SYMPOSIUM PROCEEDINGS

OCTOBER 31 TO NOVEMBER 1
NATIONWIDE AND OHIO FARM BUREAU 4-H CENTER

The New 2,4-D and Dicamba-Tolerant Crops:

Managing Risks to Farms and Communities

Edited by: Jason Shaw Parker

2011

THE OHIO STATE UNIVERSITY – AGRICULTURAL RISK ANALYSIS PROGRAM

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I. Executive Summary

By Jason Parker

Glyphosate susceptibility in many weed species has decreased in the last decade generating increased anxiety among row crop farmers who feel they are losing a valuable tool in fighting herbicide resistant weeds on their farms. In the coming years row crops with genetically modified (GM) tolerances to the herbicides glyphosate and either 2,4-D or dicamba will be available to farmers, along with new formulations of the herbicides (alleged to reduce spray drift), to combat glyphosate-resistant weeds. Row-crop farmers, desiring solutions to their weed-resistance problems, are likely to rapidly adopt these new technologies in the central U.S. where many specialty crops are also grown. Specialty crops are an integral part of diverse and healthy rural farm communities. Spray drift of either herbicide is can induce severe injury in highly sensitive fruits, vegetables and ornamentals that diminishes or even eliminates crop value. Many specialty crop growers fear that these technologies and their industry cannot co-exist. This symposium addressed the imminent risks from these advances in row crop production to the sustainability of the specialty crop industry.

Now is the time for an evaluation of the appropriateness of the new 2,4-D and dicamba formulations, and related GM crops as effective long-term weed management strategies. Nearly all stakeholder groups have concerns about the risks from the pending release of these technologies. They include: produce grower concerns of drift and volatility issues resulting from previous formulations; row-crop farmer and manufacturer concerns over prior lawsuits resulting from allegations of misuse, drift, and volatility; concerns over licensing fees and other increased expenses, consumer and environmental health and rural community well-being concerns; growing awareness and resistance to GMOs and other technologies; and product manufacturer concerns over public perception and risks associated with product use. In addition, the introduction and widespread adoption of Roundup and “Roundup Ready” crops initially decreased but then increased herbicide use and was a missed opportunities to evaluate a landscape-scale ecosystem experiment.

Moreover, the international scale and broad scope of the 2,4-D and dicamba technology in conjunction with the number of individuals and groups with a stake in the outcomes makes this the right time for formation of a multi-state, transdisciplinary, and stakeholder led working group. To address this issue, a first of its kind USDA Specialty Crop Research Initiative Research and Education Planning Program grant was proposed to support *The New 2,4-D and Dicamba-Tolerant Crops: Managing Risks to Farms and Communities* conference. Using a trained moderator specializing in large-group facilitation and conflict management, the conference consisted of a symposium and workshop held in Columbus, OH, from October 31 to November 2. A diverse set of sixty stakeholders, from 4 countries, participated in the 3-day event; they represented many positions of the herbicide-tolerant crop issue that include specialty crop grower, row-crop farmers, social scientists, economists, horticultural and weed scientists, plant pathologists, extension specialists, herbicide manufacturers, farm advocacy groups, consumer advocacy groups. Each participant shared their positions on these technologies during the conference that included potential risks, and ideas for mitigating these risks. The guiding questions of this symposium were: What are the potential risks (social, economic, ecological) to farms and communities associated with use of the reformulated 2,4-D and dicamba herbicides and related herbicide-tolerant crops? What alternative approaches exist or can be created to resolve the herbicide resistance issue that does not exclusively rely on these new technologies? Who is involved in risk assessment and solution development? Who assumes the greatest and least risk?

These proceedings present the outcomes that are the result of the momentum built among stakeholder groups.

Risks to Farms and Communities Identified at the Symposium

Risk analysis was the unifying theme of the symposium. *Systems-focused* questions were asked and addressed during the symposium to identify risks. Multiple dimensions of risk were highlighted by presenters beyond the *knowledge deficit* focus of traditional risk analysis. These include:

- Understanding the social, economic, and biological, or ecosystems-based risks;
- Understanding the experiences and intrinsic knowledge of row crop farmers as integral to mitigating risks;
- Engaging users of the technology and seeking community-based solutions to identifying and mitigating the risks of technology adoption;
- Alternatives to addressing the current weed management and herbicide resistance problems;
- Coexistence of agricultural systems.

Using this approach, risks to farms and communities were identified and fit into one of three needs: risk assessment, risk management, and risk communication.

1) Risk Assessment – Develop a standardized methodology to assess the risks of new technologies to other stakeholders and the environment.
    a. Validate BASF, Dow AgroSciences, and Monsanto claims regarding the "ultra-low volatility" and drift.
    b. Standardize applications to minimize accidents and abuse of new technologies.
    c. Develop and implement a valid, standardized methodology to assess risks.
    d. Understanding the "feeding the world" discourse and evaluate its validity.
    e. Analysis of weed management in context of the larger socioeconomic systems.
    f. Understand spatial and regional risks associated with these technologies such as gene follow and drift, effects on pollinators, effects on non-crop vegetation diversity.
    g. Evaluate how these technologies contribute to agricultural sustainability.
    h. Identify appropriate strategies and technologies to manage risks.

2) Risk Management
    a. Prolong herbicide susceptibility, and avoiding "breaking the system."
    b. Develop systematic practices to guide herbicide and GM crop use.
    c. Impacts of weed management decisions are shared by others – we need to apply new knowledge to support co-existence of farming types.
    d. Apply existing and new knowledge to extend the "shelf life" of herbicides.
    e. Influence how row-crop farmers are currently managing herbicide resistance and how they plan to integrate these new technologies into an integrated system.
    f. Develop Integrated Weed Management (IWM) that includes options for using new formulations of 2,4-D and dicamba.
    g. Launching a diagnostic and monitoring system to track and validate the incidents of off-target herbicide damage.
    h. Incentive programs to encourage proper application.
    i. Reaching laggards and late adopters who offer potential for misuse.

3) Risk Communication
    a. Communication should be tailored to farming communities being addressed and relevant to specific sensitive crops and local conditions.
    b. Accurate and transparent discourse on benefits, risk and uncertainty.
    c. Develop a comprehensive risk communication strategy.

II. Organizer Information

Symposium Organizers Listed Alphabetically

Doug Doohan, , PhD, (doohan.1@osu.edu) is Professor of Horticulture and Crop Science at the Ohio Agricultural Research and Development Center in Wooster, Ohio, with expertise in on-farm management practices and the development of environmentally acceptable technologies to manage weedy and invasive plants in Ohio agro-ecosystems. Dr. Doohan and his team have conducted extensive research in grower perceptions of food safety practices and have expertise on the costs and benefits of preventive strategies to manage weeds at different scales of conventional and organic production systems.

Roger Downer, Ph.D., (downer.2@osu.edu) is a Research Associate in the Department of Horticulture and Crop Science at the Ohio Agricultural Research and Development Center In Wooster, Ohio.

Stan Ernst, M.A. (ernst.1@osu.edu) plays two roles in the Agriculture, Environmental and Development Economics department at the Ohio State University in Columbus, Ohio: (1) Outreach Program Manager and (2) Specialist on Marketing; Information Technology Adoption in Food and Agricultural Industries; and niche food markets. As Outreach Program Manager, he develops strategies, programs, and educational products that enhance department economic outreach, research, and teaching programs. Ernst directs the Department's Policy & Outlook Program and other major Outreach and Extension programs; and serves as departmental contact on Extension-related issues. Ernst studies marketing and the use of information technology and e-business practices within food and agricultural industries. Current work relates to drivers of consumer demand for local foods, direct marketing channel options, rural retailing trends, and horticulture economics.

Gerri Isaacson, (isaacson.16@osu.edu) Program Administrator for the Agricultural Risk Analysis Program and Doohan Weed Lab Group in the Department of Horticulture and Crop Science at the Ohio Agricultural Research and Development Center in Wooster, Ohio.

Jason Parker, Ph.D. (parker.294@osu.edu) is an agricultural anthropologist and Research Scientist in the Department of Horticulture and Crop Science at The Ohio State University in Columbus, Ohio. His research focuses on multiple dimensions of sustainability and the environment including social aspects of water quality, agriculture, food and food safety, and GMOs. Research foci include the examining links between food safety and sustainability with emphasis on farm size, marketing strategies, and the social science of technology. Other work includes examinations of stakeholder group structure and land tenure and their affects on community-based watershed management, risks of GM crop technology, and developing measure of agroecosystem health.

Scott Wolfe, M.A. (wolfe.529@osu.edu) is a Research Assistant in the Department of Horticulture and Crop Science at the Ohio Agricultural Research and development Center in Wooster, Ohio. His work examines the physiological effects of herbicide drift on viticulture grapes and has additional interests in the biochemistry involved in herbicide drift scenarios and damage to sensitive plant species.

Moderator

Joe Heimlich, Ph.D. (heimlich.1@osu.edu), Associate Professor in the School of Environment and Natural Resources at the Ohio State University. His background includes expertise in Adult Education that integrates transdisciplinary understandings and is an accomplished moderator and facilitator. His work evaluates efforts in parks, zoos, science centers, nature centers, non-government organizations, and government agencies through a modified stakeholder based, utilization focused evaluations using program theory and mixed methods. Facilitate evaluation design training programs and program planning for statewide and national projects. He is a partner in the Environmental Education and Training Partnership (EETAP) where he has conducted the following: a national study of environmental education and the web; research projects leading to publications on evaluating web sites, web content, and searching for resources; development of over 100 info-sheets and meta evaluations of projects.

III. Symposium Introduction

By Jason Parker, Roger Downer, Doug Doohan, Stan Ernst, Scott Wolfe

Collaboration on this project began with a long-standing tradition of multi-state partners working together to achieve common goals. Risk assessment work was initiated in 2008 at Purdue and OSU to quantify the effect of sub-lethal doses on grapes, tomatoes, broccoli, bell pepper, and melons. Results were communicated to growers at the Ohio Produce Growers and Marketers Association, the Indiana Horticultural Congress, and the Mid-Atlantic Fruit and Vegetable Convention. The Ohio Grape Industries Committee hosted a series of listening sessions in 2010 to inform growers of the new GM crops, and to enhance awareness of spray drift issues. By 2011, key issues shaping the symposium and workshop concept began to take shape.

This symposium addressed a *critically important emerging threat* to farms and communities: reformulated 2,4-D and dicamba herbicides and GM crop technologies to cope with the increasing pressures of herbicide resistance that threatens row crop farmers and the risks associated with them. Presenters identified potential risks and benefits to farms and communities of 2,4-D and dicamba reformulations and herbicide-tolerant crops (corn in 2013, soybean and cotton in 2014) through an exploration of the science, perceived risks to stakeholders,, and other uncertainties to the environment, economy, communities, and society.

The imminent commercial release of field crops with genetically engineered tolerance to these herbicides is expected to address the short term needs of row-crop farmers who have experienced increased herbicide-resistant weeds. Despite the best intentions of farmers, commercial applicators, seed companies, and the pesticide industry, there is concern that this will inevitably lead to crop damage because of increased spray drift and movement of volatiles, some of which may result from changes in application timing that coincides with more susceptible growth stages of non-target plants.

Background on Glyphosate, “Roundup Ready”, and Known Risks

Monsanto’s release of “Roundup Ready” (glyphosate tolerant) Soybeans in 1996 marked the beginning of a 15-year landscape and social experiment in farming communities across North America. Safety claims based on Monsanto’s research were supported by the US EPA when it approved the use of Roundup and other glyphosate based “Roundup Ready” crops. However, research did not foresee the potential consequences of these technologies in the environment or the potential for misuse that led to herbicide resistance, documented cases of gene flow, impacts on pollinator species and non-crop vegetation diversity. In addition, socioeconomic implications to farms and communities were missed that included limiting on-farm decision making from the prohibitions against seed-saving and compulsory contracts for single crop use, limited or lack of locally available alternative non-GM crops, *in situ* spread of GM technology to non-GM row crops and the resulting culture of surveillance and litigation to protect company patents. Finally, the “treadmill of production” created by increased yields and costs and decreased price (from larger yields) has fostered the present farm structure and rural demographic state in which increasingly larger farms are operated by fewer and older farmers. Moreover, risks to organic and non-GM crop niche producers as a result of gene flow were missed as well. All of these factors arguable inhibit the sustainability of farms and rural communities by restricting options for decision making and limiting the adaptability to changing social, economic and environmental conditions.

As a result of "Roundup Ready" crop technology, glyphosate is the most widely sold herbicide in the world. It is almost certain to have had the greatest impact of any herbicide ever developed. Its use is the principal method of weed control on 90% of the nation's 60 million acres of soybeans, and more than 70% of corn and cotton. It is the wide-scale and intensive adoption of this method of weed control over all others that has led to rapid selection of glyphosate resistant weeds, 21 species to date. In turn development of 2,4-D- and dicamba-resistant crops has been driven by the need for new tools to manage glyphosate-resistant weeds. Herbicide resistance is a more recent phenomenon that that of pest resistance to insecticides and fungicides. The rate at which herbicide-resistant biotypes have been reported increased greatly with the introduction of as the ALS inhibitor herbicides, and more recently with the landscape-scale use of glyphosate in "Roundup Ready" crops.

Risk analysts would classify the broad socio-economic impacts of Roundup Ready technology described above, along with the unexpectedly rapid evolution of resistance as a classic failure of technical risk analysis. Failure occurred because the analysis focused solely on known risks, identified during product development by experts, without investigating other potential risks or addressing unknown outcomes and concerns of other stakeholders (Busch, per. com). The Roundup Ready example illustrates the great need to create an accurate and transparent discourse on benefits, risks, *and uncertainties* as new technologies with the potential for widespread dissemination, adoption, and societal impact are developed. With these known outcomes of the rapid adoption of glyphosate and tolerant crop technologies, it is imperative that such an enhanced risk analysis be conducted on these emerging technologies so that awareness of their potential impacts are known prior to widespread use. By engaging stakeholders on all sides of the 2,4-D and dicamba tolerant crops issue, we can identify and conduct research that would shape discussions and resulting policy decisions in ways more likely to improve weed management and protect the effectiveness of current herbicides while respecting current social, environmental and market forces.

2,4-D, Dicamba, and the Threat to Specialty Crops

Dow AgroSciences plans to sell 2,4-D tolerant corn by 2013. This will be followed in rapid succession by cotton and soybean with an identical trait. Dicamba tolerant crops are also being developed by Monsanto and will follow a similar trajectory of commercialization. These traits will be stacked with others; invariably glyphosate tolerance will be part of the mix. It is anticipated that a weed control program will consist of glyphosate plus 2,4-D, or glyphosate plus dicamba. Based on past experience, row-crop farmers plagued with glyphosate resistant weeds will embrace crops with tolerance to these growth-regulating herbicides, leading to greatly increased herbicide use and inevitably to more off-site movement. The well-known history of disease syndromes caused by off-site movement of 2,4-D, dicamba *and glyphosate* (see Section 3) is such that many specialty crop growers fear that their crops cannot be grown in a future landscape that will be inundated like never before with all of these active ingredients. It is not surprising that, as a new discourse on herbicide-tolerant crops takes shape, the prospect has led individuals such as Steve Smith, Agricultural Director of the REDGOLD COMPANY to give the following Congressional testimony (9/30/2010) opposing their release:

> I am convinced that in all my years serving the agricultural industry, the widespread use of dicamba herbicide poses the single most serious threat to the future of specialty crop industry in the Midwest.
>
> -- Steve Smith, Director of Agriculture for Red Gold

A significant complication from these technologies is that the new traits will be stacked with glyphosate resistance and weed control programs will call for the use of mixes with glyphosate (Wright et al. 2010, Seifert-Higgins and Eberwine 2010). Research indicates that injury resulting from very low-dose combinations of 2,4-D or dicamba with glyphosate can be more damaging than with either herbicide used alone (Wolfe et al. 2011).

Additionally, other potential complications for the system are not trivial. Pesticide tolerances for 2,4-D have been established for some specialty crops and none for dicamba (D. Kunkel, IR4 Program, Pers. Comm.). Thus marketing of many crops subjected to drift may not be legal. Processors generally will not accept a crop where herbicide drift is apparent even if residues are not found (T. Rabaey, General Mills, Pers. Comm.). Likewise, customers for organic fruits and vegetables expect products to be residue-free. When drift occurs, growers are left in limbo; the field cannot be abandoned because yield losses must be measured. Stakeholders report increasing difficulty in obtaining settlements, particularly when the plaintiff is a processor. Moreover, herbicide spray drift and volatility is also a particular concern to organic producers. National Organic Program standards prohibit the use of any chemical or synthetic inputs, which include 2,4-D and dicamba. Application, accidental or intentional can become grounds for revoking certification. 2,4-D and dicamba induce clearly visible effects on most sensitive crops at extremely low doses. In contrast to symptoms of glyphosate drift, those caused by 2,4-D and dicamba are distinct and readily detected even by untrained observers. Thus it is inevitable that organic producers will lose their certification when off-site movement occurs and these effects observed.

Finally, from an ecological perspective these new approaches to weed control also require close scrutiny. Increased use of dicamba and 2,4-D has the potential of reducing biodiversity in field edges and nearby noncrop habitat (Bowe 2010; Green and Owen 2010). Beneficial arthropods provide pollination and other key ecosystem services valued at over $57 billion per year (Losey and Vaughan 2006).

The planned introduction of 2,4-D and dicamba-tolerant crop technology to date has caused polarization within and between sectors of the agri-food system. However, it may be possible to achieve a better outcome than occurred following the introduction of Roundup Ready crops. Based on our collective experiences with similar issues, we believe there is an opportunity to improve the discourse and protect the interests of all stakeholders; but the timing of this effort is critical. *Central to our long-term goal is the hypothesis that people's perceptions and beliefs regarding weed management decisions are shaped through existing perceptions, beliefs, and value that are informed by the discourse on this issue. Factors influencing the technologies selected and how those decisions were made depends on the inclusiveness of that discourse such that it includes all stakeholders in our farming and food system.* Once the technology is commercially released, the opportunity for a collegial approach to perceived and real problems will quickly be lost. The purpose of this Specialty Crop Research Initiative planning grant proposal is to gather the stakeholders and take the first step in identifying all points of contention, as well as the likely costs and benefits of 2,4-D- and dicamba-tolerant crops, and alternate strategies. From this planning phase, specific research and extension education activities can be planned for deployment through a CAP that will help address these problems and continue the discussion. Ultimately, we are developing a live case study of methodology that would actively engage all stakeholders in shaping and choosing the future technologies in food production industries.

Previous research by our team has shown that farmers believe herbicides help them manage risk. Alternative approaches promoted under the umbrella of integrated weed management (IWM) are perceived as riskier in the short term. This preference for herbicides, at the cost of IWM, led to annual applications of glyphosate over immense landscapes in the US ultimately forcing the selection of resistant biotypes. In reality a farmers' weed management decisions are more than an individual farm issue – they are societal issues. The outcomes both positive and negative are shared by local communities, consumers, and the nation as a whole. For instance glyphosate resistant marestail (*Conyza canadensis*) is now established in many vineyards and vegetable fields in Ohio as a result of the biotypes selection in soybean fields. Controlling the biotype is as problematic for fruit and vegetable farmers as it is for grain producers. Now development of 2,4-D-tolerant and dicamba-tolerant crops is seen by many agronomic weed scientists and row-crop farmers as the key to preserving the utility of glyphosate. So, while corn, soybean and cotton farmers welcome these new technologies, the potential perturbations they cause will be experienced by the U.S. specialty crop industry, organic producers of grains, fruits and vegetables, pollination service providers, and the general ecology.

Public Discourse on Biotech Crops

As unintended consequences associated with GM crops emerged, the general discourse on GMOs, including herbicide-tolerant crops, shifted away from its importance to developed countries and toward the importance these technologies hold for the poor in developing countries until the herbicide resistance issue became prominent. Both proponents and opponents of these technologies embraced developing country discourses that were laden with inaccuracies and misconceptions: proponents emphasized Malthusian concerns of addressing overpopulation through GMOs; opponents focused on deskilling of the poor and the cycle of debt created through bans on seed saving (Stone 2010; Stone 2002). This example illustrates a need to create an accurate and transparent discourse on the benefits, risks, and unknowns in future releases of technologies with the potential for widespread dissemination, adoption, and societal impact. By engaging stakeholders on all sides of the 2,4-D and dicamba tolerant crops issue, we can identify and conduct research that would shape discussions and resulting policy decisions in ways more likely to improve weed management and protect the effectiveness of current herbicides while respecting current social, environmental and market forces.

Reshaping the Discourse

Lubell describes trust “as expectations about whether or not a trustee, in the context of a risky exchange relationship, will behave in a manner beneficial or at least not detrimental to the truster” (2007:237). Creating an inclusive discourse is the basis of fostering the trust that Lubell states is critical in developing effective policy on issues of the common good, such as water or herbicide application spray drift. Ostrom (1990) states that trust is decisive in creating effective environmental policy. For instance, it has been instrumental in creating agricultural water policy with outcomes supported by the members of the Sacramento Valley Water Quality Coalition (Lubell 2007).

Historically, farmers have been reticent to collaborate with regulatory agents, such as US EPA, and have expressed resistance to new forms of regulation. Water quality is a consistent area of conflict between farmers and regulatory authorities, particularly row-crop and livestock producers. These conflicts are shaped both through the real experiences of farmers and the general discourse surrounding the issue, which influences perceptions and attitudes. Prior to the last decade, environmental discourses surrounding water quality were generally expert-driven with prescriptive mandates being given to farmers by, for example, state EPA agents. This approach has changed with the development of various participatory stakeholder approaches to watershed management (Weber 2003; Koontz 2004; Sabatier 2005). As Parker et al. (2007; 2009) show, trust can develop among farmers and regulatory agents through dialogue and collaborative action in which farmers are engaged as collaborators in addressing water quality problems in the Sugar Creek Watershed. Similar to Lubell, Moore et al.’s (2008) found that institutional distance was a factor in trust in which local agency and people were trusted more than state and Federal. These trust issues are overcome through participation of all participants on an equal footing and with their input in the process of outcome development and decision making. We believe that similar discourse change is possible in dealing with the current issue of 2,4-D and dicamba-tolerant crops and associated environmentally induced specialty crop diseases.

2,4-D, Dicamba, and Glyphosate Herbicides

The herbicide 2,4-D was commercially introduced in the early 1950's and quickly adopted by cereal farmers. Its mode of action was specific to plants but selectively toxic to most broadleaf species. While 2,4-D was hailed as a great breakthrough for adequately controlling weeds in cereal crops, its side effects on non-target crops were soon noted. Spray drift because of unsophisticated equipment coupled with product volatility was such that damage to adjacent fields of cotton, grapes and tomatoes led to concerns (and increasing numbers of lawsuits) relating to pesticide drift (Akesson and Yates 1964). However, the benefits to growers seemingly outweighed the problems and use of this and other hormone weedkillers increased in spite of threats in several states to ban 2,4-D because of damage to cotton. Court records of the time document civil actions taken as a result of drift movement of the herbicide from target to non-target crops.

Environmentally induced plant diseases are an understood outcome that can result from off-target herbicide spray drift (Walker 1969). Movement of 2,4-D was easily recognized both during spraying through drift and after spraying through volatilization losses (Sherwood et al. 1970; Grover et al. 1972) because susceptible plants exposed to 2,4-D developed unique morphological symptoms (Felsot 2005). In contrast to experiences with DDT movement, where residues could only be detected following chemical analysis of tissues, 2,4-D residues were easily identified by the readily recognizable morphological changes in foliage (Zimmerman et al. 1953; Greenshields et al. 1958). Throughout the 1950's engineering of application equipment improved the precision of delivery and foliar coverage. Ground rigs, airplanes, and helicopters replaced hand-application equipment in the industrialized countries. However, despite these efforts to manage spray drift through better spray equipment, additives to reduce droplet size as well as improved formulation technology little has changed. Drift still happens and therefore organic and specialty crop grower concerns over crop damage and damage to non-crop vegetation are well-founded. In fact, Felsot (2005), on the evaluation and mitigation of spray drift, laments that "A historical review of spray drift and its potential for non-target injury shows the phenomenon, although widely discussed, has not been satisfactorily mitigated despite the many years of training pesticide applicators." In 2007, the US Environmental Protection Agency established a Pesticide Spray Drift Reduction Team with the goal of identifying drift reducing technologies through a verification program, publicize the results, and provide regulatory incentives to pesticide applicators to purchase and use these technologies. This program is on-going.

In the early 1970's glyphosate was introduced and became the #1 herbicide due in part to its utility as a broad spectrum herbicide that could control both grasses and broad-leaved weeds in a variety of situations. The broad spectrum of weeds controlled by glyphosate and the positive environmental and safety profile of the product made the use of glyphosate in crops for weed control an attractive proposition. However, because glyphosate was lethal to crop species, a method to develop crop safety was needed. According to Dill et al. (2008), Roundup Ready Crops were first introduced in the United States in soybeans in 1996. Adoption has been very rapid in soybeans and cotton since introduction and has grown significantly in corn as previously outlined. Roundup Ready Crops have grown to over 74 million hectares in five crop species in 13 countries. Currently, the USA, Argentina, Brazil and Canada have the largest plantings. To combat resistance alternative mode of action treatments have been developed. Over 50% of glyphosate-resistant (GR) corn hectares and 70% of GR cotton hectares receive alternative mode-of-action treatments, but only 25% of GR soybeans receive such a treatment in the USA. Thus the drive to develop effective controls for GR weeds is particularly acute for this crop.

GRCs have been a boon to row crop farmers who have adopted them, but overuse of this single weed management technology is jeopardizing this highly effective and economical tool due to the emergence of new weed species that are only poorly controlled by glyphosate (Owen, 2008) and the evolution of GR weeds. Around the world, weed populations have been under glyphosate selection for up to 35 years (Duke and Powles, 2008). However, it is important to emphasize that until 1996, glyphosate use was restricted in agriculture to its "traditional" use for non-selective burn-down of weeds prior to crop seeding or for weed control between established rows of tree, nut, and vine crops. In more than 30 years of the "traditional" use of glyphosate (burndown) there has been only limited evolution of GR weeds (Powles, 2008a, 2008b). Only with the introduction of GRCs did glyphosate become an in-crop, post-emergent, selective herbicide for use in annual, agronomic crops leading to the concomitant rapid selection of resistant biotypes. The popularity of GRCs led to an enormous increase in glyphosate use, and related drift issues to non GRC field crops as well as specialty crops and rural landscapes. In recent years a spate of lawsuits have emerged where sensitive crops are grown in close proximity to GRC crops. Undoubtedly drift is a too common occurrence compounded somewhat by the relative difficulty in detecting sublethal depositions in rapidly growing sensitive plants.

To address the GR weed problem, the industry is now developing 2,4-D and dicamba resistance traits that will expand the utility of currently available herbicides. However, it is critically important to recognize that these traits represent interim solutions for current weed problems and do not replace the long-term need to discover herbicides with new modes of action and to adopt integrated weed management tactics. A significant complication of the 2,4-D and dicamba technologies is that they will be stacked with glyphosate resistance and recommended weed control programs will call for the use of tank-mixes of either herbicide with glyphosate (Wright et al. 2010; Seifert-Higgins and Eberwine 2010). Research conducted in our laboratory indicates that injury resulting from combinations of 2,4-D or dicamba with glyphosate, all at very low concentrations, is far more damaging than with either herbicide used alone. The expected increased use of auxin herbicides will increase the potential for off-target movement and injury to sensitive broadleaf plants. Due to this potential environmental problem, the herbicide and trait providers will likely introduce improved herbicide formulations with better use directions before the traits are commercialized mid-decade (Bowe 2010; Qin et al. 2010). Ironically, this risk of off-target movement could drive more rapid adoption of auxin traits because growers will want to protect their soybean and cotton crops from nearby applications of auxin herbicides.

From an ecological perspective these new approaches to weed control require close scrutiny. The effect of herbicides on plant disease is an important, but generally overlooked, aspect of integrated pest management. Furthermore, these interactions can be crucial contributors to the success or failure of the biocontrol of weeds with microbes. Indirectly, through their strong effects on plants, herbicides can influence almost any process or interaction of the plant, including its susceptibility to plant diseases (Duke et al. 2007). According to Green and Owen 2010 the increased use of dicamba and other auxin herbicides in auxin-resistant crops has the potential of injuring other broadleaf crops and reducing biodiversity in field edges and nearby noncrop habitat (Bowe, 2010). Moreover, in response to the recent crisis involving honey bees and other pollinating species that are demonstrably important to fruit and vegetable growers, conserving pollinator-friendly habitat in hedgerows, woodlots, and field margins as well as establishing new habitat such as pollinator meadows and field margins is actively encouraged in many areas. These habitats have been shown to considerably improve the pollination services available to growers from bees other that honeybees (e.g., native solitary bees and bumblebees). The encouragement has come notably from the USDA NRCS, the Xerces Society and the Pollinator Partnership. One of the expected side effects of increased 2,4-D use brought about by the introduction of herbicide tolerant soybeans or corn is a change in the timing of herbicide applications. Herbicide applications will likely be later in the season than has been the norm and that this could lead to greater damage to non-crop bee habitat due to drift into field margins. This will be seen as a secondary effect since the herbicide is not directly toxic to the bees. However, if drift and volatility are not controlled, the likelihood is that bee habitat will be compromised. Opponents of the introduction of 2,4-D tolerant crops believe that herbicides containing 2,4-D will cause serious harm to native bee populations through severely reducing bee plant forage species.

Off-target movement of auxin herbicides can occur via spray particle and vapor drift. Particle drift is more problematic than vapor drift, but growers can manage with modified application techniques, drift control adjuvants, and correct decisions as to when, where, and how to apply. Particularly troublesome for auxin herbicides would be any movement onto highly sensitive crops such as soybeans, cotton (*Gossypium hirsutum* L.), or grapes (*Vitis vinifera* L.). Interestingly, 2,4-D is safer than dicamba on soybeans and dicamba is safer than 2,4-D on cotton (Sciumbato et al. 2004). As little as 0.01% of the labeled rate of dicamba can injure soybeans (Steckel et al. 2010), and 0.001% of the labeled rate of 2,4-D butyl ester formulation can injure tomatoes (*Lycopersicon esculentum* Mill.) and lettuce (*Lactuca sativa* L.) (van Rensburg and Breeze 1990). Some forms of dicamba and 2,4-D are highly volatile, especially at high temperatures. For example, the acid form of dicamba is more volatile than amine salt formulations, and some amine salts are more volatile than others. Considerable research is underway to minimize volatilization with new salts and formulations. The manufacturer can also reduce potential off-target movement with application restrictions based on temperature, droplet size, humidity, and wind speed. Because of their volatility and the sensitivity of non-target crops, growers will probably not use auxin herbicides on vast areas during warm weather as is currently done with glyphosate.

Rationale

Specialty crop production is critical to rural livelihoods and offers a diversified use of rural resources on fewer acres than most commodity production. This has positive social, environmental and economic benefits that are shared by residents in rural communities, including: lower (than livestock and row-crop) startup costs, increased job opportunities, higher per acre product values and greater potential tax base, diversified crops across smaller units of land enhances biodiversity, and increased opportunities for economic multipliers such as other local specialty crop dependent businesses and additional producer profits from constricting the supply chain using more-direct marketing channels. Although weed management is a major cause of concern for produce growers, growers are keenly aware of the importance of application timings that are critical to avoiding injury and disease syndromes caused by some herbicides such as 2,4-D and dicamba.

Less direct, but of critical importance, is the level of infrastructure available to the more disconnected pockets of specialty crop producers because of their integration into a landscape filled with grain and livestock operations. Rural services and amenities such as highways, farm input and service suppliers, financial and insurance businesses, would not be available to many specialty crop producers at the local level without this diverse group of producers. The manner in which various enterprises are interconnected within the local community and economy are difficult to measure. Moreover, the urban tourist seeking a rural farm experience expects a landscape consisting not only of boutique wineries, farm markets and u-pick operations, but also one that includes grain, forage and livestock (Randall 2002). Thus the business plan of the specialty crop producer is contingent upon an aesthetic and infrastructure contributed to significantly by those who will use 2,4-D and dicamba-tolerant technology (Lu 1985, Morrison et al. 1996).

People do not always form attitudes in a systematic or "rational" manner. Rather, they potentially mingle several issues in forming their attitudes toward a particular technology. These issues might include: a current perception of untrustworthiness of chemical companies stemming from a variety of sources; concerns regarding the "power" of chemical companies or corporations in general; the potential conflation of current formulations of 2,4D with the limitations of prior formulations or other agricultural chemicals; a general perception that chemicals need to be used sparingly, or should be avoided all together. There surely are other potential issues wrapped into a general attitude regarding the issue of herbicides that this research will illuminate.

Technologies all have positive and negative attributes, pros and cons, and the discourses surrounding those attributes affect how each is addressed. These discourses and the impact they have on the perception of technologies powerfully drive the evolution of civilization and environmental change. Because of these connections among discourses, technology, and technology applications, it is critically important to conduct a comprehensive sociocultural and risk analysis of factors influencing perceptions of both technology users and non users, and use decision making. It is vital for those who develop, regulate and use new technologies to improve their knowledge and understanding of stakeholder perceptions, beliefs and attitudes in order to better manage risk. Moreover, it is important that those in such capacities also understand and address the perceptions of non users since their neglect is likely to result in widespread public misperceptions of a technology and its use.

One such technology that we predict will cause significant measurable changes in parameters of the economic, social, and environmental function of agricultural communities in the United States is 2,4-D tolerant corn/ soybean and related innovations. Worldwide, 2,4-D is one of the most commonly used herbicide components accounting for 46 million pounds being used per year (www.24d.org). While this highly successful herbicide is sought after by those farmers of grasses and other grass-like crops, fruit and vegetable growers whose crops are broadleaf plants report that the drift and volatility of these products induces injury and other disease syndromes to their crops. Monsanto and Dow AgroSciences' introduction of new formulations of these products, and their associated herbicide tolerant engineered crops (soy, corn, and cotton – in proposed order of release) is viewed with heavy skepticism and trepidation by many Midwestern produce growers and processors who perceive their operations will be harmed should these products be misused, Dow and Monsanto's claims fall short of their promise, or natural events conspire against them. Here we itemize just a few potential impacts of the new 2,4-D and dicamba-tolerant traits based on the premise that spray drift is likely to happen despite the best application technology:

1. Weed control activities of grain producers will be under greater scrutiny by fruit and vegetable producers and this is likely to result in a sort of 'shoot first, ask questions later' mindset when it comes to suspected chemical trespass. This is an opportunity to educate both users and non users of proper application of 2,4-D. This can ensure that grain farmers follow proper use guidelines. It can also help communities (e.g. viticulturists, produce growers) develop alternative ways to challenge abusers without resorting to lawsuits. This may take the form of community arbitration or other mechanism that necessitates neighbor communication and compromise.
2. Improved understanding among farmers of the short, intermediate, and long term costs and benefits of using this technology. Continued weed control on grain farms will impact the short term economic viability of rural communities. This in turn will impact the short term economic viability of other agricultural and allied industries. Eventually use of this technology by most farmers will decrease the economic edge gained by its initial use. What are the intermediate and long term costs and benefits of use? These will ensure that farmers understand the real impacts of the technology and can then make informed decisions regarding its use.
3. Farming communities specializing mainly in conventional grain production are likely to be less vibrant than those that are more diverse. This occurs because there are fewer and less

diverse agricultural-related businesses in the community due to lack of demand and lower farming population. Grain farms tend to be larger and the land tends to be rented more often than owned (because of expense). This results in fewer farmers, farms, farmsteads, and potentially more exurban residents (who pay taxes but spend money elsewhere), and fewer job opportunities.

4. Non-farming residents of rural communities may become less tolerant of weed control and other pest management practices on grain and horticultural farms. Likely to be surprised by the impact on their properties resulting from technology. Likely to associate impacts on their gardens and ornamental plants with impacts on human and animal health.
5. Plant communities in hedgerows and field edges will be modified by increased 2,4-D and dicamba use. These modifications will cause changes in associated changes in the food change including pollinator populations.
6. Pollinator impacts will in turn impact horticulture and agronomic crop viability.
7. Land tenure will be affected and the long-term viability of some horticultural crop enterprises, including conventional growers, degraded e.g. organic and local foods movements (fastest growing sectors of the US farming sector).
8. Organic certification may be jeopardized from spray drift or gene flow.

IV. Outcomes

By Jason Parker, Roger Downer, Doug Doohan, Stan Ernst, Ashley Kulhanek, Scott Wolfe

Risk analysis was the unifying theme of the symposium. *Systems-focused* questions were asked and addressed during the symposium relate to identify risks. Multiple dimensions of risk were highlighted by presenters beyond the *knowledge deficit* focus of traditional risk analysis (discussed below). Features of this approach include:

- An emphasis on engaging users of the technology and seeking community-based solutions to identifying and mitigating the risks of technology adoption;
- Using a systems approach to understanding the social, economic, biological, and ecosystems-based risks and solutions to weed management issues;
- Finding alternatives to address the current weed management and herbicide resistance problems that move beyond placing responsibility with companies to provide solutions, identifying best approaches to solving these problems that move beyond reductionist risk-focused to broader community risk analysis that includes understanding the benefits (who benefits and has control?) and impacts (who is affected and how?) of new weed management systems;
- Coexistence of agricultural systems, and co-prosperity of farmers and communities.
- And, understanding that the experiences and intrinsic knowledge of row crop farmers, commercial applicators, and other users, are integral to mitigating the risks of these new technologies. This can assist with improvements in education enrichment, regulation improvements, and policy enhancement.

Promotion, prosperity, and persistence of specialty crop enterprises in rural economies are central goals of our future collaborations. Protecting the specialty crop system from adverse affects of increased 2,4-D and dicamba usage will impact rural communities and their economies for the good. Goldschmidt (1978) found positive community socioeconomic relationships and quality of life indicators among communities characterized by mixed farm scales and types, and specialty crops play a major role (Clark, Munroe, and Mansfield 2010; Inwood, in press). In contrast less diverse farm communities with consolidated and highly specialized enterprises had fewer positive indicators (Goldschmidt (1978).

Beyond Knowledge Deficits: Farmer/GM Row-crop User Knowledge and Experiences

We advocate for an approach to outreach that varies from the traditional *knowledge deficit* model used by many experts who assess gaps in farmer knowledge then develop educational programming without considering the expertise and practical knowledge of farmers (Cook et al. 2004, Hansen et al 2003). Adherence to this *knowledge deficit approach* can limit the impact of extension activity (Doohan et al. 2010, Parker et al. 2012a, Parker et al. 2012b, Wilson et al. 2008). Critical to bridging this divide, educators must understand the intimate knowledge that farmers possess from long-term experiences with technology in their fields in order to answer key questions shaping herbicide application. They include: How will row crop farmers integrate

2,4-D and dicamba into current cropping systems? What are current knowledge levels and perceptions about risk? How do row crop and specialty crop growers expect to manage risks? How are current record-high commodity prices affecting farmer experiences and attitudes? How does an aging farm population that operates increasingly larger scale farms with high rates of land leasing and a growing dependence on wage and contract employees manage the land? Considering that specialty crops are intermingled with row crops in the central US, what are the perceived spatial dimensions of herbicide use?

Farm sizes and types are highly variable across growing regions (Lobao 1990). This variability is important to understanding the risks to specialty crop growers because of the diverse matrix of specialty crop and row-crop farms across regions, each with dominant crop types, having different markets, and industry partners, processors and distributors, and even soils and climates. In addition, the structures of regional agricultures are intrinsically affected. Yet, the details of this interconnection of region and risks from herbicides and GM crops are little understood; there is a need to understand the spatial dimensions of herbicide use. We will move beyond the polarization of GM technology from opponents and proponents by going to the *users* of these technologies: *row-crop farmers* and *custom applicators*. These two groups have experience and functional knowledge of these technologies yet their insights are consistently missing from this discourse (Guehlstorf 2008, Mauro and McLachlan 2009). This embodied knowledge is critical to shaping user behavior through improved "best practices" recommendations and messages, and better regulation and policy.

Farmers participating in the symposium recommended development of field days and experiential learning in which participants can see the effect of 2,4-D and dicamba drift on sensitive crops but viscerally experience drift and factors that both exacerbate and moderate its severity. Farmers were also troubled about what they called the *rogue factor.* The rogue factor refers to individuals who uses pesticides, GM traits and other technologies, yet for many reasons routinely disregards the protocols, guidelines, accepted norms of behavior and regulations. They like GM crops for the same reason as other farmers; they make life easier. Unfortunately for trait companies the rogue factor can throw a wrench into the best technology, label instructions, and technology agreements. For instance as farmers in GA and WI acknowledged, the rogue may not feel obliged to use the new low-drift, low volatility formulations specified. When such a person is on the tractor anything can and often does go wrong. The rogue's knowledge, beliefs, perception and attitudes are poorly understood. A critical objective of this proposal is to develop a deep understanding of the knowledge, perception and drivers of such individuals, and involve them in designing outreach to reach members of their population.

Risks to farms and communities were identified and fit into one of three risk management needs, risk assessment, risk management, and risk communication. Each of these areas has research needs that must be addressed to facilitate risk mitigation.

1) Risk Assessment – There is a need for a standardized methodology to assess the risks of new technologies to non-GM crops, agri-food systems, agroecosystem functions and conservation, economic multipliers (e.g. processing and processors), consumers, rural communities, and crop and non crop genetic diversity.
    a. Prolong herbicide susceptibility is important, and avoiding "breaking the system" through the development of herbicide resistance, which will require "best practices" for applicators and enhanced regulatory and policy tools.
    b. The claims of chemical and genetics companies BASF, Dow AgroSciences, and Monsanto regarding the "ultra-low volatility" and drift for the new formulations of 2,4-D and dicamba need to be validated.
    c. Application technologies for validated herbicides need standardized to minimize accidental or abuse of the technologies.
    d. Develop and implement a valid, standardized methodology to assess risk of new herbicide and GM technologies to: Non GMO crops, economic multipliers (e.g. economies of scale, processing etc.), agrifood systems, consumers, rural communities, agroecosystem function (non crop species diversity, pollinator communities etc), crop genetic diversity (i.e. resulting from monocropping and gene drift).
    e. Understanding the "feeding the world" discourse and testing the validity of this concept, which is widely promoted as justification for GM technology but it currently unsubstantiated.
    f. Analysis of the relationships between land tenure (i.e. access and stability of that access to land resources), farmer demography, current equipment, and use of new herbicides and GM crop technologies is needed to understand the risks of their unintended misuse.
        i. Given current farm conditions, how will farmers integrate these technologies into their enterprises?
        ii. Do row crop farmers have realistic expectations of these products?
        iii. How will specialty crop and other non row crop farmers integrate these herbicides into burn down and other non-GM crop applications?
    g. Evaluate how these technologies contribute to agricultural sustainability. Will these technologies resolve the herbicide resistance problem and are they sustainable in high-intensity use weed management systems.
        i. HR species will be subjected to just one mode of action while others will have two. Does this speed up dicamba/2,4-D resistance in those weeds
    h. Understand spatial and regional risks associated with these technologies such as gene follow and drift, effects on pollinators, effects on non-crop vegetation diversity.
    i. Identify appropriate strategies and technologies to manage risks.
    j. Some weeds become problems because their competition is eliminated by herbicides. It is important to understand how non-glyphosate weed problems occur and how to manage them.

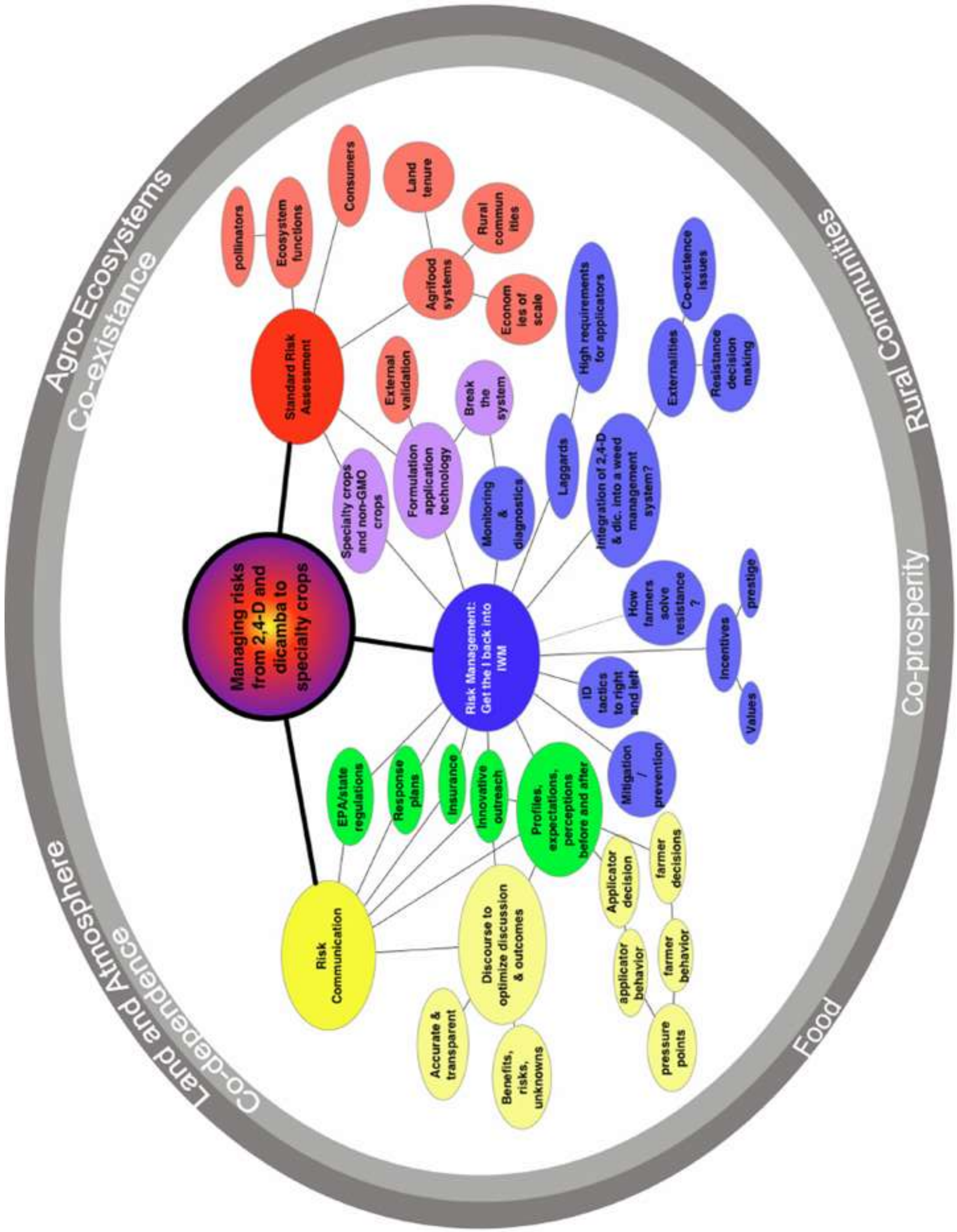
2) Risk Management
    a. Develop systematic approaches and practices that guide the use of these herbicides and GM crops that protect the interests of most stakeholders.
    b. Impacts of weed management decisions are shared by the surrounding community and others beyond its borders in the food system.
        i. Apply new knowledge to support co-existence of farm types within communities and across regional landscapes.
        ii. Apply existing and new knowledge to extend the “shelf life” of herbicides and maintain herbicide susceptibility in order to decrease the proliferation of resistant biotypes.
    c. Understand how row-crop farmers are currently managing herbicide resistance problems in the absence of these new herbicides and GMO crop systems. Then, apply this knowledge in developing systems that include new technologies in an Integrated Weed Management (IWM) program, systems that put the farmer back in control of weed management decisions that include a “many tools in the toolbox” approach.
        i. Farmers should not rely on any single management tool (e.g. fertility, pest control). What are the other “tools” that might be readily incorporated? How will those tools be integrated?
        ii. Develop IWM approaches that include options for integrating the new formulations of 2,4-D and dicamba into current cropping systems.
    d. Launching a diagnostic and monitoring system to track and validate the incidents of off-target herbicide damage.
    e. Mitigation of crop injury.
    f. How will the companies market these products and how will they ensure user compliance with the approved uses? Incentive programs to encourage proper application should be developed.
        i. Make requirements for pesticide applicator training very high.
        ii. Crop insurance restrictions.
    g. Reaching laggards (broadest definition includes non-traditional laggards) and late adopters who offer the most potential for misuse.
    h. With 8 companies producing most of the seed, will expanding the use of a single seed further diminish the available diversity of row crops and limit the adaptability of the farming system.

3) Risk Communication
    a. Accurate and transparent discourse on benefits, risk and uncertainty, in order to shape informed discussions and resulting research, policy, regulatory and marketing decisions in optimum ways.
    b. Develop a comprehensive risk communication strategy that includes many stakeholders: specialty crop growers; insurance companies; response plans;

engages EPA, state regulators, Crop Life America; private (row-crop farmers) and commercial applicators knowledge, perceptions and attitudes; and, rural communities.

c. Improved applicator training programs using hand-on experiential learning techniques.

These risks and relationships were conceptualized in the following model for managing the risks to farms and communities from 2,4-D and dicamba. It shows the relationships among the risks that were identified as fitting assessment, management, and communication risk analysis.



V. Post Symposium Activities

By Jason Parker

Following the symposium, several activities occurred during the planning and writing phases to produce the focal output of the symposium, the *Managing Risks of Herbicide Drift from 2,4-D- and Dicamba-tolerant Row Crops to Specialty Crops* USDA Specialty Crop Research Initiative – Standard Research and Extension Program (SCRI-SREP) proposal. These activities included preliminary data collection to support this process and collaboration with academic, industry, and farming stakeholders and multiple team meetings in person and via webinar.

Preliminary Data Collection: Focus Groups with Stakeholders

Six focus groups were conducted in three growing regions (Georgia, Ohio, and Wisconsin) that were chosen based on major specialty crops and herbicide-tolerant (HT) GM row crops. Four focus groups were conducted with Ohio viticulturists (Bethel in SW, Geneva in NE, Wakeman in NC, and New Concord SE) with a mean of eight growers. These focus groups demonstrate the variation within an industry that is in part related to proximity to HT row crop users. One focus group was conducted in Hancock, WI, with 5 attendees in an area of diverse farming. One occurred in Oglethorpe, GA, with 11 attendees, and was chosen due to the dominance of cotton farming.

Ohio viticulturists were very concerned about drift damage from dicamba and 2,4-D. This was particularly prevalent among the growers farming near row crops. This proximity also led to skepticism regarding industry claims of "ultra low" volatility or ability to control drift. Growers cited past experiences with drift-induced damage and skepticism regarding the ability of these technologies to manage this problem as their main reasons for concern. Concern was expressed that such claims would encourage farmers to use more herbicides with less discretion and that the returns on new HT crops would not justify the costs. Growers in non-HT crop areas were less likely to be aware of drift issues but equally pessimistic about controlling drift problem and doubted the efficacy of good communication. Others doubted the efficacy of spray regulations because of the ability of HT crop farmer to influence regulations. Growers were mixed in their belief that sprayer education about sensitive crops could minimize drift. Some thought that specialty crop growers should have input in determining spray formulations and standards and that low volatility herbicides should be less expensive to promote proper use. More skeptical growers suggested putting drift damage information on the label and even restricting or banning its use in some or all states. One group stated that identification of herbicide residues in wine and on grapes would be a benefit for proving damage claims.

Overall, both the *Wisconsin* and *Georgia* participants were less concerned about spray drift, likely because these herbicides are not commonly used. In addition, Wisconsin participants were less concern because they perceived lower demand for these new herbicides since Roundup has maintained its efficacy and new HT crops would likely have traits they did not need. Georgia participants perceived lower demand because the new technologies would require changing to a rigid system when they need flexibility, and weed resistance to the active ingredients is already common. Spraying during critical growth stages of sensitive crops was a major concern for both groups. Wisconsin participants were concerned about processors developing reasonable residue restrictions to avoid crop losses. Specialty crop seed production concerns were expressed because these herbicides impact seed production through residual herbicides being stored in seeds that damage future crops. Dicamba concerns were expressed for soil movement because of high winds in this region, specifically dicamba because it attaches to soil particles more readily. Both Georgia and Wisconsin groups expressed concern over the use of terms like “ultra-low drift” because they felt it would be a license to abuse them, although the Wisconsin group felt custom applicators would follow the label and were more concerned about “private applicators” (i.e. farmers and their potentially unlicensed or untrained workers). Both groups doubted the efficacy of a contract to restrict product uses stating that if there are some older formulations in the shed then some farmers will use them anyway. The Wisconsin growers were adamant that they should not assume the risk for row-crop farmer mistakes or misuses. Finally, while Georgia participants were concerned about having only one effective herbicide for their cotton (Ignite) and would like more options, Wisconsin participants were concerned about having fewer herbicides because of industry “drift” toward more general (and profitable) solutions, like RR sugar beets.

Stakeholder Involvement in Project Planning

Additional stakeholder groups and research partners were invited to participate in project planning who were identified during the symposium. A fruitful collaboration of stakeholders continued for three months. Then, on January 18, BASF, Dow and Monsanto withdrew after citing fears regarding data ownership. Specifically, concerns surfaced that data generated contrary to their product claims would place them in a difficult legal position. These concerns were expressed by the research team and symposium organizers months prior but it was not expected that they would emerge at such a late time in the planning process. While this reduced the scope of the project by narrowing the focus more than envisioned at the workshop; it did not change the aims or the substance, importance, or potential impact of the project. Herbicide off-site movement via drift and volatility became the focus of the project since it is the top problem addressed by pesticide education professionals and state regulators (J. Kick-Raack, Ohio Pesticide Education Program, Pers. Comm.). Experts agree that most of the problem is caused by droplet drift. Nationally, 1700 spray drift incidents are reported to state regulators each year (AAPCO 2005). Stakeholders and empirical data suggest reported incidents are only 5-10% of actual (Spray Drift Education Network 2012).

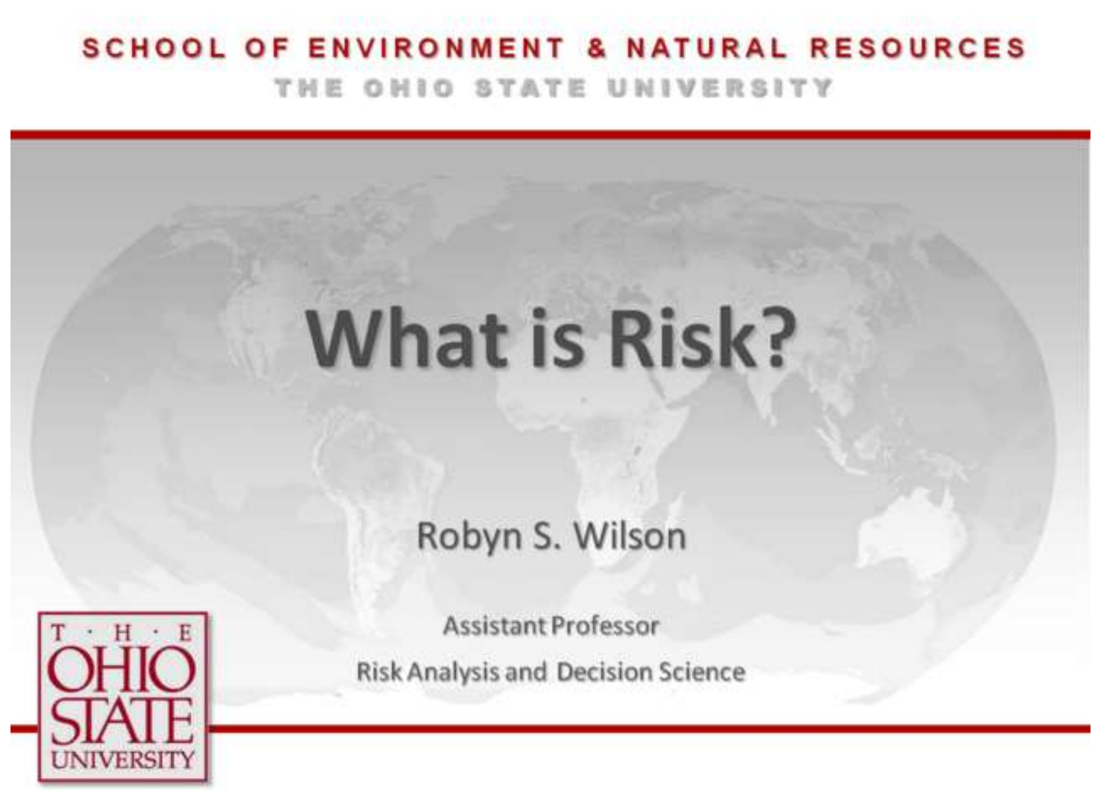
VI. Presenter Information and Presentations

Slides from each presentation follow in the order of the symposium speaker schedule (Appendix A). Information is based on that which was provided by each presenter; the completeness of the abstract and presenter information may vary.

What is Risk? – Robyn Wilson

School of Environment and Natural Resources, The Ohio State University,
wilson.1376@osu.edu, 614-247-6169

Risk is the likelihood of negative consequences occurring to something that humans value. It is essentially a social construct created to give meaning to hazards, activities, technologies, etc that may pose some threat to humans or the natural environment. Making decisions about risk is difficult because often the technical assessments of risk diverge from public perceptions of risk, and this gap in calculated versus perceived risk can cause conflict and disagreement over the appropriate response. Better understanding how different individuals and groups perceive risk is necessary to best communicate about and manage risk.



What is risk?

- The possibility of loss or injury: **PERIL**

  (Merriam-Webster Dictionary, 2003 Edition)

  - Objective component
    - Calculated risk
  - Subjective component
    - Perceived risk

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Calculated Risk

- *FORMAL DEFINITION:* The chance or probability of some measurable adverse outcome for human health, quality of life, quality of the environment, financial interests, etc.

- Risk = Probability x Consequence

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Perceived Risk

- *FORMAL DEFINITION:* A concept used to give meaning to things, forces, or circumstances that pose a threat to things that people value.

- Risk = Consequence x Outrage

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Calculated versus Perceived Risk

Which is “real” risk?

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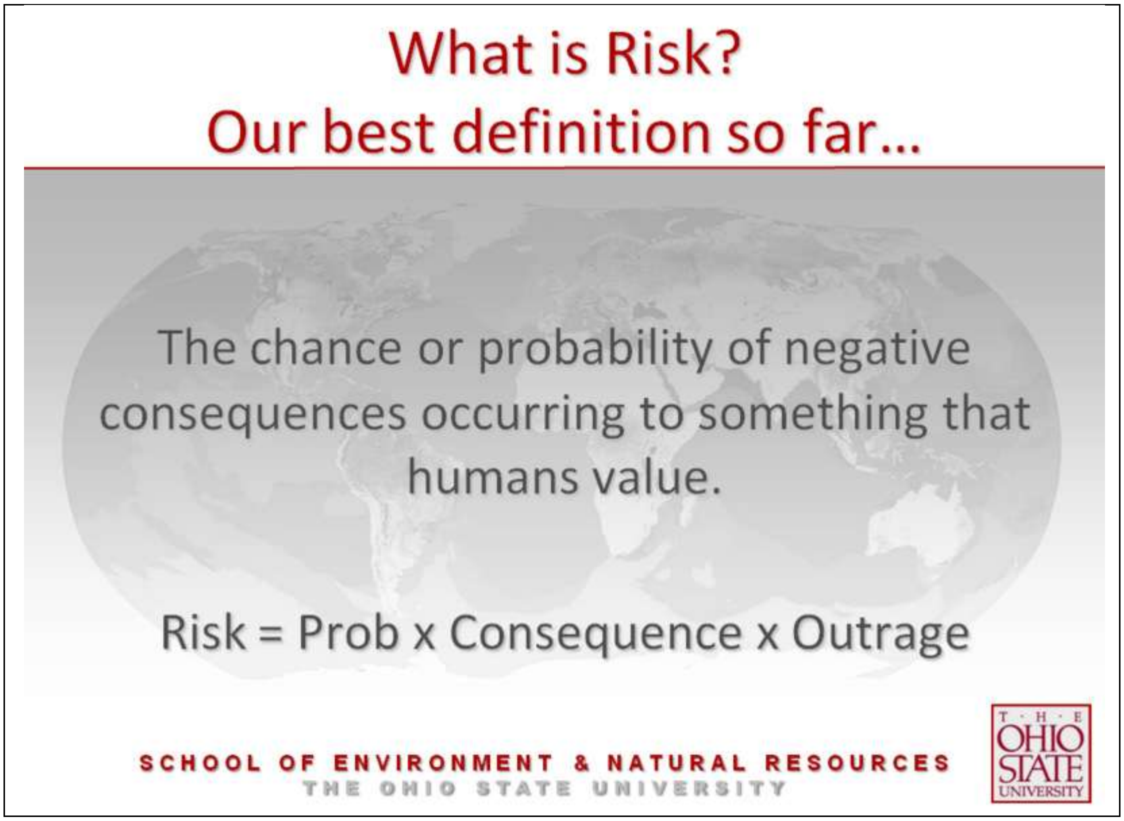
What is Risk?
Our best definition so far…
The chance or probability of negative consequences occurring to something that humans value.
Risk = Prob x Consequence x Outrage
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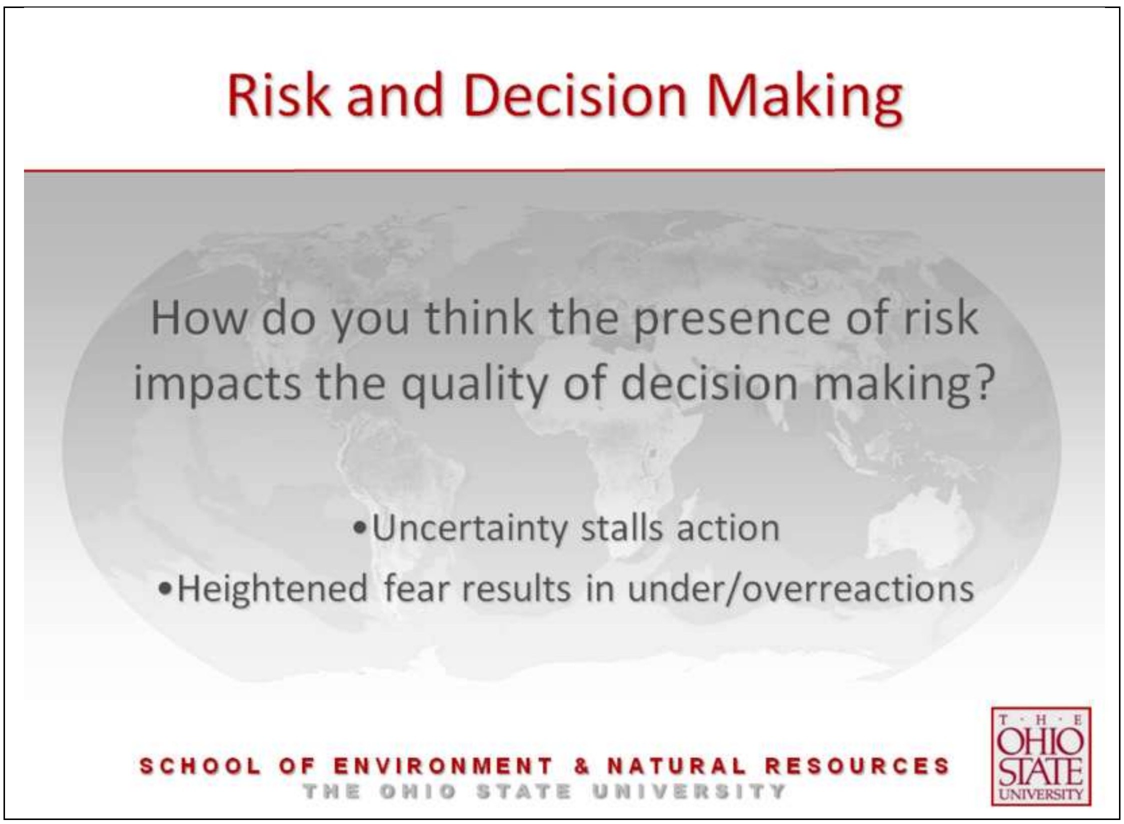
Risk and Decision Making
How do you think the presence of risk impacts the quality of decision making?
•Uncertainty stalls action
•Heightened fear results in under/overreactions
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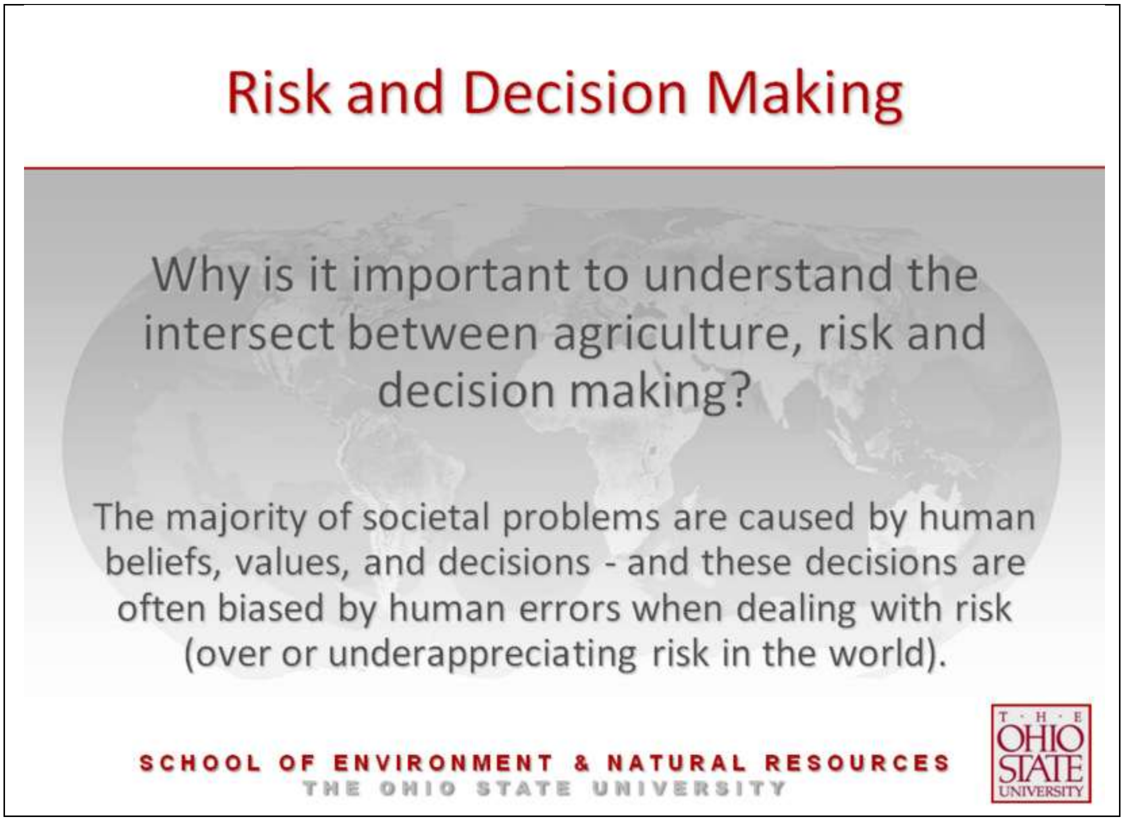
Risk and Decision Making
Why is it important to understand the intersect between agriculture, risk and decision making?
The majority of societal problems are caused by human beliefs, values, and decisions - and these decisions are often biased by human errors when dealing with risk (over or underappreciating risk in the world).
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Questions?
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The Roundup Ready Story (according to me) – Michael D. K. Owen

Associate Chair and Professor of Agronomy, Iowa State University, mdowen@iastate.edu

The commercial introduction and subsequent adoption of glyphosate-resistant crops represents an unprecedented change in global agriculture. Nothing has ever impacted the agriculture to the extent that crop systems based on the glyphosate-resistance trait and glyphosate. The entire demographics of agriculture reflected the early successes of this technology; glyphosate-based crop systems were presumed to be economically rewarding and environmentally friendly. However, growers who became lulled by the mantra of "simplicity and convenience" did not recognize nor accept the ecological risks that the selection presume imposed by the use of one herbicide recurrently represented. Relatively early in the unprecedented change in agriculture, the inevitable happened; weeds with evolved resistance to glyphosate were identified. Across US agriculture, the appearance of populations of some weeds with evolved resistance to glyphosate is increasing at an increasing rate. The problem, given the weed species that have evolved resistance, has the potential to significantly limit the utility, and thus the benefits, of this important technology. It is questionable whether or not the issues of glyphosate-resistant weeds can be mitigated without resorting to technologies whose benefit to risk ratios are may be less favorable and whose time management considerations likely will negatively impact the current crop production systems.

Micheal D. K. Owen is a Professor of Agronomy and Weed Management Extension Specialist at Iowa State University and Associate Chair of the Agronomy Department. He is also an adjunct Professor in the Department of Vegetable Protection at Esculea Agricola Panamericana at Zamorano, Honduras. Dr. Owen received his B.S. degree in Botany/Plant Physiology in 1974 and M.S. in Botany/Weed Science in 1975 from Iowa State University. He received his Ph.D. degree in Agronomy/Weed Science from the University of Illinois in 1982 while serving as an Extension Agronomist. Prior to joining the faculty at Iowa State University, he was a faculty member in teaching and extension at the University of Florida. His research interests include herbicidal weed management, weed biology and plant stress physiology. Owen was a co-author of the National Research Council report "The Impact of Genetically Engineered Crops on Farm Sustainability in the United States" released in 2010 and is on the steering committee for the National Summit on Strategies to Manage Herbicide-Resistant Weeds sponsored by the National Academy of Sciences.

The Roundup Ready Story
(according to me)

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University Extension

Introduction

- Glyphosate-resistant crop systems is unprecedented globally
- No other technology has been adopted to the extent of glyphosate-resistant crops
  - Growers and the public benefited from this technology
  - Supported conservation practices, environmental safety and economics
- Unprecedented adoption: soybean in 1996 (~91%), cotton in 1997 (~71%) and corn in 1998 (~68%)

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Introduction

- Controversies – bentgrass, sugarbeets and alfalfa, Wheat? Other crops?
- Generally, the technology has been a success but not without problems
- Simplicity and convenience – a sword with two edges
- The technology allowed growers to mismanage weed control – IWM?

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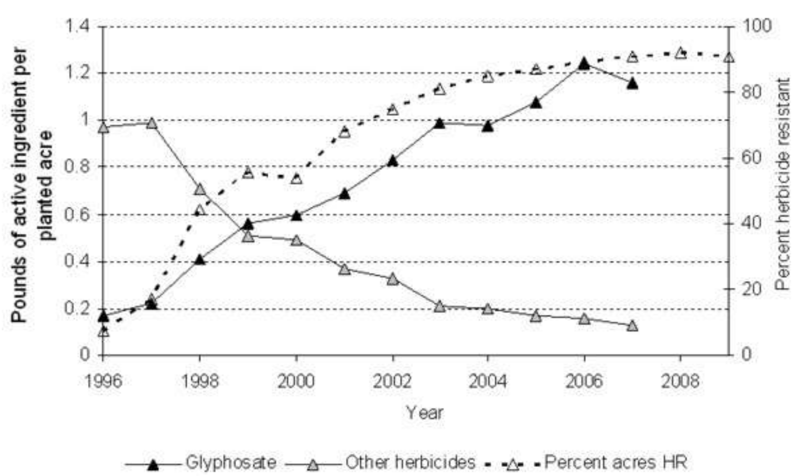
Glyphosate-resistant soybeans and herbicide use



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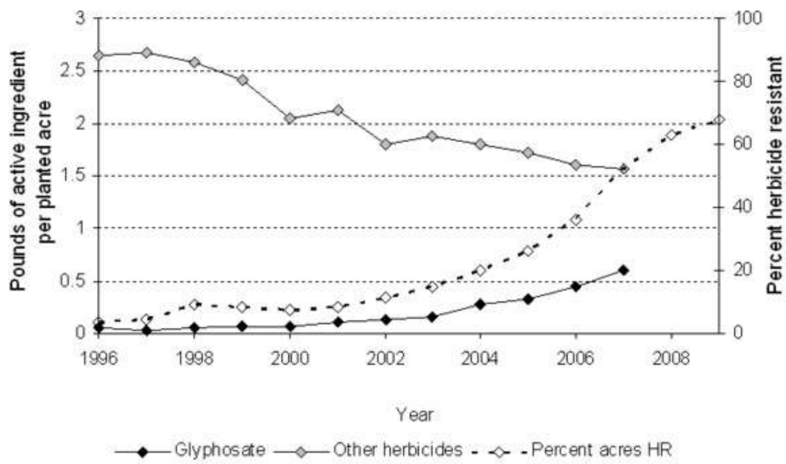
Glyphosate-resistant corn and herbicide use



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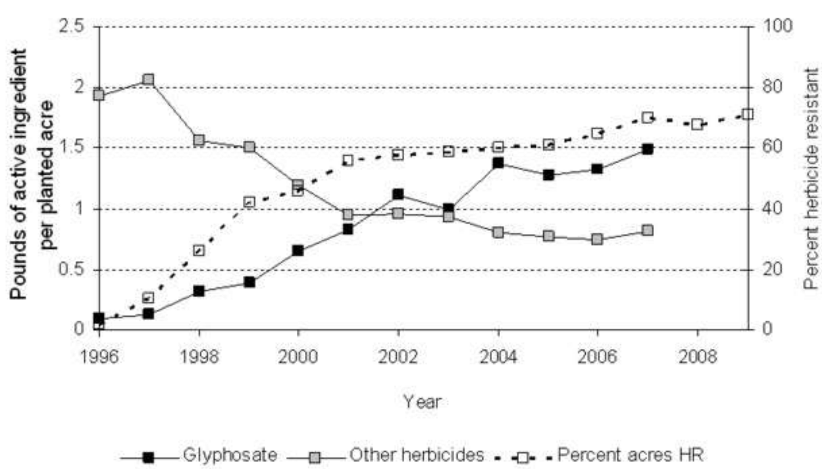
Glyphosate-resistant cotton and herbicide use



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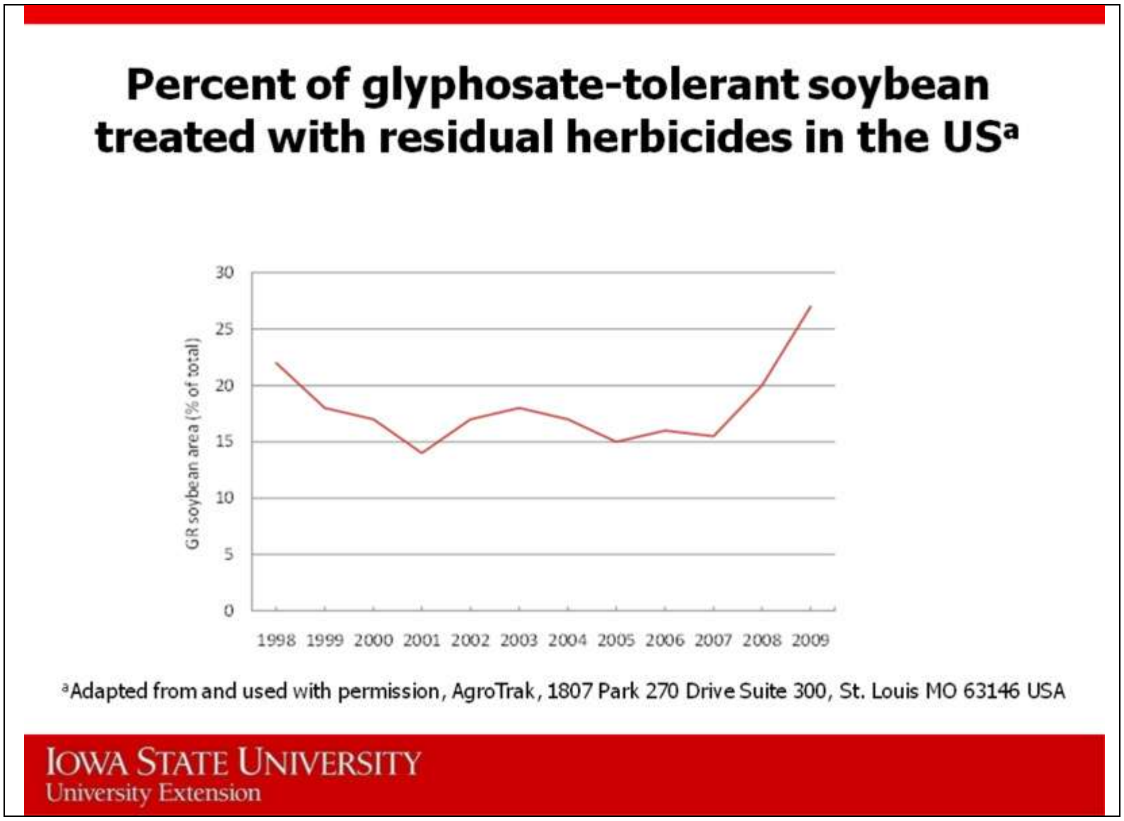
Percent of glyphosate-tolerant soybean treated with residual herbicides in the US[a]
GR soybean area (% of total)
30
25
20
15
10
5
0
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
[a]Adapted from and used with permission, AgroTrak, 1807 Park 270 Drive Suite 300, St. Louis MO 63146 USA
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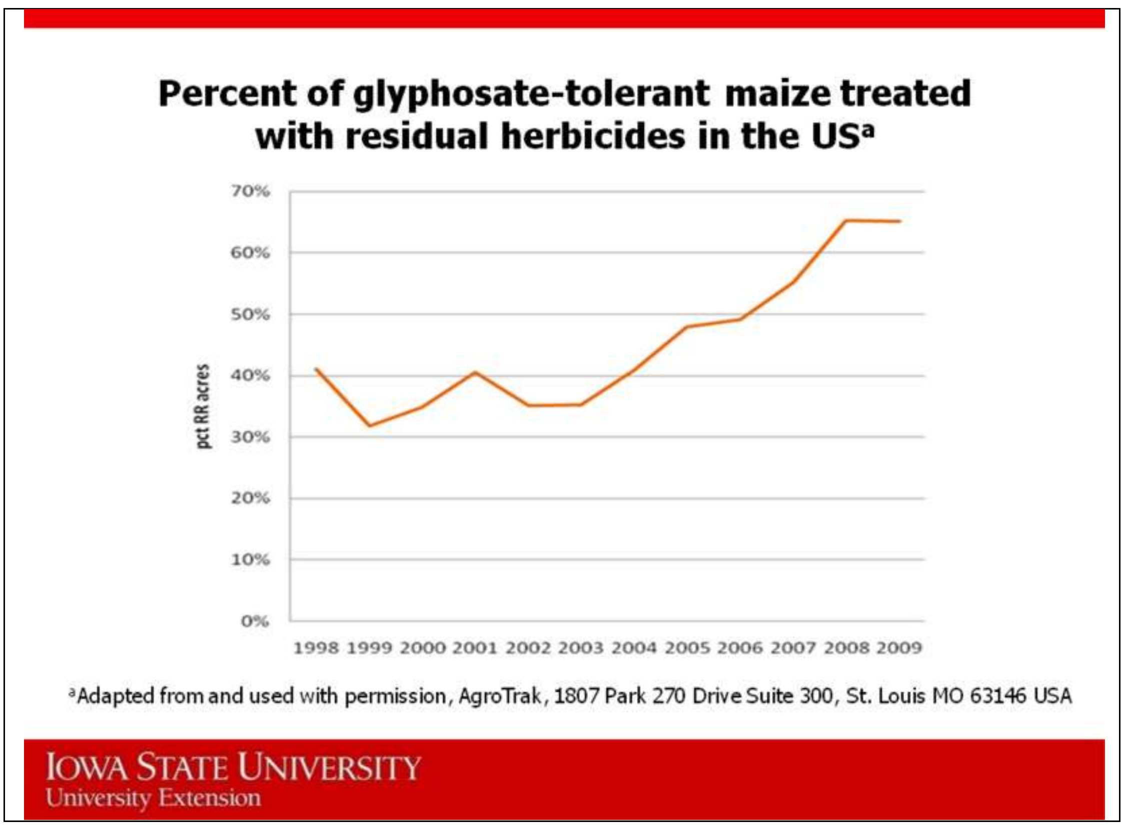
Percent of glyphosate-tolerant maize treated with residual herbicides in the US[a]
pct RR acres
70%
60%
50%
40%
30%
20%
10%
0%
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
[a]Adapted from and used with permission, AgroTrak, 1807 Park 270 Drive Suite 300, St. Louis MO 63146 USA
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Gene flow

- Gene flow occurs via pollen movement and seed contamination
- Introgression of traits to compatible plants?
  - Generally not a problem with the technology (Canola? Sugar beet? Alfalfa?)
- Pollen flow has remained a problem for corn production
- Grain segregation?

