# *NABC 27: A Focus on the Issues*

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2015 was a milestone marking the 20th anniversary of the commercial introduction of genetically engineered (GE) crops. Global acceptance of this technology by 18 million farmers has resulted in more than 181 million hectares planted in GE crops (http://www.isaaa.org/resources/publications/briefs/default). This includes greater than 90% of all soybeans, upland cotton, and corn planted in the United States (http://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us.aspx). While many traits are under development or at early stages of commercialization, GE crop technology has primarily focused on a narrow range of traits that impart herbicide tolerance and insect resistance either individually or as stacked-gene varieties. These have become effective management tools for reducing pest problems with significant benefits for agriculture.

In 2010, the National Research Council released an insightful report, *The Impact of Genetically Engineered Crops on Farm Sustainability in the United States*, which discusses the economic, environmental, and social impacts of GE crops on American farms. This report provides an excellent overview of these complex issues as we consider responsible stewardship for the sustainability of these technologies. For example, the broad use of no-till practices enabled by the adoption of herbicide-resistant crops is having positive impacts on the quality of our soils and water. Furthermore, the adoption of insect-resistant crops minimizes chemical pesticide use, reducing off-target effects of pesticides on beneficial insects. However, such wide use of a focused technology based on a limited number of genetic traits has not been without its challenges. Deployment of GE technologies—as with most agricultural advances—requires the development and use of effective management strategies. Development of resistance within the targeted pests has become an issue, especially in weed control, where herbicide-tolerance genes have been widely employed

in crop plants. Thus, adoption of cost-effective management strategies by growers is essential for the long-term utility and stewardship of GE crops. Increasingly, this includes combinations of management strategies for farming practices utilizing conventional, organic, identity-preserved (IP), and GE cropping systems that effectively "coexist" in close proximity and in the marketplace. Coexistence of farming practices provides growers with the flexibility to respond to market opportunities and improve overall profitability. Evaluating the economic impact of GE crops can be complex, especially in light of international commodity markets and trade policies. Economic impacts are also intertwined with social issues surrounding consumer views and acceptance of GE crops in local, regional, and global markets. While numerous benefits have been realized by agricultural producers' adoption of GE crops, few other issues in our society spark the passions of individuals and groups as do GE crops.

The North American Agricultural Biotechnology Council's 27th annual conference was held in State College, PA, June 2–3, 2015, hosted by the College of Agricultural Sciences at The Pennsylvania State University. The conference brought together a broad range of experts to examine and discuss the varied and often complex perspectives on key issues that impact the sustainability of GE crops, including stewardship approaches to resistance management, coexistence, trade and markets, and social and economic dimensions of sustainability. Thought leaders from academia, government, and the agricultural industry in each of these critical areas presented varied views on the topics in a constructive dialog that engaged the audience through panel discussions. The conference began with keynote presentations, defining the challenges and setting the stage for moderated plenary sessions, each followed by facilitated panel discussions. Speakers addressed the delegates at the conference banquet and during the luncheon on the second day. Graduate student participants presented their views on the conference topics in the segment *Student Voice*. Finally, the closing panel session, *Putting It All Together*, capped off the conference with a lively discussion of key issues presented during the two-day meeting.

## Keynote Addresses

**Kathleen A. Merrigan** (George Washington University) challenged the delegates with her keynote presentation, *Thinking across Time: A 20-Year Perspective on Biotech Policy*, taking a broad historical view of critical moments in the biotech industry that have framed the current issues. She stressed the need for independent voices with limited ties to industry to serve as a science-based forum to address agriculture and food policy. AGree (http://www.foodandagpolicy.org/), with its broad cross-sectional representation of the food and agricultural system, is an organization that strives for consensus among groups with differing views. Such organizations can address complex questions, such as whether biotechnology can aid the organic industry rather than put farmers with differing production approaches at odds. However, the complex issues surrounding coexistence are unlikely to be fully resolved by voluntary or market forces, but will almost certainly require government regulation. The statutory authority of the USDA empowers the agency to issue "fair and transparent regulation" as a solution to coexistence.

