

Academic Criteria — Extension, Research, and Creative Activity (Thematic PR Draft)

Summary

I have an active, productive, and extremely diverse research program that is highly visible and addresses pressing needs of my clientele. My program is notable for its diverse and ambitious research agenda and for making significant contributions to the scientific literature. I am conducting applied work on a broad range of plants (vegetables, strawberry, ornamentals, forest species, weeds), different pathogen groups (fungi, bacteria, viruses), and various key issues (endemic and invasive pathogens, pesticide use reduction, threats to agricultural production, food safety and foodborne pathogens). Because of my statewide reputation for productivity, I conduct research and extend information to clientele beyond my assigned counties and throughout California. My program is consistent with high priority core issues of our division.

I am a strong team builder, and these projects are clear evidence of my skill in recruiting research teams. A great number of my publications have multiple authors, further showing my commitment to team efforts. I am successful in obtaining grants and support for my projects. For the main projects (listed below) and diverse other minor projects, I raised \$354,000 in funds for this 3-year period. I was recipient of the equivalent of \$36,300 in contributed equipment for the outfitting of my new food safety research lab.

I showed notable initiative and creativity in expanding and building up my research capabilities in new areas. I trained myself to become familiar with thrips insect identification and taxonomy and with *E. coli* research methods. In this way I showed responsiveness and attention to changing needs of clientele.

Extension education is a prominent component of my program. Through personal contacts, numerous presentations (48 in this 3-year period), and educational publications (40 miscellaneous writings), I made great efforts to extend my research information. My extension program incorporates affirmative action elements. I made particular efforts to reach Spanish speaking clientele by making farm calls to limited resource Spanish speaking growers, presenting talks in Spanish, and preparing written materials in Spanish.

My research and extension program is structured around three major themes:

1. Managing plant diseases and enhancing agricultural productivity
2. Diseases and microbial soil ecology in strawberry
3. Field biology and ecology of foodborne pathogens

1. Managing plant diseases and enhancing agricultural productivity.

Rationale: Coastal California agriculture and horticulture are high value, high volume, intensive industries that consist of many crops, extensive acreage, and extremely high quality standards. Plant pathogens are significant limiting factors for these crops. Management of these diseases and the enhancement of agricultural productivity require diagnosis of these problems, understanding of the biology of the pathogens, and development of control methods. Goals: Provide diagnostic services, identify and document new or invasive pathogens, develop information on the biology of pathogens, and devise management strategies. Clientele: Farmers, nursery growers, pest control advisors (PCAs), seed company personnel, and other clientele who need diagnostic assistance, information on diseases, and management strategies.

The problem (synthesis of six projects): During this review period, new plant diseases occurred in the coastal region and caused quality and crop losses on diverse commodities. Unknown strains of downy mildew attacked spinach and caused 10 to 35% of the crop to be unmarketable. New, damaging virus problems affected celery (*Apium virus Y* [ApVY]) and lettuce (*Impatiens necrotic spot virus* [INSV]) for the first time in North America. The sudden oak death (SOD) disease in coastal forests is not a new issue; however, the spread of SOD to nurseries is a more recent development that results in nursery stock losses and reduction in sales due to quarantine restrictions. From 2006-2009, *Verticillium* wilt of lettuce has spread extensively; because the pathogen survives in the soil for years and has also been found on the seeds of other crops (spinach), this disease is becoming a long-term concern. Limited acreage, minor vegetable and ornamental crops also are subject to pathogens that are unfamiliar and new to growers. For these problems, information is needed on causal agent, biology of the pathogen, and control measures.

Koike role: For most of these projects, I was the first researcher to become aware of the new problems and therefore took a leadership role. I met with industry leaders and other clientele to ascertain the needs facing industry. I initiated projects, recruited teams of researchers, was primary investigator (PI) on grant proposals, and obtained funding for these projects. For nursery SOD and lettuce/spinach *Verticillium* projects, I acted as a collaborator and contributed to field and lab aspects of the research. Research expertise expanded: Because of the damaging outbreak of lettuce INSV, I took the initiative to obtain training on vector (thrips) identification. I secured funding, equipment, and supplies necessary to process and identify thrips. I have become competent at identifying thrips species and have included this aspect in the INSV project.