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Introgression of trait

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University Extension

Herbicide resistance

- The evolution of herbicide resistance is not a herbicide problem
- The evolution of herbicide resistance is not a trait problem
- The evolution of herbicide resistance is not a glyphosate problem
- The evolution of herbicide resistance is a behavioral problem

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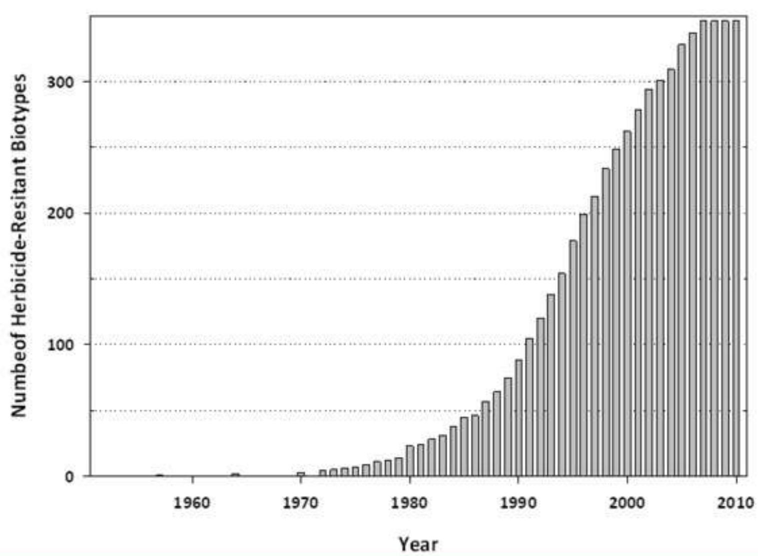
Evolution of herbicide resistance*



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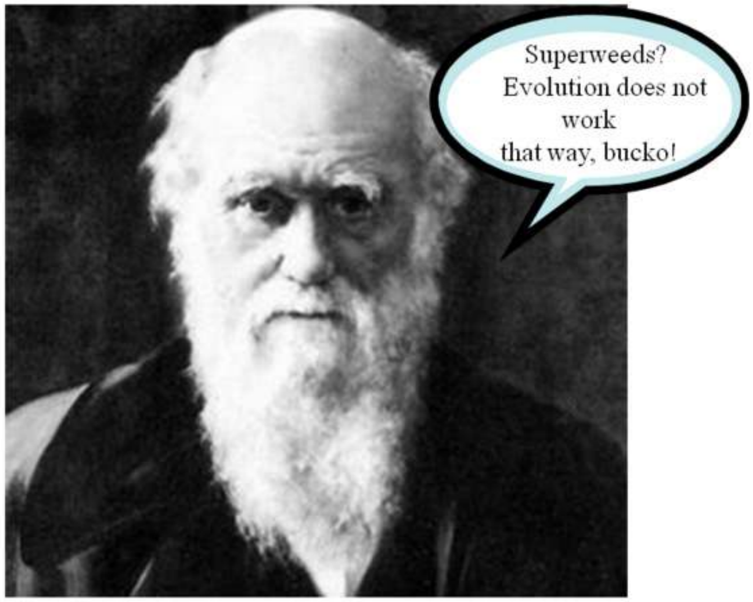
*www.weedscience.com



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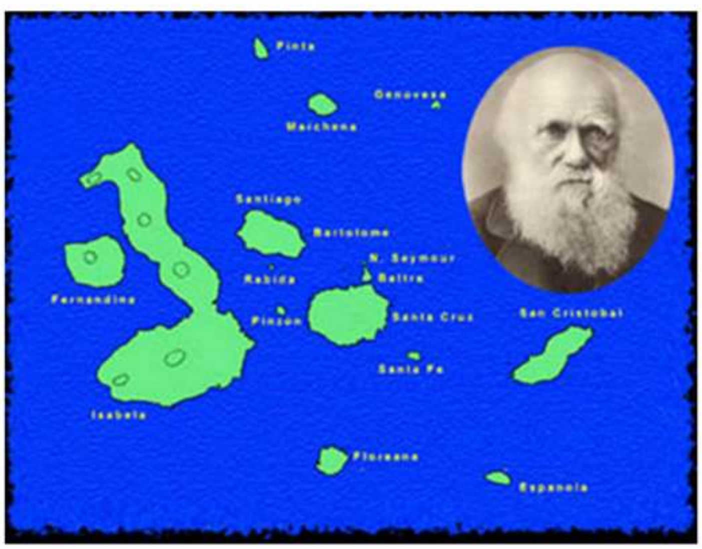
Darwin's finches



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Herbicide resistance - glyphosate

- Currently there are 21 weed species that have evolved resistance to glyphosate*
- 13 weed species have evolved resistance to glyphosate in the US
- Most of these glyphosate-resistant weeds species evolved resistance in cropping systems based on glyphosate-resistant crops
- The Midwest corn/soybean belt a has a number of glyphosate-resistant weeds as economic problems
- Major problems in cotton production in the Mississippi Delta and the Southeast US

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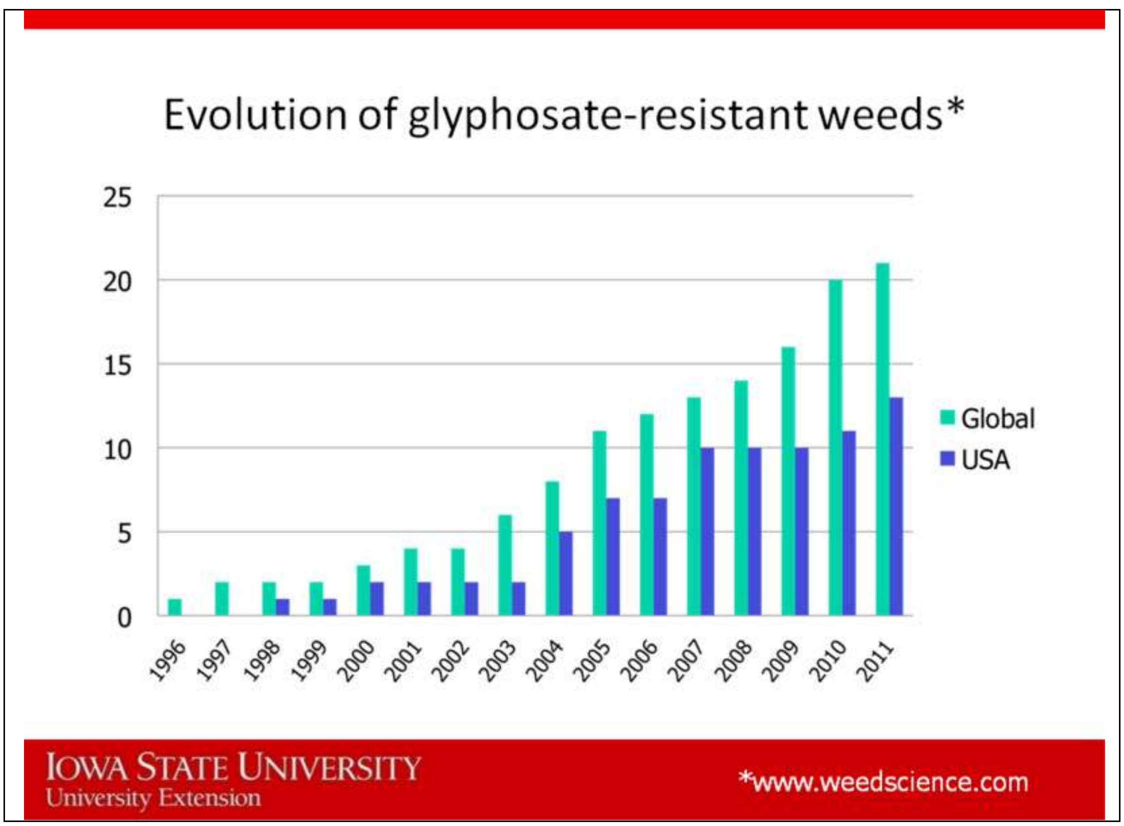
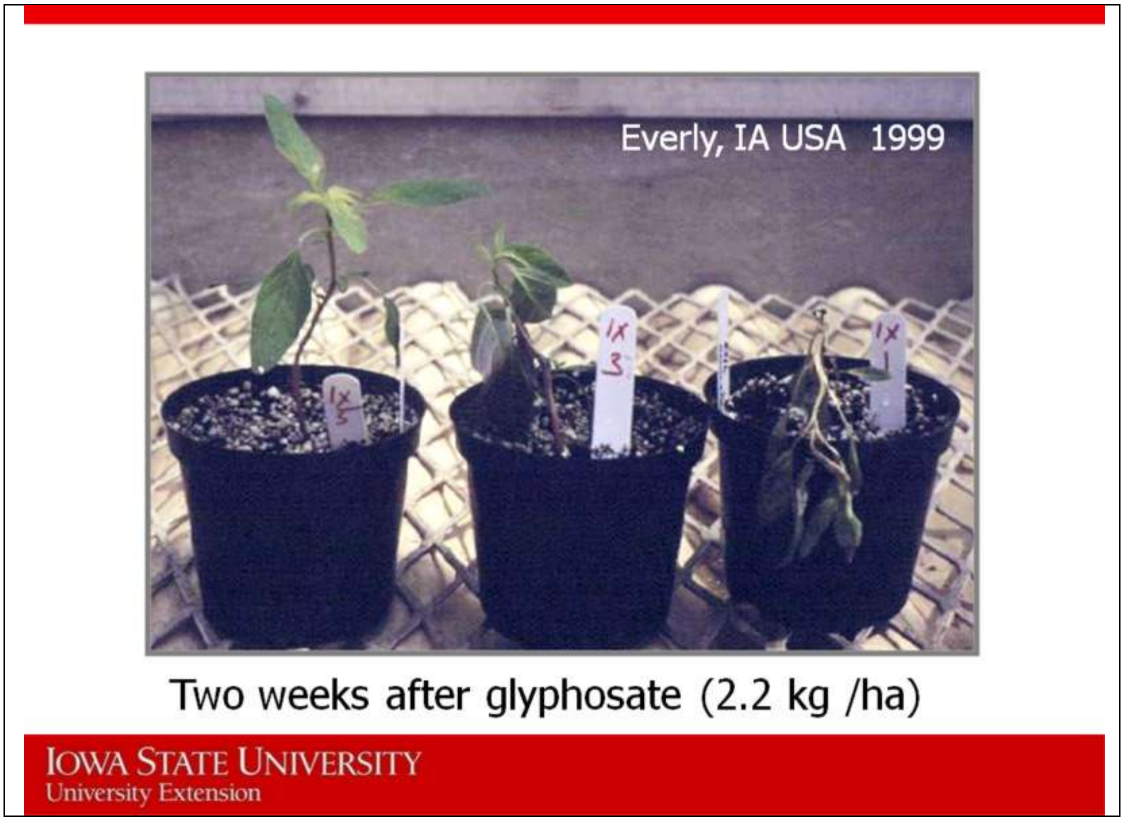
*www.weedscience.com




Everly, IA USA 1999
Two weeks after glyphosate (2.2 kg /ha)
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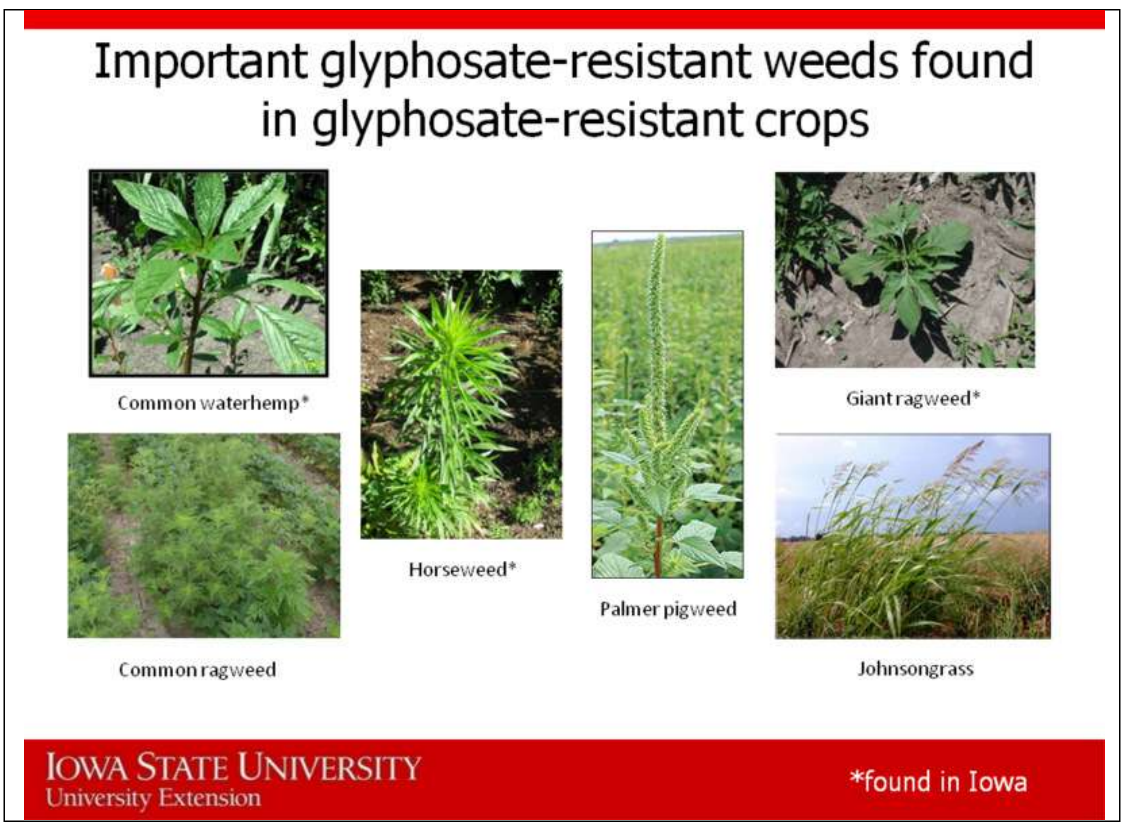
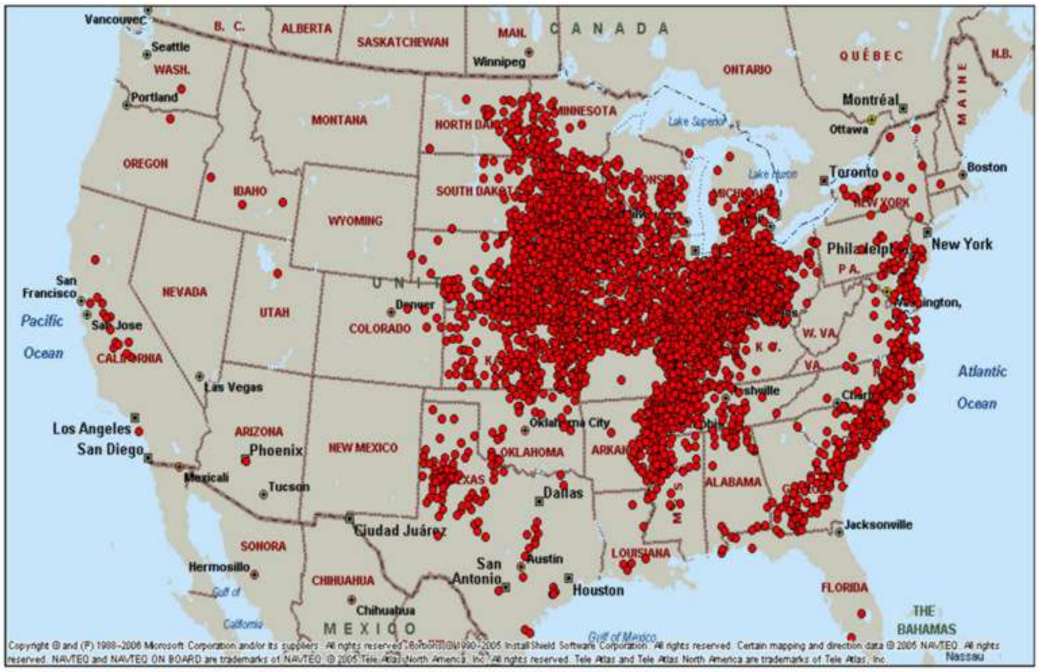

Important glyphosate-resistant weeds found in glyphosate-resistant crops
Common waterhemp*
Horseweed*
Palmer pigweed
Giant ragweed*
Common ragweed
Johnsongrass
IOWA STATE UNIVERSITY
University Extension
*found in Iowa



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Ohio "Weed Gothic"

(apologies to Grant Wood)

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Giant ragweed harvest, Indiana USA

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Palmer amaranth in cotton – a hand-weeding crew

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Asiatic dayflower, Iowa USA

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Questions?

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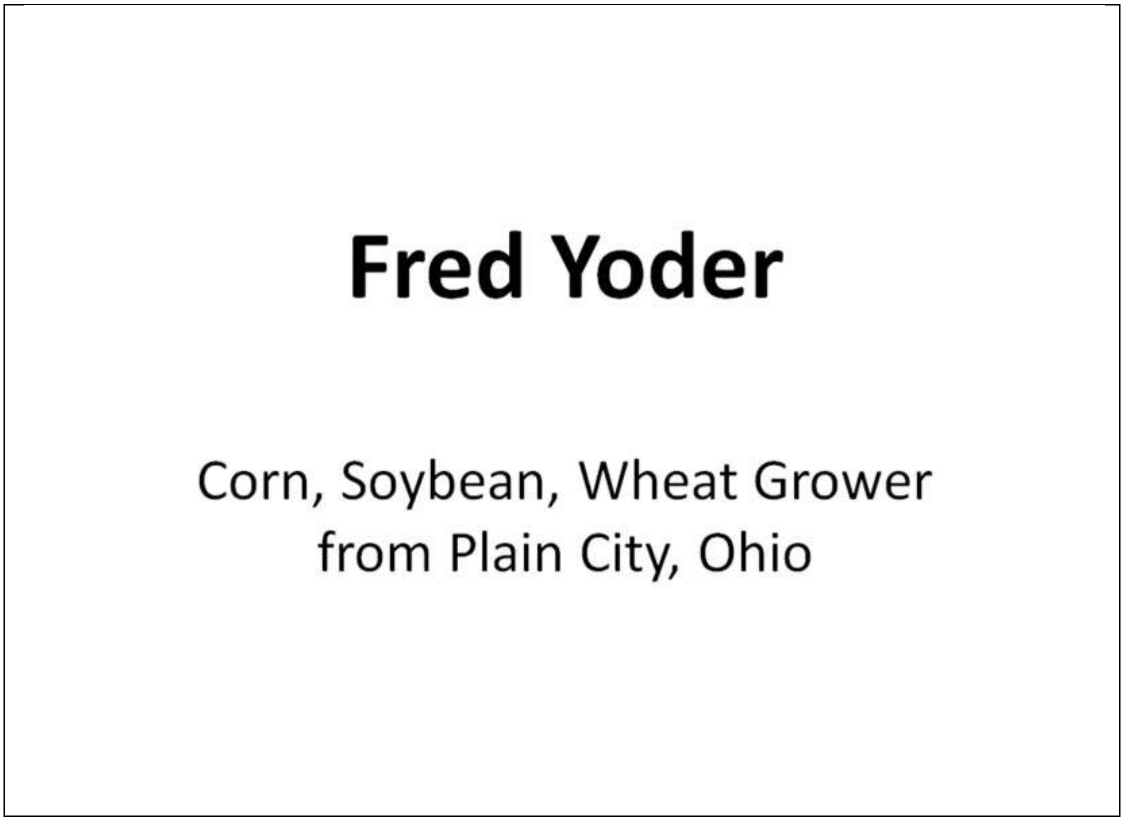
The Need for New Weed Control in Grain – Fred Yoder

Ohio Farmer

The grain producer perspective on the needs (or not) for new means of weed control. Yoder sees many advantages in adding varieties with 2,4-D and Dicamba Tolerant crops, but also sees many pitfalls if we don't do this right.



Marestail control has been very challenging in 2011

- Good burndown with Roundup and 2,4-D with Strong residual, Valor XLT (Right).
- Consistent results require strong residual products and Excellent burndown products. This approach limits Many growers.
- Many Marestail populations in Ohio are resistant to both Glyphosate and ALS chemistry, severely limiting POST options to control escapes .

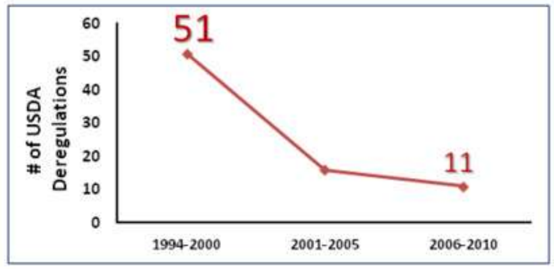
Plot Treated with Glyphosate at 32 fl oz/A.

Plot Treated with Glyphosate at 32 fl oz/A and Dicamba at 16 fl oz/A.

Marestail Seedlings Oct 15th 2011, Glyphosate resistant Site. All plants in this photo are marestail, 2012 will be a challenging season if control measures are not taken.

Biotech pipelines are bursting, but US farmers are waiting longer for new tools

- Number of USDA deregulations per year has decreased significantly

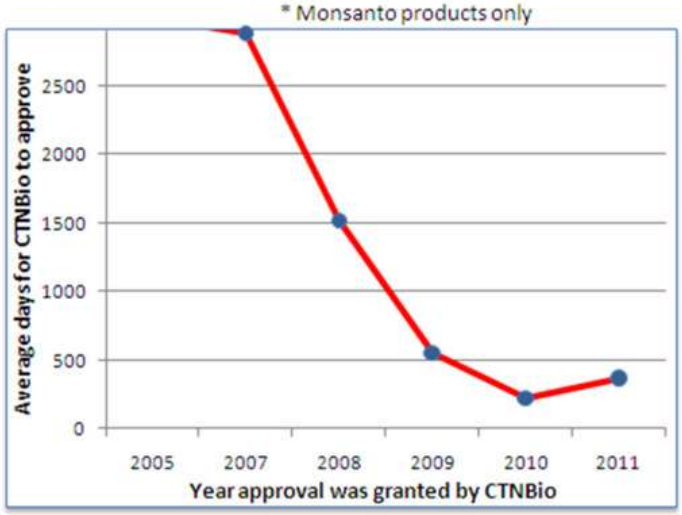


- Timelines for USDA petition review have increased significantly

Brazilian farmers are getting technology faster . . .

Brazil CTNBio Approval Timelines

* Monsanto products only



44


Thank You
Any Questions?

Glyphosate-resistant Palmer Amaranth Devastates Agronomic Crops, New Technology is Desperately Needed – Stanley Culpepper

Crop and Soil Sciences, University of Georgia, stanley@uga.edu

Herbicide-Resistant Weeds Challenging Cotton Growers

Palmer amaranth

Common waterhemp

Horseweed

Johnsongrass

Ryegrass

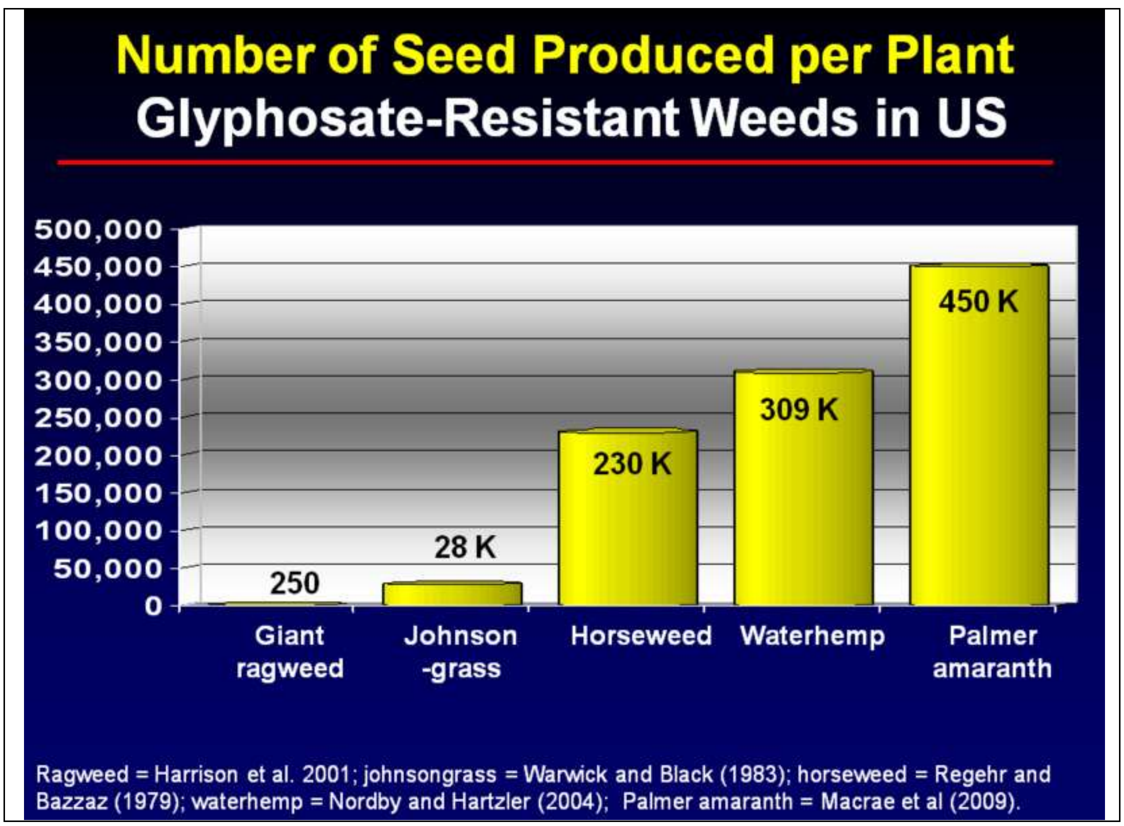
Ragweed – common and giant

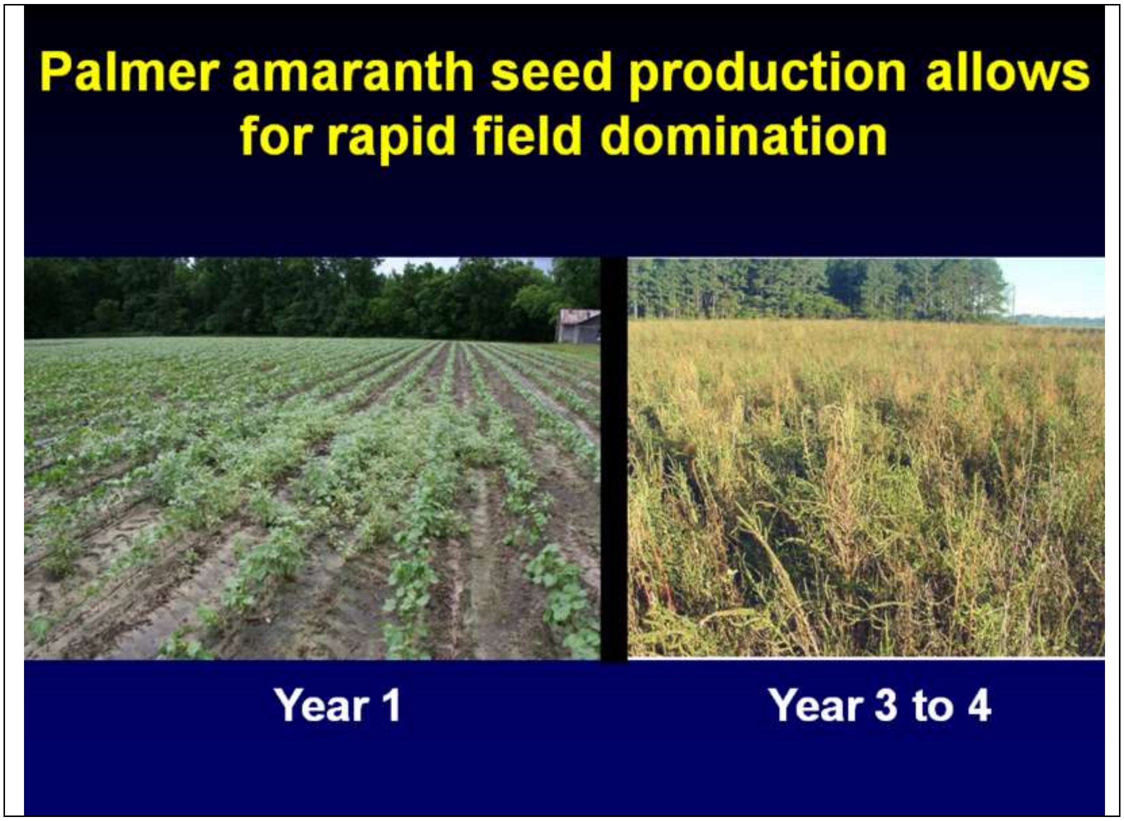
Resistance to glyphosate in all of the listed weeds is the primary issue as well as ALS resistance in several of the species.

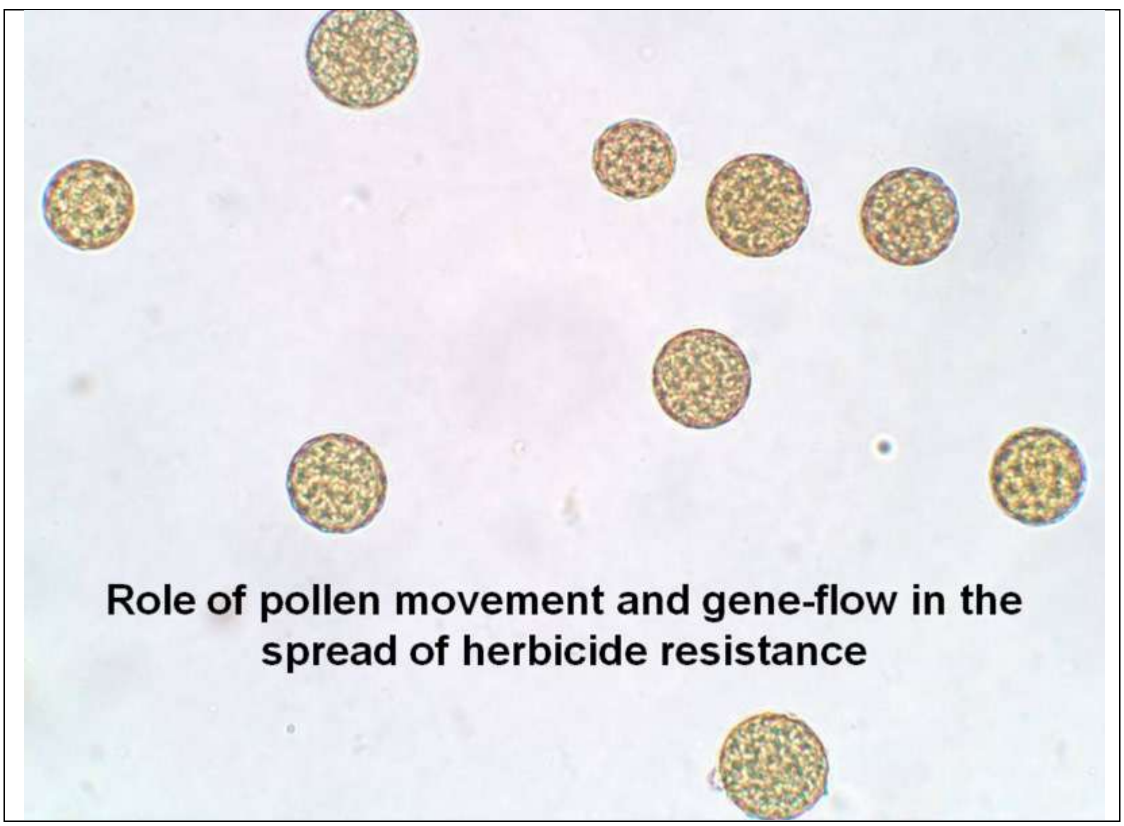

The old days are long gone, primarily because of the biology of the pest we are fighting!

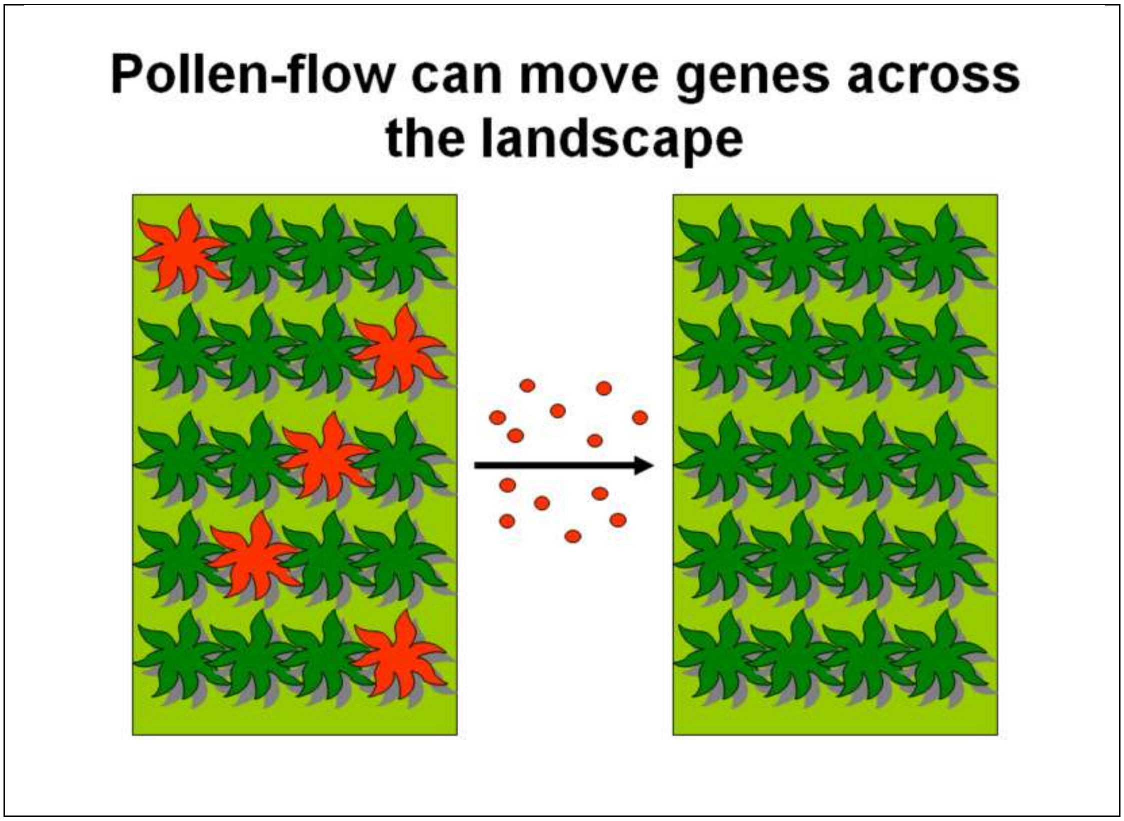

Rapid Growth Becoming Extremely Large

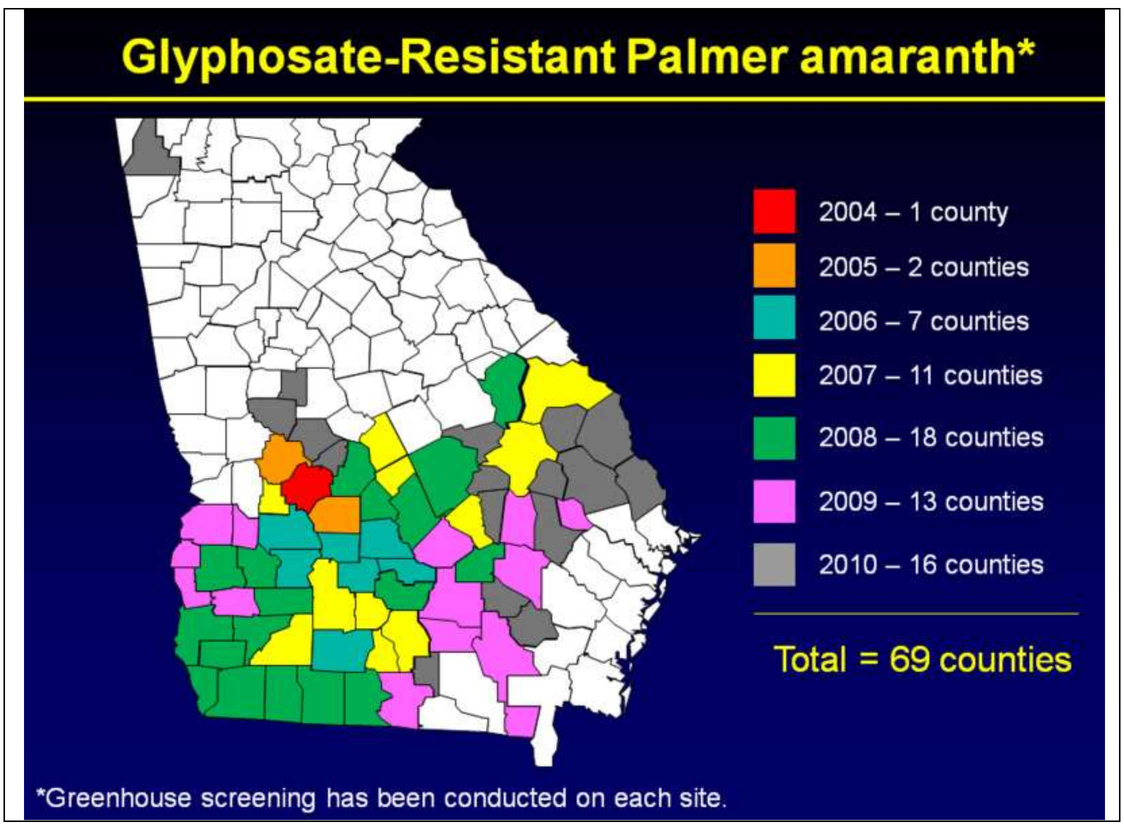

Impact on Harvest

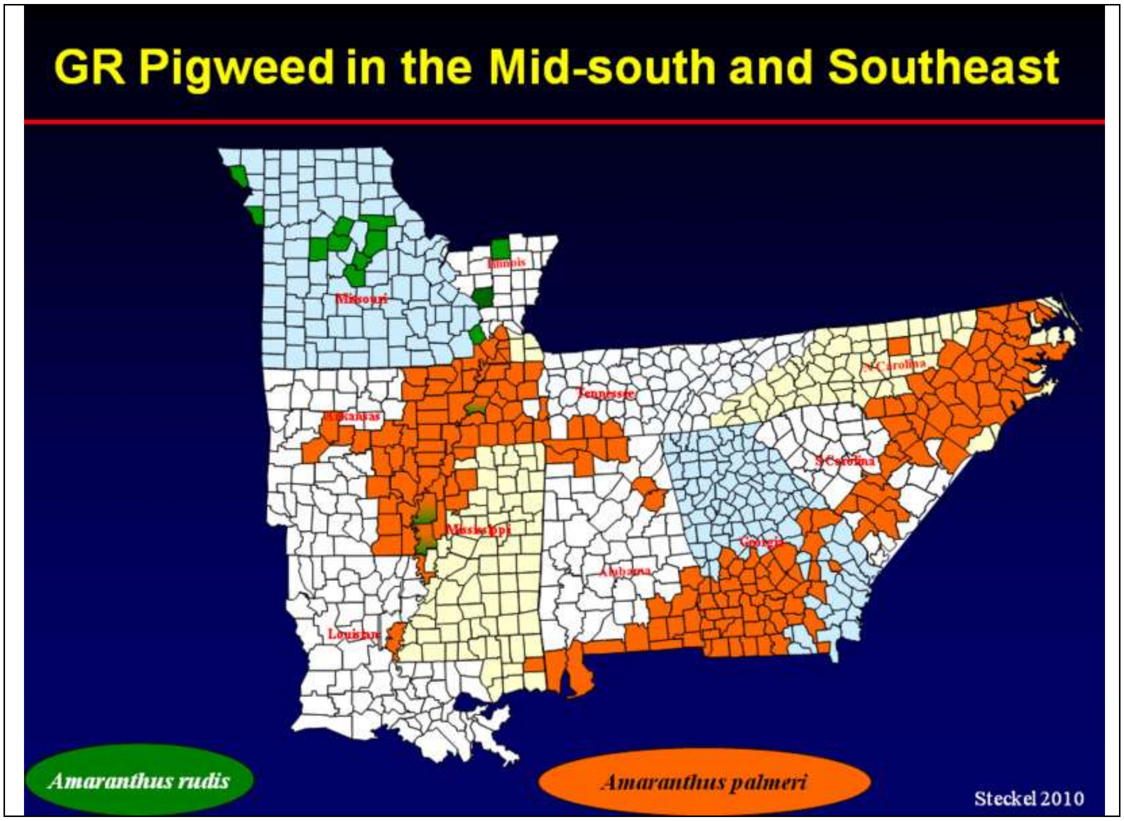

Number of Seed Produced per Plant
Glyphosate-Resistant Weeds in US
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
250
28 K
230 K
309 K
450 K
Giant ragweed
Johnson -grass
Horseweed
Waterhemp
Palmer amaranth
Ragweed = Harrison et al. 2001; johnsongrass = Warwick and Black (1983); horseweed = Regehr and Bazzaz (1979); waterhemp = Nordby and Hartzler (2004); Palmer amaranth = Macrae et al (2009).

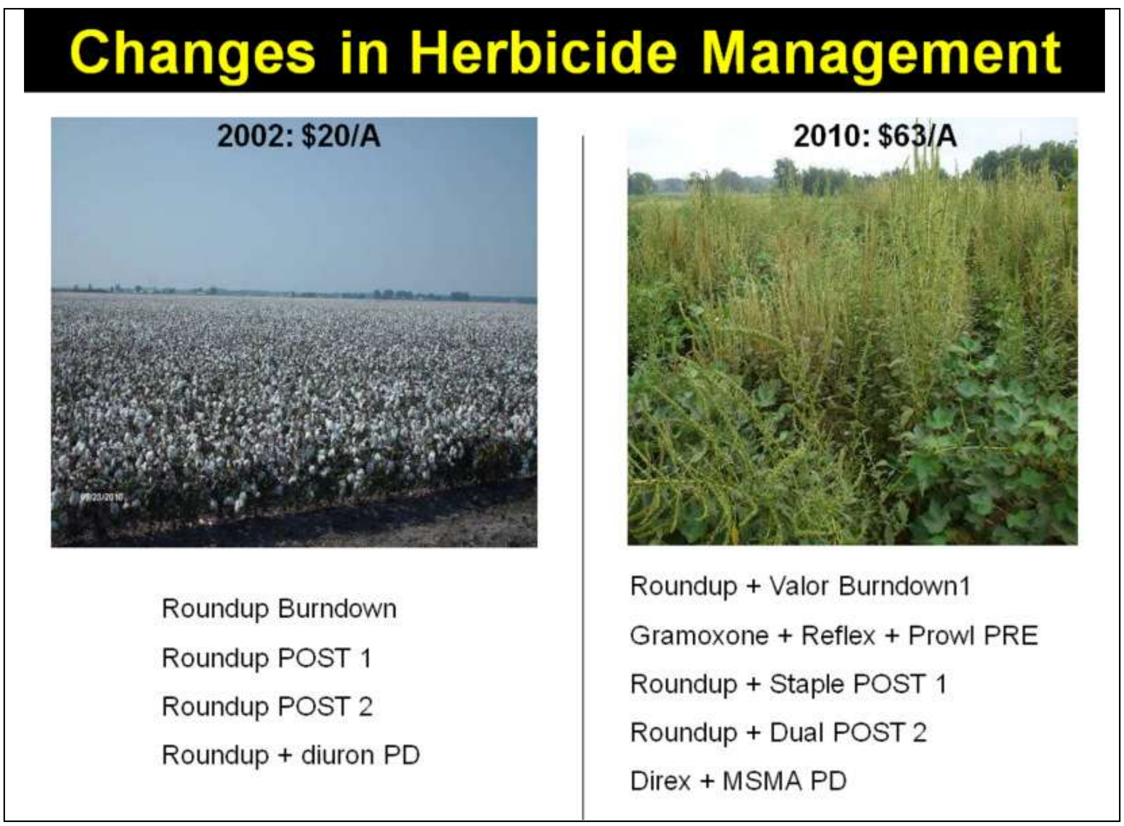

Palmer amaranth seed production allows for rapid field domination
Year 1
Year 3 to 4

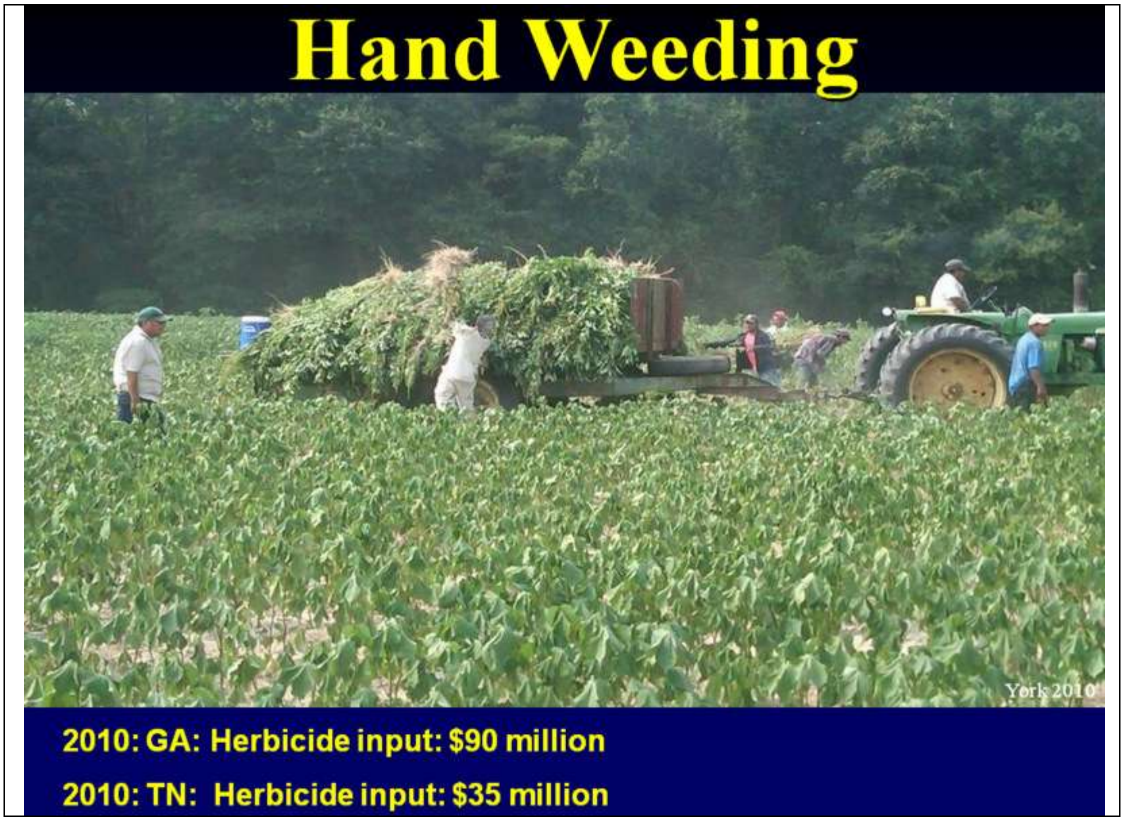

Role of pollen movement and gene-flow in the spread of herbicide resistance


Pollen-flow can move genes across the landscape

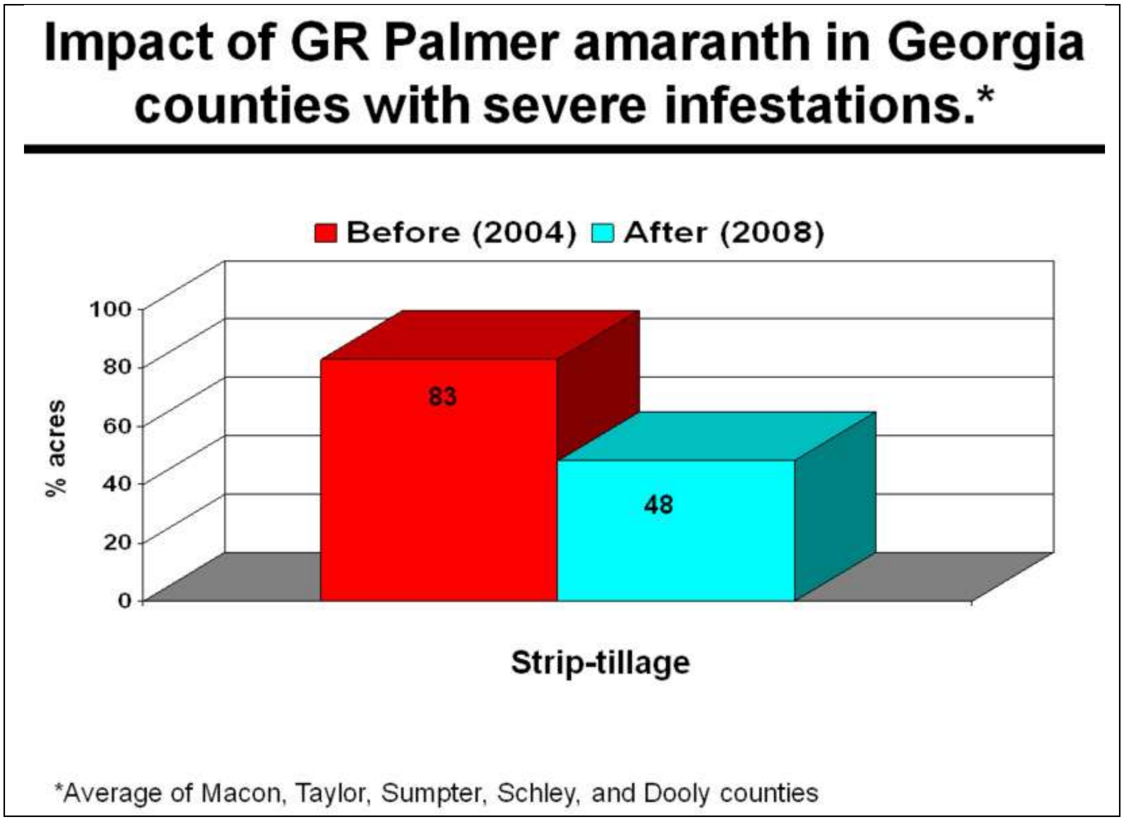

Glyphosate-Resistant Palmer amaranth*
2004 – 1 county
2005 – 2 counties
2006 – 7 counties
2007 – 11 counties
2008 – 18 counties
2009 – 13 counties
2010 – 16 counties
Total = 69 counties
*Greenhouse screening has been conducted on each site.


GR Pigweed in the Mid-south and Southeast
Amaranthus rudis
Amaranthus palmeri
Steckel 2010

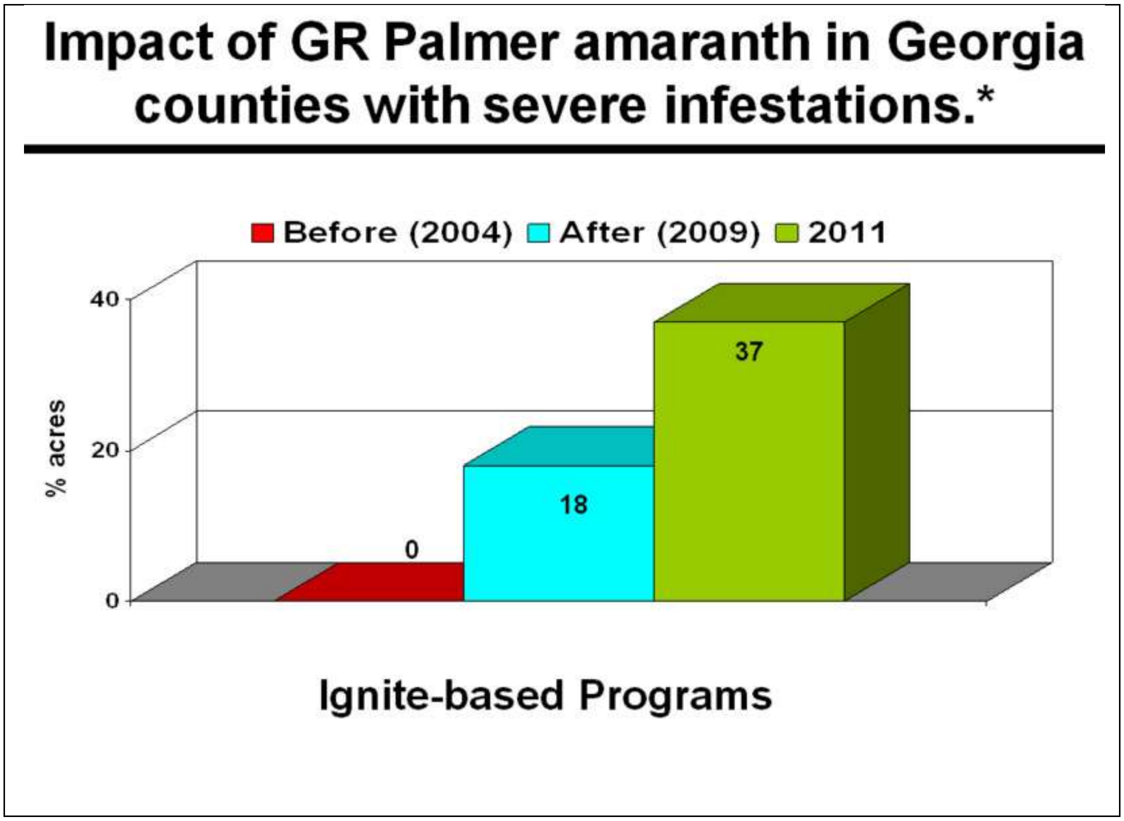

Changes in Herbicide Management
2002: $20/A
Roundup Burndown
Roundup POST 1
Roundup POST 2
Roundup + diuron PD
2010: $63/A
Roundup + Valor Burndown1
Gramoxone + Reflex + Prowl PRE
Roundup + Staple POST 1
Roundup + Dual POST 2
Direx + MSMA PD


Hand Weeding
York 2010
2010: GA: Herbicide input: $90 million
2010: TN: Herbicide input: $35 million


Hand Weeding
York 2010
GA: 92% of growers handweeding 53% of the 2010 crop = $16 million
TN: growers handweeding 20% of crop = $3 million


Impact of GR Palmer amaranth in Georgia counties with severe infestations.*
Before (2004)
After (2008)
100
80
60
40
20
0
% acres
83
48
Strip-tillage
*Average of Macon, Taylor, Sumpter, Schley, and Dooly counties

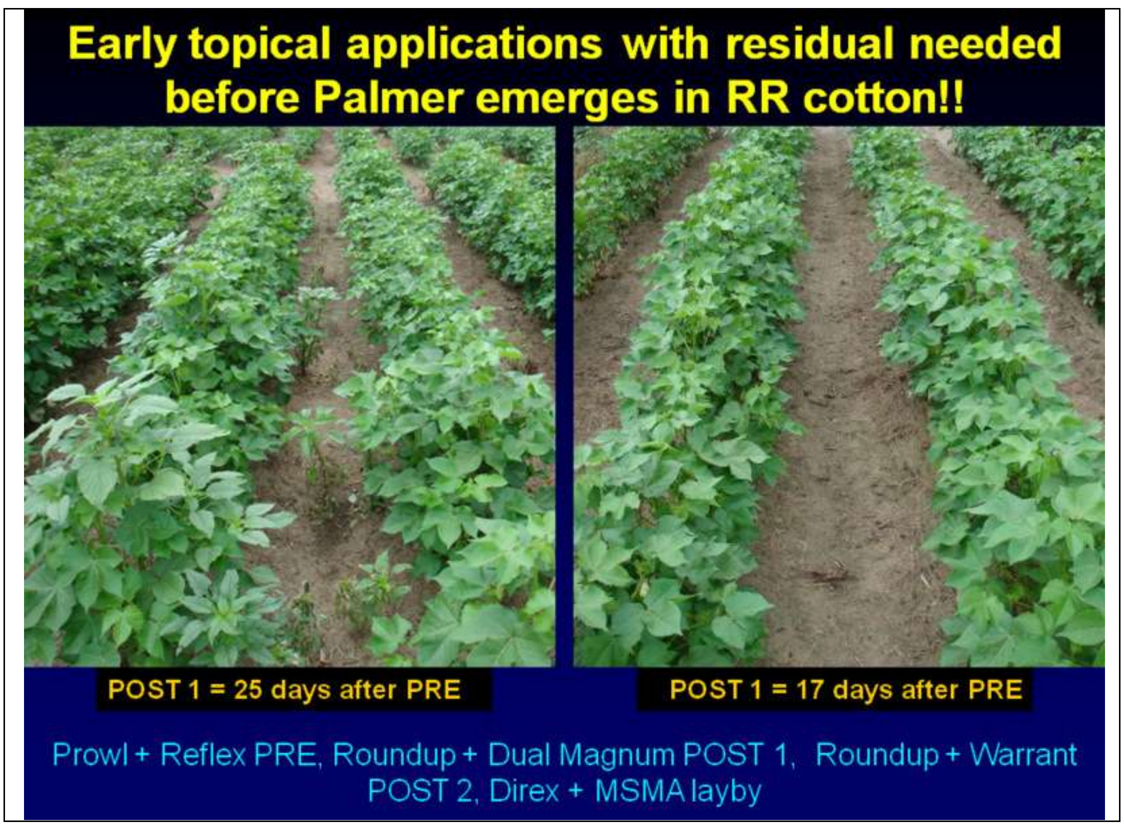

Tillage is now a common scene


Impact of GR Palmer amaranth in Georgia counties with severe infestations.*
Before (2004)
After (2009)
2011
40
20
0
% acres
0
18
37
Ignite-based Programs


Ignite on Palmer greater than 3 inch: REGROWTH

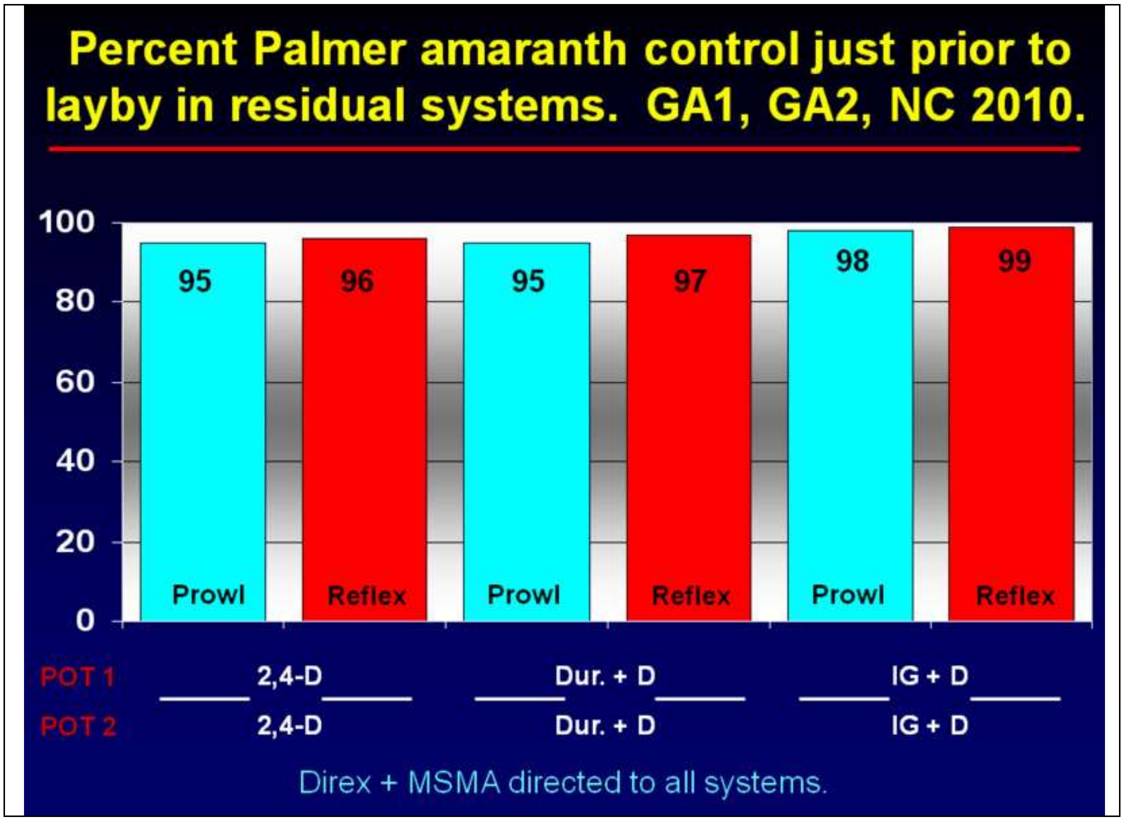
Controlling GR Palmer in RR RT Cotton. 2012.

Preplant	PRE	POST1 cot.-1 lf cotton	POST 2 5-6 lf cotton	Layby
Valor or diuron	Reflex + diuron Reflex + Prowl Reflex + Cotoran Reflex + Staple Prowl + Staple + diuron	RU + Staple (emerged pigweed)	RU + Dual or Warrant	Diuron + MSMA
		RU + Dual or Warrant	RU + Dual or Warrant	
Valor before emergence; diuron + paraquat less than 5 inch Palmer	48 hr within planting; add paraquat	10 - 12 d PRE	13 - 15 d POST 1	15-18 d POST2




2 GR Weeds in the Same Field
Steckel 2010


IN DESPERATE NEED OF NEW TOOLS!
Developing Integrated Programs


Percent Palmer amaranth control just prior to layby in residual systems. GA1, GA2, NC 2010.
100
80
60
40
20
0
95
96
95
97
98
99
Prowl
Reflex
Prowl
Reflex
Prowl
Reflex
POT 1
POT 2
2,4-D
2,4-D
Dur. + D
Dur. + D
IG + D
IG + D
Direx + MSMA directed to all systems.


Today
Herbicide Cost of $59/A
Tomorrow
Herbicide Cost of $39/A

Drift & Volatility from 2,4-D or Dicamba

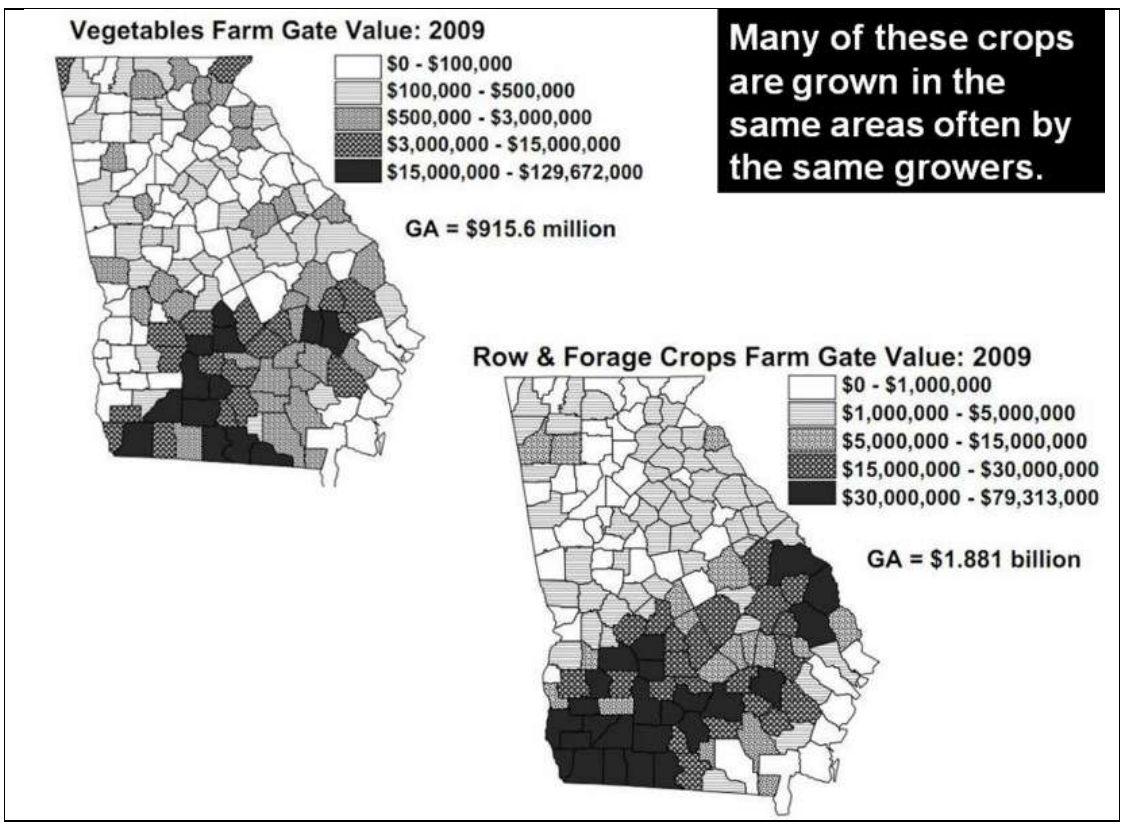
- Huge concern!!!!!
  - Biological sensitivity of non-resistant cotton or peanuts to 2,4-D or dicamba, respectively

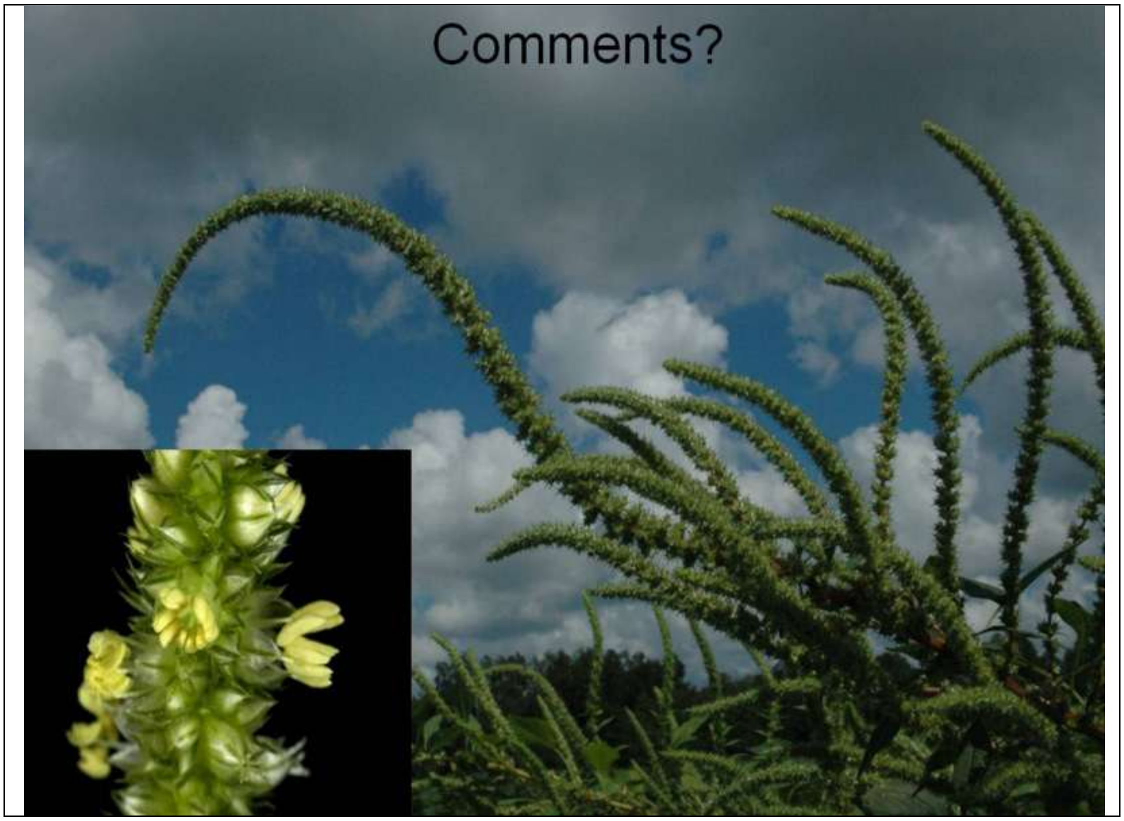
Drift & Volatility from 2,4-D or Dicamba

- Huge concern!!!!!
  - Biological sensitivity of non-resistant cotton or peanuts to 2,4-D or dicamba, respectively
  - Biological sensitivity of vegetables/ fruits

GA Vegetable Facts

- Since 2008: 7% increase in vegetable acreage
- Approximately 175,000 acres
- 40 different vegetables grown
- Third largest vegetable producing state in acres
- Farm Gate Value: **$1,200,000,000**




Comments?

Academic perspectives on 2,4-D tolerant crops – Mark Loux

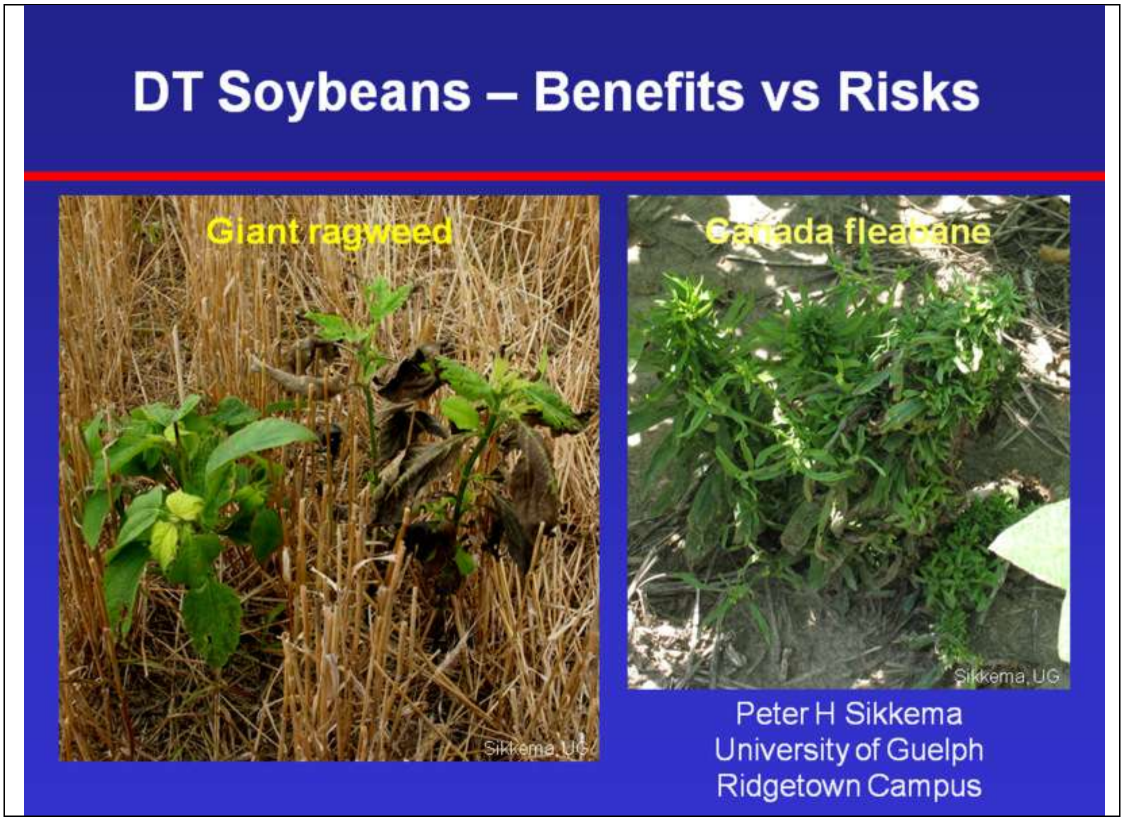
Horticulture and Crop Science, Ohio State University, loux.1@osu.edu

Dicamba Tolerant Soybean - Benefits and Risks – Peter Sikkema

Plant Agriculture, University of Guelph, psikkema@ridgetownc.uoguelph.ca

Dicamba tolerant (DT) soybean is expected to be registered for use by North American soybean producers in the near future. This technology provides soybean producers with an additional weed management tool but there are some risks associated with the use of both glyphosate and dicamba.

There are a number of benefits with the use of dicamba in DT soybean. Dicamba will provide control of selected glyphosate resistant broadleaf weed biotypes such as giant ragweed and Canada fleabane. In research conducted in Ontario, a single application of glyphosate plus dicamba provided 81-94% control of glyphosate resistant giant ragweed depending on application timing and dicamba rate. Similarly, glyphosate plus dicamba provided 70-100% control of glyphosate resistant Canada fleabane depending on application timing. A sequential application of glyphosate plus dicamba applied preplant followed by postemergence provided 100% control of glyphosate resistant giant ragweed and Canada fleabane. For both weed species improved control was obtained with early applications when the weeds were smaller at the time of application. In addition, the use of dicamba in DT soybean will provide improved control of weeds that are naturally tolerant to glyphosate such as perennial broadleaf weeds and weeds in the *Polygonum* family. Dicamba will provide short residual broadleaf weed control depending on rate. Furthermore, the addition of dicamba to glyphosate will reduce the selection intensity for additional herbicide resistant weeds. Finally, DT soybean has excellent tolerance to both glyphosate and dicamba.

