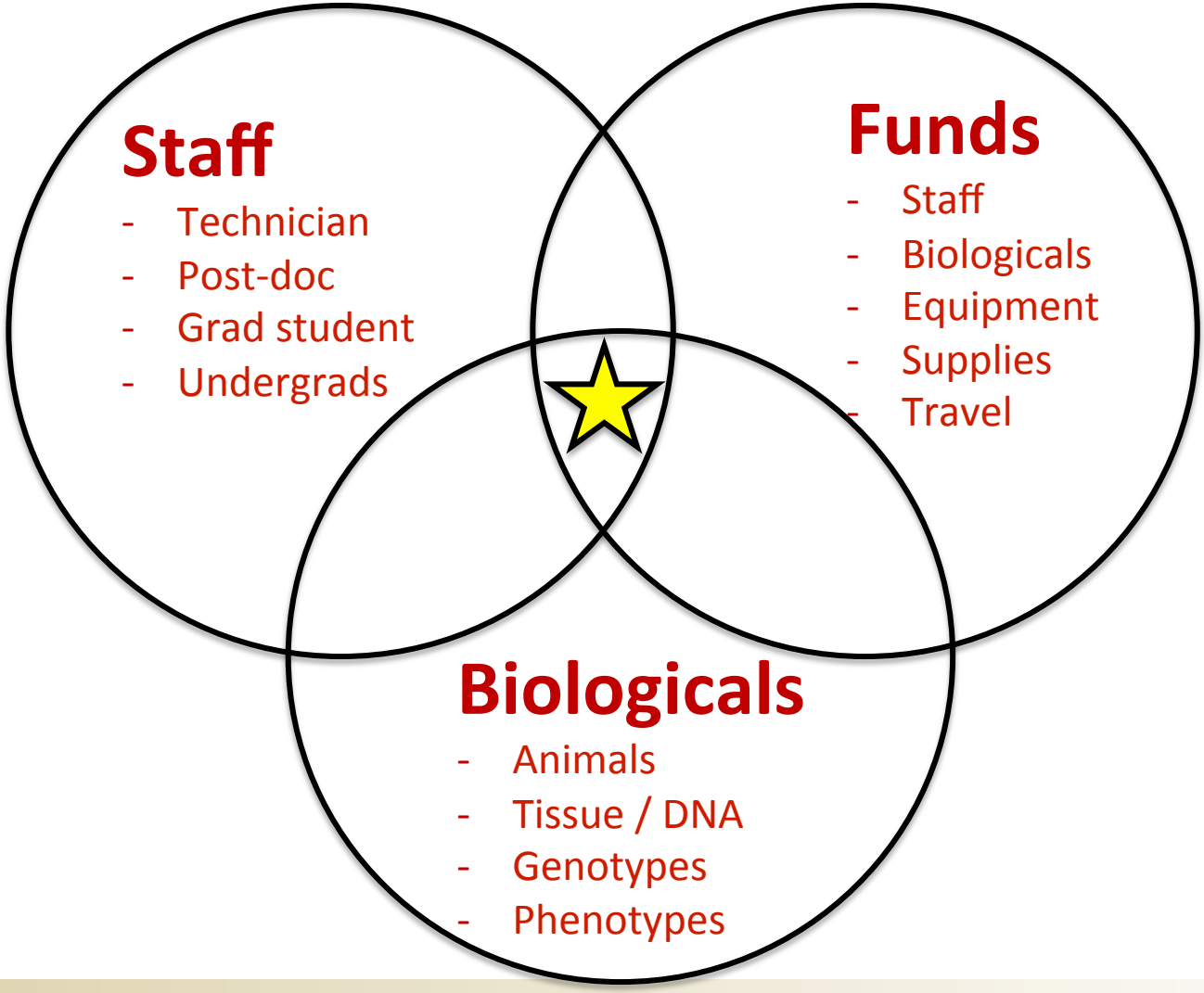
Elements of a Successful Project





Staff

- Principal investigator
  - Evolves from active researcher to research manager over time
- Post-doctoral research associate
  - Minimum is $33,583 + 23.3% fringes = $41,408 per year
- Graduate research assistant (50% full-time equivalent)
  - MS student (2.5 years) or PhD student (4 years)
  - $21,224 + 24.5% fringes + $8,000 tuition remission = $34,423 per year
- Undergraduate student hourly
  - About $10.00 per hour + 6.0% fringes (if paid, rather than for credit)
- Visiting scientist or research intern
  - Often free, but tend to favor large programs with established scientists



