Institute on Science for Global Policy (ISGP)

Food Safety, Security, and Defense: *Safeguarding the American Food Supply*

Conference organized and convened by the ISGP
in partnership with Ursinus College in Collegeville, Pennsylvania, U.S.
April 11—12, 2015

ISGP Academic Partnership (IAP) with Ursinus College

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An ongoing series of dialogues and critical debates
examining the role of science and technology
in advancing effective domestic and international policy decisions

Institute on Science for Global Policy (ISGP)

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Introduction

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Preface

The contents of this book were taken from material presented at a conference convened by the Institute on Science for Global Policy (ISGP) on April 11–12, 2015, in partnership with Ursinus College, in Collegeville, Pennsylvania, and with financial support from Sigma Xi, The Scientific Research Society. This specific ISGP conference, *Food Safety, Security, and Defense (FSSD): Safeguarding the American Food Supply,* was part of the ISGP Academic Partnerships (IAP) program, which is based on collaborations with distinguished academic institutions. These IAP conferences reflect a common commitment to significantly improve the communication of credible scientific and technological (S&T) understanding to both policy makers and to the public *writ large.*

The process used to organize ISGP conferences begins with the recognition that FSSD has become a focal point on the international stage for numerous critical issues affecting public health spanning the diverse cultural, ethical, and economic characteristic that define all societies. Societal decisions concerning how to appropriately incorporate the often transformational scientific advances associated with FSSD into public and private sector policies rely on debates that highlight the credible options developed worldwide. Given the global impact of FSSD, such debates deserve attention from both domestic and international policy makers from a wide range of disciplines. ISGP conferences offer a rarely encountered environment in which such critical debates can occur among internationally distinguished scientists, influential policy makers, societal stakeholders, and the public.

Based on extensive interviews conducted by the ISGP staff with an international group of subject-matter experts, the ISGP invited three highly distinguished individuals with expertise in FSSD to prepare the three-page, policy position papers (designed for the nonspecialist) that were debated at the Ursinus College IAP conference. These three policy position papers, together with the not-for-attribution summaries of the debates of each paper, are presented in this book. The areas of

consensus and actionable next steps that were developed by all IAP conference participants in the caucuses that followed the debates are also presented.

The debate summaries and caucus results, derived from the contributions of IAP conference participants, were prepared by the ISGP staff in collaboration with the students enrolled in the ISGP conference-inspired course taught by Ursinus College faculty.

This one-semester course, which included planning and convening an ISGP-style conference, focused on three main themes:

1. Food-borne microbial (viral, bacterial, protozoal, and worms) threats to public health, with discussions of topics such as pathogen detection and microbial hazards faced by the food industry, among others.
2. Industrial-scale animal production, including a discussion of the role of antibiotic use for livestock production with respect to the global antibiotic-resistance crisis.
3. Noninfectious quality concerns with domestic and imported foods, including topics such as adulteration and mislabeling of foods and food additives.

ISGP Academic Partnerships (IAP)

Recent history suggests that many societies would benefit from improving how scientifically credible information is used to inform policy decisions on a wide range of pressing issues (e.g., food safety, climate change, infectious diseases). Those engaged in the IAP programs recognize that communication between those with S&T expertise and those policy makers responsible for ensuring safe, secure, and prosperous societies must be effective and timely. Venues that promote the concise and accurate presentations of viable S&T options to policy makers, while encouraging critical assessments, are essential in identifying effective policy decisions that can be publicly supported and therefore, effectively implemented. No less important is the organization of venues in which the public can both witness and participate in such debates concerning the advantages and potential risks of these S&T options. IAP events provide opportunities for both college- and university-level students and the public to debate those important societal issues of our time that depend on an accurate understanding of credible S&T options.

Such public events are derived from the invitation-only debates and caucuses pioneered by the ISGP in which candid exchanges of ideas and criticism among internationally-recognized S&T professionals, policy makers in government and the private sector, and societal leaders are the norm. These critical debates and caucuses

are the centerpieces for the pedagogical approach underlying IAP programs, and therefore, are emulated in the structure of the IAP that are convened at participating colleges and universities. The participating students help organize and lead each IAP conference at their respective institutions with audiences comprised of their fellow students, faculty, and members of the public.

The academic preparation of the students begins with classroom studies under the supervision of faculty from their respective institutions. In addition to the classroom studies, participating students are offered the opportunity to (i) assist the ISGP staff in interviewing S&T experts worldwide, (ii) read the extensive background material and reports available to the ISGP (including advance copies of the policy position papers used in formal ISGP conferences), (iii) participate in the formal debates of the policy position papers alongside leading experts in the field, (iv) moderate the caucus groups to ensure Areas of Consensus and Actionable Next Steps are democratically reached and consolidated, and (v) help to craft conference publications.

The overall educational experience can be viewed as a "practical S&T-policy laboratory" designed to (i) prepare the students for active roles in informing and guiding policy makers at the local, regional, national, and global levels and (ii) expose the public to informed debates provided by distinguished S&T experts and led by students who have participated in the IAP. Taken together, both experiences are important steps toward ensuring that appropriate respect for rational thinking is given to the future formulation and implementation of public and private sector polices.

Current realities

As the second decade of the 21st century opens, most societies are facing difficult decisions concerning how to appropriately use, or reject, the dramatic new opportunities offered by modern scientific advances and the technologies that emanate from them. Advanced scientific research programs, as well as commercially viable technologies, are now developed globally. As a consequence, many societal issues related to S&T necessarily involve domestic and international policy decisions, both in the public and private sectors.

The daunting challenges to simultaneously recognize immediate technological opportunities while identifying those emerging S&T achievements that foreshadow transformational advantages and risks within specific societies are now fundamental governmental responsibilities. These responsibilities are especially complex because policy makers must consider the demands of different segments of society, which often have conflicting goals. For example, decisions must balance critical commercial

interests that promote economic prosperity with the cultural sensitivities that often determine if, and how, S&T can be successfully integrated into any society.

Since many of our most significant geopolitical policy and security issues are directly connected with the remarkably rapid and profound S&T accomplishments of our time, it is increasingly important that the S&T and policy communities (public and private) communicate effectively. With a seemingly unlimited number of urgent S&T challenges, both more- and less-affluent societies need their most accomplished members to focus on effective, real-world solutions relevant to their specific circumstances.

Recent history suggests that most societies would benefit from improving the effectiveness of how scientifically credible information is used to formulate and implement governmental policies. There is a critical need to have the relevant S&T information concisely presented to policy communities in an environment that promotes open questions and debates led by those nonexperts directly engaged in decisions. The IAP model of debate aims to simultaneously convey to the public this same degree of understanding, confidence, and acknowledgment of risk necessary to obtain the broad societal support needed to effectively implement any decision.

ISGP conference structure

At each ISGP conference, internationally recognized, subject-matter experts are invited to prepare concise (three pages) policy position papers. For the April 11–12, 2015, IAP conference at Ursinus College, these papers described the authors' diverse views and perspectives on the current realities, scientifically credible opportunities and associated risks, and policy issues concerning Safeguarding the American Food Supply. Students from the class taught at Ursinus College were invited to assist in the editing of the policy position papers prior to their public dissemination several weeks before the conference convened. Conference participants were from Ursinus College and the communities it serves, including faculty and students from colleges and universities across the country, local high schools, government and public health representatives, private-sector and industry leaders, and leading researchers in related fields.

The conference agenda was comprised of three 90-minute sessions, each of which was devoted to a debate of a given policy position paper. In each session, the author was given 5 minutes to summarize his or her views while the remaining 85 minutes were opened to all participants, including other policy paper authors, for questions, comments, and debate. The debates focused on clarifying the understanding among the nonspecialists and identifying areas of consensus and actionable policy decisions supported by scientifically credible information.

While the Chatham House Rule (no attribution of remarks to any participant outside the conference setting) is routinely used in many ISGP conferences to encourage frank discussions and critical debates, all IAP conference are conducted without any restrictions on attribution. This procedure recognizes the importance of engaging the public and press in debates that facilitate professional and respectful communication while accurately articulating well founded scientific and policy options.

The not-for-attribution summaries of each debate, prepared by the ISGP staff in collaboration with Ursinus College students in the class, are based on the collective notes and recordings from each debate and are presented here immediately following each policy position paper. These summaries represent the best effort by staff and students to accurately capture the comments and questions made by the participants, including the other authors, as well as those responses made by the author of the paper. The views expressed in these summaries do not necessarily represent the views of a specific author, as evidenced by his respective policy position paper. Rather, the summaries are, and should be read as, an overview of the areas of agreement and disagreement that emerged from all those participating in the debates.

Following the three debates, small caucus groups representing a cross section of all participants, worked to identify areas of consensus and the actionable next steps to be considered within governments and civil societies in general. Subsequently, a plenary caucus was convened for all participants. While the debates focused on specific issues and recommendations raised in each policy position paper, the caucuses focused on overarching views and conclusions that could have policy relevance both domestically and internationally.

A summary of the overall areas of consensus and actionable next steps emerging from these caucuses is presented here immediately following this introduction under the title of **Conference conclusions.**

Concluding remarks

IAP conferences are designed to provide environments that facilitate publicly accessible debates of the credible S&T options available to successfully address many of the most significant challenges facing 21st century societies. IAP debates test the views of subject-matter experts through critical questions and comments from citizens and nonspecialists committed to finding effective, real-world solutions. Obviously, IAP conferences build on the authoritative reports and expertise expressed by many domestic and international organizations already actively devoted to this task. As a not-for-profit organization, the ISGP has no opinions nor does it lobby for any issue except rational thinking. Members of the ISGP staff do not express

any independent views on these topics. Rather, IAP programs focus on fostering environments that can significantly improve the communication of ideas and recommendations, many of which are in reports developed by other organizations and institutes, to the policy communities responsible for serving their constituents in the public.

While IAP conferences begin with concise descriptions of scientifically credible options provided by those experienced in the S&T subject, they rely heavily on the willingness of nonspecialists and citizens to critically question these S&T concepts and proposals. With the introduction of the IAP conference model, now students and the general public can voice their opinions and learn how decisions that undoubtedly will impact their lives are made. Overall, IAP conferences seek to provide a new type of venue in which S&T expertise not only informs the citizen, but also in which realistic policy options can be identified for serious consideration by governments and societal leaders. Most importantly, IAP programs are designed to help ensure that S&T understanding is integrated into those real-world policy decisions needed to foster safer and more prosperous 21st century societies.

Conference Conclusions

Area of Consensus

To achieve an effective risk-based food safety system, a multidisciplinary group of stakeholders including communication experts and educators needs to convey to the public an accurate understanding of the risk associated with food. Effective communication is essential to ensure the public understanding of food risk, which needs to be based on risk-and-benefit analysis, rather than attaining zero-risk food safety environment.

Actionable Next Steps

- Establish a wide range of accessible, two-way communication avenues (e.g., online forums, YouTube videos, talk shows) between well-informed scientific authorities and the public, to be mediated by engaging, rational, and trusted media personalities. This needs to be initiated as a collaborative effort among industry, public interest groups, and scientists.
- Incorporate food safety and risk curricula into elementary through higher education to empower students to ask informed questions and to develop public understanding from an early age.
- Encourage consumers to engage with science (i.e., "citizen science") through wide-reaching marketing campaigns, including both traditional and modern media formats (e.g., social media), targeting all socioeconomic levels.
- Identify the areas of the current regulatory system that need improvement or modification, including traceability and accountability, through a coalition of industry and third-party analysts.
- Create a national system to mandate the reporting of adverse food production events with clear legal repercussions for noncompliance or the active withholding of information.

Area of Consensus 2

Because inaccurate, incomplete, and/or inaccessible information is negatively influencing the public's perception of risk related to food fraud, thereby perpetuating distrust and ignorance, stakeholders (e.g., industry, government, natural and social scientists) need to effectively communicate credible and complete information, which increases transparency and improves public understanding of risk resulting in increased levels of public trust.

Actionable Next Steps

- Utilize technologies and mechanisms for individually customized updates (e.g., smartphone push notifications, voice or email messages) on food safety and the risk of fraudulent products (e.g., allergens as adulterants). These updates must be provided by a food-fraud monitoring agency (e.g., U.S. Pharmacopeial Convention), and individual privacy and safety must be the highest priorities.
- Implement collaborative lab science curricula between high schools and colleges to test for food fraud (e.g., fish DNA barcoding kits) with the opportunity for further investigation by government regulatory agencies to validate initial findings.
- Encourage the reporting of fraudulent practices by enhancing whistleblower protection laws, ensuring that employees who report on food fraud incidents in the workplace are protected legally.
- Promote the use of existing food fraud databases and reporting systems while encouraging third party (e.g., coalitions of artisanal food producers) product verification for truthful labelling. Funding for these efforts might come from financial penalties imposed on food fraud offenders.

Area of Consensus 3

Established food policy based first on broadly accepted credible science must also consider the broad perspectives on cultural and ethical imperatives and their current and future implications. Two-way communication between an educated public and policy makers must consider all perspectives, including those less commonly addressed (e.g., animal advocates, minority groups, future generations).

Actionable Next Steps

- Inform food producers about safer ways to handle and care for animals so they further respect the ethical perspectives of the community, which will be determined by regular assessments (e.g., a periodically held public forum).
- Educate consumers through a variety of accessible and convenient platforms (e.g., QR codes on products, symbols, databases) to empower them to make informed purchasing decisions reflecting their values. This effort can be spearheaded by collaboration between government and independent organizations that reflect a range of socioeconomic perspectives (e.g., The Food Trust).
- Establish a coalition of stakeholders representing multiple disciplines (e.g., food producers, the public, government, scientists) to create a checks-and-balances system to oversee food policy and prevent the dissemination of biased food safety information to the public.
- Mandate universal labelling protocols, in addition to current nutritional labels, that inform consumers in a streamlined way such that both risks (e.g., allergen information) and benefits (e.g., reduced environmental impact) are easily communicated and understood. In practice, this might include use of QR codes, symbols, and in-store product scanners.