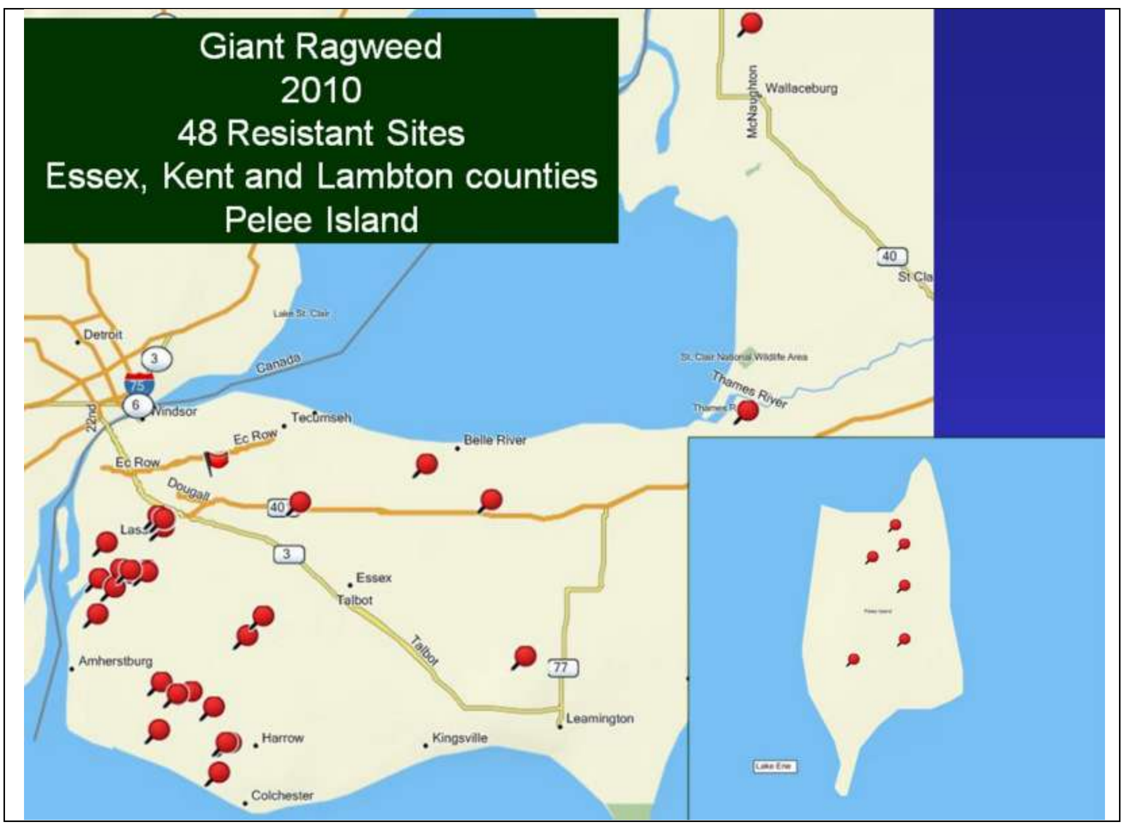

DT Soybeans – Benefits vs Risks
Giant ragweed
Sikkema, UG
Canada fleabane
Sikkema, UG
Peter H Sikkema
University of Guelph
Ridgetown Campus

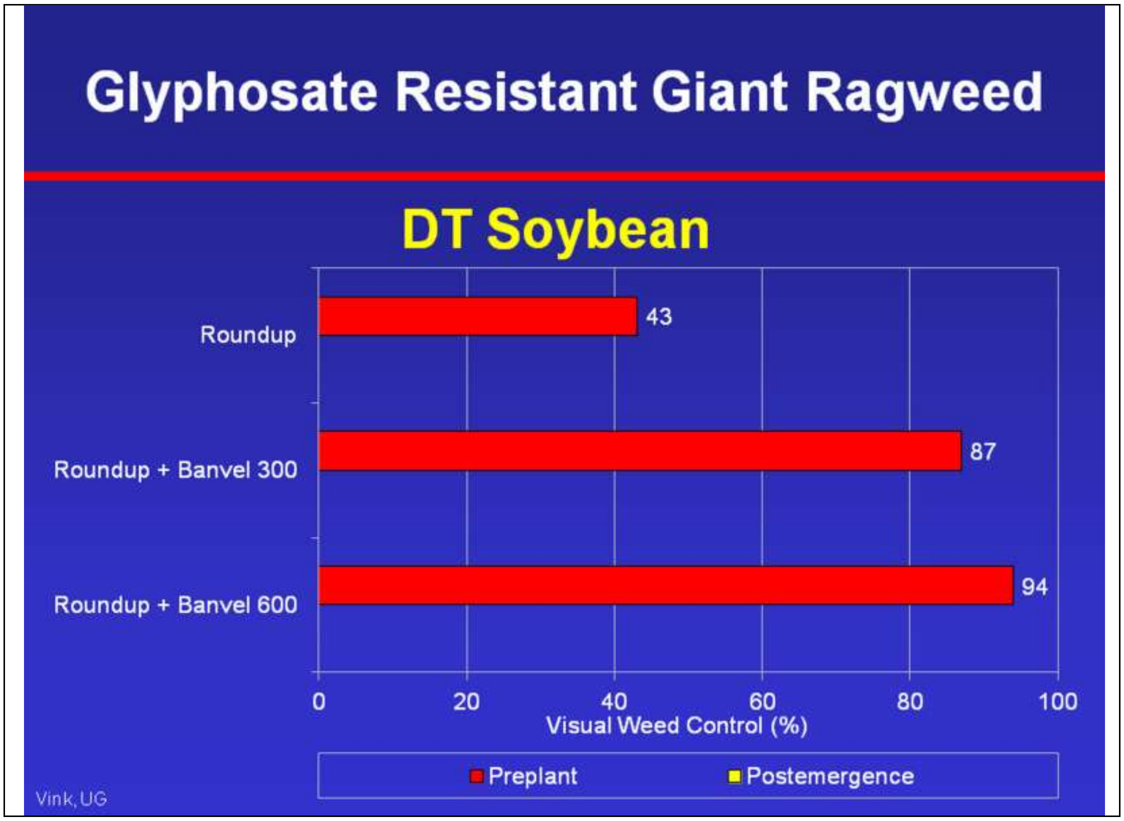

1. DT soybean and Enlist technology
2. Ontario perspective
Ottawa
Oshawa
Bay of Quinte
Prince Edward Bay
Toronto
Mississauga
Kitchener
Hamilton
Saint Catharines
Rochester
Buffalo
London
Detroit
New York

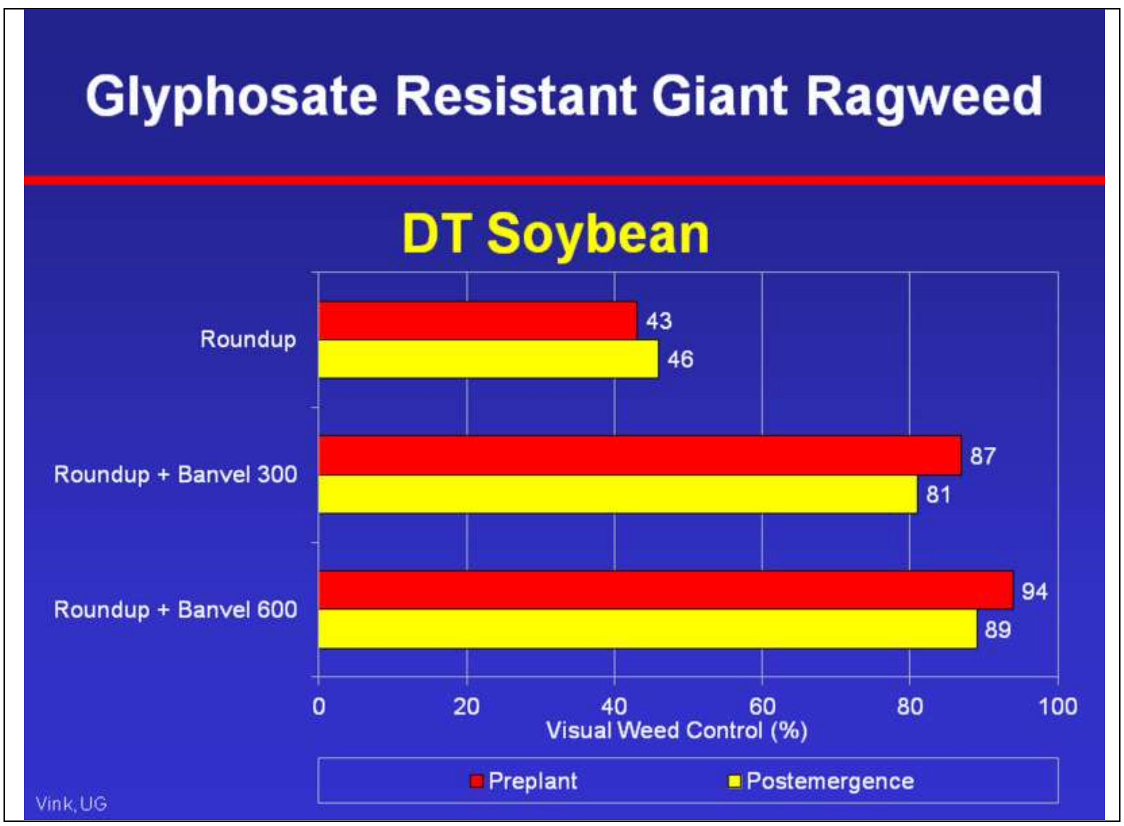
DT Soybeans

Benefits

1. Control of glyphosate resistant broadleaf weed biotypes
   a. Giant ragweed
   b. Canada fleabane (horseweed, mare's tail)

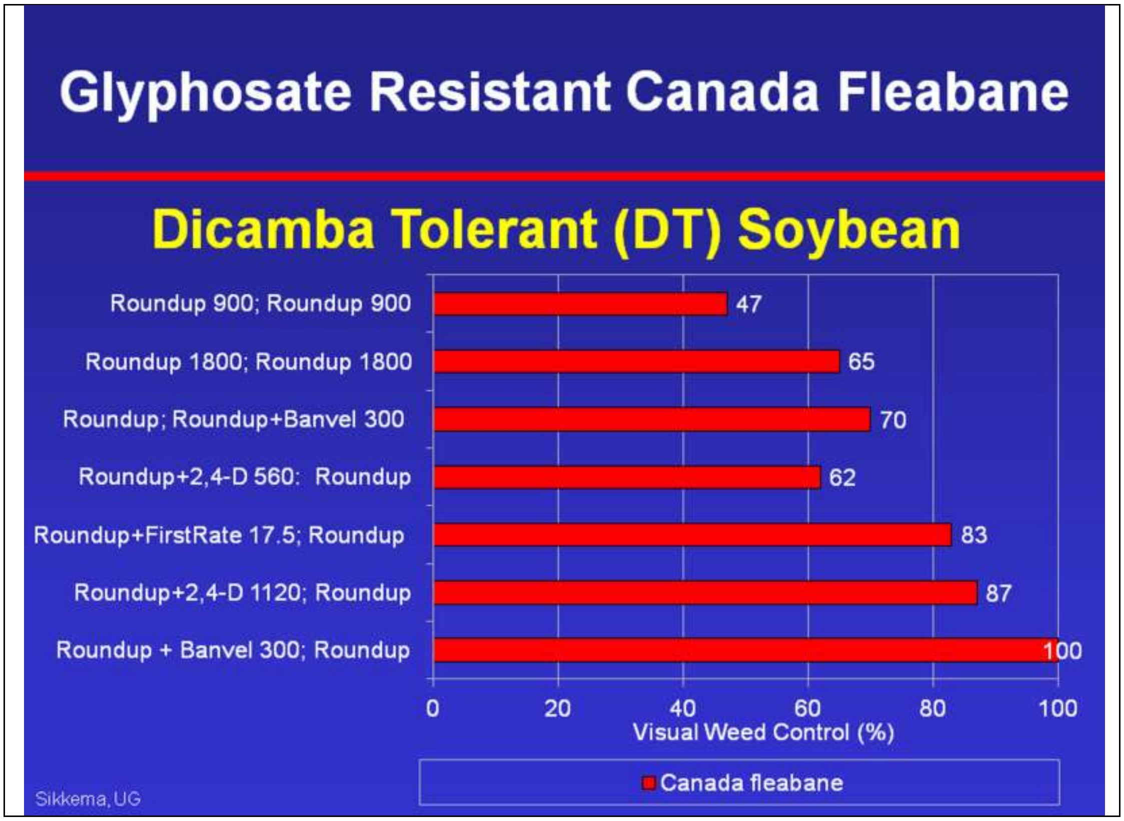


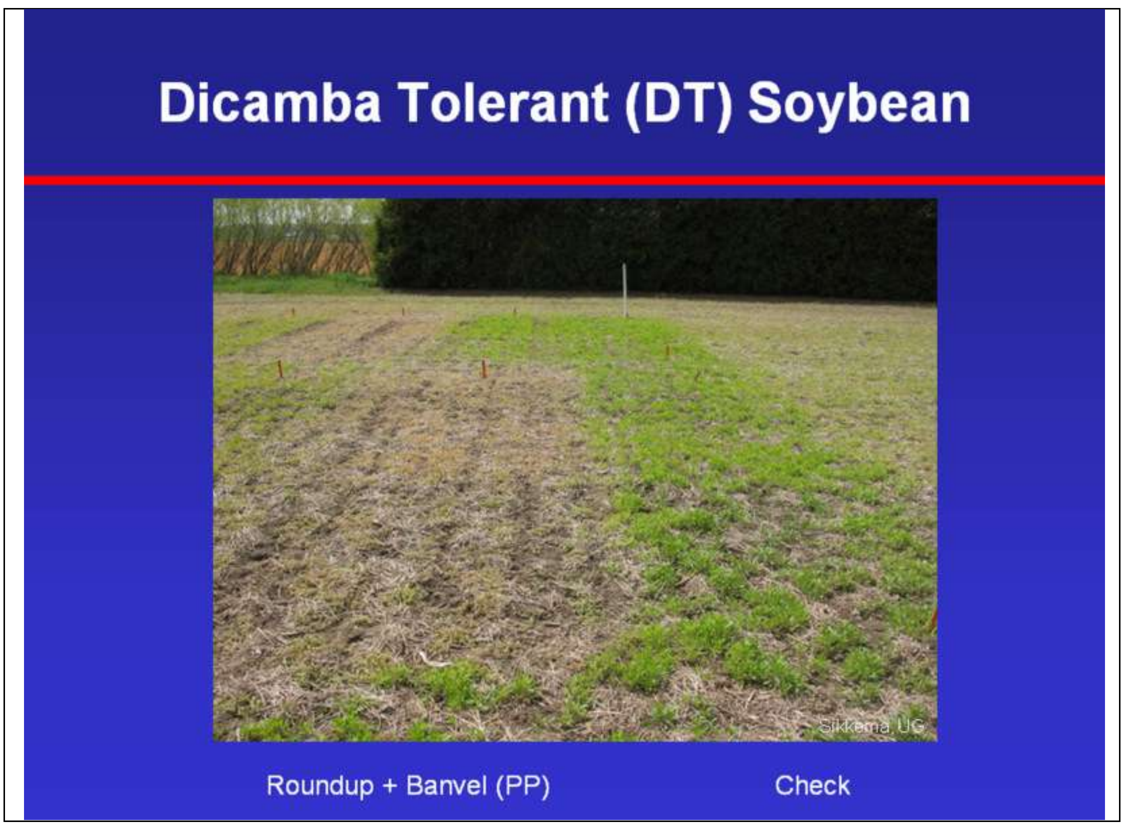

Glyphosate Resistant Giant Ragweed
DT Soybean
Roundup
Roundup + Banvel 300
Roundup + Banvel 600
43
87
94
0
20
40
60
80
100
Visual Weed Control (%)
Preplant
Postemergence
Vink, UG

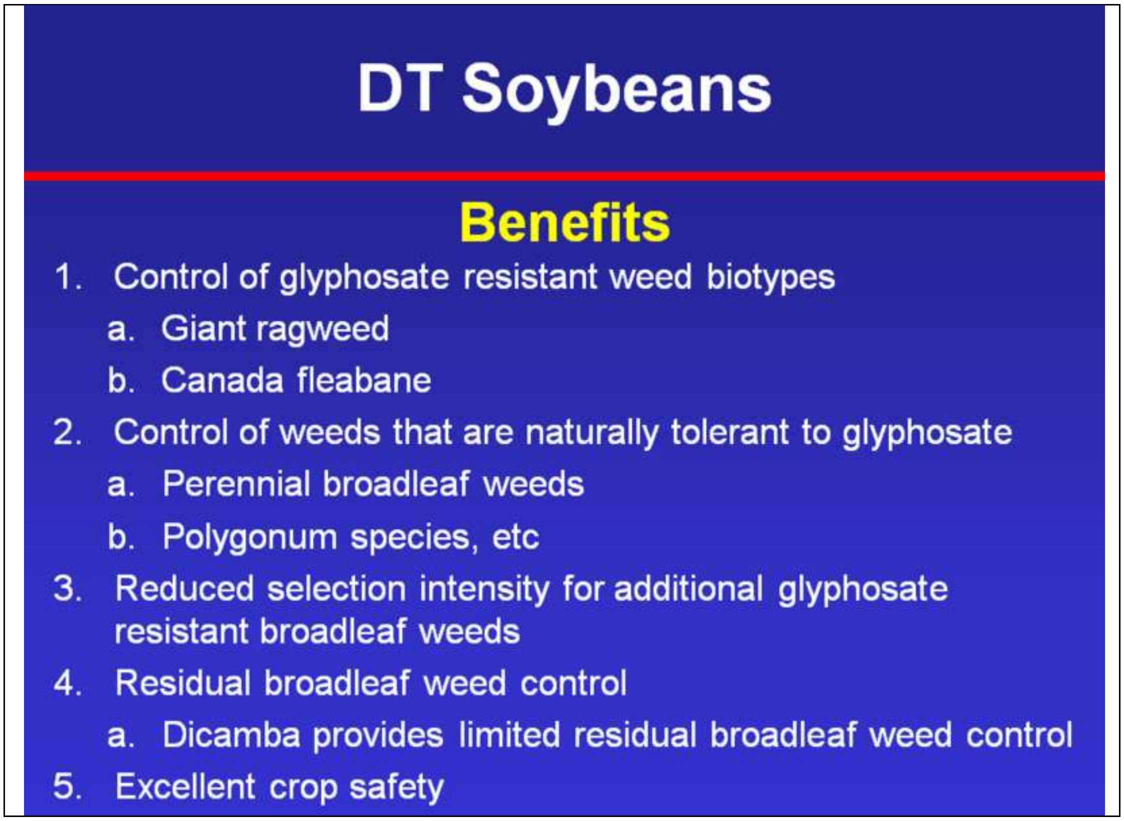

Glyphosate Resistant Giant Ragweed
DT Soybean
Roundup
Roundup + Banvel 300
Roundup + Banvel 600
43
46
87
81
94
89
0
20
40
60
80
100
Visual Weed Control (%)
Preplant
Postemergence
Vink, UG


DT Soybean
Sikkema, UG
Roundup
Roundup + Banvel
Sikkema, UG
Roundup
Roundup + Banvel

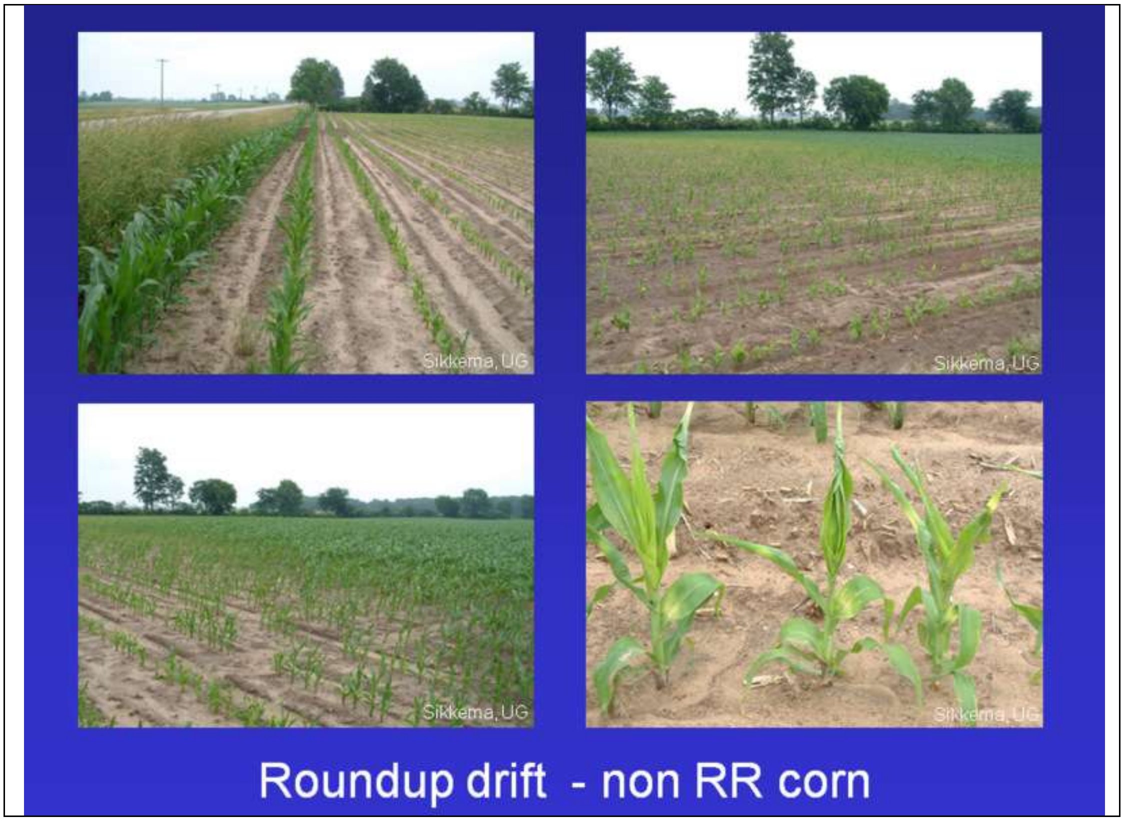

Canada fleabane
2010
8 Resistant Sites
Essex county
Detroit
Windsor
Tecumseh
Lakeshore
Leamington
Kingsville
Essex
Amherstburg
Tilbury
Wheatley
Colchester

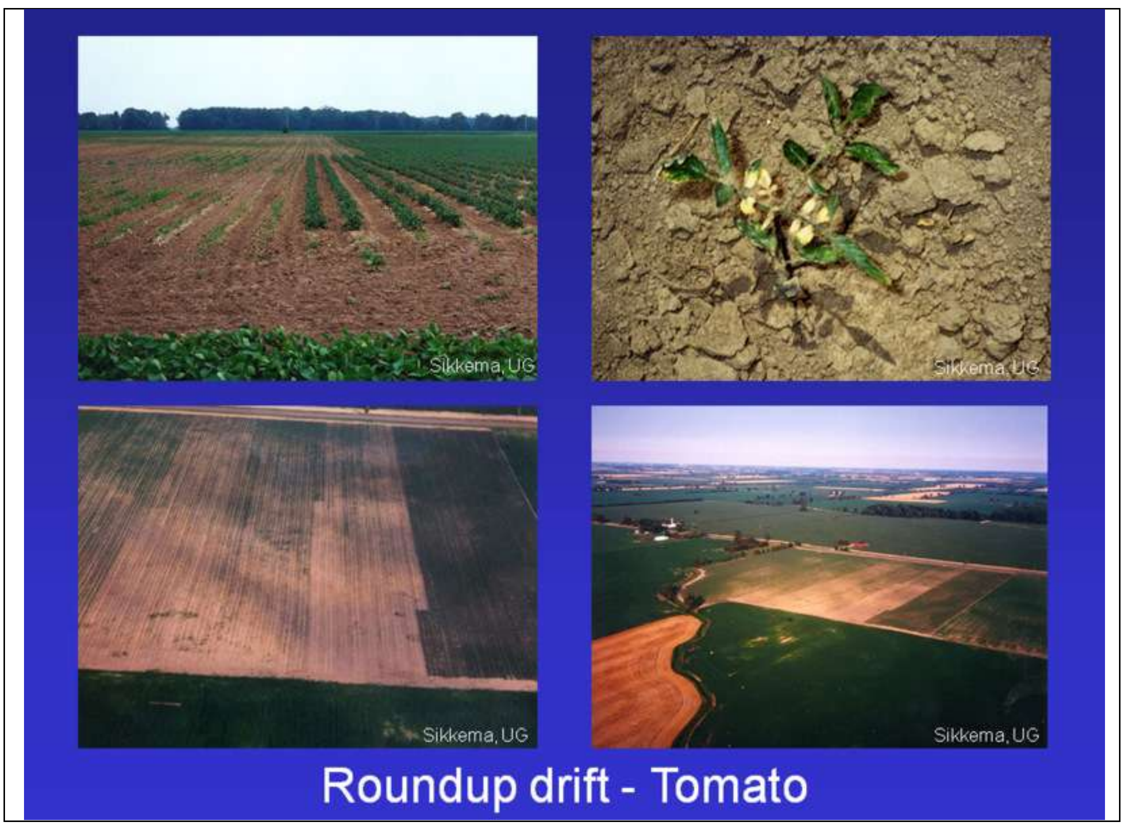

Glyphosate Resistant Canada Fleabane
Dicamba Tolerant (DT) Soybean
Roundup 900; Roundup 900
Roundup 1800; Roundup 1800
Roundup; Roundup+Banvel 300
Roundup+2,4-D 560: Roundup
Roundup+FirstRate 17.5; Roundup
Roundup+2,4-D 1120; Roundup
Roundup + Banvel 300; Roundup
47
65
70
62
83
87
100
0
20
40
60
80
100
Visual Weed Control (%)
Canada fleabane
Sikkema, UG

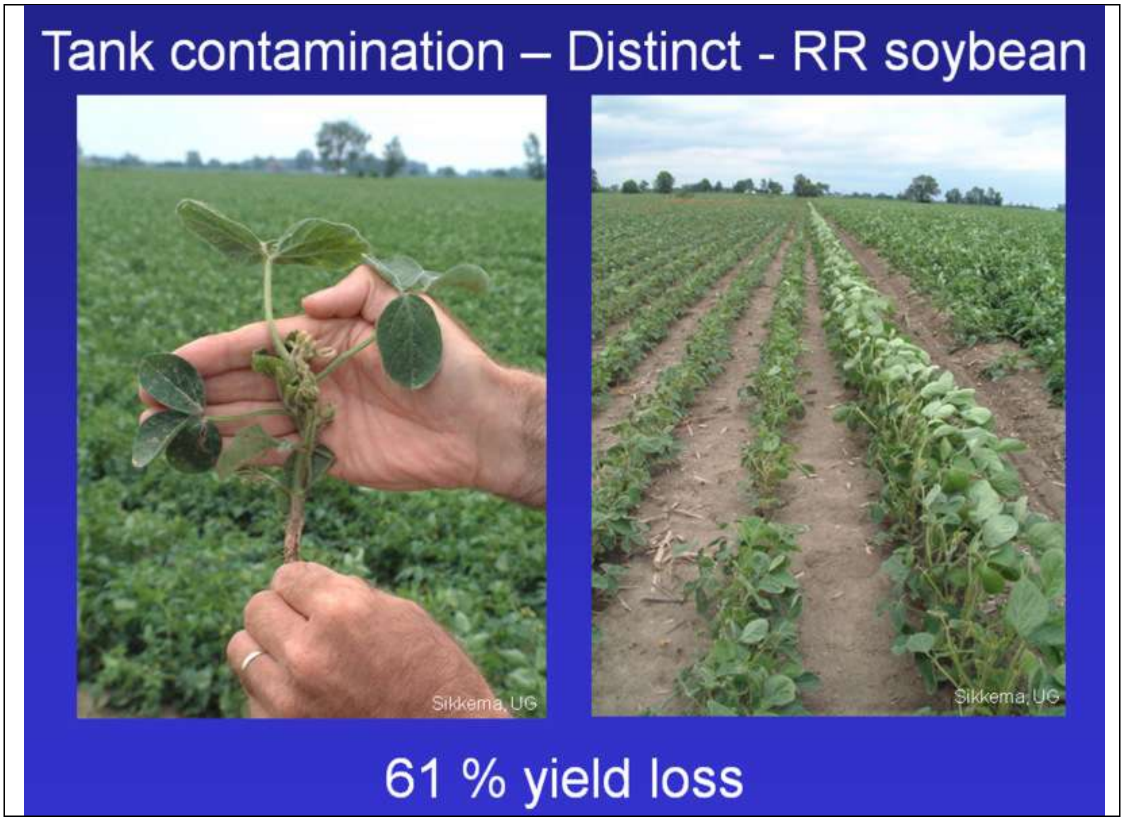

Dicamba Tolerant (DT) Soybean
Sikkema, UG
Roundup + Banvel (PP)
Check

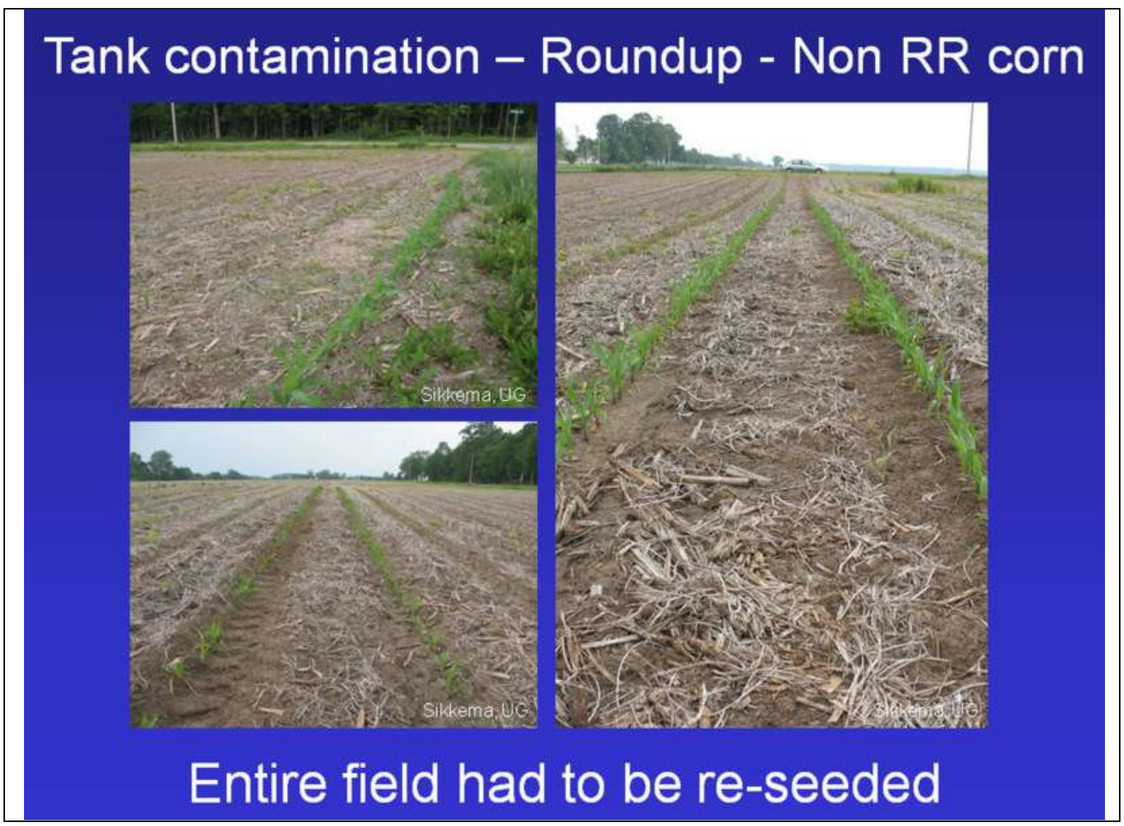

DT Soybeans
Benefits
1. Control of glyphosate resistant weed biotypes
a. Giant ragweed
b. Canada fleabane
2. Control of weeds that are naturally tolerant to glyphosate
a. Perennial broadleaf weeds
b. Polygonum species, etc
3. Reduced selection intensity for additional glyphosate resistant broadleaf weeds
4. Residual broadleaf weed control
a. Dicamba provides limited residual broadleaf weed control
5. Excellent crop safety

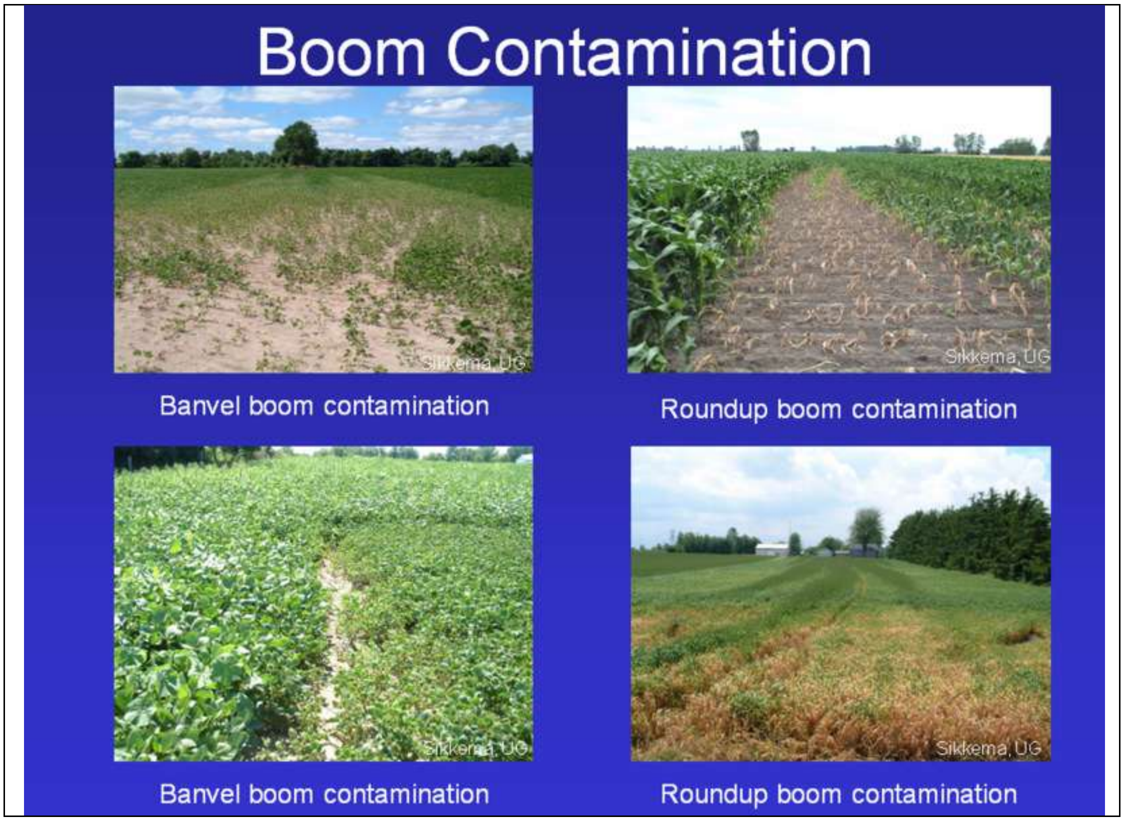

Risks
Damage to Crops/Plants
1. Off-site injury
a. Drift
b. Volatility
2. On-site injury
a. Tank, boom and injector contamination
b. Application to non-GE cultivars


Sikkema, UG
Sikkema, UG
Sikkema, UG
Sikkema, UG
Roundup drift - non RR corn


Sikkema, UG
Sikkema, UG
Sikkema, UG
Sikkema, UG
Roundup drift - Tomato


Tank contamination – Distinct - RR soybean
Sikkema, UG
Sikkema, UG
61 % yield loss


Tank contamination – Roundup - Non RR corn
Sikkema, UG
Sikkema, UG
Entire field had to be re-seeded


Boom Contamination
Sikkema, UG
Banvel boom contamination
Sikkema, UG
Roundup boom contamination
Sikkema, UG
Banvel boom contamination
Sikkema, UG
Roundup boom contamination


Injector
Contamination
Sikkema, UG
Sikkema, UG
Injector contamination – Roundup - Wheat

Application to non-GE cultivars

Are these risks manageable?

1. Past herbicide use would indicate that with caution this risk is manageable…

Field Crops - Ontario (2010)

Crop	# of acres (Million)
Hay	2.5
Soybean*	2.4
Corn	2.1
Winter Wheat	0.82
Spring cereals	0.36
Dry beans*	0.14
Canola*	0.07
Tobacco*	0.01

* - Crops that are sensitive to dicamba

Vegetable Crops – Ontario (2008)

Crop	# of acres
Asparagus*	3200
Beans*	8000
Broccoli, Cabbage, Cauliflower*	8640
Carrots, Lettuce, Onions, Spinach	16960
Corn, sweet	26000
Cucumbers, Pumpkins, Squash*	4915
Peas*	19463
Peppers*	2880
Potatoes*	36000
Rutabagas*	1780
Tomatoes*	17208

* - Crops that are sensitive to dicamba

Fruit Crops – Ontario (2008)

Crop	# of acres
Apples*	16500
Apricots*	70
Blueberries*	470
Melons*	680
Cherries*	2590
Grapes*	16350
Peaches & Nectarines*	1110
Pears*	2050
Plums*	800
Raspberries*	750
Strawberries*	3050

* - Crops that are sensitive to dicamba

Damage to Crops/Plants

Are these risks manageable?

1. Past herbicide use would indicate that with caution this risk is manageable
   a. 1999
      i. 57.4% of the Ontario corn acreage was sprayed with a herbicide containing dicamba

Herbicide Use in Corn - 1999

Stratus

Herbicide	% Base Acres
Banvel II	29.1
Marksman	19.2
Distinct	4.9
PeakPlus	2.8
Clarity	1.4
Total	**57.4**

1. 1.67 million acres of corn was sprayed with a dicamba based herbicide in 1999
2. 63.6 % of corn growers used a dicamba based herbicide in 1999
   a. However, a large percentage was sprayed early when the crop in adjacent fields had not emerged

Damage to Crops/Plants

Are these risks manageable?

1. Past herbicide use would indicate that with caution this risk is manageable
   a. 1999
      i. 57.4% of the Ontario corn acreage was sprayed with a herbicide containing dicamba
   b. 2011
      i. 90% of corn and 72% of soybean was seeded to RR hybrids/cultivars
         a) Currently Banvel, Distinct & Marksman are labeled as a tankmix in RR corn

Herbicide Use in Corn - 2010

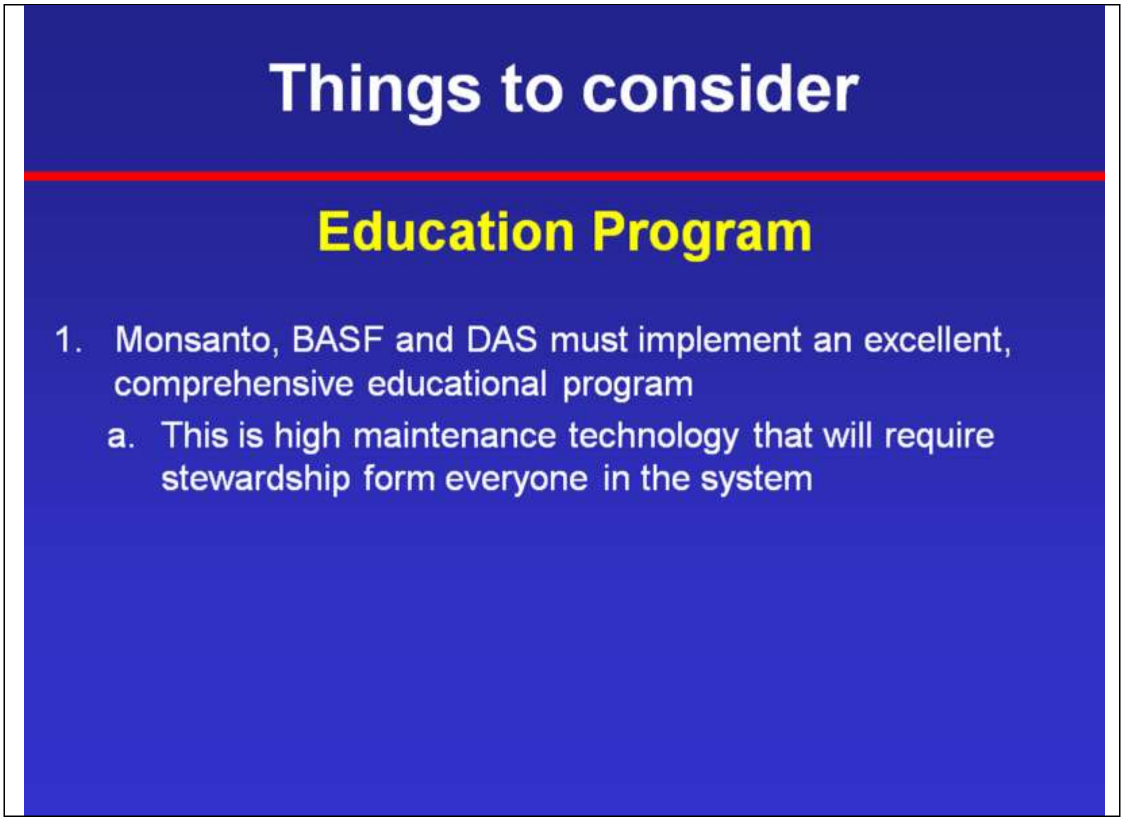
Stratus

Herbicide	% Base Acres
2,4-D	0.3
Accent Total (Accent + Distinct)	0.5
Banvel II, Oracle	1.5
Battalion (Rimsulfuron + Dual + Banvel)	1.0
Distinct	0.9
Marksman (Banvel + Atrazine)	4.7
MCPA	0.3
PeakPlus (Prosulfuron + Banvel)	0.2
Summit (Primisulfuron + Banvel)	0.1
Ultim Total (Rimsulfuron/Nicosulfuron + Distinct)	0.6
Total	**10.1**

Things to consider

My thoughts

1. Comprehensive education program
2. Label recommendations
3. Formulation development
4. Non GE hybrids/cultivars


Things to consider
Education Program
1. Monsanto, BASF and DAS must implement an excellent, comprehensive educational program
a. This is high maintenance technology that will require stewardship form everyone in the system


Things to consider
Label – 1) Steps to minimize drift
1. Wind speed
a. Do not spay above 15 kph when there are sensitive plants in adjacent fields
2. Boom height (no greater than 50 cm above the canopy)
i. The closer the boom is to the target the less time the spray droplet is suspended in air and susceptible to drift
ii. Wind speeds are usually lower close to the ground

Things to consider

Label – 1) Steps to minimize drift

3. Nozzle selection and droplet size
   a. Larger orifice, air-induction nozzles
   b. Narrower angle nozzles results in larger spray droplets
   c. Use the appropriate pressure for each nozzle
   d. Higher water carrier volume

Nozzle Selection

Things to consider

Label – 1) Steps to minimize drift

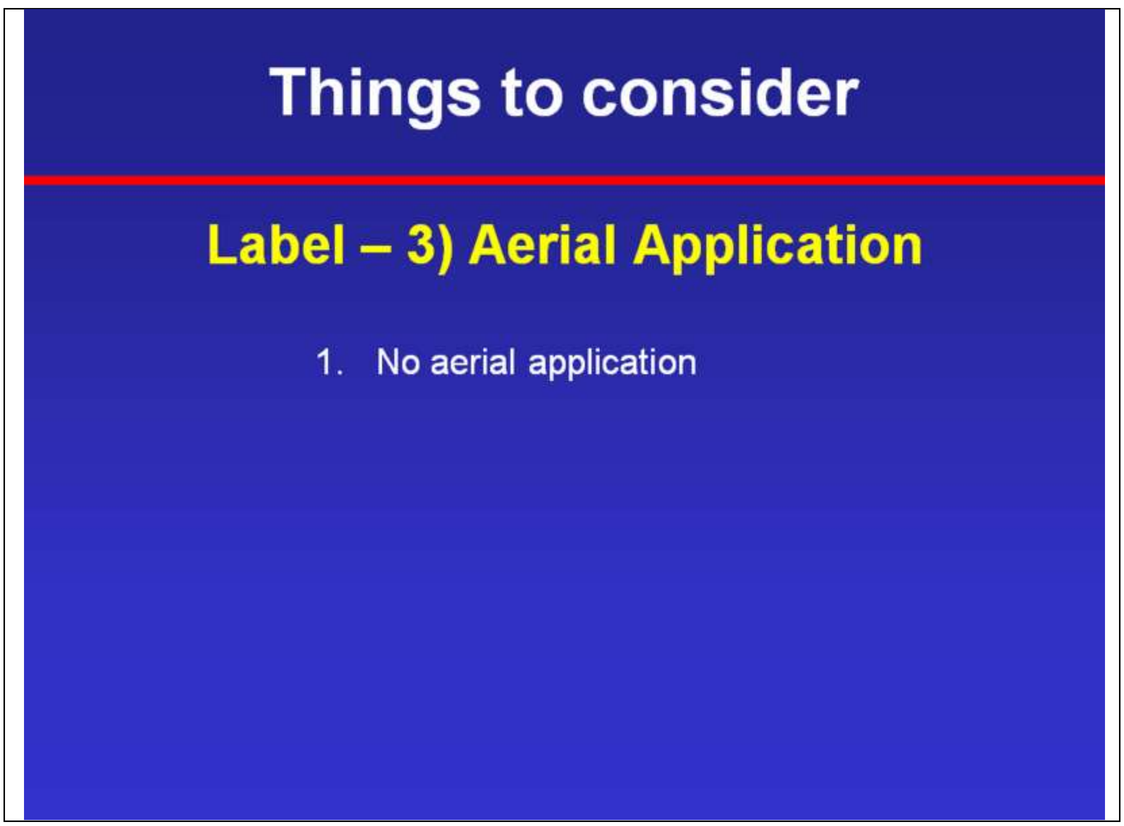
4. Avoid extremely warm temperatures
5. Avoid extremely low relative humidity
   a. Spray droplets evaporate more quickly and increased drift
6. Do not spray when sensitive plants in adjacent fields are present
   a. Early in the spring before plants emerge
   b. Late in the fall after the plants have matured
7. Do not spray close to sensitive plants

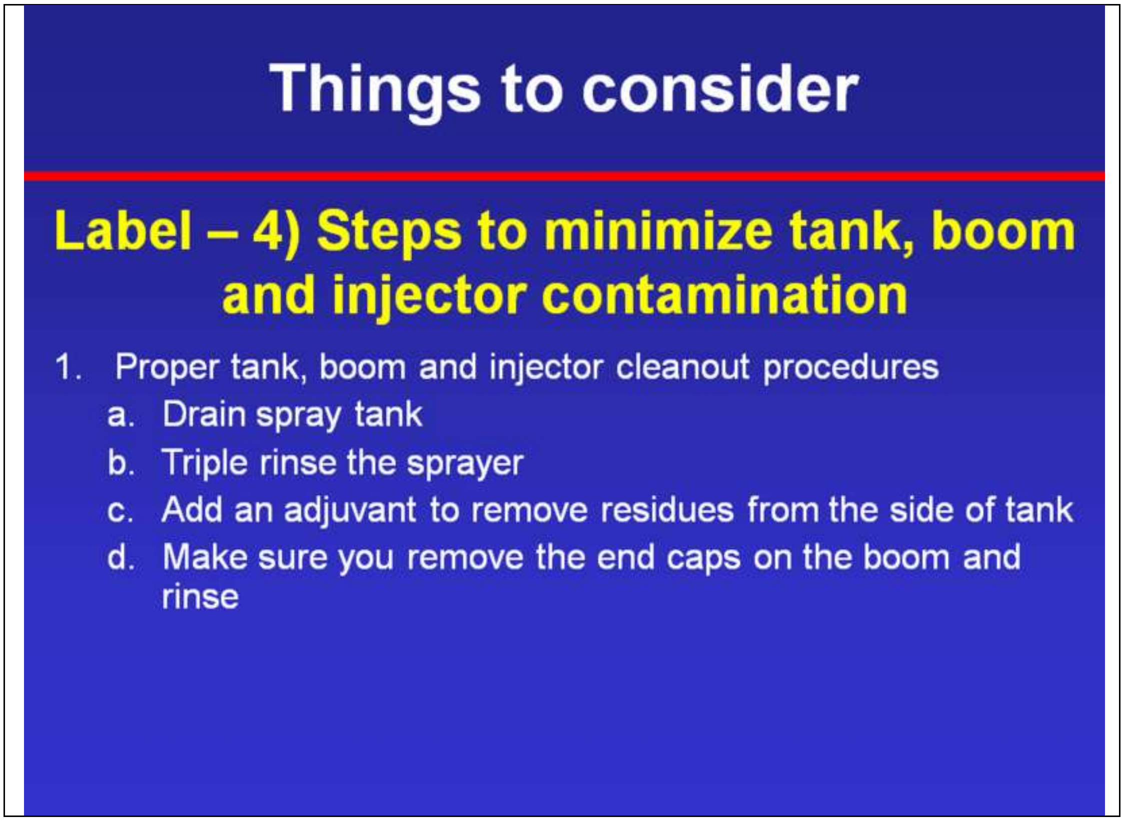
Damage to Adjacent Crops/Plants

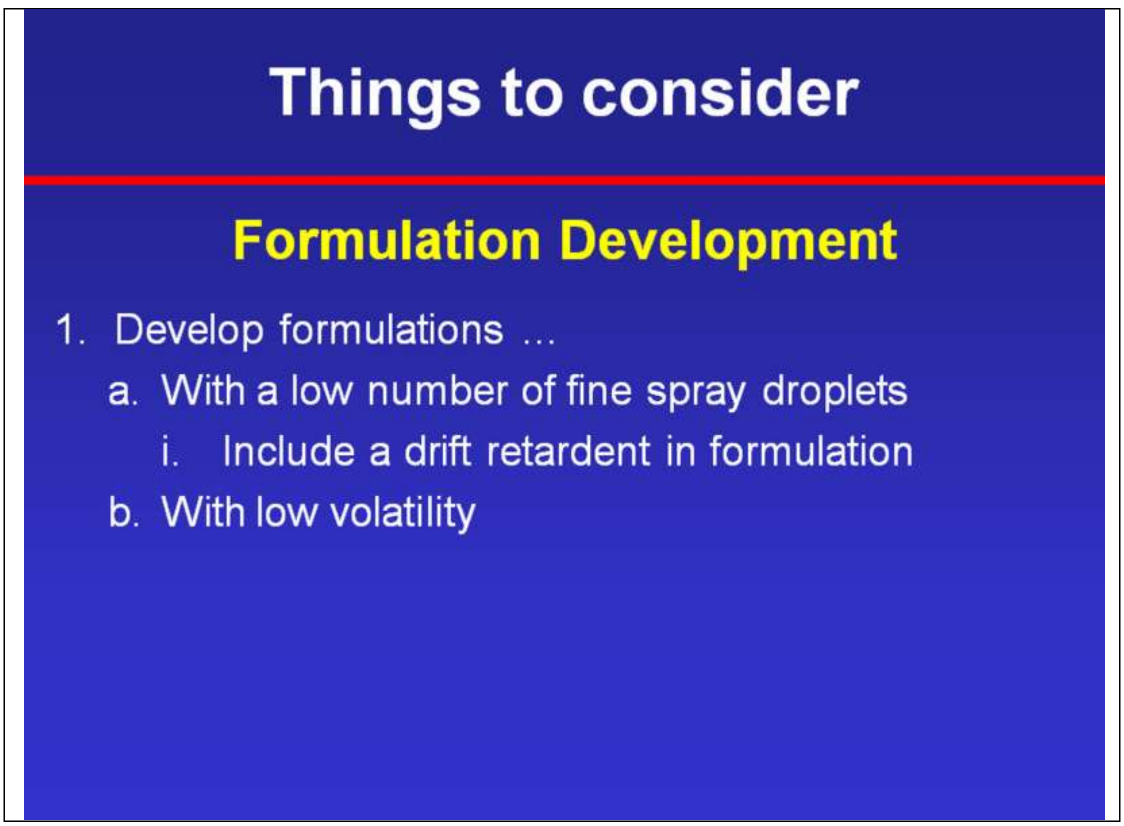
Case Study - Pelee Island

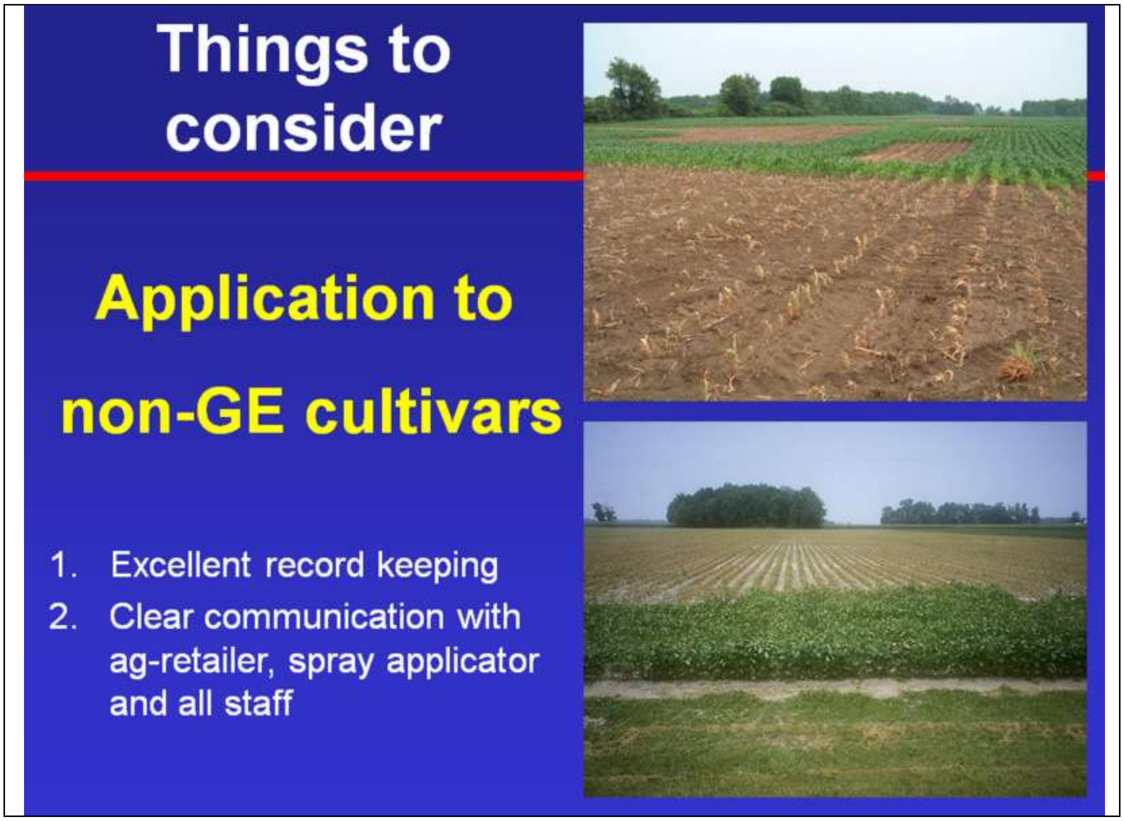
- 10,000 acres
  - Soybeans, wheat and grapes
  - Group 4 injury in grapes
    - Large lawsuit that was settled out of court
  - Gentleman's agreement among all farmers that they will not use Group 4 herbicides

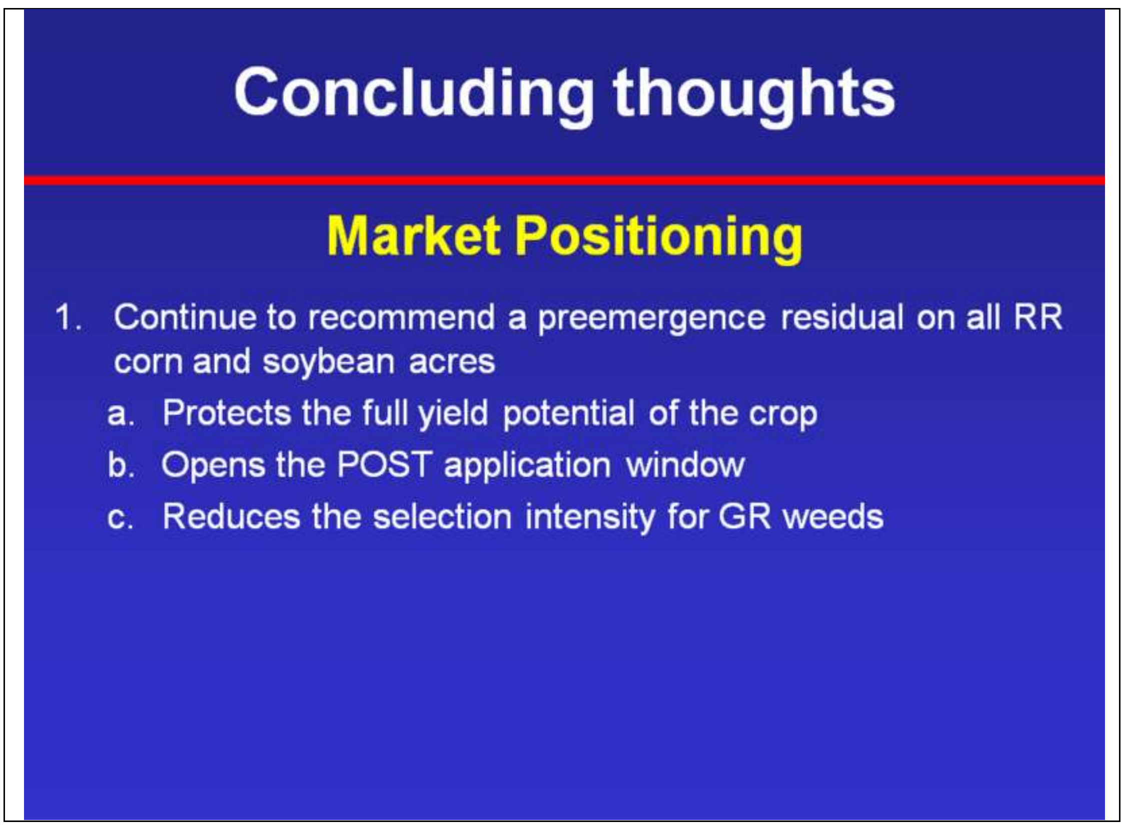

Things to consider
Label – 2) Minimum setbacks
1. Minimum setbacks to sensitive vegetation
a. Field crops (ie) canola and dry beans
b. Vegetable crops (ie) tomatoes
c. Tree fruit orchards (ie) apples
d. Vineyards
e. Nurseries
f. Greenhouses
g. Residential areas


Things to consider
Label – 3) Aerial Application
1. No aerial application


Things to consider
Label – 4) Steps to minimize tank, boom and injector contamination
1. Proper tank, boom and injector cleanout procedures
a. Drain spray tank
b. Triple rinse the sprayer
c. Add an adjuvant to remove residues from the side of tank
d. Make sure you remove the end caps on the boom and rinse


Things to consider
Formulation Development
1. Develop formulations …
a. With a low number of fine spray droplets
i. Include a drift retardent in formulation
b. With low volatility


Things to consider
Application to non-GE cultivars
1. Excellent record keeping
2. Clear communication with ag-retailer, spray applicator and all staff


Concluding thoughts
Market Positioning
1. Continue to recommend a preemergence residual on all RR corn and soybean acres
a. Protects the full yield potential of the crop
b. Opens the POST application window
c. Reduces the selection intensity for GR weeds

Concluding thoughts

Market Positioning

2. Use the DT and Enlist technology where there is a clear, known benefit
   a. Even though the cultivar may have the DT or Enlist gene does not mean it has to be sprayed with dicamba or 2,4-D
   b. There are risks with this technology and therefore they should only be used where there is a clear benefit
   c. The total acres sprayed should be limited to those with a known need/benefit

Concluding thoughts

Market Positioning

3. Promote early season application
   a. Crops in adjacent fields have not been planted or have not emerged
   b. Perennial fruit crops have not leafed out
   c. Cooler temperatures – less volatility

Concluding thoughts

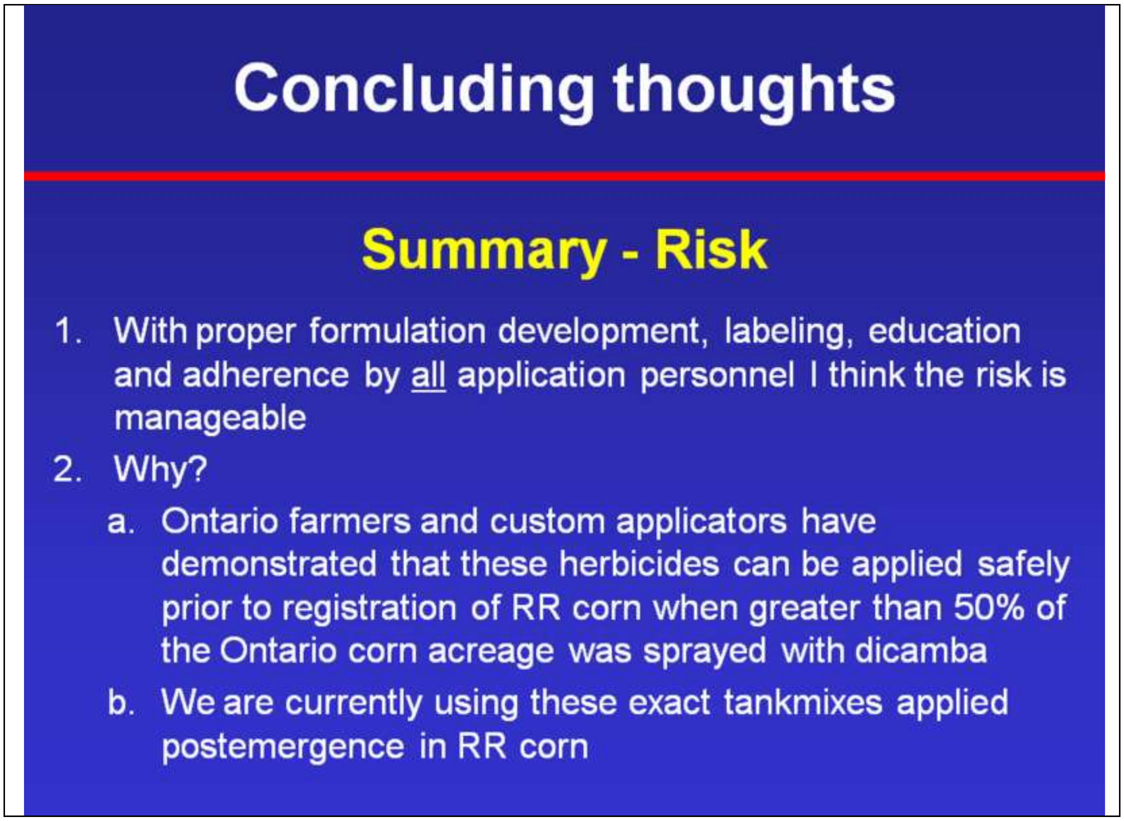
Niggling Questions

1. Glyphosate and dicamba are two of the most biologically active herbicides. Do the two herbicides combined accentuate the off-site injury?
2. Does the surfactant system in Roundup affect spray droplet size and influence drift?
3. Since soybeans are sprayed 7-14 days later than corn (warmer temperatures) will that influence the potential for vapor movement?
4. Farm size has increased in the past ten years. Does this influence application accuracy?
5. Has the % of acres sprayed by farmers vs custom applicators changed a lot in the past 10 years? Will this impact the potential for problems?

Concluding thoughts

Niggling Questions

6. How quickly are these herbicides metabolized in perennial plants? Are they there, and do they cause injury in subsequent growing seasons?
7. Over the past ten years have we lost the institutional knowledge of the potential injury from dicamba and 2,4-D and how to minimize it?
8. There is still only mode-of-action on glyphosate resistant weeds.
9. What will be the response of the non-farming community that live on acreages in the country side? High value ornamental plants?
10. Will liability from off-site movement bankrupt some small ag-dealers?


Concluding thoughts
Summary - Risk
1. With proper formulation development, labeling, education and adherence by all application personnel I think the risk is manageable
2. Why?
a. Ontario farmers and custom applicators have demonstrated that these herbicides can be applied safely prior to registration of RR corn when greater than 50% of the Ontario corn acreage was sprayed with dicamba
b. We are currently using these exact tankmixes applied postemergence in RR corn

An Integrated Stewardship Plan for Dow AgroSciences' Enlist Weed Control System – Brian Olson

Field Scientist, Dow AgroSciences LLC, bdolson@dow.com

Dow AgroSciences is developing the Enlist™ Weed Control System to help corn, soybean and cotton growers manage glyphosate resistant and hard-to-control weeds. The Enlist system confers tolerance to 2,4-D and quizalofop in corn and to 2,4-D and glufosinate in soybeans and cotton. The Enlist trait technology will be combined with glyphosate tolerance to enable use of an effective combination of herbicides on the selected Enlist crops. Dow AgroSciences also has developed Enlist Duo™ herbicide for use in Enlist crops. It is a proprietary blend of glyphosate and new 2,4-D choline. Enlist Duo features a technology package called Colex-D™ Technology that will provide growers with an herbicide product with ultra low volatility, minimized potential for physical drift, decreased odor and improved handling characteristics. Enlist Duo will provide exceptional weed control and will help to prevent and manage tough weeds. Dow AgroSciences is committed to stewardship of this technology in order to promote responsible use and sustain long-term future performance for growers. Dow AgroSciences will provide comprehensive guidance for use of the Enlist Weed Control System through education and training programs, ongoing research and development efforts, application technology improvements, and in-field performance testing.

No Presentation Available.

***Advancements and Stewardship of Dicamba in a Dicamba Tolerant Cropping System* – Steve Bowe**
BASF

Advancements and Stewardship of Dicamba for Dicamba Tolerant Cropping Systems

BASF
The Chemical Company

- Dicamba Background
- Formulation Advancements
- Stewardship

A new opportunity for weed control

Dicamba Advancements and Stewardship
Evolving Market Needs

BASF
The Chemical Company

- Global demand for grain and fiber
- Need to increase production without increasing acreage
- Focus on improved agronomic practices and integrated strategies for crop production
- Additional tools required to improve crop protection from diseases, insects and weeds

Commitment to sustainable solutions

Dicamba Advancements and Stewardship

BASF / Monsanto Collaboration on Dicamba Tolerance

BASF The Chemical Company

- Collaboration to accelerate development of next generation weed control solutions
- Leverages glyphosate and trait expertise of Monsanto and dicamba expertise of BASF
- Both organizations are working to deliver a successful system:
  - Elite Traits
  - Innovative Formulations
  - Broad Technical Support and Educational Programs

Commitment to sustainable solutions

Dicamba Advancements and Stewardship

Current Market Utility

BASF The Chemical Company

- Dicamba has been extensively used for nearly 50 years to manage more than 190 broadleaf weeds
- US EPA Re-registration in 2006 / EU Annex 1 approval Sep 2009
- Fifth most widely used herbicide in the US
- Used on more than 20 million acres annually
  - 7 million acres of corn
  - 6 million acres of wheat
  - 6.5 million acres of range/pasture
  - 6.5 million acres of turf

Proven History as an Effective Broadleaf Herbicide

Dicamba and Glyphosate
Key Tools for Weed Management

BASF The Chemical Company

Weed	Control Rating Glyphosate Ave	Dicamba Ave
Velvetleaf	G	F
Pigweed spp.*	E	G
Ragweed spp.*	G	E
Lambsquarters	G	G
Marestail*	G	F
Sunflower	E	G
Morningglory spp.	F	E
Smartweed spp.	G	E
Nightshade spp.	G	G
Cocklebur	E	E

Description	Rating	Highlight
Excellent	9-10	E
Good	8	G
Fair	6-7	F

* Asterisk or grey shading denotes existence of glyphosate resistant populations

Top "10" broadleaf weeds

Complementary spectrums to maximize broadleaf weed control

Dicamba Advancements and Stewardship
History of Continuous Improvement

BASF The Chemical Company

- **1958** **Discovery of dicamba**
- **1963** **Banvel®** Herbicide (dicamba dimethylamine (DMA))**:** Turf
- **1964-66** Corn, Sorghum, Small Grains and Pasture
- **1986** **Marksman®** Herbicide (potassium dicamba + atrazine)
- **1990** **Clarity®** Herbicide (dicamba diglycolamine (DGA))
- **1998** **Distinct®** Herbicide (sodium dicamba + diflufenzopyr (DFFP))
- **2007** **Status®** Herbicide (sodium dicamba + DFFP + safener)
- **2014+** **Next generation dicamba formulation**

Experimental Results – Not EPA approved or available for sale

Formulation Advancement

BASF The Chemical Company

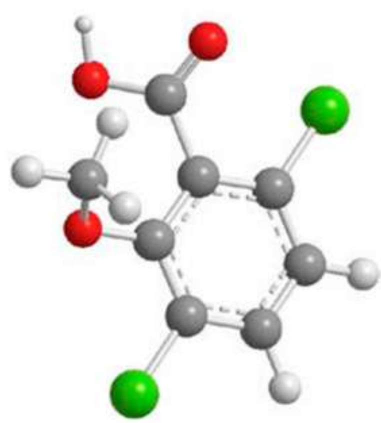
Experimental Results – Not EPA approved or available for sale

Formulation Advancement

On-Target Application

BASF The Chemical Company

- **Dicamba volatilization is minimal especially with new formulations:**
  - Clarity
  - Status
  - Dicamba EXP
- **Attention is needed for proper application (spray drift)**



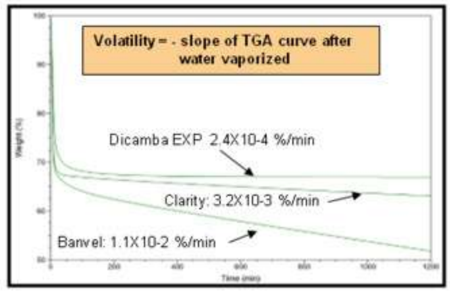
Experimental Results – Not EPA approved or available for sale

Formulation Advancement

On-Target Application: Assessment Methods

BASF
The Chemical Company

- **Thermo Gravimetric Analysis**
  - Screening tool
- **Lab Incubator**
  - Controlled temperature, humidity and air flow
- **^{14}C Closed System Analysis**
  - Mass balance loss and recovery
- **Greenhouse Humidome Bioassay**
  - Visual injury assessment
- **Field Assessment**
  - Air monitoring, bioassay assessment



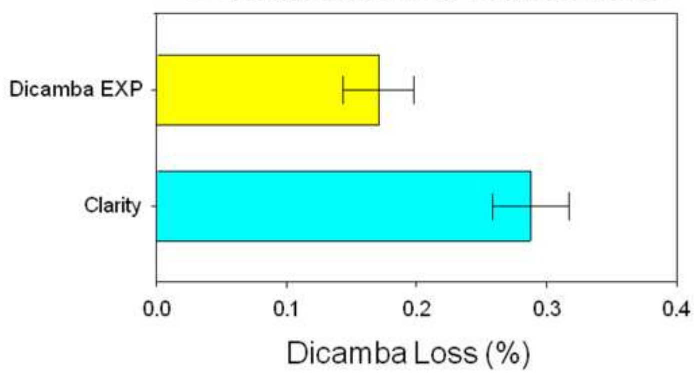
Experimental Results – Not EPA approved or available for sale

Formulation Advancement

On-Target Application: Closed System ^{14}C Study

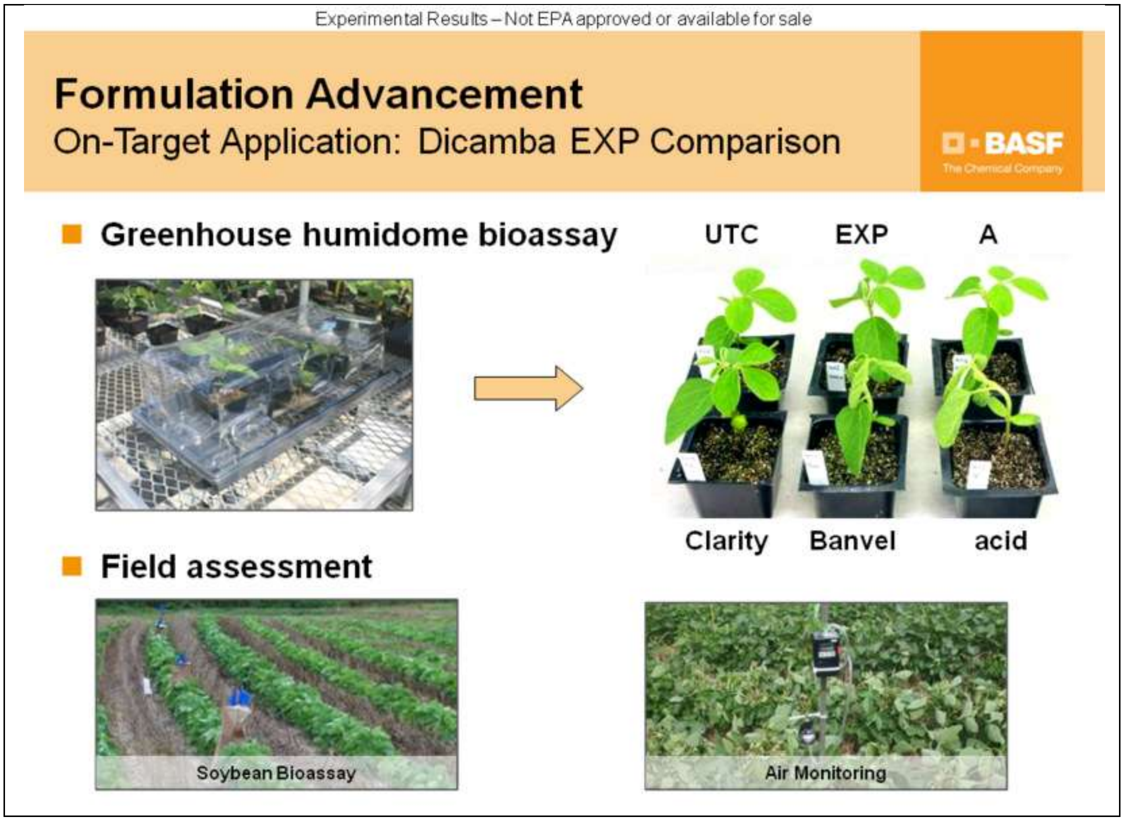
BASF
The Chemical Company

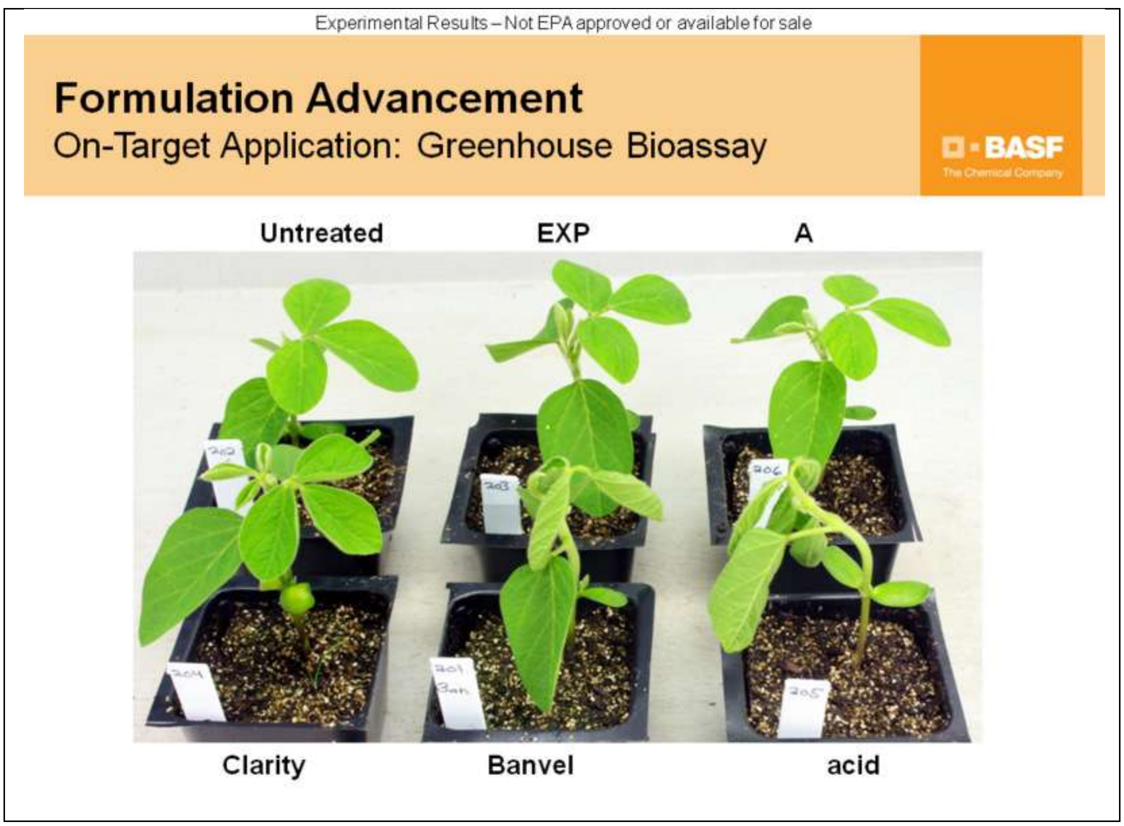
^{14}C-dicamba loss from treated surface

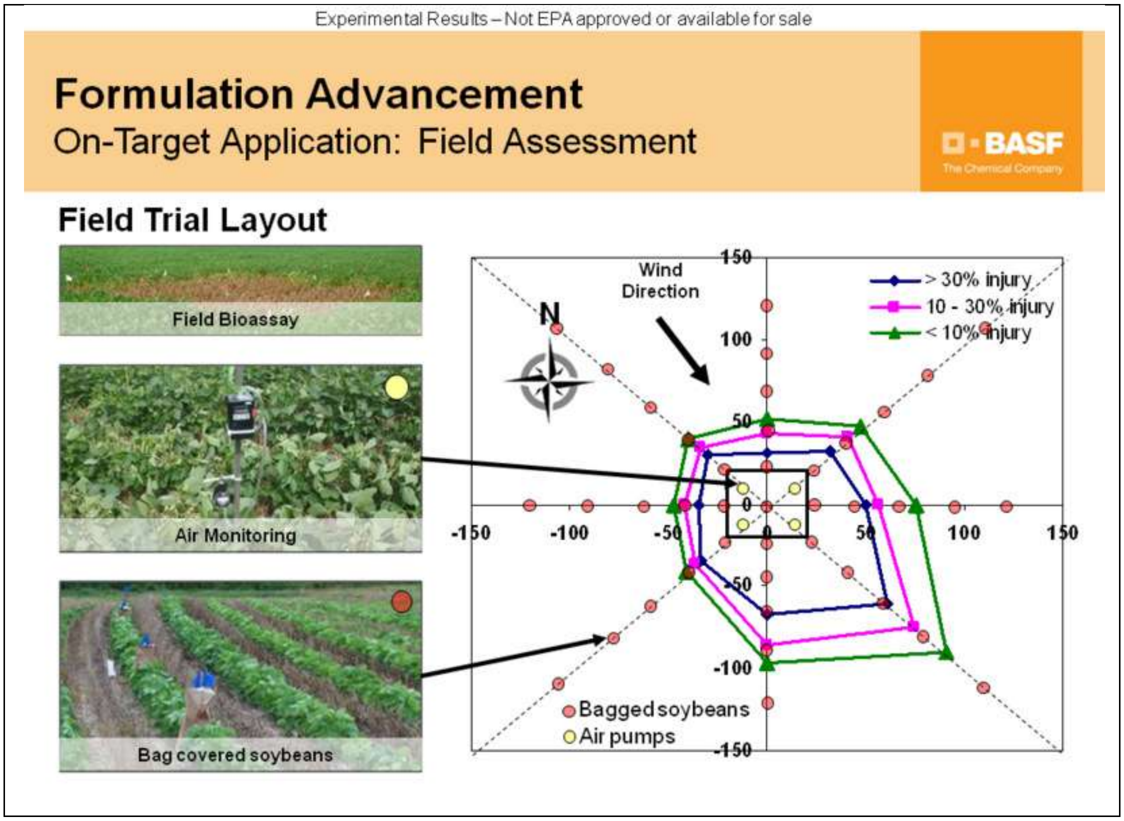


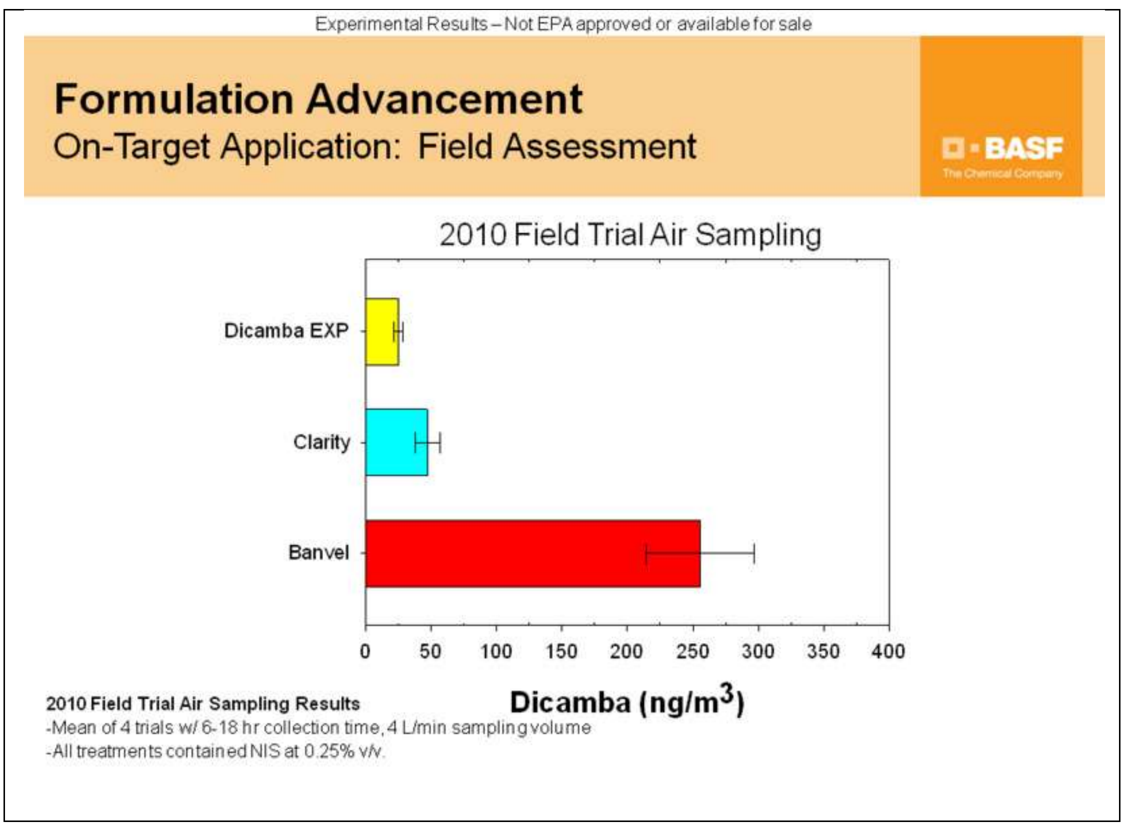
Trial conducted in a growth chamber.
Treated surface: glass
2.5 gal glass tank, 40 C / 104 F, 30% RH, 0.5 L/min air flow, 24 h duration

Volatilization is a minor factor for off-target movement


Experimental Results – Not EPA approved or available for sale
Formulation Advancement
On-Target Application: Dicamba EXP Comparison
BASF
The Chemical Company
Greenhouse humidome bioassay
UTC
EXP
A
Clarity
Banvel
acid
Field assessment
Soybean Bioassay
Air Monitoring


Experimental Results – Not EPA approved or available for sale
Formulation Advancement
On-Target Application: Greenhouse Bioassay
BASF
The Chemical Company
Untreated
EXP
A
Clarity
Banvel
acid


Experimental Results – Not EPA approved or available for sale
Formulation Advancement
On-Target Application: Field Assessment
BASF
The Chemical Company
Field Trial Layout
Field Bioassay
Air Monitoring
Bag covered soybeans
Wind Direction
N
> 30% injury
10 - 30% injury
< 10% injury
Bagged soybeans
Air pumps
150
100
50
0
-50
-100
-150
-150
-100
-50
0
50
100
150

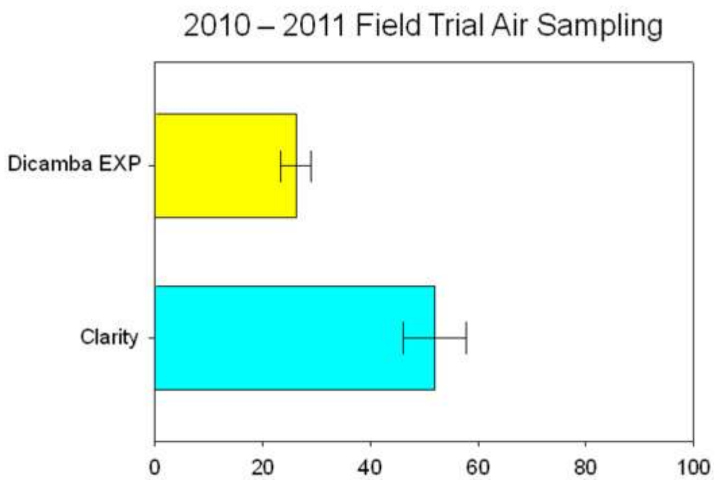

Experimental Results – Not EPA approved or available for sale
Formulation Advancement
On-Target Application: Field Assessment
BASF
The Chemical Company
2010 Field Trial Air Sampling
Dicamba EXP
Clarity
Banvel
0
50
100
150
200
250
300
350
400
Dicamba (ng/m3)
2010 Field Trial Air Sampling Results
-Mean of 4 trials w/ 6-18 hr collection time, 4 L/min sampling volume
-All treatments contained NIS at 0.25% v/v.