**Richard Roush** (The Pennsylvania State University) introduced the challenges faced by agriculture worldwide in developing and managing resistance to GE-based insect and weed control strategies in his talk, *What Are the Major Impediments to Resistance Management for Crops in the Social Sciences and Governance?* Pesticide resistance has been investigated for many years, and while the fundamentals of the genetic mechanisms and management theory are well understood, at the field level resistance management has been much more effective in preventing rapid development of pesticide resistance among insects than in preventing herbicide resistance among weeds. Why? Resistance can be delayed by killing the heterozygotes that carry the resistance alleles. Changing tactics has been a key to insect resistance management. Multiple toxins with high mortality rates across different life stages are needed to maintain a very low frequency of resistance. Pyramiding GE traits combined with refuges appears to be an effective strategy for delaying insect resistance. Weed resistance management strategies have been less robust, especially in Roundup Ready crops. Two factors have resulted in the development of more than 14 resistant weed species: lack of rotation, leading to prolonged use of a single herbicide over successive years, and applications to more mature weeds carrying the resistance trait, for which herbicide control tends to be less effective. The refuge concept also appears to be less applicable for weeds than it is for mobile insects; however, tillage may put seed back into the seed bank, reducing selection intensity. While effective strategies are understood, some level of government intervention in combination with grower education seems to be required to enforce resistance management practices.

Coexistence raises complex management, policy, economic, and consumer issues that were discussed by **Greg Jaffe** (Center for Science in the Public Interest) in his presentation, *Coexistence of Biotech, Organic, and Conventional Crops: Facts, Issues, and a Path Forward*. Coexistence "embodies the idea that consumers should be able to get the products they want." Coexistence is a complex issue that predates GE crops. For example, the alternative uses and handling of a single crop plant commodity (i.e., rapeseed) for different products (edible vs. industrial) provides some historical context for the practice of coexistence. However, it is important to understand the functional meaning of the term coexistence in the current context of biotech, organic, and conventionally produced crops. Coexistence only involves relationships within a specific, legally approved crop plant that can be produced by different farming practices and for different uses "with a specific market goal." Most controversy today concerns the coexistence of biotech crops with conventional or organically produced crops and especially focuses on issues surrounding the economic costs farmers incur as a result of unintended presence and on potential compensation mechanisms. The issues surrounding coexistence will continue to grow as the number of GE products coming into the marketplace increases, as will the need for increased educational outreach to support coexistence.

The final keynote presentation, *Agricultural Biotechnology: Facilitating Trade for Food and Feed*, by **Sharon Bomer Lauritsen** (Office of the US Trade Representative) introduced the many interconnected issues, such as asynchronous authorization, trade disruption, liability, boycotts, and policies, affecting global agricultural and international trade of

GE crops. The sheer magnitude of US exports of GE-derived commodities, along with the increasing number of countries producing GE crops, is significantly impacting this global trade. Current global trade issues being addressed by the US government include the lack of science-based regulation that is often encountered in developing countries; asynchronous authorizations (differences in the time taken to review and authorize the cultivation and import of new products); low-level presence (detection of an event approved in an exporting country but not an importing country); labeling; legal liability in a country so severe that the approval process is not pursued there; and new opt-out provisions for EU member states. Technology developers can play an important stewardship role to facilitate trade by "ensuring that products are authorized in key export markets before introducing them for cultivation."

## Plenary Sessions

Three plenary sessions were organized around the topics introduced by the keynote speakers: *resistance management, coexistence*, and *trade and markets*. A fourth plenary session focused on the complex issues of *social and economic dimensions of sustainability*.

## Resistance Management

The first plenary session, *Resistance Management*, moderated by Dave Mortensen (The Pennsylvania State University), included three talks that explored US and Canadian approaches to regulating and managing widely adopted traits for insect protection and herbicide resistance in some of our major crop plants. Agricultural biotechnology has introduced two widely adopted traits in grain, fiber, and forage crop production: plant-incorporated protectants for insect protection, and herbicide resistance enabling the use of broad-spectrum herbicides. While both are widely adopted, overreliance on these traits has resulted in a significant rise in pest resistance. Specific steps that can be taken to address pest resistance and clarify the constraints to their adoption were discussed.

**Jack Housenger** (US Environmental Protection Agency) discussed the EPA's perspectives in his talk, *Regulating Resistance*. Extending the useful life of pesticides by delaying resistance without excessively burdening growers is a goal in the EPA's regulatory strategy. This is being accomplished by requiring resistance management plans that incorporate scouting, reporting, cultural, and mechanical practices as key elements for EPA approvals of newly registered crops. For example, education and training for the early identification and reporting of resistant weeds is being combined with labeling requirements that include the mode of action and best management practices (BMPs) to slow the development of resistant weeds.