ISGP conference program

Friday, April 10

09:30 – 10:30	**Registration**
09:45 – 11:00	*Brunch*
11:15 – 11:30	***Welcoming Remarks*** **Dr. George Atkinson**, Founder and Executive Director, Institute on Science for Global Policy (ISGP) and **Dr. Terry Winegar**, Ursinus College Interim President

Presentations and Debates

11:30 – 13:00	**Dr. Robert Buchanan, Director and Professor, Center for Food Safety and Security Systems, College of Agriculture and Natural Resources, University of Maryland, United States** *Risk Perception: A Challenge to the Development of Risk- based Food Safety Policy*
13:00 – 13:30	*Break*
13:30 – 15:00	**Dr. Karen Everstine, Research Associate, National Center for Food Protection and Defense, University of Minnesota, United States** *Policies to Proactively Address the Threat of Food Fraud*
15:00 – 15:30	*Break*
15:30 – 17:00	**Dr. H. Morgan Scott, Professor of Veterinary Pathobiology, Texas A&M University, United States** *Technological Safeguards for the U.S. Food Supply: Moral and Ethical Dilemmas*

Saturday, April 11

08:30 – 09:00	*Breakfast*
Caucuses	
09:00 – 12:15	**Focused group sessions**
12:15 – 14:00	*Lunch*
14:00 – 17:00	**Plenary Caucus Session** Dr. George Atkinson, *moderator*
17:00 – 17:15	**Closing Remarks** Dr. George Atkinson

Risk Perception: A Challenge to the Development of Risk-based Food Safety Policy**

Robert L. Buchanan, Ph.D.
Director and Professor, Center for Food Safety and Security Systems, College of Agriculture and Natural Resources, University of Maryland, College Park, Maryland, U.S.

Summary

The past two decades has seen increased progress in our striving to develop food safety policies that are science-based and risk-based. However, reaching consensus about the appropriate level of protection our food safety systems should provide is still severely hampered by the widely divergent perceptions of risk among different segments of the population and similar divergent interpretations of the supporting scientific knowledge. Without a concerted effort to better understand risk perception and de-sensationalize the science underlying food safety, we will continue to struggle in achieve food safety systems that meet the needs of both the individual consumer and society in general.

Current Realities

A hallmark of modern food safety systems in developed countries is food safety policies that are built upon a science-based, risk-based foundation of decisions concerning the "Appropriate Level of Protection" needed to safeguard their citizens. This is a key concept formalized in the World Trade Organization's Sanitary and Phytosanitary Agreement (SPS Agreement), which the world's nations have agreed should underpin international trade in food commodities and food products. The SPS Agreement establishes the right of a country to articulate the level of control that it expects from domestic and foreign manufacturers of foods and food ingredients, and that these requirements should be equivalent for both domestic and foreign providers. Further, if a country establishes requirements greater than those agreed upon by international standard setting bodies, then that country must be able to demonstrate via a risk evaluation that its citizenry requires a higher level of control. Many countries have procedural requirements for the detailed consideration of the science and risks associated with proposed food safety policies.

As with virtually all public health policies, food safety policies represent a combination of scientific and societal considerations. The establishment of new

regulations in the United States is guided by the procedures established by the Administrative Procedure Act of 1946 (APA), which establishes steps that federal agencies must follow to develop and implement new regulations. This includes consideration of (i) the scientific evidence and rationale for a proposed regulation and (ii) public opinions through public comments and proactive outreach activities. Since the initial passage of the APA, a number of additional requirements have been added to the regulatory process. A relatively recent addition is the need for a formal risk assessment for major regulations. During the past several decades, the role and sophistication of risk assessments as the basis for developing and implementing sound risk management strategies has steadily increased to the point where food safety agencies and larger entities in the food industry have dedicated risk assessment personnel. This has led to the emergence of risk-based decision-making that takes into account the reality that while it is essentially impossible to totally eliminate foodborne hazards, it is possible to manage the risks to achieve an "appropriate level of protection." Such decisions involve weighing food safety risks to public health burden versus competing "costs" to society. Costs to society should not be considered solely in terms of financial burden. For example, there have been calls to ban consumption of raw shellfish, a notoriously risky food. In addition to lost revenues, a clear societal cost would be limiting the dietary choices of presumably knowledgeable consumers. Thus, the articulation of a food safety policy establishes a society's decision on how to balance public health "costs" and other societal costs.

Scientific Opportunities and Challenges

Food safety professionals view food safety systems as a continuum where decisions must be reached regarding the level of stringency that will be required. A highly stringent requirement (e.g., banning of a specific food) would emphasize reducing public health risks regardless of other societal costs, whereas developing less stringent options would potentially increase public health risks due to the need to mitigate unacceptable societal costs. Reaching national consensus about tolerable levels of risks is hampered by differing perceptions of food safety risks. While the food safety experts view risk as a relative attribute, the typical consumer views safety as a binary attribute (i.e., the food is either safe or unsafe). In part, this reflects differences in the scope of their concerns: food safety experts are typically dealing with the risk to the nation, whereas individual consumers are focused on the risks to their immediate families. In addition, consumers are often more risk adverse regarding food than many other potential risks (e.g., drugs). This is compounded by a general lack of understanding of risk and probability theory by the general public. As an example, if one asks a number of people who have just purchased a lottery ticket what their

odds are of winning, a significant portion will reply 50:50, (i.e., they either do or do not have the winning numbers). This binary approach to food safety risks tends to be reinforced by the fact that the legal system under which food safety policies must be implemented is binary to achieve a clear demarcation between safe and unsafe.

A good example of how ineffective risk communications can hamper reaching consensus on appropriate levels of protection is the use of the term "zero tolerance" to articulate the expectations for the management of microbiological food safety risks. This phrase, which was originally used to describe the goal for the prevention illegal drugs sales around schools, began to be used by food safety managers to articulate their high levels of concern for the presence of infectious bacteria such as *Escherichia coli* O157:H7 and *Salmonella enterica*. Consumers take this on face value (i.e., zero means zero). However, to be implemented in a regulatory setting, zero needs to be defined in an unambiguous manner so that the actions of regulatory agencies are standardized for all food manufacturers. If not, regulatory actions could be deemed to be "arbitrary and capricious." Establishing a standard method and sampling plan, either through an official method or an "action level," can lead to huge differences in the stringency among requirements that are typically not transparent to the general public. For example, the routine sampling of powdered infant formula requires the absence of *Salmonella* in 60 25-gram samples, which is equivalent to being 50% confident that the level of the microorganism is less than one cell in more than 4,000 grams of product. Conversely, the sampling of raw meat is typically based on a single 25-gram sample, which provides 50% confidence that the level of *Salmonella* is less than one cell in 40 grams of product. Without this knowledge, the consumer would assume that the level is the same for both products. It is obvious that more effective means of exchanging information and understanding risk perception are critical foundations for developing risk-based food safety policies.

Traditionally both consumers and food safety experts rely on the help and advice of professional communicators (e.g., the media) to help bridge this communication gap. However, the fragmentation of the media during the past decade has made it increasingly difficult to reach anything approaching consensus. The consumers' increasing reliance on information sources that reflect the viewpoint of the listener reinforce preconceived conclusions regarding food safety issues, thereby limiting the benefits of hearing and weighing different arguments. This is further amplified by the rush to publicize food safety related studies that identify new safety concerns without putting it into the context of the actual risk to the public. Often preliminary in nature, when such research is flawed it is almost impossible to remove its influence if the findings support the suspicions that a portion of the population has about the underlying food safety issue. At its extreme, it has led to speculation of conspiracies

between the government and the food industry to suppress "the truth" about a food safety issue. A classic example has been the continuing effort to allow the interstate shipment of raw milk for direct human consumption. Despite a long history of public health concerns associated with the consumption of unpasteurized milk, particularly by young children, raw milk advocates continue to explore ways for getting around current restrictions. Likewise, the internet is replete with Web sites touting the benefits of raw milk consumption, despite numerous studies to the contrary. This situation is not restricted to foods. The media currently is awash with news, commentary, and political debate about the public health "costs" of allowing parents to elect not to immunize their children against preventable childhood diseases, such as the measles epidemic that started in the U.S. in late 2014, despite strong recommendation by the public health community.

Policy Issues

The broad question facing the food safety community is whether a science-based, risk-based food safety system is achievable, considering the context discussed above? As inferred above, key corollary questions that impact public policy are:

- Can we more effectively exchange views and information concerning the appropriate level of protection to reach a consensus?
- How can we balance and optimize public health needs in relation to other societal mandates?
- How can food safety experts become more effective in articulating the trade-offs that have to be considered in developing and implementing practical food safety policies, particularly when it is international in scope?

A particular hurdle is that this must be done in a manner that does not imply that the general public is incapable of understanding the scientific knowledge that must be analyzed. Further, this must be done in a manner that is transparent in the broadest sense to the broadest segments of the population possible. Key challenges and possible solutions include:

- Increase the stringency of peer reviews of scientific studies that have policy implications and provide an open public, internet-based forum that allows the results, ramifications, and veracity of the studies to be debated and reinterpreted as appropriate.
- Increase the transparency regarding agencies' consideration of public comments during the development of the final format of new food safety regulations.

- Work with major media outlets, professional organizations, public health community, and industry to de-sensationalize the reporting of new research, including de-incentivizing researchers from making speculative statements about the risk to public health as a means of enhancing funding of future research.
- Make it easier to modify regulatory requirements and guidance as a result of new scientific or technological findings.
- Find the funds and societal mandate to institutionalize these changes.

Without an ongoing effort to explain and discuss the risks associated with the food supply, we will continue to have groups of consumers who lack trust in the food industry and the public health institutions that are dedicated to safeguard the public. If we fail to attain a reasonable level of communication and trust, we will continue to see segments of the consuming population making decisions that increase their food safety risks. Given the global nature and interdependence of the modern food supply, implementation of risk-based food safety systems are critical to ensuring the safety of a food supply that is nutritious, secure, and reasonably priced.

*** A policy position paper prepared for presentation at the conference on Food Safety, Security, and Defense: Safeguarding the American Food Supply, convened by the Institute on Science for Global Policy (ISGP), April 10 – 11, 2015, at Ursinus College, Collegeville, Pennsylvania, U.S.***

Debate Summary

The following summary is based on notes recorded by the ISGP staff during the 90-minute not-for-attribution debate of the policy position paper prepared by Dr. Buchanan (see above). Dr. Buchanan initiated the debate with a 5-minute statement of his views and then actively engaged the conference participants, including other authors, throughout the remainder of the 90-minute period. This Debate Summary represents the ISGP's best effort to accurately capture the comments offered and questions posed by all participants, as well as those responses made by Dr. Buchanan. Given the not-for-attribution format of the debate, the views comprising this summary do not necessarily represent the views of Dr. Buchanan, as evidenced by his policy position paper. Rather, it is, and should be read as, an overview of the areas of agreement and disagreement that emerged from all those participating in the critical debate.

Debate conclusions

- It is imperative that food safety policies accounting for the interests of a variety of stakeholders be formulated using scientific, risk-based data. Food regulations must simultaneously protect the consumer and all participants within the supply chain, requiring balance and compromise between the needs of individual consumers, the nation, and private sector stakeholders.
- Lack of transparency among food system industry, regulators, policy makers, and the public undermines consumer trust in the science that underlies the regulation of food safety. Current means of eliciting public commentary on proposed regulations need to be improved by increasing transparency and by using publicly accessible technologies that are clearly relevant to the tasks (e.g., Internet-based forums).
- Because noncredible sources of information (e.g., bloggers, freelance writers, sensationalized media reports) successfully compete with information provided by legitimate scientists and policy makers regarding the dissemination of food-related material, discrediting untrustworthy sources is necessary to ensure effective food safety. Such contrasts are important even though they may draw unwanted attention to inaccurate information and its disseminators.
- Because consumers often misinterpret risk information as it pertains to food safety, there is an opportunity for improved education regarding how the safety of the food supply system is monitored. Community

outreach programs and other engaging platforms are ideal supplements for traditional classroom education regarding food safety concerns.

Current realities

When considering risk in food safety and security, the public frequently adopts different views depending on whether the risk is posed to the individual or the nation. It is therefore necessary to adopt food safety strategies that balance the needs of a nation with the desires of the individual. Recent trends in public opinion suggest that individuals want to be provided with the safest and least-processed products, two qualifiers that may not be achievable simultaneously because food technologies that enhance safety often require processing. Additionally, it was recognized that radical food processing treatments exist that promote food safety (e.g., bacteriophages, radiation), but their current use is rarely publicized broadly.

Incorporating the individual needs of the consumer with those of a nation requires that consumers be a part of the policy decision and the writing of the associated laws. Accordingly, the establishment of laws or regulations must follow the guidelines set out in the Administrative Procedures Act of 1946. In accordance to these rules, novel regulations must be subjected to public comment prior to enactment, and the public comment period may manifest during public meetings or, more recently, online. However, the Federal Register for public commentary is not viewed as user-friendly or easily accessible. These impracticalities limit the number and variety of opinions gathered from the general public. It was generally agreed that the current method of involving the public in establishing policies and laws, including food safety laws, is ineffective and hinders transparency between policy makers and their constituents.

The public tends to distrust the government-regulated system of establishing and maintaining food safety, in part because of the ineffective methods of obtaining public comments on food regulations. The food industry's profit motives generate public distrust that food safety and profitable business practices can co-exist. Lack of public trust in the safety of the food supply also was attributed in part to nontransparency between supply chain actors and the public. There was some disagreement, however, regarding the amount of information made available to consumers from food producers. It was generally agreed that production practices may not always be shared with the public, but this depends largely on individual producers, as many producers regularly open their facilities to the public.

Consumer distrust is exacerbated when risk information is disseminated by groups or individuals that are not trustworthy or knowledgeable in food safety risk assessment. It was generally recognized that while such individuals and

groups should not be the final authority influencing the public's perceptions, such noncredible sources are often the most accessible suppliers of information (e.g., online blogs, social media). While the First Amendment right to free speech means scientists and policy makers cannot prevent the dissemination of incorrect food-related information by untrustworthy sources, consumer advocates need to play a vital role in raising concerns, and incorrect information can be viewed as a point of engagement for scientists.

Ultimately, the quality and source of information are correlated, and the scientists performing the studies upon which food safety regulations are developed are typically untrained in communication tactics targeting the public. Consequently, both traditional and nontraditional (e.g., blogs, twitter, social media) media sources contribute to sensationalized risk information for consumers. Specifically, social media provide a platform for both accurate and inaccurate information to be communicated to the public, and it becomes the reader's responsibility to identify the valuable material. It was agreed that consumers need access to a reliable source of information that can be used to corroborate media-disseminated reports or alleviate associated concerns.