Experimental Results – Not EPA approved or available for sale

Formulation Advancement

On-Target Application: Field Assessment

BASF The Chemical Company



Historical Field Trial Air Sampling Results
-Mean of 11 trials w/ 6-18 hr collection time, 4 L/min sampling volume
-All treatments contained NIS at 0.25% v/v.

Experimental Results – Not EPA approved or available for sale

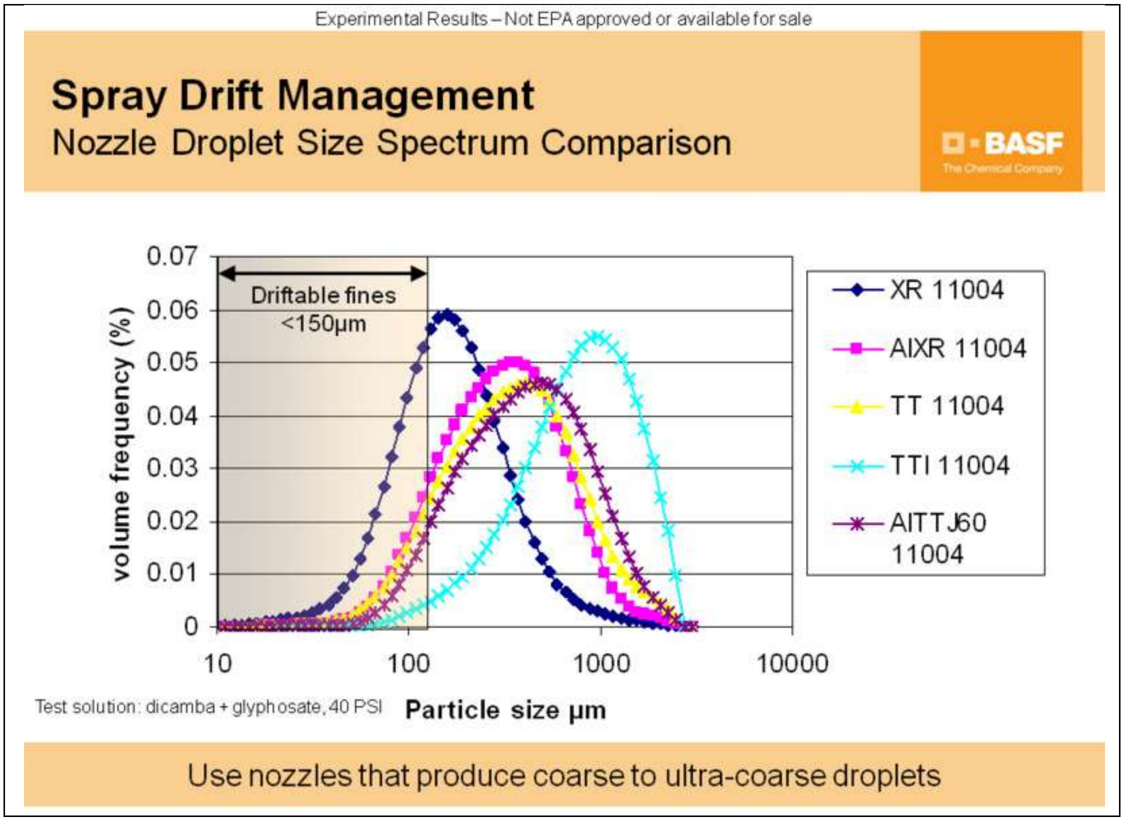
Formulation Advancement

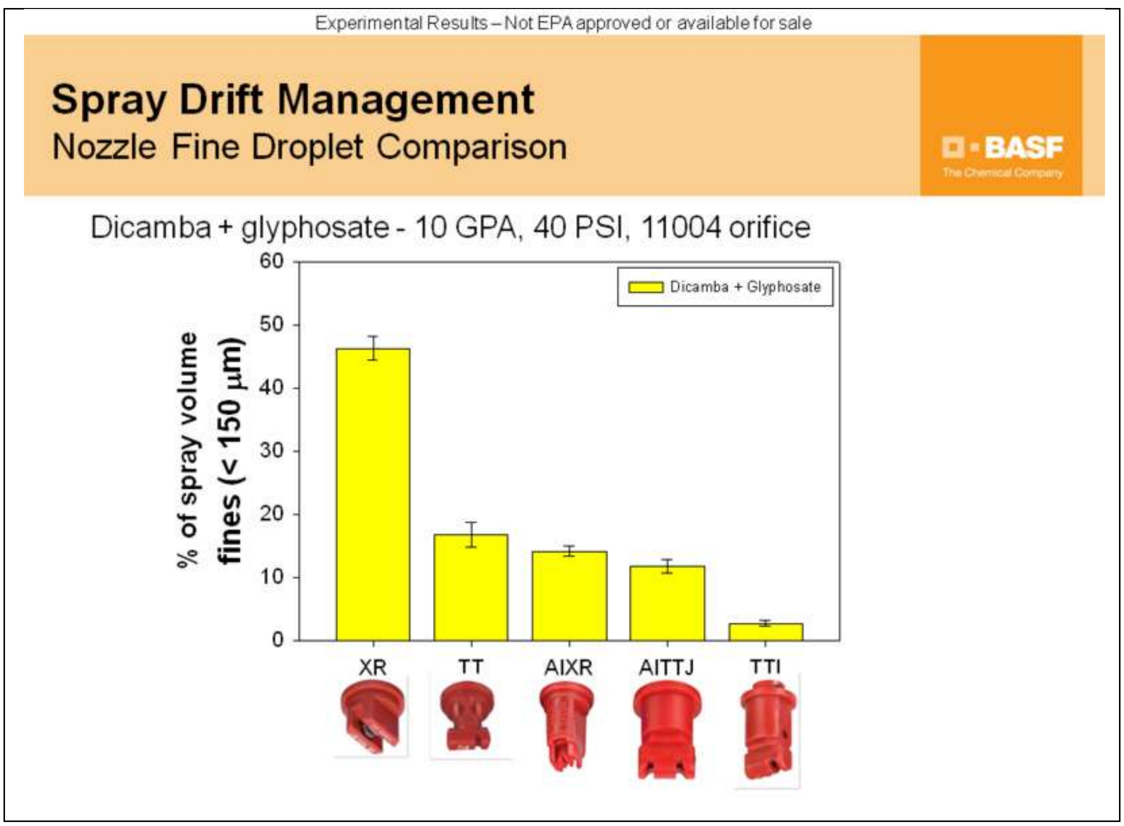
On-Target Summary: Clarity vs EXP

BASF The Chemical Company

	Percent Reduction Compared to Standard			
	Lab		Greenhouse	Field
Form	TGA[1] (weight loss min^{-1})	Incubator[2] (ai loss)	Bioassay[3] (visual injury)	Air Sampling[4] ($ng\ m^{-3}$)
Clarity	-	-	-	-
EXP	91%	86%	77%	50%

[1] Thermal Gravimetric Analysis @ 100 C after water loss for 20 hours (% weight loss/min).
[2] AE weight loss @ 40-50 C & 30% RH (% dicamba acid loss after 2 wks).
[3] Soybean injury assessment at 14 DAT.
[4] Samples collected at 4L/min for 6-18 hrs within the treated area. Air pumps were started approximately 15 mins following application


Experimental Results – Not EPA approved or available for sale
Spray Drift Management
Nozzle Droplet Size Spectrum Comparison
BASF
The Chemical Company
Driftable fines
<150µm
volume frequency (%)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
10
100
1000
10000
Particle size µm
XR 11004
AIXR 11004
TT 11004
TTI 11004
AITTJ60 11004
Test solution: dicamba + glyphosate, 40 PSI
Use nozzles that produce coarse to ultra-coarse droplets


Experimental Results – Not EPA approved or available for sale
Spray Drift Management
Nozzle Fine Droplet Comparison
BASF
The Chemical Company
Dicamba + glyphosate - 10 GPA, 40 PSI, 11004 orifice
Dicamba + Glyphosate
% of spray volume fines (< 150 µm)
60
50
40
30
20
10
0
XR
TT
AIXR
AITTJ
TTI

Experimental Results – Not EPA approved or available for sale

Dicamba Advancements and Stewardship
Best Management Practices

BASF The Chemical Company

- Jointly developed by BASF and Monsanto in connection with the Dicamba tolerance collaboration
- Focused on the use of dicamba PRE, burndown and over-the-top (OTT) applications in dicamba tolerant cropping systems
- Designed to maximize performance, on-target spray deposition, and sustainability of the system
- Will be incorporated into:
  - Labels
  - Technical Use Guides
  - Educational Program and Training Materials

Experimental Results – Not EPA approved or available for sale

Dicamba Advancements and Stewardship
Best Management Practices

BASF The Chemical Company

- **Effective Weed Control**
  - Rates, timing and programs tailored for optimum control
- **Weed Resistance Management**
  - Planned use of multiple MOAs, residual herbicides and cultural practices
- **Proper Application**
  - Spray drift management, equipment cleanout and sensitive crop awareness

An integrated approach for sustainable success of Dicamba Tolerant crops

Dicamba Advancements and Stewardship
Example: BASF AAA Best Application Practices

BASF The Chemical Company

- Application Preparation
  - Nozzles, spray pressure, spray volume, boom height, travel speed
- Environmental Conditions
  - Wind, temperature inversions
- Application Awareness
- Spray System Cleanout

Advancements and Stewardship of Dicamba for Dicamba Tolerant Cropping Systems

BASF The Chemical Company

- Proven history of effective broadleaf weed control
- Weed control spectrum well matched for soybean, cotton and corn production
- R&D delivering new formulations with performance improvements
- Proper selection of dicamba formulation and application methods can help ensure on-target application
- Sustained stewardship, outreach and education programs will help encourage best practices

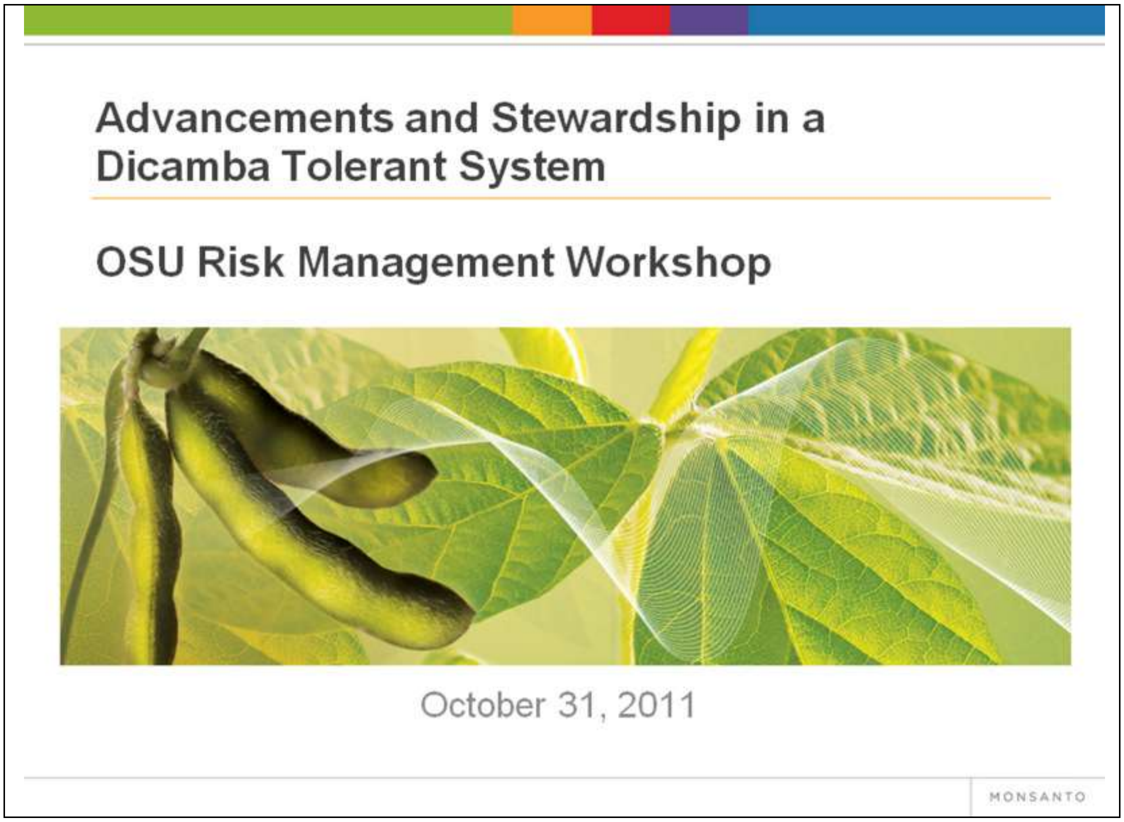
A new and needed opportunity for weed management


Advancements and Stewardship of Dicamba for Dicamba Tolerant Cropping Systems
BASF
The Chemical Company
Experimental products described in this presentation are neither registered nor available for sale.
Information contained in this presentation is intended for educational purposes and is not intended to promote the sale of a product.
Any sale of this product after registration is obtained shall be solely on the basis of the EPA approved product label, and any claims regarding product safety and efficacy shall be addressed solely by the label.
Clarity®, Status®, Distinct®, Marksman®, Banvel® herbicides are registered trademarks of BASF Corporation.
Always read and follow label directions.


Advancements and Stewardship of Dicamba for Dicamba Tolerant Cropping Systems
BASF
The Chemical Company
For more information contact:
Steven Bowe – steven.bowe@basf.com
Daniel Pepitone – daniel.pepitone@basf.com

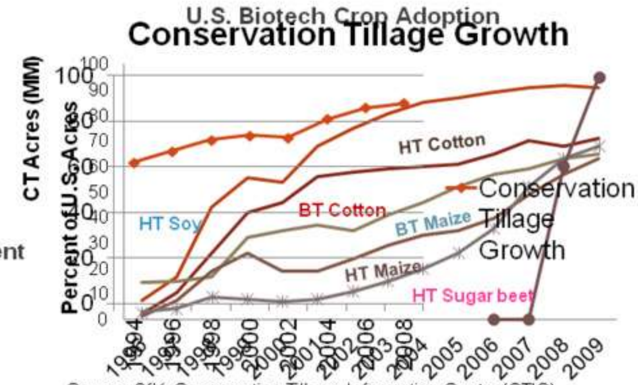
Advancements and Stewardship in a Dicamba Tolerant System – Douglas Rushing

Monsanto Company, douglas.w.rushing@monsanto.com



Roundup Ready Crop Technology

- Seventeen Years of Roundup Ready Soybeans
  - Seven years of field research trials
  - Hundreds of locations
- Step Change In Weed Management
  - Use of technology evolved
  - Conservation tillage
  - Non pecuniary benefits
- Change in weed management philosophy
  - Roundup Ready PLUS



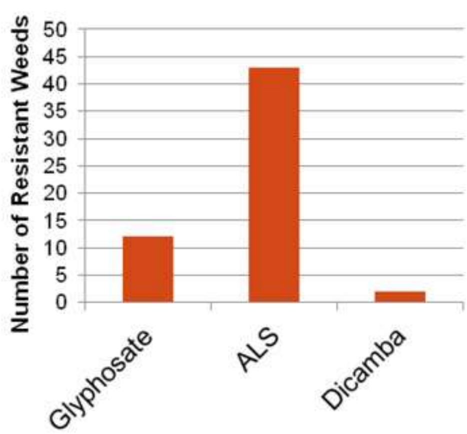
Source: GfK, Conservation Tillage Information Center (CTIC)

*USDA, National Agricultural Statistics Service

MONSANTO

Why Dicamba Tolerance?

- Many positive attributes
  - Immediate planting after burn down, over-the-top applications
  - Residual activity on some weed species
  - Low number of resistant weeds
  - Tank mixes well with glyphosate
- History of safe use when used according to label instructions
- U.S. farmers have used dicamba on 237 million acres in past 10 years
- Dicamba efficacious on palmer pigweed, waterhemp, marestail, and other tough broadleaf weeds



MONSANTO

DT Soy System Delivers Excellent Weed Control

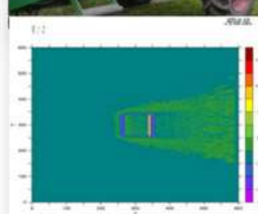
Untreated Check	Dicamba-Tolerant *Roundup Ready 2 Yield Soybeans* Residual + Glyphosate	Dicamba-Tolerant *Roundup Ready 2 Yield Soybeans* Residual + Glyphosate + Dicamba

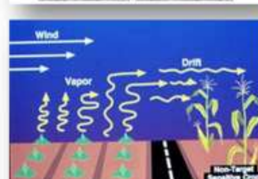
Mt. Olive, NC– July 2011: Addition of dicamba allows control of glyphosate-resistant palmer amaranth

MONSANTO

Off-Target Movement

- **Sprayer Residue**
  - Residue from previous spray applications that are subsequently applied onto sensitive crops
- **Particle Drift**
  - The movement of herbicide/pesticide droplets through the air to an off-site area after spraying.
  - Caused by: wind, temperature inversion, improper boom height, improper nozzle selection, droplet size
- **Volatility/Vapor Drift**
  - The tendency of a substance to vaporize
  - Each chemical has a vapor pressure, which is typically related to temperature and/or humidity





MONSANTO

Best Management Practices

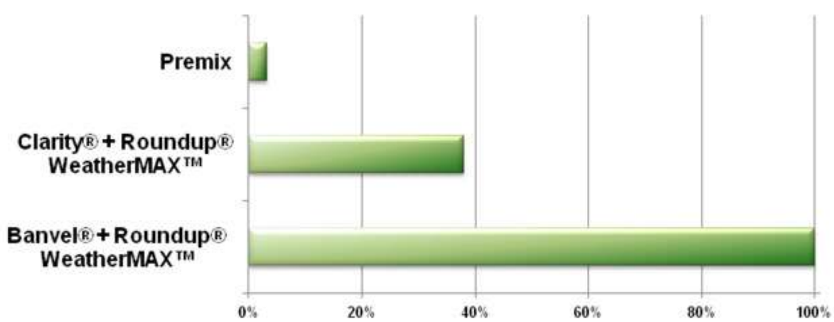
- Formulation selection
- Label development
- No aerial application
- Weed Management & Effective Control
  - Use pre-emergence residuals and multiple modes of action
  - <4" weeds
- Nozzles, Spray Pressure, and Spray Volume
  - Coarse to ultra-coarse droplets
- Equipment Ground Speed and Boom Height
  - < 15 mph
  - Boom low to canopy
- Wind
  - 15/10 mph or less
  - Blowing away from sensitive areas
  - Do not spray during temperature inversions
- **Buffer from downwind sensitive crops**
- Application Awareness
  - Awareness of proximity to sensitive crops
  - Sensitive crop registries—e.g. DriftWatch
  - Grower communication
- Drift reduction agents
- Proper sprayer clean out

MONSANTO

Formulation Advancement

Off-Target Loss: Lab Assessment

Glyphosate/Dicamba Premix Candidate Relative Volatility as Measured in Humidome



- Roundup + Dicamba Premix shows reduced volatility
- Formulation Type: Soluble Concentrate
- Contains Surfactant

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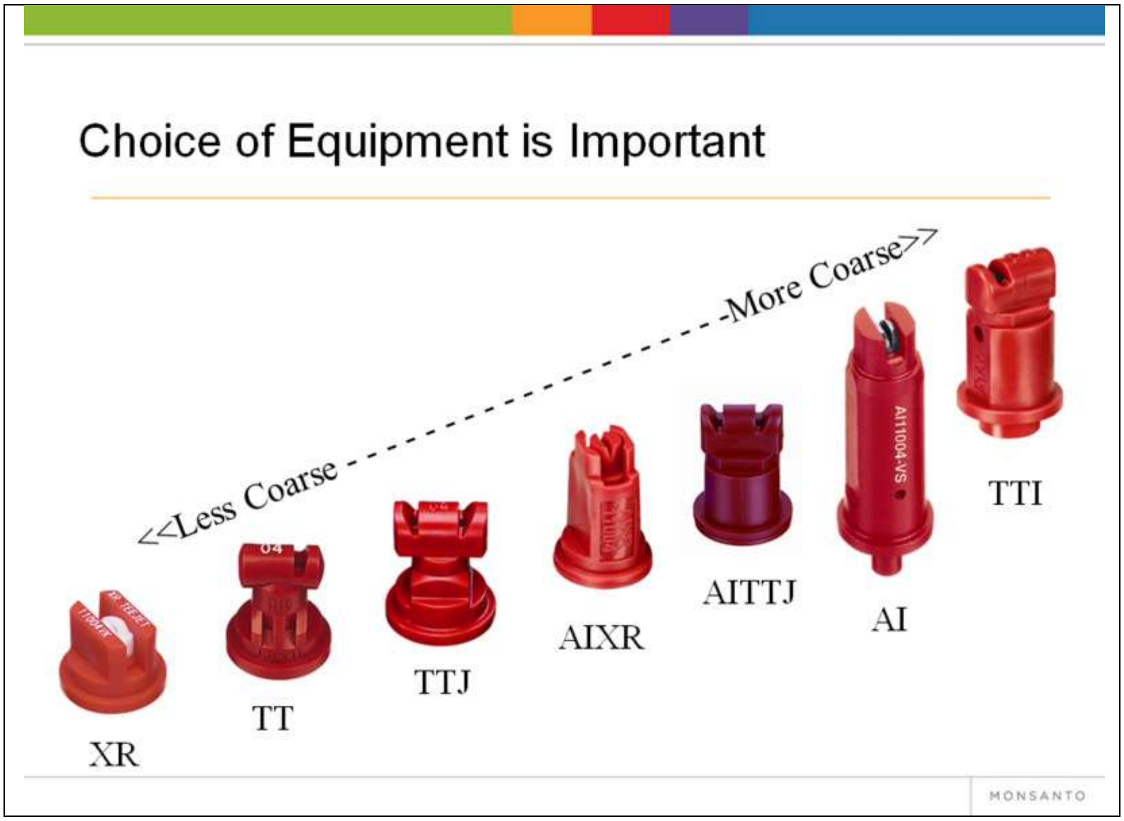
Choice of Equipment is Important
<<Less Coarse - - - - - - - - - - - - - - - - - - -More Coarse>>
XR
TT
TTJ
AIXR
AITTJ
AI
TTI
AI11004-VS
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Technology Can Enables BMPs
FNR Farm Plot Map
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Multiple Collaborations and Input Sought

- **Monsanto & BASF**
  - Systems recommendations
  - Formulation development
  - Off-target movement studies
  - BMPs
- **Ag Retail**
  - Large scale off-target movement studies
- **Sensitive Crop Registries**
  - DriftWatch
- **Dicamba Advisory Council**
  - Est. 2009
  - Academics
  - Retailers
  - Farmers
  - Grower groups
  - Sensitive Crop stakeholders
- **Academics**
  - System recommendations
  - Off-target movement studies

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Dicamba-Tolerant Soybeans

- **Multiple modes of action = more dead weeds**
  - Field trial results show that adding the world's fifth-most used herbicide to the already successful Roundup Ready® and Roundup Ready PLUS™ systems will deliver excellent weed management of tough-to-control broadleaf weeds.
- **The next generation of dicamba**
  - Next-generation low-volatility herbicide formulations are under development and are designed to make weed control simpler and easier.
- **Flexibility**
  - An increased window of application for dicamba—from burndown to early in-crop applications to kill weeds when they are small—would provide farmers the opportunity to kill weeds early.
- **Commitment to stewardship**
  - Monsanto is developing best management practices, such as proper rates and timing, to support successful on-farm stewardship to give you and your neighbors peace of mind when dicamba-tolerant soybeans are launched.

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•**Commercialization is dependent on multiple factors**, including successful conclusion of the regulatory process. Monsanto's Dicamba tolerant soybean product is currently in Phase IV of Monsanto's R&D pipeline. Dicamba formulations and premixes discussed herein are in various phases of development in Monsanto's R&D pipeline. Dicamba is not currently registered for over the top use on soybeans. It is a violation of federal law to use a pesticide in a manner inconsistent with its label.

•**Monsanto Company is a member of Excellence Through Stewardship® (ETS).** Monsanto products are commercialized in accordance with ETS Product Launch Stewardship Guidance, and in compliance with Monsanto's Policy for Commercialization of Biotechnology-Derived Plant Products in Commodity Crops. Commercial product(s) must be approved for import into key export markets with functioning regulatory systems prior to commercialization. Any crop or material produced from biotech products can only be exported to, or used, processed or sold in countries where all necessary regulatory approvals have been granted. It is a violation of national and international law to move material containing biotech traits across boundaries into nations where import is not permitted. Growers should talk to their grain handler or product purchaser to confirm their buying position for this product. Excellence Through Stewardship® is a registered trademark of Biotechnology Industry Organization.

•**ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. Roundup Ready®** crops contain genes that confer tolerance to glyphosate, the active ingredient in Roundup® brand agricultural herbicides. Roundup® brand agricultural herbicides will kill crops that are not tolerant to glyphosate. Banvel® and Clarity® are registered trademarks of BASF Corporation. Genuity and Design®, Genuity Icons, Genuity®, Roundup Ready 2 Yield®, Roundup Ready PLUS™, Roundup Ready®, and Roundup® are trademarks of Monsanto Technology LLC. All other trademarks are property of their respective owners. ©2011 Monsanto Company.

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***Are these new technologies needed?* – David Mortensen and Franklin Egan**

Crop and Soil Sciences, Penn State University dmortensen@psu.edu

Outline

- Limited tactic weed management
- Principles of Integrated Weed Management (IWM)
- Is it realistic to think a broader integration of tactics would fly with farmers?
- Field-Ready Tactics that complement herbicides
  - Cover crops
  - Crop rotations
  - Band applications
  - Cultivation
  - Crop tolerance
  - Seed harvesting

9. Implementation of IPM in the Corn and Soybean Transgenic Landscape: A Lost Cause?

According to the USDA Economic Research Service, 80% of all corn and 92% of all soybeans planted in 2008 were genetically modified (transgenic). In recent years, the prophylactic use of corn and soybean seed treated with an insecticide and/or fungicide also has become a more common approach by producers. Not surprisingly, overall production input costs have risen sharply. Against this backdrop of escalating production costs and risk aversion, is the deployment of traditional IPM tactic in the large-scale commercial production of corn and soybeans relevant? Are producers integrating management tactics for pests in this landscape? Are the widespread use of transgenic crops and the pyramiding of genes in modern corn hybrids the new integration strategy?

1995:

"Furthermore, the complex genetic transformations which were required for the development of glyphosate-tolerant crops would be unlikely to be duplicated in nature to yield glyphosate-resistant weeds"

From "Perspectives on the lack of potential of development of glyphosate resistance in weeds" Bradshaw, LD, SR Padgette, BH Wells, and Y Fichet. 1995. Author affiliation, Monsanto Agricultural Group, *in* Seizieme conference du Columa. Journees internaionales sur la lutte contre les mauvaises herbes.

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2010:

"The lack of widespread development of 2,4-D–resistant weeds may be because of the genetic redundancy inauxin/2,4-D receptors, the essentiality of auxin perception for plant development, and/or the pleiotropic nature of the downstream auxin effects. These observations suggest that the frequency of 2,4-D–resistant weed appearance may be low."

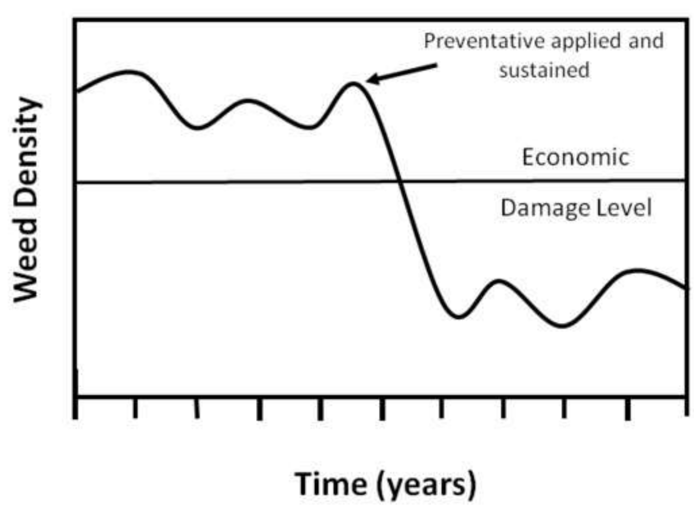
Wright TR, et al. 2010. Robust crop resistance to broadleaf and grass herbicides provided by aryloxyalkanoate dioxygenase transgenes. *Proc Natl Acad Sci* USA 107:20240–20245.

Glyphosate-resistance has been documented in 21 weedy plant species since the introduction of glyphosate-resistant soybean in 1996.

#	Species	Country (Click for Details)	Year
1.	*Amaranthus palmeri* Palmer Amaranth	2005 - USA (Georgia) 2005 - USA (North Carolina) 2006 - USA (Arkansas) 2006 - USA (Tennessee) 2008 - USA (Mississippi)	2005
2.	*Amaranthus rudis* Common Waterhemp	2005 - USA (Missouri) *Multiple - 3 MOA's 2006 - USA (Illinois) *Multiple - 2 MOA's 2006 - USA (Kansas) 2007 - USA (Minnesota)	2005
3.	*Ambrosia artemisiifolia* Common Ragweed	2004 - USA (Arkansas) 2004 - USA (Missouri) 2007 - USA (Kansas)	2004
4.	*Ambrosia trifida* Giant Ragweed	2004 - USA (Ohio) 2005 - USA (Arkansas) 2005 - USA (Indiana) 2006 - USA (Kansas) 2006 - USA (Minnesota) 2007 - USA (Tennessee)	2004
6.	*Conyza canadensis* Horseweed	2000 - USA (Delaware) 2001 - USA (Kentucky) 2001 - USA (Tennessee) 2002 - USA (Indiana) 2002 - USA (Maryland) 2002 - USA (Missouri) 2002 - USA (New Jersey) 2002 - USA (Ohio) 2003 - USA (Arkansas) 2003 - USA (Mississippi) 2003 - USA (North Carolina) 2003 - USA (Ohio) *Multiple - 2 MOA's 2003 - USA (Pennsylvania) 2005 - Brazil 2005 - USA (California) 2005 - USA (Illinois) 2005 - USA (Kansas) 2006 - China 2006 - Spain 2007 - Czech Republic 2007 - USA (Michigan)	2000
14.	*Sorghum halepense* Johnsongrass	2005 - Argentina 2006 - Argentina 2007 - USA (Arkansas)	2005

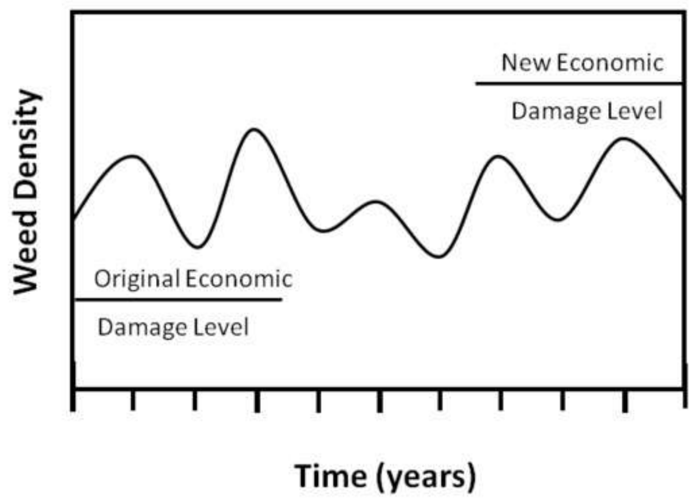
Ian Heap. October 28, 2011. International Survey of Herbicide Resistant Weeds. http://www.weedscience.org/In.asp

1st Principle: Lower the equilibrium weed density



Mortensen, D. A., Integrated pest management reduces reliance on "The Big Hammer", *Weeds as Teachers*, AERO 1997, p 15

2nd Principle: Increase system tolerance to weeds



Mortensen, D. A., Integrated pest management reduces reliance on "The Big Hammer", *Weeds as Teachers*, AERO 1997, p 15

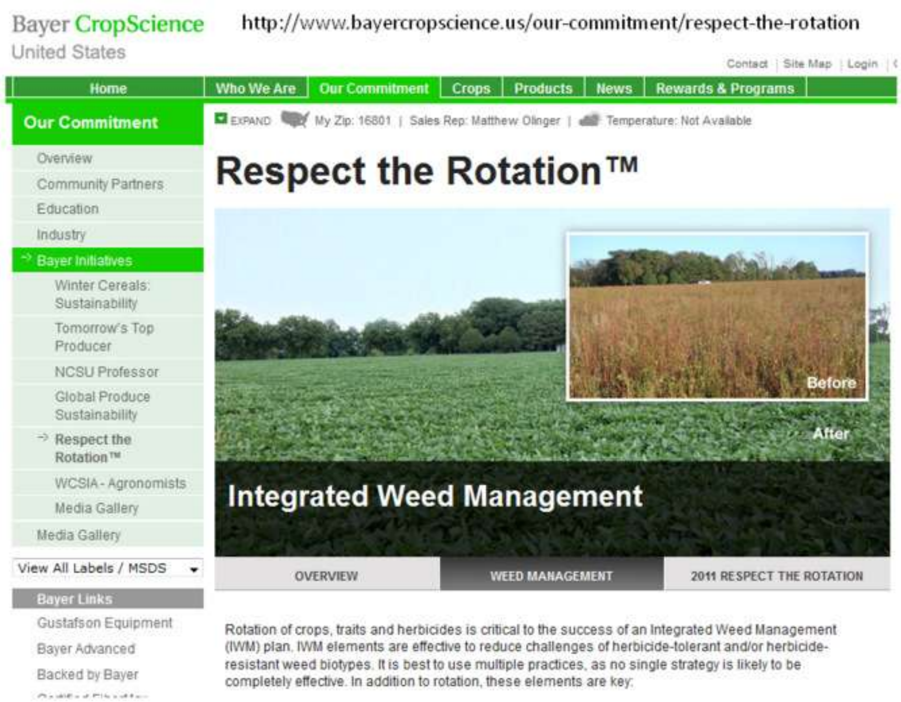
3th Principle: Rely on multiple practices to accomplish that avoid selection for and adapted weedy flora

We know that an adapted weed flora arises from a simplification of tactics where weedy plants can adapt by:

•*Avoidance* where plants emerge before or after a control practice

•*Tolerance* variation within and among weedy species in response to control

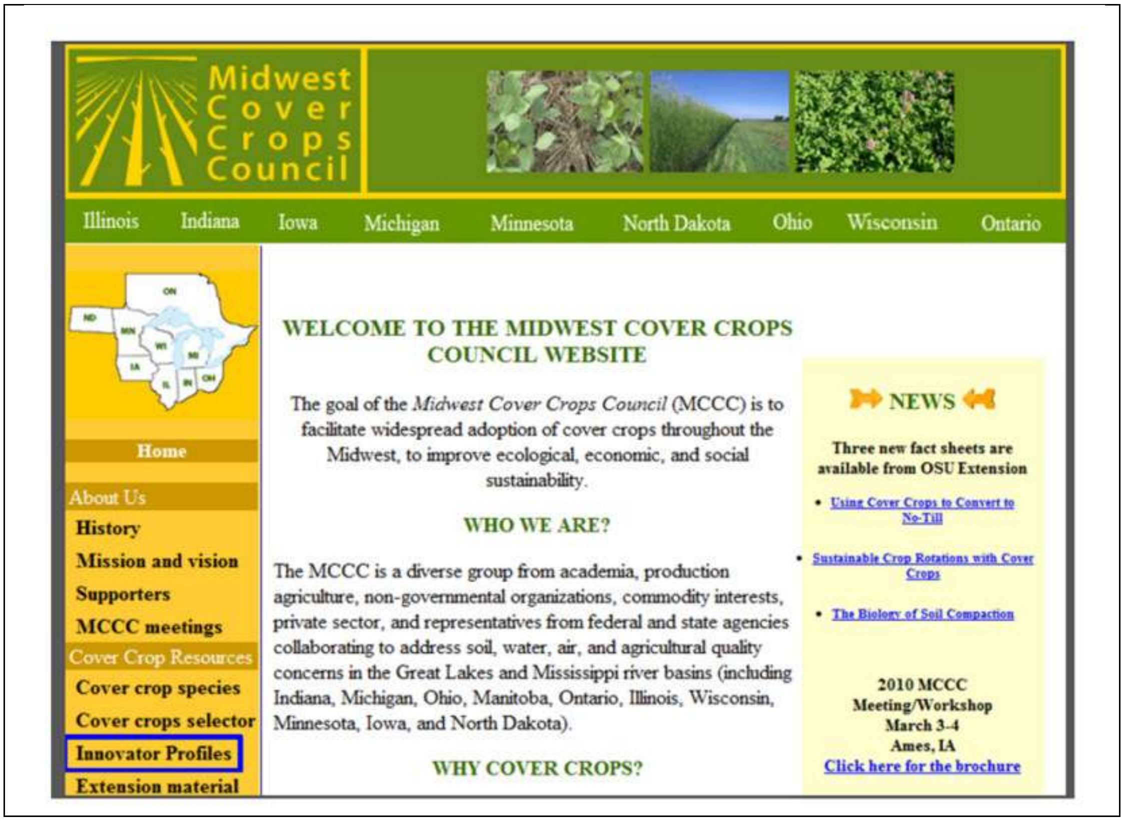
•*Resistance* a directional heritable change in response to a control enabling a species to survive where it once was controlled

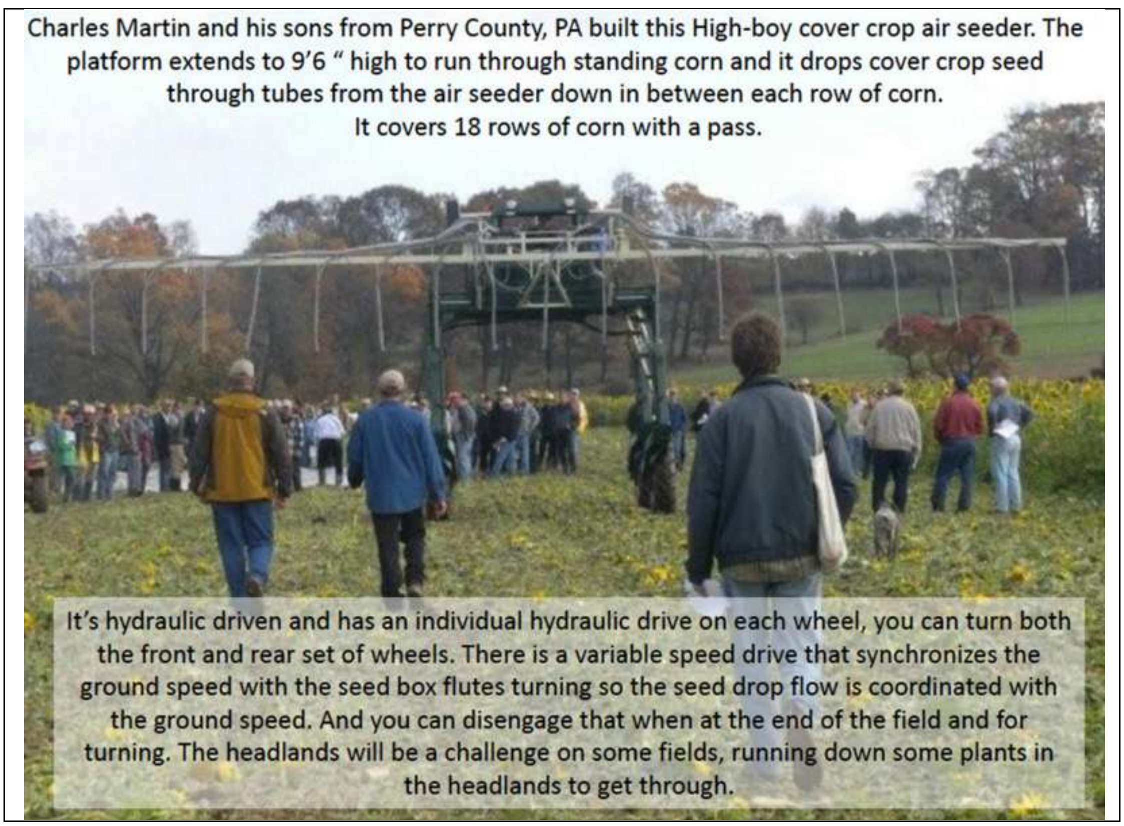


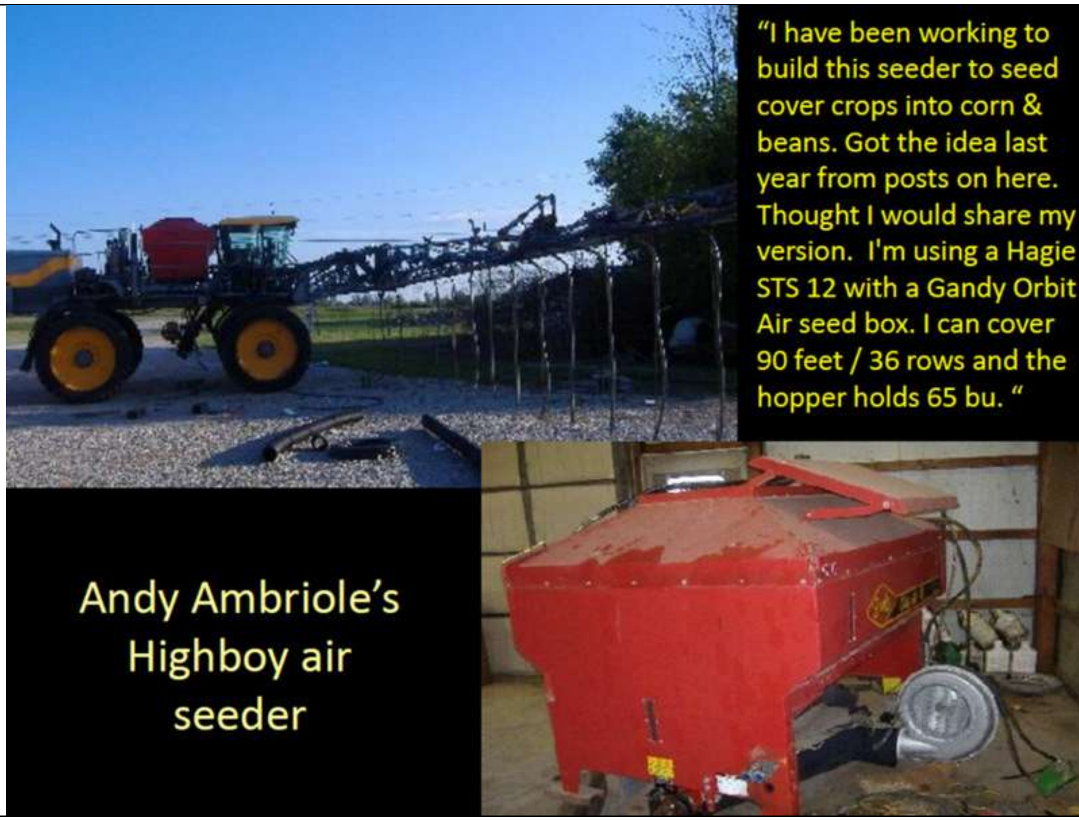
What do we mean by Integrated Weed Management?

Outline

- Limited tactic weed management
- Principles of Integrated Weed Management (IWM)
- Is it realistic to think a broader integration of tactics would fly with farmers?
- Field-Ready Tactics that complement herbicides
  - Cover crops
  - Crop rotations
  - Band applications
  - Cultivation
  - Crop tolerance
  - Seed harvesting


Midwest Cover Crops Council
Illinois
Indiana
Iowa
Michigan
Minnesota
North Dakota
Ohio
Wisconsin
Ontario
Home
About Us
History
Mission and vision
Supporters
MCCC meetings
Cover Crop Resources
Cover crop species
Cover crops selector
Innovator Profiles
Extension material
WELCOME TO THE MIDWEST COVER CROPS COUNCIL WEBSITE
The goal of the Midwest Cover Crops Council (MCCC) is to facilitate widespread adoption of cover crops throughout the Midwest, to improve ecological, economic, and social sustainability.
WHO WE ARE?
The MCCC is a diverse group from academia, production agriculture, non-governmental organizations, commodity interests, private sector, and representatives from federal and state agencies collaborating to address soil, water, air, and agricultural quality concerns in the Great Lakes and Mississippi river basins (including Indiana, Michigan, Ohio, Manitoba, Ontario, Illinois, Wisconsin, Minnesota, Iowa, and North Dakota).
WHY COVER CROPS?
NEWS
Three new fact sheets are available from OSU Extension
Using Cover Crops to Convert to No-Till
Sustainable Crop Rotations with Cover Crops
The Biology of Soil Compaction
2010 MCCC Meeting/Workshop
March 3-4
Ames, IA
Click here for the brochure


Charles Martin and his sons from Perry County, PA built this High-boy cover crop air seeder. The platform extends to 9'6 " high to run through standing corn and it drops cover crop seed through tubes from the air seeder down in between each row of corn.
It covers 18 rows of corn with a pass.
It's hydraulic driven and has an individual hydraulic drive on each wheel, you can turn both the front and rear set of wheels. There is a variable speed drive that synchronizes the ground speed with the seed box flutes turning so the seed drop flow is coordinated with the ground speed. And you can disengage that when at the end of the field and for turning. The headlands will be a challenge on some fields, running down some plants in the headlands to get through.



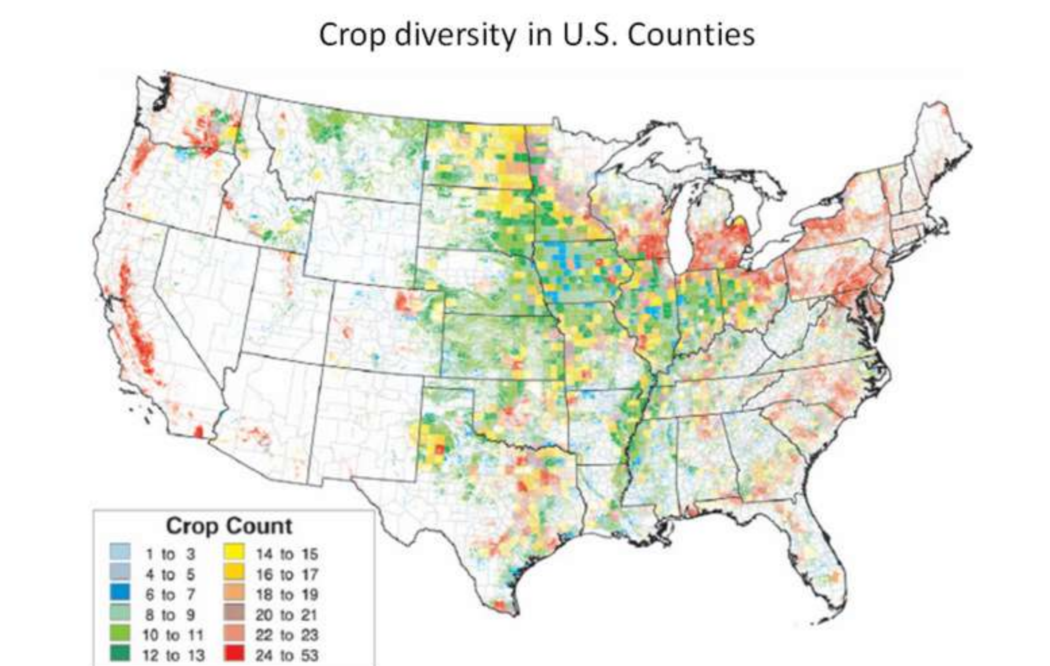
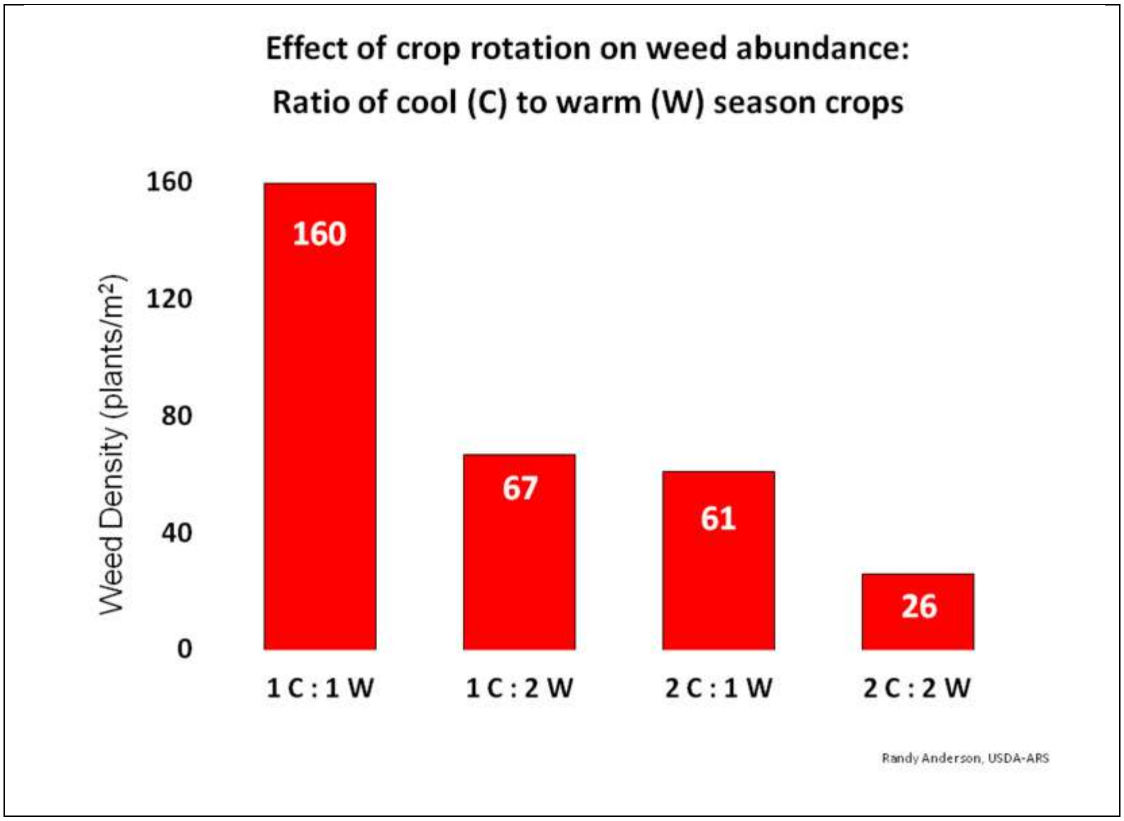


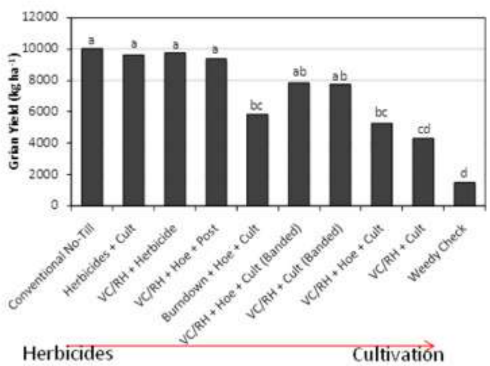
Fig. 3. The number of crops grown in a U.S. county based on the 1997 Census of Agriculture [11]. Only portions of counties identified as agricultural land by National Land Cover Characterization Database [12,13] are shown. White areas are not in crop production.


Effect of crop rotation on weed abundance:
Ratio of cool (C) to warm (W) season crops
Weed Density (plants/m²)
160
120
80
40
0
160
67
61
26
1 C : 1 W
1 C : 2 W
2 C : 1 W
2 C : 2 W
Randy Anderson, USDA-ARS

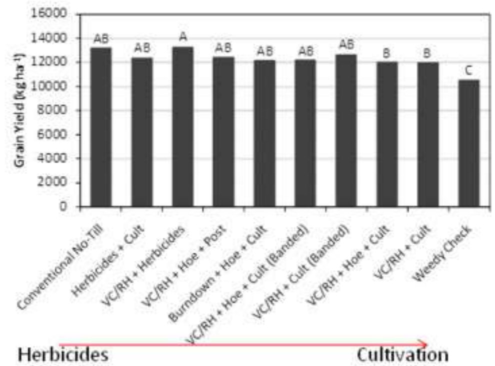

Mechanical weed control in high residue environments
Vertical Coulter
Rotary Harrow
Rotary Hoe
High Residue Cultivator

Corn yields in a IWM Study

2008 (high weed pressure)



2009 (low weed pressure)



Ryan Bates, M.S. thesis.

Combining banded herbicides and the vertical coulter

On this 1700 acre Nebraska farm, like many in the region, weed management involves banded herbicide application followed by a row cultivation pass. Here, the herbicide load is reduced by 2/3, distributing control across herbicides, cultivation and crop competition.

Break even Prices

	Treatment	Weed Control Cost ($ ha^{-1}) 2008	Weed Control Cost ($ ha^{-1}) 2009	Breakeven Price ($ kg^{-1}) 2008	Breakeven Price ($ kg^{-1}) 2009
Herbicides	Conventional No-Till	146	146	0.11	0.08
	Herbicides + Cult	170	194	0.11	0.09
	VC/RH + Herbicide	151	139	0.11	0.08
	VC/RH + Hoe + Post	157	145	0.11	0.09
	Burndown + Hoe + Cult	92	116	0.17	0.09
	VC/RH + Hoe + Cult (Banded)	133	145	0.13	0.09
	VC/RH + Cult (Banded)	111	124	0.13	0.08
	VC/RH + Hoe + Cult	90	102	0.19	0.08
Cultivation	VC/RH + Cult	68	81	0.22	0.08
	Weedy Check	0	0	0.59	0.09

Ryan Bates, M.S. thesis.

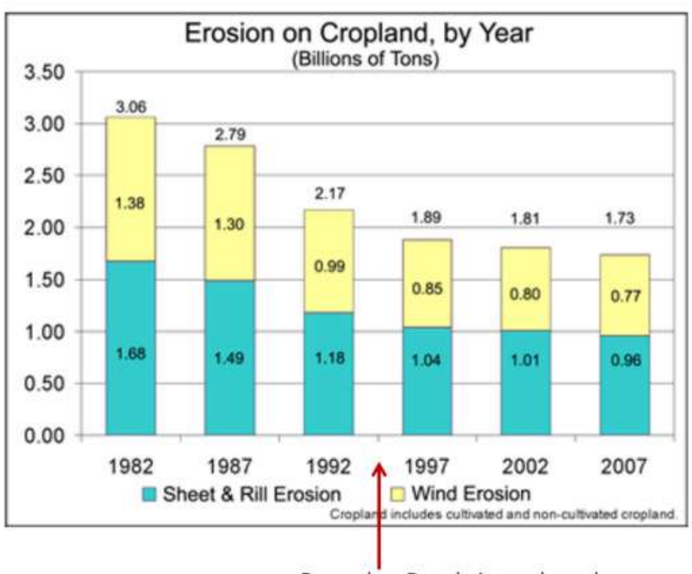
Soil Conversation and HR crops?

Table 3 Area under no-tillage farming in the United States[20]

Year	Area (million ha.)
1994	15.7
1996	17.3
1998	19.3
2000	21.1
2002	22.4
2004	25.3
2007	26.5

More detailed information under CRM data collection http://www.conservationinformation.org/?action=members_crm.

Derpsch et al. 2010.



Roundup Ready introduced

NRCS 2010

Sustainable Agriculture Demonstration Project, USDA-ARS, Beltsville, MD

A 9-yr. study of corn-wheat-soy cropping systems on erodible soils in Maryland

- **NT**: no till with herbicide weed control, NPK fertility
- **CC**: no-till with vetch and rye cover crops
- **CV**: no-till with crown vetch living mulch
- **OR**: organic with chisel plow and sweep cultivation, clover and rye cover crops, manure fertility.

Table 4. Total soil combustible C and N averaged over 2001 and 2002 at the conclusion of the cropping systems comparison.

	Soil depth, cm		
System	0–7.5	7.5–15	15–30
Soil C		$g\ kg^{-1}$	
No-tillage	15.5c†	11.1c	7.1b
Cover crop	17.3b	12.4b	7.8b
Crownvetch	14.4c	11.1c	7.4b
Organic	19.2a	15.9a	10.3a
Soil N			
No-tillage	1.29c	0.93c	0.58b
Cover crop	1.43b	1.04b	0.64b
Crownvetch	1.22c	0.98bc	0.66b
Organic	1.59a	1.30a	0.87a

† Values within a depth range followed by the same letter are not different at $P < 0.05$.

Soil Losses (Mg/ha)[1]

NT: 3.45

CC: 3.10

CV: n/a

OR: 3.69

Differences were not significant

Teasdale et al. 2007

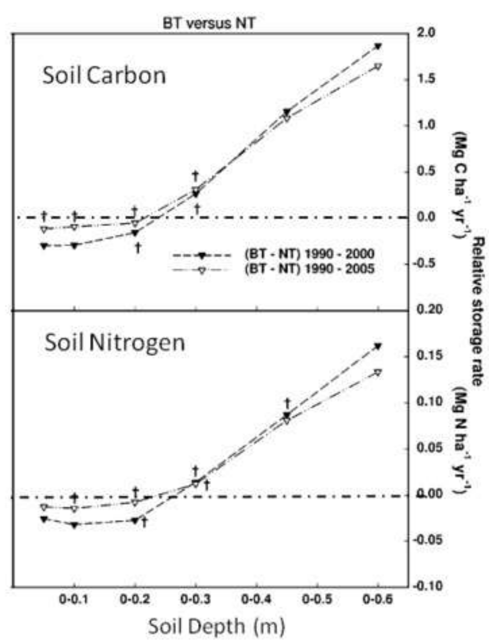
[1]Modeled from Revised Universal Soil Loss Equation

Venterea et al. 2006

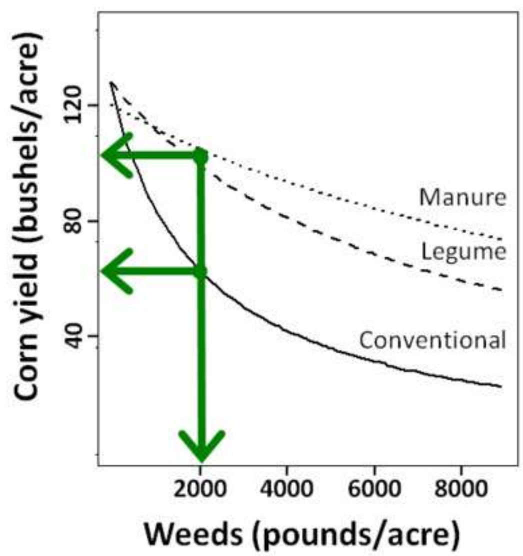
Corn-soy rotation in MN

NT: no tillage

BT: biennial tillage (chisel plow following corn, surface cultivation before soybean)



Weed-Crop Competition



Weeds in organic corn were less competitive

Why?

Ryan et al. 2010

Weed-Crop Competition in Organic and Conventional Systems

Table 2 Correspondence between conventional and organic maize and soyabean yields and weed abundance from sources published in the agricultural literature

				Conventional			Organic				
Study	ID	Crop	Years	No. crop species	Fertility source	RPD	No. crop species	Fertility source	RPD	Crop yield reduction relative to conventional (%)	Weed abundance increase relative to conventional (%)
1	1	Maize	5	4	NPK	5	7	GM, AM	9	18	633
	2	Soyabean	5	4	NPK	5	7	GM, AM	9	8	2000
2	3	Maize	4	1	NPK	2	6	GM, AM	8	4	938
3	4	Maize	4	2	NPK	3	7	GM, AM	9	7	353
	5	Soyabean	4	2	NPK	3	7	GM, AM	9	0	152
4	6	Maize	1	2	NPK	3	4	AM	5	0	29
	7	Soyabean	1	2	NPK	3	4	AM	5	13	133
5	8	Maize	1	2	NPK	3	5	GM	6	0	145
	9	Soyabean	1	2	NPK	3	5	GM	6	0	53

Smith et al. 2010

Weed-Crop Competition in Organic and Conventional Systems

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	5	Soyabean	4	2	NPK	3	7	GM, AM	9	0	152
4	6	Maize	1	2	NPK	3	4	AM	5	0	29
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5	8	Maize	1	2	NPK	3	5	GM	6	0	145
	9	Soyabean	1	2	NPK	3	5	GM	6	0	53

Smith et al. 2010

Possible reasons for difference in tolerance to weeds

- Later planting date
  - Warmer soil and fewer weeds
- Higher seeding rate
  - Increase the relative competitive ability of crops
- Greater soil organic matter
  - Cover crops, manure, and compost
- Soil nutrient availability more synchronized with crop demand
  - Mineralization of organic matter vs. mineral fertilizer
- Crops growing before period when they compete with weeds

Weed seed collection in the Western Australian wheatbelt

Modifications to the header to generate a narrow chaff trail concentrating weed seeds and allowing a hot burn.
Photo: Wayne Parker

A chaff cart can be towed by the header collecting chaff, straw and weed seeds, thus minimising weed seed return to the seedbank.
Photo: Wayne Parker

Table T4.1a-1 Percentage control of annual ryegrass with various seed collection techniques in Western Australia (anecdotal evidence from farmer experience, Steve Sutherland pers. comm)

Harvest treatment	Percentage control
Harvested using chaff spreader	0
Harvested with narrow header trail	95
Harvested using chaff cart	65
Windrowed with narrow header trail	82
Windrowed, harvested using chaff cart	91

The Rotomill (www.harvestaire.com/au)

The Rotomill® destroys seeds as it grinds chaff.
Photo: Michael Walsh

Collects, grinds, and destroys weed seeds that pass through the wheat harvester. Can destroy **> 90%** of collected seeds.

In Summary

"Is it realistic to think a broader integration of tactics would fly with farmers?"

We think so!

- Crop-diversity can be increased in many regions of the U.S.
- Cover crops are being adopted rapidly.
- New machinery has been developed for cover crop planting, high-residue cultivation, and weed seed harvesting.
- We can design cropping systems that minimize weed-crop competition and maximize crop tolerance for weeds.

Now is time to put the "I" back in Integrated Weed Management!

Why Risk Analysis is not Enough – Larry Busch

Center for the Study of Standards in Society, Michigan State University, lbusch@msu.edu

For the last 30 years debates have dragged on about genetic modification of crops. Intertwined with those debates are others on the role of intellectual property and research. As a result of decisions made during the Reagan administration, regulation of GM crops was cobbled together using existing laws, resulting in the creation of the 'Coordinated Framework.' This put the regulatory experts firmly in charge while ruling out most democratic debate. Nearly simultaneously, Land Grant universities began to invest in biotechnology research, largely abandoning conventional plant breeding. Hence, today the research agenda is no longer set in the public sector. Some research trajectories (e.g., apomixis) have been abandoned. Although the debate continues, the expert community insists, backed by the Coordinated Framework, that risk issues are all that count. Hence, all other issues are forced through the frame of risk. Even questions of distribution of risk are rarely discussed. What is needed is a new approach that recognizes legitimate concerns that go beyond risk and that opens debate to the public at large.

Lawrence Busch is University Distinguished Professor of Sociology and Co-Director of the Center for the Study of Standards in Society at Michigan State University. He has been on the faculty at the Norwegian University of Science and Technology, Lancaster University (UK), and what is now the *Institut de Recherche pour le Développement (IRD)*. He is (co)author or (co)editor of twelve books including *Plants, Power and Profit: Social, Economic, and Ethical Consequences of the New Biotechnologies* (Blackwell, 1991), *Toward a New Political Economy of Agriculture* (Westview, 1991), *From Columbus to Conagra: The Globalization of Agriculture* (University of Kansas Press, 1994), *Making Nature, Shaping Culture: Plant Biodiversity in Global Context,* (University of Nebraska Press, 1995), *The Eclipse of Morality: Science, State and Market,* (Aldine DeGruyter, 2000), *Agricultural Standards: The Shape Of The Global Food And Fiber System,*(Springer, 2006), *Universities in the Age of Corporate Science: The UC Berkeley–Novartis Controversy,* (Temple University Press, 2007), and *Standards: Recipes for Reality* (MIT Press, 2011). He has also authored or coauthored more than 150 other publications. He is past president of both the Rural Sociological Society and the Agriculture, Food, and Human Values Society, a fellow of the American Association for the Advancement of Science, a *Chevalier de l'Ordre du Mérite Agricole* and an elected member of the *Académie d'Agriculture de France*. He recently received a *doctor honoris causa* from the *Universidade Técnica de Lisboa*. Dr. Busch's current interests include the use of standards in public and private policy making, biotechnology and nanotechnology policy, agricultural science and technology policy, higher education in agriculture, and public participation in the policy process.

Why Risk Analysis is not Enough

Lawrence Busch
Center for the Study of Standards in Society
Michigan State University
USA

Paper presented at ***The new 2,4-D and dicamba tolerant crops: Managing risk to farmers and communities*** Ohio State University, October 2011

Plan of this talk

- 25 years of debates over genetic modification of crops
- Intellectual property and research
- The debate today
- Role of risk analysis
- Limits of risk analysis
- Precaution vs. familiarity

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GM 25 years ago
• Claims of proponents:
– 2' ears of maize
– 6' tall cattle
– Nitrogen-fixing maize
• Claims of opponents:
– Frankenfoods
– Environmental nightmares
– Global food supply at risk
FRANKENFOOD
IT'S NOT EASY TO LIVE GMO FREE


GM crops 25 years ago
Are they new?
• Intellectual Property = Yes!
• For raising venture capital = Yes!
• As novel crops/food = No!
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GM crops 25 years ago
How to regulate them? US response:
• New project of positive law? = No
• Fitted into existing regulations? = Yes
– Coordinated framework for safety
– Court reinterpretation of IP law
• Experts in charge; democratic debate ruled out
205


Coordinated Framework
• Cobbled together by OSTP food safety and environmental laws from…
– Food and Drug
– US Departmen
– Environmental Prot
USDA
FDA:
No Labeling Necessary
OF SCIENCE AND TECHNOLOGY POLICY
AGENCY: Executive Office of the President, Office of Science and Technology Policy.
51 FR 23302
June 26, 1986
Coordinated Framework for Regulation of Biotechnology
ACTION: Announcement of policy; notice for public comment.
SUMMARY: This Federal Register notice announces the policy of the federal agencies

Intellectual Property Law

- < 1980 plants are not patentable material
- However, PVPA and PPA gave protection to developers of improved seeds
- Diamond v. Chakrabarty (1980): "everything under the sun that is made by man…"
- *Ex parte* Hibberd (1985): plants patentable
- J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Int'l, Inc. (2001): Seeds patentable

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Decline of Public Research

- Neoliberal push for small government reduces funding for public agricultural research
- Land Grant Universities invest in biotechnology research, abandoning plant breeding
- Research agenda no longer set in public sector

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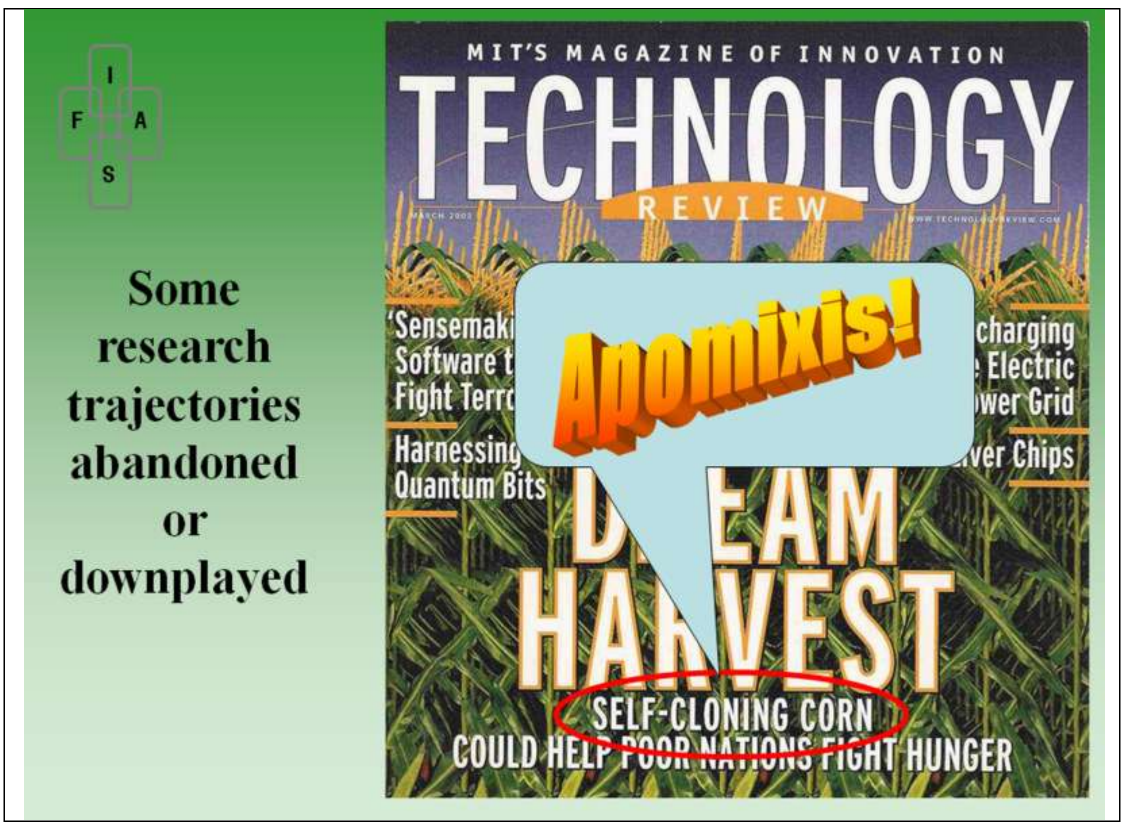
Competing Imaginaries

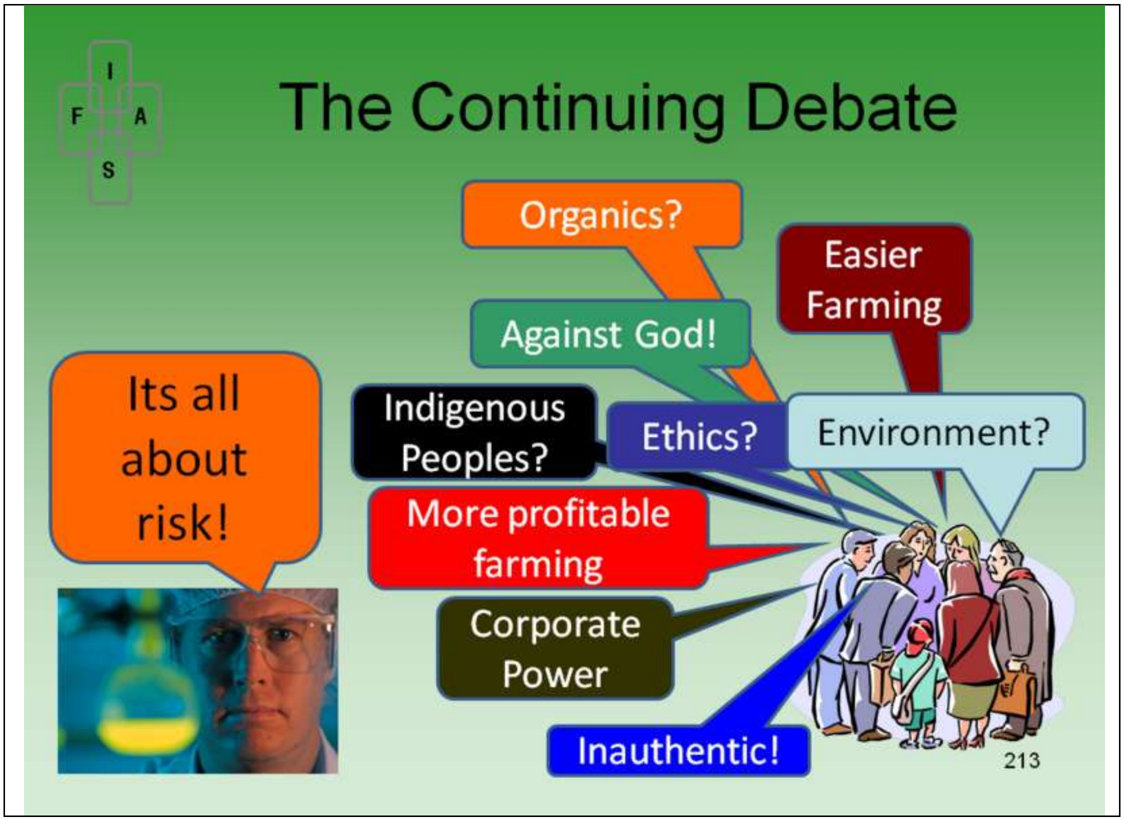
- Combination of reinterpretation of IP law and Coordinated Framework led to…
- Exclusion of many public concerns from official discourse
- Withdrawal to war of images…

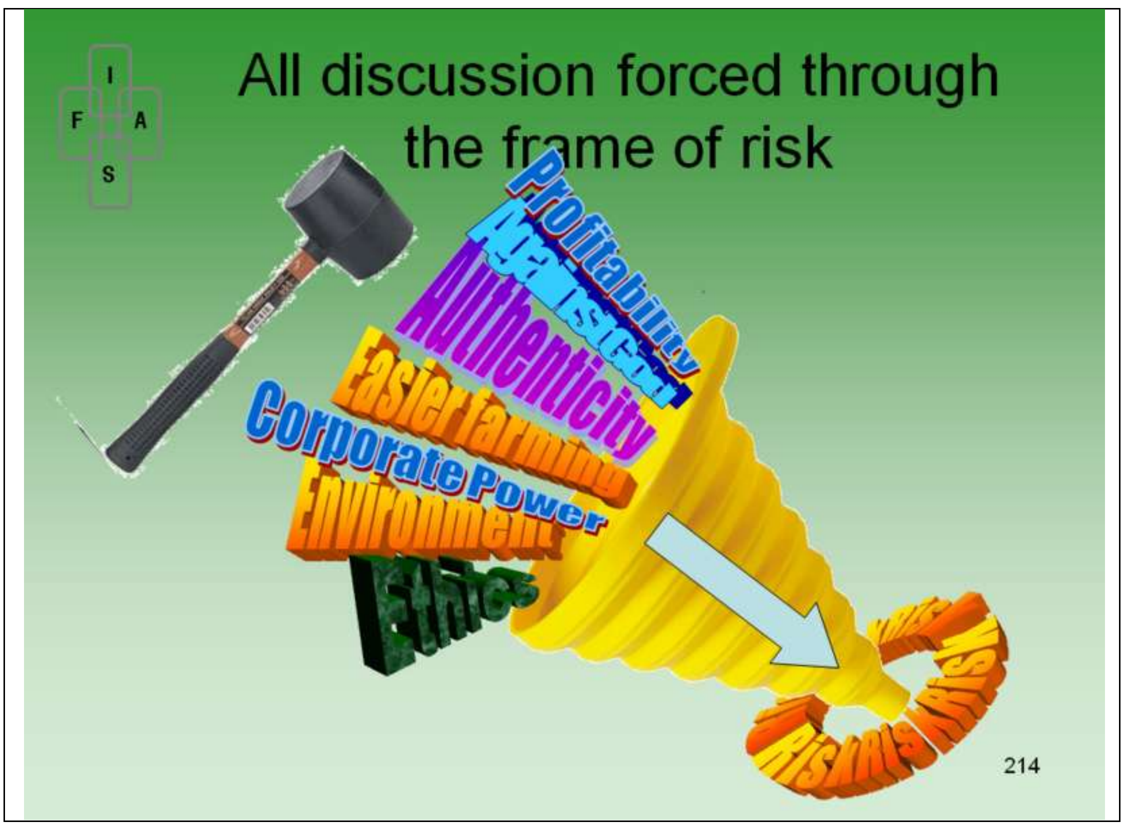
9

Activist view …


Industry perspective...
We Back Biotech !
NOVARTIS
www.webackbiotech.com
211


Some research trajectories abandoned or downplayed
MIT'S MAGAZINE OF INNOVATION
TECHNOLOGY
REVIEW
Apomixis!
Harnessing
Quantum Bits
HARVEST
SELF-CLONING CORN
COULD HELP POOR NATIONS FIGHT HUNGER


IFAS
The Continuing Debate
Organics?
Easier Farming
Against God!
Its all about risk!
Indigenous Peoples?
Ethics?
Environment?
More profitable farming
Corporate Power
Inauthentic!
213


IFAS
All discussion forced through the frame of risk
Profitability
Authenticity
Easier farming
Corporate Power
Environment
Ethics
214

Limits to Risk Analysis

- Requires both highly specialized equipment and trained scientists

- Meeting international requirements expensive and difficult

- In practice, risk analysis restricted to a small number of nations

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Measurement of Risk

- What criteria should be used for risk assessments?
  - For well known products/processes not too problematic
  - For less known products/processes very difficult
- Who will (should) set the criteria?
  - National bodies?
  - International bodies?
  - Private sector?