**Nicholas P. Storer** (Dow AgroSciences) provided a biotech industry perspective in his talk, *Insect Resistance Management for GE Crops: Industry Principles, Policies, and Programs*, focusing on the commitment across the industry to implement strategies for durable GE crop deployment based on effective insect resistance management (IRM). Refuges, "high dose" traits, and pyramiding toxins with multiple modes of action are widely advocated as effective IRM techniques. However, the practice of pyramiding toxins is currently

hampered by the narrow range of useful insecticidal proteins. Major companies within the industry are clearly committed to the deployment of durable GE crop technologies that can be reasonably integrated into a farmer's resistance management program as the basis for stewardship of the technology.

**Hugh J. Beckie** (Agriculture and Agri-Food Canada Research Centre), in his presentation, *Herbicide-Resistant Crop Management: A Canadian Perspective*, focused on the comprehensive approaches to weed resistance in Canada for GE canola, corn, and soybeans, including reporting requirements, BMPs to minimize resistance, and systematic monitoring for herbicide-resistant weeds. Resistance management plans have been required to deregulate herbicide-resistant crops for more than a decade in Canada. Following deregulation, a framework that incorporates weed surveys was developed to facilitate the early identification of herbicide-resistant weeds through environmental monitoring of released GE crops. While such regulatory strategies are important, proactive herbicide-resistant weed management is rare and should be reinforced by third-party random field surveys, mandatory training sessions for growers on BMPs, robust industry stewardship strategies that go beyond stacked-HR-trait cultivars, and government programs that incentivize reduced herbicide use.

## Coexistence

The second plenary session, *Coexistence*, moderated by Carol Mallory-Smith, presented academic and industry perspectives on the issues that affect both grower and consumer choices and the challenges presented to the marketplace in an increasingly diverse food system. A recurring theme of this session, as well as of others, was stewardship of GE crops to address adventitious presence in conventional and organic crops. Practical solutions that can be implemented at the farm and market levels will ensure the greatest success of these measures.

**Carol Mallory-Smith** (Oregon State University) delivered the introductory session talk, *Coexistence: The University Role*, focusing on the challenges land grant universities face in fulfilling their mission of providing unbiased information through research, education, and extension for the broad range of stakeholders that coexist in this technologically diverse landscape. Coexistence can be thought of in the full agricultural context as providing farmers with choices among production methods, such as conventional, organic, and GE, while meeting both legal obligations and market standards. This definition of coexistence extends beyond the issues of genetics or production methods most often addressed by the agricultural and life sciences to the less defined and potentially more complex issues addressed by the social and political sciences. Thus, a truly interdisciplinary approach is required for land grant universities to remain true to their mission of providing unbiased, relevant information to the agricultural community.

**Lynn Clarkson** (Clarkson Grain Company) discussed the issues involved in managing for purity when meeting client quality standards in commercial-scale handling of conventional, GE, and organic crops in his talk, *Segregating GMO Crops—Cultural and*

*Functional Challenges*. Identity preservation (IP) (tracking the specific identity of bulk agricultural commodity shipments to maintain unique characteristics that would be lost by commingling during storage, handling, or shipping) is essential when multiple pathways to the marketplace exist for an individual commodity. IP provides market access by growing and delivering a crop as it is desired, creating a competitive advantage in the marketplace. Managing for purity begins with the grower, regardless of whether a crop is GE, organic, or based on functional traits. Segregation buffers support farmers' choices and minimize the potential impacts of their neighbors' market choices. Premiums for delivering quality and purity in contracts are a strong inducement for growers. Meeting buyers' standards for purity is a challenge for IP. Tolerance levels for contamination due to adventitious presence, including testing protocols, lack consistent global industry standards, and could provide a role for government. It is important that everyone within the industry, from seed providers to farmers to shippers, participate in achieving the common goal of delivering products that the market desires.

**Greg Loberg** (West Coast Beet Seed Company) told delegates about a highly successful program for coexistence through the Willamette Valley Specialty Seed Association in his presentation, *Coexistence in the Oregon Seed Industry*. Lessons from the Oregon seed industry seem to be rooted in proactive stewardship policies that support coexistence. These policies should be developed by a stewardship committee in anticipation of the release of a GE trait. Sustaining a stewardship policy needs the proactive engagement of all affected parties, including trait owners, growers, and relevant organizations and agencies. An important consideration when establishing new policies is the development of reasonable tolerance thresholds for GE traits, to avoid inflicting zero tolerance standards on an industry. Furthermore, the Oregon seed industry has a long history of demonstrating the value of arbitration as the primary means of resolving conflicts. The "will to coexist" by overcoming ideological differences with tolerance is a particularly important way to avoid political and legal problems.