Funds (Internal Programs)

- College of Ag & Life Sciences Hatch competition (federal funds)
  - 4 years of research assistant support (salary, fringes, tuition remission)
  - Small budget for research supplies (about $5,000 per year)
  - Limit is 1 individual investigator + 1 multidisciplinary award per scientist
- Graduate School funding competition (patent royalties)
  - 1 year of flexible funding up to $40,000
  - Bridge funding as insurance for federal grant proposals (e.g., USDA, NIH)
- Various university-wide “seed money” programs:
  - Draper Technology Innovation Fund (patent royalties)
  - Reilly Baldwin Wisconsin Idea Endowment Grants (private donor funds)
  - UW System Consortium Grants (partner with smaller UW System school)



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Funds (External Competitions)

- USDA National Institute of Food & Agriculture (NIFA)
  - CAP grants ($10-20 million per project, very highly targeted)
  - Integrated grants ($1-5 million per project, highly targeted)
  - Foundational grants ($500,000 per project, very broad)
  - Fellowship programs (partial funding, US citizens only)
- Industry competitions, such as:
  - Jersey Assn Research Foundation ($5,000-10,000 per project)
  - Select Sires Competitive Grants ($10,000-15,000 per project)
- Sponsored research agreements (↑ cost, ↑ control)
  - Usually $25,000-150,000 per project (including 53.0% indirect costs)
- Unrestricted gifts (↓ cost, ↓ control)
  - Usually $1,000-25,000 per gift (no indirect costs)



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Examples

- Sources of funding for my program over the past 14 years:
  - American Jersey Cattle Association (4)
  - Hatch Act Formula Funds (6)
  - John Brandt Memorial Foundation
  - Korean Rural Development Administration
  - National Association of Animal Breeders
  - Research Council of Norway
  - Select Sires
  - USDA National Institute of Food & Agriculture Animal Genome (5)
  - USDA National Institute of Food & Agriculture Integrated (2)
  - USDA National Institute of Food & Agriculture National Needs
  - Wisconsin Alumni Research Foundation / Graduate School (2)
  - Various gifts from $500 to $20,000 (Alta, Accelerated, Merial, Zoetis, etc.)



Biologicals (Experimental Herd)

- Many land-grant universities still have dairy herds
  - < 100 animals on one farm for smaller dairy states
  - > 1,000 animals on multiple farms for largest dairy states
- Well-suited for nutrition experiments
- Way too small for most applied reproduction projects
- Challenging for genetics projects
  - Multi-generation selection studies may last 30 years
  - Too few animals for genomic prediction studies
- Cow user fees vary based on:
  - Stage of lactation (higher for early lactation cows)
  - Amount of additional labor required



Biologicals (Outside Collaborators)

- Planned experiments on commercial farms
  - Good when 100's of animals needed (e.g., repro trials)
  - Treatments must be minimally invasive
  - Compliance challenges, especially for long trials
- On-farm observational data (e.g., DC305 records, SCR activity data)
  - Can be highly variable in quality and completeness
  - Good for targeted projects and newly available protocols or technologies
- Proprietary materials from companies
  - Often accessible for research, need material transfer agreement (for IP)
  - Good for targeted projects and not-yet-available technologies



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Anatomy of a Major Federal Grant

NewsWatch

UW receives grant to solve dairy puzzle

IT'S a dilemma for dairy farmers. While dairy cattle's capacity to produce milk continues to increase, their ability to reproduce is on the decline. A cow that can't make calves can't make milk, so profits slip away, no matter what her genetic potential.

Unraveling this reproduction puzzle is the focus of a new research program at the University of Wisconsin-Madison Department of Dairy Science. A team of researchers there has landed a $1 million grant from USDA's Agriculture and Food Research Initiative to sort through all of the factors that influence reproduction, such as nutrition, genetics, health, housing and management. The team will employ new statistical processes and computing power to tie together these factors, says dairy management specialist Victor Cabrera, the team leader.

"We're going to collaborate with dairy producers to gather data from all parts of the operation, then use statistical modeling to draw inferences about the factors involved," he explains.

Key Points

- UW gets $1 million USDA grant to study cow reproduction.
- Two hundred dairies will participate in the research.
- UW proposal was selected from 22 grant proposals.