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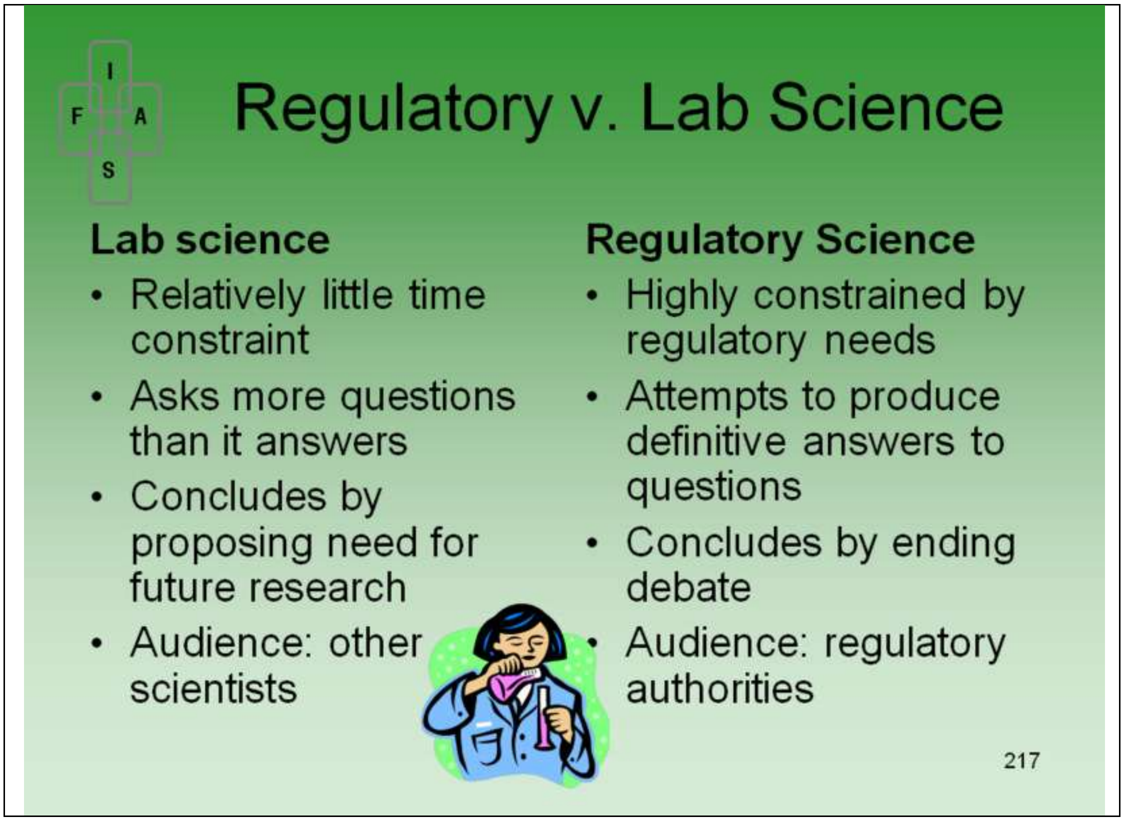
I
F A
S
Regulatory v. Lab Science
Lab science
• Relatively little time constraint
• Asks more questions than it answers
• Concludes by proposing need for future research
• Audience: other scientists
Regulatory Science
• Highly constrained by regulatory needs
• Attempts to produce definitive answers to questions
• Concludes by ending debate
• Audience: regulatory authorities
217


I
F A
S
How not to settle an issue
• Global GM debate going on for more than 25 years
• No sign that it is ending
• Few societal benefits or dangers found
• British House of Lords noted the problem in 2000…

British House of Lords:

"Some issues currently treated by decision-makers as scientific issues in fact involve many other factors besides science. Framing the problem wrongly by excluding moral, social, ethical and other concerns invites hostility."

-- *Science and Society*, House of Lords Select Committee on Science and Technology, third report (HMSO, 2000)

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GM Debate as Ethical Debate

All three major ethical positions implicated:

- What is the virtuous thing to do?
- Whose rights are expanded/reduced?
- Who benefits? Who loses?

Toward Resolution?

- ✓ Based on the debate, determine if and where compromise is possible
- ✓ Ensure that issues of social justice trump those of corporate profit and technical advance
- ✓ Incorporate both experts and general public into the process

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Transgenic Crops

- Transparency needed
  - To clarify positions and issues
  - To permit greater public understanding
- Translation needed
  - To articulate concerns
  - To develop a common ‘grammar’ of debate

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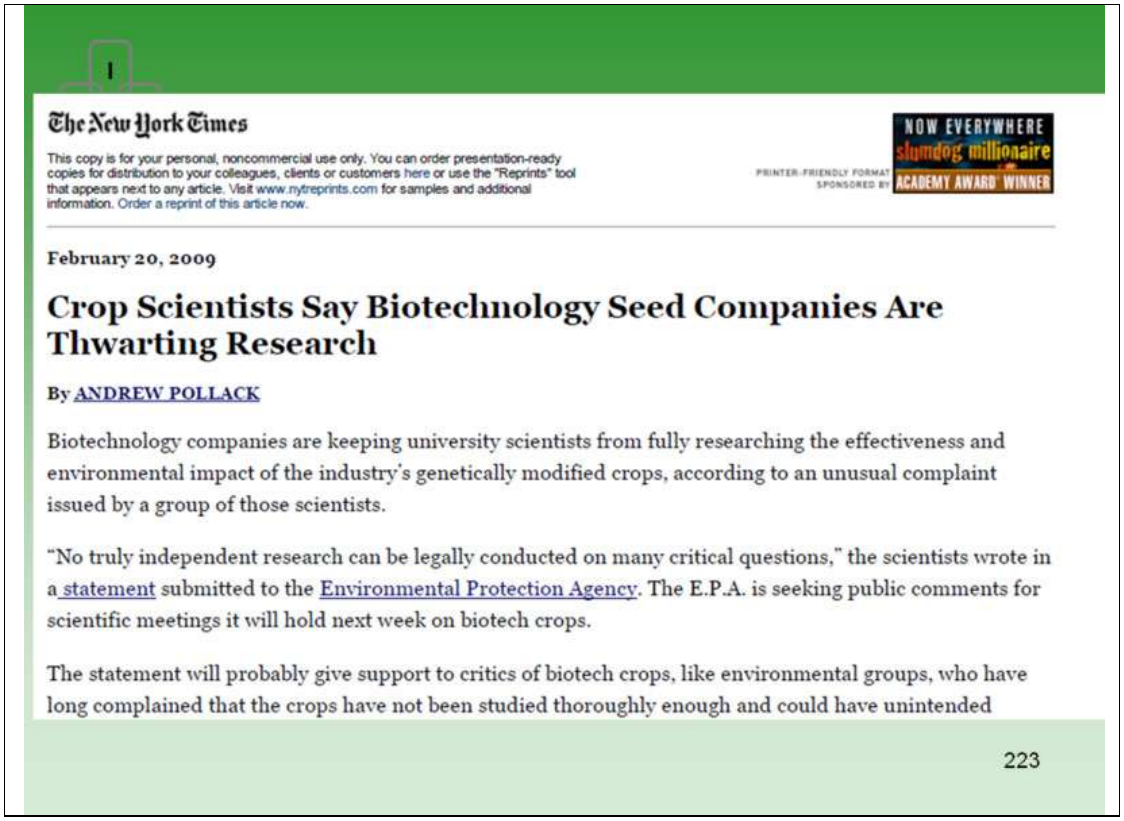

The New York Times

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February 20, 2009

Crop Scientists Say Biotechnology Seed Companies Are Thwarting Research

By ANDREW POLLACK

Biotechnology companies are keeping university scientists from fully researching the effectiveness and environmental impact of the industry's genetically modified crops, according to an unusual complaint issued by a group of those scientists.

"No truly independent research can be legally conducted on many critical questions," the scientists wrote in a statement submitted to the Environmental Protection Agency. The E.P.A. is seeking public comments for scientific meetings it will hold next week on biotech crops.

The statement will probably give support to critics of biotech crops, like environmental groups, who have long complained that the crops have not been studied thoroughly enough and could have unintended

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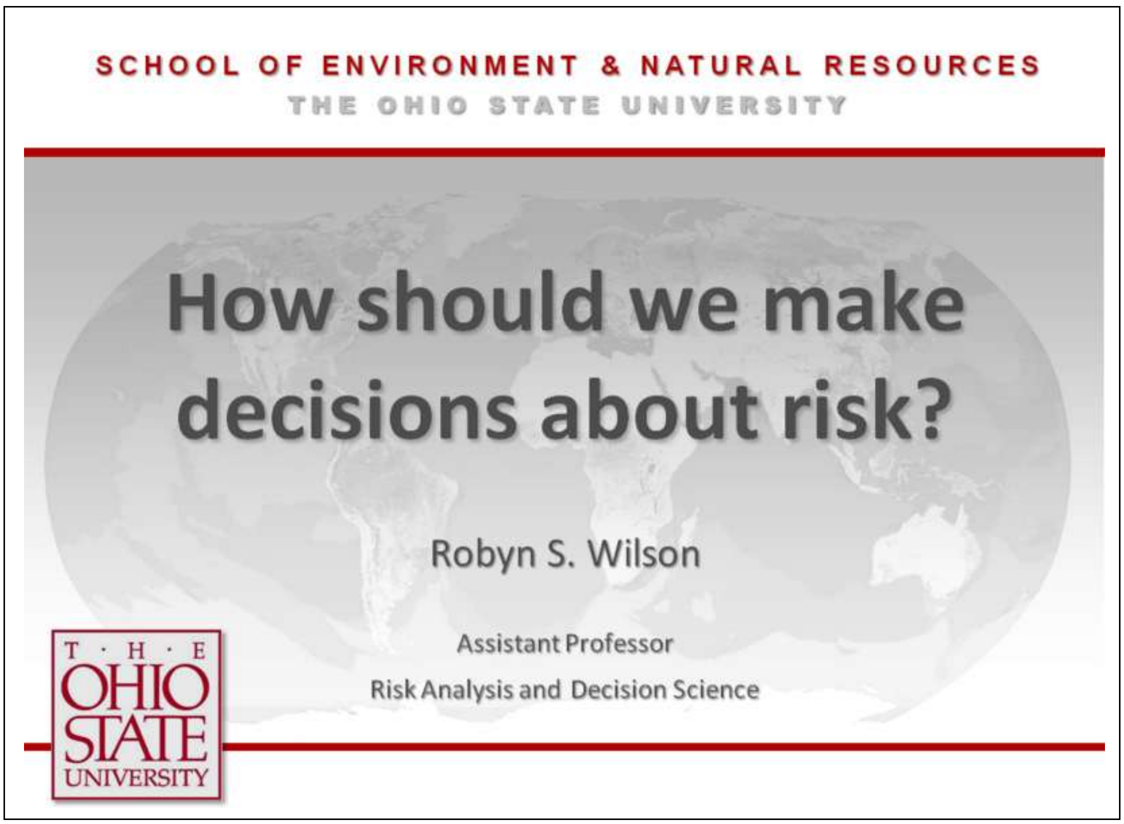
How Should We Make Decisions about Risk? – Robyn Wilson

School of Environment and Natural Resources, The Ohio State University, wilson.1376@osu.edu, 614-247-6169

Too often, decisions about risk conducted in a typical risk analysis framework are expert-centered, treating risk as real and objective, and seeking to identify a standard attainable level of risk. A broader and perhaps more defensible framework for making complex decisions in the face of risk and uncertainty can be found in decision analysis. Decision analytic approaches make the problem and stakeholder values the central concepts, and risk is identified as both objective and subjective. Such an approach seeks a context-dependent acceptable level of risk that is based on assessing the threat to the fundamental values and objectives of everyone involved.



What is risk?

- Calculated & perceived risk do not always align
- Calculated risk based on likelihood and severity of consequences
- (High) risk perceptions (and behavior!) driven by:
  - Low control, inequitable exposure, involuntary exposure, impact to future generations, catastrophic potential (i.e., the dread factor)
  - Unobservability, delayed effects, newness, low scientific knowledge (i.e., the unknown factor)

What is risk?

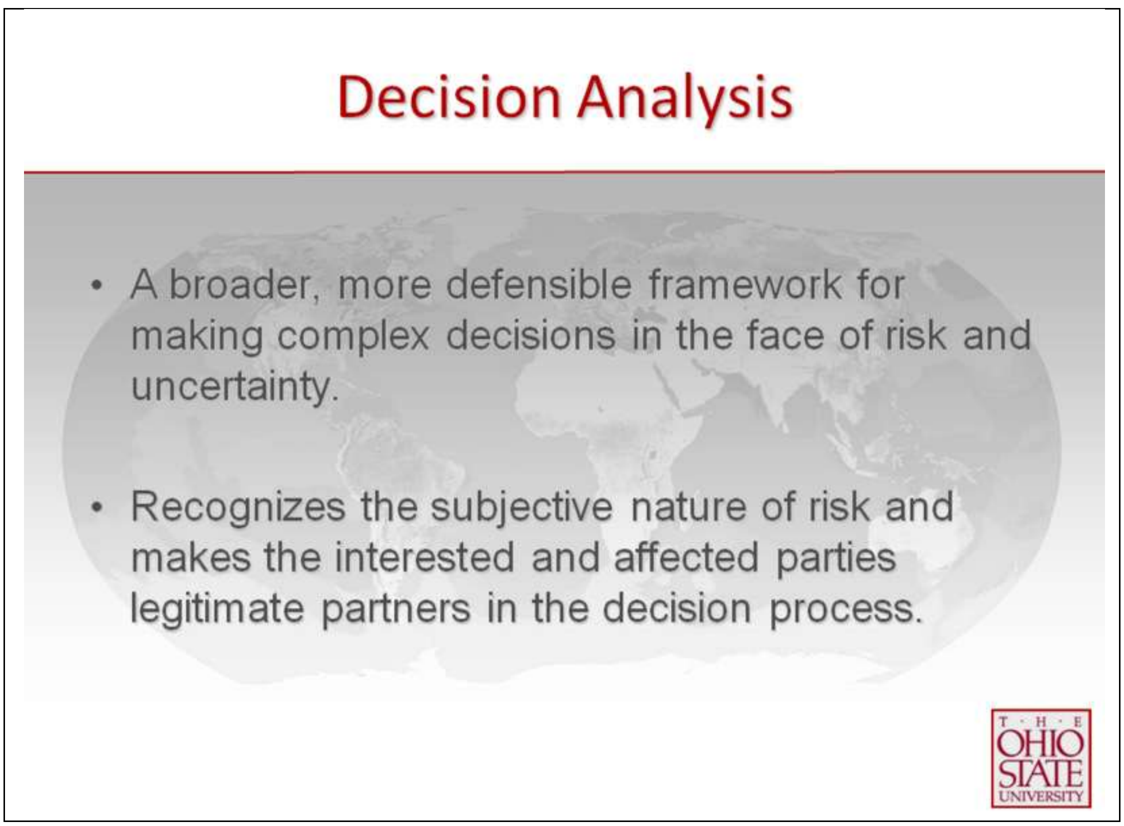
- However, lower risk perceptions found among individuals who:
  - Trust scientific/technological advances
  - Trust risk management officials
  - Hold hierarchical and individualistic worldviews
  - Have relatively higher income, education
  - Are politically conservative

What is risk?

- Traditional risk analysis does not account for public perception
  - Expert-driven assessment, communication and management
- Assumption being that better decisions result from technical assessments of risk
  - E.g., Likelihood and severity of consequences – not perceived voluntariness of exposure, individual tolerance, etc.

Risk Analysis


Risk Analysis
Risk is central concept
Risk is real and objective
Risk perception is subjective and irrational
Expert-centered
Seeks a standard attainable level of risk
Any problems with this?


Decision Analysis
A broader, more defensible framework for making complex decisions in the face of risk and uncertainty.
Recognizes the subjective nature of risk and makes the interested and affected parties legitimate partners in the decision process.

Decision Analysis

- Problem structure, probabilities and values are central concepts
- Risk is both objective and subjective
- Models the multi-dimensional views of all interested and affected parties
- Seeks a context-dependent acceptable level of risk

PrOACT

- Carefully define the **pr**oblem
- Consider **o**bjectives
- Identify or analyze potential **a**lternatives
- Establish the **c**onsequences of each alternative with respect to its ability to meet stated objectives
- Address the **tr**adeoffs that each alternative entails

Sometimes…

- Simplify decisions involving uncertainty
- Account for risk tolerance
- Think about future decisions

Hammond, J. S., Keeney, R. L., & Raiffa, H. (1999). *Smart choices: a practical guide to making better decisions*. Boston, Massachusetts: Harvard Business School Press.

Defining the Problem

What is the problem that you're trying to solve?

If a problem is incorrectly defined, then the entire process is off-base and will often result in a sub-optimal choice

THE OHIO STATE UNIVERSITY

Defining the Problem

Is the problem…

Glyphosate technology?

Farmer behavior?

Agribusiness marketing?

The increasing demand due to a growing global population?

The current food system?

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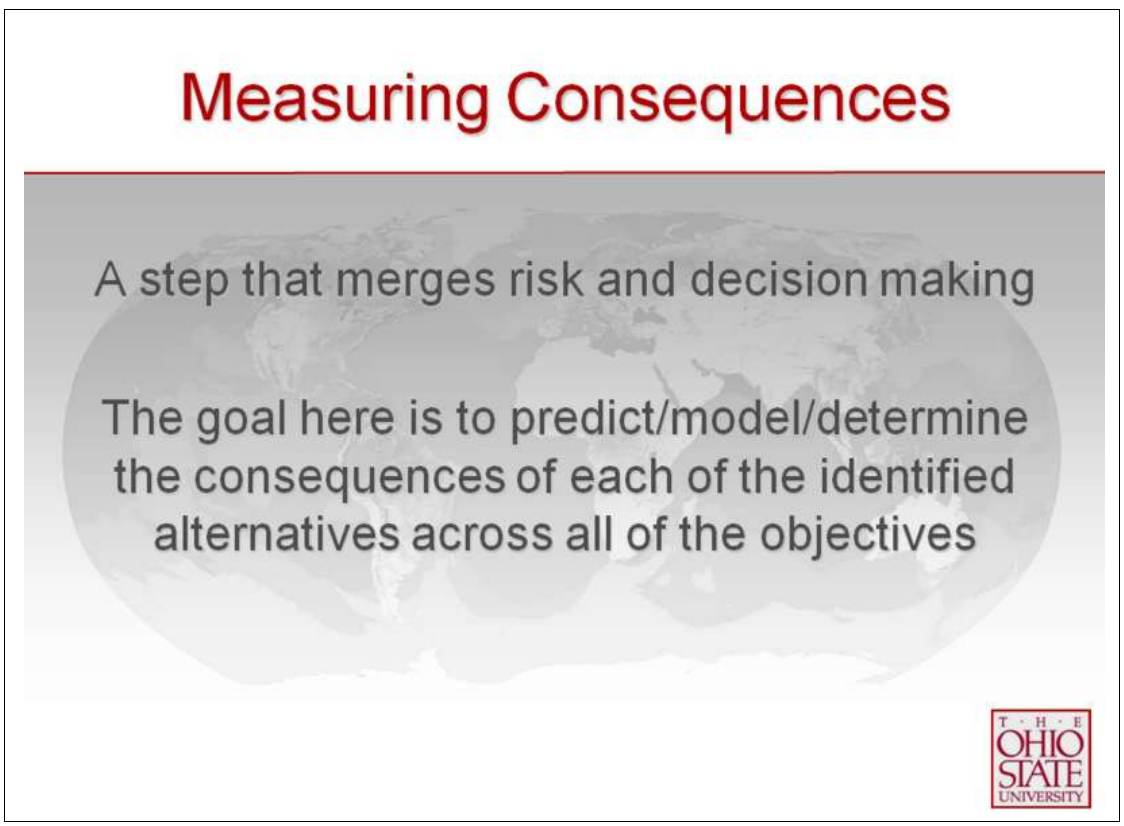
Considering Objectives
What is it that you want to achieve with your decision?
Objectives are essentially concerns or values that are important to the interested/affected parties.


Cosidering Objectives
I want a technology that…
…is cheap
…is simple
…is convenient
…promotes soil/water conservation
…maximizes productivity
…and so on.


Identifying Alternatives
Don’t be constrained by the obvious – be creative!
THE OHIO STATE UNIVERSITY


Measuring Consequences
A step that merges risk and decision making
The goal here is to predict/model/determine the consequences of each of the identified alternatives across all of the objectives
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Measuring Consequences

Objectives	Attributes	Status Quo	No Round-up Ready	Regulated Use
Environment Minimize erosion	Tons/acre/yea r			
Economic Maximize yield	Bushels/acre			
Time Maintain simplicity	# of hours/season			

MEASURES/CONSEQUENCES

Tradeoffs

By far, the most important step in a structured decision making approach because objectives will conflict

You cannot have your cake and eat it too!

Tradeoffs

Objectives	Attributes	Status Quo	No Round-up Ready	Regulated Use
Environment Minimize erosion	Tons/acre/yea r	Low	High	Low
Economic Maximize yield	Bushels/acre	High		um
Time Maintain simplicity	# of hours/season	Low		um

"Value" is not a function of any one measure

Tradeoffs

Objectives	Attributes	Status Quo	No Round-up Ready	Regulated Use
Environment Minimize erosion	Tons/acre/yea r	Low	High	Low
Economic Maximize yield	Bushels/acre	High		
Time Maintain simplicity	# of hours/season	Low	High	Medium

Nor is it just the function of some composite score

Tradeoffs

Objectives	Attributes	Status Quo	No Round-up Ready	Regulated Use
Environment Minimize erosion	Tons/acre/yea r	[illegible]	[illegible]	[illegible]
Economic Maximize yield	Bushels/acre	[illegible]	[illegible]	[illegible]
Time Maintain simplicity	# of hours/season	Low	High	Medium

Instead, the value of a given option exists in the tradeoffs that people are willing to make across not just their objectives, but also the level of achievement with respect to them.

Questions?

Robyn Wilson
Wilson.1376@osu.edu
614.247.6169

Summary of Ohio Grape Grower Focus Groups - March 2011 – Scott Wolfe, Dave Scurlock, Julia DeNiro, Jason Parker, Doug Doohan

Department of Horticulture and Crop Science, The Ohio State University, wolfe.529@osu.edu

Today, herbicide use is widespread in agriculture as an integral weed management tool. With genetically modified crops, such as RoundUp Ready corn and soybean, herbicides that normally would have killed a crop can be used for weed control. Over years of use, certain weeds have developed a resistance to RoundUp and require new management tools. New technologies, including 2,4-D and dicamba resistant crops, will add the tools needed for corn and soybean farmers to better manage weeds, however, these herbicides can drift off the target area and damage sensitive crops, such as grapes, tomatoes, and peppers. Research over the last 30+ years has shown some of the effects of these herbicides on sensitive crops. With the impending introduction of new resistance traits in other crops, the use of the herbicides is about to change and therefore the damage seen on sensitive crops may also change. Grapes are an important crop in Ohio for table and wine production. The wine industry also attracts millions of tourists each year. In early 2011, 6 expert one on one interviews were held to create an expert model of the concerns these new technologies might pose to the grape industry in Ohio. Based on those interviews, 4 regional focus groups were held with grape growers and wine producers throughout the state. These interviews and focus groups told us that there were some key issues that everyone agreed upon, such as communication between all farmers and industries, and also some differences in opinion about the possibly solutions to concerns held by the grape industry. The ideas and topics brought up by each focus group and by the experts, will help guide future work by researchers, the grape industry, corn and soybean farmers, and the companies involved.

Summary of Ohio Grape Grower Focus Groups March 2011

Scott Wolfe
Dave Scurlock
Julia DeNiro
Jason Parker
Doug Doohan

November 1, 2011

Expert Interview and Focus Group Participation

- Expert interviews held January and February 2011
  - 6 experts interviewed to understand/learn key concepts
- Focus groups held March 2011
  - Used concepts from experts to form questions for focus groups

Vineyard Location	Region of Ohio	Date	Number in Attendance
Harmony Hill	Southwest	March 11, 2011	17
Terra Cotta	Southeast	March 15, 2011	13
Harpersfield	Northeast	March 17, 2011	4
Matus	Northwest	March 31, 2011	20
Total			**60**

Key Concepts from Expert Interviews

- Reduce drift
  - different, better formulas
- Enforce/Educate
  - spray conditions/techniques/equipment
- Communication between all parties
- Driftwatch
- Possibly over-reaction
- Some concerns valid

Differences between focus groups

- Level of knowledge
  - zero to soybean/corn + grape growers
- Driftwatch (1 of 4)
- GMO Grapes (2 of 4)
- Optimistic vs. Pessimistic (2 vs. 2)
- Ban 2,4-D and dicamba (1 of 4)

Similarities between focus groups

- Very mixed surroundings
  - corn and soybean fields near vineyards
- Concern over 2,4-D and dicamba drift
- 3 of 4 focus groups had growers with previous drift problems
- Communication between all parties is key
  - (industry, corn & soybean farmers, sensitive crop growers)
- Spray education and enforcement
- Low volatility, low drift formulations
- Perception that grape growers are the "little guy" and industry will listen to corn and soybean farmers

Ideas from focus groups

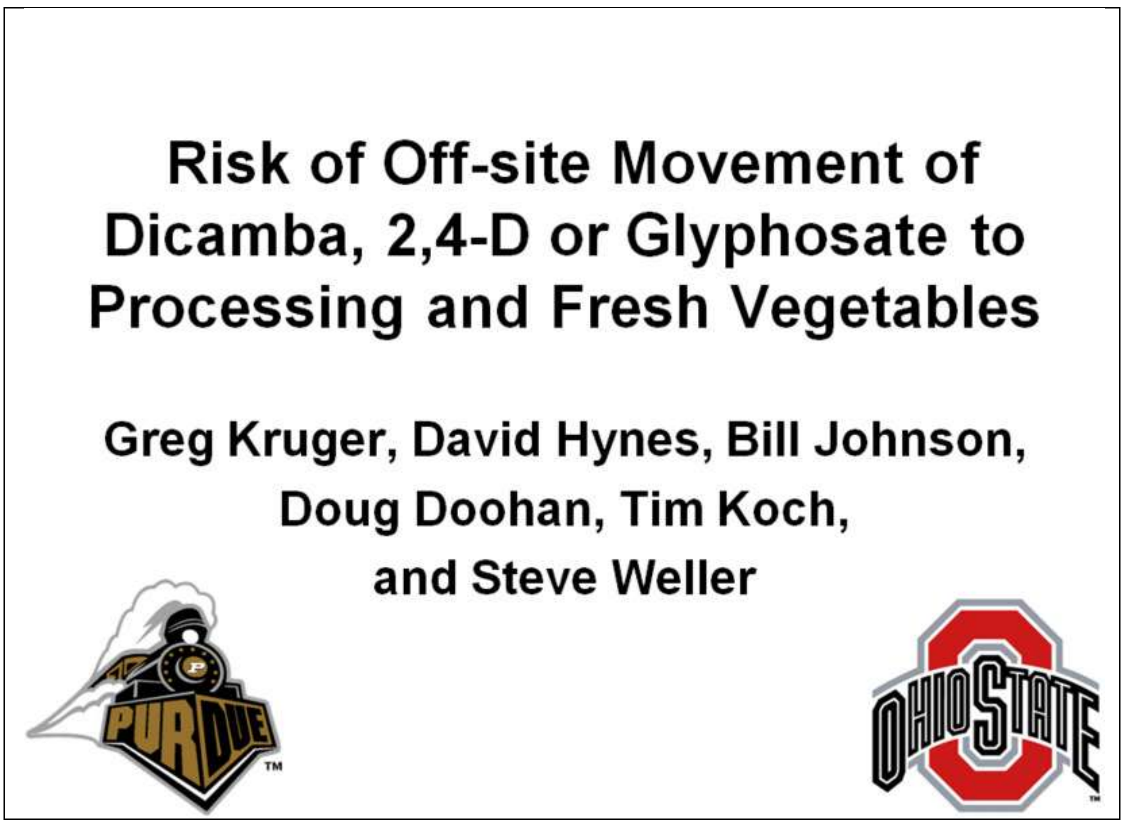
- Regulating or banning 2,4-D and dicamba
- Special warning labels about drift
- Increase ability to identify source of drift/damage and receive compensation
- Residual herbicide on quality of grape/juice/wine
- No mention of residual damage or increased winter sensitivity


Acknowledgements
THE OHIO STATE UNIVERSITY
OARDC
Ohio WINES
love at first sip
Ohio Grape Industries Committee
DEPARTMENT OF AGRICULTURE
STATE OF OHIO
Dow AgroSciences
MONSANTO
Double A
VINEYARDS, Inc.

Risk to processing and fresh vegetables – Stephen Weller

Purdue University, (Greg R. Kruger, William G. Johnson, Douglas J. Doohan)
weller@purdue.edu

Herbicide drift from agronomic fields onto tomato crops is a concern. Glyphosate is the most commonly used postemergence herbicide in corn and soybean and if dicamba and 2,4-D resistance is engineered into these crops, they could become a widely used postemergence herbicide. This study determined the impact of simulated glyphosate and dicamba drift on tomatoes. Dose response studies for dicamaba and glyphosate herbicides were conducted on two commercial processing tomato lines at either a vegetative stage or early bloom stage. Both glyphosate and dicamba caused higher yield losses when sprayed at the early bloom stage. A 25% yield loss was observed with 8.5 and 7.5 g ae/ha for glyphosate and dicamba, respectively, at bloom stage and 43.9 and 11.9 g ae/ha for glyphosate and dicamba, respectively, at vegetative stage. Overall, tomatoes were more sensitive to dicamba than to glyphosate. Other vegetable crops response to dicamba and 2,4-D will be briefly discussed.



Introduction

- Drift of herbicides into vegetable crops is a major concern
- Studies have shown auxin and amino acid herbicides can cause symptoms
- Little quantitative evidence of yield effects from drift
- Future development of dicamba and 2,4-D resistance in crops and current RUR crops
- Risk of drift and volatility

Concerns for Off-site Movement in Vegetables

- Crop injury
  - Residual herbicide concerns
- Slow crop recovery
- Effects on time of maturity
- Delayed maturity
  - Loss of market share
  - Split maturity in once over harvest crops
  - Loss of income and markets

Processing Tomatoes Experiments

- Two Application Timings
  - Small plants / Large plants
- Cultivars
  - 2007: 611
  - 2008: 611 & 311 (IN), 616 & 818 (OH)
- 7 Rates
  - 0, 1/1000, 1/300, 1/100, 1/30, 1/10, & 1/3X rates where X= 0.5 lbs ae/A for dicamba and X= 0.6 lbs/A for glyphosate
- Data collected
  - Crop injury, yield (red and green fruit), and % flower loss
- Analysis
  - Non-linear log logistic modeling in R
- Plot Design
  - 1.5 m x 6 m plots
  - Tomatoes transplanted into raised beds

Commonly Observed Symptoms with Dicamba

Results

Flower Loss

- 5 %
  - Timing 1: 1/233rd
  - Timing 2: 1/373rd
- 25 %
  - Timing 1: 1/42nd
  - Timing 2: 1/88th
- 50 %
  - Timing 1: 1/15th
  - Timing 2: 1/36th

Marketable Fruit Loss

- 1 %
  - Timing 1: 1/1120th
  - Timing 2: 1/622nd
- 5 %
  - Timing 1: 1/243rd
  - Timing 2: 1/224th
- 10%
  - Timing 1: 1/124th
  - Timing 2: 1/144th

(0.5 lbs ae/A = 1X)

Conclusions

- Low rates of dicamba drift resulted in significant yield loss regardless of timing
- Second timing at flowering caused higher yield loss than first timing
- Results were similar at both locations and for all cultivars tested
- There is a risk of tomato yield loss from dicamba drift

Commonly Observed Symptoms caused by Glyphosate

3 days after treatment

21 days after treatment

7 days after treatment

28 days after treatment

Results

Flower Loss

- 5 %
  - Timing 1: 1/20th
  - Timing 2: 1/229th
- 25 %
  - Timing 1: 1/13th
  - Timing 2: 1/85th
- 50 %
  - Timing 1: 1/10th
  - Timing 2: 1/47th

Marketable Fruit Loss

- 1 %
  - Timing 1: 1/58th
  - Timing 2: 1/337th
- 5 %
  - Timing 1: 1/30th
  - Timing 2: 1/164th
- 10%
  - Timing 1: 1/22nd
  - Timing 2: 1/120th

(0.6 lbs ae/A= 1X)

Conclusions

- Glyphosate drift at fruit set leads to greater fruit loss than at transplanting
- Glyphosate drift delayed fruit ripening
- Both cultivars responded similarly to glyphosate drift
- Tomatoes are sensitive to even low rates of glyphosate

Effect of Combinations of Glyphosate and Dicamba Drift onto Tomatoes

- Experiment to observe effects of drift from glyphosate and dicamba combinations
- Observe vegetative response to simulated drift
- Rates 1/30x,1/100x and 1/300x of either herbicide or combinations

Tomato Response to combinations of Glyphosate and Dicamba Drift

Untreated | 1/300X glyphosate | 1/300X dicamba | 1/300+1/300 gly + dicamba

Tomato Response to combinations of Glyphosate and Dicamba Drift

Untreated | 1/100X glyphosate | 1/100X dicamba | 1/100+1/100 Gly + dicamba

Tomato Response to combinations of Glyphosate and Dicamba Drift

Untreated | 1/30X glyphosate | 1/30X dicamba | 1/30+1/30 Gly + dicamba

The effects of three different drift rates of dicamba and glyphosate on commercial processing tomatoes.

Glyphosate rate		Dicamba rate	Expected results[1]	Observed results[2]	Difference in results	Joint activity
——lbs ae/A——			————	% Control	————	
2 WAT						
1/300	+	1/300	26	21	-5	Additive
1/100	+	1/100	61	74	13	Synergistic
1/30	+	1/30	95	94	-1	Additive
5 WAT	+					
1/300	+	1/300	40	32	-8	Additive
1/100	+	1/100	67	69	2	Additive
1/30	+	1/30	95	91	-4	Additive

Conclusions

- Drift from combinations of glyphosate and dicamba have an additive effect on causing tomato injury
- 1/30x + 1/30 X resulted in > 90% injury
- Drift from either glyphosate or dicamba caused serious injury
- Drift from a combination of the 2 herbicides caused greater injury

Low-Dose Effects of 2,4-D and Dicamba on Solanaceae and Cucurbitaceae Vegetables

- 2011 study at Lafayette, IN.
- Four vegetable crops used:
  - "Mt. Fresh Plus" tomato
  - "Aristotle" bell pepper
  - "Aphrodite" muskmelon
  - "Estrella" watermelon

Methods and Materials

- Two planting timings – Mid-May then early June
- Application timing was 3 weeks after transplant.
- 19 treatments using:
  - Dimethylamine salt of 2,4-D
  - Diglycolamine salt of dicamba
  - Dimethylamine salt of glyphosate
- Applied with backpack sprayer and 3-nozzle boom.
  - 51 cm nozzle spacing
  - 140 L/ha spray volume
  - CO_2 propellant
  - 179 kPa boom pressure
  - TeeJet 8002VS nozzle

Methods and Materials - Treatments

Rate Fraction	2,4-D g ae / ha	Glyphosate g ae / ha
1X	800	-
1/50X	16	-
1/100X	8	-
1/100X	8	8
1/150X	5.3	-
1/200X	4	-
1/200X	4	4
1/400X	2	-
1/400X	2	2

All treatments included 0.25% v/v NIS and 2.8 kg/ha AMS.

Methods and Materials - Treatments

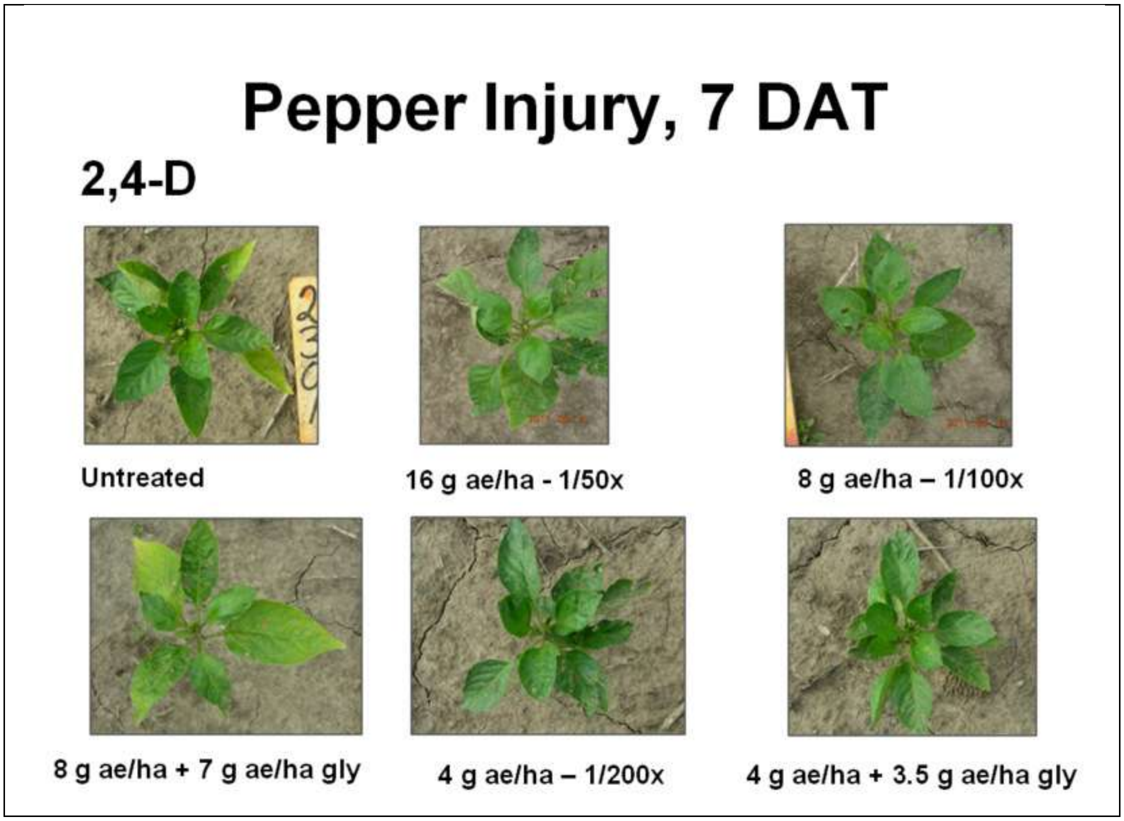
Rate Fraction	Dicamba g ae / ha	Glyphosate g ae / ha
1X	560	-
1/50X	11.2	-
1/100X	5.6	-
1/100X	5.6	8
1/150X	3.7	-
1/200X	2.8	-
1/200X	2.8	4
1/400X	1.4	-
1/400X	1.4	2

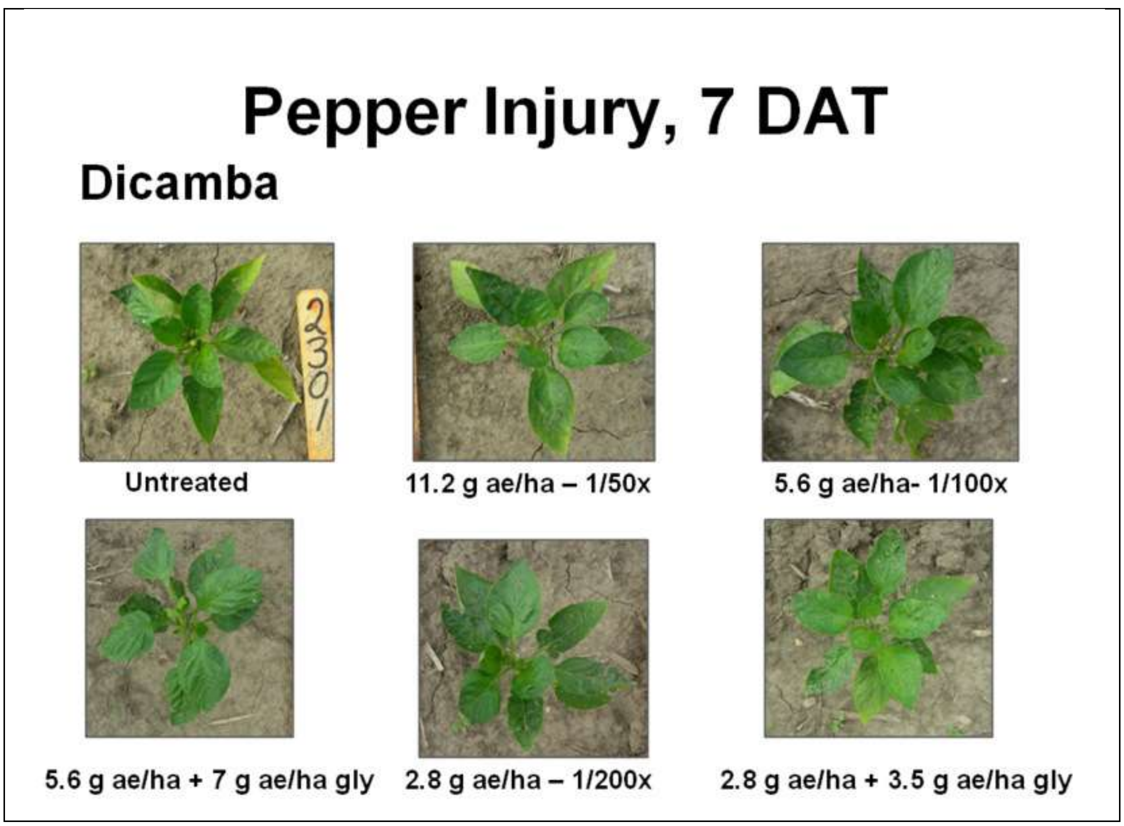
All treatments included 0.25% v/v NIS and 2.8 kg/ha AMS.

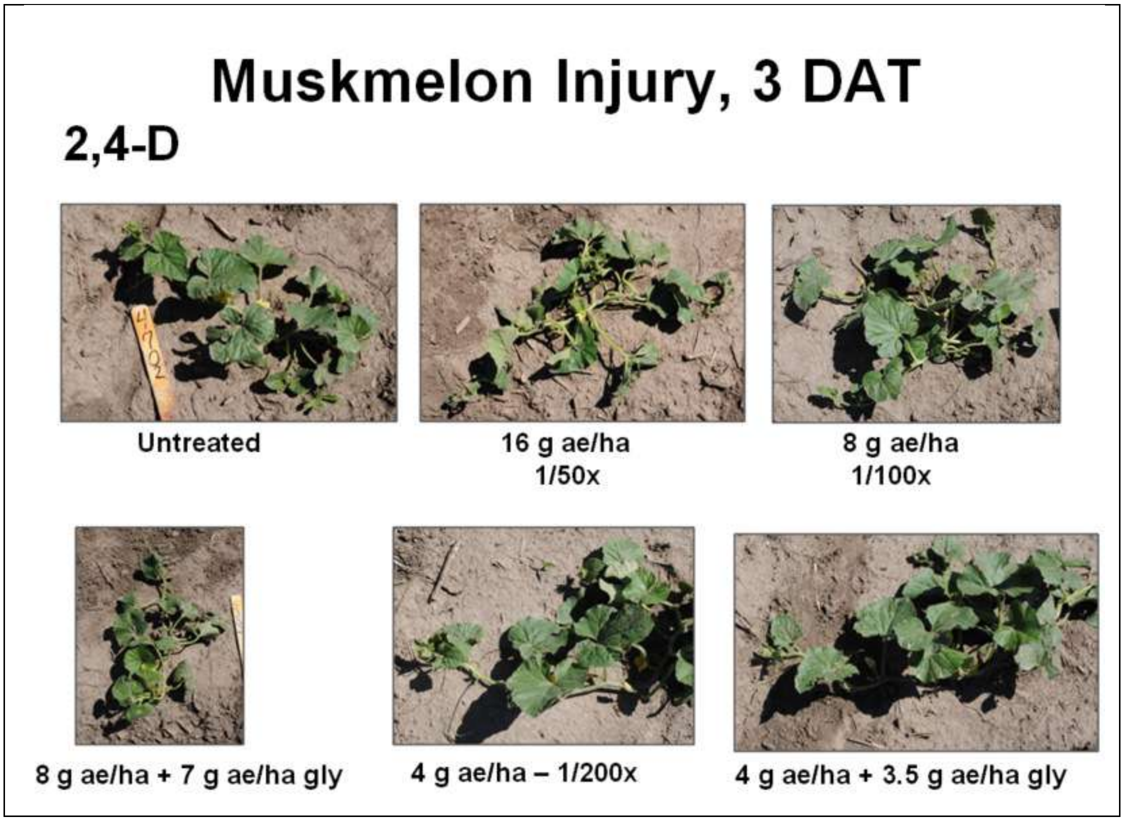
Methods and Materials

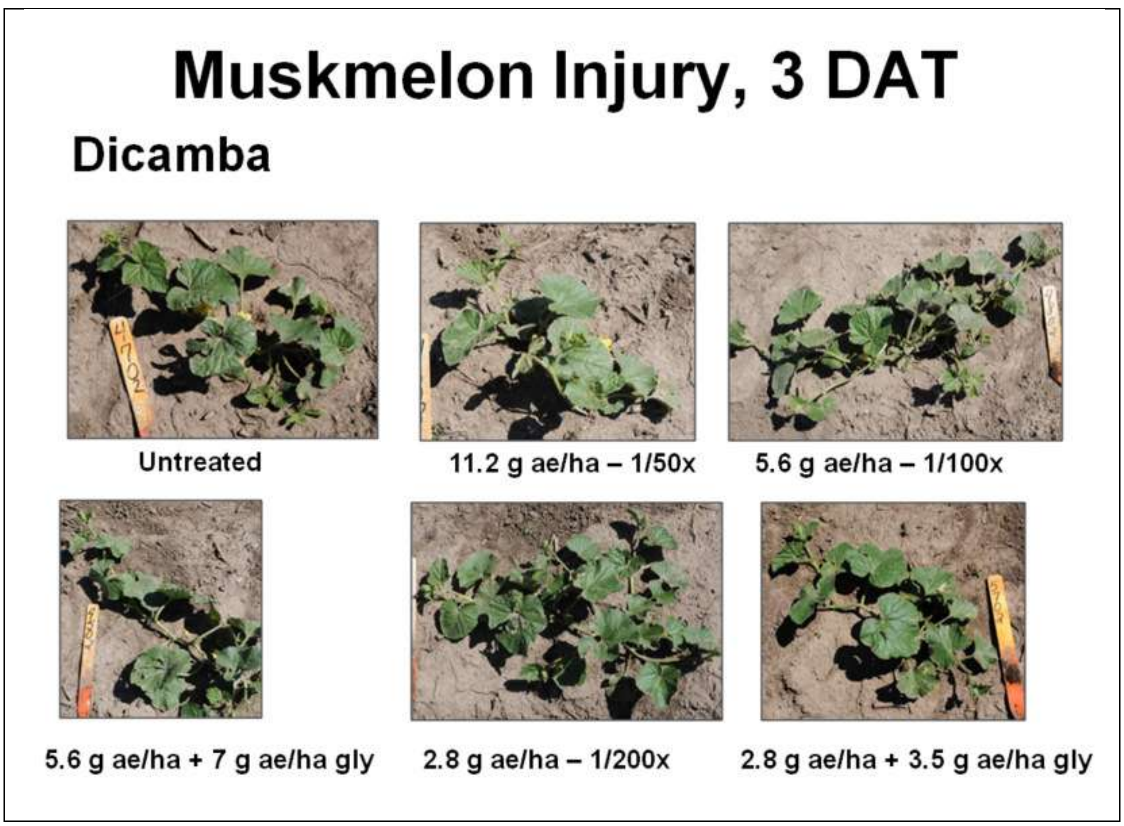
Data collected:

- Visual injury at 3, 7, 14, 21 days after treatment (DAT)
  - Scale of 0 to 100 (0 = no injury, 100 = dead plants)
- Harvest
  - Time of first mature fruit
  - Total yield
  - Grade


Pepper Injury, 7 DAT
2,4-D
Untreated
16 g ae/ha - 1/50x
8 g ae/ha – 1/100x
8 g ae/ha + 7 g ae/ha gly
4 g ae/ha – 1/200x
4 g ae/ha + 3.5 g ae/ha gly


Pepper Injury, 7 DAT
Dicamba
Untreated
11.2 g ae/ha – 1/50x
5.6 g ae/ha- 1/100x
5.6 g ae/ha + 7 g ae/ha gly
2.8 g ae/ha – 1/200x
2.8 g ae/ha + 3.5 g ae/ha gly


Muskmelon Injury, 3 DAT
2,4-D
Untreated
16 g ae/ha
1/50x
8 g ae/ha
1/100x
8 g ae/ha + 7 g ae/ha gly
4 g ae/ha – 1/200x
4 g ae/ha + 3.5 g ae/ha gly


Muskmelon Injury, 3 DAT
Dicamba
Untreated
11.2 g ae/ha – 1/50x
5.6 g ae/ha – 1/100x
5.6 g ae/ha + 7 g ae/ha gly
2.8 g ae/ha – 1/200x
2.8 g ae/ha + 3.5 g ae/ha gly

Conclusions

Visual Injury

- Pepper –
- 3 DAT only 1X dicamba and 1X 2,4-D treatments caused significant plant injury compared to untreated
- 7DAT 1X dicamba and all 2,4-D treated plants but 1/150X exhibited significant injury compared to untreated plants

Conclusions

Visual Injury

- Muskmelon–
- 3 DAT 1X dicamba and 1X, 1/50X, 1/100X and 1/100X mix 2,4-D treatments caused significant plant injury compared to untreated
- 7DAT all treatments caused significant injury when compared to untreated

Conclusions

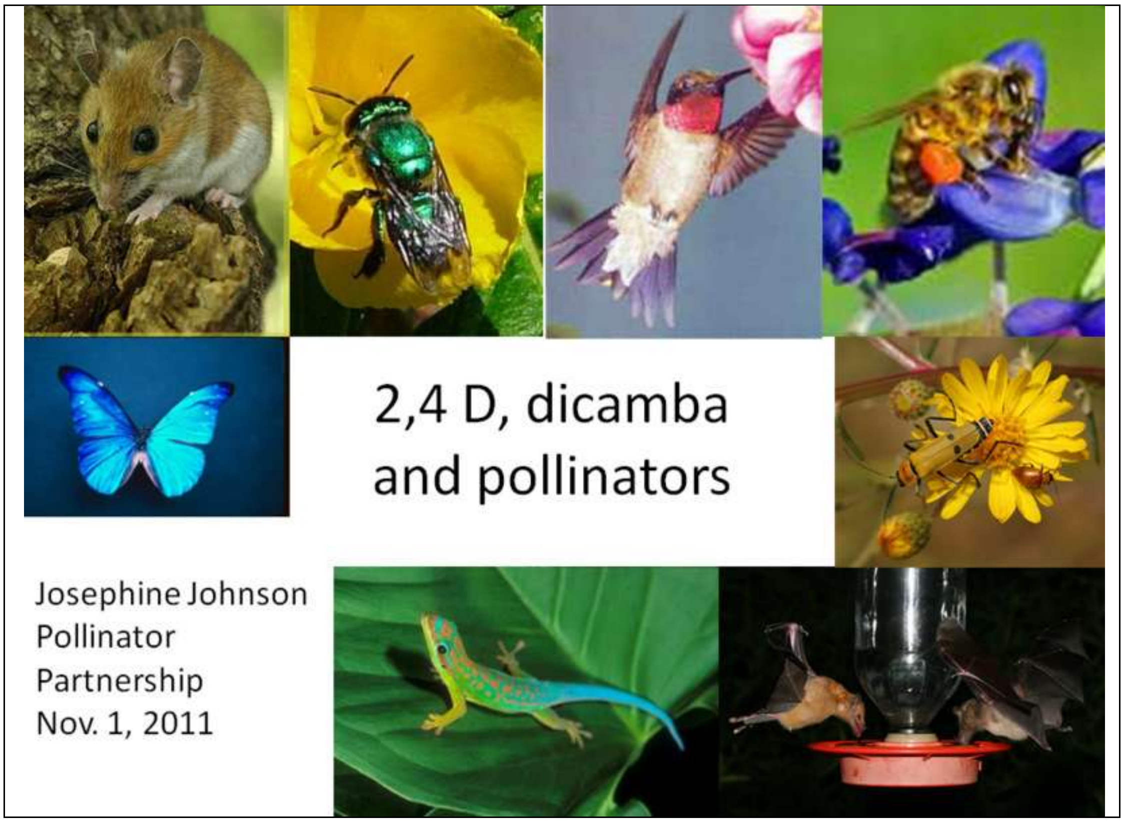
On-set of first ripe fruit

- Pepper – all treatments delayed maturity compared to untreated.
- Muskmelon –
  - no delay compared to untreated for dicamba-treated plants;
  - 1/50X, 1/100X mix and 1/150X 2,4-D treated plants delayed compared to untreated

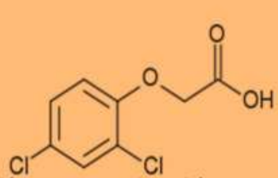
2,4-D, Dicamba, and Pollinators – Josephine Johnson

Pollinator Partnership, jdjohnso@epi.umaryland.edu

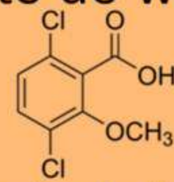
Herbicides, designed to target plants, affect animals as well. Pollinators are present in ecosystems as mammals, birds, reptiles, and insects. Off target doses of herbicides to riparian strips, shelter belts, and roadway wildflowers may diminish plant biodiversity that, by cascade effect, causes loss of animal biodiversity. Some pollinators feed on single source pollens or nectars; others are generalists. Timing issues of plant presences may affect migrating pollinators, insect development, or hibernation resources. Careful use of herbicides is mandatory to preserve diverse species that communally contribute to decomposition, pollination, temperature and moisture control within microsystems, and recycling.



What do 2 herbicides have to do with pollinators?



2,4-Phenoxyacetic acid



3,6-**dic**hloro-2-**m**ethoxy**b**enzoic **a**cid

2,4 D →meristem cell elongation kills plant by overgrowth

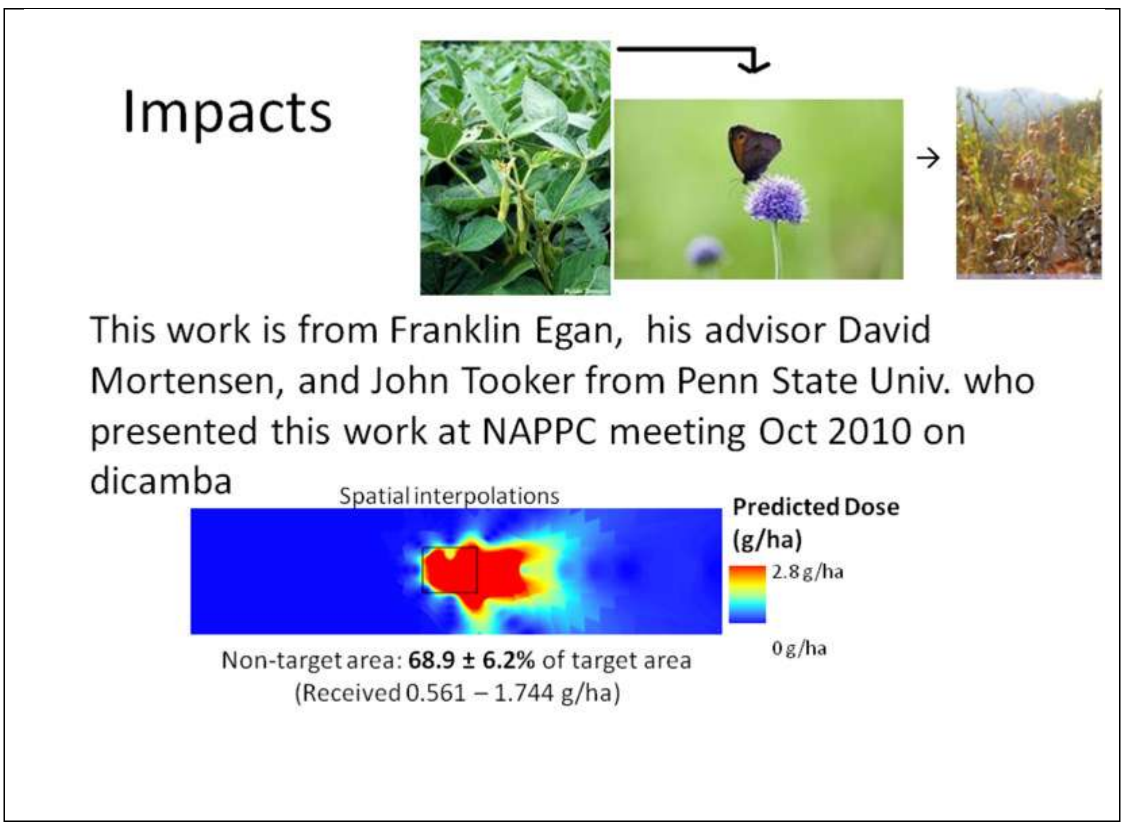
Dicamba- ties up glutathione, a compound with many roles at the cross roads of biochemical processes

Both kill broadleaf plants (dicots) vs grasses(monocots)

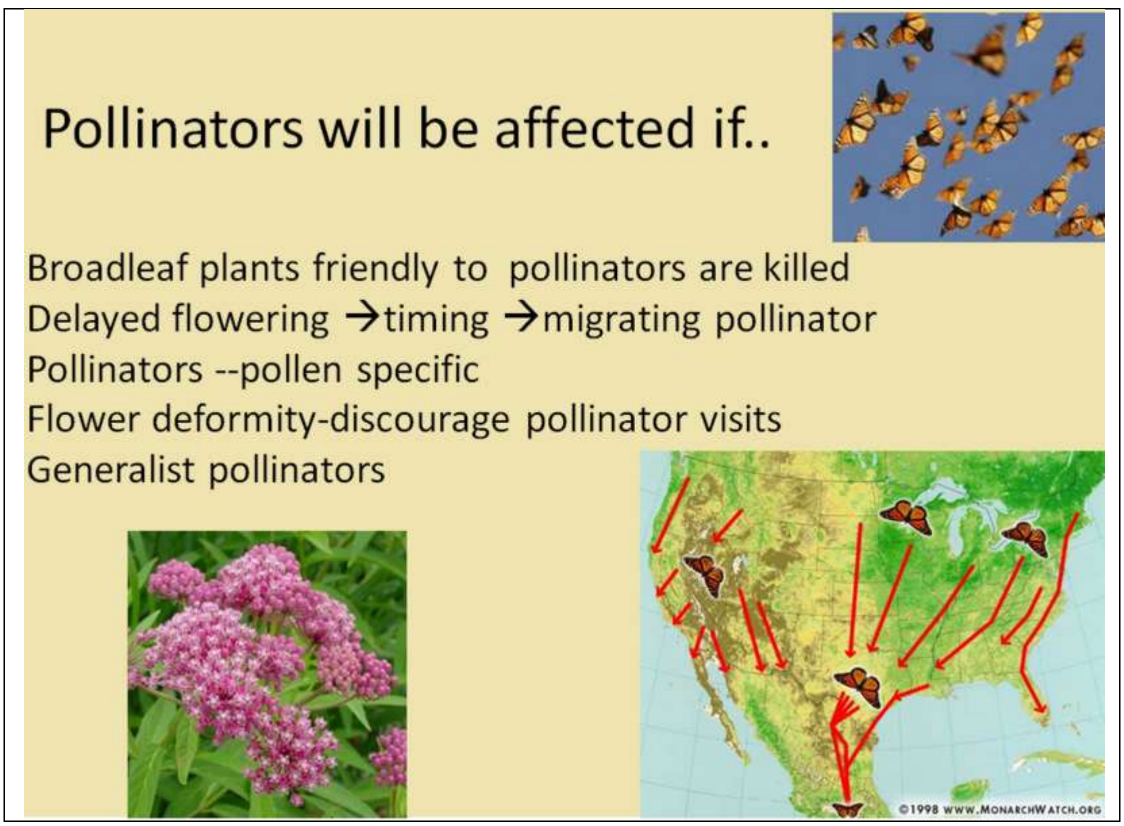
Pollinators to plants relationship?

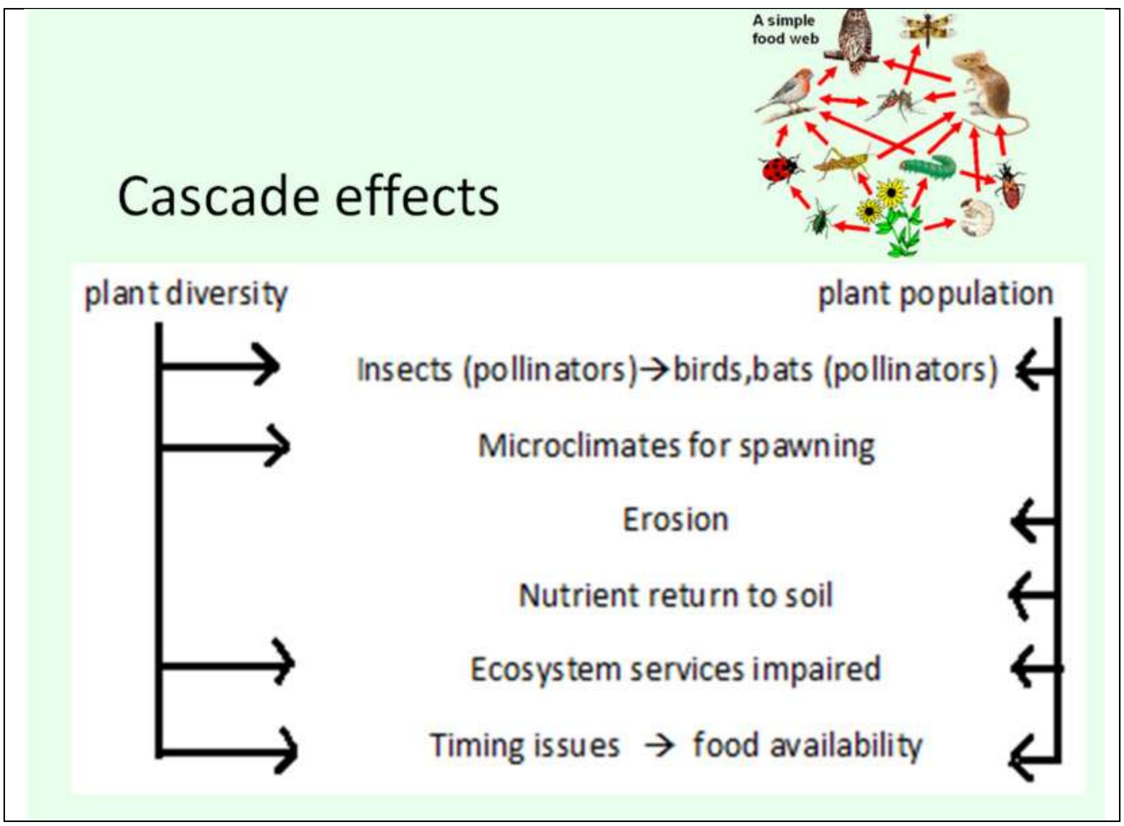
- All pollinators depend on plants for pollen and/or nectar
- Broadleaf plants? Goldenrods, bloodroot, ivy, maples, willows, bergamot, thyme etc
- Are herbicides a threat?


Yes, by misapplication (human error) Chris Krupke's presentation at NAPPC 2011
Yes by wind drift
Yes by volatility (fume off)
Yes, by dissolution into streams , less so in soils.


Impacts
This work is from Franklin Egan, his advisor David Mortensen, and John Tooker from Penn State Univ. who presented this work at NAPPC meeting Oct 2010 on dicamba
Spatial interpolations
Predicted Dose (g/ha)
2.8 g/ha
0 g/ha
Non-target area: 68.9 ± 6.2% of target area
(Received 0.561 – 1.744 g/ha)


What happens to non target plant?
Diminished dose may not kill but plants may grow oddly.
Flowering may be delayed
Fruit set might be delayed, misshapen, or compromised in some way.


Pollinators will be affected if..
Broadleaf plants friendly to pollinators are killed
Delayed flowering →timing →migrating pollinator
Pollinators --pollen specific
Flower deformity-discourage pollinator visits
Generalist pollinators
©1998 WWW.MONARCHWATCH.ORG


A simple food web
Cascade effects
plant diversity
plant population
Insects (pollinators)→birds,bats (pollinators)
Microclimates for spawning
Erosion
Nutrient return to soil
Ecosystem services impaired
Timing issues → food availability

How do we solve this?

Limit the use or decrease the dose of the herbicides?
Transform the herbicides by chemically changing the structure/formula?
Change the application method?
Change the degradation time on an herbicide?
Change farming practices so herbicides are less necessary or unnecessary?
Change the industry concept on xenochemicals?

THE OHIO STATE UNIVERSITY

Thank you

Roger Downer--Specialty Crop Research Initiative- Research and Extension Planning Project
Laurie Davies Adams – Pollinator Partnership
Dr. Jeff Pettis – USDA Bee Research Lab
Dr. Katherine Squibb- Univ. of MD, Baltimore, Dept of Toxicology

In simulated overspraying event, it is likely that herbicide dissipation (2,4 D and dicamba) was due, in part, to mass lost by way of infiltration t
Toxicol Chem. 2011 Sep;30(9):1982-9. doi: 10.1002/etc.598.

Maize plants expressing the gene encoding dicamba monooxygenase (DMO) linked with an upstream chloroplast transit peptide (CTP) display
either pre-emergence or postemergence. Cao *et al.* J Agric Food Chem. 2011 Jun 8;59(11):5830-4. Epub 2010 Dec 6.

Replacing ST core cultivation with HT core cultivation reduced surface waterconcentrations of the pesticides to levels below the LC50 and EC5(
aquatic organisms they studied Rice *et al.* Environ Toxicol Chem. 2010 Jun;29(6):1215-23

Dose-dependent DNA polymorphism was induced by both 2, 4 D and dicamba in common bean seedlings.
Genomic template stability was significantly affected at all 2,4-D and Dicamba
doses tested. By comet and RAPD assays. Cenkci *et al.* Ecotoxicol Environ Saf. 2010 Oct;73(7):1558-64.

Extracellular polymeric substances (EPS)
from aerobic activated sludge -protein-like substances bound dicamba more strongly than humic-like substances.
Pan *et al.* J Colloid Interface Sci. 2010 Feb 11.

Crystal structure of dicamba monooxygenase: a Rieske nonheme oxygenase that catalyzes oxidative demethylation. Dumitru *et al.* J Mol Biol. :
demethylationof dicamba to 3,6-dichlorosalicylic acid (DCSA) and formaldehyde. by this enzyme

Spray drift also can damage shelterbelts, garden and ornamental plants, cause water pollution, and damage non-susceptible crops in a vulnera
flowering or seedling stage, for example). Damaging drift is directly related to the level of susceptibility of the non-target plant to the herbicide
the downwind side of a field, in a shelterbelt at the edge of a field, or in a portion of an adjacent field. In some cases, herbicide accumulated ir
the field, with a small portion from each pass of the sprayer drifting to the non-target area. Shelterbelts are particularly susceptible to accumu
intercept the drift. 2,4-D or MCPA esters may produce damaging vapors, while 2,4-D or MCPA amines are essentially non-volatile and can drift
esters may produce damaging vapors, while 2,4-D or MCPA amines are essentially non-volatile and can drift only as droplets or dry particles.. T
herbicides. Research results indicate that vapor formation from a high volatile ester of 2,4-D approximately tripled with a temperature increas
2,4-D vapor formation was about 24 times greater from a high volatile than a low volatile ester. Horizotntal air movement (wind)vs vertical ai
formation from gravel roads) http://www.ag.ndsu.edu/pubs/plantsci/weeds/a657w.htm 10 29 1

A threat to beneficial-insect habitat from new herbicide programs David A. Mortensen, Department of Crop and Soil SciencesJohn I
State UniversityUniversity Park , PA , Presented NAPPC Oct 2010

References

- Honey bee research-Chris Krupke / Purdue treated seed- planting process.Seeds are sticky , add talc to dry out them out, blow out the seed dresser- cleaning off talc to lubricant drift , landed bloom

Environmental concerns beyond our borders: maize landraces and gene flow – Kristen Mercer

Horticulture and Crop Science, The Ohio State University, mercer.97@osu.edu

The advent of genetically modified crops spurred an interest in the movement of transgenes into related wild populations and other crop fields. Such gene flow into landraces or wild relatives in crop centers of origin could have implications for their *in situ* conservation. For instance, the world was surprised by the discovery of transgenes in landraces maize grown in southern Mexico, the center of crop origin for corn, despite the moratorium on the planting of transgenic varieties. Thus, we need to consider the ultimate destination of our seeds and their ecological implications in other countries when developing novel technologies.

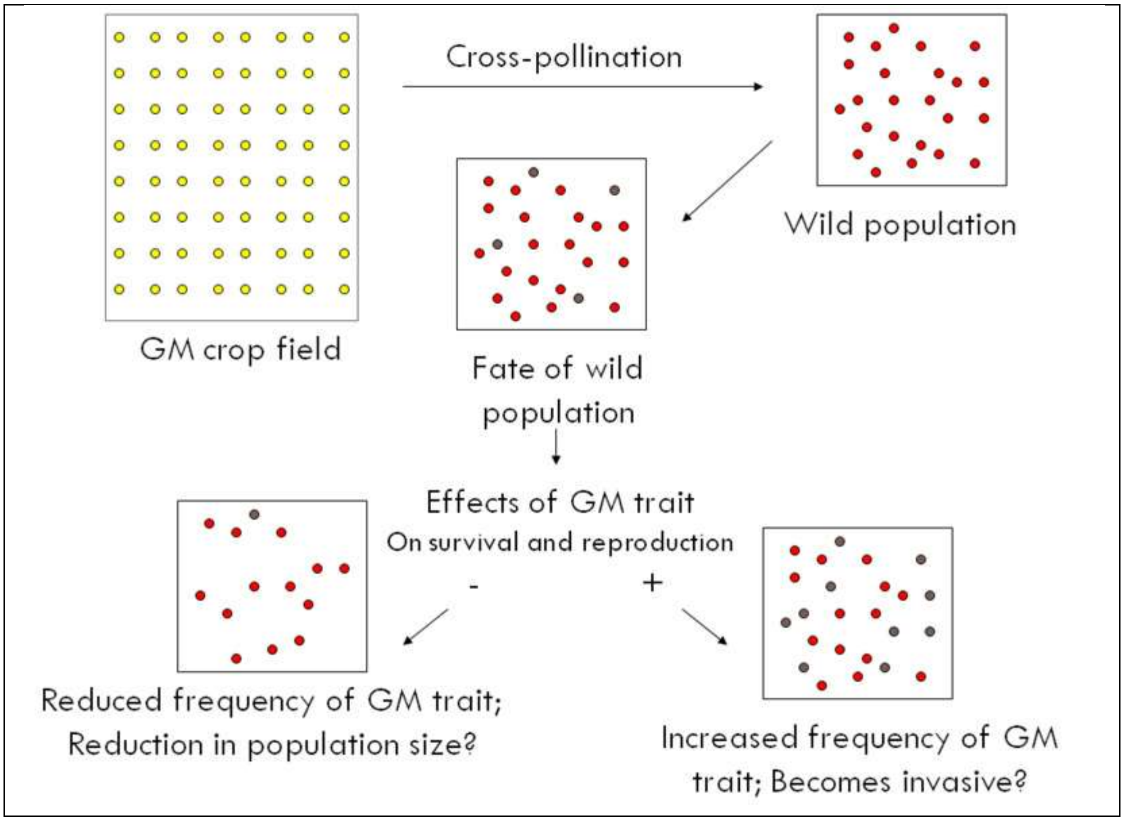
Transgenic crops spur gene flow studies

- Realization that we do not understand much about how crop alleles move across the landscape
  - Into wild populations? Into other crop fields?
- Concerns voiced:
  - Where will transgenes go?
  - Will they create a "super weed", especially if contain novel traits like herbicide resistance?
  - Will they "contaminate" non-transgenic fields?

Outcome hinges on concepts

- **Gene flow:** movement of genetic material between populations of the same or different species
  - Migration
  - Seed-mediated or pollen-mediated
- **Hybridization:** crossing between individuals of same or different species
- **Introgression:** integration of genetic material into a population such that it is maintained over time
  - Neutral processes (drift) or adaptive (selection)
  - Frequency in population is irrelevant

Gene flow, often through **hybridization**, can lead to the **introgression** of novel crop alleles (e.g., transgenes) into populations of wild relatives or other crop populations.