Scientific opportunities and challenges

Since consumers tend to be skeptical of supply-chain practices and regulations, scientific advancements in food safety can seek to enhance trust in the food system. This can be achieved by identifying values shared by all stakeholders in the supply chain, making parties with fundamentally different interests or goals (e.g., producers and consumers) more relatable to one another. For instance, two common values regarding food are safety and environmental protection; these two concerns could underlie science-based decisions impacting the food system.

Another opportunity for enhancing trust in the food supply chain involves encouraging consumers to take more active roles in the production of their food by working in large-scale or personal food production. In this way, individuals gain firsthand knowledge to improve their understanding of the complex challenges that dictate how food is produced and processed. However, there was some disagreement regarding the practicality and effectiveness of this suggestion, since working in food production is not currently a popular occupation.

Scientists face a massive challenge in finding and utilizing appropriate methods to transmit relevant food safety and risk information to consumers. This is particularly true because scientists are competing against pseudoscientists and celebrities who disseminate incorrect information and hinder trust in scientific authority. It is difficult to address the spread of misinformation. Overtly discrediting

the views suggested by unreliable sources may draw unnecessary attention to those sources and their opinions, resulting in inadvertent validation and public attention. In addition, individuals may seek information that supports previously held beliefs; noncredible sources generally can provide such information.

In light of these challenges, many opportunities exist to improve transparency between scientific authorities and the public by designating appropriate individuals to communicate scientific information in an accessible manner. It was undecided whether scientists should adopt the responsibility of interacting with the public, since scientists often are unable to translate technical information into universally understandable language. It was proposed that the most successful liaison between science and the recipients of scientific information would be an individual or group that can empathize with consumers' needs and give context to the complexities of the global food system's producers and regulators.

Stakeholders within the food industry are also responsible for disseminating information, occasionally contributing to the public's acceptance of incomplete or inaccurate food safety material. Companies compete with each other for shelf space and consumers' loyalty and dollars in the marketplace, resulting in brand information being pitched in such a way that could mislead the consumer. Such marketing strategies also influence what consumers think they want or need. There was disagreement regarding whether larger or smaller businesses are more likely to use marketing strategies that detrimentally impact public understanding of accurate food-related information. However, it was agreed that if communication practices change, private industry stakeholders need to be able to promote and protect their brands.

There exists a need to educate the electorate — a challenging task because people often struggle with the interpretation of statistics and their practical significance. Finding better ways to educate the public requires developing methods by which information can be presented to maximize interest and minimize sensationalizing the material. Scientific material delivered by popular science television shows (e.g., *Cosmos*) or documentaries is often embraced by the public, and similar formats might provide opportunities to present scientifically credible food safety information to consumers.

Consumers can be educated by a variety of sources and although it is impossible to ensure that they receive accurate information, it is important to increase the likelihood that they will. There is a fundamental difference between obtaining information from a company attempting to promote its product and receiving information from individuals disseminating inaccurate information for other purposes. Because of technology and social media, freelance writers and bloggers

(e.g., Food Babe) are extremely accessible sources of information for consumers, and they are skilled at communicating in a way that is understandable to the general public. Much disagreement arose regarding the level of harm such communicators pose to the goal of providing credible food safety information to consumers. Freelance communicators may not an overwhelming problem because eventually they are discredited or ridiculed in the public eye, which discourages others from spreading misinformation. However, a concern was raised that these writers often reach many consumers and gain a large following before the information may be discredited, after which time they are not held accountable.

Policy issues

Food safety policies need to be both risk- and science-based and, to maximize effectiveness, they also must incorporate the interests of as many stakeholders as possible. These interests can only be determined by successfully including stakeholders in the conversation when policies are written. Both social and economic costs need to be considered. Individuals need to have the opportunity to make decisions that may include a risk to themselves. However, their decisions cannot endanger the lives of others. Just as physically harming another person results in legal action, imperiling others on the basis of personal food preferences (e.g., serving unpasteurized milk) also needs to be addressed by policy.

When developing policies for food production, it is particularly important to balance the needs of small- and large-scale producers. Conflicting opinions were expressed regarding whether regulations should be enacted in a size-neutral or size-dependent manner. Creating regulations may be more uncomplicated when all producers are affected equally regardless of facility size. However, smaller farms lack the resources, including novel technologies, possessed by larger operations and therefore might be unable to enact the same protocols.

Another area of concern is the role of the media in dispersing food safety information. Government, industry, and academia need to effectively work together to minimize the dissemination of incorrect food-related data from both scholarly and nonscholarly sources. Professional communicators within a respected scientific society (e.g., National Academy of Sciences) could fulfill the role with their responsibilities including the dispersal of accurate information and confirmation that food safety data submitted for publication are well-supported. U.S. government agencies involved in monitoring and regulating food safety (e.g., Food and Drug Administration, the Centers for Disease Control and Protection) need to have their authority expanded to allow for a more active role in discrediting inaccurate information from media sources.

Transparency needs to be facilitated among all stakeholders in the food supply chain, enabling both consumers and policy officials to make informed decisions. Although risk information may not be interpreted accurately by the public, the information needs to be provided freely. It was generally agreed that an improved format for two-way communication be established by creating a publicly accessible Internet forum through which consumers and other food stakeholders can exchange information. Such a forum could provide an effective venue for the solicitation of public commentary on proposed food-based regulations.

It was recognized that trained communicators are necessary in all facets of the food system to more effectively transfer information to the public. Giving full authority for food safety information to a single department or organization may not be the solution because a single organization is unlikely to earn enough public trust to be seen as the final authority. However, it was agreed that science communicators need to be trained to interpret technical scientific information, allow for perform peer review, and also simplify a message for dissemination by popular media.

Consumers need to take an active, engaged role in the two-way communication regarding food. Improved public education may prompt consumers to ask the right questions about food risk and safety. Policy makers also need to better explain the criteria they used to enact regulations. It was agreed that schools need to incorporate curricula to teach students about food safety and risk. Case study-based learning could demonstrate what happens before, during, and after events of compromised food safety. It was suggested it would be beneficial to bolster high school-level education regarding civics, government, and the process of policy making in an effort to improve the public's understanding of how food-related policies are created.

Policies to Proactively Address the Threat of Food Fraud**

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Summary

Food fraud presents a threat to the health of American consumers. Food fraud is the intentional misrepresentation of food products or ingredients for economic gain. Although not intended to cause illness, food fraud incidents have resulted in consumer illnesses and deaths. Furthermore, they cause considerable economic losses to industry, and the public health response requires substantial resource allocation by regulatory and public health agencies. The true scope of food fraud is not known, but it is known that it has occurred in a variety of ways and in a wide array of food products. Due to the intentional nature of food fraud, the threat will not be adequately addressed through strategies designed to control unintentional food contamination. The increased risks created by an increasingly globalized food supply require policies that foster innovative and multidisciplinary solutions for food protection. The threat of food fraud will require innovative approaches to risk assessment and the use of methods and data from a variety of disciplines. Strategic collaborations and information sharing among regulatory agencies, the food industry, academic organizations, and nonprofit groups are necessary for constructing a holistic solution to the problem of food fraud. Ultimately, food fraud prevention efforts must be industry-driven, but these efforts must be based on collaborative research and development.

Current realities

Food fraud can occur through a variety of methods, including substitution of one ingredient for another (e.g., fish species swapping); dilution of products such as oils or juices with cheaper ingredients; fraudulent identification of country-of-origin, harvesting, or processing techniques; or artificial enhancement with unapproved substances (see Figure 1). Food fraud presents a real threat to the American food supply. Multiple large-scale food fraud incidents over the past 10 years in products as diverse as oils, fish, infant formula, and ground beef have illustrated that we cannot assume that any of our food supply chains are completely protected. Food fraud perpetrators have proven to be knowledgeable about food safety and quality

systems, and adept at evading those systems. Therefore, prevention strategies that are designed along the lines of traditional food safety practices will not effectively address the threat of food fraud.

We do not know the true scope of food fraud. It is very likely that documented incidents are merely the tip of the iceberg, and that most incidents are undetected or unreported. If fraudulent practices are identified within a food company's supply chain before a product goes to market, they are usually addressed through the contractual relationship between the supplier and buyer, and not addressed through regulatory channels. Most food fraud incidents do not cause illnesses or deaths in consumers since the intent of the perpetrators is to evade detection and continue the fraudulent practice. However, perpetrators sometimes make mistakes. In 1981 in Spain, 20,000 illnesses and more than 300 deaths were attributed to the fraudulent sale of olive oil that was actually industrial rapeseed oil denatured with the chemical aniline. In 2008, adulteration of milk supplies in China led to 300,000 illnesses and at least six infant deaths.

Since the vast majority of incidents do not result in immediate public health consequences, from a regulatory perspective, food fraud is generally considered less of a priority than food safety (i.e., prevention of unintentional contamination of foods and ingredients with pathogens or allergens). Given regulatory agency resource constraints and a focus on public health protection by those agencies, this prioritization appears reasonable. However, the increasing globalization of the food supply is arguably increasing all risks to food protection, including unintentional contamination, intentional contamination for ideological reasons, and intentional adulteration for economic gain.

Large-scale food fraud incidents that do not cause consumer illnesses nonetheless result in serious financial losses to industry and substantial resource expenditures by regulatory agencies. The horsemeat adulteration incident of 2013 in the European Union (E.U.) affected hundreds of companies and resulted in recalls of more than 40 products. Recalls related to a 2005 incident of adulteration of chili powder with an industrial dye in Europe cost the food industry in the U.S. an estimated $145 million. Finally, although there were no reported illnesses in American consumers related to melamine adulteration of milk in China, resource expenditures related to investigation of the incident, product trace-back investigations, recalls, and risk assessments were extensive.

Scientific opportunities and challenges

Food Safety and Modernization Act (FSMA) legislation mandated that the Food and Drug Administration (FDA) issue regulations to prevent intentional adulteration of

food. The FDA has addressed food fraud (what they call "economically motivated adulteration" or EMA) in two of the proposed rules subsequently issued as a result of FSMA legislation. The tentative conclusion by the FDA as of the writing of this paper is that food fraud would be most appropriately addressed in "Current Good Manufacturing Practice and Hazard Analysis and Risk-Based Preventive Controls for Human Food" (hereafter, the "PC rule"). Therefore, food fraud regulations would be included with the rule that primarily addresses traditional food safety threats instead of the rule focused on intentional adulteration of foods. The FDA tentatively concluded to include EMA provisions in the PC rule because the adulterants used "could be viewed as reasonably likely to occur" given a historical pattern of use.

One of the main challenges with food fraud historically has been the use of new or unexpected adulterants or fraud practices. At the time of melamine adulteration of milk in China, melamine was not considered to be an expected adulterant with a historical pattern of use. While the FDA's approach may prevent certain types of food fraud, it is not likely to detect new adulteration methods. Therefore, many food industry stakeholders may find it necessary to implement food fraud prevention strategies above and beyond those mandated by the FDA. The food industry has a vested interest in preventing food fraud. Food fraud incidents can result in widespread recalls, economic losses, and brand damage, even when there are no consumer illnesses. Multiple industry groups are currently pursuing food fraud initiatives, most notably the Global Food Safety Initiative (GFSI). However, specific guidance and recommendations for reducing the risk of fraud in food supply chains are still in development.

Many food fraud incidents result in short-term increases in targeted adulterant testing within the supply chain. While this is one important component of a holistic food fraud prevention strategy, increased testing is not a practical solution to the larger challenge of food fraud. Food safety risk assessments consider environmental factors that lead to contamination. In the case of food fraud, these "environmental" factors include the drivers behind incentive and opportunity. Some of these drivers may include the cost and availability of ingredients and adulterants, supply chain control and oversight, and the political climate. Development of an efficient, comprehensive, and holistic food fraud prevention strategy requires a multidisciplinary approach that includes a consideration of these factors.

Policy issues

A holistic and efficient strategy for prevention and control of food fraud will take advantage of the most appropriate roles and resources among federal agencies, the food industry, and academic and nonprofit organizations.

- Implementation of food fraud prevention and control strategies must be led by industry since industry has primary visibility into and oversight of the supply chains for their food products.
- Federal agencies must provide broad regulatory guidelines that empower food companies to tailor these strategies to their supply chains. Federal agencies must fund the appropriate research to inform and develop food fraud prevention and control methodologies, and foster information sharing among stakeholders in government, industry, and academia.
- Academic researchers must form multidisciplinary teams for developing and testing food fraud vulnerability and risk assessment methodologies. Academic or nonprofit institutions also may serve as third-party facilitators of information sharing between federal agencies and the food industry.

Grant opportunities targeted at food fraud (or EMA) have been limited. Agencies that fund food protection research and development must include food fraud as a priority area of interest.

- Given the intentional nature of food fraud, federal funding opportunities should encourage innovative approaches to risk analysis. This will likely include the incorporation of "nonscientific" or "nontraditional" data sources, such as economic drivers.
- Funding opportunities must prioritize the formation of multidisciplinary research and development teams that include academic, government, and industry partners.

Information is critical for early identification of food fraud incidents, or increased potential for food fraud in particular food products or ingredients.

- Regulations and policies must remove barriers to information sharing between government and industry.
- Actionable information sharing will require a protected environment with legal and IT resources dedicated to protecting confidentiality, data security, and information vetting.