Research: (1) Spinach downy mildew: Field collections were made to determine the extent of disease outbreaks. We tested spinach for susceptibility to new races, and worked to revise identification methods. (2) Celery ApVY: We conducted in depth characterization of this new virus. We completed surveys for this virus, examining fields of celery, other apiaceae crops, and weeds in six counties. Different celery cultivars were evaluated for susceptibility to ApVY. (3) Lettuce INSV: We characterized the INSV lettuce strains, surveyed coastal regions, made disease severity assessments, searched for alternate or weed hosts, and collected thrips for species identification. (4) SOD in nurseries: We tested fungicides in nursery settings for controlling the pathogen, studied the pathogen host range, and explored how the pathogen spreads and survives in irrigation water and potting mix. (5) *Verticillium* wilt in lettuce and spinach: Our team is documenting the seedborne nature of *Verticillium* in lettuce and spinach seed, examining the host range of *Verticillium* isolates, and determining the extent of the problem. (6) Diseases of minor crops: I devoted significant efforts to identify new and unknown problems in minor crops such as corn salad, chives, cilantro, fennel, and other vegetable and ornamental commodities. I completed biological studies on these new pathogens.

Extension: Because the new disease threats were causing economic losses, I made extensive and timely efforts to alert industry. Between 2007-2009 I gave nine or more presentations each on downy mildew, ApVY, and INSV. I also extended background and research information on lettuce/spinach *Verticillium* and minor crop diseases. My presentations took place in eight different California counties as well as in Arizona. I promoted my lab diagnostic services and analyzed several hundred samples that were submitted by growers and PCAs. I wrote a large

number of extension articles and newsletter pieces to describe, illustrate, and explain these new problems (see Outputs below).

Results/Outputs (numbers refer to Bibliography): I was the first to confirm the new, invasive nature of these pathogens. I wrote extensively to document these problems in the scientific literature and to extend research-based information to clientele: (1) spinach mildew: peer-review 211, 213; non-peer-review 278, 282, 284, 285, 295, 300, 303, 312; newsletter 148. (2) celery ApVY: peer-review 220; non-peer-review 302, 307; newsletter 143. (3) lettuce INSV: peer-review 218; non-peer-review 279, 297, 301, 313, 314; newsletters 140, 151, 156, 157. (4) nursery SOD: peer-review 216, 225, 232; non-peer-review 308. (5) *Verticillium*: non-peer-review 305, 315; newsletter 150. (6) minor crops: numerous writings (see Bibliography).

Outcomes and Impacts: Our spinach mildew team documented that multiple new races were damaging the crop; growers therefore stopped planting the most susceptible cultivars and made other cultivar choices. Our mildew race identifications also enabled spinach breeders to move forward to develop new resistant cultivars. Our celery work revealed that the poison hemlock weed was a reservoir of the virus. At the most severely affected ranches, farmers removed this weed which significantly reduced, though did not eliminate, ApVY in 2009. Our research also showed that ApVY is not seedborne in celery, thereby dismissing concerns that celery transplants were the source of ApVY. We confirmed that the lettuce virus disease is caused by INSV and that the western flower thrips is the vector. We also found that the malva weed might be widely infected and provide a reservoir of the virus; our suggested management of malva could contribute to the control of INSV. We helped nurseries have additional fungicide options for control of SOD. Our SOD host range information has nationwide impact in that nursery personnel, foresters, and researchers in the eastern part of the country have early indication of which eastern species are susceptible to the SOD pathogen. Our team findings that *Verticillium* is seedborne in some vegetable crops is causing industry to consider new avenues of control, such as seed treatments and seed testing programs. My diagnostic work on minor crops and commodities has assisted growers and PCAs in understanding the cause of such problems. I conducted follow up extension activities to assist growers regarding management options.

2. Diseases and microbial soil ecology in strawberry.

Rationale: The strawberry industry is embracing alternative disease control methods due to health and environmental concerns with traditional pesticides and fumigants. The search for alternatives to methyl bromide fumigation is a highly publicized example of this trend. There is a need to continue to develop safer disease control alternatives for strawberry. Goals: Devise practical, commercially viable means of managing plant diseases through safer alternatives. Investigate role of biological, microbial, and ecological factors for novel control methods. Provide diagnostic services to the industry and investigate new strawberry production problems that occur as the industry reduces its dependency on soil fumigants. Clientele: Strawberry industry members (growers, PCAs) throughout coastal California. I especially target limited resource, Spanish-speaking growers who produce strawberry.

The problem (synthesis of four projects): There is a need for effective, creative alternatives to traditional fumigants. However, while implementing some alternatives to methyl bromide,

growers began to experience new problems. Plant collapse problems started occurring in 2006 and increased in severity through 2009. This has developed into a statewide issue, with the new collapse problem occurring in Ventura, Santa Barbara, Orange, Fresno, and Alameda counties.

Koike role: I operate a statewide diagnostic service for strawberry growers and was the first researcher to detect these problems. Based on my diagnoses, I took a leadership role and met with industry leaders to inform them of these developments. I recruited a research team and was PI on the grant and project. I am also a collaborator on two other projects that investigate crop rotations (Subbarao, PI) and soil amendments (Shennan, PI) for pathogen management.