CABRERA

The goal is to give dairy producers the knowledge to adjust management of all the appropriate areas to increase reproductive performance, rather than fixating on a single factor as is often done now, Cabrera notes.

Wisconsin producers will see activity on the project soon. The researchers will begin to identify 200 dairies to participate in the research as early as January. Once those dairies are chosen, management teams will be formed to gather real-world data, and will begin to help participating producers manage reproduction right away.

"There's a big Extension component to the proposal that calls for strong collaboration with Wisconsin Extension faculty and the Extension specialists and researchers across the country. This was important to getting the grant," Cabrera says.

In addition to the on-farm work, researchers will use UW-Madison dairy research facilities to conduct controlled research on the impacts of nutrition and mastitis on reproduction.

Dairy scientists collaborating with Cabrera include Pam Ruegg, Paul Fricke, Randy Shaver, Kent Weigel and Milo Wiltbank. Five of the six collaborators are Extension specialists.

Competition for the grant was intense. Sixty-five "letters of intent" were sent to the USDA, and 22 proposals were submitted in hopes of getting a piece of a $4 million pool.

"Ours was the top proposal," Cabrera says.

Source: UW College of Agricultural and Life Sciences

- USDA-AFRI Integrated Reproduction Project
  - 65 letters of intent
  - 22 full proposals
  - #1 ranked proposal
  - $1 million for 5 years
  - Team of 6 scientists
  - All UW-Madison Dairy Science
  - No subcontracts!



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Anatomy of a Major Federal Grant

Specific Aim 1:
Characterize the contributions of specific management factors to the observed variation between commercial dairy farms in cow fertility.
Aim leader: K.A Weigel and V.E Cabrera
PhD students: Saleh Shahinfar and Afshin Kalantari

Specific Aim 2:
Determine the impact of specific nutritional components on reproductive performance of lactating dairy cows.
Aim leaders: R.D. Shaver and M.C. Wiltbank
PhD student: Matt Akins

Specific Aim 3:
Identify the impact of mastitis on fertility and pregnancy loss in lactating dairy cows.
Aim leaders: P.M. Fricke and P.L Ruegg; Milk Quality laboratory technician: C. Hulland
Ph.D. Student: Maria Jose Fuenzalida Valenzuela

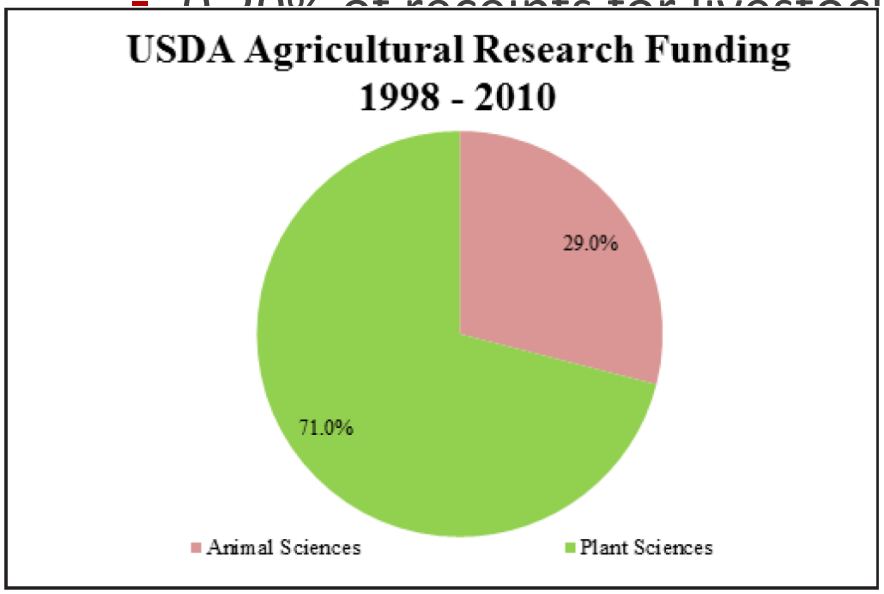
Specific Aim 4:
Evaluate the economic impact of reproductive management strategies on overall farm sustainability under a variety of management scenarios.
Aim leaders: V.E. Cabrera and K.A. Weigel
PhD Students: Saleh Shahinfar and Afshin Kalantari