References

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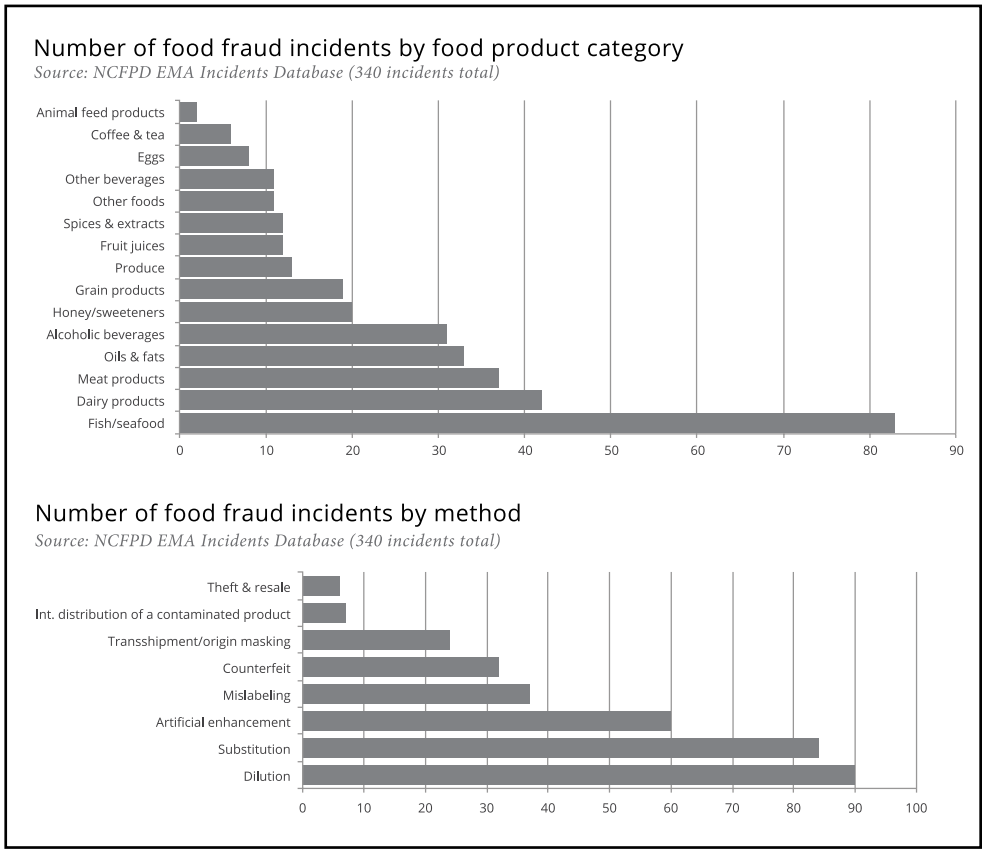
***** A policy position paper prepared for presentation at the conference on Food Safety, Security, and Defense: Safeguarding the American Food Supply, convened by the Institute on Science for Global Policy (ISGP), April 10–11, 2015, at Ursinus College, Collegeville, Pennsylvania, U.S.***

Figure 1. Documented food fraud incidents by method and by food product category.



Debate Summary

The following summary is based on notes recorded by the ISGP staff during the 90-minute not-for-attribution debate of the policy position paper prepared by Dr. Karen Everstine (see above). Dr. Everstine initiated the debate with a 5-minute statement of her views and then actively engaged the conference participants, including other authors, throughout the remainder of the 90-minute period. This Debate Summary represents the ISGP's best effort to accurately capture the comments offered and questions posed by all participants, as well as those responses made by Dr. Everstine. Given the not-for-attribution format of the debate, the views comprising this summary do not necessarily represent the views of Dr. Everstine, as evidenced by her policy position paper. Rather, it is, and should be read as, an overview of the areas of agreement and disagreement that emerged from all those participating in the critical debate.

Debate conclusions

- Because an enhanced level of accountability needs to be built into prevention strategies for food fraud (i.e., deliberate adulteration or misrepresentation of food), policies and the regulators responsible for overseeing them, need to emphasize enforcement to hold guilty parties legally accountable, rather than increasing punishments for food fraud infractions.
- To improve safety and accountability in the global food system, the ability to trace the sources of products and their ingredients needs to be greatly enhanced.
- The effectiveness of strategies to prevent food fraud, and thereby ensure food safety, relies strongly on the sharing of information among government regulators and industry stakeholders for the benefit of all parties. Such information sharing may require Incentives for private sector stakeholders to provide access to otherwise proprietary data.
- Organizations (e.g., Information Sharing Analysis Centers within the U.S. Department of Homeland Security [DHS]) charged with promoting the transparent sharing of information among government and private sector entities are needed if food fraud is to be more effectively controlled.

Current realities

Although the term "food fraud" is commonly used internationally, in the U.S. the FDA uses another term: "economically motivated adulteration" or EMA. While

widely reported incidents such as the 2013 European horsemeat adulteration scandal (i.e., food labeled as containing beef were found to contain undeclared or improperly declared horse meat — as much as 100% of the meat content in some cases) periodically highlight the practice of food fraud, the large majority of cases likely go undetected. Such dilution of high-cost products with lower-cost ingredients is viewed as the most prevalent form of food fraud, along with the false labeling of food products as "organic" or from "free-range" animals. While these examples suggest that the majority of acts leading to food fraud do not result in serious public health consequences, in fact large-scale outbreaks of illness, and in some cases deaths, associated with food fraud serve as stark demonstrations of the significant harm that can be caused. Cited as one example was the 2008 adulteration of milk and infant formula with melamine in China, with hundreds of thousands of victims getting sick and at least six infants dying.

Food fraud is often perceived as mainly a concern for high-income consumers, such as recent issues with adulterated olive oil and honey. However, it was emphasized that food fraud is a concern for all demographics. All consumers need to be able to purchase food that is legitimately identified through its advertisements. Food fraud can compromise human health in many ways including degrading the nutritional value of products, retarding the growth of the young, endangering the aging of the elderly, and facilitating diseases, and even death in immunocompromised people.

Food fraud also affects supply chain control and oversight, impeding traceability, and creating risks to the safety of food in general. This lack of traceability (i.e., being able to follow an ingredient only "one step forward or one step back within the food supply chain") undermines consumers' ability to make informed food choices. It can create unfair market competition and create financial hardship for legitimate producers and suppliers. Limited traceability also impedes regulatory actions at governmental, organization (e.g., FDA). FDA investigators tend to feel legally hampered in their investigations because they do not want to reach premature conclusions or implicate any wrongdoers when they cannot accurately trace an adulterated product or ingredient to its source.

Communication between regulatory agencies and food manufacturers is often limited, with the food industry routinely receiving very little actionable information from federal regulatory agencies. Recognizing that new food fraud regulations can result in perpetrators becoming harder to identify, some progressive components of the U.S. food safety system (both public and private entities) are working to expand information-sharing networks. Within the U.S., Information Sharing Analysis Centers (ISAC) help the private sector and government reach agreements regarding regulations and requirements. The goal of these venues is to promote discussions

between private industry stakeholders and government regulators.

While U.S. government oversight of food safety is often viewed as inefficiently redundant, the opposite situation applies to food fraud prevention: government agencies appear to try to distance themselves from exerting authority. For example, U.S. Customs and Border Protection is responsible for trade issues, but they defer to the FDA on food regulations. The FDA in turn is focused primarily on public health harm, and its regulatory enforcement is limited. An organizing body or group that can champion food fraud prevention is needed and ISAC was proposed as a valuable model of this kind of organizing body.

Globally, regulations on food fraud and food safety are disjointed. Regulations vary among countries, with some stricter or more transparent than others. It was difficult to highlight one system as being better than others because defining successful outcomes can be difficult. For example, should the primary measure of success for food fraud prevention efforts be public health, or the number of identified adulterations, or the number of product recalls? European programs, specifically programs in the United Kingdom, were identified as more progressive than U.S. systems in how they investigate food fraud and their multidisciplinary prevention teams.

The FDA's regulatory approaches prevent certain types of food fraud, but were considered less effective at identifying new methods of adulteration. This may be because of the FDA's strong focus on public health concerns, as well as the fact that it is difficult to hold industry responsible for not preventing unintentional, unanticipated adulterations. While food fraud can legitimately threaten public health, the majority of known instances have been economic challenges rather than health challenges. The FDA is not in a position to shift significant resources away from activities focused preventing food-related public health problems. Because of these factors, regulatory prevention and detection efforts are in a perpetual cycle of lagging behind food fraud perpetrators.

The presence of EMA in the preventive controls section of the Food Safety and Modernization Act (FSMA), and thus, within the framework of "reasonably foreseeable," was criticized as creating limitations on the FDA's ability to significantly reduce food fraud incidents and hold perpetrators accountable for criminal acts. However, it was generally agreed that having food fraud specifically addressed in FSMA is an improvement.

The food industry needs to take the lead in driving efforts to prevent food fraud, even if it does not threaten public health (e.g., product dilution with cheaper, but safe ingredients). Several proactive fraud prevention efforts were noted, including industry's constant development of new analytical tests for ingredient integrity,

organizing "early warning groups" that assess both scientific and econometric data, and the gathering of expert panels by organizations such as United States Pharmacopeia to prioritize resource allocation on particular ingredient issues.

While discussing the scope of food fraud nomenclature and regulations, it was clarified that instances of food products carrying technically or culturally incorrect descriptions, such as "parmesan" for cheese not from the Parmigiano-Reggiano region of Italy, are not necessarily cases of food fraud. Food safety and fraud regulations are based on listed ingredients and health concerns, and these other concerns revolve around marketing and advertising, and are thus an issue for the Federal Trade Commission.

Scientific opportunities and challenges

Product traceability is a major challenge for food safety. The food supply chain is truly global, and there are often very lengthy supply chains with numerous small-scale growers combining their products for distribution to a wholesaler or manufacturer. It can be immensely difficult to trace food fraud back to its exact origin, and accountability is of major concern. Often, no one is fully held accountable for an identified incidence of food fraud.

Food vulnerability assessments are an essential component of food supply safety. These assessments can account for relationships among producers, suppliers, and distributors, and the level of supply chain oversight. However, assessments cannot completely maintain product consistency, as production demands and the need for expediency routinely require the use of alternative ingredients and suppliers that may have different levels of verification.

Another key challenge lies in developing the most appropriate tests for food composition. Often the tests assess chemical proxies rather than an actual ingredient. For example, in the 2008 Chinese milk scandal, milk was adulterated with melamine to artificially add nitrogen content, which was the basis of the test for total protein content. This case illustrates how analytical tests that measure markers rather than assessing true food identity can be exploited.

It is virtually impossible to test for all possible contaminants and nontargeted analytical approaches are necessary tools. Nontargeted approaches are not based on tests for known or likely contaminants, but on what constitutes a "true" product. Any deviation from that true characterization indicates an adulteration, dilution, or contamination of the product. Analytical chemists need to continue to develop nontargeted methodologies and industry and regulatory agencies need to work to standardize analytical measures to verify product identity as the critical step in revealing food fraud.

Multidisciplinary approaches are needed to optimize the processes for identifying food fraud. Public health specialists, epidemiologists, analytical chemists, lawyers, economists, and procurement specialists are particularly important. For example, effective utilization of economics and trade data could help focus regulators' attention on specific problem areas and potentially provide early indications of fraudulent behaviors. Multidisciplinary approaches also can expand the scope of food fraud prevention beyond the conventional strategies of increased testing, harsher punishments, or stricter regulations. Researchers are looking more carefully at the factors motivating food fraud (e.g., economic gain) and analyzing how the supply chain is structured to inform more accurate strategic risk assessments.

Food import data may serve as an early indicator of fraudulent activities. It is not uncommon for products to be considered adulterated under U.S. law, but legal in another country (e.g., different pesticides are permitted for use in different countries). Increased analyses and accounting of food imports would help uncover unexpected fluctuations in the supply chain, which might in turn identify shipments and points of origin that require higher scrutiny.

Consumers play a vital role in food fraud prevention. Their concerns regarding accurate food labeling need to be heard and addressed in regulations. Communication mechanisms can enable accurate, rapid information exchange among consumers, industry, researchers, and regulators regarding fraud. Improved communication with consumers also is important to properly frame the ways in which food fraud directly affects them. Innovative social media interfaces are under development to achieve this goal, but more work is needed.

Food fraud understanding in the U.S. is hampered by a lack of complete information. Because most fraud goes undetected, reported statistics are believed to be misleading. Increased media attention on a particular commodity also can skew the numbers in incident reports or fraud prevalence. Current food fraud data are often inadequate to demonstrate true causality and therefore, the quality of these data needs to be improved to achieve accountability throughout the food system.

Policy issues

Food fraud prevention policies need to be more holistic to account for the motivators and drivers behind fraud. Changes in supply and demand, price fluctuations, and alterations in tariffs and duties need to be considered in food fraud risk assessments. Academic researchers have a strong role to play, both in testing products for adulterants and in identifying and assessing early indicators of fraudulent behavior.

The "one step forward and one step back" nature of traceability in the global supply chain is inconsistent with maintaining food safety and preventing fraud.

Instead, policies and regulations need to allow for comprehensive traceability of ingredients and products throughout the food chain. Additionally, quantitative risk assessment approaches need to be further developed and promoted in strategies to prevent food fraud.

Increasing the amount of testing or regulations will not necessarily improve the effectiveness of prevention and enforcement efforts. There already are a number of third-party certification and audit programs available, and unintentional acts will not be addressed by increased regulation. One approach involves the enhanced accounting of food production and food sales focused on issues such as monitoring sales that exceed known production as an indicator of dilution or substitution leading to fraud.

Policies and funding need to support agricultural extension education programs and improved production efficiency as issues identified as factors that motivate the commission of fraud. While strategies that shorten the supply chain (e.g., distributors obtaining products directly from manufacturers) may improve oversight and safety, these strategies are not universally applicable.

Rather than increasing punishments for food fraud, policies and regulators need to focus on enforcing current regulations and ensuring that guilty parties are held accountable. A more effective policy goal may be to ensure appropriate legal accountability, especially in instances with public health consequences (e.g., common allergen ingredients substituted in fraudulent acts).

Regulatory policies and testing approaches need to outline specific testing methodologies, either targeted or nontargeted, where appropriate. Product testing also needs to be performed at strategic points in the supply chain, determined by risk assessment and vulnerability analyses. Quantitative risk assessment approaches, which are currently utilized in some food safety areas, need to be expanded into the area of food fraud.

U.S. regulators and policy makers may reconsider classifying certain food safety risks as "adulterants" (e.g., antibiotic-resistant bacteria normally found in animals). Current regulatory language broadly classifies any product that doesn't meet requirements as "adulterated." Categorizing "natural" or inadvertent contaminations as food fraud may weaken enforcement of regulations meant to identify criminal acts for which there can be legal punishments.

Support needs to continue for organizations like the DHS Centers of Excellence for food protection and defense against terrorism. Funding for these efforts mainly derive from the DHS, with additional funding from the FDA and USDA.

Comprehensive safety oversight likely is more achievable on domestic products rather than imports. However, the food system is truly global and there are certain

ingredients and products that cannot be obtained domestically. Therefore, policies and regulations must build safety and accountability into the international supply system, rather than broadly excluding certain supply regions.

