RESEARCH HIGHLIGHTS 2016--RUSSELL RANCH SUSTAINABLE AGRICULTURE FACILITY

Compiled below are some very brief summaries to give an idea of the breadth and diversity of research (and teaching) activities at Russell Ranch over the past year. Please contact Kate Scow or the appropriate researcher if you would like more information.

WATER

We've installed subsurface drip irrigation in the Century Experiment in almost all irrigated rotations. A working group of our farmers, faculty, extension specialists and postdocs have used data collected from installed water meters, soil moisture probes, and evapotranspiration sensors to better understand crop water demands and optimize water use in our different systems and crops. One new challenge is integrating subsurface drip irrigation in our organic system for which the source of fertility is cover crops and composted poultry manure. For this reason, we have maintained a comparison of furrow and subsurface drip (single and double lines) irigation in the organic plots to evaluate irrigation strategies (Daniel Zaccaria, Tim Hartz, Mark Lundy, Amelie Gaudin, Kate Scow, UCD and UC ANR--funding from Wells Fargo and UC Water Center)

FARMING SYSTEMS EXPERIMENT

We are the 23rd year of our tomato-corn under organic, conventional and a mixed management system. The 6 yr rotation that includes 3 year alfalfa followed by tomato-corn-tomato has just moved shifted from alfalfa to tomatoes. A longterm statistical analysis that compares system differences in variation in crop yields, and factors driving these differences, is underway.

We are investigating if we can reduce fossil fuel based mineral N inputs using legume sources of N in 2 ongoing experiments in the Century Experiment

- How much N can be provided by the winter cover crop (vetch, bell bean, oats) to tomatoes and corn in the mixed system (compare yields and soil N in strips with different mineral N inputs)
- How much N can be provided to tomatoes following 3 years of alfalfa in a rotation (compare yields and soil N in strips with different mineral N inputs)

WHEAT

In wheat plots in Century Experiment we compare water productivity in SDI versus furrow irrigated wheat (in rotation with tomatoes) and compare how injected versus broadcast application of N improves grain protein content and apparent fertilizer recovery. The overall goal is to figure out if small grains rotated with crops like tomatoes could leverage the existing SDI setups of those crops to improve water and nitrogen use efficiency. (Mark Lundy UCD)

We are in year 2 of testing different varieties of drought resistant wheat as well as perennial wheat varieties from the Land Institute in Kansas, with the goal of identifying new varieties that may be resistant to drought and other aspects of climate change. We are measuring water and N productivity and changes, as well as soil N and soil C as a function of productivity differences in perennial wheatgrass Anza. This is a unique type of crop that could have multiple purposes (grain-though low productivity, forage, and C farming) and it survived its first season in California without any irrigation in the driest year on record (Mark Lundy UCD)

Whole wheat flour from Russell Ranch wheat was milled for UC Davis's Dining Service for a second year and 14,000 lbs. was delivered for campus bakery and pizza production.

BIODIVERSITY AND ECOLOGY

Research on milkweed habitat for monarch butterflies is in its 3rd year with an extensive corridor of milkweed plantings. In addition to monarch butterflies, milkweed provides a habitat to a fascinating community of

herbivores, predators, pollinators, parasites and other organisms. Investigations focus on identifying factors determining consequences of species interactions, with a specific emphasis on factors that change over time. For example, monarch caterpillars do best on milkweed in the late spring and early fall and researchers are exploring roles of climatic factors, predator communities and changes in plant quality/defense (Louie Yang, UCD).

The effect of corn seed treatment (clothianidin, a neonicotinoid insecticide and various fungicides) on abundance of ground-nesting bees (Lasioglossum (Dialectus) spp.) is being studied in conventional and organic corn plots. (Valerie Fournier and Neal Williams, UCD).

A native plant garden at our front entry was installed in collaboration with the UC Davis Arboretum and Public Garden.

COLLABORATION WITH NASA-Jet Propulsion Lab (JPL)
Two 30 feet towers for thermal radiometers have been installed in larger research plots (wheat and tomato) adjacent to Russell Ranch. Plans exist for 2016 for UAV flights within the Century Experiment.
Collaboration with Ustin lab has led to the Century Experiment being selected as a demonstration site for weekly measurements of visible, IR, and thermal data over the past 3 years. (Darren Drewry, Simon Hook NASA; Susan Ustin UCD)

BIOCHAR PLOTS
We are in the 5th year of our long term biochar experiment looking at effects of this soil amendment made from pyrolyzed walnut hulls (from Dixon Ridge farm) on a tomato-corn rotation. We found biochar (10 tons/ha) boosted corn yields by 8%, but not tomato, however only in year 2---after that the benefit disappeared.
In addition there is an effect of biochar amendment on water relations in soil: adding biochar (20 tons/ha) to sandy soil—but not a higher clay soil-- increased soil water holding capacity by 17%.
(Deirdre Griffin, Daoyuan Wang, Sanjai Parikh, Kate Scow, UCD).