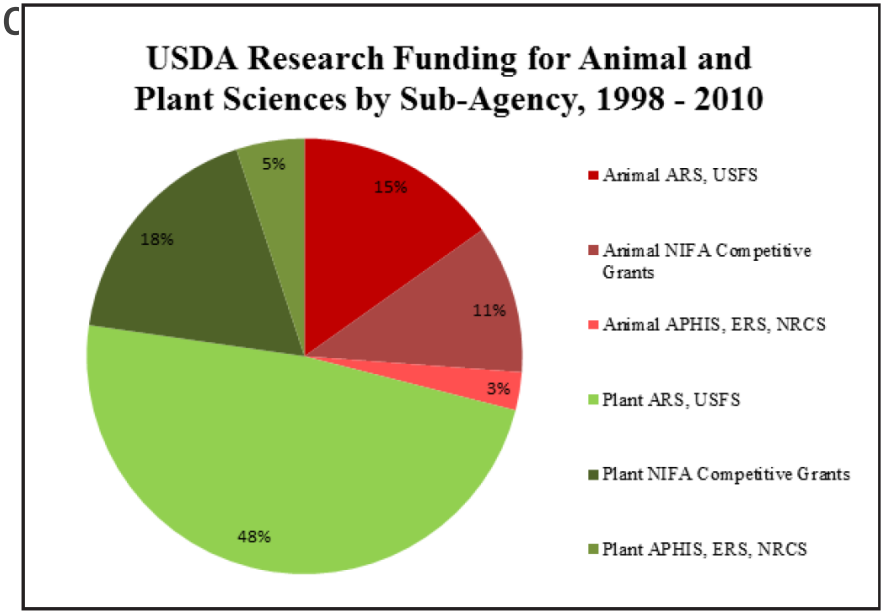
Specific Aim 5:
Generate measurable improvement in the reproductive performance of dairy herds by developing and implementing an integrated team-based extension program that builds on existing professional relationships within the farm community.
Aim leaders: P.L. Ruegg, V.E. Cabrera, P.M. Fricke, K.A. Weigel, and R.D. Shaver
Extension Outreach Specialist: Connie Cordoba

Category	Item	Amount	
Indirect Costs			**$220,095**
Aims 1 + 4 (Victor & Kent)	Post-doc salary (3 years)	$106,907	**$144,515**
	Post-doc fringe benefits	$31,559	
	Travel to PI meetings	$4,000	
	Publication costs	$2,050	
Aim 2 (Randy & Milo)	Post-doc salary (3 years)	$106,907	
	Post-doc fringe benefits	$31,559	**$178,473**
	Travel to farms	$12,796	
	Materials and supplies	$25,162	
	Publication costs	$2,050	
Aim 3 (Pam & Paul)	Graduate student salary (4 years)	$84,443	**$212,915**
	Grad student fringe benefits	$25,364	
	Grad student tuition remission	$32,000	
	Academic staff salary (0.6 years)	$26,985	
	Academic staff fringe benefits	$11,074	
	Travel to farms	$12,796	
	Materials and supplies	$18,203	
Aim 5 (everyone)	Academic staff salary (3 years)	$134,922	**$226,054**
	Academic staff fringe benefits	$55,368	
	Travel to farms	$25,592	
	Materials and supplies	$10,172	

Today's Challenge

- USDA National Institute of Food & Agriculture
  - Primary funding source for nearly every agricultural scientist
  - $236.7 million per year for animal research ($597.7 million for plants)
  - 0.20% of receipts for livestock c







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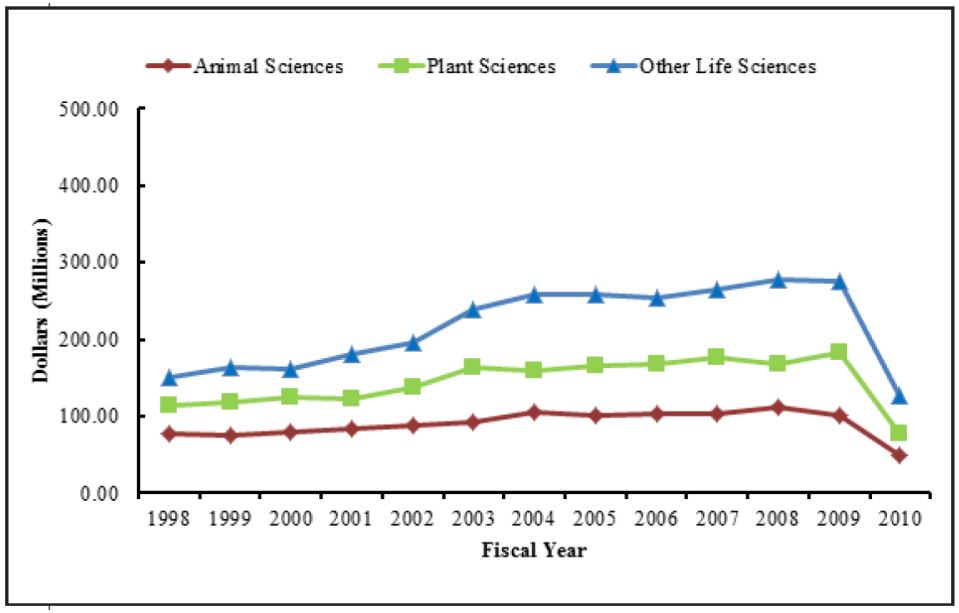
Today's Challenge

