## UNL Resistance Management Working Group 2010 RAMP Proposal

*Working Title*: **An Interdisciplinary Framework to Address and Reduce Pesticide Resistance in Plant Production Systems**

*Project Coordinator:* Thomas E. Hunt, Univ. of Nebraska, NEREC Haskell Ag Lab, UNL Entomology
*Core Team Members:* Blair D. Siegfried, Lance J. Mienke (UNL Entomology), Mark L. Bernards, Don J. Lee, (UNL Agronomy & Horticulture), Stephen Wegulo, Loren Giesler (UNL Plant Path.), Robert K.D. Peterson (Montana State Univ. Risk Assessment Specialist), Gary L. Hein (Director, UNL Doctor of Plant Health).
*Potential Team Members:* Robert J. McGovern (Director, Univ. of Florida Doctor of Plant Medicine), University of Florida plant pathology, entomology, and agronomy faculty, Paul D. Mitchell (Univ. of Wisconsin Ag & Applied Economics).

THE PROBLEM: The United Nations Environmental Program has listed pesticide resistance as the third most serious threat to global agriculture behind soil erosion and water pollution. In the United States alone, crop losses due to pesticide resistance are estimated to be $1.4 billion annually. The effects of pesticide resistance are far-reaching, not only resulting in decreased pesticide utility, but also increasing the frequency and rates of pesticide application, which in turn increases the cost of management and environmental contamination (e.g. ground and surface water) and pesticide exposure to humans and other non-target organisms (e.g. fish, beneficial insects). Although pesticide resistance is recognized as a large and costly problem, resistance management programs are typically curative in nature and are a response to the appearance of resistance in the field. Ideally, resistance management programs should be proactive and be implemented with the adoption of a new management technology, or at least before resistance adversely affects product performance. Currently, little organized work on proactive resistance management is being conducted outside of insect resistant transgenic crops. Pesticide resistance management has yet to be fully integrated into the fabric of agriculture in America. It is essential to systematically, objectively, and transparently identify, prioritize, and initiate coordinated research on the factors contributing to resistance evolution.

THE SOLUTION: Reduce the financial and environmental impacts of insects, weeds, and plant pathogens evolving resistance to pesticides by: 1) developing and applying a novel framework that assesses the risk of key pest species evolving pesticide resistance using a comparative risk assessment approach; 2) proactively addressing crop/pest scenarios that present the greatest risk for resistance to develop (e.g. developing resistance monitoring protocols and establishing baseline susceptibilities) and 3) embedding pesticide resistance management into the consciousness of American agriculture through interdisciplinary and coordinated research-based curriculum development, graduate student and practitioner training, and targeted outreach that cuts across disciplines.

We are developing a novel framework that uses a comparative risk assessment approach to prioritize pesticide resistance research objectives in insect, weed, and plant disease management. To our knowledge, this effort represents the first time issues of pesticide resistance would be prioritized and investigated using the science-based paradigm of risk assessment. The corn/soybean cropping system is the most prevalent cropping system in United States field crops and provides a starting point from which to build the framework to address pesticide resistance in plant production systems. The specific focus areas in this system are Bt rootworm transgenic corn and neonicotinoid insecticides, dicamba resistant soybean, and strobilurin resistance. The methodology established from this system will then be tested and optimized by applying it to a completely different system, such as fruit and/or vegetable production. In this way we expect to develop a pesticide resistance assessment framework that can be applied to a wide range of plant production systems.

The only way to make pesticide resistance management an integral component of agricultural practices and pest management is through education not simply directed at current farmers, but which also targets future farmers, consultants, agribusiness leaders, and educators. Because an understanding of resistance development must be premised on fundamental principles of evolutionary biology and population genetics, the basic principles of resistance management can be broadly applied to the various disciplines of pest management. However, the disciplinary expertise of weed scientists, entomologists and plant pathologists must also be integrated into the curricula to address topics that are unique to the various pest organisms. As pest management practices become more and more integrated into a single package of traits for weed, insect and pathogen control there is increasing need to discuss resistance management across disciplines and to educate pest management practitioners at all levels. This can be accomplished by: 1) involving graduate students in the development of a framework that uses a comparative risk assessment approach to prioritize pesticide resistance research objectives in insect, weed, and plant disease management; 2) developing undergraduate, graduate, and extension curricula focusing on pesticide resistance management; and 3) delivering the curricula via traditional and module-based electronic methods.

Our general approach will be to form sub-teams to work on each specific focus area with graduate students directly involved in developing research questions, prioritizing research needs through a risk assessment procedure, and conducting the identified research studies. In addition, these students would assist in developing pesticide resistance curricula that are driven by the assessment and research procedures. Although curricula will be delivered via traditional methods (e.g. classroom, workshops) a primary goal is to develop module-based units to be delivered through our existing distance education programs. The University of Nebraska is uniquely positioned to offer distance delivered educational materials and has a documented record of establishing degree programs. This infrastructure will be used to offer the pesticide resistance curricula to undergraduate students, graduate students, and life-long learners (e.g. farmers, consultants, and other agribusiness persons).

**Outcomes will include:**

1. A framework to address the risk of resistance evolution to pesticides.
2. The initial database and tools needed to address emerging resistance risks in the corn/soybean that can be applied to other cropping systems.
3. Cross-discipline leadership in the development of an integrated approach to addressing pesticide resistance management.
4. A pesticide resistance curricula with world-wide availability.
5. A cadre of farmers, consultants, other agribusiness persons, and educators that have a firm foundation in the theory and importance of pesticide resistance, as well as the tools to teach and/or implement pesticide resistance management.
6. Increased economic stability for U.S. agriculture.