U.S. policy needs increased information sharing among government regulators and industry. Incentives for information sharing, conducted in secured environments and designed to benefit both public and private interests, are necessary. One example was the FDA Guidance Documents designed to assist the private sector in meeting regulatory requirements. These documents, used to prioritize prevention efforts to the areas of highest vulnerability and in turn, inform resource allocation, need to be based on transparent communication and shared information. Information-sharing arrangements such as the ISAC are models for effective communication between government and industry. Legally forcing information-sharing agreements upon industry was not endorsed as an appropriate means to achieve this goal.

Ultimately food fraud prevention and control strategies need to be driven by the food industry. While regulators may have access to some unique information, food producers and manufacturers generally know the most about their supply chains. Food fraud reporting in a national registry is one possible approach for enhancing communication, industry leadership, and accountability. Systems-based risk assessments also provide a strong approach to evaluating fraud vulnerabilities across the supply chain.

Private industry needs to ensure that policies are in place to protect whistle blowers who report food fraud incidents. Industry needs to be incentivized to lead these efforts, both to protect their brands and to decrease the demand for more regulatory oversight.

Technological Safeguards for the U.S. Food Supply: Moral and Ethical Dilemmas**

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Summary

Safeguarding the American food supply through actions that improve food safety, security, and defense (FSSD) appears — at first glance — to be an objective without contention. True, there will always be priorities to be set, and trade-offs to be made, especially given limited and dwindling budgets. That said, the imperative to provide readily available food, at a reasonable cost, and free from pathogen and toxin contamination — whether intentional or unintentional — seems obvious. While technological solutions to FSSD problems abound, large-scale adoption and widespread diffusion of these often depends on ease of use, cost-benefit calculations, and effective marketing. Meanwhile, implementation decisions typically are made by the individuals or groups that bear the costs, even if that sector does not benefit directly from the technology.

Conflicting moral obligations, combined with vague guidelines for ethical practice, can create untenable situations regarding adoption of new technology in agriculture and food, especially when readily apparent animal health, production, or welfare needs in the present are weighed against poorly characterized or future impacts on animal and human health and well-being. Antibiotics and beta-adrenergic agonists (BAA) used in United States animal agriculture are explored as exemplar technologies, with the potential to simultaneously safeguard the U.S. food supply while also posing temporally distinct risks to widely disparate parties. Science-based policy in this arena cannot shy away from exploring and seeking to understand the conflicting moral and ethical dilemmas that face multiple stakeholders, both present and future, and must seek to optimize effectiveness of these technologies for future generations through ethical practices in the present. Policy options for navigating this complex landscape must carefully be examined even as difficult and timely choices need to be made.

Current realities

Demographic predictions concerning human population growth as we head toward the year 2050, along with economic forecasts of massive shifts toward a growing middle class during the forthcoming 35 years, have led many to argue that future demands for a vastly expanded supply of animal-based protein warrant wider acceptance of controversial technologies in our food system. Examples of such technologies include growth promoting agents such as BAA in swine, turkeys, and cattle, genetically modified organisms (GMOs) of various kinds throughout agricultural production systems, growth hormones generated using recombinant DNA techniques, steroidal implants, and the routine use of antibiotics to promote growth and prevent disease. Moral and ethical considerations of these technologies are not simple, especially since potential risks and benefits seem unlikely to be borne by the same individuals or groups, and can take years or even decades to fully manifest.

The various uses of antibiotics, from growth promotion through prevention, control, and treatment of bacterial disease, are well documented as to their benefits to animal health and well-being, though arguably less so in their potential to reduce risks related to food safety. The narrative that has emerged concerning the continued use of antibiotics in animal agriculture versus in human medicine tends to involve as much a discussion of moral beliefs or social norms as a discussion of science. Such a values-based approach to public deliberations and policy-making was well-illustrated in the precautionary principle-based approach used to enact a 2013 restrictive-use policy change in Europe concerning the use of colistin, an old antibiotic with little evidence of resistance, in animal agriculture. In June of 2010, Dr. Joshua Sharfstein, then U.S. Food and Drug Administration (FDA) deputy commissioner, suggested that antibiotics should be used only to protect the health of an animal and not for faster or more efficient growth. His quote during a conference call with reporters: "To preserve the effectiveness, we simply must use them as judiciously as possible." Within this seemingly simple statement exists both the moral imperative to preserve effectiveness of antibiotics for the future, and the ethical framework by which such goals are to be achieved (i.e., avoid injudicious use in the present). The direct result of this statement was the rollout of two of the major policy initiatives of the FDA in the past 10 years: Guidance for Industry (GFI) 209 and 213, both of which are being implemented through 2016.

In relatively few countries, BAAs may be fed to certain food-producing animals late in their production cycle to enhance growth, feed efficiency, meat protein, and carcass yield. Approval of BAAs for use in the U.S. is not without controversy, though federal regulators determined that benefits to producers outweighed risks

for the food animals and that there exists minimal risks to human health. Since approval, reports have emerged that suggest there can be negative impacts of BAAs on animal health and well-being in certain situations. Policy decisions made under certain circumstances (e.g., where benefits to food security are weighted against documented animal welfare concerns in an *ex post facto* manner) are not well grounded in a regulatory sense. Further, they carry enormous consequences for commerce and affect a variety of interested parties. Since the summer of 2013, there has been a voluntary ban on sales of one BAA, zilpaterol, by its manufacturer and meat packers refuse to accept animals raised with the product. In this case, policy was set by downstream meat packer, retailer, and consumer expectations of animal welfare and supply chain accountability.

Scientific opportunities and challenges

In addition to human health and food security concerns, animal health and well-being also need to be considered in deliberations concerning research, development, commercialization, and adoption of technology. Many in the agrifood research and production community, including some Fortune 500 companies, argue that current public health, animal health, and welfare concerns must yield priority to the future needs of a growing population. In a January 19, 2015 New York Times investigation into animal welfare shortcomings at a U.S. Department of Agriculture (USDA) research facility, a recently retired scientist was quoted as saying, "It's not a perfect world. We are trying to feed a population that is expanding very rapidly, to nine billion by 2050, and if we are going to feed that population, there are some trade-offs." Clearly, the temporal scale of the risks and the benefits of many of these technologies test the limits of moral reasoning when it comes to defining our obligations to future individuals (i.e., the unborn and, in many cases, 2 to 3 generations removed from the present) and the proposed and expanded population numbers. Logic alone would suggest that if 7 billion or even 8.5 billion people lack sufficient resources to be fed, the population could not possibly multiply to reach 9 billion. Furthermore, arguments concerning the desirability of such a population size are completely lacking, implying an inevitability of the outcome.

Regardless of these lapses in reasoning, the core question remains: Do we sacrifice tangible – if conflicted – moral obligations in the immediate present, in favor of a more nebulous obligation to unknown, unknowable, or even unconceived persons in the future? Further, how do we account or adjust for unforeseen risks and benefits in the present, even if not fully realized at the time a new technology is brought to market. These are among the grand challenges of our day; the next Green Revolution may instead be an animal protein revolution, if not a 'Red Revolution,' and

the ethical litmus tests needed when applying new technology to sentient beings such as animals — rather than plants — greatly complicates the policy-making process.

Policy issues

- Technologies displaying unique hallmarks of risk and benefit, as borne by different players in the food production system, must be subjected to rigorous assessments encompassing these multiple endpoints. Transparent dialog among sponsors, stakeholders (or their advocates in the case of animals), and regulators needs to occur to explicate the risk/benefit scenarios and inform the debate on the merits of approval.
- Policy, as developed and executed by regulatory agencies (including both the approval and post-approval process) needs to account more holistically for the intertwined nature of the food system and its actors and also for the unforeseen circumstances that cannot be uncovered in a pre-approval setting. As one example, although drugs are not metabolized as efficiently in sick as in healthy animals, pre-approval trials are almost always conducted using the latter. Residue-avoidance milk and slaughter-withholding periods established in these settings have been shown to be inadequate to protect public health.
- The ability of animals to physiologically adapt to endocrine agonists such as BAAs may not be adequate during periods of heat stress, nor is statistical power sufficient in small experiments to address the innumerable adverse endpoints that can emerge in a post-approval period. Formal post-approval surveillance systems must be developed, monitored, and overseen by independent parties (i.e., such as FDA or USDA), especially for products not developed to improve animal health or well-being.
- Quantitative risk assessment, the gold standard of regulatory approval, remains rigidly structured in linear systems. It defers to "hard sciences" even when technical solutions remain elusive and ignores human values even when problems demand their consideration. Instead, scenario-based risk assessments offer the potential for multiple stakeholders to more fully explore the breadth of known, and unknown, unknowns, even if resulting estimates appear to lack the rigor of a purely quantifiable and single endpoint. The major advantage of the more qualitative approaches exists in offering stakeholders the opportunity to mirror the multitude of potential outcomes against their own values and to engage in constructive debate with others, hopefully avoiding marginalization.

- Moral imperatives and accepted ethical practice must share the stage with the so-called hard sciences in determining the acceptability of novel technologies in the FSSD realm. When interested parties invoke implicit or explicit moral high ground, their worldviews need to be balanced against those views of others with equal stake in the process and the degree of scientific risk certainty. Acquisition of the most relevant data often begins the day that a new technology is first marketed. However, few formal mechanisms exist for capturing these data in a meaningful and systematic manner nor can re-evaluation of approval decisions occur without a very high threshold for proving harm or at great cost. A careful analysis of the post-approval process at regulatory agencies is warranted.
- Who speaks for the future? This question must immediately follow the question: Who speaks for those with no voice (i.e., the animals)? When developing technologies applied to sentient beings. we must aim to pass the litmus test of "do no harm" while they are under our care. Given the difficulty in achieving this completely, let alone measuring it, the focus of animal industries and food producers must be on constant vigilance, reevaluation, and independent oversight by third party auditors to assess well-being, minimize discomfort, and explore and adopt the best alternatives.

***** A policy position paper prepared for presentation at the conference on Food Safety, Security, and Defense: Safeguarding the American Food Supply, convened by the Institute on Science for Global Policy (ISGP), April 10 – 11, 2015, at Ursinus College, Collegeville, Pennsylvania, U.S.***

Debate Summary

The following summary is based on notes recorded by the ISGP staff during the 90-minute not-for-attribution debate of the policy position paper prepared by Dr. H. Morgan Scott. Dr. Scott initiated the debate with a 5-minute statement of his views and then actively engaged the conference participants, including other authors, throughout the remainder of the 90-minute period. This Debate Summary represents the ISGP's best effort to accurately capture the comments offered and questions posed by all participants, as well as those responses made by Dr. Scott. Given the not-for-attribution format of the debate, the views comprising this summary do not necessarily represent the views of Dr. Scott, as evidenced by his policy position paper. Rather, it is, and should be read as, an overview of the areas of agreement and disagreement that emerged from all those participating in the critical debate.

Debate Conclusions

- Technologies designed to meet global demands for animal protein by increasing animal growth (e.g., antibiotics) need to be more comprehensively evaluated by comparing their potential benefits to their effects on public health, environmental health, and animal wellbeing. The urgent demand to feed a growing worldwide population needs to be balanced with humane and sustainable food production.
- Effective solutions for food insecurity, current and future, need to include cultivating and marketing plant-based protein and eliminating the excessive waste that exists in the food supply chain.
- To establish effective regulations regarding the use of animal-agriculture technology, policy makers need to provide forums in which diverse stakeholders can transparently discuss and prioritize scientific, economic, moral, and ethical concerns. Such stakeholder input needs to be accurately reflected into policy decisions.
- While some animal-agriculture technologies appears to be promising in terms of increasing food yield while minimizing the environmental impact of production and improving public health, there is a need for regulatory oversight that ensures data on drug usage are gathered over the long term (i.e., post-approval) to track the impact of the technology on human and animal health.

Current realities

Currently, it's estimated some 1.2 billion people are food-insecure. In 2050, it's projected that the world population will require 70% more food than today, and that a growing middle class will seek more animal protein for its diet. To meet current and anticipated future demand, farm-animal food producers are using technologies (e.g., antibiotics) to increase per animal food yields. The imperative to increase yields in food production without further degrading the environment is resulting in the use of new technologies in animals that may be harming animals and may increase antibiotic resistance.

Although different stakeholders in the food industry (e.g., producers, public health advocates) may have conflicting obligations regarding safeguarding the American food supply, common concerns exist. Because one such common goal is the desire to preserve future antibiotic effectiveness in humans, the FDA is currently discouraging the use antibiotics to promote animal growth, even though it was noted that this practice generally has improved the health and quality of life of the treated farm animals. Surveys suggest that economics is a low-level motivator for antibiotic use among animal producers. A more prime motivator for using antibiotics on farm-raised animals is a moral sense of duty to prevent illness. It was suggested that bridging the divide between public health advocates and producers would be easier if the former group recognized that producers don't want to see their animals get sick before they use antibiotics.

There is a need for better regulatory and surveillance systems to ensure new food technologies are not harmful. Little data are available regarding how antibiotics are used in animal production. Surveillance systems generally are focused on detecting antibiotic resistance in treated animals. Such resistance takes at least a decade to develop after a new drug is introduced. Although datasets of information on antibiotic use and adverse reactions can be consulted when new drugs are introduced, databases are difficult to access and omit information, sometimes because of nondisclosure agreements with multisite investigators.

Pre-market tests analyzing the presence of adverse effects of new technologies may not be large enough or encompass a long enough time frame to detect adverse effects. Only when a technology is in widespread and prolonged use may effects develop. One example was given of a 2013 event in which it was reported a spike in deaths of cattle traced to beta-2 adrenergic agents, which were used to promote growth. Cattle had to be destroyed because their hooves fell off. Increased animal mortality has been documented with the use of beta agonists to promote animal growth. It was noted that the U.S. currently approves many animal production

technologies that other countries do not, which suppresses prices because the products cannot be exported.