Research: Because these strawberry collapse problems appeared to be new diseases, I collected and tested plant samples from throughout strawberry growing regions. Once we isolated and identified the cause of the problems, I tested strawberry cultivars for susceptibility. Our team set up trials to test fumigant alternatives for possible control of the new pathogen. The Subbarao project studied the role of broccoli rotations for combating *Verticillium* wilt in strawberry. The Shennan project is investigating novel soil amendments for pathogen management.

Extension: I alerted the strawberry industry about the new collapse issues that were only occurring when traditional fumigants were not used. In 2008-2009 I presented seven extension talks on strawberry collapse. I met with Spanish speaking clientele regarding the new problems and presented information in Spanish. I wrote numerous extension and newsletter articles to describe, illustrate, and explain these new problems (see Outputs below). In extension meetings we also highlighted the utility of broccoli rotations for reducing *Verticillium* populations.

Results/Outputs (numbers refer to Bibliography): This research has resulted in a number of publications that have defined strawberry production issues, characterized new strawberry diseases, and advised growers about new problems and control options: peer-review 208, 219, 230, 233, 237, 238, 239; non-peer-review 276 (in Spanish), 277, 283, 289, 290, 293, 294, 304, 306, 310, 311; newsletter 145.

Outcomes and Impacts: I played a central role in alerting the strawberry industry to two new soilborne problems caused *Macrophomina* and *Fusarium* fungi. These were significant scientific findings and the first such reports for California. Our findings and extension information enabled growers to avoid planting in badly infested locations, hence avoiding subsequent crop loss. Regarding our successful broccoli rotation results, strawberry growers (both conventional and organic) have adopted this practice. In addition, because this strategy affects the microbial ecology of the soil and is not crop specific, vegetable growers are also rotating with broccoli to combat soil pathogens. The soil amendment project is still in progress.

3. Field biology and ecology of foodborne pathogens.

Rationale: There is an immense increase in food safety concerns due to the *E. coli* O157:H7 contaminated spinach in 2006. Because our central coast industries lead the world in lettuce, spinach, and leafy greens production, foodborne pathogens associated with such commodities are of critical importance here. Unfortunately, there is a decided lack of information on the ecology of foodborne pathogens as found in commercial field environments. Goals: Develop research-

based information on the ecology of *E. coli* under commercial field conditions and contribute to improved food safety practices and policies. Clientele: All clientele involved with growing edible products and especially growers of leafy green vegetables.

The problem (synthesis of 3 projects): The lack of field based, scientific information on the dynamics and ecology of *E. coli* in commercial leafy green production is a major shortcoming facing farmers, regulators, and policy makers. Currently many policies, industry corrective practices (metrics), and discussions are based on assumptions or incomplete information.

Koike role: Because I had previously established a county-based plant pathology/microbiology lab in Salinas, I was in a position to contribute to the field research needs in this food safety area. I obtained funding to convert one of my labs to a food safety research facility. Thus prepared, I was PI on two new grants to study the ecology and survival of *E. coli* under field conditions and was a collaborator on a third (Harris) project. These three grants exemplify the effective county-campus coalition that we have developed between UCCE Monterey County and UC Davis.

Research expertise expanded: To prepare myself for this new area of research, I consulted with campus-based food microbiology researchers, attended training on food safety, and conducted an extensive review of *E. coli* literature.

Research: I conducted field studies to explore how *E. coli* can persist and spread under commercial farming conditions. We implemented a series of experiments that involved inoculating Salinas Valley fields with non-pathogenic *E. coli*, subsequently growing lettuce or spinach in such plots, and testing soil, water, and plants for the inoculated strains. These studies are in progress.

Extension: We have kept the agricultural industry and government agencies informed of our research progress. From 2007-2009 I presented 16 extension education talks on our *E. coli* field studies and other food safety topics. I wrote numerous extension and newsletter articles on this subject (see Outputs below).

Results/Outputs (numbers refer to Bibliography): This research has resulted in a number of publications on food safety issues: non-peer-review 281, 296, 298, 299, 309, 316; newsletter 136, 138, 144, 146, 152.

Outcomes and Impacts: While these studies are still in progress, we have found that under these conditions of simulated contaminated irrigation water the *E. coli* bacteria may not persist for long periods of time, in contrast to findings from greenhouse or growth chamber studies from other states. These practical field results may have important implications for growers, showing that early season exposure via water may not be the major mechanism of contamination. A major outcome of these projects is that our county-based UCCE program is now considered a part of the coalition seeking solutions to food safety issues in California. Industry is now expecting our research team (county-based Advisors plus campus-based researchers) to provide findings to help guide future policies and directions. As a result of my involvement, I am a member of the Food Safety Advisory Committee (Hartnell College) that is training harvest supervisors, industry food safety officers, and others.