Weedy "Volunteer" Canola in Canada

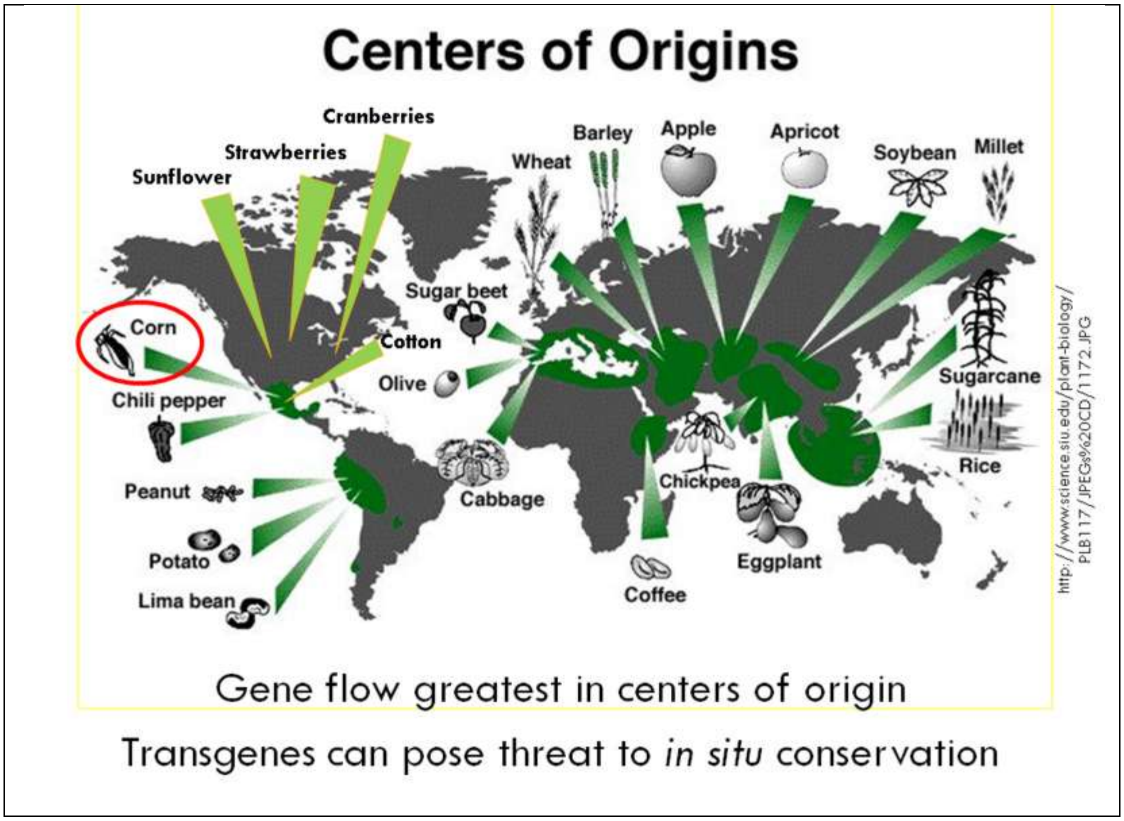
Resistant to three herbicides:

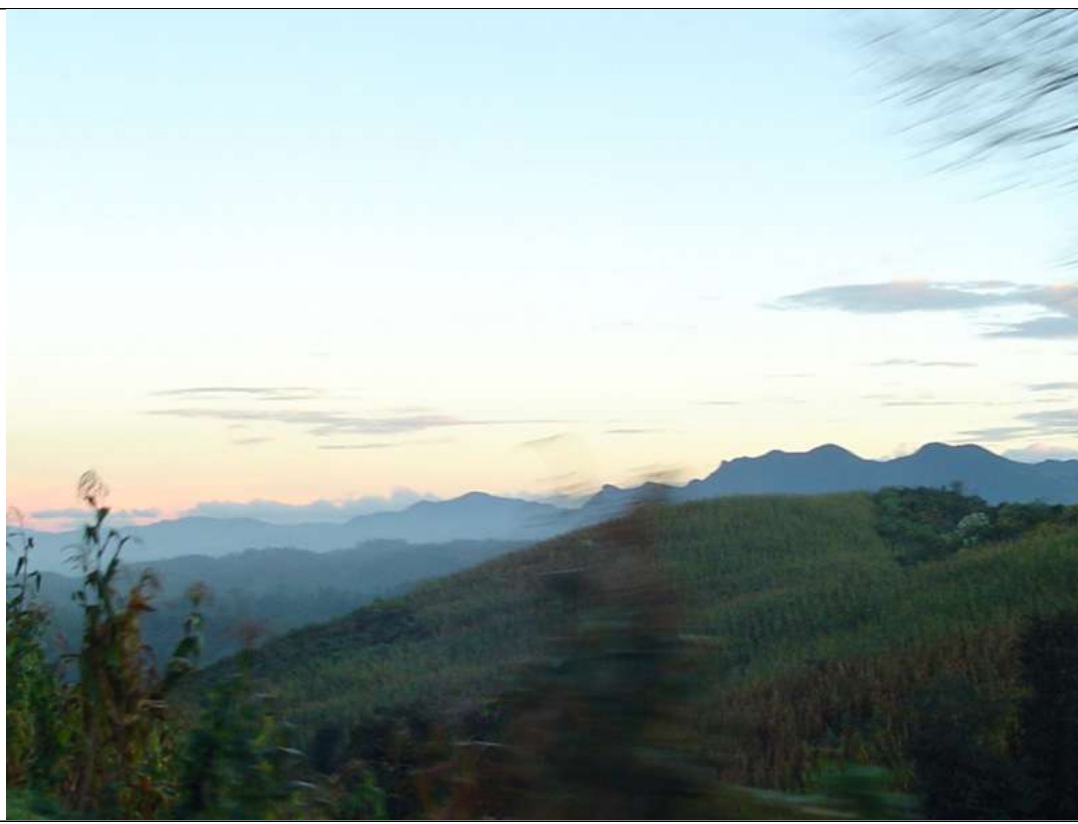
- glyphosate (transgenic)
- glufosinate (transgenic)
- imidazolinone (not transgenic; ALS-inhibiting)

Triple resistance likely selected for due to advantage conferred to weedy volunteers

- Can still be controlled by 2,4-D and other herbicides

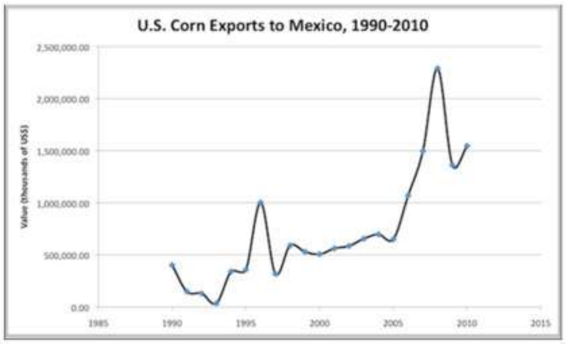
(**Hall et al. 2000. Weed Science**)

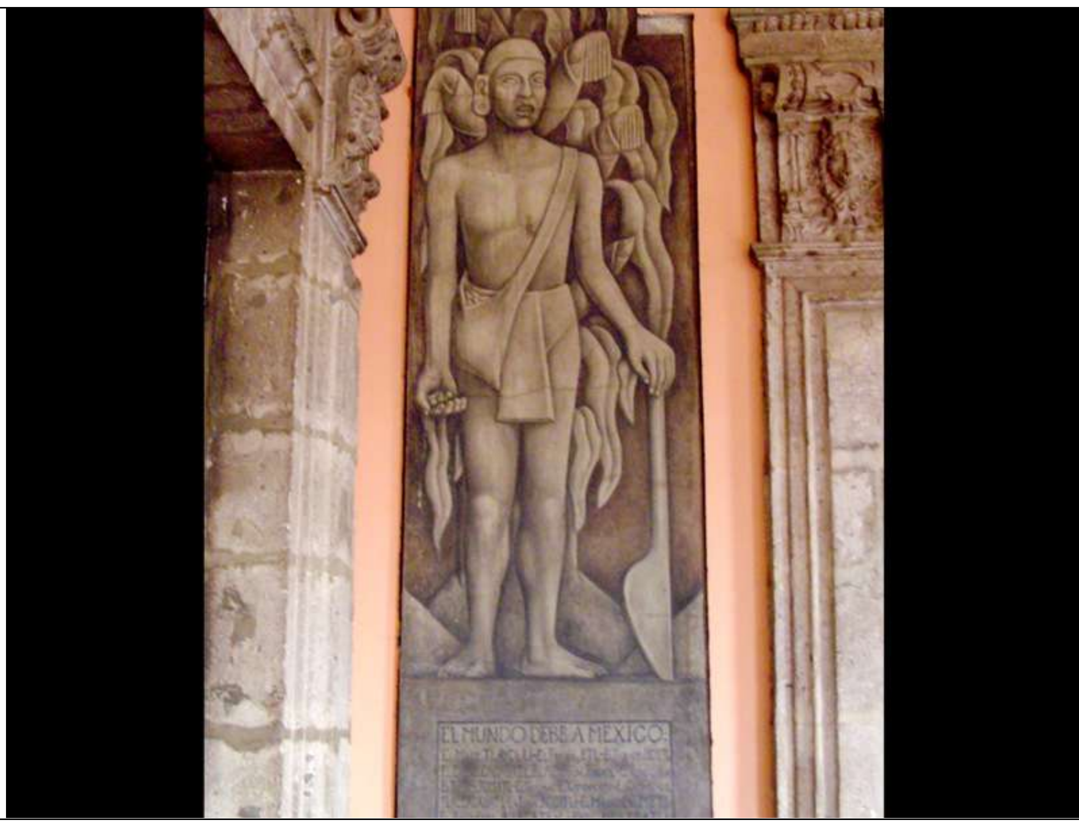

Centers of Origins
Cranberries
Strawberries
Sunflower
Wheat
Barley
Apple
Apricot
Soybean
Millet
Corn
Sugar beet
Cotton
Olive
Chili pepper
Sugarcane
Rice
Peanut
Cabbage
Chickpea
Potato
Eggplant
Lima bean
Coffee
http://www.science.siu.edu/plant-biology/
PLB117/JPEGs%20CD/1172.JPG
Gene flow greatest in centers of origin
Transgenes can pose threat to *in situ* conservation

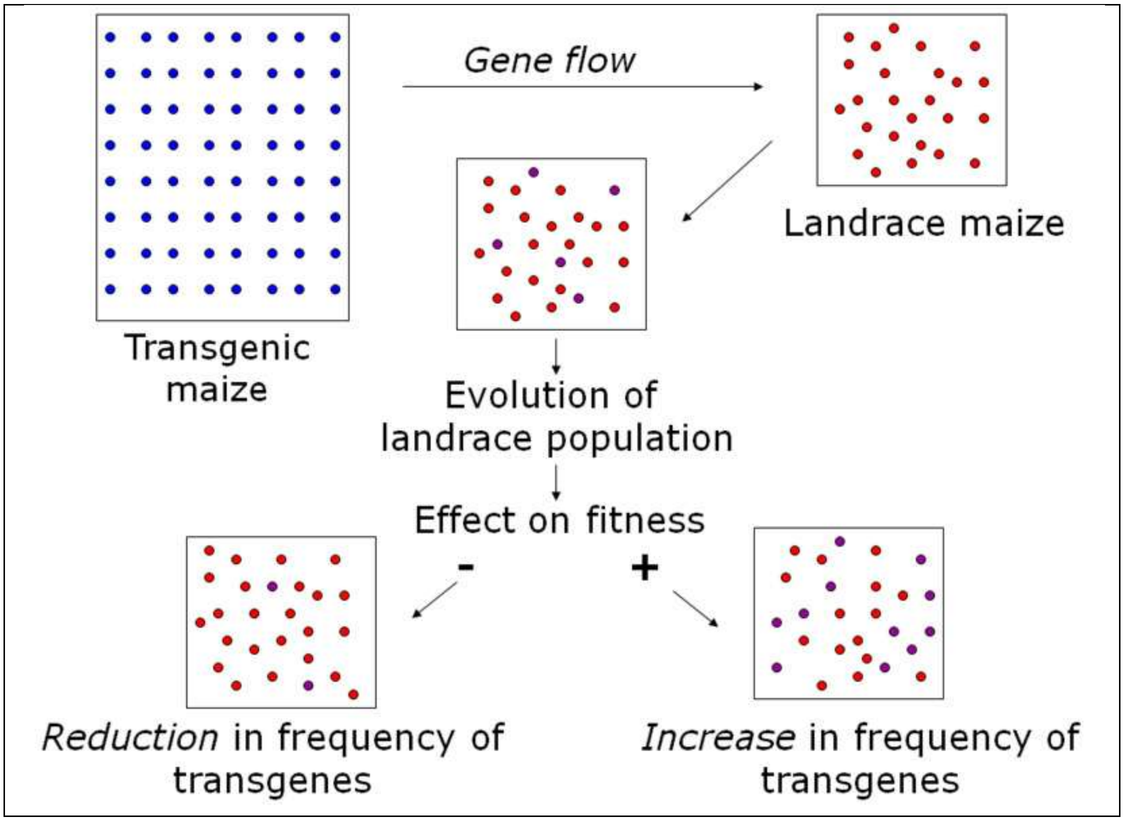


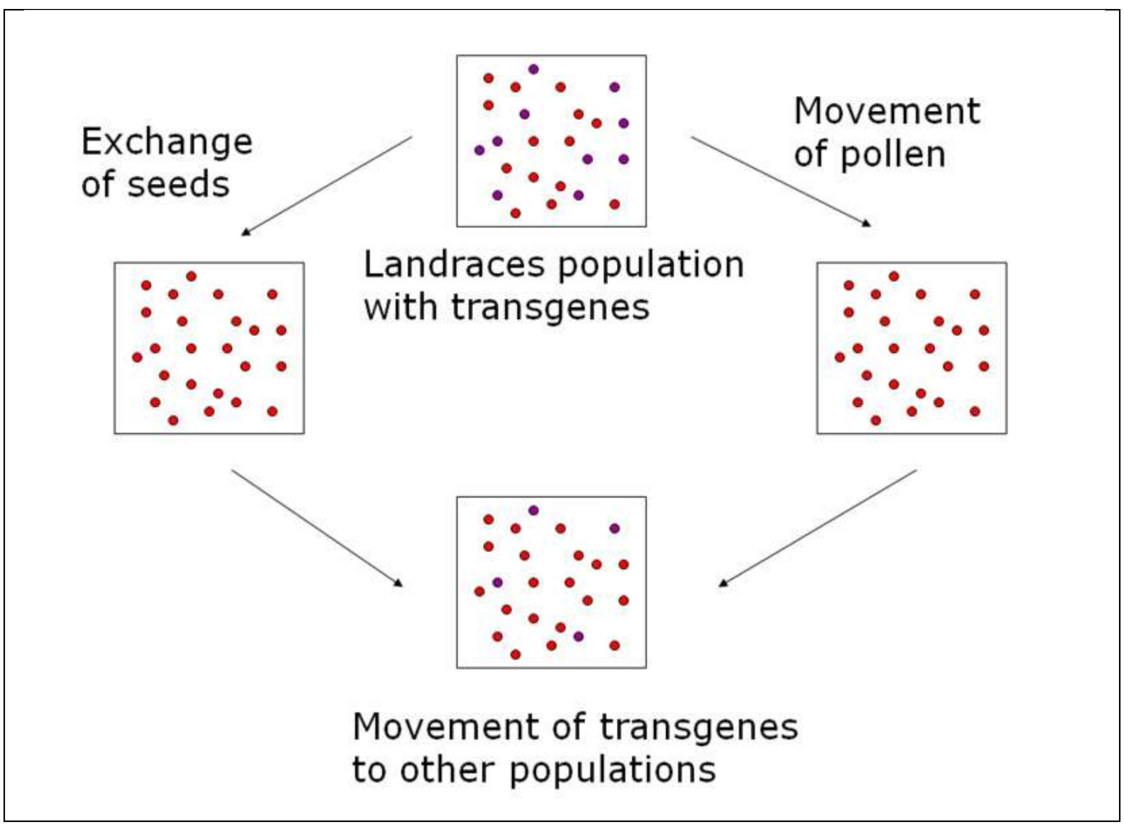
Maize in southern Mexico

- The center of origin of maize
- Home to ≥59 races & many distinct local varieties
- Site of in situ conservation
- Since NAFTA US exports to Mexico have climbed






Gene flow
Landrace maize
Transgenic maize
Evolution of landrace population
Effect on fitness
-
+
Reduction in frequency of transgenes
Increase in frequency of transgenes


Exchange of seeds
Movement of pollen
Landraces population with transgenes
Movement of transgenes to other populations

Transgenes found in southern Mexico

After Quist and Chapela (2001), *Nature*

- 2 communities in Oaxaca
- 6 samples
- 5 positives = 83% of samples

Study authors	Year	Were results published?	# of communities	# of samples	% samples (GM+)
Quist and Chapela	2001	Yes*	2 Oaxaca	6	83
INE/ SEMARNAT	2001	Conf	21 Oaxaca / Puebla	21	93 0 or 13
INIFAP / SAGARPA	N/a	No	12 Oaxaca	162	?
CBIOGEN / SAGARPA	2002	No	13-27 Oaxaca	13-29	?
CIMMYT	2002	Rep	Seed bank and Oaxaca	>300	0
ETC	2003	Rep	138 9 states	411	20
Ortiz et al.	2005	Yes	16 Oaxaca	43 81	0
ENHRM	2002	Conf	~84 14 states	530	?
Alvarez-Buylla et al.	2004	No	2 Oaxaca	60	?
Serratos-Hernandez et al.	2007	Yes	4 Federal District	42	1
Pineyro-Nelson et al.	2008	Yes	27 Oaxaca / Puebla	32	1

Summary of studies

- Transgenes common, but low frequencies
- Transgenes selected against, possibly due to effects of other genes
- Education and policy changes reduced gene flow

Other lessons from new results

- Transgenes persist across years where present
- Use of multiple methods to identify positives improves precision
- Spotty distribution of transgenes makes appropriate sampling protocol difficult

(Pineyro-Nelson et al. 2009)

Where do new products go after leaving the US?

- Can we think outside our borders?
- Even if US is not center of origin for a given crop, seed still might be exported or sold there
- Farmers may have concerns about transgenes in their crops – conservation risk
- Concerns within Mexico of industrial traits or traits with human health effects
  - High maize consumption
  - No way to take it back

Risks to organic vegetable producers – Ben Sippel

Sippel Family Farm, Ohio, sippelfamilyfarm@brightchoice.net

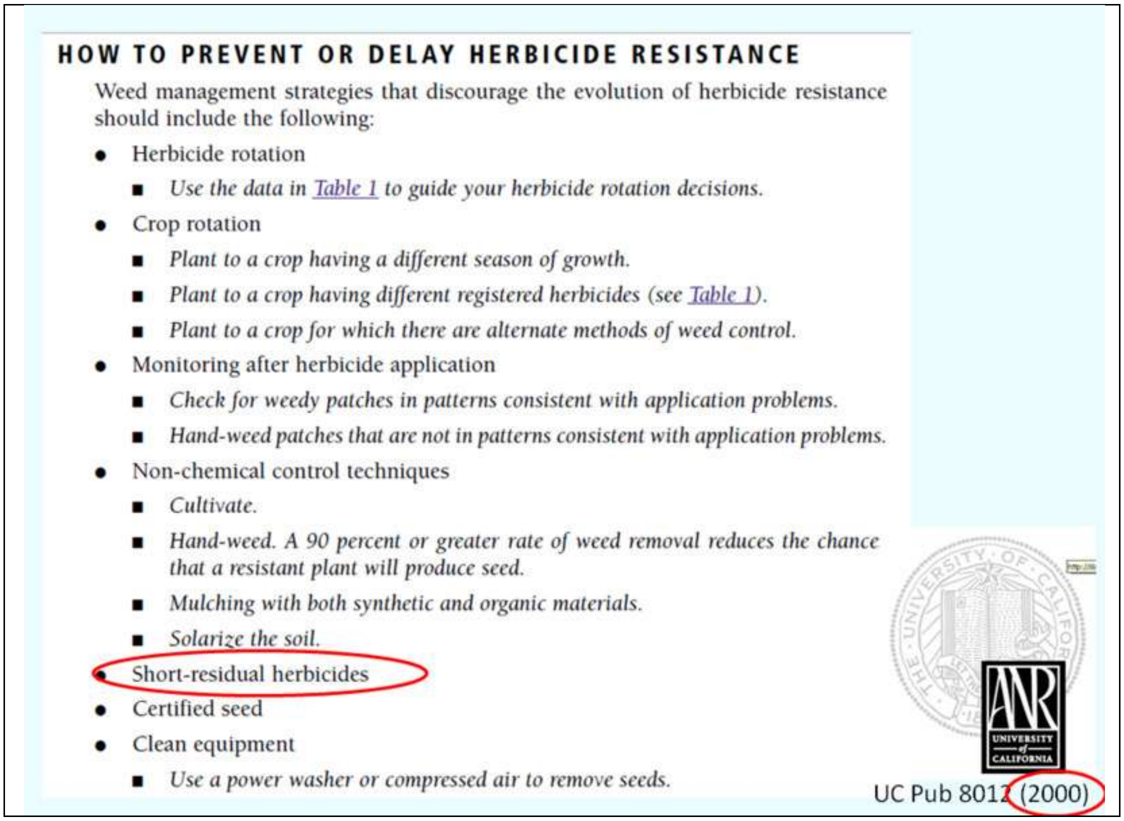
What are the concerns for producers marketing to the organic, GMO-free, or other specialty consumer niches? And do these technologies make a difference one way or the other for younger producers?"

Ben Sippel

Needles in a Haystack – Frank Forcella

USDA-ARS, Morris, MN, Forcella@morris.ars.usda.gov

One in a billion, needles in haystacks, resistant weeds – all seemed equally rare just a few years ago. Why then are there so many resistant weeds nowadays, and how might we prevent even more of them? Explicit answers won't be forthcoming here. Instead, two ideas, arguably related, will be explored. Hopefully, each will be at least entertaining if not informative for the audience. The first topic involves the human dimensions of resistance prevention and management. In other words, we know what we must do to prevent resistance, so why don't we do it? The second topic centers on the idea that weed resistance to herbicides and dietary habits of our citizenry may be two faces of the same coin. That is, both possibly are consequences of the same general phenomenon, which is the extraordinarily productive food and fiber production system that has evolved in North America in recent decades. Do the benefits of high productivity outweigh the detriments associated with weed resistance and, for instance, human obesity?

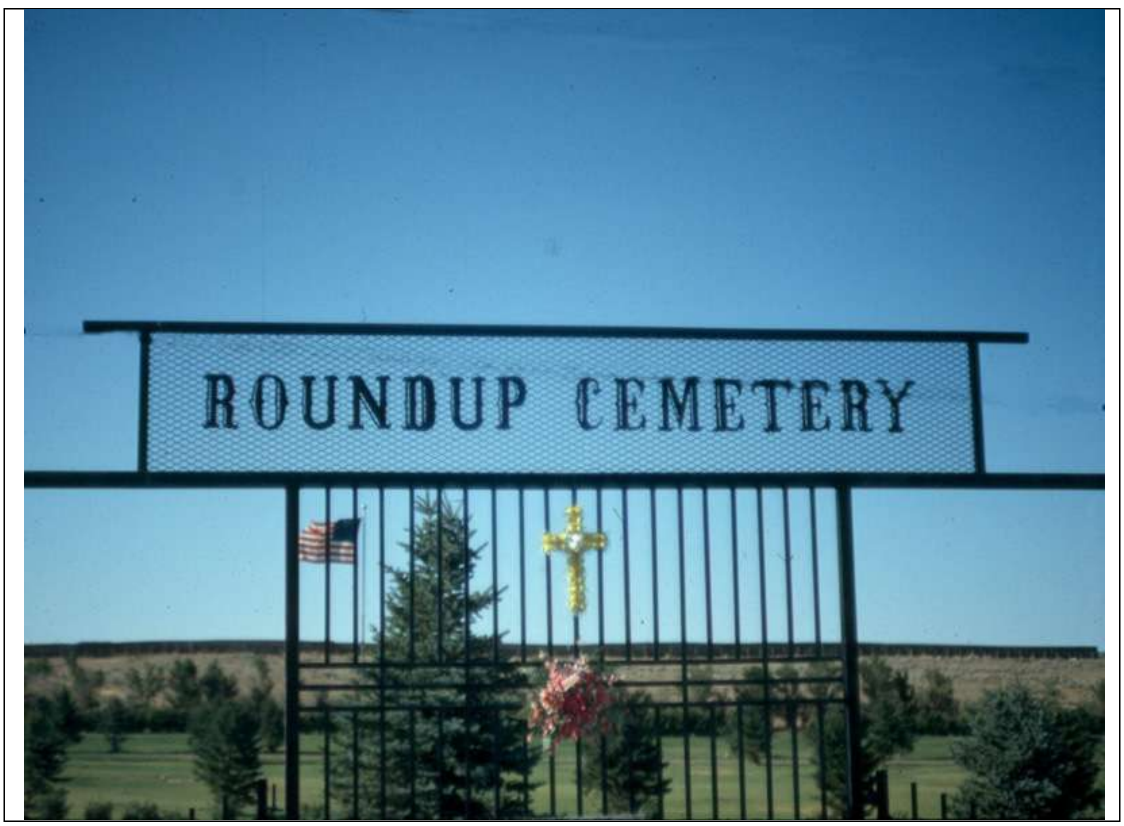


HOW TO PREVENT OR DELAY HERBICIDE RESISTANCE

Weed management strategies that discourage the evolution of herbicide resistance should include the following:

- Herbicide rotation
  - *Use the data in Table 1 to guide your herbicide rotation decisions.*
- Crop rotation
  - *Plant to a crop having a different season of growth.*
  - *Plant to a crop having different registered herbicides (see Table 1).*
  - *Plant to a crop for which there are alternate methods of weed control.*
- Monitoring after herbicide application
  - *Check for weedy patches in patterns consistent with application problems.*
  - *Hand-weed patches that are not in patterns consistent with application problems.*
- Non-chemical control techniques
  - *Cultivate.*
  - *Hand-weed. A 90 percent or greater rate of weed removal reduces the chance that a resistant plant will produce seed.*
  - *Mulching with both synthetic and organic materials.*
  - *Solarize the soil.*
- Short-residual herbicides
- Certified seed
- Clean equipment
  - *Use a power washer or compressed air to remove seeds.*

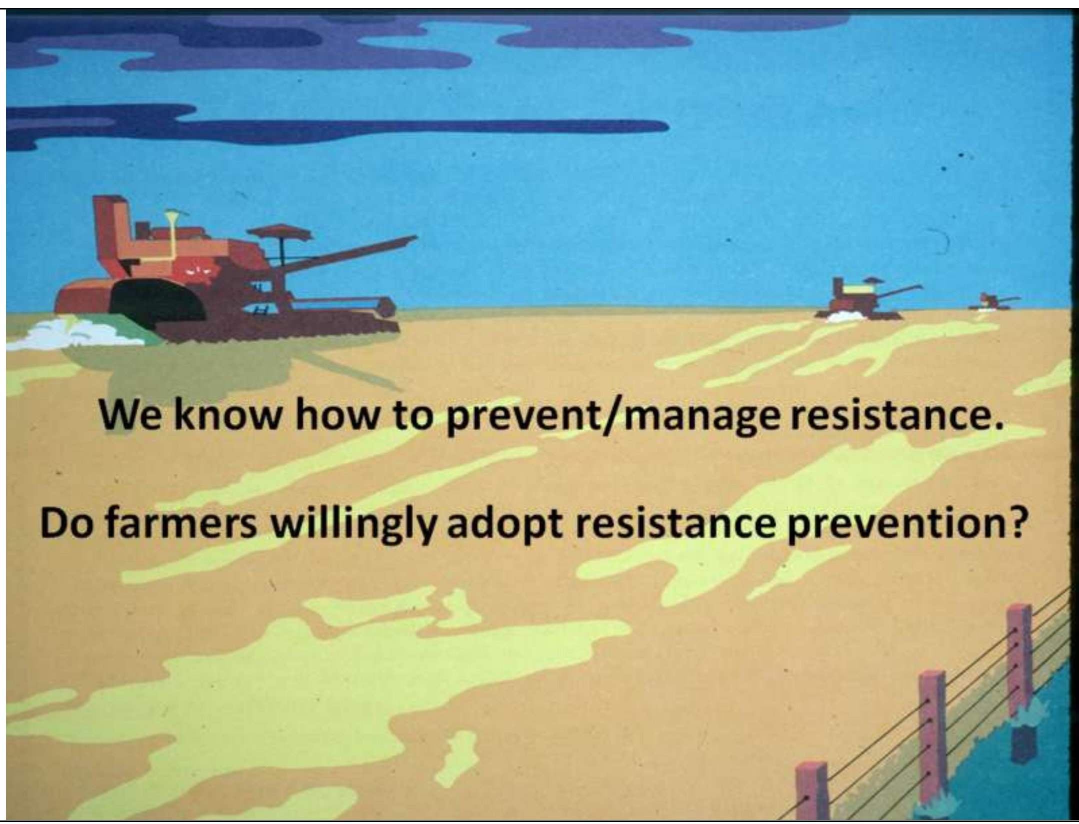
UC Pub 8012 (2000)



What is your best defense against herbicide resistant weeds?

- Reduce intensity of selection pressure.
- Scout fields throughout the growing season.
- Determine whether control is necessary.
- Rotate herbicides with different modes of action.
- Apply tank-mixed, pre-packaged or sequential MoAs.
- Use non-chemical treatments.
- Sanitize equipment.
- Keep off-season populations low.
- Rotate crops.

Paraphrased from UNL website



INTERNATIONAL FARM MANAGEMENT CONGRESS 2003 — FARMING AT THE EDGE

Translated by: Agro Lingua – Karl Kerner, May 2003

FARMING ON THE EDGE SHARPENS MANAGEMENT FOCUS

Chris Henderson

Applecross, Western Australia

67 sq mi

Our Operation:

C & E Henderson is a family business owned and managed by Chris and Evelyn Henderson. We made the decision 3 years ago to move away from the farm and live in Perth. Our farming properties are located in the Varley/Lake King area, 420 kilometres South-East of Perth. The total area farmed is 17,200ha of which 5,200ha is leased. The main property is 13,500 ha while the second property is 3,700 ha. The main property has a staff of 4 permanents including the manager, mechanic, and 2 general farm operators. The second property has a working manager only as the permanent staff. While the 2 properties are managed separately and have their own plant compliment, resources flow between the 2 operations when required. Seasonal staff are employed for the critical periods of seeding and harvest.

The dominant enterprise on the properties is cropping while sheep are the more minor enterprise. Cropping area is typically 13,500ha or 80% of the effective area farmed.
Cropping areas are approx as follows: Wheat - 7700ha, Canola - 2000ha, Lupins - 3000ha, Barley - 800ha. The sheep enterprise is focussed on meat production with cross bred lambs produced and sold in Feb/March. Approx 2500 are sold each year while the ewes are merino and shorn in Jan.

There are many things that I believe make our operation different from others in our locality and in deed in the grain growing regions of WA.

1) Our business and strategic management is remote from the operation. This I believe is advantageous in that the separation between the operation and business/strategic management allows for much better clarity of thinking and decision making without being bogged down with the operational detail and negative events that are always part of the farming landscape.

2) We have a relatively large operation that allows for scale of enterprise, efficiency and the management structure discussed above.

3) We have very good long standing managers who are well rewarded. We put enormous trust in these guys and allow them to make decisions while being well supported with adequate advice and back up.

Summary of Awareness and Perceptions on Weed Resistance to Glyphosate in Roundup Ready Cropping Systems.

75-88% of growers aware of glyphosate resistance potential.

30% or less think it is a serious problem.

44-57% think crop/herbicide rotation is effective.

For how long has the weed research community been harping about resistance?

How have growers changed?

How have we changed?


HERBICIDE RESISTANCE
SOCIETY of AMERICA
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Scientists Point To Precarious State Of U.S. Pesticide Safety Education Program
Press Release
Technical Paper
AAPSE PSEP Funding Survey
WSSA Lesson Modules: Herbicide Resistant Weeds
WSSA October Newsletter
WSSA EPA Liaison Report: 3rd Quarter, 2011
WSSA EPA Liaison Report: Tour Of Weed Resistance Management Challenges
Recent Press Releases: WeedOlympics; Herbicide Resistance Lesson Modules; more...
At least 73 papers on "weed resistance" at 2011 meeting in Portland, Oregon
Hotel Reservations
Transportation
Title/Abstract Submission
Graduate Student Annual Meeting Travel Award
Undergraduate Research Award Nomination
MISSION STATEMENT
The WSSA
a non-profit professional society,
Promotes research, education, and extension outreach activities related to weeds;
Provides science-based information to the public and policy makers;
Fosters awareness of weeds and their impacts on managed and natural ecosystems.
AFFILIATED SOCIETIES
Aquatic Plant Management Society
Canadian Weed Science Society
Southern Weed Science Society
Western Society of Weed Science
LINKS of INTEREST


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Resistance
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Health Issues
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RSS
WSSA NEWS
Scientists Point To Precarious State Of U.S. Pesticide Safety Education Program
Press Release
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Recent Press Releases: WeedOlympics; Herbicide Resistance Lesson Modules; more...
2012 ANNUAL MEETING QUICK LINKS
Informational Brochure
Title/Abstract Submission
Graduate Student Annual Meeting Travel Award
Undergraduate Research Award Nomination
Photo Contest Information
Meeting Webpage
Glyphosate Resistance
WSSA Lesson Module: Herbicide Resistant Weeds
SCIENTISTS POINT TO PRECARIOUS STATE OF U.S. PESTICIDE SAFETY EDUCATION PROGRAM
Scientists with the Weed Science Society of America (WSSA), the American Phytopathological Society (APS) and the Entomological Society of America (ESA) expressed concern about the precarious state of the U.S. Pesticide Safety Education Program (PSEP). Funding for the program has plummeted in recent years and is now in danger of evaporating completely.
Press Release
Technical Paper
AAPSE PSEP Funding Survey
WSSA EPA Liaison Report: 2011 TOUR OF WEED RESISTANCE MANAGEMENT CHALLENGES IN MISSOURI, ILLINOIS, AND ARKANSAS.
CONCERNS REGARDING ELIMINATION OF THE AQUATIC PLANT CONTROL RESEARCH PROGRAM
ABSTRACTS FROM THE 2011 ANNUAL MEETING
Visit the WSSA Abstracts website to view the presentations sorted by various methods. In each of these reports, click on the title of interest to view/print the abstract.
WSSA CLASSICATIONS OF HERBICIDE RESISTANCE MECHANISM OF ACTION
Herbicide Mechanism of Action according to the Weed Science Society of America (WSSA) Classification has been added to the Resistance section of the website by the Herbicide Resistant Plants Committee (E12).

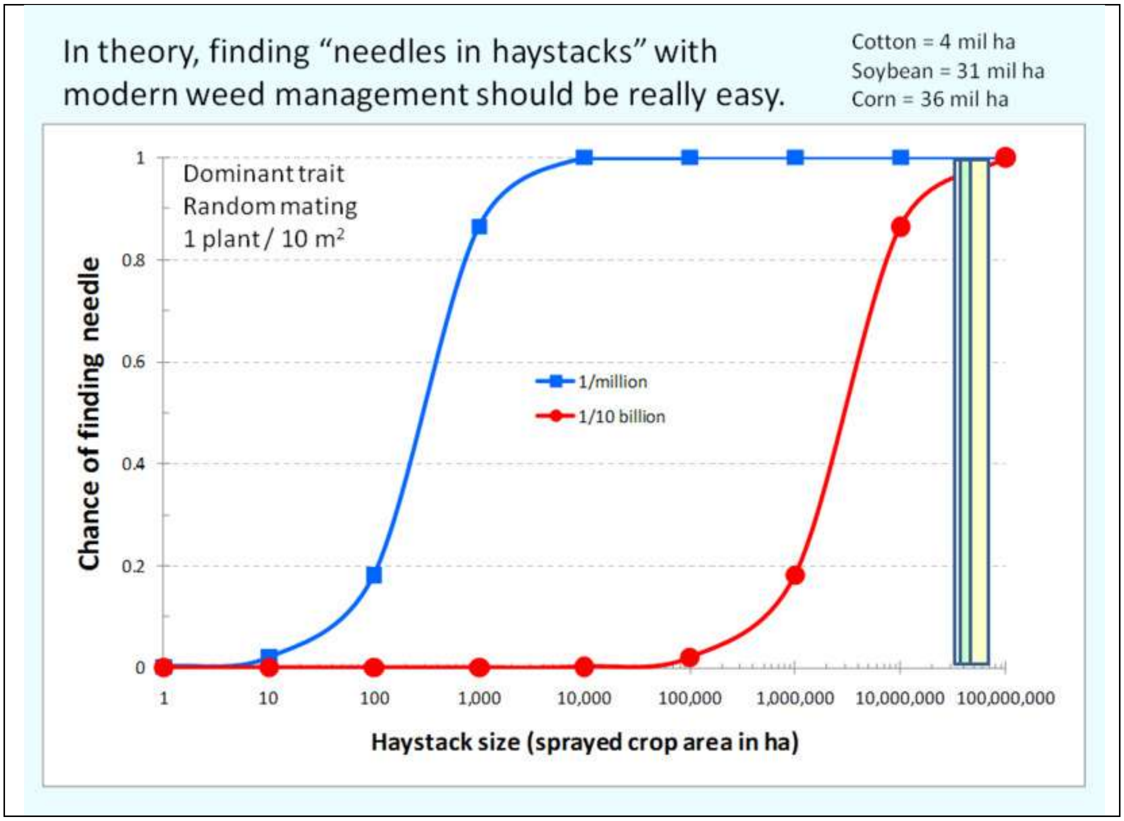
A 500 HP tractor is needed to pull a deep-ripper big enough to alleviate the compaction caused by a 400 HP tractor.
- Ward Voorhees

We now are re-engineering cotton and soybean to control weeds whose resistance may have been caused by the over-use of engineered cotton and soybean.

Does this reflect our current food & fiber system? Change?

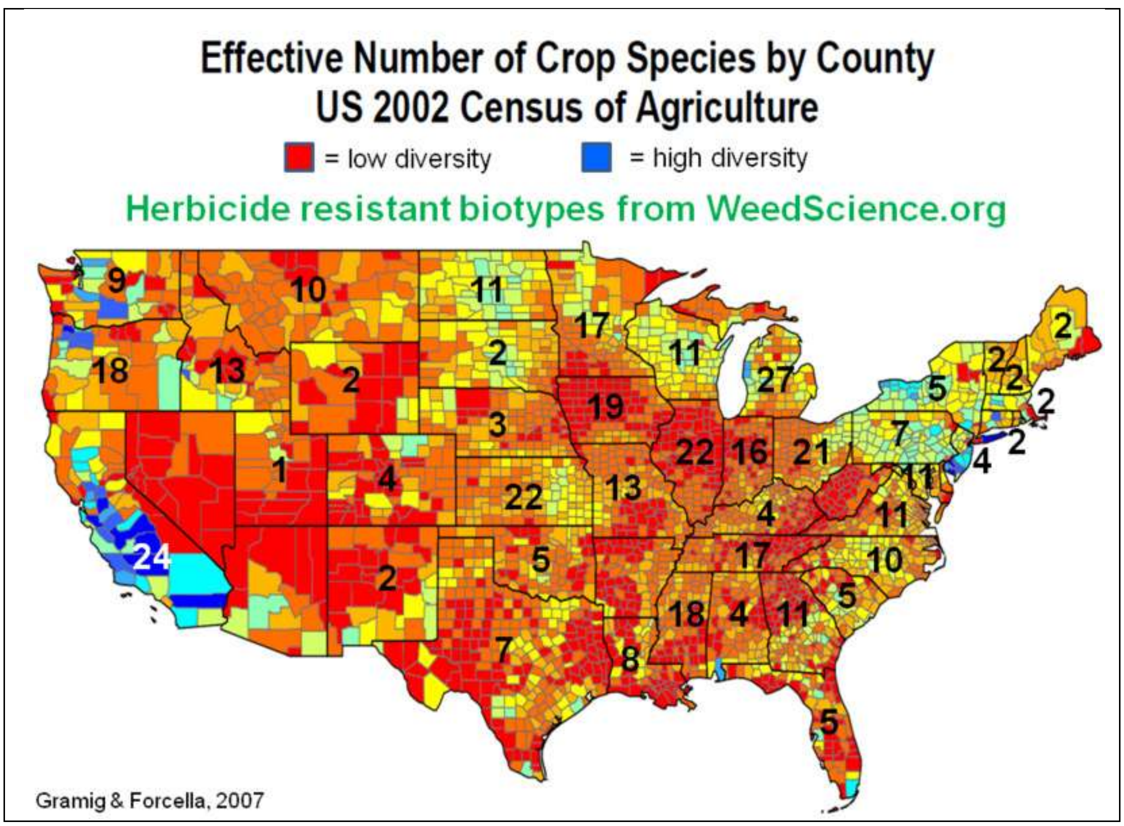
Three basic elements for successful change:

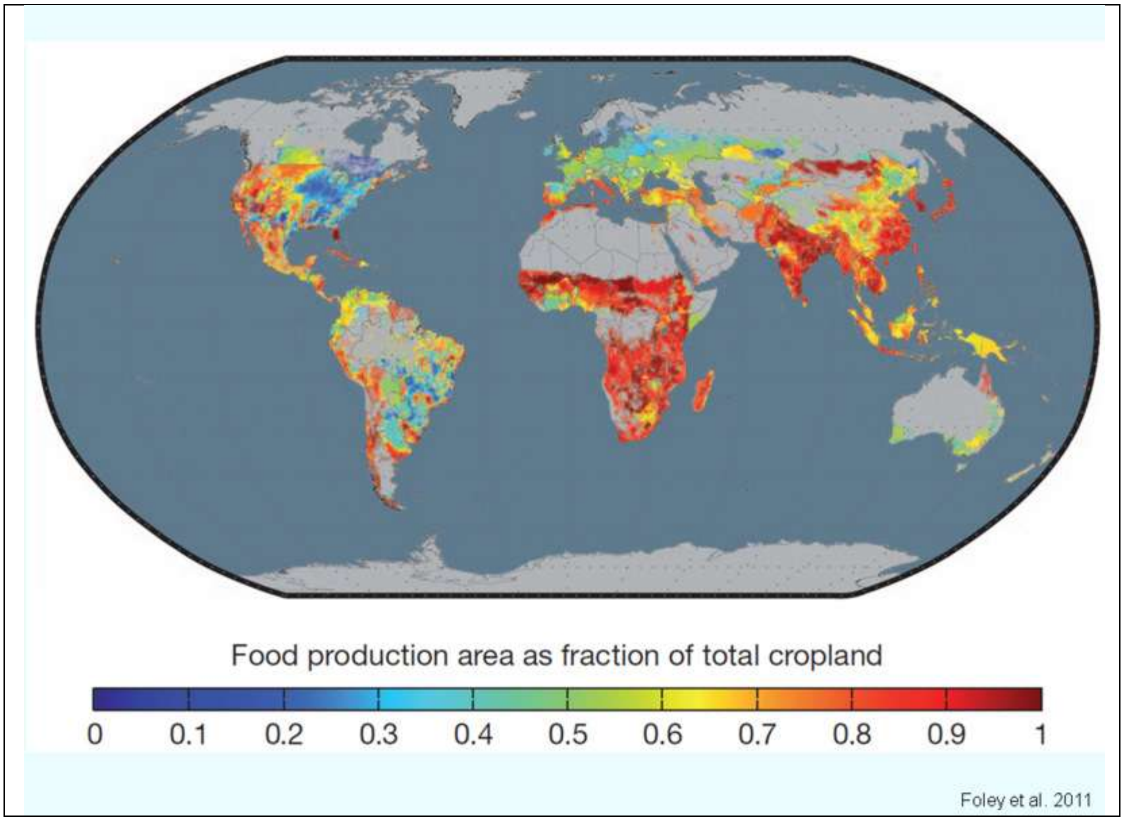
1. **Desire to change**
   - √ a. **Awareness** (already done by extension)
   - √ b. **Perception** (need is inverse to wealth [& health?])
2. **Ability to change**
   - a. **Psychological**
   - b. **Financial**
   - √ c. **Environmental** (alter environment)
3. **Permission to change**
   - a. **Land owners**
   - b. **Bankers**
   - √ c. **Regulators** (policies imposed or withdrawn)

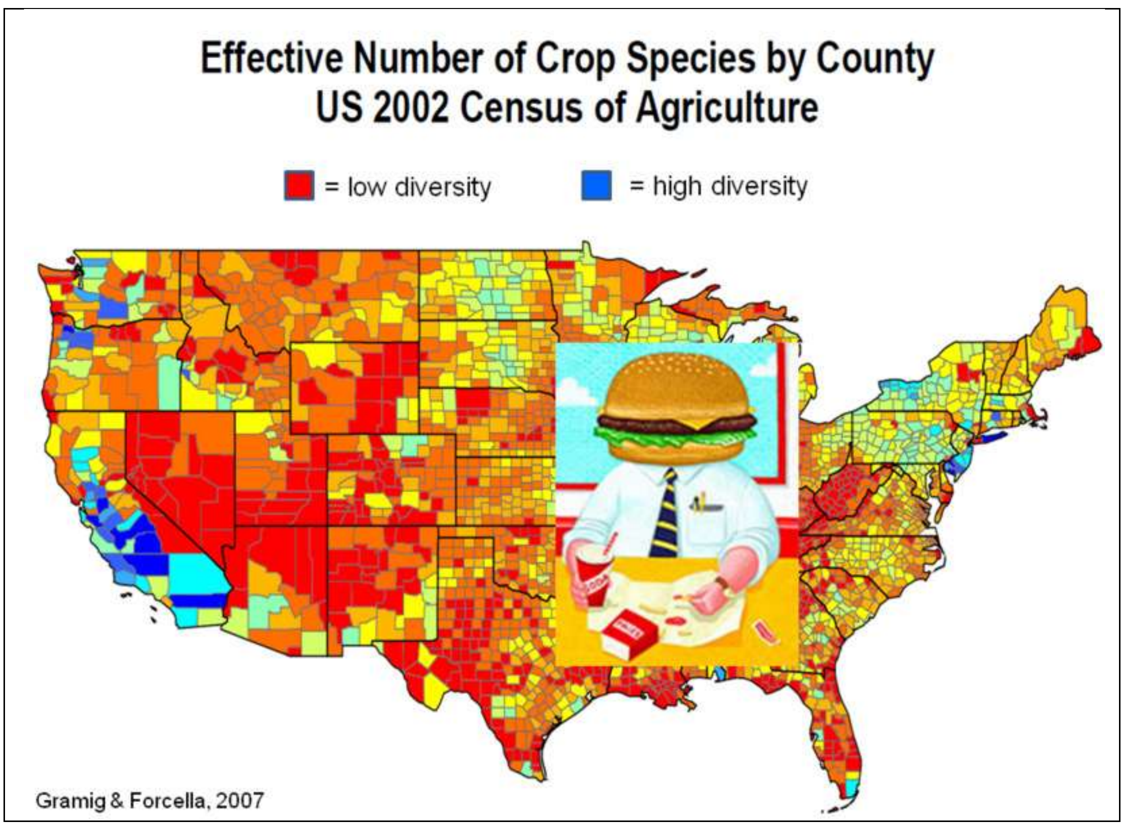


When selection pressure is sufficiently intense, needles are easy to find.

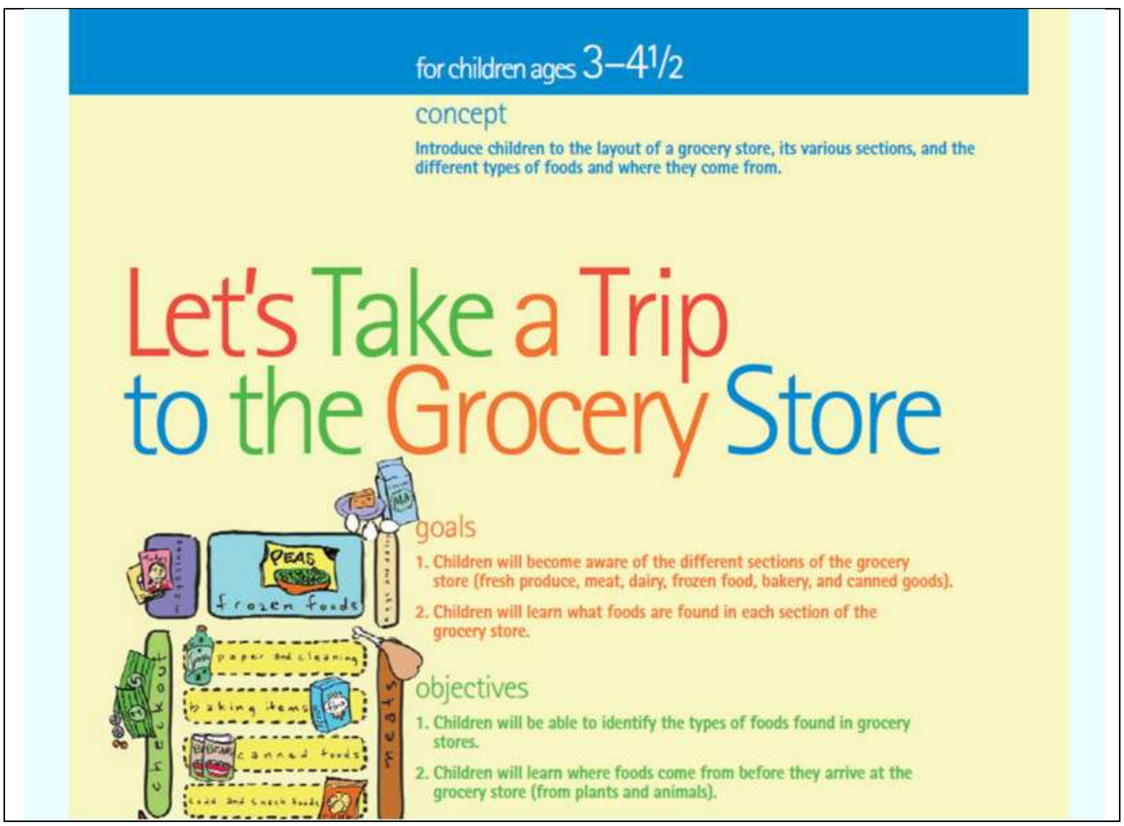

Ironically, the bigger the haystack, the more obvious the needle.


Effective Number of Crop Species by County
US 2002 Census of Agriculture
= low diversity
= high diversity
Herbicide resistant biotypes from WeedScience.org
Gramig & Forcella, 2007

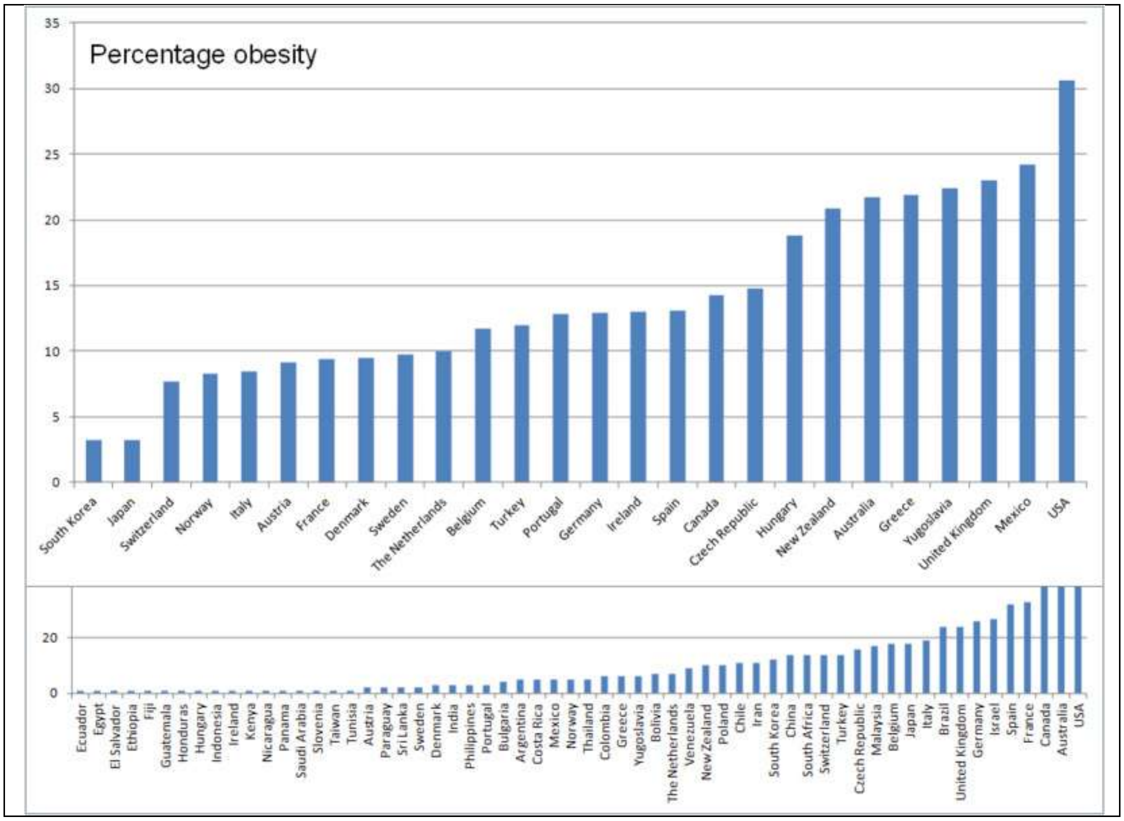

Food production area as fraction of total cropland
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Foley et al. 2011

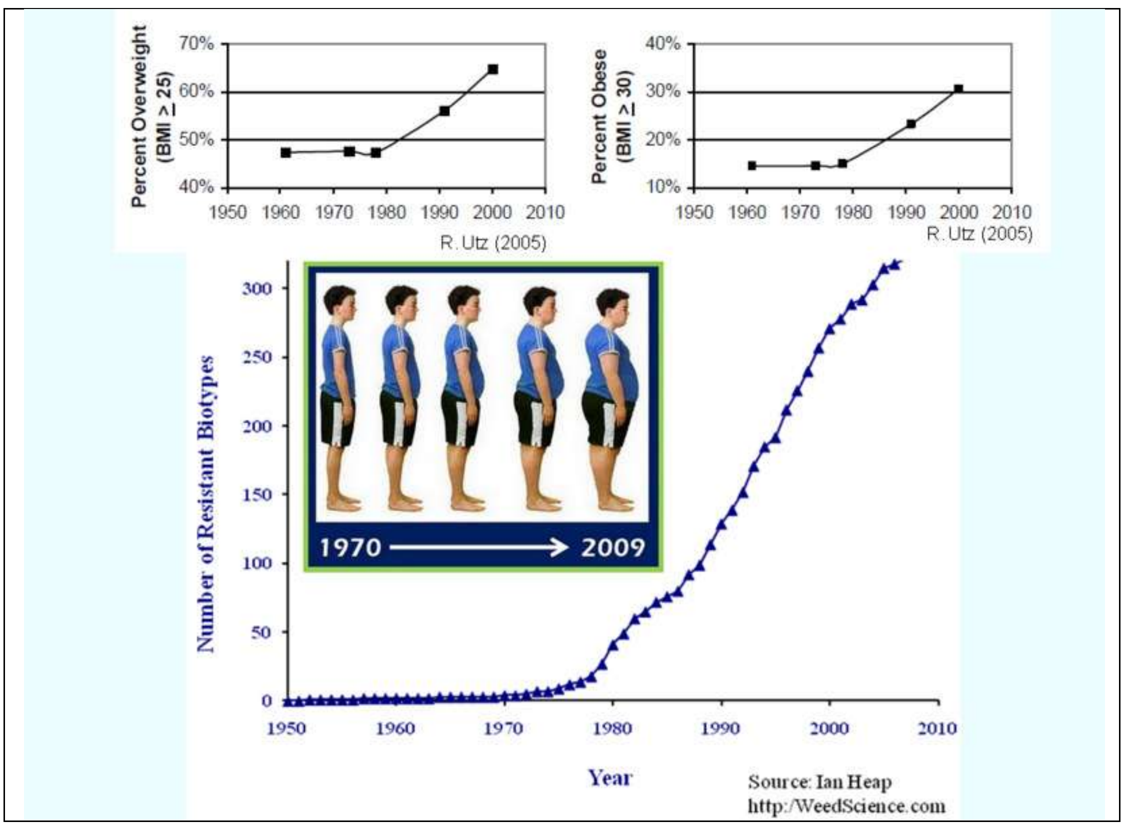

Effective Number of Crop Species by County
US 2002 Census of Agriculture
= low diversity
= high diversity
Gramig & Forcella, 2007


Luke (Marines) & Matt (Army)
Oct. 2010
Chef 5 Minute Meals
self heating meal
A freshly cooked
The complete take-out meal!
Oven included!
BEEF STEW


for children ages 3–4½
concept
Introduce children to the layout of a grocery store, its various sections, and the different types of foods and where they come from.
Let's Take a Trip to the Grocery Store
goals
1. Children will become aware of the different sections of the grocery store (fresh produce, meat, dairy, frozen food, bakery, and canned goods).
2. Children will learn what foods are found in each section of the grocery store.
objectives
1. Children will be able to identify the types of foods found in grocery stores.
2. Children will learn where foods come from before they arrive at the grocery store (from plants and animals).
PEAS
frozen foods
meats
checkout


Aren't these items luxuries?
How can we afford them?
Are most derived from corn and soybean?
Are corn and soybean too cheap?


Percentage obesity
35
30
25
20
15
10
5
0
South Korea
Japan
Switzerland
Norway
Italy
Austria
France
Denmark
Sweden
The Netherlands
Belgium
Turkey
Portugal
Germany
Ireland
Spain
Canada
Czech Republic
Hungary
New Zealand
Australia
Greece
Yugoslavia
United Kingdom
Mexico
USA
20
0
Ecuador
Egypt
El Salvador
Ethiopia
Fiji
Guatemala
Honduras
Hungary
Indonesia
Ireland
Kenya
Nicaragua
Panama
Saudi Arabia
Slovenia
Taiwan
Tunisia
Austria
Paraguay
Sri Lanka
Sweden
Denmark
India
Philippines
Portugal
Bulgaria
Argentina
Costa Rica
Mexico
Norway
Thailand
Colombia
Greece
Yugoslavia
Bolivia
The Netherlands
Venezuela
New Zealand
Poland
Chile
Iran
South Korea
China
South Africa
Switzerland
Turkey
Czech Republic
Malaysia
Belgium
Japan
Italy
Brazil
United Kingdom
Germany
Israel
Spain
France
Canada
Australia
USA


Percent Overweight (BMI ≥ 25)
70%
60%
50%
40%
1950 1960 1970 1980 1990 2000 2010
R. Utz (2005)
Percent Obese (BMI ≥ 30)
40%
30%
20%
10%
1950 1960 1970 1980 1990 2000 2010
R. Utz (2005)
Number of Resistant Biotypes
300
250
200
150
100
50
0
1970 → 2009
1950 1960 1970 1980 1990 2000 2010
Year
Source: Ian Heap
http:/WeedScience.com

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Should Morbid Childhood Obesity Be Considered Child Abuse?

By Philip Yam | July 13, 2011 | 34

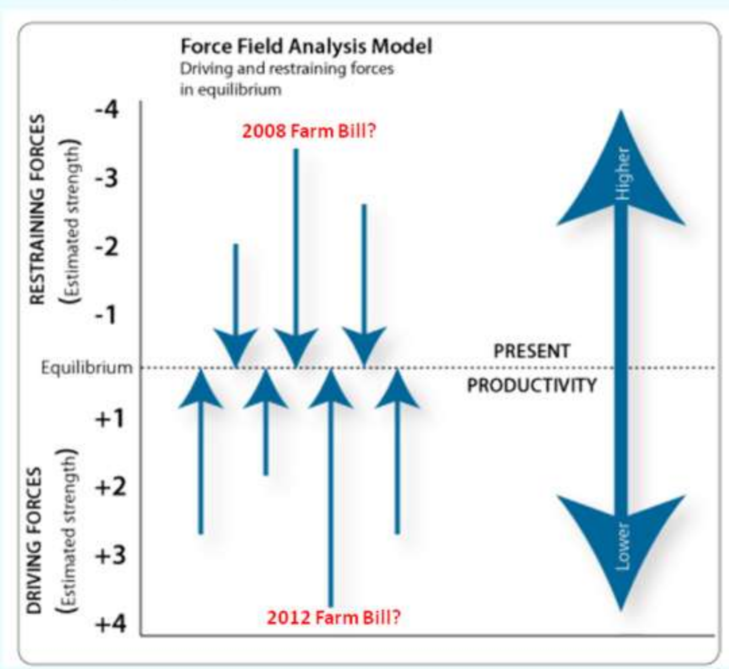
Share Email

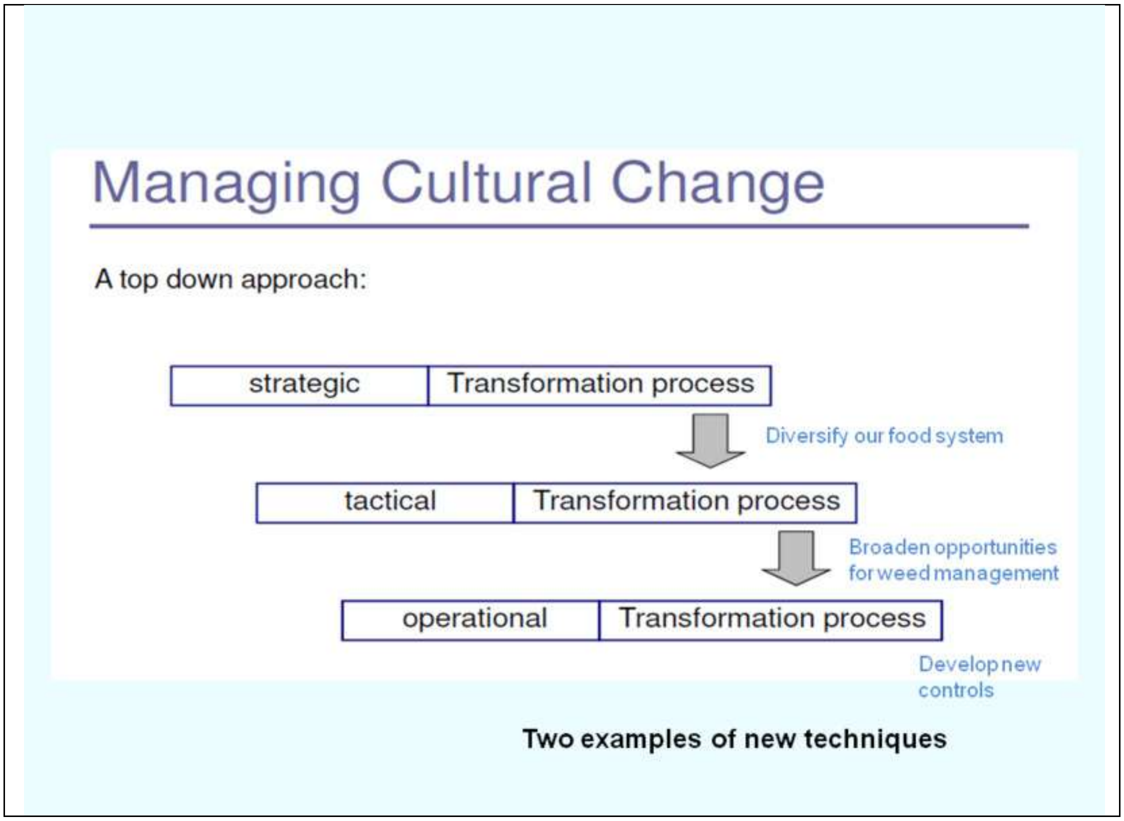
So, whose's responsible for resistant weeds?

Now that the battle against the bulge in the U.S. has reached the grade school level, plenty of efforts have begun to fight childhood obesity and its dangers. They range from educational efforts, such as First Lady Michelle Obama's Let's Move! campaign, to new pediatric surgical programs nationwide. Now two researchers float a legal approach: make severe obesity a crime.

Lindsey Murtagh of the Harvard School of Public Health and David S. Ludwig of the Children's Hospital in Boston present their case in the July 13 issue of *JAMA, The Journal of the American Medical Association*. Their commentary, "State Intervention in Life-Threatening Childhood Obesity," makes the point that kids with a body-mass index in the 99th percentile face serious health threats:

Lewin's force-field analysis is a commonly used model to illustrate elements of change and resistance to change:



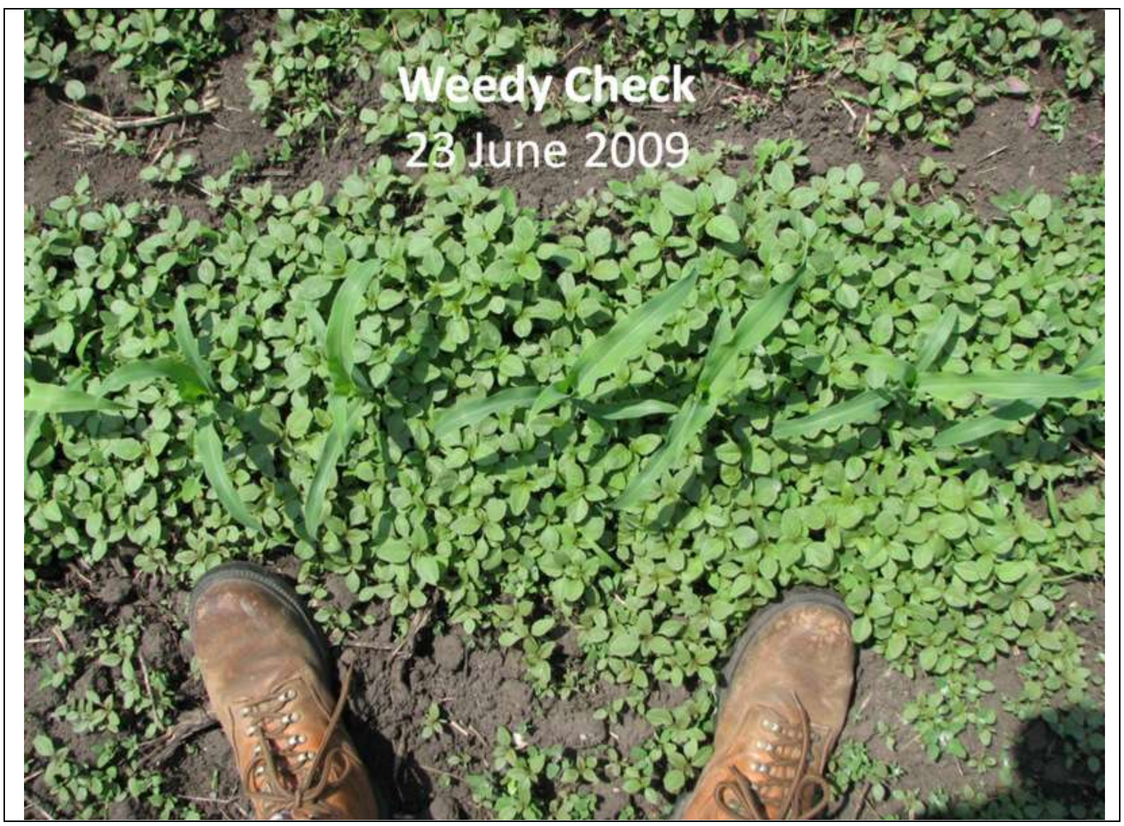

Managing Cultural Change
A top down approach:
strategic
Transformation process
Diversify our food system
tactical
Transformation process
Broaden opportunities for weed management
operational
Transformation process
Develop new controls
Two examples of new techniques


"Harrington Seed Destructor" in an Australian wheat paddock
Annual brome 99%
Annual ryegrass 95%
Wild oat 99%
Wild radish 93%
Walsh et al. 2011 (ms)

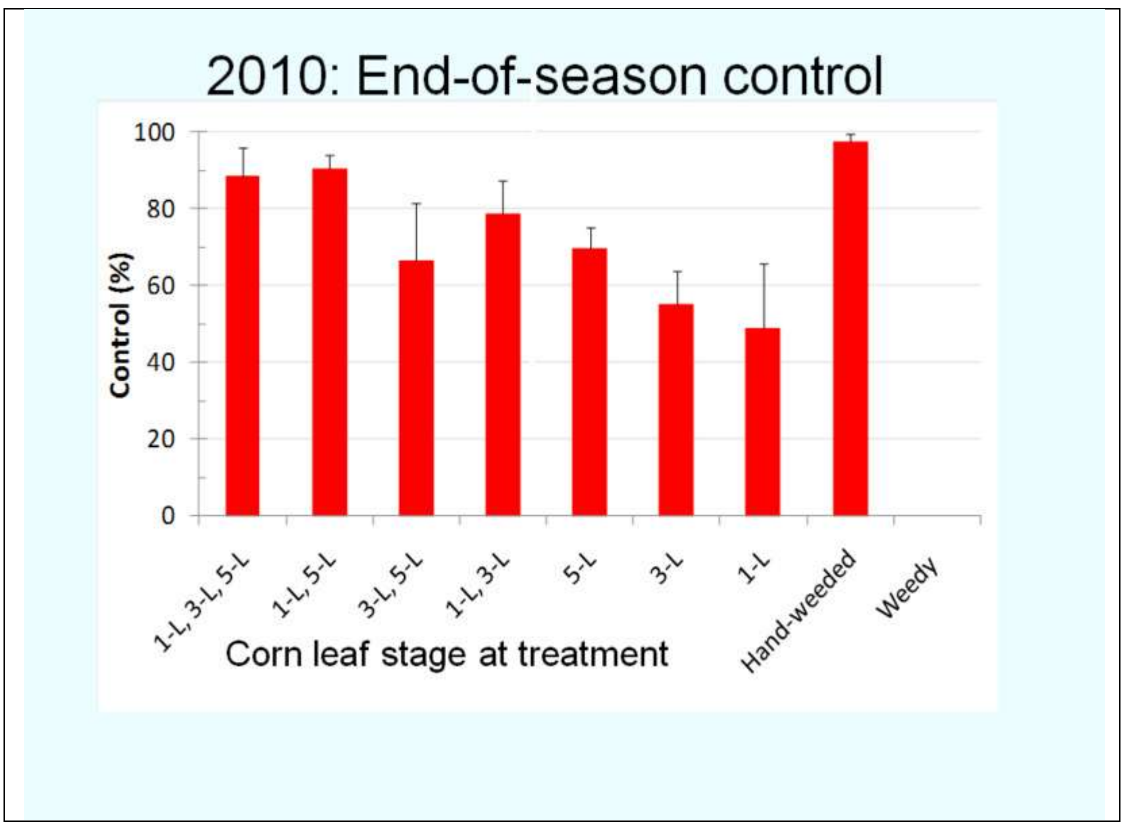

Sand blasters
& abrasive grit

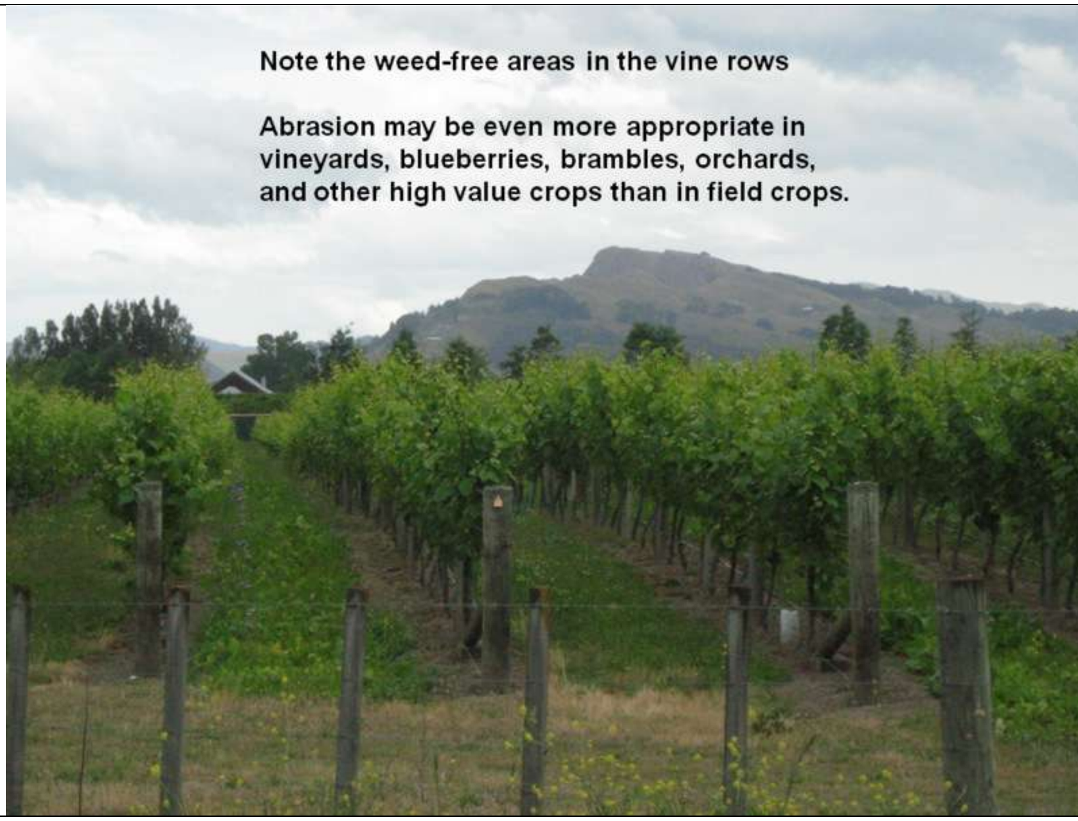

Rube Goldberg applicator


17 June 2009
Testing the concept in the field
Corn cob grit


Weedy Check
23 June 2009


1&3-Leaf Treatment
23 June 2009


2010: End-of-season control
Control (%)
100
80
60
40
20
0
1-L, 3-L, 5-L
1-L, 5-L
3-L, 5-L
1-L, 3-L
5-L
3-L
1-L
Hand-weeded
Weedy
Corn leaf stage at treatment



Ending questions:

- Is our current food system the one you want for your grandchild?
- How vigorously should the *status quo* be reinforced?
- Can weed researchers conceive new management options at tactical and operational levels?

Angus Murphy

Active Ingredient Fingerprinting - Angus Murphy and Josh Blakeslee

Department of Horticulture and Landscape Architecture, Purdue University, murphy@purdue.edu,
Horticulture and Crop Science, Ohio State University, blakeslee.19@osu.edu

GMOs and the Social Science of Technology – Craig Harris

Department of Sociology, Michigan State University, harrisc@msu.edu

Craig Harris is an associate professor of sociology, specializing in the sociology of food and agriculture, and the sociology of the environment. Craig is also appointed in the Michigan Agricultural Experiment Station (Michigan AgBio Research) and the National Food Safety and Toxicology Center. Craig is one of the principals of the Institute for Food and Agricultural Standards. Craig has been exploring the social dimensions of agrifood biotechnology for over 25 years. With colleagues he is the author of a chapter on what makes agrifood biotechnology so scary to consumers, two articles on the discourse concerning GM cotton in India, and a forthcoming chapter on agrifood biotechnology decision making in Uganda.

In his presentation he will discuss the regulation of biotechnology, the roles of trust in social processes, and decision making under uncertainty.

Nine Questions

- what are science/technology ??
- where do science/technology come from ??
- how does society foster the development of science/technology ??
- how do science/technology change ??
- on what criteria should technology be evaluated ??
- what is a fair return on investment in the development of a technology ??
- what is a fair bargain for the technology ??
- how should decisions about science/technology in society be made ??
- what are the goals of science/technology ??

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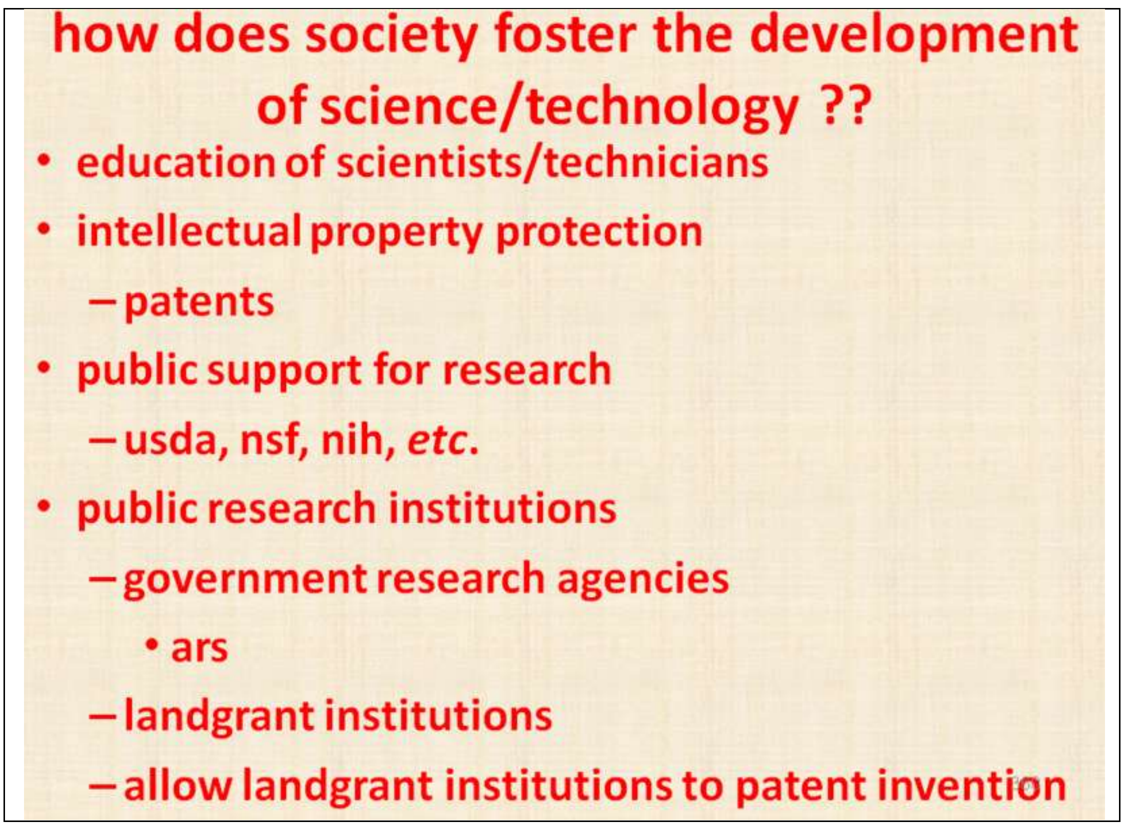
what are science/technology ??

- modern western science
- citizen science
- traditional, local, folk knowledge

358


where do science/technology come from ??
• internal generation
– disciplinary research
– recombination of concepts and ideas
• external direction
– subject matter
• stakeholder group
– problem solving
• who sets the agenda for science/technology development ??
• how is the agenda for science/technology development set ??
359


how does society foster the development of science/technology ??
• education of scientists/technicians
• intellectual property protection
– patents
• public support for research
– usda, nsf, nih, etc.
• public research institutions
– government research agencies
• ars
– landgrant institutions
– allow landgrant institutions to patent invention

how do science/technology change ??

- invention
- development of innovation
  - pipeline
- adoption of innovation
  - adaptation
- extension and outreach
- *at each of these stages, ask which innovations move forward ??*
- *what happens to earlier science/technology ??*

361

on what criteria should technology be evaluated ??

- production
- efficiency, productivity
  - first law efficiency (output/input)
    - per unit of land
    - per unit of labor
      - what kind of labor ??
    - per unit of energy or other resources
  - second law efficiency (least input for goal)
- neutrality
- producer autonomy
- sustainability

362

what is a fair return on investment in the development of the technology ??

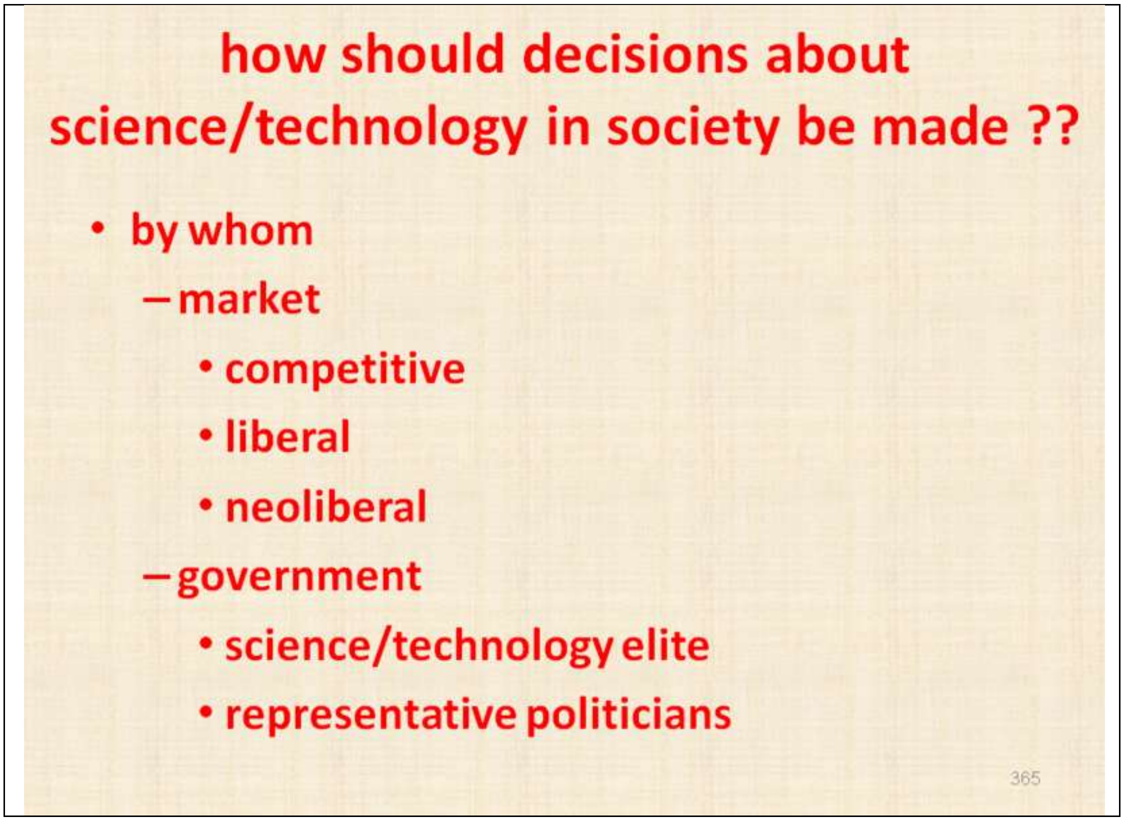
- competitive market

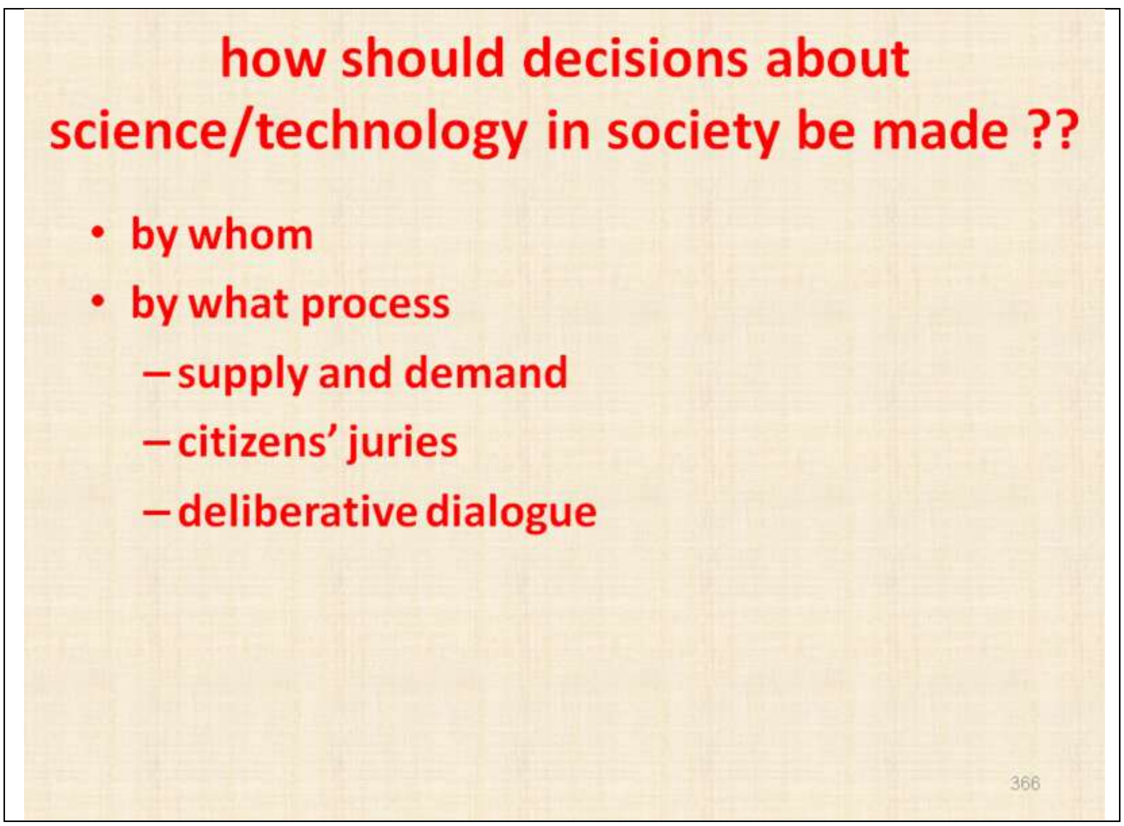
363

what is a fair bargain for the technology ??