- USDA National Institute of Food & Agriculture
  - Funds for competitive programs have declined dramatically
  - Affects all federal programs (USDA, NIH, NSF, etc.)
  - Current success rate is about 6%



- 2014 AFRI Foundational Program
  - $18 million available for research
    - Animal Reproduction
    - Animal Nutrition, Growth, and Lactation
    - Animal Well-Being
    - Animal Health and Disease
    - Animal Breeding, Genetics, and Genomics
    - Veterinary Immune Reagents
    - US-UK Collaborative Projects
  - About 600 proposals received
  - Roughly $300 million requested



Future Options and Opportunities

- Wisconsin Electric Machines and Power Electronics Consortium
  - In UW-Madison Department of Electrical and Computer Engineering
  - Started in 1981 to fund applied research
    - 4 industry partners
    - $10,000 annual gift apiece
  - Major funding source in 2014
    - 90 industry partners
    - $15,000 annual gift apiece
    - $1.35 million per year supports nearly 50 projects and grad students
    - Annual research symposium, early access to papers, partner job fair



Future Options and Opportunities

- UW-Madison Food Research Institute
  - Started at University of Chicago in 1946
  - Moved to Madison in 1966
  - Spans CALS, School of Veterinary Medicine, College of Engineering
  - Focus is food safety
  - Funded by industry sponsors
    - 11 major sponsors at roughly $30,000 per year
    - 30 smaller sponsors at $2,500 to $25,000 per year
    - Provides seed money to faculty to leverage with external grants
    - Annual sponsor meeting, biweekly seminars, hands-on training sessions



Future Options and Opportunities

- John Lee Pratt Endowment at Virginia Tech University
  - Established with an $11 million endowment in 1975-1981
  - By 2013, value of the fund had grown to $40.2 million
  - Split between the fields of animal nutrition and engineering
  - Provided $1,184,072 for animal nutrition research in 2012-2013
    - Salaries, tuition, and supplies for MS and PhD fellows ($370,567)
    - Undergraduate scholarships and research programs ($194,920)
    - Visiting scholars and seminars ($31,634)
    - Equipment purchases and maintenance ($439,200)
    - Nutrition laboratory technicians ($161,467)



Future Options and Opportunities

- Southeast Milk Inc. dairy check-off program at University of Florida
  - Started in the mid-1990s
  - $0.01 per cwt assessment for dairy research and extension
  - $250,000 to $270,000 per year for faculty, students, youth programs
  - Other milk cooperatives in the region are now contributing as well
  - Faculty present research proposals to a panel of producers
    - About 25 proposals submitted each year, of which 10 are funded
    - Typical grants are $5,000 to $30,000 for one year
    - Proposal also accepted from Georgia, Auburn, LSU, and Clemson
- Florida Cattlemen's Association has a similar program for beef



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Future of Dairy Research at UW-Madison

- Our research has an enormous impact on Wisconsin agriculture
- Our faculty and staff are widely recognized as the best in the world
- Our alumni are the leaders of Wisconsin's dairy industry
- Low federal funding rates create huge opportunity costs
  - State-of-the-art dairy facilities at Madison, Arlington, and Marshfield
  - Capacity to carry out additional research projects
  - Capacity to train additional students
- Other universities in "lesser" dairy states have found solutions
- What approach is most likely to succeed at UW-Madison?



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Mooving Forward.

DAIRY SCIENCE AT WISCONSIN

Questions?