

Hanson lab research program:

Introduction and justification

Technological advances in many areas such as engineering and medicine have fueled an unprecedented growth in the human population over the past century. Simultaneous advances in engineering, chemistry, and genetics allowed agriculture yields to keep pace with this expansion in population. Unfortunately, current methods used for food production are not sustainable and the human race is facing a very real future food crisis. This crisis will be double edged as the human race tries to feed an increasing population on diminishing land and input resources that are being eroded by current unsustainable food production practices. While population growth ultimately must be controlled in order to solve this problem, improved food production practices where technology is leveraged to improve sustainability and efficiency while decreasing the environmental impact of food production will be necessary. This same technology and land / resource pool will also be leveraged to help meet the energy and materials needs of human kind as our current reliance on fossil fuels for energy and synthetic materials becomes more untenable in the future.

The Hanson lab performs both basic and applied biotechnology research aimed at improving the sustainability and efficiency of agricultural production in order to improve the livelihood of agricultural producers in NM and throughout the world. Research areas expanded on below include pest and pathogen surveillance and characterization, development of sustainable strategies for mitigation of pest and pathogen damage, and development of fossil fuel alternatives.

Research areas, projects, and accomplishments

Identification and characterization of pests and pathogens is the first step in developing mitigation strategies. Agricultural producers face a dynamic situation where they are confronted with new and emerging pathogens and existing pathogens introduced from other locations in addition to pests and pathogens that are already present which may not be well characterized. The Hanson lab applies molecular biology tools such as DNA fingerprinting for pest and pathogen surveillance and characterization. Examples of recent work include:

- Identification and characterization of a novel phytoplasma as the cause of an emerging disease of chiles.
- Identification of a novel strain of *Xylella fastidiosa* (a highly damaging pathogen of many crops in other regions) in several NM crops including grapes, peaches, and landscape ornamentals,
- Characterization of diversity for tomato spotted wilt virus, *Phytophthora capsici*, and other pathogens affecting NM crops.

In addition to working on characterization of pathogens, the Hanson lab is also active in developing cutting edge technologies for improved pathogen detection. Work in this area includes a prior project done in collaboration with researchers at the Russian Center for Molecular Diagnostics and Therapeutics in Moscow, Russia, which led to the development of an improved system for the generation of recombinant antibody mimics that can be used as pathogen detection reagents.

While pathogen detection enables some control strategies such as avoidance and eradication mitigation of pest losses through resistance is also a focus of the Hanson lab research program. Over the past century chemical and genetic resources have been relied upon for prevention of pest and pathogen losses. While effective both have limited lifetimes as pests and pathogens will adapt to overcome chemical controls and resistance genes much the same way microbes evolve antibiotic resistance. Further, while continued development has extended the frontiers of chemical control these options are generally not sustainable. Therefore the Hanson lab has a major focus in developing biotechnology based resistance solutions where genes replace chemicals for control of pests and pathogens. Ongoing work in this area includes:

- Identification of natural microbial antagonists for nematodes and soil borne fungi both for development of biocontrol agents as well as identification of antagonistic genes that could be mobilized into engineered crop plant analogous to the widely successful Bt genes.
- Horizontal movement of known resistance genes between plant species such as our efforts to move the broad spectrum *Phytophthora infestans* resistance gene (Rb gene) from potato into chile for control of *Phytophthora capsic.*
- De novo development of resistance genes against pathogens such as beet curly top virus, tomato spotted wilt virus, soil borne fungi, and others.

The Hanson lab is also applying biotechnology toward improving the economic balance of bioenergy production. Currently, biodiesel is not close to being cost competitive with fossil fuels. This economic reality is one of major barriers to adoption of renewable fuel resources. The Hanson lab is currently applying biotechnology to create plants that express high value oils and waxes in addition to generic fuel oils. Our goal is to provide growers with plants that contain a value added component that will contribute toward making biofuel feedstocks economically competitive with petroleum sources for liquid fuels.

The Hanson lab is also well integrated into interdisciplinary research and contributes biotechnology and molecular biology expertise to a number of collaborative projects within the department and university. Examples include working with other groups to develop pest and pathogen identification assays for fire ants, alfalfa weevils, and nematodes as well as serving as a molecular testing resource for pest and pathogen identification. Other collaborative work includes genetic dissection of the mechanism of insecticide resistance in an emerging population of aphids affecting pecan production.

Students are responsible for generating much of the research output from the Hanson lab and in return receive training in molecular biology and independent research. Students in the Hanson lab generally start by learning DNA fingerprinting technology, a mainstay of molecular biology, and then move on to more involved research projects. By pairing new students with experienced staff and students the Hanson lab is able to provide solid training and research experience for many EPPWS students while maintaining research productivity.

Summary

The overall goal of the Hanson lab is to utilize biotechnology and molecular biology to improve the efficiency and sustainability of agricultural production. Specifically, the Hanson lab seeks to utilize biotechnology to improve crop genetics address shortcomings of previous chemical based pest and pathogen treatment strategies. Student training through research experience and contributing our expertise to larger interdisciplinary problems are cornerstones of our approach. Ultimately, success in developing and applying biotechnology solutions as replacements chemicals and enhancements to genetics will create a more efficient and sustainable food production system that will improve the lives of both producers and consumers of agricultural products in NM and the world.