Ionophores (a class of antibiotics not used in humans) were cited as an example of a current technology that could have many positive benefits for humans, animals, and the environment if proper safeguards could be found. The use of ionophores in animal feed has positive ecological effects (e.g., reduces the animals' carbon footprint and greenhouse gases), increases feed efficiency, and helps control the intestinal parasite Coccidia. However, these molecules are lethal to horses and pigs. Feed producers for several different animals may create issues of possible ionophore cross-contamination. Another technology held up as having positive attributes is recombinant bovine somatotropin, or rbST, a synthetic version of a growth hormone naturally found in milk. The technology increases milk yield in dairy cows, meaning farms need fewer cows, decreasing costs and environmental impact. Although numerous studies have failed to document any ill effects on humans or cows from rbST usage, the public is suspicious of the technology, and dairy producers have been urged not to use it so their product is more marketable. The use of somatotropin was cited as an example of poor and misleading communication.

The view that a rising global population will create a larger middle class that will want more animal protein was challenged by the observation that protein can come from nonanimal protein sources, which are safer and more economical to produce. However, it was observed that animals are more than a food source in many parts of the world and that the public should be allowed the freedom to choose what they eat. It also was noted that the pet food industry utilizes animal protein that could be applied to human consumption.

Ethical questions about who gets access to how much and what kind of protein are rapidly becoming more pressing. The answers are different in different societies. In less-affluent countries, animal agriculture usually is small-scale and forms an integral part of a family's assets beyond the protein it provides. In affluent countries, animal protein consumption could be reduced in favor of other sources of protein, perhaps with the help of public education campaigns. However, the freedom of individuals to choose to eat protein from animal was emphasized.

Significant discussion centered on eliminating waste as a way to improve current and future food security without increasing production. A 2014 study by the United States Department of Agriculture (USDA) found that $162 billion of food — enough to feed as many as 870 million people — is wasted each year worldwide. The cost to dispose of this food is an estimated $400 billion. It was stated that certain public health rules exist that promote this waste (e.g., rules regarding feeding waste

to pigs). Although solutions exist that reduce food waste, (e.g., treating waste before feeding it to pigs, innovating production systems, gleaning crops after mechanical harvesting), it was stated that the economic threshold has not yet been crossed that justifies investing in the technology or labor to reduce food waste.

Consumers have power to change conditions in the animal production industry by changing their spending habits. The example was cited of McDonalds' March 4, 2015, announcement that it is making changes in its food supply chain regarding the use of antimicrobials in chicken.

Scientific opportunities and challenges

It was argued that, from an ecological perspective, increased animal-protein production to feed a growing population needs to come from improved technology that will increase yields without increasing environmental degradation. Opportunities exist to design and implement new technologies that will not harm, or will cause less harm to, the environment, and to investigate alternative food sources such as plant protein. New technologies for animal agriculture must not endanger the health and well being of treated animals.

There is also an opportunity to change the way new technologies are evaluated, using a system that carefully weighs the benefits and consequences of each technology for different stakeholders. Poor risk analysis can have disastrous consequences. The example cited was Peru's decision in the late 1980s to stop chlorinating drinking water because chlorine caused a slightly increased risk of bladder cancer. This decision led to a cholera epidemic in Peru in the early 1990s that ultimately spread to adjacent countries.

Evaluating new technologies also involves the difficult task of prioritizing ethical and moral values of stakeholders with differing, and sometimes conflicting, perspectives on what constitutes ethical practice. It was agreed that serious challenges exists in devising a process by which scientifically informed, culturally sensitive, and representative panels can oversee and regulate farm-animal production technologies, from the local to the international level. Although there is no clear answer, it was emphasized that this challenge is imminent and needs to be addressed.

Opportunities exist to improve access to the current drug reporting system. Obtaining and distributing more information on antibiotic tests requires benchmarking and data collection, improving current databases and making those databases more available. This improved access to the data would create a greater transparency in the drug-approval process.

Another scientific challenge involves reducing food waste, and using and distributing food more efficiently. Better consumer education regarding food waste

and improvements that eliminate waste in food production, harvesting, packaging, and distribution need to be an integral part of the solution to feeding a growing population.

Policy issues

It was generally agreed that regulatory oversight of animal agriculture technologies need to consider the health and welfare of the animal as well as public health and economic considerations. The practical execution of this policy will involve ethical and cultural decisions and risk analysis that will vary by time, place, and situation. However, the urgent need to increase food production must not overshadow the need to consider the impact of human actions on animals, even those meant for slaughter. In order to prepare to support future generations, it was emphasized that people need to learn how to ethically feed the people who are alive now.

Policies need to be developed to enact surveillance systems subsequent to drug approval. These systems would allow for more complete data collection on antibiotic use, improving incomplete drug reporting databases. Targeted surveillance in the post-approval drug environment is needed to ensure that drugs are not unsafe for animals.

Policies that account for the unexpected consequences of new drug technologies are necessary because these ramifications are often missed in a preapproval environment. Policy makers need to consider the long-term consequences when engaging in decision-making.

A third party that provides independent oversight to assess animal well being, minimize animal discomfort, and explore and adopt the best alternatives in the animal production industry, may need to be created. This third party also can monitor whether producers are acting ethically in regards to how their actions affect public health. The states of Wisconsin and Pennsylvania currently have programs in which third-party auditors examine ethical standards for animal treatment.

To operate internationally, a panel of ethical, cultural, and political advisors is needed to contribute during the drug approval process. Advisory groups need to include informed individuals who will raise reasonable questions, increasing transparency and introducing potential implications.

A call was made for citizens to undertake a process of exploration and prioritization of moral and ethical values regarding animal production policies. Input from multiple stakeholders is needed for reasonable compromises to be reached. This input needs to consist of transparent dialogue between such stakeholders as state and federal entities, farmers, animal rights activists, and others.

Consumers have an opportunity to use their economic influence to effect changes in the food production industry. Whether it is through exploring alternative practices when treating and preventing animal illnesses, or adopting new technologies on both a local or global scale, society needs to be challenged to examine the long-term consequences of safeguarding the American food supply for a growing population. No single solution likely will to address the needs and values of all stakeholders.

Acknowledgment

Numerous individuals and organizations have made important contributions to the Institute on Science for Global Policy (ISGP) program on Food Safety, Security, and Defense. Some of these contributions directly supported the efforts needed to organize the ISGP conference, *Safeguarding the American Food Supply,* convened in partnership with Sigma Xi, The Scientific Research Society, and Ursinus College on its campus in Collegeville, Pennsylvania, April 11–12, 2015. Other contributions aided the ISGP in preparing the material presented in this book, including the three invited policy position papers and the summaries, presented without attribution, of the views presented in the discussions, critical debates, and caucuses that ensued at Ursinus College.

The willingness of those in the scientific and policy communities to be interviewed in the preparation for the conference is appreciated, as are the efforts of the three subject-matter experts invited to present their views concerning safeguarding the American food supply in their policy position papers. The willingness of these authors to engage all conference participants in the vigorous debates and caucuses that compose all ISGP conferences was especially noteworthy. The biographies of these three authors are provided here.

The success of every ISGP conference critically depends on the active engagement of all participants in the often-intense debates and caucuses. The exchange of strongly held views, innovative proposals, and critiques generated from questions and debates fosters an unusual, even unique, environment focused on clarifying understanding for the nonspecialist. Since these debates and caucuses address specific questions related to formulating and implementing effective public and private-sector policies, ISGP and Ursinus College are greatly indebted to all those who participated in the conference.

The efforts made by the faculty, students, and administration of Ursinus College in collaboration with the ISGP to organize and convene the second conference within the ISGP Academic Partnership (IAP) program were uniformly recognized as outstanding and are appreciated. The results of their efforts served the interests not only of the academic community, but of the communities engaged with Ursinus College. The brief biographies of the faculty and students from Ursinus College involved are presented here.

The members of the ISGP Board of Directors also deserve recognition for their time and efforts in helping to create a vital, increasingly relevant not-for-profit organization that is addressing many of the most important societal questions of our time. The ISGP remains a not-for-profit organization that does not lobby on any issue except rational thinking. The brief biographical backgrounds for the ISGP Board members are presented here.

The energetic, highly professional work of the ISGP staff merits special acknowledgment and appreciation. The staff's outstanding interviewing, organizing, and writing skills remain essential to not only organizing the conference itself, but also to recording the often-diverse views and perspectives expressed in the critical debates, capturing the areas of consensus and actionable next steps from the caucuses, and persevering through the extensive editing process needed to assure the accuracy of the material published here. Biographical information on all the ISGP staff involved is presented here.

ISGP programs are financially supported by government agencies and departments and through gifts from private-sector entities and philanthropic individuals. Specifically, the IAP conference on *FSSD: Safeguarding the American Food Supply* received funding for its general activities from a grant by the Howard Hughes Medical Institute to Ursinus College. The ISGP also benefited greatly from generous gifts provided by Sigma Xi, The Scientific Research Society, the MARS Corp., Monsanto Corp., and Edward and Jill Bessey.

It is also important to note that the ISGP has benefitted from a major contribution from Sigma Xi, The Scientific Research Society, that has helped facilitate the organizing and convening of the conference on Safeguarding the American Food Supply.

Dr. George H. Atkinson
Founder and Executive Director
Institute on Science for Global Policy
July 5, 2015

ISGP books from ISGP conferences listed below are available to the public and can be downloaded from the ISGP Web site: www.scienceforglobalpolicy.org. Hardcopies of these books are available by contacting info@scienceforglobalpolicy.org.

ISGP conferences on, or related to, Emerging and Persistent Infectious Diseases (EPID):

- *EPID: Focus on Antimicrobial Resistance,* convened March 19–22, 2013, in Houston, Texas, U.S., in partnership with the Baylor College of Medicine.
- *21st Century Borders/Synthetic Biology: Focus on Responsibility and Governance*, convened December 4–7, 2012, in Tucson, Arizona, U.S., in partnership with the University of Arizona.
- *EPID: Focus on Societal and Economic Context*, convened July 8–11, 2012, in Fairfax, Virginia, U.S., in partnership with George Mason University.
- *EPID: Focus on Mitigation*, convened October 23–26, 2011, in Edinburgh, Scotland, U.K., in partnership with the University of Edinburgh.
- *EPID: Focus on Prevention*, convened June 5–8, 2011, in San Diego, California, U.S.
- *EPID: Focus on Surveillance*, convened October 17–20, 2010, in Warrenton, Virginia, U.S.
- *EPID: Global Perspectives*, convened December 6–9, 2009, in Tucson, Arizona, U.S., in partnership with the University of Arizona.

ISGP conferences on Food Safety, Security, and Defense (FSSD):

- *FSSD: Food Security and Diet-linked Public Health Challenges*, to be convened September 20–23, 2015 in Fargo, North Dakota, in partnership with North Dakota State University.
- *FSSD: Focus on Food and the Environment*, convened October 5–8, 2014, in Ithaca, New York, in partnership with Cornell University.
- *FSSD: Focus on Food and Water,* convened October 14–18, 2013, in Lincoln, Nebraska, U.S., in partnership with the University of Nebraska–Lincoln.
- *FSSD: Focus on Innovations and Technologies,* convened April 14–17, 2013, in Verona, Italy.
- *FSSD: Global Perspectives,* convened October 24, 2012, in Arlington, Virginia, U.S., in partnership with George Mason University.

ISGP Academic Partnership (IAP) conferences

- *Food Security: Production and Sustainability*, convened April 24–25, 2015, in St. Petersburg, Florida, in partnership with Sigma Xi, The Scientific Research Society, and Eckerd College.
- *FSSD: Safeguarding the American Food* Supply, convened April 10–11, 2015, in Collegeville, Pennsylvania, in partnership with Sigma Xi, The Scientific Research Society, and Ursinus College.
- *EPID: Focus on Pandemic Preparedness,* convened April 11–12, 2014, in Collegeville, Pennsylvania, U.S., in partnership with Ursinus College.

ISGP conferences on Science and Governance (SG):

- *The Genomic Revolution,* convened September 6, 2014, in cooperation with the Parliamentary Office on Science and Technology of the British Parliament within the House of Lords. London, United Kingdom.

ISGP reports from ISGP conferences on Global Challenges are available to the public and can be downloaded from the ISGP Web site: www.scienceforglobalpolicy.org:

- ISGP Climate Change Arctic Program (ICCAP): *Sustainability Challenges: Coping with Less Water and Energy,* convened June 5, 2015, in Whittier, California, in cooperation with the Whittier Working Group
- ICCAP: *Living with Less Water*, convened February 20–21, 2015, in Tucson Arizona, in cooperation with the Tucson Working Group.

Biographical information of Scientific Presenters

Robert L. Buchanan, Ph.D

Dr. Buchanan, Director of the University of Maryland's Center for Food Safety and Security Systems, received his B.S, M.S. M.Phil, and Ph.D. degrees in Food Science from Rutgers University, and post-doctoral training in mycotoxicology at the University of Georgia. Since then he has 35+ years experience teaching, conducting research in food safety, and working at the interface between science and public health policy, first in academia, then in government service in both USDA and FDA, and most recently at the University of Maryland. His scientific interests are diverse, and include extensive experience in predictive microbiology, quantitative microbial risk assessment, microbial physiology, mycotoxicology, and HACCP systems. He has published widely on a wide range of subjects related to food safety, and is one of the co-developers of the widely used USDA Pathogen Modeling Program. Dr. Buchanan has served on numerous national and international advisory bodies including serving for 20 years as a member of the International Commission on Microbiological Specification for Foods, as a six-term member of the National Advisory Committee for Microbiological Criteria for Foods, and was the U.S. Delegate to the Codex Alimentarius Committee on Food Hygiene for a decade.

Karen Everstine, Ph.D., MPH

Dr. Everstine is a Research Associate at the National Center for Food Protection and Defense (NCFPD), a Department of Homeland Security Center of Excellence based at the University of Minnesota. NCFPD is a research consortium that addresses the vulnerability of the food system to intentional contamination with biological or chemical agents. Dr. Everstine directs multiple federally-funded research projects focused on mitigating the risk of economically motivated adulteration (EMA) of foods, or "food fraud." This research has received funding from the Department of Homeland Security, the U.S. Food and Drug Administration, and the U.S. Department of Agriculture. Current research efforts are focused on assessing the scope of food fraud, developing methods for assessing the vulnerability of foods and ingredients to fraud, and developing algorithms to incorporate "non-traditional" data sources into food fraud risk models. Dr. Everstine sits on the United States Pharmacopeia Expert Panel on Food Ingredients Intentional Adulterants. Prior

to her work NCFPD, Dr. Everstine was a foodborne disease epidemiologist at the Minnesota Department of Health, where she conducted numerous foodborne disease outbreak investigations and contributed to CDC-funded studies aimed at describing food service practices and identifying contributing factors to outbreaks.