## Trade and Markets

The third plenary session, *Trade and Markets*, moderated by **Dave Abler** (The Pennsylvania State University), addressed current issues on the certification of GE crops and regulations affecting their commercialization in the international marketplace, including asynchronous approval, inconsistent testing, transfer of liability, and identity preservation.

**Michael Schechtman** (USDA/ARS) discussed the challenges of marketing GE crops in commodity agriculture worldwide in *Trade and Markets for Genetically Engineered Crops: A USDA Perspective*. The USDA plays a key regulatory role in developing and marketing by ensuring the safe and appropriate use of genetic engineering in the US and bringing the products derived from GE plants to the worldwide marketplace. In 2014, US exports of corn and soybeans, mostly GE, exceeded $37 billion. While the US leads in the development and production of plant biotechnology products, other countries, notably Brazil, are producing and developing domestic GE products. Furthermore, GE crop varieties are being adopted in both Asia and Africa, with large research and development investment taking

place in China. Yet global trade issues abound for GE products. Issues with the European Union continue and may increase if individual member states are allowed to ban GE crops using non-science-based criteria, even when those same crops have been determined to be safe by EU authorities. Asynchronous approvals in China, the largest importer of US plant commodities, create potential trade issues with the US. Low-level presence of lawfully grown GE crops in the export stream also presents risks for trade disruptions.

**Randal Giroux** (Cargill Incorporated) addressed the challenges of managing the coexistence of commodity crops within supply chains and global food systems in *Enabling Coexistence: Balancing Innovation and Market Access*. For biotechnology to fully realize the benefit of increased global food security, its products must be effectively integrated into the global food system. However, many international challenges exist in balancing innovation with market access, including asynchronous approvals and zero tolerance for approved GE traits. Governments, with the assistance of independent scientific groups, are in the best position to provide cogent policies that assure both industries and consumers. However, national approval systems lack uniformity, impeding the development of responsible global commercialization models. The overall value of global exports to US agriculture is substantial, which should stimulate the US government to lead by example in developing proactive policies for the commercialization of GE crops within globally interdependent agricultural supply chains.

**William A. Kerr** (University of Saskatchewan) explained how divergent regulation of GE commodities on the world market leads to trade barriers and reduces trade flow in his talk, *Worlds Apart on GMOs—Can Trade Agreements Bridge the Gap?* Rules regulating international trade of GE crops do not exist, even though there is a long history of actions taken by the World Trade Organization to establish paths forward to address trade barriers in the global marketplace for GE crops. Political realities in some countries, especially those with strong anti-GE agendas, are supplanting science as the primary basis for domestic policies and trade rules. Furthermore, the ever-increasing worldwide presence of GE crops in the global marketplace becomes more problematic in light of zero tolerance policies for adventitious presence of GE materials in shipments of non-GE crops. Harmonization of trade standards among different countries could resolve current policies that result in trade barriers; however, harmonization requires establishing mutually acceptable regulatory frameworks for trade in GE crops that exceed the scope of trade negotiations.

## Social and Economic Dimensions of Sustainability

The fourth and final plenary session, *Social and Economic Dimensions of Sustainability*, moderated by **Leland Glenna** (The Pennsylvania State University), was organized as "lightning talks" introducing the issues, immediately followed by an interactive discussion between speakers and delegates. This robust and fascinating discussion of the contributions of biotechnology to a sustainable food and agricultural system explored the evolving roles of the agricultural research and development infrastructure and consumer acceptance of GE technologies.

**Paul W. Heisey** (USDA Economic Research Service) focused on the complementarity and changing dynamics of public and private research in his talk, *The Structure of US Agricultural and Food Research, with an Emphasis on Seed-Biotechnology Research*. The early innovations in biotechnology primarily occurred within university and public research institutions, yet research investment by the private sector has well surpassed public investment. The nature of the research conducted in the public and private sectors still remains complementary, as the more fundamental work carried out in public institutions informs the translational research often emphasized by private industry. Both in the US and globally, the seed-biotechnology industry has concentrated, resulting in fewer small and medium-sized private biotechnology companies and the dominance of larger companies. Industry concentration appears to have reduced research intensity in agricultural biotechnology, even though small and midsized companies continue to produce major innovations. Large seed-biotechnology companies are also becoming involved in farm management research, augmenting research traditionally done by the public sector.