- monetary price
- restrictions
  - mode of us
  - reuse

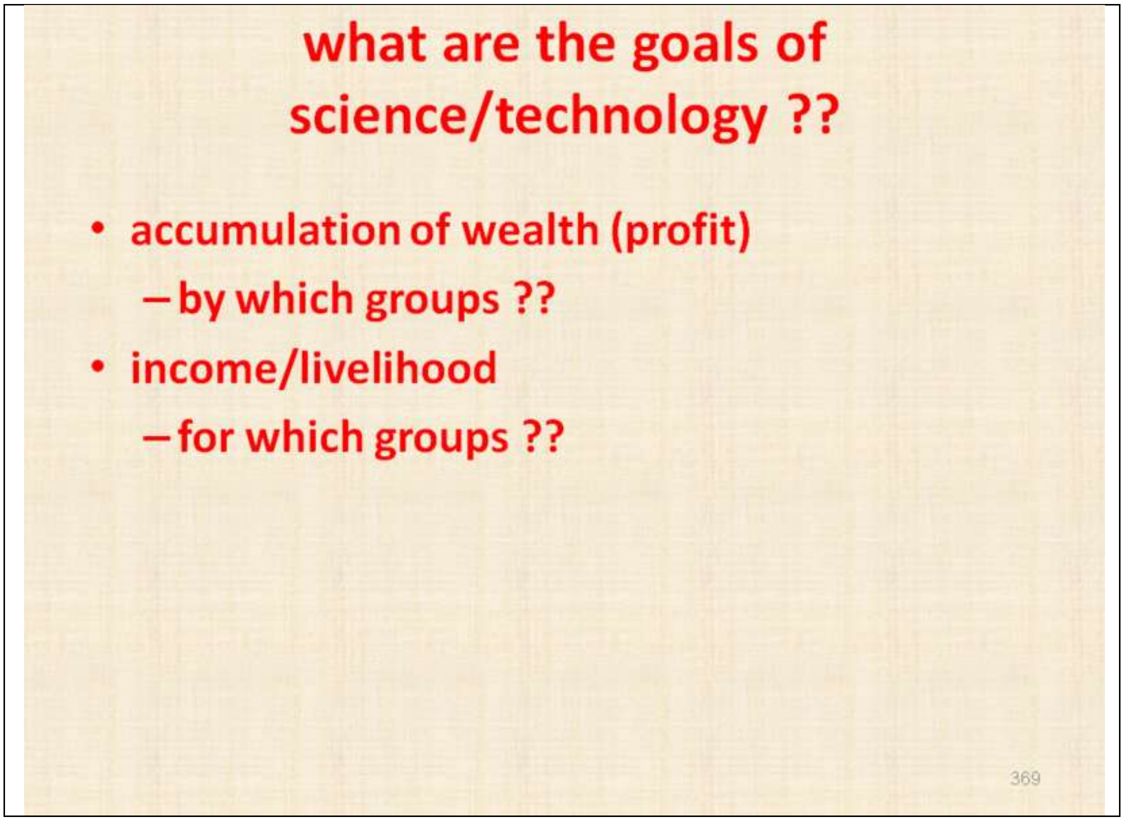
364


how should decisions about
science/technology in society be made ??
• by whom
– market
• competitive
• liberal
• neoliberal
– government
• science/technology elite
• representative politicians
365


how should decisions about
science/technology in society be made ??
• by whom
• by what process
– supply and demand
– citizens' juries
– deliberative dialogue
366


how should decisions about science/technology in society be made ??
• by whom
• by what process
• what attributes
– openness
– transparency
– participation
– access
– temporary or permanent
– ongoing review
367


how should decisions about science/technology in society be made ??
• by whom
• by what process
• what attributes
• risk and uncertainty
– precautionary principle
– wicked problems
368


what are the goals of science/technology ??
• accumulation of wealth (profit)
– by which groups ??
• income/livelihood
– for which groups ??
369


what are the goals of science/technology ??
• accumulation of wealth (profit)
• income/livelihood
• production of goods and services
– of what kinds
• basic human needs
–shelter
–health
–food for nutrition and health
–education
• comforts of life
• luxuries
370


what are the goals of science/technology ??
• accumulation of wealth (profit)
• income/livelihood
• production of goods and services
– of what kinds
• basic human needs
• comforts of life
• luxuries
– for which groups
• economically marginal people in the u.s.
• economically marginal in developing countries
• is this the best way to help these groups ??
71


what are the goals of science/technology ??
• accumulation of wealth (profit)
• income/livelihood
• production of goods and services
– of what kinds
– for which groups
• sustainable development
– environmental
– economic
– social
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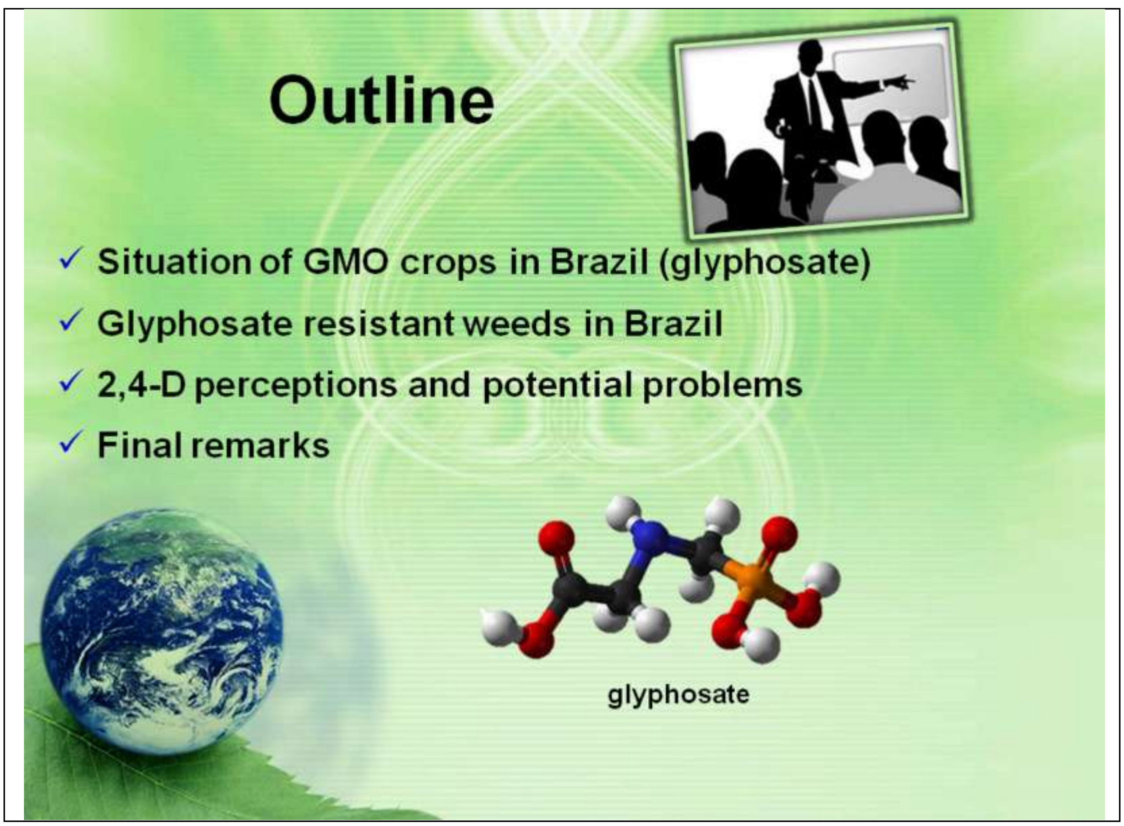
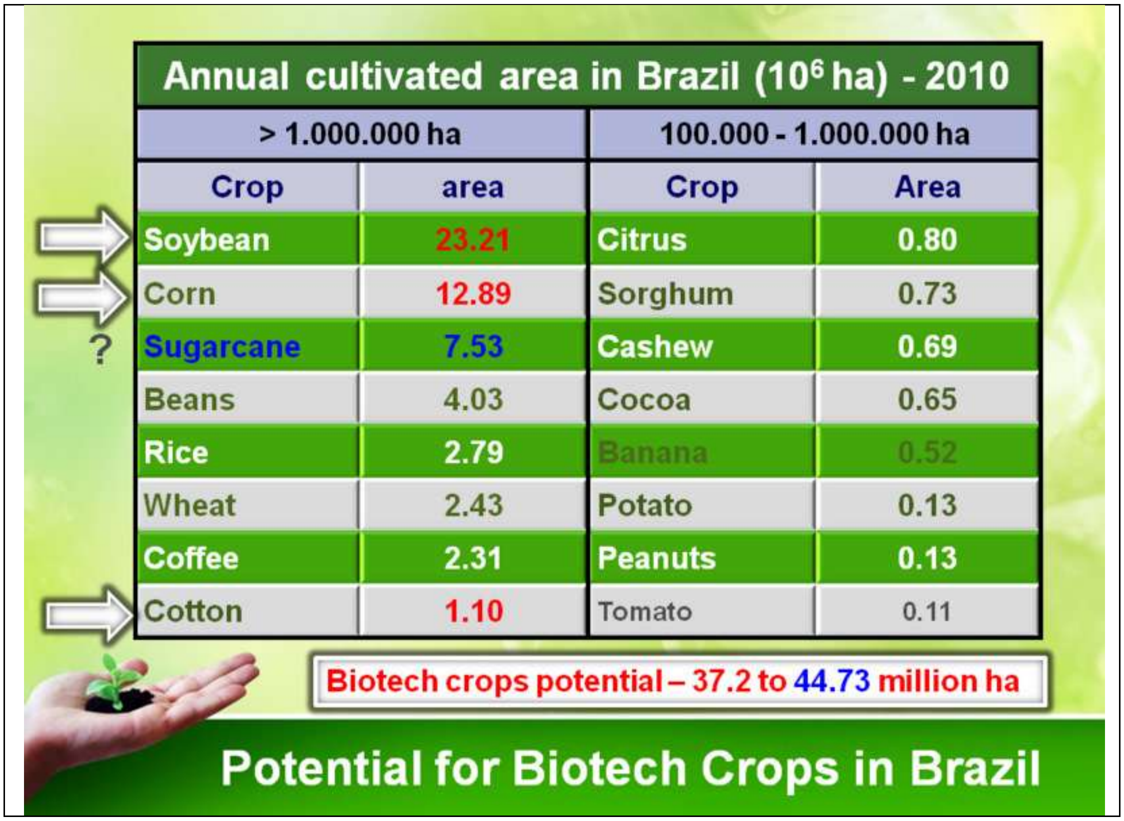
Farmer experience with and current status of Roundup Ready crops in Brazil, and the receptivity of regulators and farmers to the new 2,4-D and dicamba tolerant crops – Pedro Christoffoleti

University of Sao Paulo, College of Agriculture "Luiz de Queiroz", Department of Crop Science, Weed Science Area, Piracicaba, SP, Brazil pjchrist@esalq.usp.br

After 14 years of adoption of Roundup Ready soybean in Brazil, the technology brought gains to farmers, especially in the production cost, when compared to conventional crops. However, risk on the adoption of Roundup Ready technology is related to selection of glyphosate resistant weed biotypes. Five species have been selected in the country with resistance to glyphosate, being *Conyza* spp the most frequent selected species. It is estimated that 3,3 million hectares of the 25 millions of soybean cultivated in the country has resistant horseweed. The process of registration fo 2,4-D and dicamba resistant crop is still in the early stages and probably will take at least 3 to 4 years for approval. However, 2,4-D is officially registered to several non-resistant crops in Brazil, but it is mainly used for weed control in soybean (burndown treatment –7 to 10 days pre-planting). It is also used for the crop sugarcane (post-emergence) and corn (burndown and initial post emergence of the crop). Despite the fact of being a "old" product it is still being used due to it broad weed spectrum of control and better cost/benefit when compared to other products in the market, as well it may be used to control resistant weeds to ALS inhibitor herbicides and glyphosate. There are two formulations registered in the country (ester and amine), however only the amine formulation has been commercialized, in 13 commercial producers. So, risks in the future use of 2,4-D might be related to drift. Drift may represent source of contamination to non-target crop. Therefore, special recommendations of spray application of the herbicide must be followed regard to droplet size, sprayer pressure, boom height, climatic conditions at application, distance of the non target crops from the sprayed area and wind velocity.

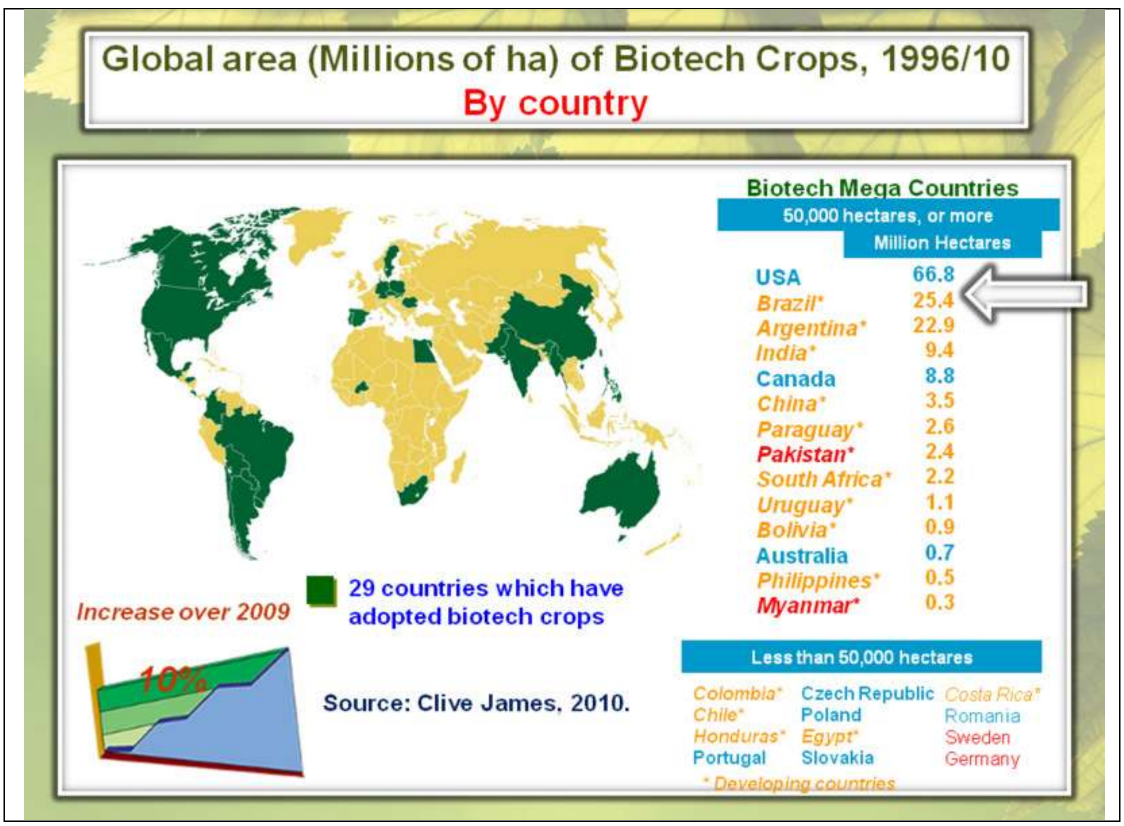

Workshop
The New 2,4-D and Dicamba Tolerant Crops:
Managing Risks to Farmers and Communities
Presentation
Farmer experience with and current status of Roundup Ready crops in Brazil, and the receptivity of regulators and farmers to the new 2,4-D and dicamba tolerant crops.
Pedro J. Christoffoleti
Associate Professor
University of São Paulo – Brazil
College of Agriculture "Luiz de Queiroz"
Weed Science specialist
pjchrist@esalq.usp.br
++55 19 9727 8314

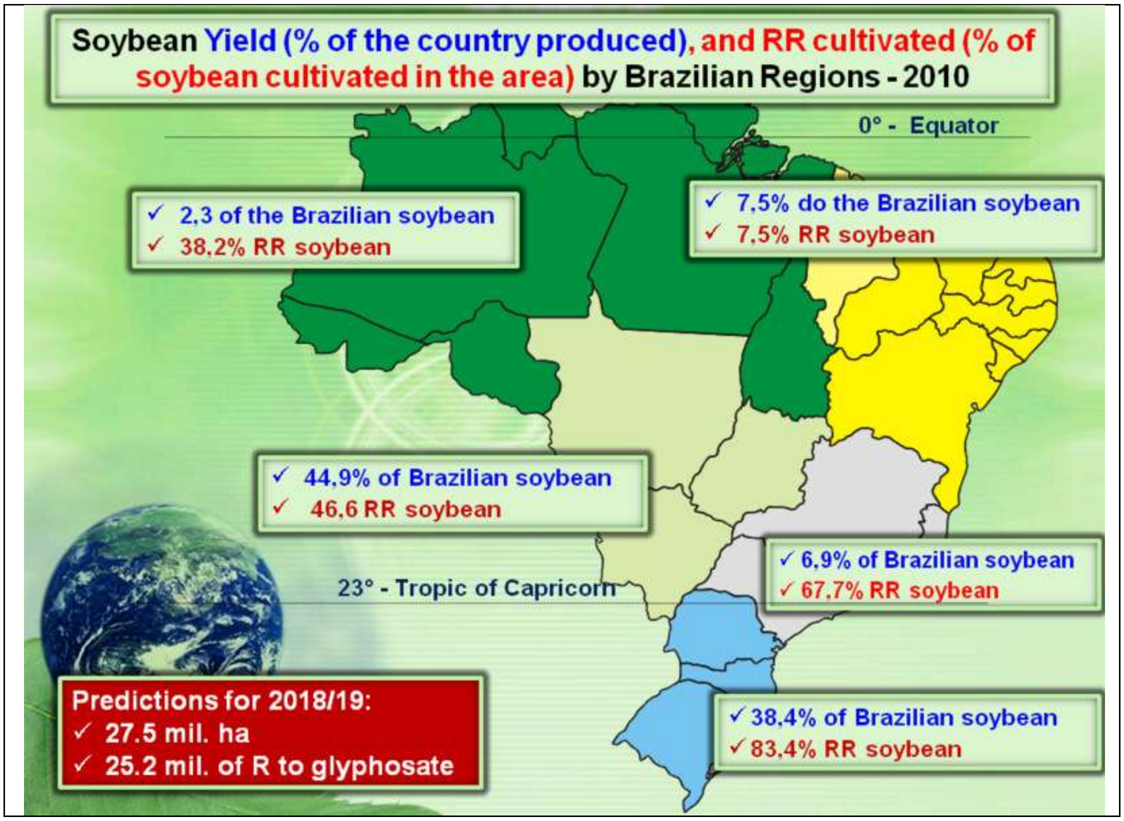

Outline
✓ Situation of GMO crops in Brazil (glyphosate)
✓ Glyphosate resistant weeds in Brazil
✓ 2,4-D perceptions and potential problems
✓ Final remarks
glyphosate



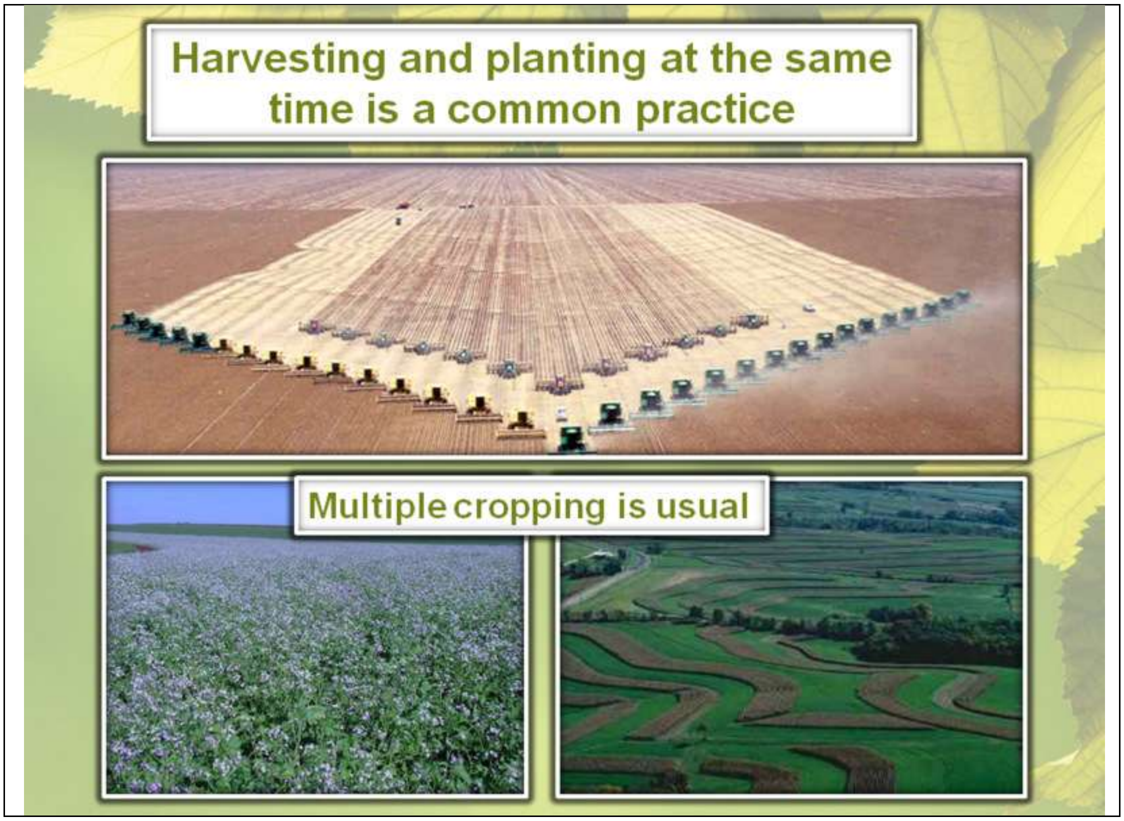
Annual cultivated area in Brazil (10^6 ha) - 2010

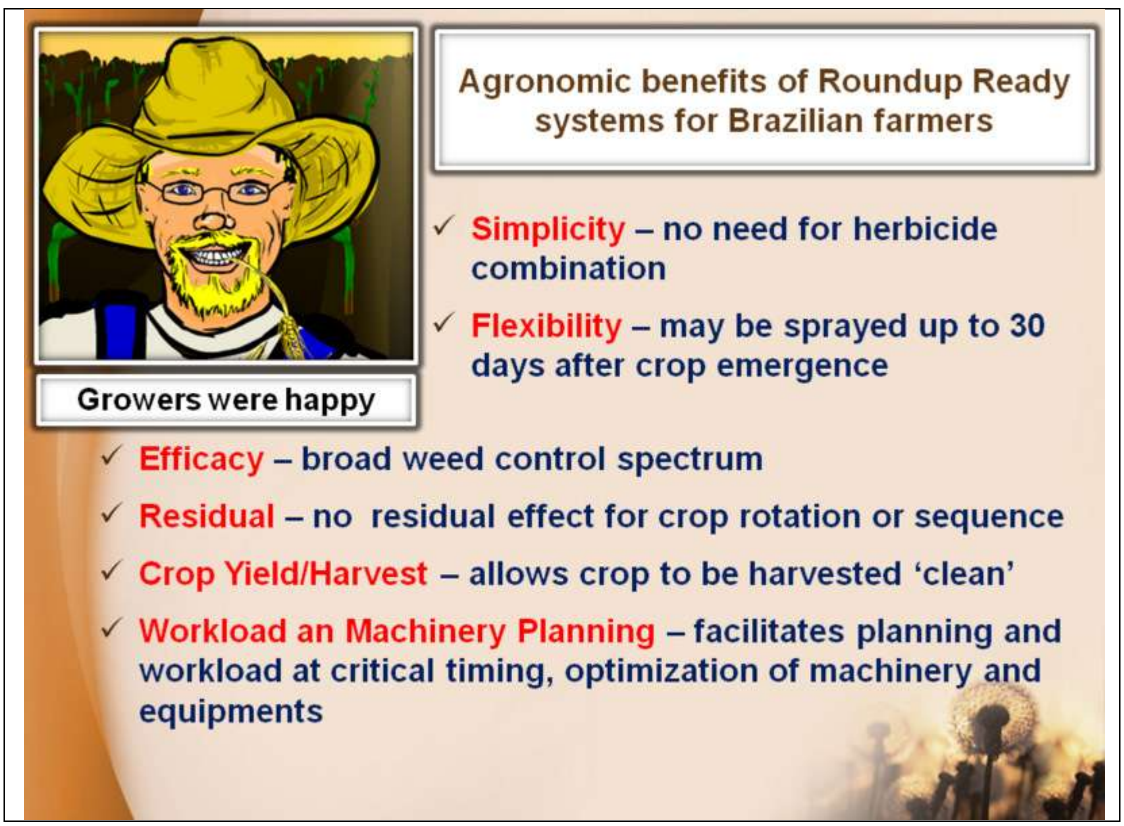
> 1.000.000 ha		100.000 - 1.000.000 ha	
Crop	area	Crop	Area
Soybean	23.21	Citrus	0.80
Corn	12.89	Sorghum	0.73
Sugarcane	7.53	Cashew	0.69
Beans	4.03	Cocoa	0.65
Rice	2.79	Banana	0.52
Wheat	2.43	Potato	0.13
Coffee	2.31	Peanuts	0.13
Cotton	1.10	Tomato	0.11

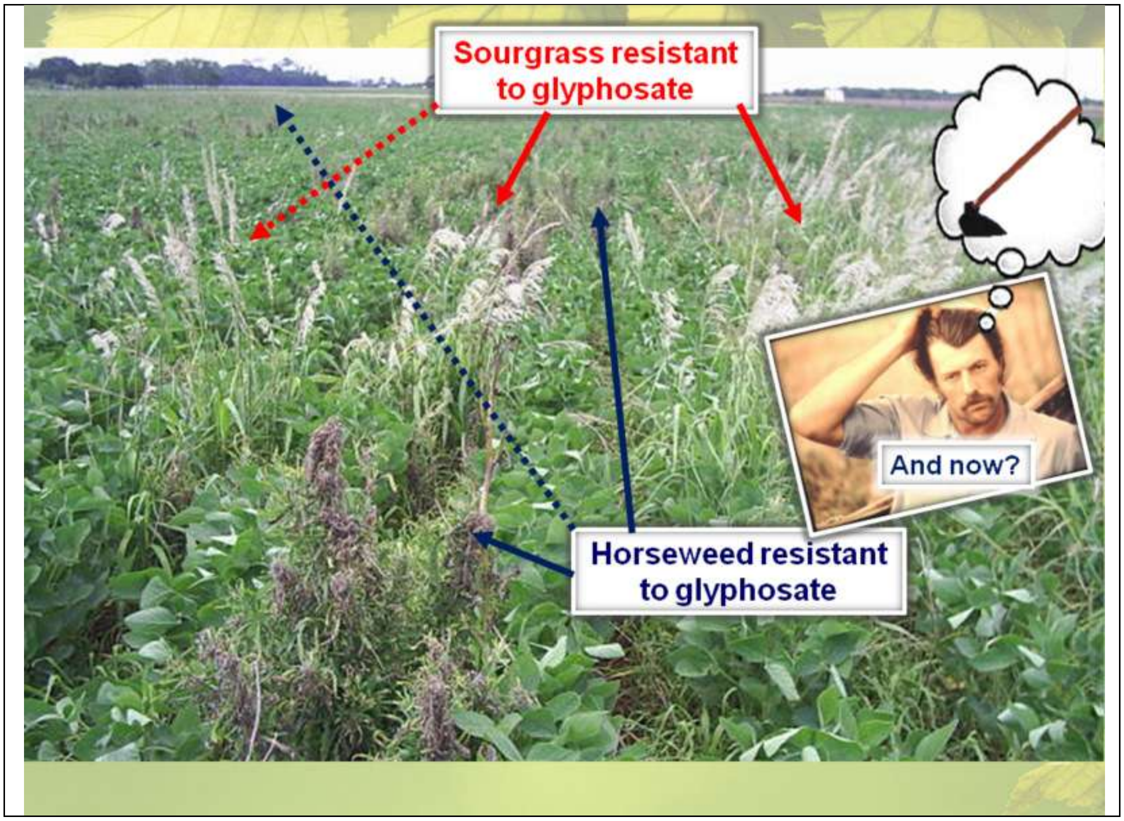




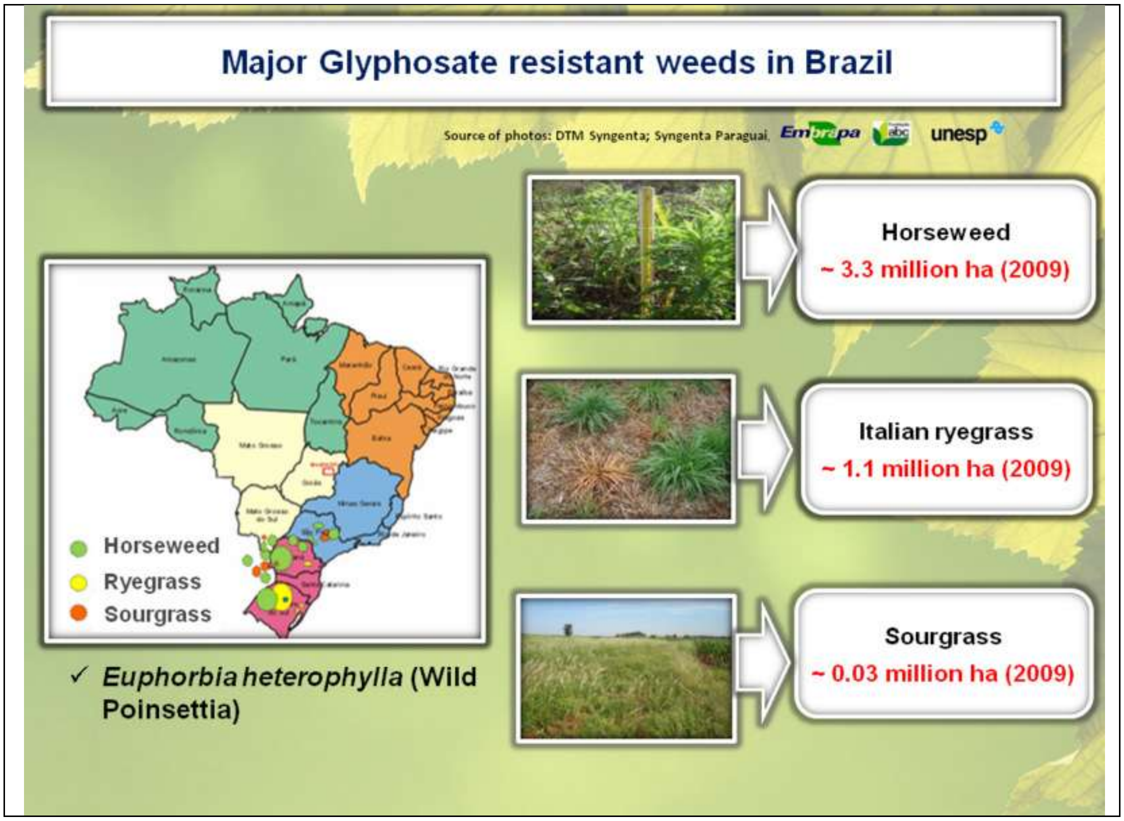
Systems		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Season	Planting	1	23	64	12								
	Harvesting					1	8	46	40	5			
'*Off season*'	Planting					10	80	8	2				
	Harvesting									10	75	15	
Rainfall (in) – Paraná		2.0	4.8	5.4	6.9	8.8	8.0	7.1	5.6	4.7	4.6	4.2	2.2
Average Temp. (C)		18.6	19.7	22.0	23.2	23.6	23.8	23.7	23.2	21.3	18.4	16.6	16.8
Rainfall (in) – Mato Grosso		1.0	2.0	3.1	6.1	8.6	10.4	7.2	6.7	4.1	1.9	1.1	0.9
Average Temp. (C)		22.9	24.8	27.0	26.7	26.5	26.4	26.3	26.5	26.8	25.0	21.8	21.6

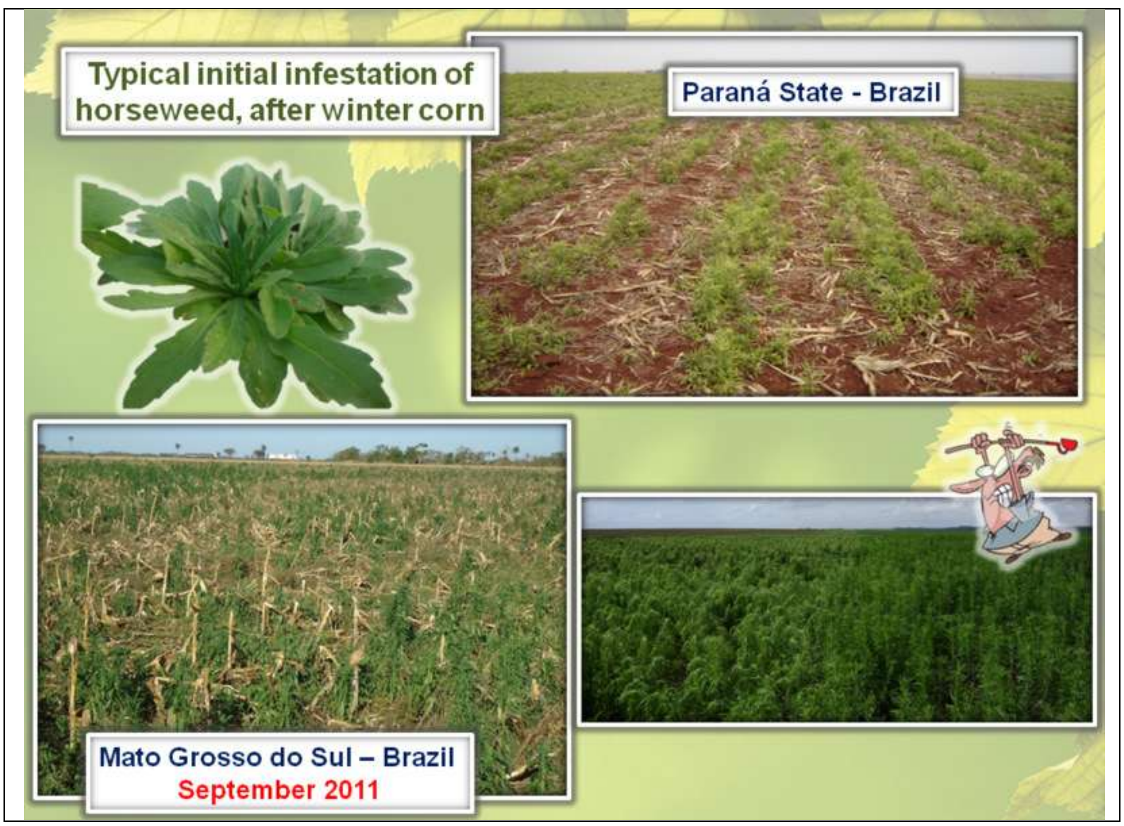

Harvesting and planting at the same time is a common practice
Multiple cropping is usual


Growers were happy
Agronomic benefits of Roundup Ready systems for Brazilian farmers
✓ Simplicity – no need for herbicide combination
✓ Flexibility – may be sprayed up to 30 days after crop emergence
✓ Efficacy – broad weed control spectrum
✓ Residual – no residual effect for crop rotation or sequence
✓ Crop Yield/Harvest – allows crop to be harvested 'clean'
✓ Workload an Machinery Planning – facilitates planning and workload at critical timing, optimization of machinery and equipments

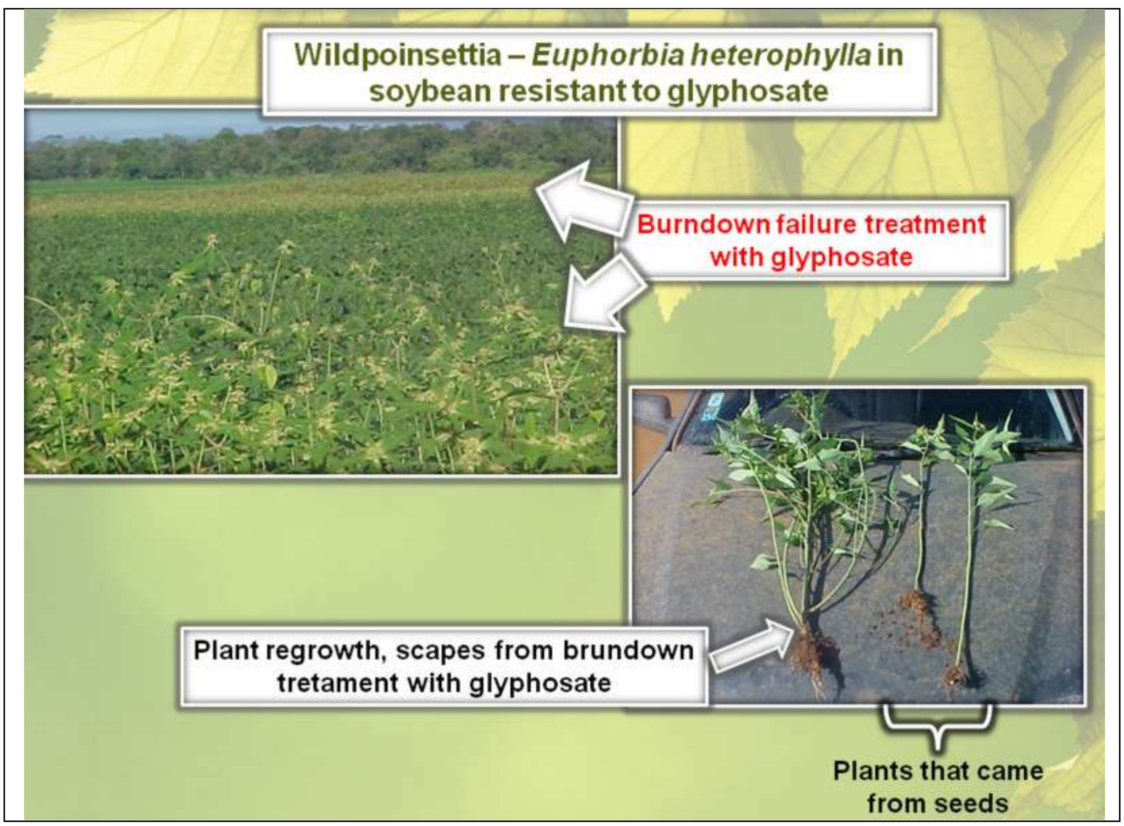

Sourgrass resistant to glyphosate
And now?
Horseweed resistant to glyphosate

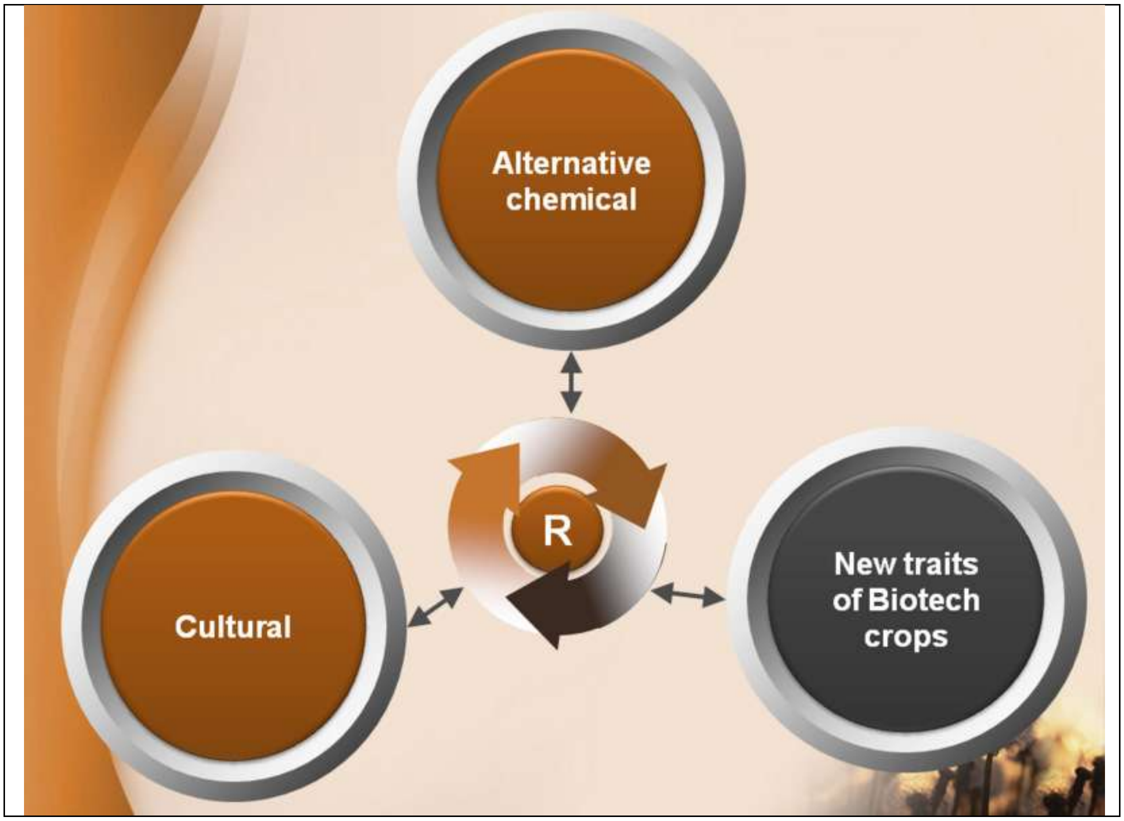

Glyphosate Resistant Weeds Globally - 2011
http://www.weedscience.com/
Copyright © 1993-2011 WeedScience.org All rights reserved.
1
13
5
5
3
3
Resistant Biotypes
0
11

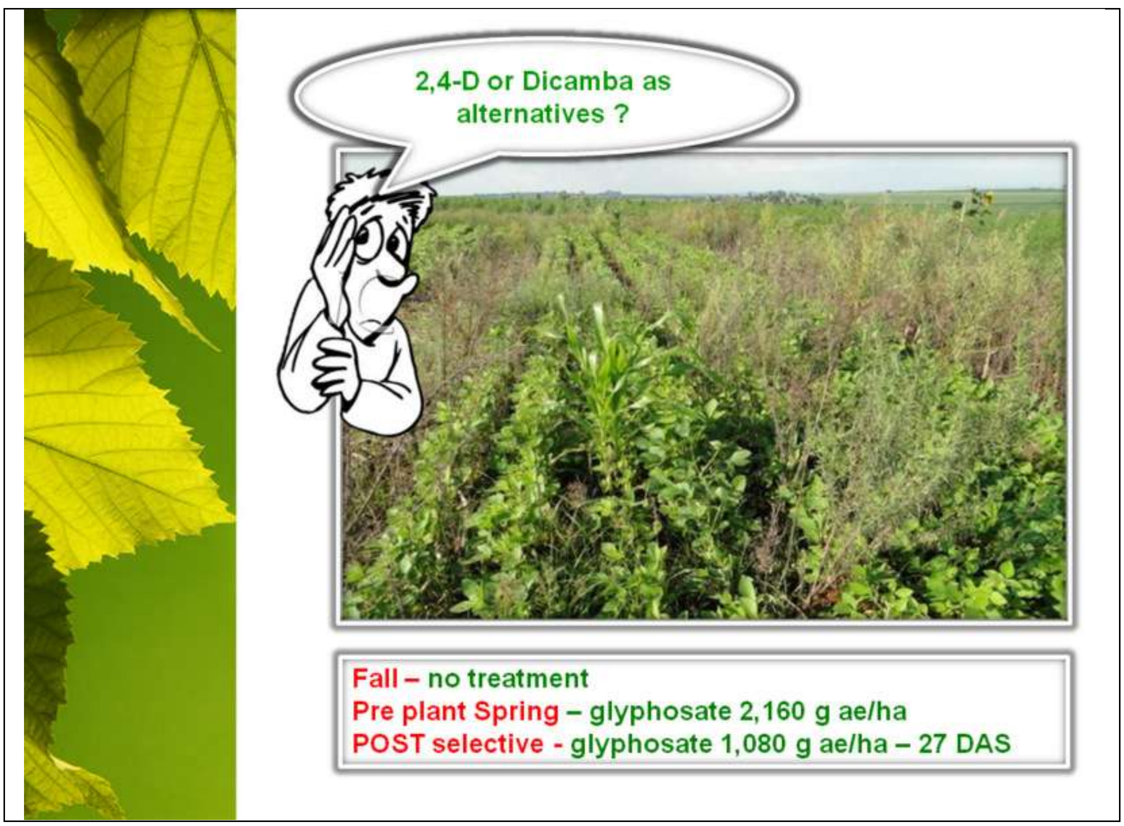

Major Glyphosate resistant weeds in Brazil
Source of photos: DTM Syngenta; Syngenta Paraguai, Embrapa, abc, unesp
Horseweed
~ 3.3 million ha (2009)
Italian ryegrass
~ 1.1 million ha (2009)
Sourgrass
~ 0.03 million ha (2009)
Horseweed
Ryegrass
Sourgrass
✓ Euphorbia heterophylla (Wild Poinsettia)

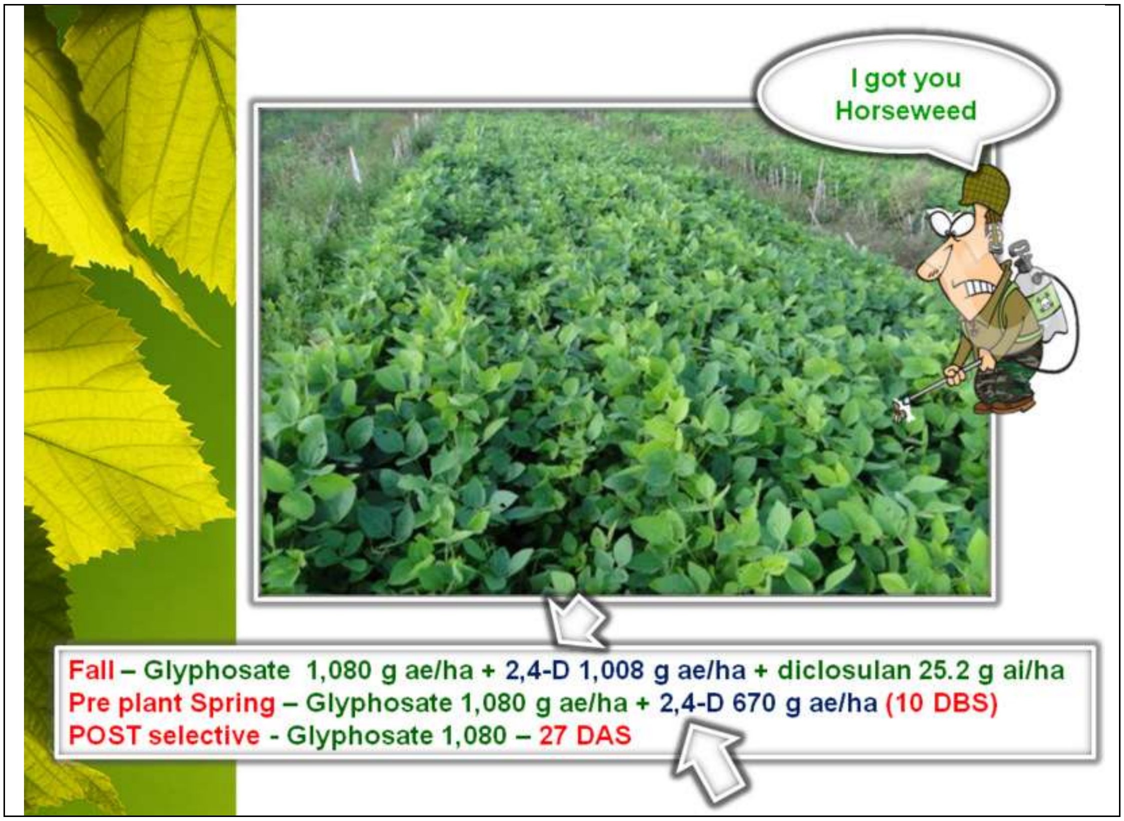

Typical initial infestation of horseweed, after winter corn
Paraná State - Brazil
Mato Grosso do Sul – Brazil
September 2011

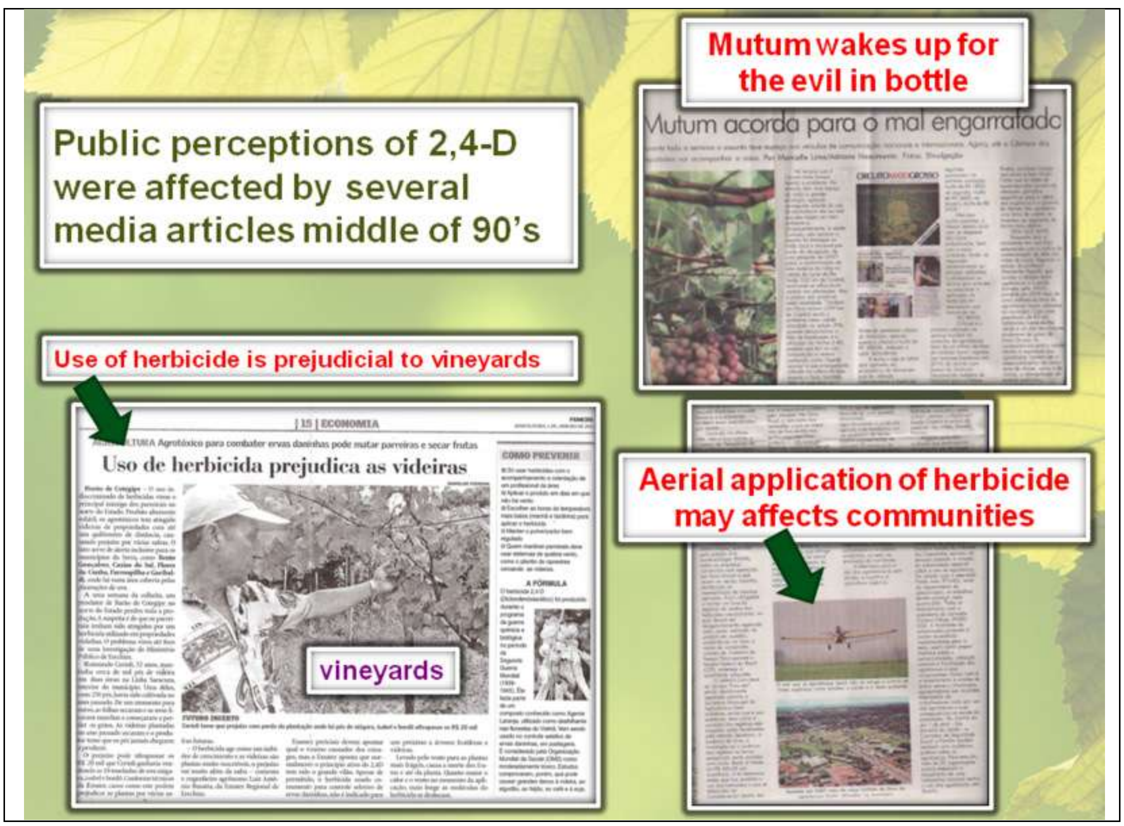

Too late for chemical control

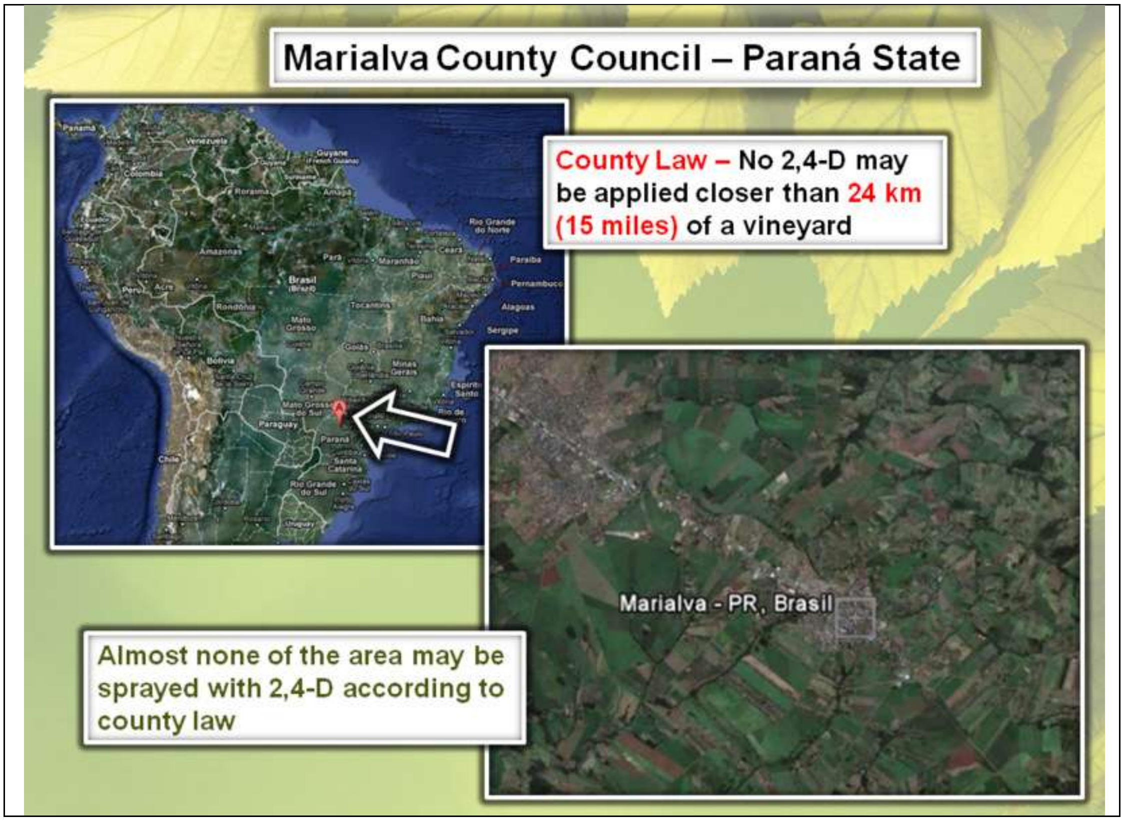

Wildpoinsettia – *Euphorbia heterophylla* in soybean resistant to glyphosate
Burndown failure treatment with glyphosate
Plant regrowth, scapes from brundown tretament with glyphosate
Plants that came from seeds

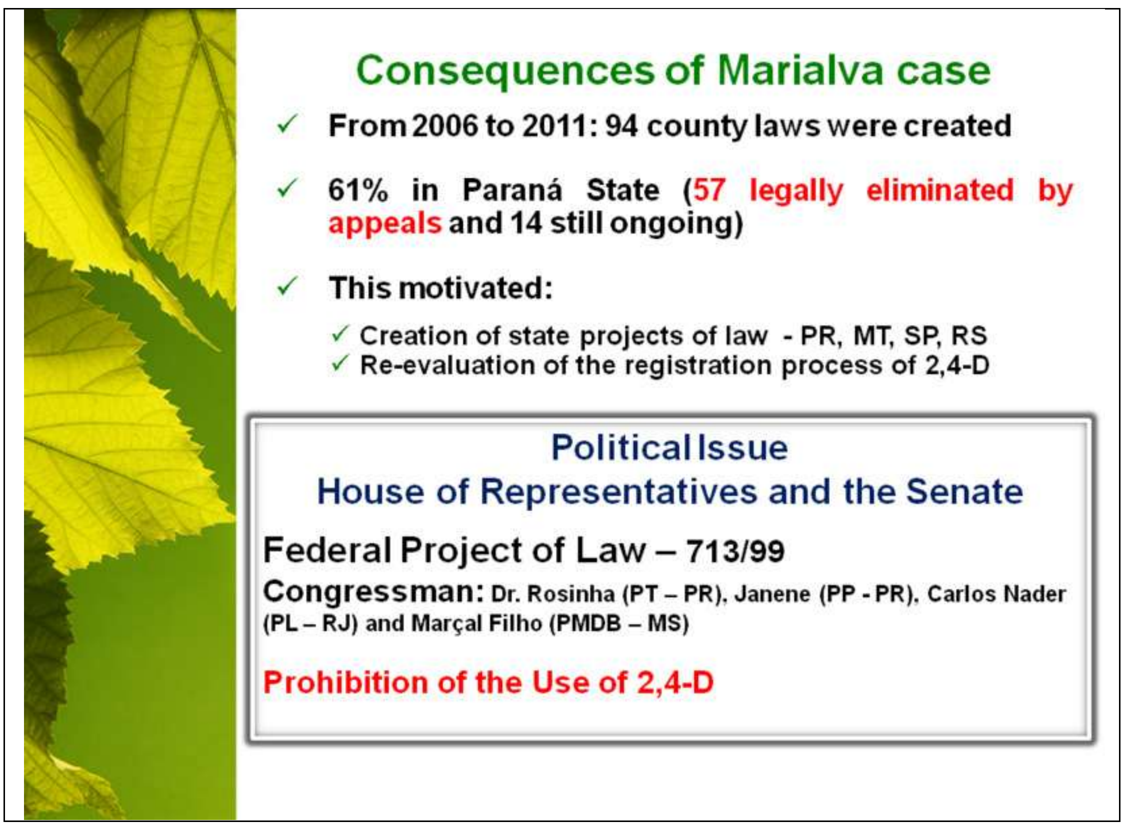

Alternative chemical
R
Cultural
New traits of Biotech crops

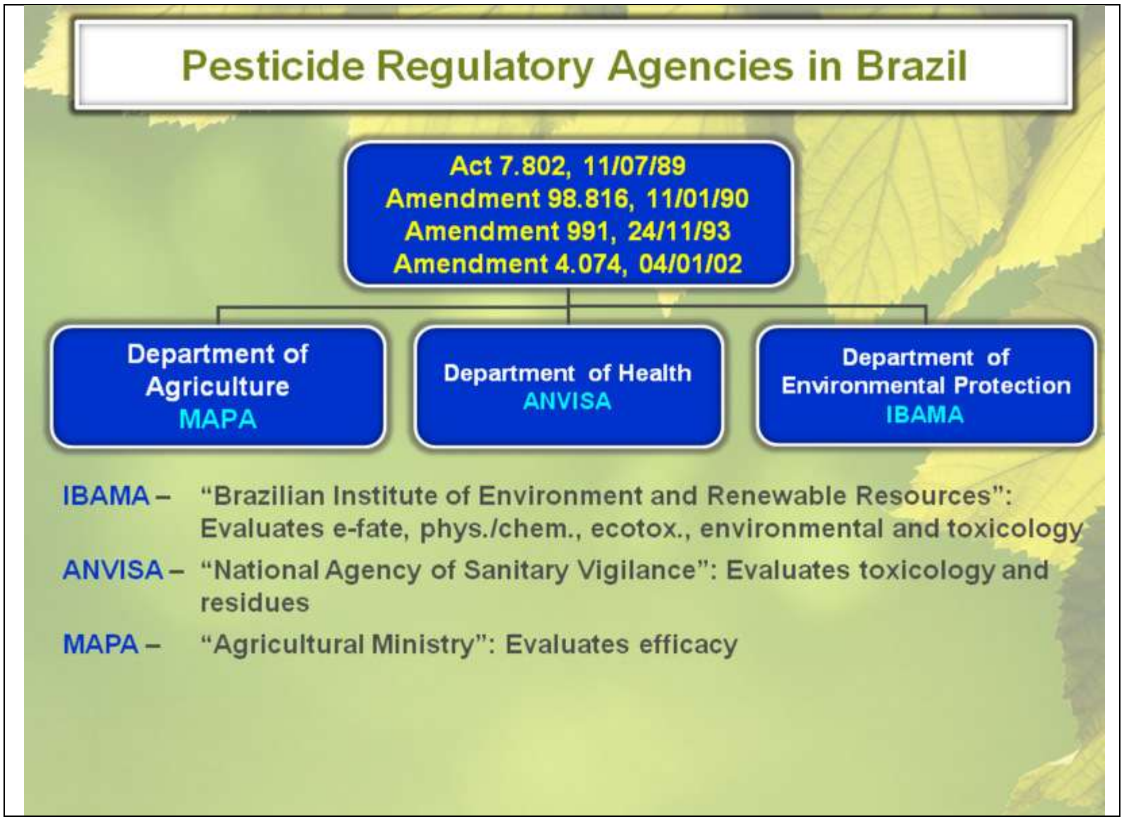

2,4-D or Dicamba as alternatives ?
Fall – no treatment
Pre plant Spring – glyphosate 2,160 g ae/ha
POST selective - glyphosate 1,080 g ae/ha – 27 DAS

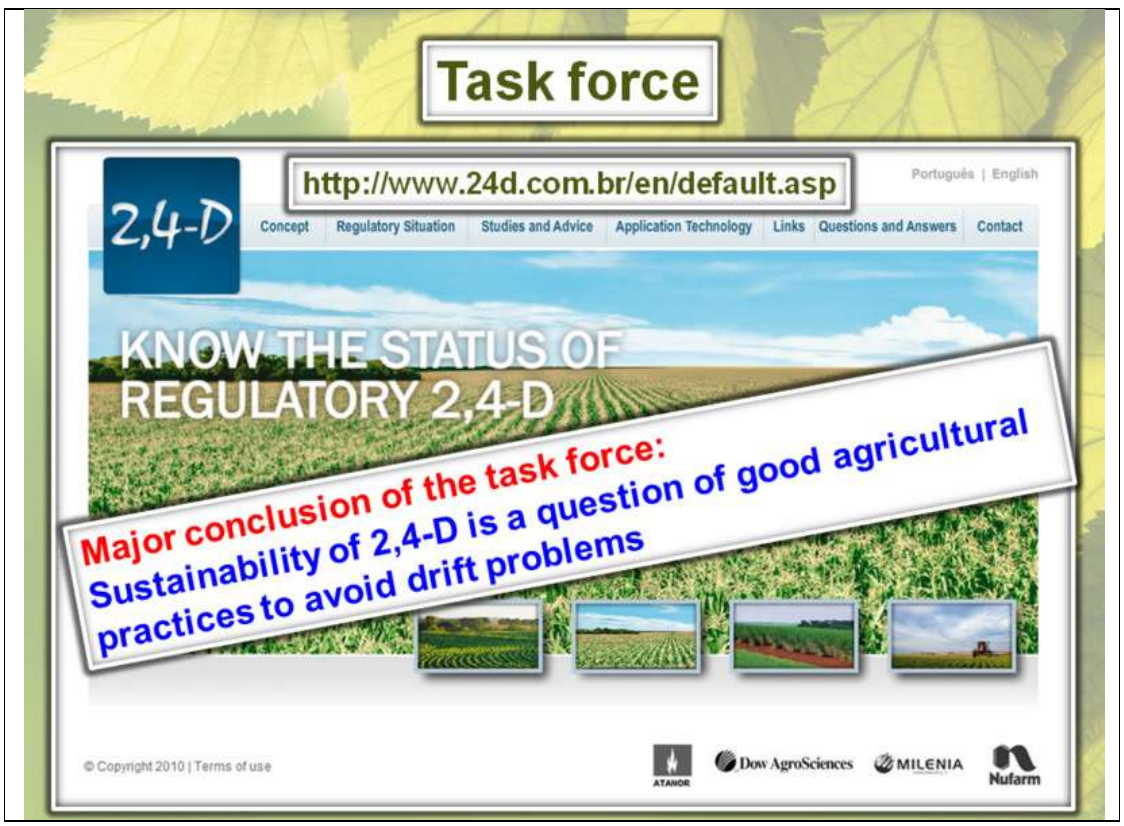

I got you Horseweed
Fall – Glyphosate 1,080 g ae/ha + 2,4-D 1,008 g ae/ha + diclosulan 25.2 g ai/ha
Pre plant Spring – Glyphosate 1,080 g ae/ha + 2,4-D 670 g ae/ha (10 DBS)
POST selective - Glyphosate 1,080 – 27 DAS


Public perceptions of 2,4-D were affected by several media articles middle of 90's
Mutum wakes up for the evil in bottle
Mutum acorda para o mal engarrafado
Use of herbicide is prejudicial to vineyards
Uso de herbicida prejudica as videiras
vineyards
Aerial application of herbicide may affects communities


Marialva County Council – Paraná State
County Law – No 2,4-D may be applied closer than 24 km (15 miles) of a vineyard
Marialva - PR, Brasil
Almost none of the area may be sprayed with 2,4-D according to county law


Consequences of Marialva case
✓ From 2006 to 2011: 94 county laws were created
✓ 61% in Paraná State (57 legally eliminated by appeals and 14 still ongoing)
✓ This motivated:
✓ Creation of state projects of law - PR, MT, SP, RS
✓ Re-evaluation of the registration process of 2,4-D
Political Issue
House of Representatives and the Senate
Federal Project of Law – 713/99
Congressman: Dr. Rosinha (PT – PR), Janene (PP - PR), Carlos Nader (PL – RJ) and Marçal Filho (PMDB – MS)
Prohibition of the Use of 2,4-D


Pesticide Regulatory Agencies in Brazil
Act 7.802, 11/07/89
Amendment 98.816, 11/01/90
Amendment 991, 24/11/93
Amendment 4.074, 04/01/02
Department of Agriculture MAPA
Department of Health ANVISA
Department of Environmental Protection IBAMA
IBAMA – "Brazilian Institute of Environment and Renewable Resources": Evaluates e-fate, phys./chem., ecotox., environmental and toxicology
ANVISA – "National Agency of Sanitary Vigilance": Evaluates toxicology and residues
MAPA – "Agricultural Ministry": Evaluates efficacy


Task force
http://www.24d.com.br/en/default.asp
Português | English
2,4-D
Concept
Regulatory Situation
Studies and Advice
Application Technology
Links
Questions and Answers
Contact
KNOW THE STATUS OF REGULATORY 2,4-D
Major conclusion of the task force:
Sustainability of 2,4-D is a question of good agricultural practices to avoid drift problems
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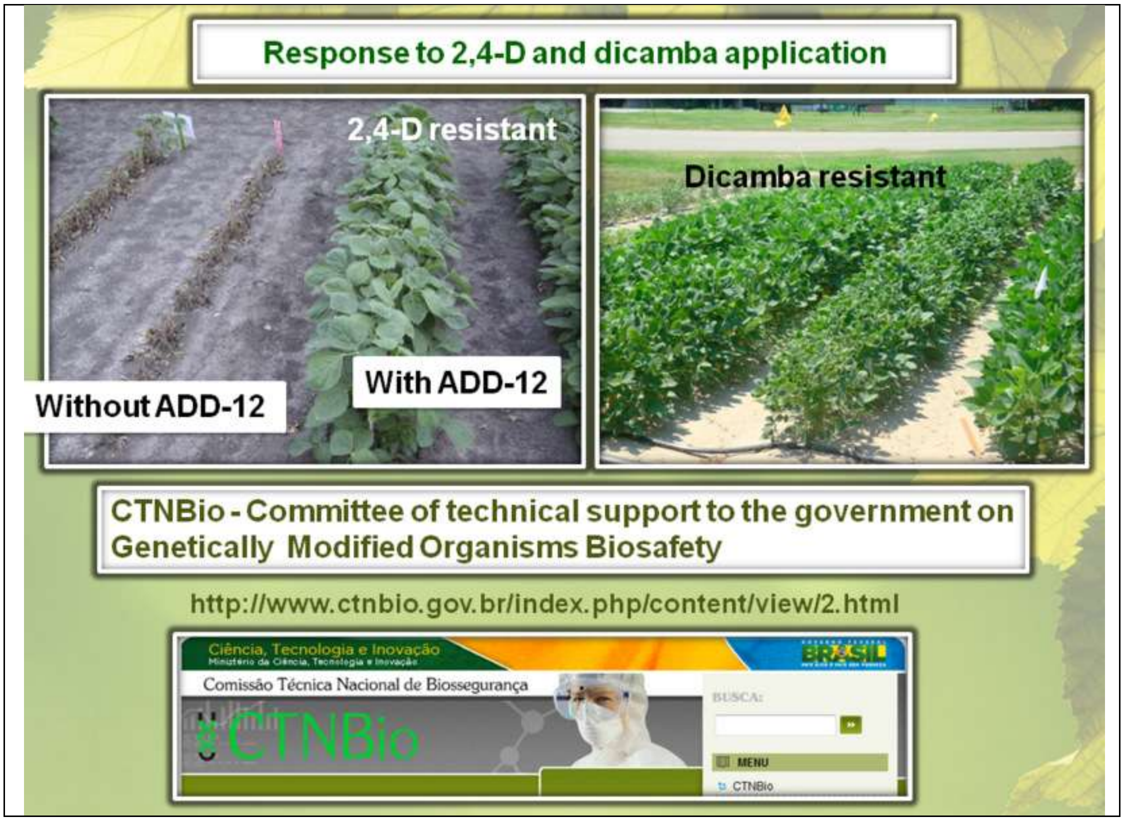
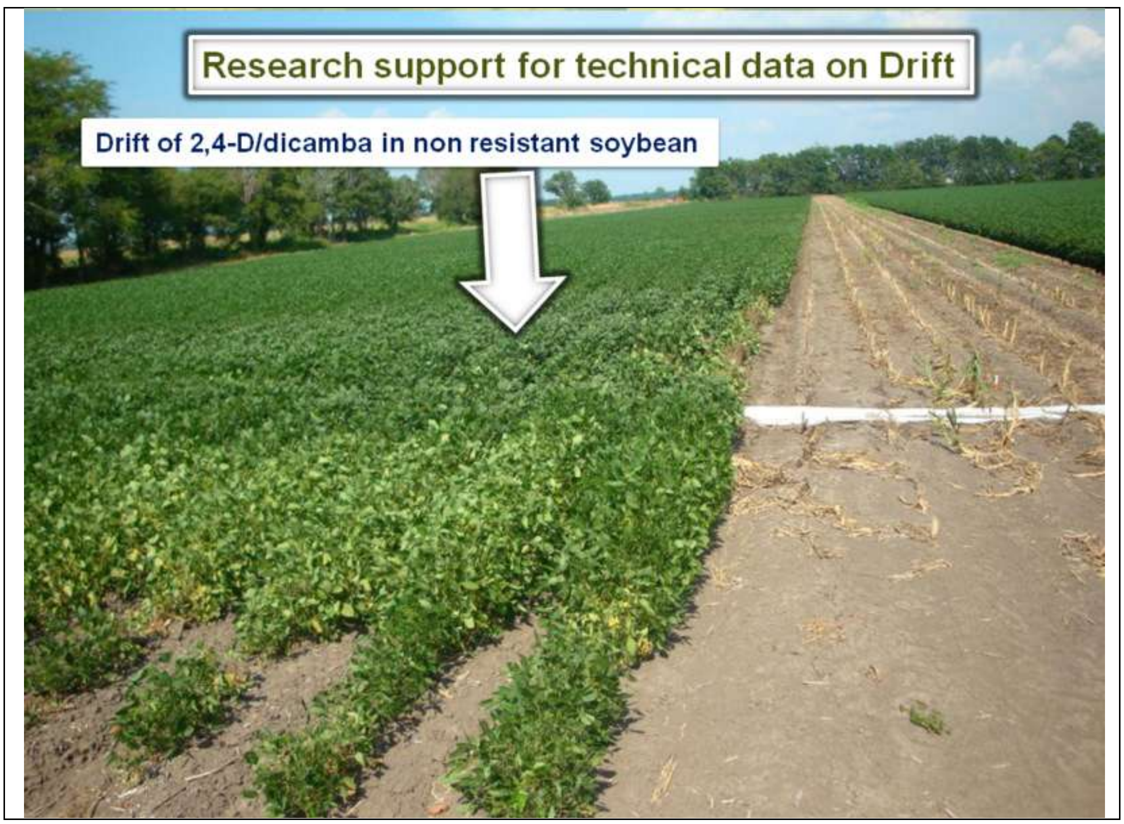
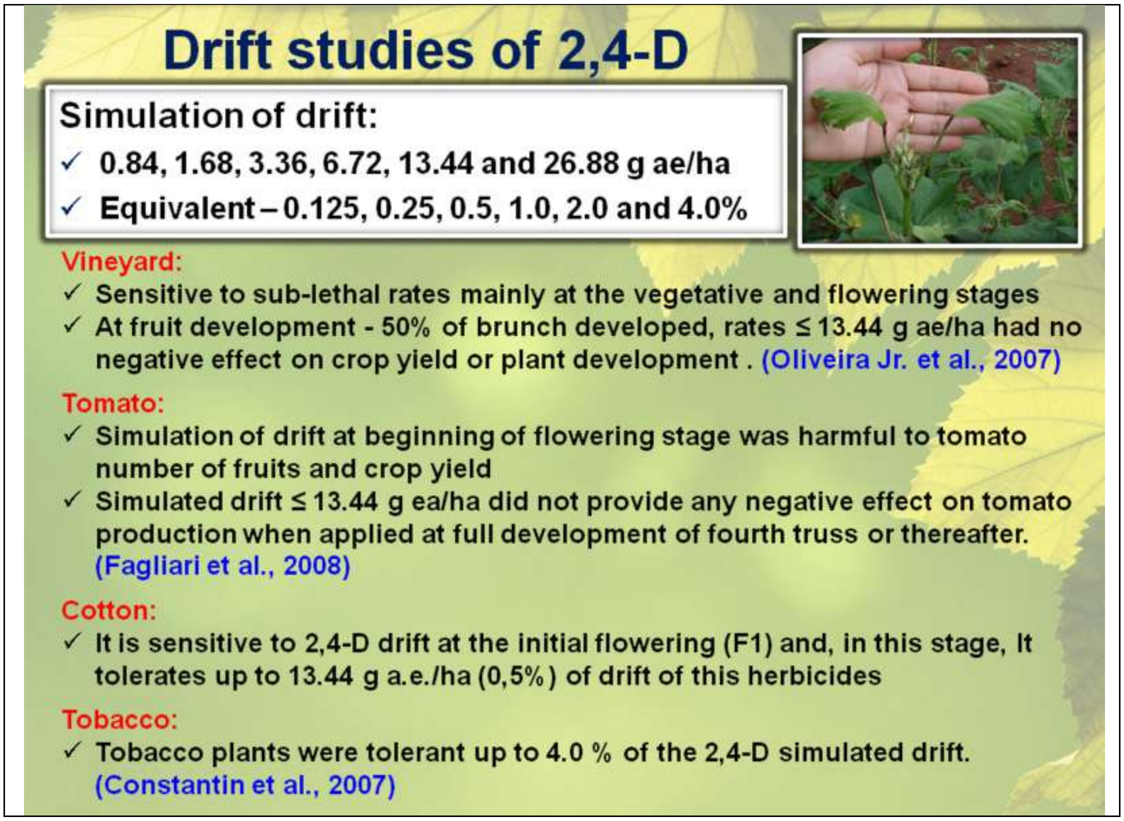
ATANOR
Dow AgroSciences
MILENIA
Nufarm


Response to 2,4-D and dicamba application
2,4-D resistant
Without ADD-12
With ADD-12
Dicamba resistant
CTNBio - Committee of technical support to the government on Genetically Modified Organisms Biosafety
http://www.ctnbio.gov.br/index.php/content/view/2.html
Ciência, Tecnologia e Inovação
Comissão Técnica Nacional de Biossegurança
CTNBio
BUSCA:
MENU
CTNBio

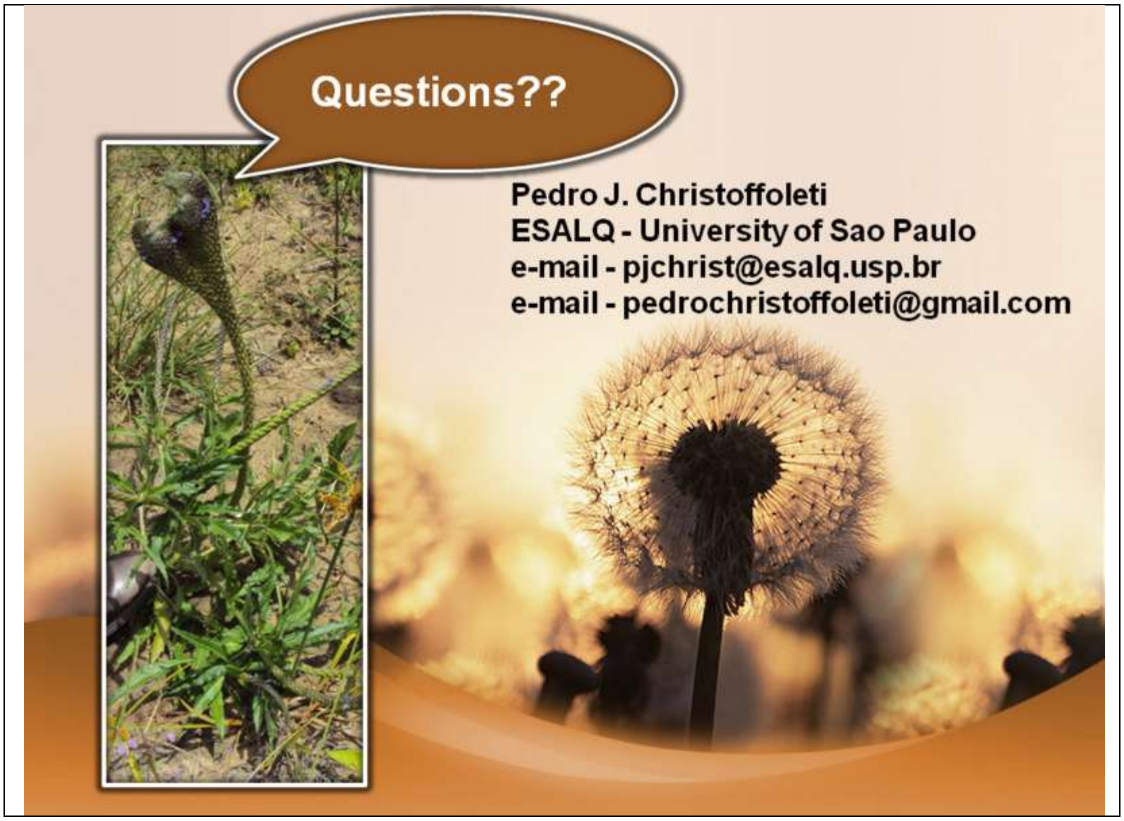

Research support for technical data on Drift
Drift of 2,4-D/dicamba in non resistant soybean


Drift studies of 2,4-D
Simulation of drift:
✓ 0.84, 1.68, 3.36, 6.72, 13.44 and 26.88 g ae/ha
✓ Equivalent – 0.125, 0.25, 0.5, 1.0, 2.0 and 4.0%
Vineyard:
✓ Sensitive to sub-lethal rates mainly at the vegetative and flowering stages
✓ At fruit development - 50% of brunch developed, rates ≤ 13.44 g ae/ha had no negative effect on crop yield or plant development . (Oliveira Jr. et al., 2007)
Tomato:
✓ Simulation of drift at beginning of flowering stage was harmful to tomato number of fruits and crop yield
✓ Simulated drift ≤ 13.44 g ea/ha did not provide any negative effect on tomato production when applied at full development of fourth truss or thereafter. (Fagliari et al., 2008)
Cotton:
✓ It is sensitive to 2,4-D drift at the initial flowering (F1) and, in this stage, It tolerates up to 13.44 g a.e./ha (0,5%) of drift of this herbicides
Tobacco:
✓ Tobacco plants were tolerant up to 4.0 % of the 2,4-D simulated drift. (Constantin et al., 2007)


Educational and extension actions
Field tours
Drift simulator
Training courses on Application Technology
'Reach the target'
Acerte o Alvo!
Elimine a Deriva nas Pulverizações de Agrotóxicos
Sprayer inspection & calibration


Final thoughts
✓ The agronomic use of 2,4-D and dicamba is certainly an essential option for weed control
✓ Technical aspects should overcome political issues
✓ Responsible use of 2,4-D and dicamba is essential for the sustainability in the system
✓ Promote compatibility with other crops and cropping systems
✓ Provide users comprehensive guidance on responsible use.