H. Morgan Scott, D.V.M, Ph.D.

Dr. Scott is a veterinary epidemiologist who studies antibiotic resistance mechanisms among foodborne pathogens and their relation with the use of antibiotics in food animals. This is a topic of increasing concern, especially where limited field data have not previously been available. In addition, Dr. Scott works to improve public health and animal well-being and to sustain healthy ecosystems by using risk analysis and epidemiologic studies to minimize the impacts of infectious hazards. Dr. Scott works closely with the livestock industry and serves as an advisor for the World Health Organization. He is currently a professor in the school of Veterinary Medicine and Biomedical Sciences at Texas A&M University.

Biographical information of Ursinus College faculty and staff

Akshaye Dhawan, Ph.D.

Dr. Dhawan is an Assistant Professor at Ursinus College. He received his Ph.D. in Computer Science from Georgia State University in 2009. He received his M.S. in Computer Science from Georgia State and his Bachelor of Engineering in Computer Science and Engineering from Visvesvaraya Technological University, India. His research work has focused on distributed algorithms for Wireless Sensor Networks and Social Networks.

Anthony Lobo, Ph.D.

Dr. Lobo is an Associate Professor of Biology at Ursinus College. His research involves studying the physiology, biochemistry, and molecular biology of archaea, and he teaches courses in microbiology, cell and molecular biology, and immunology. Dr. Lobo formerly was a postdoctoral research scientist at the University of Wisconsin-Madison. He received his Ph.D. from Cornell University in Microbiology and his Bachelor's degree in Microbiology from Pennsylvania State University.

Charlene Wysocki

Charlene Wysocki, Director of Research and Sponsored Programs at Ursinus College, works with faculty and staff to provide information and assistance in the grant-funding process. Along with researching funding opportunities, she is responsible for monitoring all grant activity as well as ensuring compliance with college and federal regulations for all sponsored programs. Ms. Wysocki also facilitates programming aspects of the college's institutional grants from the Teagle and Mellon Foundations and the Howard Hughes Medical Institute (HHMI).

Biographical information of Ursinus College student participants

Elizabeth Cooley

Elizabeth Cooley is a member of the Ursinus College Class of 2016. She is majoring in Biology and is double minoring in Health Exercise Physiology and Psychology. Ms. Cooley is a pole vaulter on the Ursinus College track and field team. She is the president of UC OSOS (Outstanding Students Organizing Spirit) club and also participates in Fighting for Ophelia and Best Buddies. Elizabeth works alongside Dr. Ellen Dawley and conducts research on tail regeneration in amphibians. She will be involved with Summer Fellows during the summer of 2015 where she will be doing research under the guidance of Dr. Jennifer King.

Shantelle Crawford

Shantelle Crawford is a junior at Ursinus College. She is working toward her Bachelor of Science degree in Biology with an Art and Art History minor. During the 2014-15 academic year, Ms. Crawford has served as the senate liaison for Ursinus' black student union organization Sankofa Umoja Nia (SUN). In addition, she works in an undergraduate lab doing research using mice as a model for research on Fetal Alcohol Spectrum Disorder (FASD).

Marilyn Day

Marilyn Day is a member of the Ursinus College class of 2016. She is a Biology major with a Neuroscience minor and conducts research at the intersection of these disciplines. Ms. Day is a member of the Center for Science and the Common Good and will be interning for the ISGP in summer 2015. She is also Vice President of her sorority, Tri Sigma, and Vice President of Tri Beta, the Biology honors society. This coming summer, Ms. Day will be participating in the Amgen Scholars Program at UCLA. After graduation, she plans to attend graduate school to earn her Ph.D. in neurobiology.

Summer Gavin

Summer Gavin is a member of the Ursinus College Class of 2016 majoring in Biology. Ms. Gavin will be interning as an orthodontic assistant and beginning

laboratory research in the microbial ecology of fermented foods with Dr. Anthony Lobo in the fall of 2015.

Christian Hoogheem

Christian Hoogheem is a member of the class of 2016 at Ursinus College majoring in Biology. Mr. Hoogheem currently conducts research on the neural regeneration of axolotl salamanders. He is also a teaching assistant and tutor in the biology department as well as a member of the Ursinus wrestling team.

Keven Hoogheem

Keven Hoogheem is a member of the Ursinus College class of 2016, pursuing a Bachelor of Science in Biology. He works as a teaching assistant for Biology labs and tutors in biology and carries out research involving salamander spinal cord regeneration. Mr. Hoogheem is also a wrestler and will be participating in a Summer Research Fellowship at Ursinus over the summer.

Erin Klazas

Erin Klazas is a member of the Ursinus College Class of 2016. She is a Biology and Media and Communication Studies double major. Ms. Klazas is a Bonner Leader, and a member of Phi Alpha Psi sorority. She also teaches an After-School Science Exploration recreational course at Eisenhower Leadership academy in Norristown, PA, where she brings the fun in science to fifth and sixth graders in underprivileged environments.

Allison LaClair

Allison LaClair is a member of the Ursinus College Class of 2017. She is majoring in Biology and minoring in Studio Art. She also participates in the Best Buddies organization and is member of the Ursinus Cheerleading Team.

Christine Le, B.S.

Christine Le earned her Bachelor of Science degree from Ursinus College in Environmental Studies and Sociology. She ran for the UC Cross Country team and the UC Track team from 2010 to 2012, and then again in 2014. She was also a member of the UC College Choir and UC Wind Ensemble in 2015. From 2012 to 2014, she interned with both government agencies and private firms regarding sustainability, renewable energy, and active transportation.

Colleen Leahy

Colleen Leahy is a member of the Ursinus College class of 2017. Ms. Leahy is majoring in Biology and minoring in Economics. She is a tour guide for the Office

of Admissions and a circulation desk assistant at the Myrin Library. She is a member of the Ursinus College Women's Field Hockey Team. She is also a Biology tutor as well as a teaching assistant for Biology labs.

Edward Lee

Edward Lee is a member of the Ursinus College Class of 2016, majoring in Biochemistry and Molecular Biology and Philosophy. He is a Fellow of the Ursinus College Center for Science and the Common Good and interned for the ISGP Academic Partnership program in the summer of 2014. At Ursinus, he has held positions as a Teaching Assistant for introductory chemistry and biology courses, and is also a Resident Advisor.

Kevin Monahan, B.S.

Kevin Monahan earned his Bachelor of Science degree from Ursinus College with a major in Biology and minor in Spanish. Kevin was a member of the varsity football team as a quarterback for the last four years and served as a captain in his senior season. He is currently in the Phi Beta Kappa national honor society, was inducted to various honor societies during his time at Ursinus and has worked for the Foundation for International Medical Relief of Children in Nicaragua. Kevin also conducted research in the Biology department, focusing on the effects of the cardiovascular system during pregnancy. As a fellow of the Center for Science and the Common Good, Kevin also has worked closely with the ISGP in a previous conference regarding emerging infectious diseases. After graduation, Kevin plans to pursue a degree in Medicine.

Aubrey Paris, B.S.

Aubrey Paris earned her Bachelor of Science degree in Chemistry and Biology from Ursinus College, where she was also a French minor and Fellow of the Center for Science and the Common Good. Her honors chemistry research involved the development of novel transition metal complexes in the electro- and photochemical reduction of carbon dioxide, and she is continuing this work at Princeton University in pursuit of her Ph.D. in Chemistry. She was a 2014 AMGEN Scholar at the University of California, Berkeley, and is a co-founder of Globalized Ethics for Medical Science (GEMS), a not-for-profit and publicly accessible infectious-disease reporting database. Ms. Paris is a Fellow of the Institute on Science for Global Policy and has also worked for the advancement of the biotechnology industry at BioNJ in Trenton, New Jersey.

Carrie Putscher, B.S.

Carrie Putscher earned her Bachelor of Science degree from Ursinus College in Environmental Studies, with minors in Anthropology, Biology, and Creative Writing. Ms. Putscher was a tour guide in the Admissions Office, secretary of the Ursinus College Environmental Action club, and is a member of Phi Beta Kappa and the Whitians Honor Society. She hopes to pursue a career in sustainable agriculture, starting with a six-month internship on a goat dairy farm in Hudson Valley, NY.

Brenna Rasmussen, B.S.

Brenna Rasmussen earned a Bachelor of Science degree from Ursinus College in Biology with a minor in Psychology. She was President of Ursinus College Environmental Action, an Ursinus tour guide, a biology research student and a volunteer at Pottstown Memorial Medical Center. She is a member of Tri Beta and Psi Chi Honors Societies. She is planning to enter the workforce for a year and then attend Physician Assistant Graduate School.

Mary Kate Speth, B.S.

Mary Kate (MK) Speth received a Bachelor of Science degree in both Biology and Environmental Studies, graduating Cum Laude from Ursinus College. She was an intern for ISGP in the summer of 2014 and attended the Food Safety, Security, and Defense conference at Cornell University. She also participated in the Summer Fellows Research Program at Ursinus in the summer of 2013 where she studied agro-ecology. In addition, MK was a fellow of the Center for Science and the Common Good, a mentor for the FUTURE program, and a Bonner Leader and Intern. In the following year, MK will be working as a Visiting Service Learning Tutor at Lingnan University in Hong Kong.

Mallory Vukovic, B.S.

Mallory Vukovic earned a Bachelor of Science degree in Biology from Ursinus College. She studied the proteins involved in establishment of the anterior-posterior body axis in the one-cell C. elegans embryo in Dr. Rebecca Lyczak's research lab. She has worked at the Berman Museum of Art for the past three years and will be working as a dental assistant in her year off between graduation and dental school.

Samantha White

Samantha White is a member of the Class of 2017 at Ursinus College. Ms. White is majoring in Biology and minoring in Neuroscience. During the summer of 2013, she was involved in the Howard Hughes Medical Institute-funded FUTURE program,

studying the effects of prenatal ethanol exposure on the corticothalamic system. Currently, Ms. White continues her research in the Biology department and works as a teaching assistant for the Biology labs. Outside of her studies, she is an Ursinus College Ambassador and the Vice President of Campus Activities Board.

James Worrilow

James Worrilow is a member of the Ursinus College class of 2016 majoring in Biology with a focus in Pre-Medical studies while minoring in Spanish. Mr. Worrilow holds numerous leadership roles on campus, including Vice President and member of the men's a capella group, member of the Beta Beta Beta National Biology Honor Society, and captain of the football team.

Conference debaters

Valerie Arkoosh
Vice Chair, Montgomery County Board of Commissioners

Kristin Awrachow
Clinical Nutrition/Patient Services Manager, Abington Health Lansdale Hospital

Barbara Brungess
Vice President, Corporate Investor Relations, AmerisourceBergen

Elizabeth Kiersten Cooley
Ursinus Student
Biology Major

Shantelle Crawford
Ursinus Student
Biology Major

Marilyn Day
Ursinus Student
Biology Major, CSCG Fellow

Catherine Duckett
Associate Dean, School of Science, Monmouth University

Elizabeth Zorzanello Emery
Director, Coordinated Program in Nutrition and Assistant Professor, La Salle University

David Thomas Galligan
Professor of Animal Health Economics, University of Pennsylvania School of Veterinary Medicine

Summer Gavin
Ursinus Student
Biology Major

Christian Hoogheem
Ursinus Student
Biology Major

Keven Hoogheem
Ursinus Student
Biology Major

Brandon Hoover
Ursinus College Sustainability Coordinator

Leonard Jankauska
Drug Safety Scientist, numerous corporations worldwide

Erin Klazas
Ursinus Student
Biology & Media and Communications Double-Major

William Koch
Board of Directors, Sigma Xi

Allison LaClair
Ursinus Student
Biology Major

Christine Le
Ursinus Student
Anthropology and Sociology & Environmental Studies Double-Major

Colleen Leahy
Ursinus Student
Biology Major

Edward Lee
Ursinus Student
Biochemistry and Molecular Biology & Philosophy Double-Major, CSCG Fellow

Apryl Martin
Director of PAPA, a poverty relief nonprofit in Philadelphia

Diane Mattiford
Retired health care professional

Kevin Monahan
Ursinus Student
Biology Major, CSCG Fellow

Walter Moore
Owner, Waltmoore Holsteins, Inc.

Alan Novak
Executive Director, Professional Dairy Managers of Pennsylvania
Chairman, Ursinus College Board of Trustees

Aubrey Paris
ISGP Fellow
Ursinus Student, CSCG Fellow
Chemistry & Biology Double-Major

Caroline Putscher
Ursinus Student
Environmental Studies Major

Brenna Rasmussen
Ursinus Student
Biology Major

Martine Scannavino
Chair, Department of Nutrition, Cedar Crest College

Wayne Schultz
Owner, Perky Hydroponic Gardens

Dean Scott
New Morning Farm

Kelly Sorensen
Ursinus College Philosophy and Religious Studies Department

Mary Kate Speth
Ursinus Student
Biology & Environmental Studies Double-Major, CSCG Fellow

Jen Tepel
Project Coordinator, Healthy Corner Store Initiative, The Food Trust

Bert Tussing
Director, Homeland Defense and Security Issues, U.S. Army War College

Mallory Vukovic
Ursinus Student
Biology Major

John Weaver
Owner, Foodcrafters, LLC

Robert White
Hazardous materials responder

Samantha White
Ursinus Student
Biology Major

James Worrilow
Ursinus Student
Biology Major

Biographical information of ISGP Board of Directors

Dr. George Atkinson, Chairman

Dr. George Atkinson founded the Institute on Science for Global Policy (ISGP) and is an Emeritus Professor of Chemistry, Biochemistry, and Optical Science at the University of Arizona. He is former head of the Department of Chemistry at the University of Arizona, the founder of a laser sensor company serving the semiconductor industry, and Science and Technology Adviser (STAS) to U.S. Secretaries of State Colin Powell and Condoleezza Rice. He launched the ISGP in 2008 as a new type of international forum in which credible experts provide governmental and societal leaders with understanding of the science and technology that can be reasonably anticipated to help shape the increasingly global societies of the 21st century. Dr. Atkinson has received National Science Foundation and National Institutes of Health graduate fellowships, a National Academy of Sciences Post Doctoral Fellowship, a Senior Fulbright Award, the SERC Award (U.K.), the Senior Alexander von Humboldt Award (Germany), a Lady Davis Professorship (Israel), the first American Institute of Physics' Scientist Diplomat Award, a Titular Director of the International Union of Pure and Applied Chemistry, the Distinguished Service Award (Indiana University), an Honorary Doctorate (Eckerd College), the Distinguished Achievement Award (University of California, Irvine), and was selected by students as the Outstanding Teacher at the University of Arizona. He received his B.S. (high honors, Phi Beta Kappa) from Eckerd College and his Ph.D. in physical chemistry from Indiana University.