CARBON SEQUESTRATION AND OTHER CHANGES IN SOIL UNDER DIFFERENT MANAGEMENT PRACTICES
Analyses are continuing for the twenty-year soil survey of Century Experiment (3400 samples in 8 depth increments to 3 meters deep in 72 plots) for the following properties: total carbon and nitrogen, Fourier Throughput Infrared Spectroscopy (FTIR), Permanganate oxidizable carbon (POXc) and Olsen P. These data wil provide valuable information about the potential for California agricultural soils to sequester carbon and offset greenhouse gas emissions (Jessica Chiartas, Kate Scow, Amelie Gaudin, Toby O'Geen UCD)

WATER-ENERGY NEXUS
Russell Ranch received funding from the California Energy Commission as a collaborator with PowWow Energy, Co., for a grant on "Irrigation optimization and well pump monitoring leveraging smart meter data". We have implemented a demonstration field at Russell Ranch for water savings in tomato and have collected data from our groundwater wells, as well as we collaborate with four other farms. (Olivier Jerphagnon PowWow Energy, Daniele Zaccaria, Kate Scow, UCD).

CLOSING THE LOOP THROUGH RECYCLING NUTRIENT FROM WASTES
Question: Can biodigestate—the by-product of biogas generation--from dairy manure and food wastes, provide sufficient N fertility to grow tomatoes and corn? We are measuring how anaerobically digested food waste and dairy manure perform as fertilizer sources. The liquid form is provided in buried drip to tomatoes and the solid form is soil applied in furrow irrigated corn. A visiting professor from Korea is investigating the potential to extract mineral fertilizer from the biodigestate (Rhuihong Zhang, Sungpyo Kim, Kate Scow UCD; funded by California Department of Food and Agriculture (CDFA))

Soil phosphorus budgets--including major stocks, inputs and outputs--were compiled to compare the different Russell Ranch farming systems and also compare to longterm vegetable experiment in Salinas (Gabriel Maltais-Landry, Peter Vitousek, Stanford University).

ISOTOPE ANALYSIS OF LONGTERM TRENDS IN CROP WATER RELATIONS

Research is being conducted on the effect of irrigation and annual rainfall on the isotopic composition of cellulose in the long-term irrigated and rainfed wheat plots. We are using isotopic proxies and direct measurements using archived wheat from past 22 years to assess the effects of fluctuations in precipitation and rising CO2 levels on the productivity and nutritional quality. (Laura Emberson and Lucas Silva, UCD)

MICROBIAL ECOLOGY

Russell Ranch soils were used to study the effect of organic, conventional and mixed systems soil on survival of Shiga Toxin producing E. coli (STEC) on lettuce in growth chamber experiments. The organic managed soil appears to be more suppressive to the pathogen than is conventional soil with the mixed system soil being intermediate in its effect. (Michael Cooley USDA-ARS)

Addition of a mineral N as urea increased water stable microaggregates in organic tomato soils but decreased them in conventional tomato soils. Differences in responses were related to differences in soil microbial community composition (Radomir Schmidt, UCD).

TEACHING

A number of laboratories associated with UCD courses have been developed that include one or two field trips to Russell Ranch including SSC 100 (Southard, Introduction to Soil Science), SSC 109 (Horwath, Soil Nutrient Management), SSC 111 (Scow, Soil Microbiology), SSC 211 (Scow, Advanced Soil Microbiology). Students found differences in soil aggregate stability, soil carbon, and biodiversity in the following ranking: native grassland > organic > conventional. We encourage more courses at UCD to utliize Russell Ranch for field trips and class projects.

Ten undergraduates participated in a special 2 quarter seminar entitled “Soil Sampling Internship” led by LAWR Professors Toby O’Geen and Randy Dahlgren and analyzed four systems (nine samples each) for a range of soil properties. The students found higher extractable sodium in the tomato-corn rotations as compared to the wheat rotations and higher nitrate at depth in the organic corn-tomato system compared to the other systems.

FOR MORE INFO CONTACT: Kate Scow kmscow@ucdavis.edu