Stakeholder Workshop
"Future Directions & Research Priorities for the
USDA Biotechnology Risk Assessment Grants Program"
Washington, DC
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Research Needs & Priorities for **Plants: Unintended Effects**[1]

This group discussed research needs related to the assessment of potential "unintended effects" associated with genetically modified plants. We focused primarily on possible direct and indirect effects of genetically modified plants on nontarget organisms, especially those that are beneficial or threatened/endangered. In all, our group identified four priority areas of research related to unintended effects. We felt that top priority should be given to research that addresses how best to design and perform rigorous assessments of unintended effects. Key issues include experimental design and scale in both the lab and field, as well as the identification of appropriate indicator species. We also encourage research to aid in the development of guidelines for post-release monitoring. Finally, we identified two categories of genetically modified plants that we feel warrant particular research attention. Each of the four priority research areas are described below.

1. **How to test for unintended effects: experimental design, indicators, field and lab protocols.**

   a. ***General Aspects of Experimental Design.*** We encourage researchers to synthesize existing field and lab data and/or conduct novel experiments with the goal of providing recommendations regarding statistically sound experimental design for risk assessment activities (e.g., statistical power, sample size, plot size, study duration). Of critical importance is defining the magnitude of changes in indicator species or groups that should trigger concerns regarding ecosystem impacts. To address this issue, researchers should seek to characterize natural variation, and time scales should accommodate possible recovery of populations following initial impacts. There is a need to identify appropriate positive and negative controls or reference points, including consideration of specific pesticides in conventional agronomic practices, a suite of best management practices, untreated control plots, and organic or sustainable production. To assist regulatory agencies, proposals should attempt to address how experimental design can balance cost-effectiveness against the ecological meaningfulness of data that will be obtained.

   b. ***Indicator organisms.*** Typically, assessments of unintended effects focus on a handful of species that have been selected as surrogates or indicators of critical ecological functions. We encourage proposals that address the choice of appropriate species in relationship to defined functional groups or that examine the predictability of an organism's linkage with an ecological process. We also encourage proposals that help elucidate the influence of genetically modified crops on ecosystem function through measurement of key ecological processes. Processes may include nutrient cycling, decomposition, pollination, and regulation of pest populations by parasitoids, predators or herbivores. It is important to understand how the biology and ecology of indicator taxa are influenced by geography, seasonal fluctuations, and crop species. These types of studies should be implemented under field conditions at scales appropriate to the dispersal of the organism chosen. Additional areas of concern include evaluation of logistical feasibility and consideration of contrasting ecology and diet associated with larval and adult life stages.

c. ***Field protocols***. Future risk assessment research should include community- and ecosystem level field studies designed to examine the direct and indirect effects of genetically modified plants, including effects on communities. The goal of this research should be to develop field protocols that are practical and repeatable. Field studies, ranging from mid- to large-scale plots, can be used to evaluate laboratory and in vitro findings, and to determine whether effects observed in the laboratory are also observed in the field or are negated by other factors. In addition, there is substantial need for the collection of baseline data to aid in interpretation of field study results. Baseline data may include community composition, relative abundance, geographical distribution, seasonal fluctuations and the phenology of plant-organism interactions. These baseline data can allow for meaningful comparisons of natural and agricultural communities before and after the widespread planting of genetically modified varieties.

d. ***Lab protocols***. We encourage efforts to improve Tier I toxicity testing and to recommend appropriate organisms, exposure routes, endpoints (e.g., mortality, physiological), and triggers for additional testing. The goal of this research should be to develop laboratory protocols that are feasible (e.g. using organisms that are amendable to culture), practical, and repeatable. In addition to mortality studies, we recommend the development of cell lines that may be used for more rapid, *in vitro* studies of sub-lethal effects including growth rate, molting, and reproductive rate. In vitro protocols are especially needed for studies of mode of action for threatened and endangered species. Guidelines for laboratory testing should be detailed yet flexible, so that experts can modify procedures as appropriate for specific crops and / or geographical regions.

2. Develop **post approval-monitoring guidelines** as an early warning or sentinel system. Simulation models should be used to establish recommendations regarding the optimum number of species to monitor, number of sites, site allocation, and sampling frequency. Research examining the feasibility of training and using on site experts (e.g. farmers) for monitoring is especially welcome.

3. **Plant Made Pharmaceuticals (PMPs) & Plant Made Industrial Proteins (PMIPs)**. Because the number of registrations for genetically modified plants with these phenotypes is expected to increase in the near future, projects that identify and evaluate risk management and confinement strategies for genetically modified plants with these phenotypes are welcome. Risk management and confinement strategies may be biological or physical. For example, markers useful in identity preservation and monitoring should be developed and evaluated. We also recommend an evaluation of food or non-food plant species that may help minimize unintended effects resulting from these genetically modified traits. Finally, sampling and/or simulation modeling should be used to quantify the risk of unintended release from field trials or commercial fields under unusual conditions such as extreme weather events, vandalism, and animal movement.

4. Develop protocols to test for **plant mediated effects independent of expressed proteins** and elucidate the mechanisms underlying such effects. Such effects may be manifested as changes in plant composition or quality traits, or as changes in physiology or morphology that affect interactions with non-target species, e.g., pollinators, pathogens, decomposers. These effects may result from transgenes moving within the genome, or changes in plant metabolism that affect chemical communication among organisms, general plant defense responses, or root nodulation.

In addition to these specific research priorities, we offer several general recommendations regarding future directions of the USDA Biotechnology Risk Assessment Grants Program with respect to all areas of risk assessment research covered by this program. First, we recommend priority be given to proposals that address issues for genetically modified organisms or genetically modified phenotypes that will require regulatory decisions within the next 5 to 10 years. To minimize potential surprises after crops are deregulated or implemented on a large scale, rigorous and thorough research should be completed prior to deregulation. Knowing which crops and which phenotypes are on the horizon will require open dialogue between those developing genetically modified organisms and those interested in risk assessment research. Thus, our second recommendation is that access to information and materials (e.g., genetically modified lines and near isolines) is essential for progress in risk assessment. In particular, widespread claims of confidential business information (CBI) may impede risk assessment efforts. Third, risk assessment would benefit from improved information support including databases listing threatened and endangered species, key pollinators, and possibly other indicator species by crop and by geographic region. We encourage the development of a data repository where details of results and experimental design from past toxicity studies and field studies could be compiled. Finally, we support the development and funding of proposals that would help to promote liaisons between industry, government, and academic researchers. Given the limited amount of funding available, we are concerned that it may not be feasible to thoroughly investigate all of the issues posed by all of the breakout groups. It is our hope that limited funding will not preclude a thorough investigation of the key concerns identified by this workshop.

[1] Some of the research needs and priorities listed in this document may be outside the scope of the USDA Biotechnology Risk Assessment Grants Program. This document was prepared by one or more of the individuals listed below. USDA program staff did not edit the content of this document. The USDA Biotechnology Risk Assessment Grants Program supports risk assessment and risk management research projects regarding the safety of introducing into the environment genetically modified animals, plants, and microorganisms. More information is available at: www.reeusda.gov/crgam/biotechrisk/biotech.htm. Questions regarding the suitability of research proposals should be discussed with the Program Director (dhamernik@csrees.usda.gov).

A list of people that attended this workshop is available at: http://www.isb.vt.edu/brarg/brarg_wshop/brarg_meeting.htm. The following individuals contributed to the discussion of this topic at the workshop and/or preparation of this document after the workshop:

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