Dr. Ben Tuchi, Secretary/Treasurer

Dr. Ben Tuchi is chairman of the board of directors of the Arizona Research Park Authority. He received his B.S. and M.S. degrees in Business Administration from the Pennsylvania State University and his PhD in Finance from St Louis University. His full-time teaching career began in 1961 at St. Francis College and continued until 1976 at West Virginia University. From 1976 through 1996 he served in cabinet levels at West Virginia University, The University of Arizona, The University of North Carolina at Chapel Hill, and finally as Sr. Vice Chancellor for Business and Finance of the University of Pittsburgh. During those assignments he was simultaneously a tenured professor of finance. He retired from the last executive post in 1996 and returned to a full-time teaching position as Professor of Finance at the University of

Pittsburgh, until his retirement in 1999. For the two years prior to his retirement he was the Director of Graduate Programs in Business in Central Europe, at Comenius University, making his home in Bratislava, The Slovak Republic.

Dr. Janet Bingham, Member

Dr. Janet Bingham is former President and CEO of the George Mason University (GMU) Foundation and GMU's Vice President for Advancement. GMU is the largest university in Virginia. Previously, she was President and CEO of the Huntsman Cancer Foundation (HCF) in Salt Lake City, Utah. The foundation is a charitable organization that provides financial support to the Huntsman Cancer Institute, the only cancer specialty research center and hospital in the Intermountain West. Dr. Bingham also managed Huntsman Cancer Biotechnology Inc. In addition, she served as Executive Vice President and Chief Operating Officer with the Huntsman Foundation, the private charitable foundation established by Jon M. Huntsman Sr. to support education, cancer interests, programs for abused women and children, and programs for the homeless. Before joining the Huntsman philanthropic organizations, Dr. Bingham was the Vice President for External Relations and Advancement at the University of Arizona. Prior to her seven years in that capacity, she served as Assistant Vice President for Health Sciences at the University of Arizona Health Sciences Center. Dr. Bingham was recognized as one of the Ten Most Powerful Women in Arizona.

Dr. Henry Koffler, Member

Dr. Henry Koffler is President Emeritus of the University of Arizona (UA). He served as President of the UA from 1982-1991. From 1982 he also held professorships in the Departments of Biochemistry, Molecular and Cellular Biology, and Microbiology and Immunology, positions from which he retired in 1997 as Professor Emeritus of Biochemistry. His personal research during these years concentrated on the physiology and molecular biology of microorganisms. He was Vice President for Academic Affairs, University of Minnesota, and Chancellor, University of Massachusetts/Amherst, before coming to the UA. He taught at Purdue University, where he was a Hovde Distinguished Professor, and the School of Medicine at Western Reserve University (now Case Western Reserve University). Dr. Koffler served as a founding Governor and founding Vice-Chairman of the American Academy of Microbiology, and as a member of the governing boards of Fermi National Accelerator Laboratory, the Argonne National Laboratory, and the Superconducting Super Collider Laboratory. He was also a board member of the Association of American Colleges and Universities, a member and Chairman of the Council of Presidents and a member of the executive committee of the National Association

of Land Grant Colleges and Universities. He was also Founder, President and board member of the Arizona Senior Academy, the driving force in the development of the Academy Village, an innovative living and learning community. Among the honors that Dr. Koffler has received are a Guggenheim Fellowship and the Eli Lilly Award in Bacteriology and Immunology.

Mr. Jim Kolbe, Member

For 22 years, Mr. Jim Kolbe served in the United States House of Representatives, elected in Arizona for 11 consecutive terms, from 1985 to 2007. Mr. Kolbe is currently serving as a Senior Transatlantic Fellow at the German Marshall Fund of the United States, and as a Senior Adviser to McLarty Associates, a strategic consulting firm. He advises on trade matters as well as issues of effectiveness of U.S. assistance to foreign countries, on U.S.-European Union relationships, and on migration and its relationship to development. He is also Co-Chair of the Transatlantic Taskforce on Development with Gunilla Carlsson, the Swedish Minister for International Development Cooperation. He also is an adjunct Professor in the College of Business at the University of Arizona. While in Congress, he served for 20 years on the Appropriations Committee of the House of Representatives, was chairman of the Treasury, Post Office and Related Agencies subcommittee for four years, and for his final six years in Congress, he chaired the Foreign Operations, Export Financing and Related Agencies subcommittee. He graduated from Northwestern University with a B.A. degree in Political Science and then from Stanford University with an M.B.A. and a concentration in economics.

Dr. Charles Parmenter, Member

Dr. Charles Parmenter is a Distinguished Professor Emeritus of Chemistry at Indiana University. He also served as Professor and Assistant and Associate Professor at Indiana University in a career there that spanned nearly half a century (1964-2010). He earned his bachelor's degree from the University of Pennsylvania and served as a Lieutenant in the U.S. Air Force from 1955-57. He worked at DuPont after serving in the military and received his Ph.D. from the University of Rochester and was a Postdoctoral Fellow at Harvard University. He has been elected a Member of the National Academy of Sciences and the American Academy of Arts and Sciences, and a Fellow of the American Physical Society and the American Association for the Advancement of Science. He was a Guggenheim Fellow, a Fulbright Senior Scholar, and received the Senior Alexander von Humboldt Award in 1984. He has received the Earle K. Plyler Prize, was a Spiers Medalist and Lecturer at the Faraday Society, and served as Chair of the Division of Physical Chemistry of the American Chemical Society, Co-Chair of the First Gordon Conference on Molecular Energy

Transfer, Co-organizer of the Telluride Workshop on Large Amplitude Motion and Molecular Dynamics, and Councilor of Division of Chemical Physics, American Physical Society.

Mr. Thomas Pickering, Member

Mr. Thomas Pickering is Vice Chairman of Hills & Co, international consultants, and Strategic Adviser to NGP Energy Capital Management. He co-chaired a State-Department-sponsored panel investigating the September 2012 attack on the U.S. diplomatic mission in Benghazi. He served as U.S. ambassador to the United Nations in New York, the Russian Federation, India, Israel, El Salvador, Nigeria, and the Hashemite Kingdom of Jordan. Mr. Pickering also served on assignments in Zanzibar and Dar es Salaam, Tanzania. He was U.S. Under Secretary of State for Political Affairs, president of the Eurasia Foundation, Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs, and Boeing Senior Vice President for International Relations. He also co-chaired an international task force on Afghanistan, organized by the Century Foundation. He received the Distinguished Presidential Award in 1983 and again in 1986 and was awarded the Department of State's highest award, the Distinguished Service Award in 1996. He holds the personal rank of Career Ambassador, the highest in the U.S. Foreign Service. He graduated from Bowdoin College and received a master's degree from the Fletcher School of Law and Diplomacy at Tufts University.

Dr. Eugene Sander, Member

Dr. Eugene G. Sander served as the 20th president of the University of Arizona (UA), stepping down in 2012. He formerly was vice provost and dean of the UA's College of Agriculture and Life Sciences, overseeing 11 academic departments and two schools, with research stations and offices throughout Arizona. He also served as UA Executive Vice President and Provost, Vice President for University Outreach and Director of the Agricultural Experiment Station and Acting Director of Cooperative Extension Service. Prior to his move to Arizona, Dr. Sander served as the Deputy Chancellor for biotechnology development, Director of the Institute of Biosciences and Technology, and head of the Department of Biochemistry and Biophysics for the Texas A&M University system. He was Chairman of the Department of Biochemistry at West Virginia University Medical Center and Associate Chairman of the Department of Biochemistry and Molecular Biology at the College of Medicine, University of Florida. As an officer in the United States Air Force, he was the assistant chief of the biospecialties section at the Aerospace Medical Research Laboratory. He graduated with a bachelor's degree from the University of Minnesota, received his master's degree and Ph.D. from Cornell University and completed postdoctoral

study at Brandeis University. As a biochemist, Dr. Sander worked in the field of mechanisms by which enzymes catalyze reactions.

Mr. Richard Armitage, Special Adviser

Mr. Richard L. Armitage is the President at Armitage International, where he assists companies in developing strategic business opportunities. He served as Deputy Secretary of State from March 2001 to February 2005. Mr. Armitage, with the personal rank of Ambassador, directed U.S. assistance to the new independent states (NIS) of the former Soviet Union. He filled key diplomatic positions as Presidential Special Negotiator for the Philippines Military Bases Agreement and Special Mediator for Water in the Middle East. President Bush sent him as a Special Emissary to Jordan's King Hussein during the 1991 Gulf War. Mr. Armitage also was Deputy Assistant Secretary of Defense for East Asia and Pacific Affairs in the Office of the Secretary of Defense. He graduated from the U.S. Naval Academy. He has received numerous U.S. military decorations as well as decorations from the governments of Thailand, Republic of Korea, Bahrain, and Pakistan. Most recently, he was appointed an Honorary Companion of The New Zealand Order of Merit. He serves on the Board of Directors of ConocoPhillips, ManTech International Corporation, and Transcu Ltd., is a member of The American Academy of Diplomacy as well as a member of the Board of Trustees of the Center for Strategic and International Studies.

Biographical information of ISGP staff

George Atkinson, Ph.D.

Dr. George Atkinson is the Founder and Executive Director of the Institute on Science for Global Policy (ISGP) and is an Emeritus Professor of Chemistry, Biochemistry, and Optical Science at the University of Arizona. His professional career has involved academic teaching, research, and administration, roles as a corporate founder and executive, and public service at the federal level. He is former Head of the Department of Chemistry at the University of Arizona, the founder of a laser sensor company serving the semiconductor industry, and Science and Technology Adviser (STAS) to U.S. Secretaries of State Colin Powell and Condoleezza Rice. In 2014, Dr. Atkinson was elected President of Sigma Xi, The Scientific Research Society. Based on principles derived from his personal experiences, he launched the ISGP in 2008 as a new type of international forum in which credible experts provide governmental and societal leaders with the objective understanding of the science and technology that can be reasonably anticipated to help shape the increasingly global societies of the 21st century.

Jennifer Boice, M.B.A.

Ms. Jennifer Boice is the Program Coordinator for ISGP. She worked for 25 years in the newspaper industry at the Tucson Citizen before joining the ISGP. She was the Editor of the Tucson Citizen when it was closed in 2009. She received her M.B.A. from the University of Arizona and graduated from Pomona College in California with a degree in economics.

Samantha Cermignano, B.S.

Ms. Samantha Cermignano is a Senior Fellow with oversight over the ISGP Academic Partnership (IAP) program. She received her Bachelor of Science in Biology with a concentration in Pre-Health from Ursinus College, Pennsylvania. She previously held a position at the University of Pennsylvania as a visiting undergraduate researcher in hematology, and has been published in the journal *Blood*. She will be entering medical school in fall 2015.

Sweta Chakraborty, Ph.D.

Dr. Sweta Chakraborty is Associate Director of ISGP. She received her doctorate in

Risk Management from King's College London, and has more than 20 published articles, has contributed to three books, and is author of the forthcoming book "Pharmaceutical Safety: A Study in Public and Private Regulation." She is currently an adjunct assistant professor at Columbia University and a program associate at Oxford University's Centre for Socio-Legal Studies.

Christina Medvescek, B.A.

Ms. Christina Medvescek is Program Administrator for the ISGP. She is an internationally published journalist and editor specializing in health, human development and conflict resolution. She also serves as an EEO mediator for the U.S. Postal Service, and as a volunteer mediator, facilitator and instructor at the Center for Community Dialogue in Tucson, Arizona.

Aubrey Paris, B.S.

Ms. Aubrey Paris is a Senior Fellow with the ISGP. She earned her Bachelor of Science degree in Chemistry and Biology from Ursinus College, where she was also a French minor and Fellow of the Center for Science and the Common Good. Her honors chemistry research involved the development of novel transition metal complexes in the electro- and photochemical reduction of carbon dioxide, and she is continuing this work at Princeton University in pursuit of her Ph.D. in Chemistry. She was a 2014 AMGEN Scholar at the University of California, Berkeley, and is a co-founder of Globalized Ethics for Medical Science (GEMS), a not-for-profit and publicly accessible infectious-disease reporting database.

Renita Polk, Ph.D.

Dr. Renita Polk is a Fellow with the ISGP. She is a postdoctoral research fellow at Johns Hopkins University, studying cardiovascular genetics. Dr. Polk received her doctorate in Human Genetics and Molecular Biology from Johns Hopkins University and her undergraduate degree in Genetic Engineering from Cedar Crest College. She has published original articles in peer-reviewed journals and presented her research at several national and international conferences. Dr. Polk is very interested in the intersection of science, policy and society, and is active in post-doctoral advocacy activities at Johns Hopkins.

Sperry van Langeveld, Ph.D.

Dr. Sperry van Langeveld is a Fellow with the ISGP. His career has included positions in polymer research and senior management in large suppliers to the automotive and other industries. In 1984, he established a personal computer manufacturing business that he and his wife operated until their retirement in 1999. He holds

diverse graduate degrees; his doctoral thesis formed the basis for Du Pont's "Design of Experimentation" program, utilizing statistics to predict reaction optima with minimal experimentation. Sperry is a life member of Sigma Xi and has participated at board level in environmental and educational organizations. He studies and teaches at the University of Arizona and is interested in statistical modeling.

Ramiro Soto, B.S.

Mr. Ramiro Soto is a Fellow with the ISGP. He graduated in May 2015 from University of Arizona College of Science with a degree in General Applied Mathematics and a minor in Hebrew Studies. He plans to enter a doctoral program to further his studies in mathematics.

Andrea Vazquez

Ms. Andrea Vazquez is a Fellow with the ISGP. She currently is a student at Arizona State University pursuing her bachelor's degree in social work. She also serves as a college prep assistant at a Tucson, Arizona, high school. Her goal as a social worker is to advocate for people who are vulnerable and oppressed, especially youth.