**Rick Welsh** (Syracuse University) expanded the discussion of GE crops to examine the public discourse of the technology as a "social problem" in his talk, *Understanding Social Controversies over Agricultural Biotechnology*. Robust intellectual property protection for GE technologies stimulated a shift in agricultural chemical companies toward "an integrated pesticide and seed sector" that over a relatively short time has concentrated the seed industry into a few large companies. This evolution in the biotech industry has, in part, contributed to a polarized dialogue around technological changes in the food system, especially in the US. Proponents and opponents of the technology each have common viewpoints that frame the issues in support of their perspective. Concerns of GE critics include the lack of safety data for the consumer, insufficient government regulation, and potential ecological impacts. GE advocates, including policy makers, focus on the contributions of the technology to food security and environmental sustainability. The conflicting strategies of the two sides are not contributing to greater social consensus on GE technology in the food system.

**William K. Hallman** (Rutgers University) presented a stimulating perspective on the role of consumer perceptions in the acceptance of GE products in his talk, *Do American Consumers Want GM Food Labeling? It Depends on How You Ask the Question*. Interestingly, data show that the vast majority of Americans know little or nothing about GE foods or foods containing GE ingredients in their supermarkets. There is considerable confusion among consumers: ingredients thought to be GE-derived are often not, there is uncertainty whether foods containing GE products are currently available, and most don't know that they are consuming foods containing GE ingredients. While many consumers are uninformed about GE foods, they readily develop opinions that can influence their attitudes and decisions regarding these foods. Interestingly, purchasing decisions tend to solidify people's opinions about the nature of their food, further supporting their beliefs by adjusting information to conform to those beliefs.

**Stephen Palacios** (Added Value Cheskin) conducts market research to assist Fortune 500 companies with marketing strategies. In his talk, *The Limits of Science in Impacting the GMO Discourse: How Food Manufacturers and Retailers Affect Consumer Opinion*, he suggested that much of the GMO conversation has already been framed by a well-entrenched anti-GMO communications structure. The anti-GMO messages consumers get on Amazon, Google, or Netflix are indicative of a sophisticated, trend-oriented, popular culture approach that generates quick advocacy. Consumer opinions, especially those on the perceived relationships between GMOs and health, significantly impact the food industry. This becomes even more important as consumers see GMOs as "potent symbols of the ills of the American food industry." Establishing consumer trust and relevance in the context of the marketing strategies of their competitors strongly influences the decisions of industry executives. For example, the no-GMO stance that Chipotle recently adopted in marketing their products as "food with integrity" sensitizes other food companies about their position on the technology, regardless of the scientific arguments. Science might still have an opportunity to mitigate the frame set by the long-standing anti-GM campaign, but it will require carefully crafting consumer-oriented responses.

## Special Presentations

At the conference banquet, delegates were addressed by **Russell C. Redding** (Pennsylvania Secretary of Agriculture), who presented *AC21—The Journey to Coexistence*. The Advisory Committee on 21st Century Agriculture (AC21), in response to Agriculture Secretary Thomas Vilsack's charge to advise the USDA on key issues facing the increasingly complex and diverse US agricultural system, focused on a set of recommendations and implementation strategies to enhance coexistence among different agricultural production systems. At luncheon on the second day of the conference, **John F. Tooker** (The Pennsylvania State University) presented *Sustainability of Genetically Engineered, Insect-Resistant Crops: A View from the Fringe*, strongly advocating for product flexibility in the marketplace. Such flexibility would allow growers to maximize economic returns by responding to local pest populations, especially through the use of IPM, rather than being limited to specific management strategies aimed at potential pest problems.

An important component of NABC conferences is the **Student Voice**, which empowers students to be active participants in the meeting. Graduate students from Penn State, University of Arkansas, Washington State University, and Iowa State University met the evening of June 2 and presented their views on the conference topics to the delegates on June 3. The students stated that greater science advocacy through effective educational programs and science communications to the public should be a priority. Basic genetics taught at early ages would help people grasp the concepts that underpin these new technologies. It also could be the time to change the focus in the discussion of GE crops from human safety, which is well documented, to potential ecological impacts that can only be accomplished through broad collaborations of scientists from different disciplines. It is also time for life scientists to work more closely with social scientists to reach out and create closer ties to the community.

## Putting It All Together

The closing interactive panel session, *Putting It All Together*, moderated by **Steve Pueppke** (Michigan State University), was a stimulating conversation with two speakers (Greg Jaffe, CSPI, and William Kerr, University of Saskatchewan) and two delegates (Andy Hedgecock, DuPont Pioneer, and Tony Shelton, Cornell University) who reflected on the issues, scope, and content of the conference to synthesize a way forward in stewardship for the sustainability of GE crops.