Acknowledgments
✓ Gerri Isaacson - OSU
✓ Doug Doohan - OSU
✓ Luiz L. Foloni - Unicamp
✓ Monsanto Brazil
✓ Dow Agrosciences Brazil


Questions??
Pedro J. Christoffoleti
ESALQ - University of Sao Paulo
e-mail - pjchrist@esalq.usp.br
e-mail - pedrochristoffoleti@gmail.com

Managing risks with sprayer technology – Mark Hanna

Extension Ag Engineer, Iowa State University hmhanna@iastate.edu

Potential for application drift is related to droplet size, ambient weather conditions, sprayer set up and proximity to sensitive crop areas. Application of appropriate spray technology involves consideration of tradeoffs between drift and efficacy. A knowledgeable applicator with appropriate technology and good understanding of risks involved should be an objective for application.

Mark Hanna

DriftWatch – Roy Ballard

Purdue Extension, Purdue University, rballard@purdue.edu

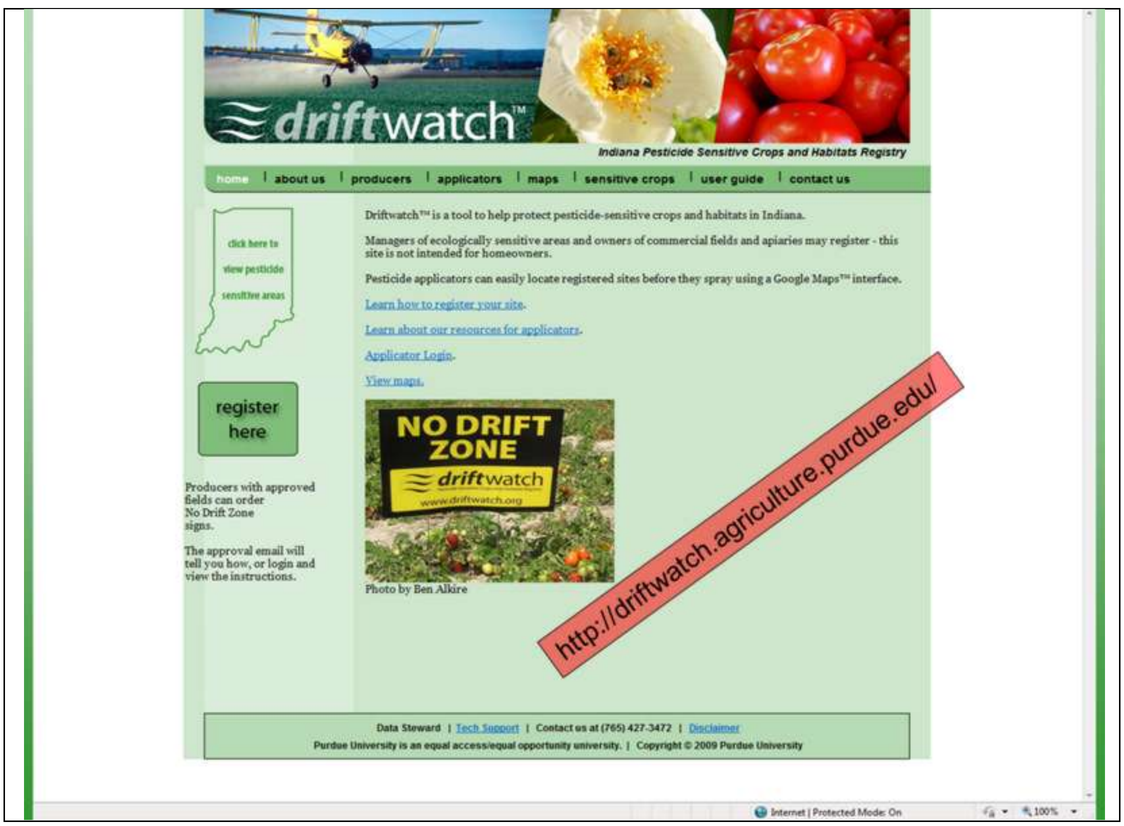
Beekeepers and producers of specialty crops such as certified organic produce, tomatoes, grapes and tree fruits are concerned about impacts caused by pesticide drift from neighboring farm fields. Protecting native and managed pollinators and their habitats has become a national priority resource concern (H.R. 2913, 2007). Concurrently, market demands for organic produce and specialty crops have increased and acres under production have expanded seventy-five percent during the last five years (Indianapolis Star, 2009). Within the traditional row crop production system, increases in the volume of 2,4-D, fungicide and insecticide use seem imminent with the introduction of new phenoxy resistant soybean varieties, the emergence of Asian soybean rust and rising corn acres to meet biofuel production needs.

In response to the emerging need, a collaboration of producers of pesticide sensitive crops, stewards of at-risk habitat and the pesticide applicator community developed an Indiana Pesticide Sensitive Crops and Habitats Registry website www.driftwatch.org *(formerly BeAware)*. The goal of the newly established registry is to allow public, private and commercial pesticide applicators to access the Google Maps TM based website and search for pesticide sensitive crops and habitats in their area to facilitate better informed pesticide use.


DriftWatch Overview
www.driftwatch.org
driftwatch
Pesticide Sensitive Crops and Habitats Registry
Roy Ballard
Purdue Extension-Hancock County Indiana
rballard@purdue.edu
317-462-1113
Leighanne Hahn
hahnl@purdue.edu
Office of Indiana State Chemist
www.driftwatch.org


driftwatch
Goal:
Enable communications that promote pesticide sensitive site awareness and stewardship activities between stewards of at-risk resources, producers of pesticide sensitive crops and pesticide applicator communities


Search this site
www.driftwatch.org
Minnesota Driftwatch Site
Wisconsin Driftwatch Site
Michigan Driftwatch Site
Illinois Driftwatch Site
Indiana Driftwatch Site
Sitemap
www.driftwatch.org
driftwatch™
Registry of Pesticide-sensitive Areas
driftwatch(TM) is a tool to help protect pesticide-sensitive crops and habitats
from the drift that sometimes occurs during spray operations.
Select your state: [Indiana] [Ohio] [Minnesota] [Michigan] [Illinois] [Wisconsin] or use the map:
http://www.driftwatch.org/Home
Canada
Minnesota
Michigan
Wisconsin
Michigan
Illinois
Indiana


driftwatch™
Indiana Pesticide Sensitive Crops and Habitats Registry
home | about us | producers | applicators | maps | sensitive crops | user guide | contact us
click here to
view pesticide
sensitive areas
register here
Producers with approved fields can order No Drift Zone signs.
The approval email will tell you how, or login and view the instructions.
Driftwatch™ is a tool to help protect pesticide-sensitive crops and habitats in Indiana.
Managers of ecologically sensitive areas and owners of commercial fields and apiaries may register - this site is not intended for homeowners.
Pesticide applicators can easily locate registered sites before they spray using a Google Maps™ interface.
Learn how to register your site.
Learn about our resources for applicators.
Applicator Login.
View maps.
NO DRIFT ZONE
driftwatch
www.driftwatch.org
Photo by Ben Alkire
http://driftwatch.agriculture.purdue.edu/
Data Steward | Tech Support | Contact us at (765) 427-3472 | Disclaimer
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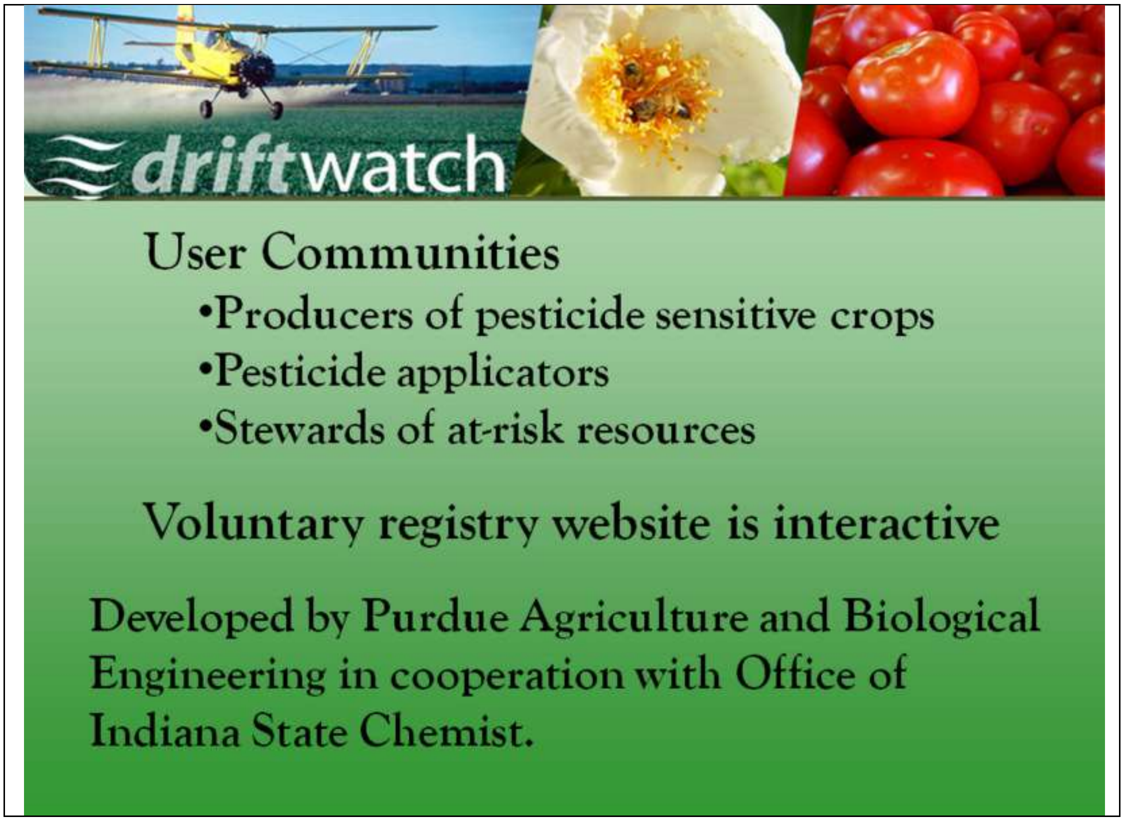
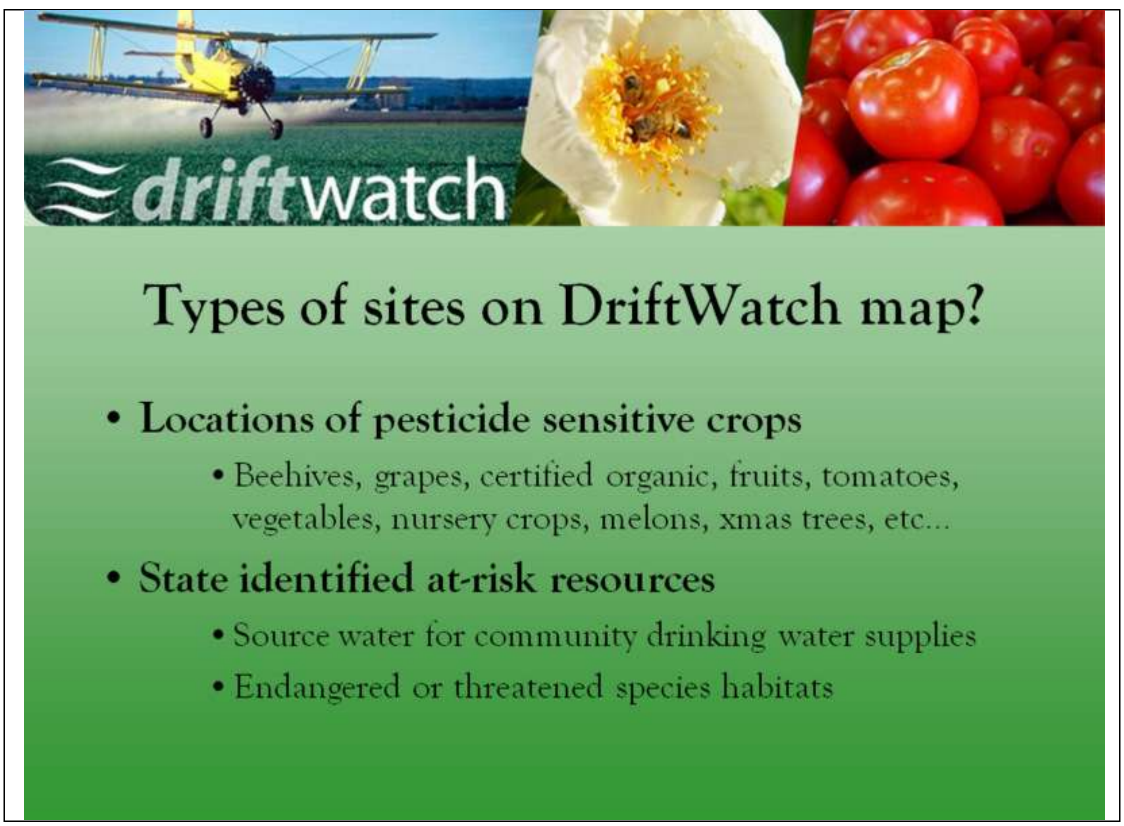
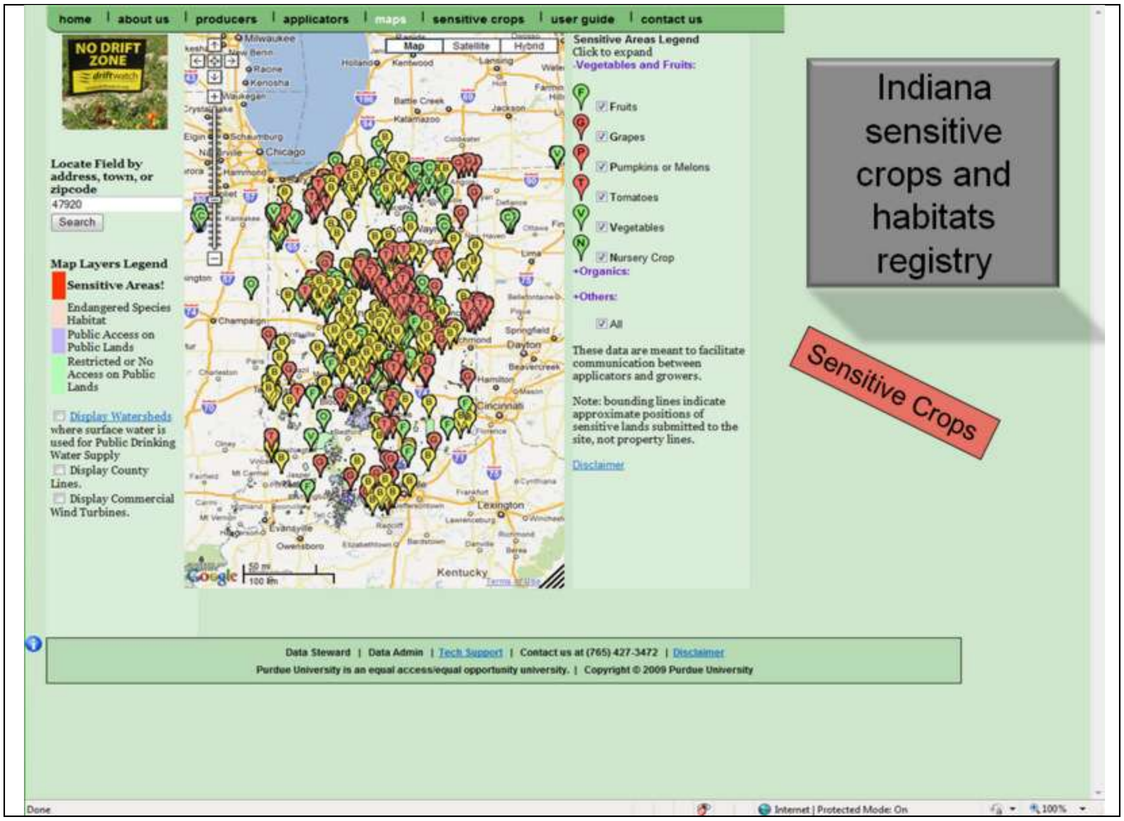

driftwatch
User Communities
•Producers of pesticide sensitive crops
•Pesticide applicators
•Stewards of at-risk resources
Voluntary registry website is interactive
Developed by Purdue Agriculture and Biological Engineering in cooperation with Office of Indiana State Chemist.


driftwatch
Types of sites on DriftWatch map?
• Locations of pesticide sensitive crops
• Beehives, grapes, certified organic, fruits, tomatoes, vegetables, nursery crops, melons, xmas trees, etc...
• State identified at-risk resources
• Source water for community drinking water supplies
• Endangered or threatened species habitats


home | about us | producers | applicators | maps | sensitive crops | user guide | contact us
NO DRIFT ZONE
Locate Field by address, town, or zipcode
47920
Search
Map Layers Legend
Sensitive Areas!
Endangered Species Habitat
Public Access on Public Lands
Restricted or No Access on Public Lands
Display Watersheds where surface water is used for Public Drinking Water Supply
Display County Lines.
Display Commercial Wind Turbines.
Map
Satellite
Hybrid
Sensitive Areas Legend
Click to expand
-Vegetables and Fruits:
Fruits
Grapes
Pumpkins or Melons
Tomatoes
Vegetables
Nursery Crop
+Organics:
+Others:
All
These data are meant to facilitate communication between applicators and growers.
Note: bounding lines indicate approximate positions of sensitive lands submitted to the site, not property lines.
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Indiana sensitive crops and habitats registry
Sensitive Crops
Data Steward | Data Admin | Tech Support | Contact us at (765) 427-3472 | Disclaimer
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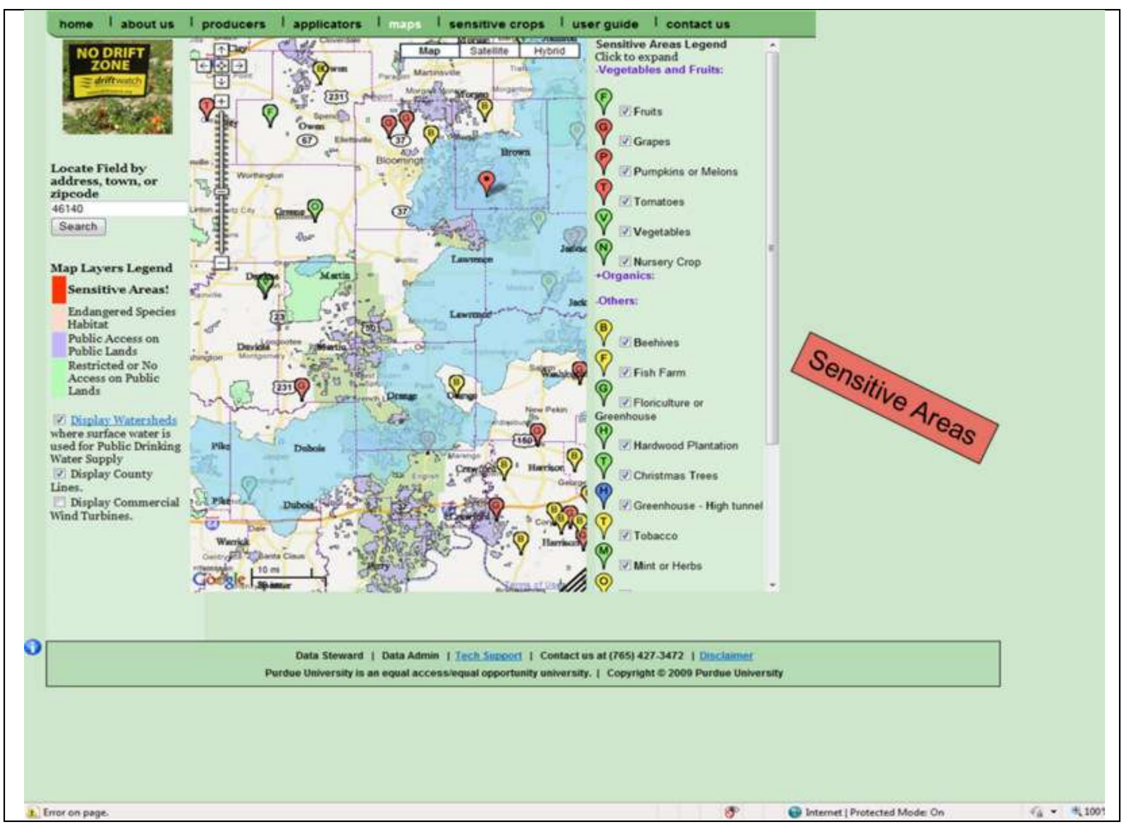
Done
Internet | Protected Mode: On
100%


home | about us | producers | applicators | maps | sensitive crops | user guide | contact us
NO DRIFT ZONE
Locate Field by address, town, or zipcode
46140
Search
Map Layers Legend
Sensitive Areas!
Endangered Species Habitat
Public Access on Public Lands
Restricted or No Access on Public Lands
Display Watersheds where surface water is used for Public Drinking Water Supply
Display County Lines.
Display Commercial Wind Turbines.
Map
Satellite
Hybrid
Sensitive Areas Legend
Click to expand
-Vegetables and Fruits:
Fruits
Grapes
Pumpkins or Melons
Tomatoes
Vegetables
Nursery Crop
+Organics:
-Others:
Beehives
Fish Farm
Floriculture or Greenhouse
Hardwood Plantation
Christmas Trees
Greenhouse - High tunnel
Tobacco
Mint or Herbs
Sensitive Areas
Data Steward | Data Admin | Tech Support | Contact us at (765) 427-3472 | Disclaimer
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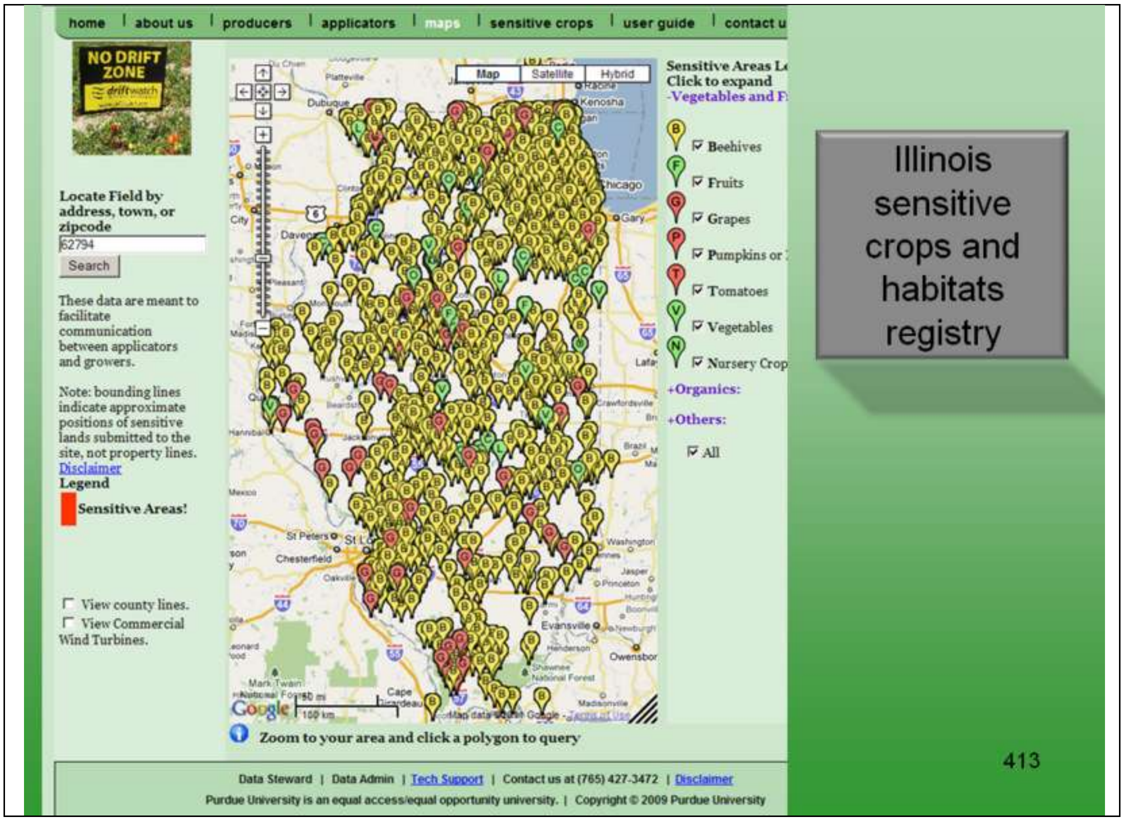
home | about us | producers | applicators | maps | sensitive crops | user guide | contact u
NO DRIFT ZONE
Locate Field by address, town, or zipcode
62794
Search
These data are meant to facilitate communication between applicators and growers.
Note: bounding lines indicate approximate positions of sensitive lands submitted to the site, not property lines.
Disclaimer
Legend
Sensitive Areas!
View county lines.
View Commercial Wind Turbines.
Map Satellite Hybrid
Sensitive Areas L
Click to expand
-Vegetables and F
Beehives
Fruits
Grapes
Pumpkins or
Tomatoes
Vegetables
Nursery Crop
+Organics:
+Others:
All
Zoom to your area and click a polygon to query
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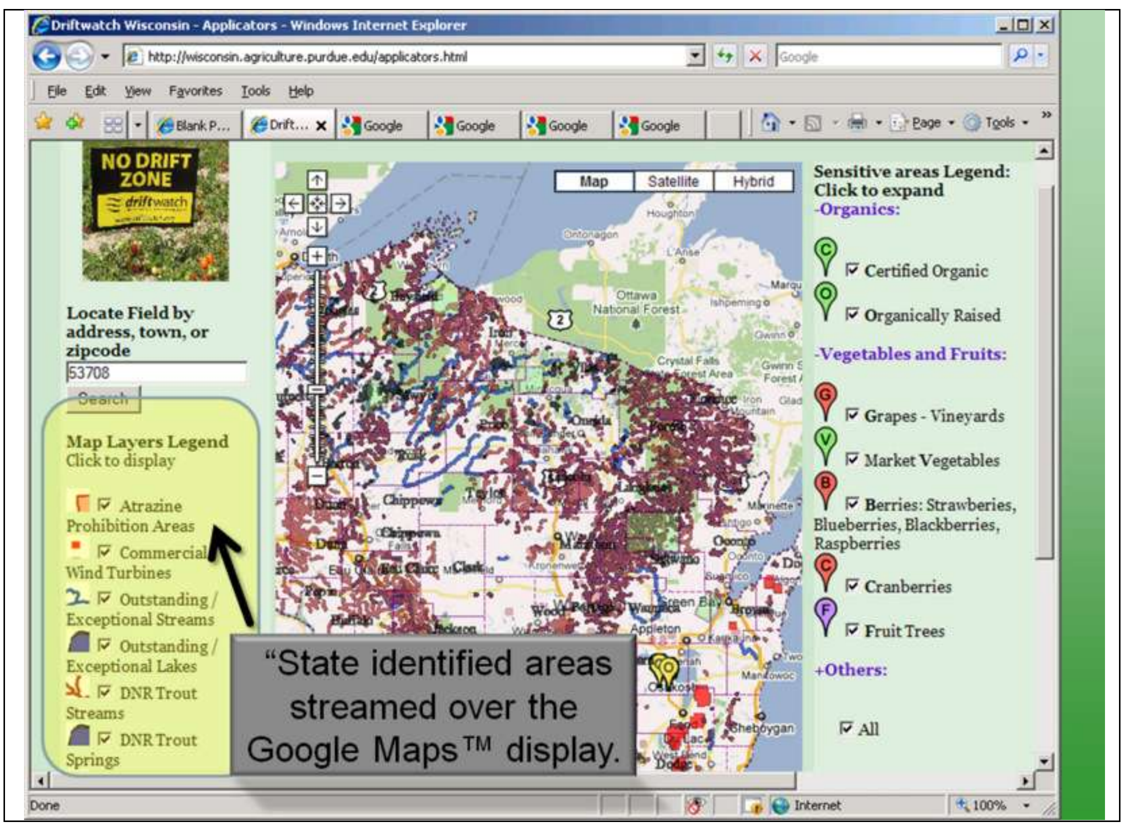
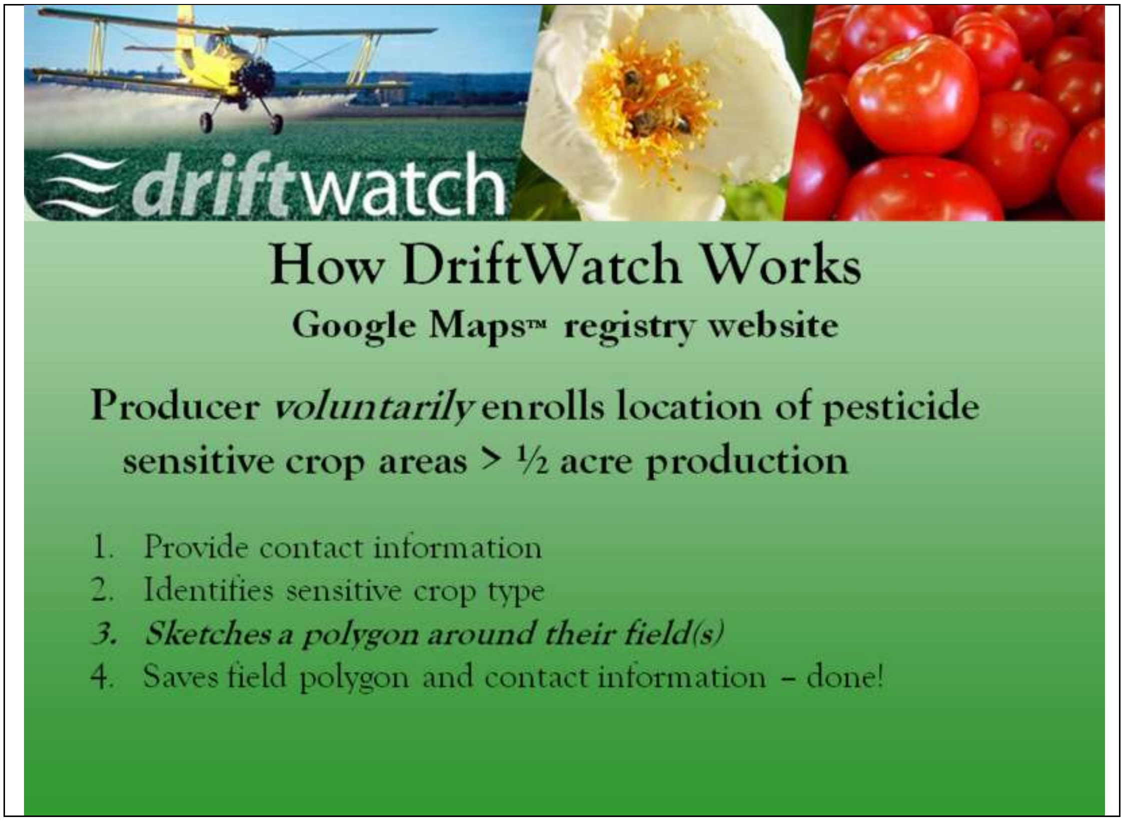
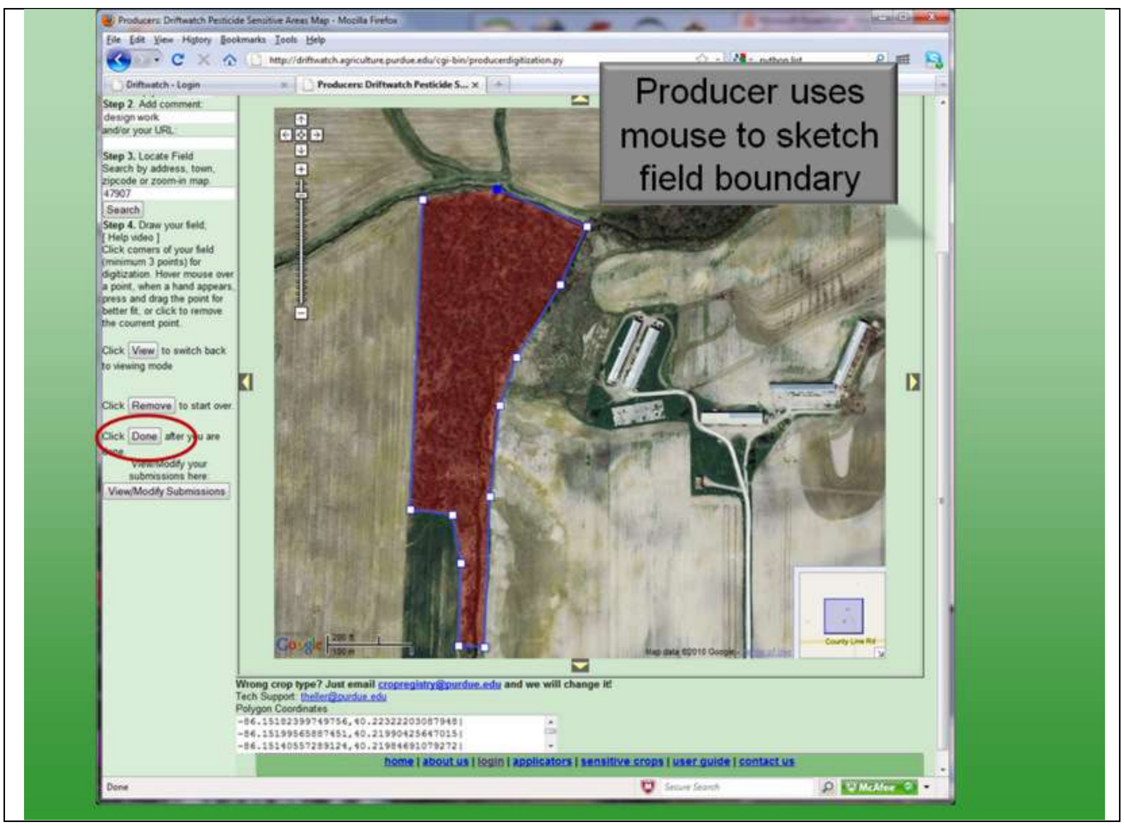
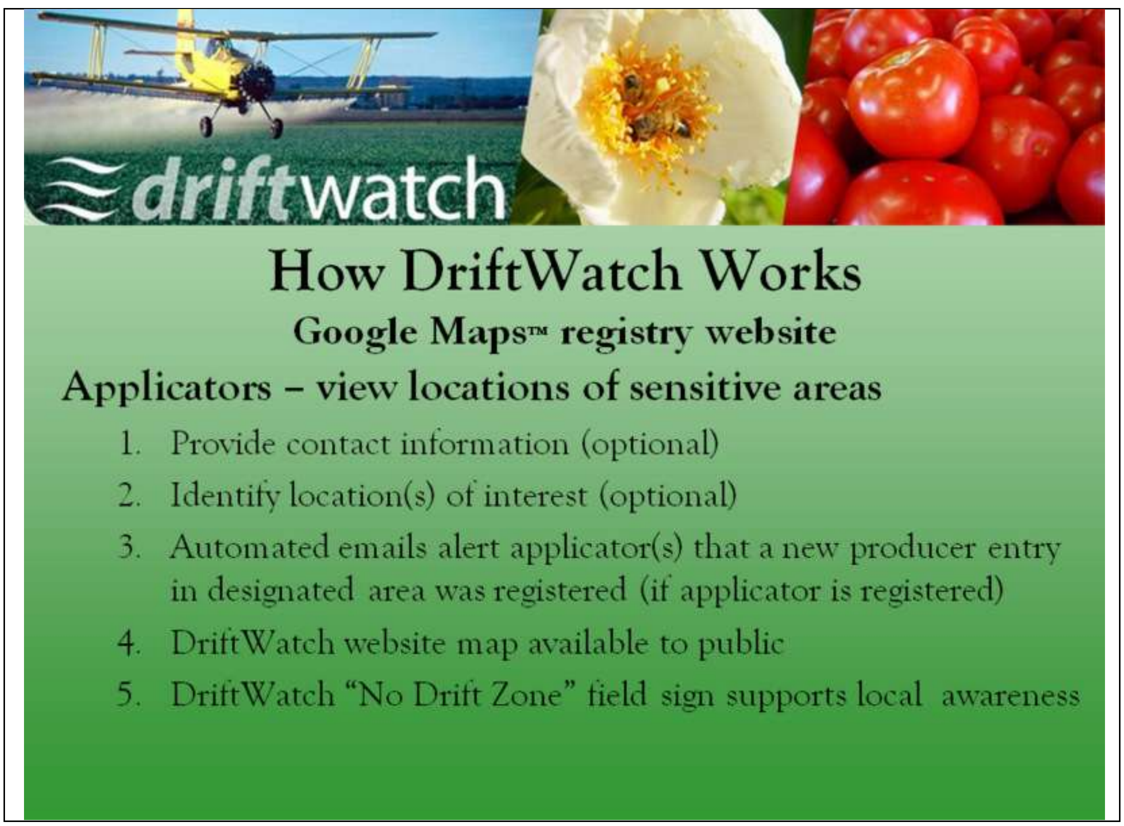
Illinois sensitive crops and habitats registry
413

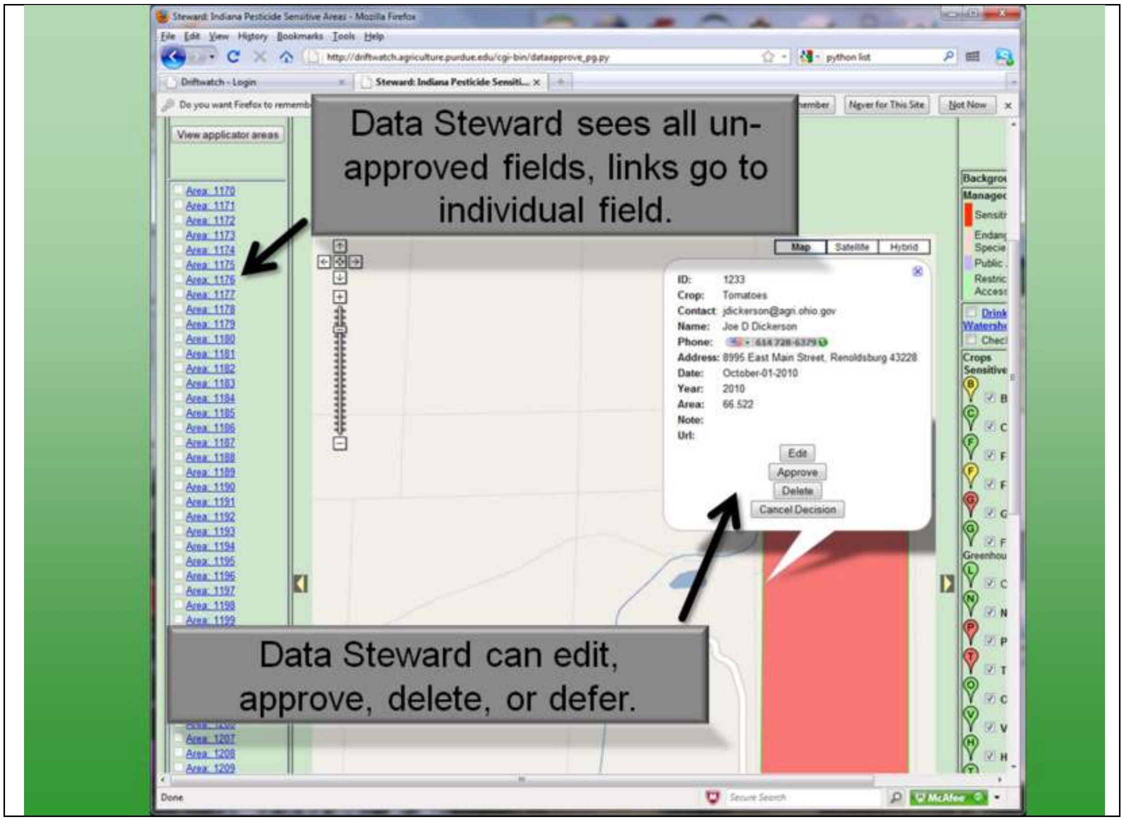

Driftwatch Wisconsin - Applicators - Windows Internet Explorer
http://wisconsin.agriculture.purdue.edu/applicators.html
File Edit View Favorites Tools Help
NO DRIFT ZONE
Locate Field by address, town, or zipcode
53708
Search
Map Layers Legend
Click to display
Atrazine Prohibition Areas
Commercial Wind Turbines
Outstanding / Exceptional Streams
Outstanding / Exceptional Lakes
DNR Trout Streams
DNR Trout Springs
Map Satellite Hybrid
Sensitive areas Legend:
Click to expand
-Organics:
Certified Organic
Organically Raised
-Vegetables and Fruits:
Grapes - Vineyards
Market Vegetables
Berries: Strawberries, Blueberries, Blackberries, Raspberries
Cranberries
Fruit Trees
+Others:
All
"State identified areas streamed over the Google Maps™ display.
Done
Internet
100%

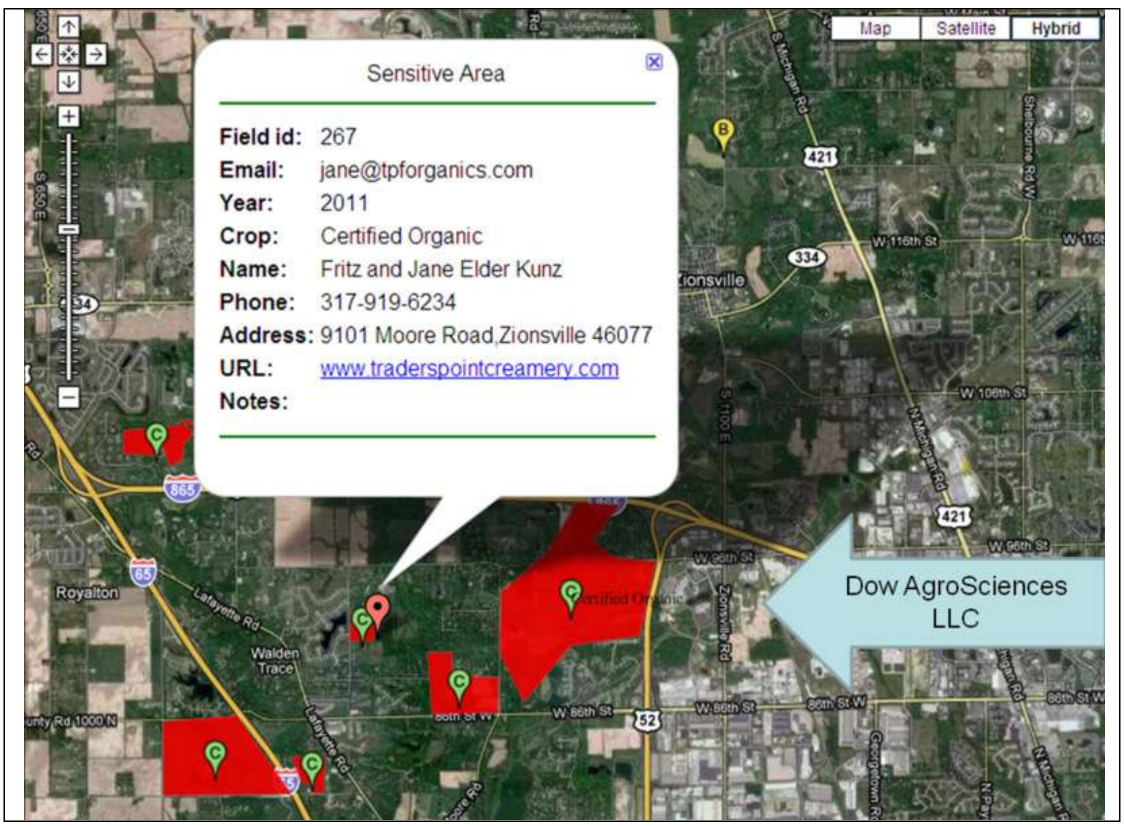

driftwatch
How DriftWatch Works
Google Maps™ registry website
Producer *voluntarily* enrolls location of pesticide sensitive crop areas > ½ acre production
1. Provide contact information
2. Identifies sensitive crop type
3. *Sketches a polygon around their field(s)*
4. Saves field polygon and contact information – done!

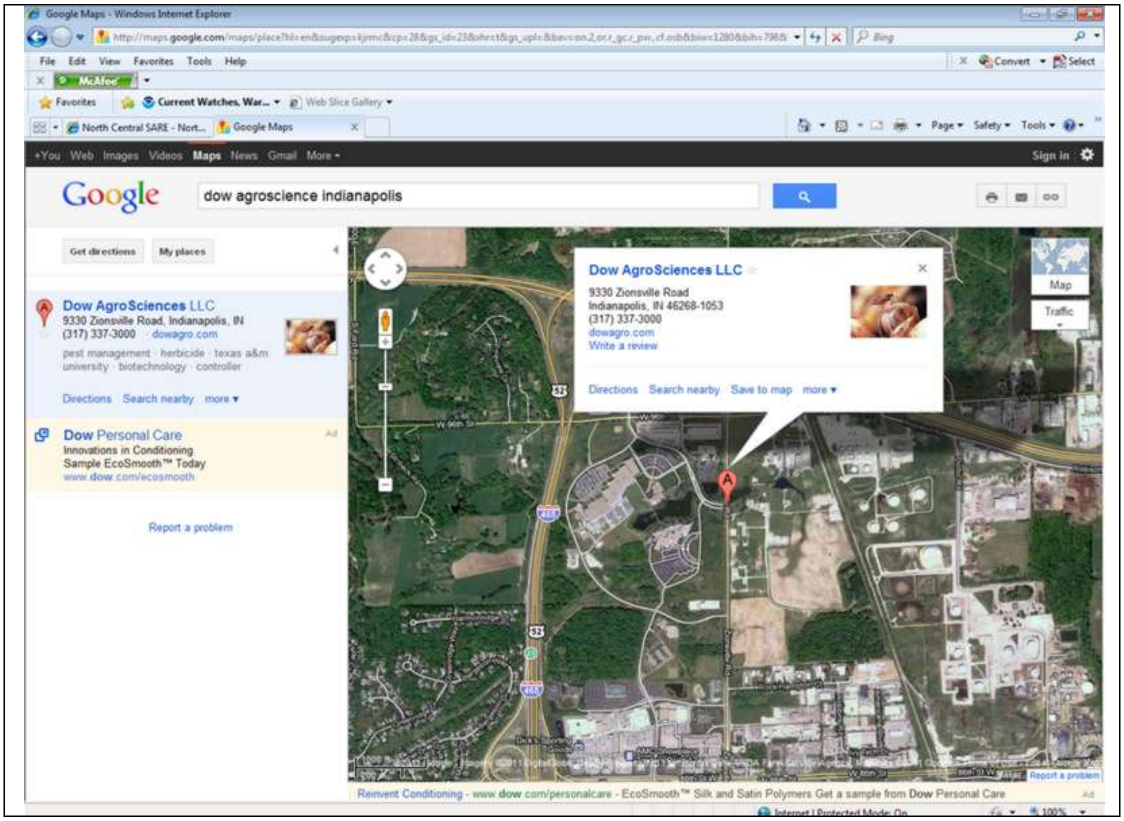

Producer uses mouse to sketch field boundary
Step 2. Add comment:
Step 3. Locate Field
Search
Step 4. Draw your field.
Click View to switch back to viewing mode
Click Remove to start over.
Click Done after you are done
View/Modify Submissions
Wrong crop type? Just email cropregistry@purdue.edu and we will change it!
Tech Support: theller@purdue.edu
Polygon Coordinates
home | about us | login | applicators | sensitive crops | user guide | contact us

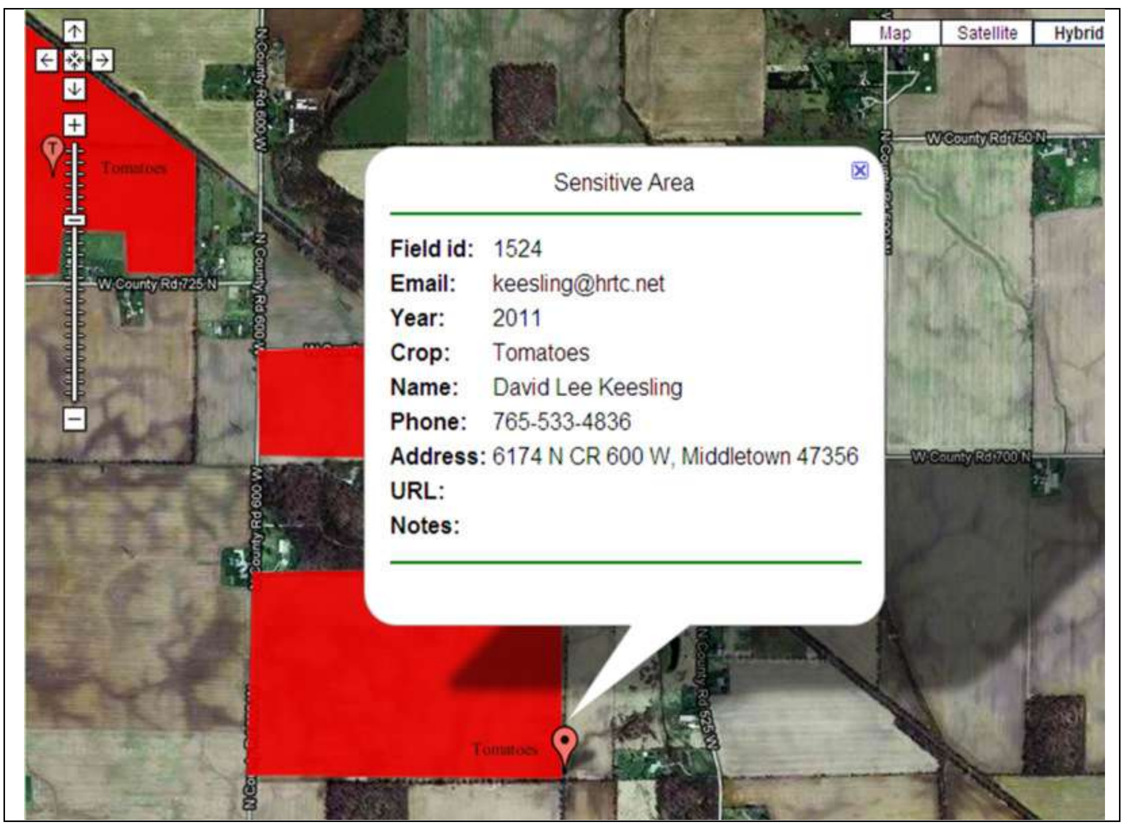

driftwatch
How DriftWatch Works
Data steward - provides quality control of registry content
1. Receives information provided by producer
2. Performs quality control review
3. Accepts/rejects producer information into DriftWatch registry
4. Acceptance adds field to public website www.driftwatch.org
5. Producer receives email confirmation
6. Registered pesticide applicators receive email notice of new sensitive crop within designated area of interest (digest)


driftwatch
How DriftWatch Works
Google Maps™ registry website
Applicators – view locations of sensitive areas
1. Provide contact information (optional)
2. Identify location(s) of interest (optional)
3. Automated emails alert applicator(s) that a new producer entry in designated area was registered (if applicator is registered)
4. DriftWatch website map available to public
5. DriftWatch "No Drift Zone" field sign supports local awareness


Data Steward sees all un-approved fields, links go to individual field.
Data Steward can edit, approve, delete, or defer.
ID: 1233
Crop: Tomatoes
Name: Joe D Dickerson
Date: October-01-2010
Year: 2010
Area: 66.522
Edit
Approve
Delete
Cancel Decision
Map
Satellite
Hybrid


Map
Satellite
Hybrid
Sensitive Area
Field id: 267
Email: jane@tpforganics.com
Year: 2011
Crop: Certified Organic
Name: Fritz and Jane Elder Kunz
Phone: 317-919-6234
Address: 9101 Moore Road,Zionsville 46077
URL: www.traderspointcreamery.com
Notes:
Dow AgroSciences LLC
Royalton
Zionsville


Google Maps - Windows Internet Explorer
dow agroscience indianapolis
Get directions
My places
Dow AgroSciences LLC
9330 Zionsville Road, Indianapolis, IN
(317) 337-3000 · dowagro.com
pest management · herbicide · texas a&m university · biotechnology · controller
Directions Search nearby more
Dow Personal Care
Innovations in Conditioning
Sample EcoSmooth™ Today
www.dow.com/ecosmooth
Report a problem
Dow AgroSciences LLC
9330 Zionsville Road
Indianapolis, IN 46268-1053
(317) 337-3000
dowagro.com
Write a review
Directions Search nearby Save to map more
Map
Traffic

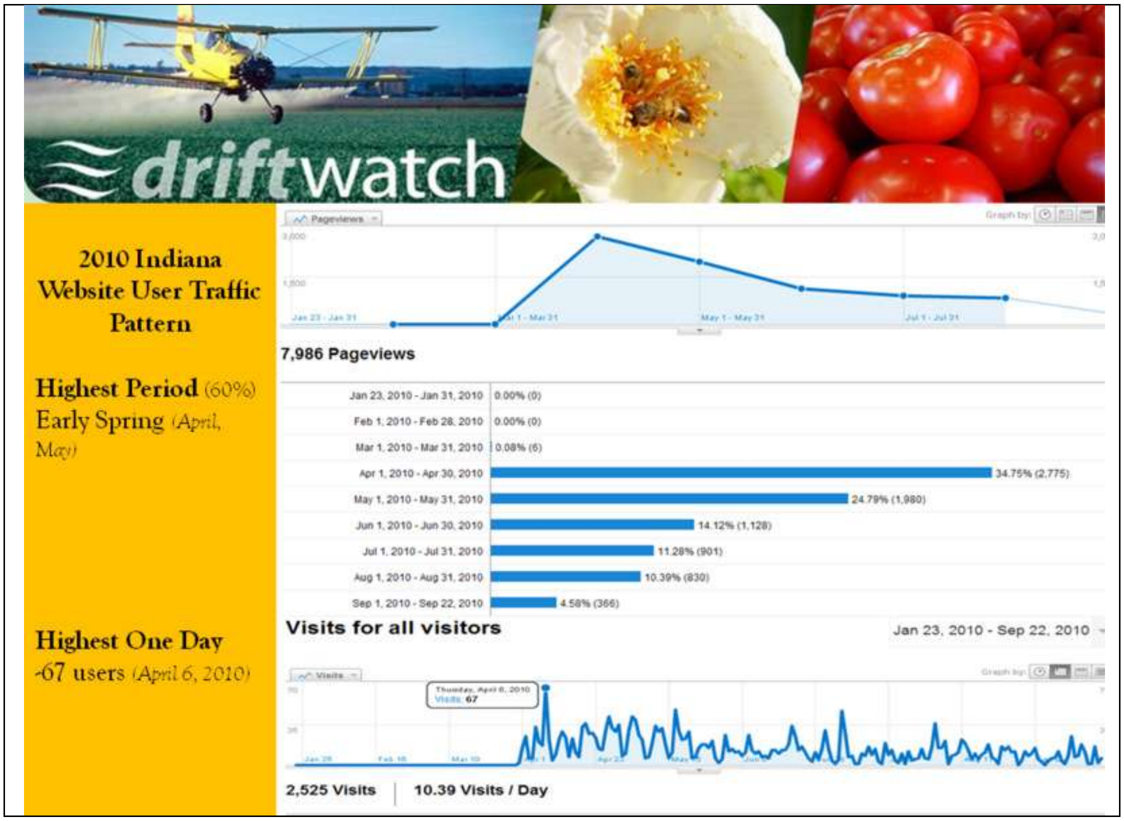

Map
Satellite
Hybrid
Tomatoes
W County Rd 725 N
W County Rd 750 N
W County Rd 700 N
N County Rd 600 W
N County Rd 525 W
Sensitive Area
Field id: 1524
Email: keesling@hrtc.net
Year: 2011
Crop: Tomatoes
Name: David Lee Keesling
Phone: 765-533-4836
Address: 6174 N CR 600 W, Middletown 47356
URL:
Notes:
Tomatoes

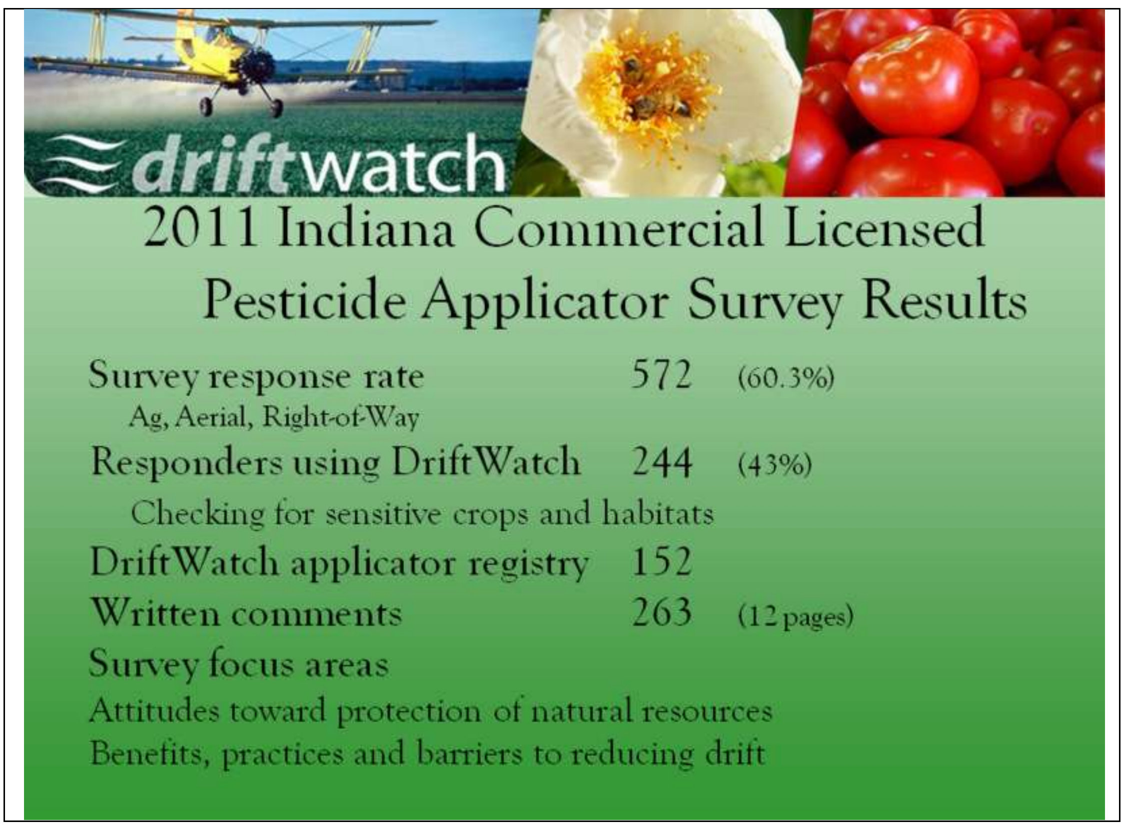

NO DRIFT ZONE
driftwatch
Pesticide Sensitive Crops and Habitats Registry
www.driftwatch.org
Sensitive Crop Registry participants may also purchase field signs to identify their crop areas

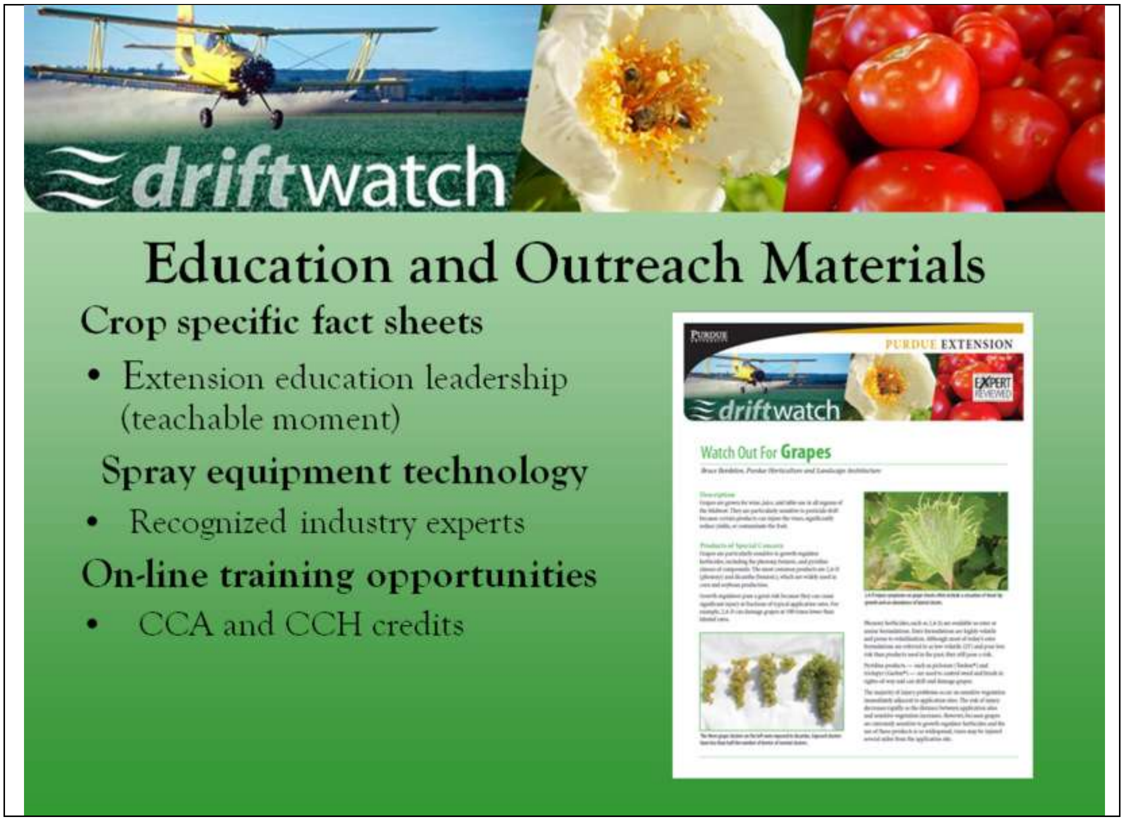

driftwatch
Is DriftWatch Effective?
"Since participating in DriftWatch, our commercial tomato producers have experienced a precipitous drop in claims due to drift.
2008 - >$750,000 claims due to drift
2009 - Drift incidents reduced 50%, damage reduced 90%
2010 - Negligible damage due to drift"
- Steve Smith, Director of Agriculture Red Gold
"There are no communication methods as efficient or easy to use as the DriftWatch mapsite available to commercial applicators.
Step 1 - pesticide application order is placed
Step 2 - immediately enter address in DriftWatch map search tool
Step 3 - determine sensitive areas within 3 seconds located in the vicinity of our intended field application area."
-David Eby, Owner Agriflite Services


driftwatch
Recent Enhancements:
✓ Automated email notifications to applicators/producers
✓ Field signage for registered producers
✓ Improved digitizing tools
✓ Data sharing capabilities
• Aerial Applicators (realtime prototype launched)
✓ County registration workshop for non-computer producers
✓ Illinois, Minnesota, Michigan and Wisconsin DriftWatch launch
✓ Pesticide applicator survey and results
✓ Improved crop registry annual renewal process
✓ Educational materials and stewardship bulletins
✓ Google™ analytics - measure website activity
✓ Next states Colorado, Montana, North Dakota and Nebraska

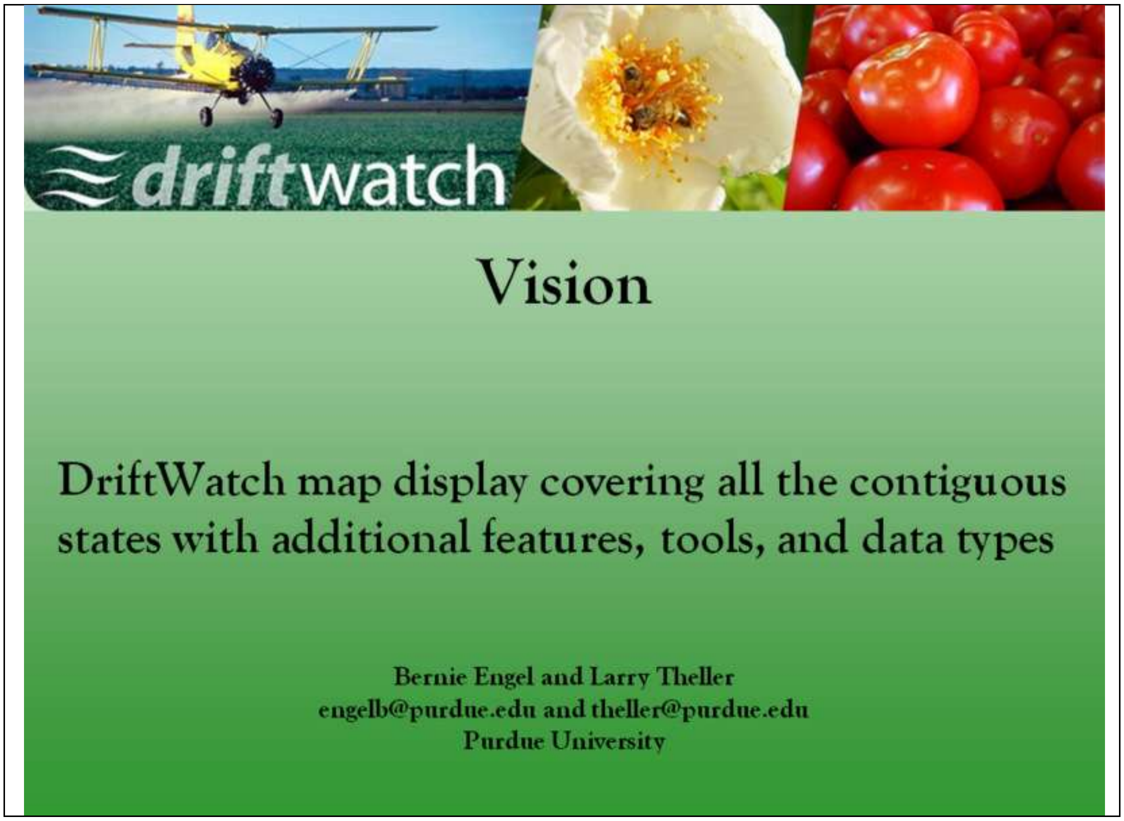

driftwatch
2011 Measures of Effectiveness
2010 (IN)
2011 (IN, IL, MI, MN,WI)
Registered producers 389 1,880
Total fields 1,193 2,107
Total acres 18,831 35,238
Apiaries registered 82 1,380
Registered applicators 152 175
Email notifications 3,000 29,958 (digests)
Public website visits 7,956 11,969 (41,036)
April, May = 60% of activity


driftwatch
2010 Indiana Website User Traffic Pattern
Highest Period (60%)
Early Spring (April, May)
Highest One Day
-67 users (April 6, 2010)
7,986 Pageviews
Jan 23, 2010 - Jan 31, 2010 0.00% (0)
Feb 1, 2010 - Feb 28, 2010 0.00% (0)
Mar 1, 2010 - Mar 31, 2010 0.08% (6)
Apr 1, 2010 - Apr 30, 2010 34.75% (2,775)
May 1, 2010 - May 31, 2010 24.79% (1,980)
Jun 1, 2010 - Jun 30, 2010 14.12% (1,128)
Jul 1, 2010 - Jul 31, 2010 11.28% (901)
Aug 1, 2010 - Aug 31, 2010 10.39% (830)
Sep 1, 2010 - Sep 22, 2010 4.58% (366)
Visits for all visitors
Jan 23, 2010 - Sep 22, 2010
2,525 Visits
10.39 Visits / Day


driftwatch
2011 Indiana Commercial Licensed Pesticide Applicator Survey Results
Survey response rate 572 (60.3%)
Ag, Aerial, Right-of-Way
Responders using DriftWatch 244 (43%)
Checking for sensitive crops and habitats
DriftWatch applicator registry 152
Written comments 263 (12 pages)
Survey focus areas
Attitudes toward protection of natural resources
Benefits, practices and barriers to reducing drift


driftwatch
Education and Outreach Materials
Crop specific fact sheets
• Extension education leadership (teachable moment)
Spray equipment technology
• Recognized industry experts
On-line training opportunities
• CCA and CCH credits
PURDUE EXTENSION
driftwatch
EXPERT REVIEWED
Watch Out For Grapes


NO DRIFT ZONE
driftwatch
Pesticide Sensitive Crops and Habitats Registry
www.driftwatch.org
Sign Up!
DriftWatch Signage Perceptions
Applicator feedback
"Pesticide sensitive area - act with caution"
Public feedback
"Believe products growing in the field are safe"


driftwatch
Vision
DriftWatch map display covering all the contiguous states with additional features, tools, and data types
Bernie Engel and Larry Theller
engelb@purdue.edu and theller@purdue.edu
Purdue University

***Economic concerns with adoption or non-adoption of herbicide-resistant traits for agricultural sectors and rural communities* – Allan Lines**

Professor Emeritus, Agricultural Economics,Ohio State University, lines.1@osu.edu

Allan Lines

VII. Bibliography

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VIII. Appendices

Appendix A: Symposium Schedule

Day 1: Monday October 31

1:00 PM……………. Welcome & Introduction
Doug Doohan & Joe Heimlich, Ohio State University

1:20 PM……………. What is Risk?
Robyn Wilson, Ohio State University

1:40 PM……………. Setting the Stage
Doug Doohan, Ohio State University

1:50 PM……………. The Roundup Ready Story (According to Me)
Mike Owen, Iowa State University

2:20 PM……………. The need for new weed control in grain
Fred Yoder, Ohio Farmer

2:35 PM……………. Glyphosate-resistant Palmer amaranth devastates agronomic crops, new technology is desperately needed
Stanley Culpepper, University of Georgia

2:50 PM……………. Academic perspective on 2,4-D tolerant crops
Mark Loux, Ohio State University

3:20 PM…………… 20 Minute Break

3:40 PM……………. Dicamba Tolerant Soybean – Benefits and Risks
Peter Sikkema, University of Guelph

4:10 PM……………. An Integrated Stewardship Plan for Dow AgroSciences' Enlist Weed Control System
Brian Olson, Dow AgroSciences LLC

4:50 PM……………. Advancements and Stewardship of Dicamba in a Dicamba Tolerant Cropping System
Steve Bowe, BASF, and Doug Rushing, Monsanto Company

5:30 PM…………… Dinner

6:30 PM……………. Are the new technologies needed?
David Mortensen, Penn State University

7:00 PM……………. Working Group Session 1
Joe Heimlich, Ohio State University

8:00 PM…………… End of Day 1 Program

Day 2: Tuesday, November 1

8:00 AM................ Introduction to Day 2
Joe Heimlich, Ohio State University

8:10 AM.................. Why Risk Analysis is not Enough
Lawrence Busch, Michigan State University

8:30 AM............... How Should We Make Decisions about Risk?
Robyn Wilson, Ohio State University

9:00 AM................ Summary of Perceived Risks from Ohio Grape Grower Focus Groups - March 2011
Scott Wolfe, Ohio State University

9:10 AM................ Risk to processing and fresh vegetables
Steve Weller, Purdue University

9:20 AM................ Risks to pollinator communities
Jody Johnson, Pollinator Partnership

9:30 AM................ Environmental concerns beyond our borders: maize landraces and gene flow
Kristen Mercer, Ohio State University

9:40 AM............... Break

10:00 AM............... Risk to organic vegetable producers
Ben Sippel, Ohio Farmer

10:20 AM............... Needles in haystacks
Frank Forcella, USDA-ARS

10:40 AM............... Active ingredient fingerprinting
Angus Murphy, Purdue University, and Josh Blakeslee, Ohio State University

11:00 AM............... GMOs and the social science of technology
Craig Harris, Michigan State University

11:20 AM............... Working Group Session 2
Joe Heimlich, Ohio State University

12:20 PM............ Lunch

1:20 PM................. Farmer experience with and current status of Roundup Ready crops in Brazil, and the receptivity of regulators and farmers to the new 2,4-D and dicamba tolerant crops
Pedro Christofolletti, University of Sao Paulo

1:40 PM................. Sprayer technology to control application
Mark Hanna, Iowa State University

2:10 PM……………. Driftwatch.org: Commercial Applicator
Roy Ballard, Purdue University Extension

2:30 PM……………. Economic concerns with adoption or non-adoption of herbicide-resistant traits for agricultural sectors and rural communities
Allan Lines, Ohio State University

3:00 PM……………. Reaching the "unreachables"
Interactive Discussion

3:20 PM……………. Pulling it all together presentation
Joe Heimlich, Ohio State University

3:50 PM……………. Working Group Session 3
Joe Heimlich, Ohio State University

4:50 PM……………. Final Comments

5:00 PM…………… End of Symposium

Appendix B: Participant List

Roy	Ballard	Extension Educator, Purdue University, Driftwatch
Mark	Bennett	Horticulture and Crop Science, Ohio State University
Josh	Blakeslee	Horticulture and Crop Science, Ohio State University
Steve	Bowe	BASF
Larry	Busch	Sociology, Michigan State University
John	Cardina	Horticulture and Crop Science, Ohio State University
Pedro	Christoffoleti	Department of Crop Science, University of Sao Paulo – College of Agriculture "Luiz de Queiroz", Brazil
Stanley	Culpepper	Crop and Soil Sciences, University of Georgia
Julia	DeNiro	Environmental Science Graduate Program, Ohio State University
Doug	Doohan	Horticulture and Crop Science, Ohio State University
Roger	Downer	Horticulture and Crop Science, Ohio State University
Christy	Eckstein	Ohio Grape Industries Committee
Franklin	Egan	Weed Ecology, Penn State University
Stan	Ernst	Agriculture, Environment and Development Economics, Ohio State University
Frank	Forcella	USDA Agriculture Research Service, Morris, MN
Michelle	Gregg	Ohio Ecological Food and Farming Association
Mark	Hanna	Extension Agricultural Engineer, Iowa State University
Craig	Harris	Sociology, Michigan State University
Joe	Heimlich	School of Environment and Natural Resource, Ohio State University
Brad	Hopkins	Dow AgroSciences
Casey	Hoy	Endowed Chair, Agroecosystems Management Program
Levi	Huffman	Row crop farmer, Indiana
Gerri	Isaacson	Department of Horticulture and Crop Science, Ohio State University
Linjian	Jiang	Department of Horticulture and Crop Science, Ohio State University
Josephine	Johnson	Department of Toxicology, University of Maryland Baltimore, and the Pollinator Partnership
Matt	Kleinhenz	Horticulture and Crop Science, Ohio State University
Daniel	Kunkel	IR-4 Program, Rutgers University
Yajun	Li	China Agricultural University, Beijing, China
Allan	Lines	Agriculture, Environment and Development Economics, Ohio State University
Peter	Ling	Agricultural Engineering, Ohio State University
Mark	Loux	Horticulture and Crop Science, Ohio State University
Kenneth	Martin	Furmano's
Kimberly	Martin	Monsanto Co.
Kristen	Mercer	Horticulture and Crop Science, Ohio State University
Sally	Miller	Plant Pathology, Ohio State University
Dave	Mortensen	Weed Ecology, Penn State University
Angus	Murphy	Department of Horticulture and Landscape Architecture, Purdue

		University
George	Oliver	Dow AgroSciences
Brian	Olson	Dow AgroSciences
Mike	Owen	Agronomy Department, Iowa State University
Jason	Parker	Horticulture and Crop Science, Ohio State University
Daniel	Pepitone	BASF
Tom	Puch	Agland Co-Op
Matthew	Rekeweg	Dow AgroSciences
Doug	Rushing	Monsanto Co.
David	Schacht	Farmer, Franklin County, Ohio
Lisa	Schacht	Farmer, Franklin County, Ohio
Peter	Sikkema	Field Crop Weed Management, University of Guelph, Ridgetown Campus
Ben	Sipple	Farmer, Morrow County, Ohio
Steve	Smith	RedGold
Joe	Steiner	Ohio Soybean Association
Weiming	Tan	China Agricultural University, Beijing, China
Dave	Tierney	Monsanto Co.
Joe	Unverferth	Hirtzel Canning Company and Farms
Russ	Wallace	Aggie Horticulture, Texas A&M University
Steve	Weller	Department of Horticulture and Landscape Architecture, Purdue University
Robyn	Wilson	School of Environment and Natural Resource, Ohio State University
Scott	Wolfe	Horticulture and Crop Science, Ohio State University
Fred	Yoder	Farmer, Union County, Ohio
Mingcai	Zhang	China Agricultural University, Beijing, China