

I chose agroecology as my field of research because it offers a holistic approach to help address the multiple challenges agriculture is facing. Agricultural systems must produce more food to feed a growing population, adapt to changing weather patterns, and adopt more efficient and sustainable production methods. By promoting ecological interactions and the inherent capacity of soils, agroecological approaches help improve yields, mitigate yield gaps when environmental stresses occur, improve water conservation and help enhance nutrient cycling, storage and use efficiencies at the systems level. Additionally, the basic principles of agroecology can be adapted to target all production systems, from intensive horticultural systems to extensive field crop production.

I am interested in integrating previous results gathered from the study of diverse agroecosystems to help achieve the main goals of sustainable agriculture: higher yields with fewer resources and maintenance of long-term yield stability in a changing climate. Specifically, I would like to: (1) develop and test novel strategies to improve water and nutrient use efficiencies in diverse cropping systems; (2) assess their effectiveness in enhancing yield resilience to abiotic stresses and less intensive management practices; and (3) evaluate their agroecological and economic impact under various weather scenarios. I present here some applied research objectives with some non-exhaustive examples of how I attempt to tackle these ambitious research goals.

### **1. Explore the roots of agroecology.**

I would like to place root systems at the center of my agroecological approaches to sustainable crop production. Roots are involved in nearly all agroecological processes and are the main interface between soil resources and crop production. They represent up to half of a plant's biomass, are the sites of major element fluxes and so affect water, carbon and nitrogen cycles. Plant roots also drive microbial processes in the rhizosphere, sustain soil fertility and physically stabilize soils. In my opinion, root systems have a significant role to play in increasing yields, carbon sequestration, water and nutrient use, erosion prevention as well as reduction of GHG emissions.

I am interested in developing interdisciplinary research projects to: (1) enhance annual and perennial crop beneficial interactions with soil biota, explore the potential of root systems to (2) help close nutrients, water, carbon and wastes cycles, (3) improve crop yields under less intensive management practices and (4) enhance synergies between crop populations in time and space. For instance, root architecture has been largely overlooked in intercropping studies despite the recognition that root placement is important for competition mechanisms. Exploiting differences in root architecture between crops during intercropping to allow the exploration of various soil depths may enhance the use of irrigation water compared to corresponding monocultures. Similarly, plasticity in root anatomy is of major importance for more sustainable rice water management. Roots systems have been largely understudied because of the technical challenges inherent to root research, many of which I have experienced and partially overcome in field and greenhouse studies. I am hopeful that investigating the hidden half of crops will provide new opportunities to improve cropping system yields, decrease runoff and enhance crop and system resilience to lower water and nutrient supplies.

### **2. Contribute to cropping system adaptation to climate change.**

Changing ecological interactions caused by climate change places new challenges on agroecosystem stability. Among the potential climate-related phenomena that could threaten agricultural production in California, I am interested in investigating agronomic and managerial solutions to mitigate further reductions in water supplies, the associated increases in crop heat stress, decreases in nighttime chill and shifts in pollinator life cycles. I would like to conduct research that: (1) adds to our understanding of the effects of changing weather patterns on the efficiency of soil ecological processes; (2) be involved in the development of mitigating management strategies acceptable to growers and consumers; and (3) assess their agroecological impact. For instance, it would be interesting to investigate the vulnerability of soil organic matter to changes in temperature and precipitation patterns and its impact on cropping system ability as a buffer against climate variation.

### **3. Investigate sustainable management practices to maximize resource use efficiencies.**

Most Californian agroecosystems enjoy long growing seasons, fertile soils and irrigation, all of which favor high yields and crop diversity. In my opinion, a key strategy in sustainable agriculture is to promote diversity in the agricultural landscape to improve sunlight, water and nutrient use efficiencies at the system and watershed levels and provide timely habitat for wildlife. I am interested in investigating possibilities to increase crop diversity in

time and space through crop rotations, legume cover crops, inter and relay cropping strategies, and through better integration of different farm operations in perennial/livestock mixtures for instance. I am also interested in measuring the effects of increasing crop diversity on biophysical processes, nutrient recycling and cropping system dependence on inputs. I have never visited California but from my research it seems that a large diversity of farm operations exist, from small and diversified to large field crop farms. I think it is important to propose management strategies that can be carried out within the constraints of each specific agricultural system and that are economically viable for growers. I also have an interest in testing the use of new renewable sources of phosphorus, nitrogen and water and the potential of other management strategies to decrease losses from the system (e.g. no tillage).

#### **4. Help reduce yield gaps and ecologically intensify production in developing nations.**

Agricultural production in developing countries is primarily limited by drought, low soil fertility and rapid urbanization of the workforce. I would like to collaborate with various institutions to develop ecological intensification strategies adapted to specific agroecosystems. I will make use of my network within the International Rice Research Institute (IRRI), International Potato Center (CIP) and World Vegetable Center (AVRDC) to build research collaborations targeting agroecosystems in developing countries. I have an interest in: (1) testing crop rotations which include green manures and are adapted to target environments and traditional farming practices; (2) provide the means to enhance ecological processes (e.g. test the efficacy of rhizobia inoculum); and (3) explore the potential of various indigenous agroecological practices and orphan crops that I have seen during my international research experiences in order to provide a more stable food supply. Finally, I am interested in developing safe agroecological practices for urban agriculture in cities located in developing nations. Most of the world's fastest growing cities are found in low-income countries of Asia and Africa, and various opportunities to improve the sustainability of urban growth while providing food for urban dwellers exist.

#### **5. Develop interdisciplinary collaborations and outreach activities.**

I am interested in developing interdisciplinary research projects with agronomists, soil microorganism specialists as well as breeders, biotechnologists and plant physiologists, to extrapolate their research and the benefits of genetic improvement to cropping systems. This approach also provides an opportunity to investigate the agroecological impact and adaptive value of new crop traits at the systems level. I place a high value on my interactions with farmers and other practitioners. Over the years, these interactions have had a considerable influence on the research that I have undertaken. I would like to carry out relevant outreach activities in conjunction with research that entails the active participation of farmers.

The long tradition of research on sustainable agricultural practices at the University of California, Davis, provides a solid building block for developing an applied research and outreach program that addresses diverse biophysical constraints to sustainable farming in California and elsewhere. I am looking forward to use resources of the Agricultural Experiment Station and other institutions to conduct experiments, teach and mentor, and complement the on-going research and extension work with farmers and national partners to develop ways to adapt agricultural production to the upcoming challenges of the 21<sup>st</sup> century.